Ecodesign preparatory study for lifts implementing the Ecodesign Working Plan 2016 -2019

Final report

Reference:
N° 617/PP/GR(MMA/17/1131/9709 for the conclusion of a specific contract in application of the Framework Contract No 409/PP/2014/FC Lot 2 with reopening of competition

Client:
European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

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Executive summary

The Ecodesign Directive (Directive 2009/125/EC) establishes a framework for the setting of Community Ecodesign requirements for energy-related products with the aim of ensuring the free movement of such products within the internal market. The main objective of the first task is to determine a clear scoping for lifts according to the needs of the Ecodesign process. This Ecodesign preparatory study focuses on lifts for persons and/or goods with the following characteristics which fall under the lift definition of the Lift Directive 2014/33/EU and which are new according to the Guidance on application of Directive 95/16/EC still valid for the enforced 2014/33/EU. Lifting appliances fulfilling the requirements of the Machinery Directive (2006/42/EC) but which do not fall under the Lift Directive 2014/33/EU, such as home lifts, moving walking or escalators, are accordingly excluded from this study.

Lifts are products that have been regulated for safety reasons for a long time. However, a review of the lift legislations carried out in **Task 1** (Scope) shows that no specific policy regulations on the energy efficiency of lifts could be identified in the EU or in other countries.

Only voluntary requirements on lifts or indirect regulations on lifts could be found. Existing mandatory requirements deal with the energy performance of certain lift components (e.g. interior lighting and ventilation) that are covered by the Ecodesign Directive. Furthermore, there are energy performance requirements for buildings. In Europe, the Energy Performance in Buildings Directive (EPBD) does not exclude taking the energy performance of lifts into account when considering the performance requirements of buildings. Italy used this legal flexibility to consider lifts and escalators as one aspect when calculating the overall energy performance index of the building. Two additional Member States went further and set mandatory energy performance requirements for lifts when implementing the EPBD. In Denmark for example, lifts in new buildings or the installation of new lifts in already existing buildings that are not solely intended for residential usage have to comply with the energy class B set out in ISO 25745-2 or VDI 4707 in case the former cannot be calculated. This applies to lifts with a nominal load of up to 2 000 kg. Higher energy consumption than energy class B may be accepted if equivalent compensatory energy savings are implemented. Portugal prescribes lifts in non-residential buildings to comply at least with energy class B standards from VDI 4707 since 2016. A similar approach can be observed in other countries in the world, where energy efficiency of lifts is usually regulated within a building regulation. With regard to information requirements, it is stated in the most recent energy labelling regulation (EU 2017/1369) that the energy consumption of means of transport is excluded if it is regulated by other Union laws and policies. Lifts are mentioned as an example where this would apply.

While in absence of any legislative regulations regarding energy efficiency on the European level, attention has been paid to the energy performance of lifts in recent years by industry. The VDI association was the first to release a methodology (VDI 4707) to assess the energy efficiency of lifts and a scheme for rating their energy class. The International Organization for Standardization published an international standard (EN ISO 25745) defining a similar methodology thereafter. Both EN ISO 25745 and VDI 4707 have found practical use in various voluntary labelling programs that have been established in different countries around the world, whereby the EN ISO 25745 family is the internationally recognised standard. Finally, Life Cycle Analysis is an important aspect for lifts, as they have a long technical lifetime. The Product Category Rules PCR

UN CPC 4354 has been elaborated in 2015 and sets down the rules for lifts that are either new or modernised.

In **Task 2** (Markets) a total lift sales forecast was made based on extrapolation of the existing replacement or renovation rate of 1,46 % which corresponds to a 68 years economic life time for an average elevator:

Year	1995	2005	2015	2025	2035	2045
Total renovation sales	66176	72281	78962	85683	90065	93374
Total new building sales	40093	43882	48038	48200	30815	23123
Total annual sales	106269	116162	127000	133883	120880	116497

Because more renovation due to the upcoming EPBD targets is expected, also a more ambitious sales forecast was made based on a 3 % building stock lift renovation rate in 2025 decreasing to 2% in 2045. This resulted in the following forecast:

Year	1995	2005	2015	2025	2035	2045
Total renovation sales	66176	72281	78962	175893	154073	127787
Total new building sales	40093	43882	48038	48200	30815	23123
Total annual sales	106269	116162	127000	224093	184888	150910

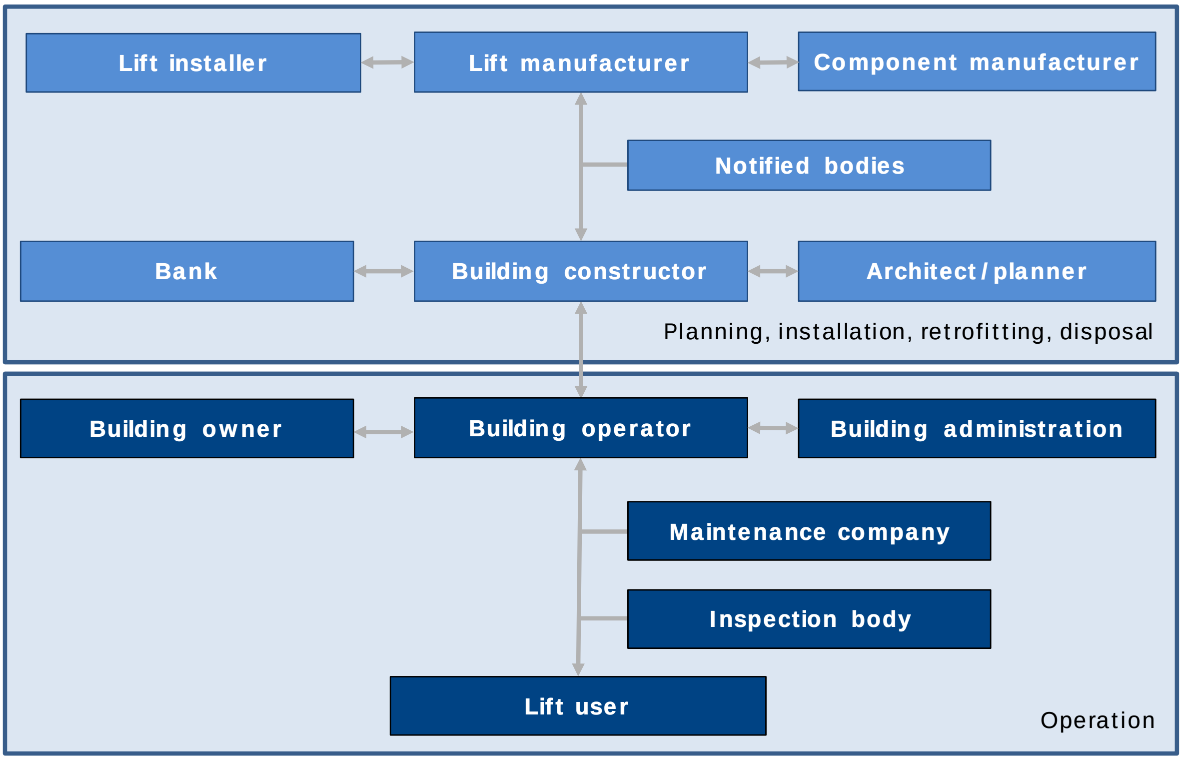
According to this forecast the annual lift sales is expected above 200 000 units per year in 2025.

The existing lift stock was also disaggregated by country using data from ELA and ELCA. The E4 Project was used as an information source for the type of lift, maximum load allowed and type of installation.

The lift stock in 2009 categorised by sector and usage categories according to ISO 25745-2:2015 was derived from the lift stock per sector data available from the E4 Project and carefully used as an indicative distribution. Lifts modernization values for 2013-2016 were also gathered from ELA.

Task 3 (Users) analyses user behaviour. User behaviour is particularly relevant for the environmental impact of lifts as it directly determines their utilisation. This task therefore deals with the influence of users on the life-cycle performance of lifts. For this purpose, the direct impact of lifts on the environment and resources during the use phase is discussed first. The analysis is based on different scoping levels, starting with the strict product scope, and then extending this perspective to an extended product approach, thereafter proceeding to a technical system approach and finally discussing lifts from a functional system approach. Large parts of this discussion make use of the EN ISO 25745 family to structure the analysis. Thereafter, system aspects with indirect effects on energy consumption are discussed. This is followed by a discussion of end-of-life behaviour and local infrastructure.

Based on this it can first be observed that lifts can be characterised as technical goods that are closely related to building operation. The planning and operation of lifts are thus influenced by many stakeholders as illustrated in the following figure. Findings on barriers to energy efficiency for lifts suggest that especially users and operators often lack information on the environmental performance of lifts and that they also tend to pay little attention to the topic. Furthermore, split incentive problems are identified as a challenge to the energy-efficient operation of lifts. Second, the lift utilisation of users strongly influences the energy demand and thus the environmental performance of lifts. Depending on this usage, both standby in infrequently operated lifts or running-mode consumption in intensively used installations can dominate the overall energy demand. EN ISO 25745 takes these different usages into consideration by introducing different default classifications. As shown above, the underlying assumptions do not necessarily correspond in detail to specific situations, but on an aggregate level, they can be considered as a means to deal with the complexity of the real-life situation. Third, lifts are generally characterised by a relatively long lifetime. Unlike products such as white goods, they are subject to regular repairs and upgrades. Thus, measures to improve the environmental performance of new lift installations will only gradually impact the stock of installed lifts. Fourth, the ventilation of shafts has been identified as a particularly relevant consideration with regard to the indirect energy demand of lifts.



Based on these observations, several conclusions for the scoping and subsequent analysis in the following tasks is derived. First, the analysis and discussion of the energy-related standards have shown that lift usage considerably influences the environmental impact of lifts. This confirms the need to consider user behaviour next to functional parameters in the product categories as defined in Task 1. Second, given the relevance of barriers to the implementation of energy-efficient lifts, the encouragement of a demand-pull mechanism for energy-efficient equipment may be challenging. Doing so would entail giving users more information but also requires finding a means to overcome the existing split incentive problems. Furthermore, the annual energy costs for lift operation are rather limited, especially when the operation is financed by several parties, e.g. inhabitants. Third, ventilation has been identified as a relevant topic. Even if ventilation is not part of the product definition, available data suggests that it seems to be a non-negligible issue.

Task 4 (Technologies) presents the processes involved in the functional performance of lifts via a brief and simple technological description and analysis. This is conducted for technologies that are already on the market and that will become the basis for the base cases which are used as proxies for average new lifts placed on the market. Based on tasks 1, 2 and 3, six base cases have been identified for this Ecodesign Preparatory Study which are shown in the following table.

Base Case ID	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
Type	traction	hydraulic	traction	hydraulic	traction	traction
Rated load in [kg]	450	450	630	630	1000	1250
Rise [m]	12	12	12	12	21	30
Number of floors [-]	4	4	4	4	7	10
Nominal speed [m/s]	1	0,7	1	0.63	1	1.6
Acceleration [m/s^2]	0.5	0.5	0.5	0.5	0.5	0.5
Jerk	1	1	1	1	1	1
Roping	2:1	n.a.	2:1	n.a.	2:1	2:1
Usage Category	1	1	2	2	3	4
Daily trips [-]	50	50	125	125	300	750
Average travel distance [%]	49%	49%	49%	49%	49%	44%
Average car load [%]	7.5%	7,5%	7.5%	7.5%	4.5%	6.0%
Counterbalancing [%]	50.0%	-	50.0%	-	50.0%	50.0%
Number of operating days per year [d/a]	360	365	360	360	360	360
Designed service life [a]	25	25	25	25	25	25
FU [tkm]	89.3	89.3	312.6	312.6	1250.2	6682.5

In addition to the base case definition, Best Available Technologies (BAT) and state-of-the-art Best Not-yet Available Technologies (BNAT) are analysed. The process addresses both the product level and the component level as well as improvement potentials. For this purpose, a comprehensive dataset across the whole product life cycle is collected on which to undertake the analysis of the life cycle environmental impact and economics in the subsequent tasks of this preparatory study. An exhaustive bill of materials has been gathered for each single base case.

In **Task 5** (Life Cycle Analysis) was carried out for all Base-Cases based on the bill of materials. The results reveal that the use phase is very important in the impact categories Total Energy and 'Volatile organic compounds (VOC)' for all Base-Cases. For Base-Case 3 and 4 the use phase is also the most important life cycle phase in the impact category global warming. The production phase is the most relevant life cycle phase in many of the other environmental impact categories.

For Base-Cases 1 and 2 both a hydraulic and a traction lift were considered and LCA results have been calculated for both lift types. The hydraulic lift had a higher impact over the its life cycle in the impact categories 'VOC', 'Heavy metals to air', 'Heavy metals to water' and 'Eutrophication'. The traction lift (1A) has a higher impact in the impact categories ‘Waste’, ‘Persistent organic pollutants (POP)’, ‘PAHs’ and ‘Particulate matter (PM)’. For Base-case 1, the impact of the two lift types over the entire life cycle is almost equal in the impact categories ‘Total energy’, ‘Greenhouse gases’ and ‘Acidification’. The traction lift has a slightly lower environmental impact these impact categories for Base-Case 2. The table below provides an overview of the environmental impact of the Base-Cases.

Parameter	Unit	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
Total Energy (GER)	MJ	228827	243427	329810	402853	640065	1510789
Water (process and cooling)	Liter	46607	44161	55136	56170	86184	146746
Waste, non-haz./ landfill	g	1575070	1260575	2042671	1613919	3927589	6078794
Waste, hazardous/ incinerated	g	100402	69765	101908	72170	105836	146685
Greenhouse Gases in GWP100	kg CO2 eq.	12064	12194	16812	19234	32181	71255
Acidification, emissions	g SO2 eq.	75082	74169	95253	105560	166418	345541
Volatile Organic Compounds (VOC)	g	3528	6843	5491	11669	11287	29497
Persistent Organic Pollutants (POP)	ng i-Teq	19840	14911	26319	19185	52808	79875
Heavy Metals to air	mg Ni eq.	34777	39519	37579	44207	65712	95481
PAHs	mg Ni eq.	2385	1785	2942	2367	4482	7312
Particulate Matter (PM, dust)	g	48446	44623	58566	54881	97591	129838
Heavy Metals to water	mg Hg/20	22193	24843	22790	26953	35135	46584
Eutrophication	g PO4	832	1152	902	1450	1258	1661

Furthermore, a LCC analysis was carried out in Task 5. The table below provides an overview of the Life Cycle Costs in year 2015 for the different Base-Cases and also provides the EU28 total annual consumer expenditures.

The base cases described in the previous tasks are baselines for assessing improvement potentials by using Best Available Technologies (BAT)/Best Not-yet Available Technologies (BNAT) in **Task 6** (Design Options). These potentials are to be analysed using so-called “design options”, i.e. (aggregated clusters of) measures to increase the performance of lifts. This task identifies, describes and analyses these options. It should be noted that information on the design options, especially their costs, is limited and thus, there is some uncertainty to the results even if they are expected to point in the right direction.

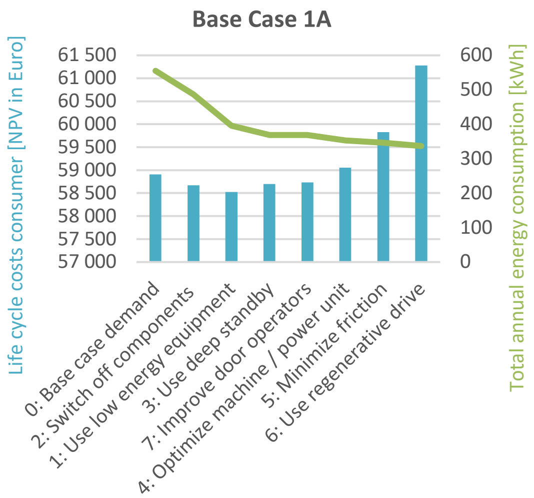
Category	Subcategory	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
New product [in €]	Product	17 000	15 500	21 500	19 000	28 500	45 000
	Installation	15 000	15 000	17 000	17 000	17 000	22 000
	Electricity	2 716	3 199	4 510	6 235	9 754	27 084
	Repair & Maint. /Insp. & EoL	24 190	23 291	26 813	25 978	57 136	101 800
	Total	58 904	56 989	69 822	68 213	112 390	195 884
Total annual consumer expenditure [in mio. €]	Product	54	38	751	246	836	1 238
	Installation	48	36	594	220	498	605
	Electricity	15	13	266	137	484	1 260
	Repair & Maint./Insp. & EoL	130	96	1 583	570	2 833	4 736
	Total	247	183	3 194	1 173	4 650	7 838

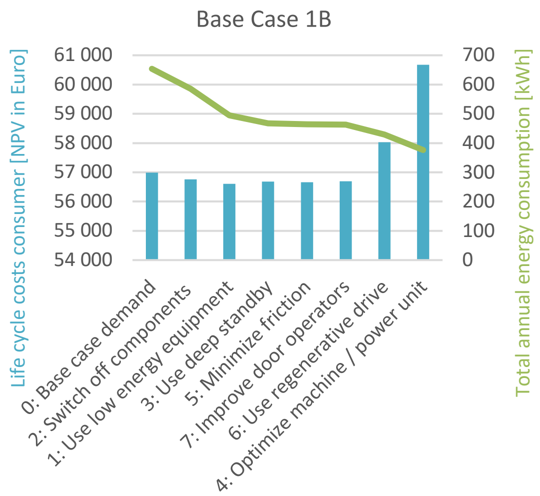
Following the MEErP, a set of seven design options was identified and described. Their major impact on environmental parameters is related to energy; changes in other environmental parameters only entail rather small changes in terms of material usage as compared to the overall mass of the lifts. With regard to electricity demand, some design options affect running demand while others only concern standby. A combination of all design options would lead of a shift from the energy efficiency classes B and C according to EN ISO 25745-2:2015 in the base cases to classes A to B using best available technology. A few design options could lead to trade-offs, e.g. they might affect waiting time or component lifetime. The actual shift in energy classes depends on the specific base case. More specifically, the results indicate that measures to address stand-by consumption are most relevant for the group of smaller base cases, while for the larger base cases, measures to address running consumption are most important. For the smallest base case with a reference consumption of approximately 550 kWh per year, the impact of the largest individual design option in terms of electricity savings reduces annual demand by slightly above 100 kWh. For the largest base case, this value increases to roughly 1600 kWh per year with a base case consumption of about 5500 kWh per year. A combination of options which corresponds to the BAT level will obviously allow higher savings, yet it will also entail higher implementation costs.

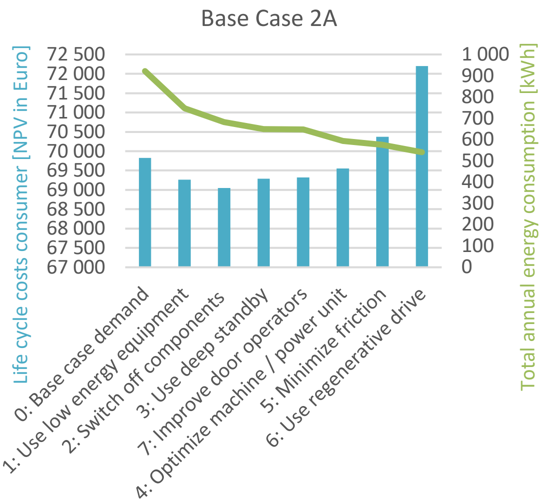
A more thorough investigation of the economic performance of the individual design options from both a user and a societal perspective underlines that the life cycle costs remain largely dominated by purchase, installation, maintenance and repair costs. Approximately 5 % of the life cycle costs of about 59 000 Euro are caused by energy consumption while this value increases to 14 % for the largest base case with life cycle costs of about 196 000 Euro. Correspondingly, the achievable savings in the life cycle costs from design options applied individually range up to 234 Euro in the smallest base case and up to 5364 Euro for the largest base case.

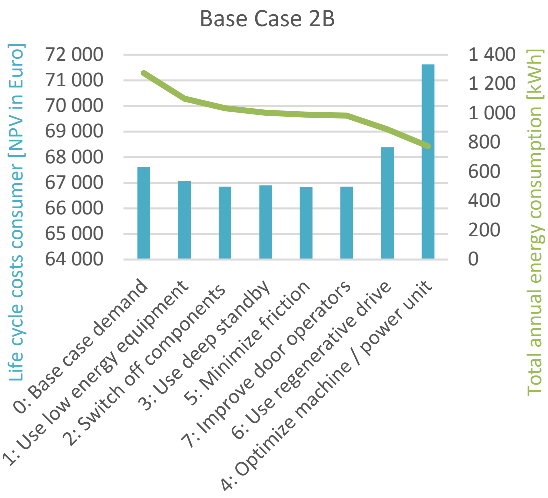
Further investigations underline that from an economic perspective, a combination of measures is usually more beneficial than applying only a single one. The figures below summarize these findings in a visual way. For base case 1A, for instance, it can be observed that applying a combination of options 1 ("use low energy equipment") and 2 ("switch off components") will minimize the life cycle costs by saving 380 Euro in total and 159 kWh of electrical energy per year (corresponds to a "least cost" case). A combination of options 2, 1, 3 and 7 would still be economically favourable as compared to the base case with savings of 173 Euro over the life cycle and a reduction in electricity demand of 187 kWh per year (corresponding to an "equal cost" case). Applying all options combined would lead to savings in electricity demand of 218 kWh per year. Yet it would also entail an increase in the life cycle costs of 2372 Euro (corresponds to a "best available technology" case).

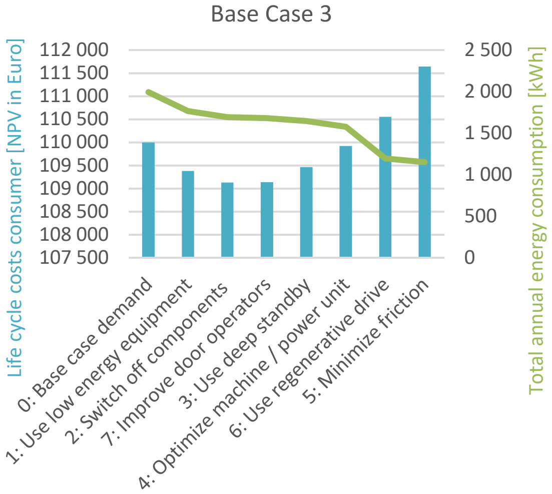
An outlook beyond currently used systems and towards best not yet available technologies (BNAT) underlines that no fundamentally different BNAT design options could be identified for the near future. Most advances are expected from incremental improvements in current technologies. However, entirely new lift design might have an impact on the environment; it yet is still too early to foresee their adoption by the market and their future role for the environmental performance of transportation in buildings.

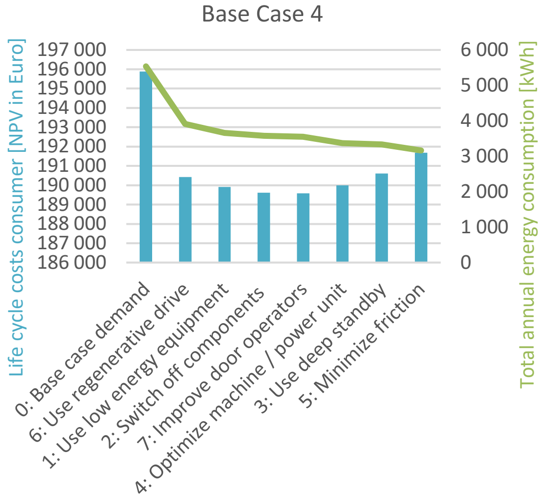












The purpose of the final task, **Task 7** (Scenarios) is to provide an understanding of the impacts of future scenarios in line with policy measures that could be introduced at EU-level. This is a key task as it requires the combination of the results of all previous tasks to derive estimates of the impacts of different Ecodesign policy measures and design options, and thereby is aimed at providing an analytical basis to support the Ecodesign decision-making process. A set of quantitative scenarios are provided of the market penetration levels of various lift technologies and the consequences for the environment, users and industry.

To this end, a stock model has been developed to estimate future sales and stocks of lifts under different policy scenarios. The outcomes are then compared with the Business-as-Usual scenario.

Based on the results of Task 6, four scenarios have been elaborated: Business-as-Usual (BAU), Least Life Cycle Cost (LLCC), Break-Even Point (BEP) and Best Available Technology (BAT). The analysis shows that by 2045, electricity demand under the BAT scenario could be reduced from 18.73 TWh/year (BAU) to 15.73 TWh/year compared to the BAU, corresponding to a 16% reduction. The BEP achieves a 14% reduction and the LLCC an 11% reduction compared to the BAU.

Criteria			MAIN IMPACTS IN YEAR 2045						
			1	2	3	4	Improvements vs. BAU		
			BAU	LLCC	BEP	BAT	LLCC	BEP	BAT
ENVIRONMENT									
	Electricity	TWh/year	18.73	16.67	16.19	15.73	-11%	-14%	-16%
	GHG	Mt CO2-eq./	5.25	4.67	4.53	4.40	-11%	-14%	-16%
CONSUMER									
EU totals	Expenditure	€ bln./year	33.17	32.85	32.95	33.18	-1%	-1%	0%
	of that, purchase costs	€ bln./year	3.34	3.43	3.63	3.95	3%	9%	18%
	of that, installation costs	€ bln./year	2.11	2.11	2.11	2.11	0%	0%	0%
	of that, maintenance costs	€ bln./year	23.98	23.98	23.98	23.98	0%	0%	0%
	of that, energy costs	€ bln./year	3.73	3.32	3.22	3.13	-11%	-14%	-16%
Per product sold	Sales (regulated)	000	116.50	116.50	116.50	116.50	0%	0%	0%
	Product price	€	28,662.90	29,463.66	31,142.27	33,926.65	3%	9%	18%
	Installation costs	€	18,144.77	18,144.77	18,144.77	18,144.77	0%	0%	0%
	Energy costs	€/year	474.03	336.25	304.73	273.54	-29%	-36%	-42%
BUSINESS									
EU turnover	Manufacturers	€ bln./year	3.34	3.43	3.63	3.95	3%	9%	18%
	Installers	€ bln./year	2.11	2.11	2.11	2.11	0%	0%	0%
	Maintenance	€ bln./year	23.98	23.98	23.98	23.98	0%	0%	0%
	Electricity Companies	€ bln./year	3.73	3.32	3.22	3.13	-11%	-14%	-16%
	Revenue	€ bln./year	4.12	4.13	4.16	4.21	0%	1%	2%
EMPLOYMENT									
Employment (jobs)	Manufacturers	000	17.31	17.36	17.48	17.67	0%	1%	2%
	Maintenance	000	123.76	123.76	123.76	123.76	0%	0%	0%
	Installers	000	40.16	40.16	40.16	40.16	0%	0%	0%
	Electricity Companies	000	2.92	2.59	2.52	2.45	-11%	-14%	-16%

In 2045, the total expenditures for all four scenarios are nearly at the same level: close to €33 bn/year. The energy cost savings under the BAT scenario are of almost the same magnitude as the additional purchase costs. Overall costs are lower under the LLCC scenario, but the magnitude of the reduction is very modest (around 1% of the total costs).

Consequently, there would be benefit from setting energy efficiency requirements for lifts in order to tap the significant savings potentials, at least for the cases which do not lead to an increase in the LCC (see BEP level). Though it would be technically possible to establish an Ecodesign regulation with a minimum threshold based on EN ISO 25745-2, there are some challenges to doing so. An important issue is that, lifts are assembled in buildings and – according to the Lift Directive 2014/33/EU - only come into existence as finished products once installed. Despite this, and because lifts (as components) are traded across the EU, it would be beneficial to mandate the provision of information with regard to energy assessment under the EN ISO 25745 standard, for both the required input parameters as well as for the results of the energy assessment itself. This could be done under Article 11 of the Ecodesign Directive because lifts are a component or sub-assembly of a building. Making this data available would enable market actors to include energy performance within their procurement decisions, and would facilitate market surveillance activities (whenever relevant). It would also facilitate the introduction of energy efficiency performance requirements in the future should these be deemed to be appropriate in subsequent review and revision cycles. The study established that there is a significant lack of information and awareness among market actors and thus setting such an information requirement would help to address this deficit. Such data would also enable the energy consumption of lifts to be included in future Energy Performance Certificates (EPCs) for buildings. However, it is unusual to implement an Ecodesign implementing measure which covers only information requirements.

Given that lifts are a system that only formally comes into being when they are installed the Energy Performance in Buildings Directive (EPBD) would seem to better suited than the Ecodesign Directive for the establishment of minimum energy performance requirements, as discussed in the body of this report. Nonetheless, the specification of measures within the EPBD would benefit from the proposed information requirement under the Ecodesign Directive. Two Member States have already elaborated energy efficiency Class B[1] requirements for lifts in existing buildings that are not solely intended for residential usage. The study team therefore recommends a two-step approach:

- based on the current EPBD Directive: encourage Member States to include mandatory minimum energy performance requirements set specifically for lifts in their national implementation of the directive, as Denmark and Portugal have already done. Energy Efficiency Class B according to EN ISO 25745-2:2015 seems to be an adequate level for such requirements. The experience gathered by the early adopter countries during the implementation of the EPDB will be very valuable to improve the data available to public authorities on the energy performance of lifts sold in their markets

- in a second step: the study team strongly supports the idea of extending the list of technical building systems under the EPBD to include lifts and also to include lifts in the list of systems subject to regular inspections. Whenever this occurs, if more information are available on home lifts at that time, then this product group might also be included.

In addition, the study team encourages the Technical Committee ISO/TC 178 to update the EN ISO 25745-2, in particular with regard to the definitions of lift energy efficiency classes. A rescaling of the thresholds seems to be necessary as the performance level for most of the base cases examined in this study was Class B, which indicates that a differentiation in performance among the "more energy efficient" lifts is currently not very visible to potential investors.

[1] According to EN ISO 25745-2 or VDI 4707, depending the on Member State considered

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Task 1 report: Scope

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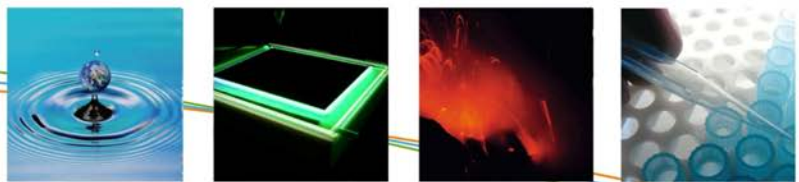

Table of contents: Task 1

List of Figures

List of tables

List of Abbreviations and Acronyms

AC	alternating current
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAT	Best Available Technology
BBSR	Federal Institute for Research on Building, Urban Affairs and Spatial Development
BNAT	Best not yet available technology
CEN	Comité Européen de Normalisation
CENELEC	European committee for electrotechnical standardization
CPA	classification of products by activity
DC	direct current
DIN	German Institute for Standardization
ECCJ	Energy Conservation Center Japan
EEE	electrical and electronic equipment
ERP	Energy-related Products
EN	European Standard
EP	European Parliament
EPA	Environmental Protection Agency
EPBD	Energy Performance Building Directive
EPD	Environmental Product Declaration
ESO	European Standardisation Organisation
ETSI	European Telecommunications Standards Institute
EU	European Union
FU	functional unit
ISO	International Organization for Standardization
LCA	life cycle assessment
LEED	Leadership in Energy and Environmental Design

LLCC	Least Life Cycle Cost
MEErP	Methodology for Ecodesign of Energy-related Products
MRL	Machinery Directive
MS	Member States
NACE	National Association of Corrosion Engineers
NEEAP	National Energy Efficiency Action Plans
PCR	Product Category Rule
RoHS	Restriction of Hazardous Substances
PRODCOM	Production Community
RC	Regulatory Committee *on the Ecodesign of Energy-related Products*
SS	Singapore Standard
VDI	Association of German Engineers
WEEE	Waste Electrical and Electronic Equipment
WTO	World Trade Organization

0. Introduction

The Ecodesign Directive (Directive 2009/125/EC) establishes a framework for the setting of Community Ecodesign requirements for energy-related products with the aim of ensuring the free movement of such products within the internal market. This preparatory study is carried out in the framework of this Directive. Its aim is to provide the European Commission with a technical, environmental and economic analysis of lifts according to Article 15 of the Ecodesign Directive.

0.1. Legislative process

The process of making Ecodesign Regulations for specific product groups is represented in Figure 0-1.

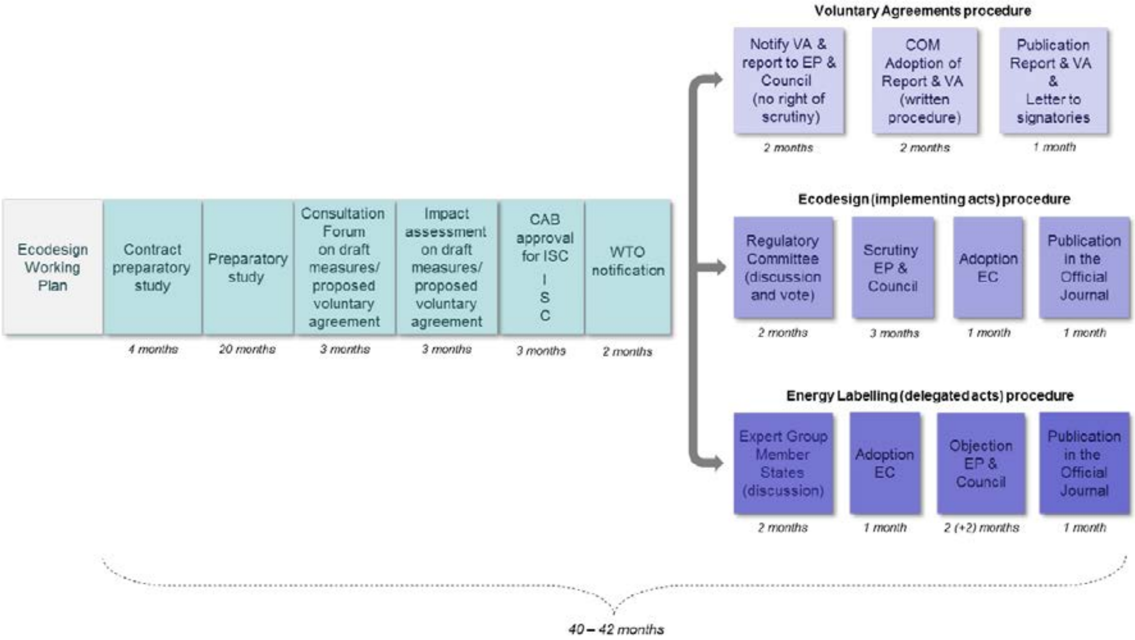

Figure 0-1: Process of making Ecodesign Regulations (source: EC 2015)

Firstly, a preparatory study is conducted that gives recommendations on how to improve the environmental performance of the product. The study then serves as a basis for the decision as to whether, and if so which, Ecodesign requirements should be set out for that particular product. It provides the Commission with the necessary information to prepare for the next phases in the policy process (to be carried out by the Commission) and in particular the impact assessment, the Consultation Forum, and the possible draft implementing measures laying down Ecodesign requirements for products.

The scope of this study includes the technical properties of the product as well as its market data. This enables the determination of parameters such as for the Best Available Technology (BAT) and Least Life Cycle Cost (LLCC) of the product.

A working document is then prepared by the Commission based on the results of the preparatory study. Following the completion of the working document the Consultation Forum's first meeting is organised in which stakeholders are invited to give input on the working paper and the possible implementing measures presented in it. The Consultation Forum consists of representatives from Member States, industry and NGOs. An external impact assessment study is prepared in parallel to the meetings.

Afterwards, the final version of the proposed legislation is sent to the Regulatory Committee (RC) on the Ecodesign of Energy-related Products (ERP), which is made up of officials from all Member States. The committee is then allowed to adjust the proposal. It still has to reach a qualified majority for the Commission to present the proposal to the EP and the Council. After the RC has successfully voted for the proposal, the European Parliament (EP) and the Council have three months to apply scrutiny, in which they can review the final proposal and potentially still inhibit its introduction.

The World Trade Organization (WTO) is notified after 3 months and the implementing measure is officially legal after publication in the Official Journal of the European Union.

The result of the process can be a Commission Regulation implementing the Ecodesign Directive and/or the Energy Labelling Regulation. In some cases, the process can lead to a Voluntary Agreement with industry or to no action, if the process is abandoned. In practice, the whole process typically takes 49 months.

0.2.Ecodesign evaluation

The effectiveness of the Ecodesign Directive and its implementing measures was reviewed and assessed, according to Article 21 of the Directive. In order to prepare for the review and to examine the functioning of the Directive, an independent study[1] was conducted in 2012 to assess the appropriateness of extending the scope of the Ecodesign Directive beyond energy-related products.

The results of the study concluded that, in general, the Ecodesign Directive is effective in attaining its policy objectives (free movement of goods and environmental protection) and that no revision of the Directive is deemed appropriate at the moment or necessary to increase its effectiveness and of its implementing measures.

The study also indicated challenges faced at both the EU and Member State levels in the application of the Ecodesign Directive and its implementing measures, including:

- Complex and lengthy preparatory procedure;
- Unavailability of reliable data to inform policy decisions (e.g. market trends and technological changes, market data, performance data from market surveillance activities etc.);
- Insufficient coordination of Ecodesign measures with other pieces of the EU legislation, such as WEEE, RoHS or EPBD Directives;
- Lack of resources to deal with the increasing amount of the regulatory, communication and standardisation work;
- Question on the level of ambition of requirements, and especially in Tier-1;
- Remaining potential to further address non-energy related issues of energy related products (e.g. material efficiency, recyclability etc.);
- Delays in the elaboration of suitable harmonised standards;

[1] CSES (2012)

- Insufficient and ineffective market surveillance.

In 2015, the Energy Labelling and Ecodesign Directives were evaluated again.[2] The new Regulation (EU) 2017/1369 setting a framework for energy labelling and repealing Directive 2010/30/EU is based on the analysis of the evaluation report. The major changes arising from this are the rescaling of the energy label – so that in the future the energy classes will range from A to G - and the establishment of a product database to improve market transparency for market surveillance purposes.

1.Task 1- Scope

1.1. Objectives

The main objective of this task is to determine a clear scoping for lifts according to the needs of the Ecodesign process. For this definition, legal, normative and functional aspects relevant to the topic have been taken into account. These considerations will then serve as a basis for the whole study.

The product classification and definitions to be applied are developed in close agreement with the Commission following a stakeholder consultation process. These are subject to on-going review throughout the course of the following tasks.

1.2. Product scope

1.2.1. General description and definition

In this preparatory study, "lifts" are defined according to the recent Directive 2014/33/EU on the harmonisation of the laws of the Member States relating to lifts and safety components for lift, which specifies in Article 2:

" ‘lift’ means a lifting appliance serving specific levels, having a carrier moving along guides which are rigid and inclined at an angle of more than 15 degrees to the horizontal, or a lifting appliance moving along a fixed course even where it does not move along rigid guides".

1.2.2. Lift

The scope of this preparatory study on lifts[3] is in line with those of the Lift Directive 2014/33/EU, namely:

"[the scope] include[s] lifts permanently serving buildings and constructions and intended for the transport of:

- persons;
- persons and goods;
- goods alone if the carrier is accessible, that is to say a person may enter it without difficulty, and fitted with controls situated inside the carrier or within reach of a person inside the carrier."

But will exclude:

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[2] see EC (2015)

[3] In this study henceforth “lift” is a synonym for “elevator” (American English)

- lifting appliances whose speed is not greater than 0,15 m/s;
- construction site hoists;
- cableways, including funicular railways;
- lifts specially designed and constructed for military or police purposes;
- lifting appliances from which work can be carried out;
- mine winding gear;
- lifting appliances intended for lifting performers during artistic performances; lifting appliances fitted in means of transport;
- lifting appliances connected to machinery and intended exclusively for access to workstations including maintenance and inspection points on the machinery;
- rack and pinion trains;
- **escalators and mechanical walkways**."

Due to the 0,15 m/s threshold, products like home lifts are excluded from the study.[4]

1.2.3. New lifts

In this study, according to the Guidance on application of Directive 95/16/EC,[5] approved by the lift committee on 9 September 2004, new lifts include the following:

- lifts installed in new buildings;
- lifts installed in existing buildings;
- lifts installed in existing wells in replacement of existing lifts, including when the existing guide rails and their fixings or the fixings alone are retained.[6]

---

4 This is motivated by following reasons: statistics on lifting appliances whose speed is less than 0,15 m/s are poor, energy consumption of such appliances (e.g. home lift) is usually much less than those of lifts with speed higher than 0,15 m/s. Finally, it is meaningful to care on a common definition of lifts for a clear EU policy framework, since such products are defined in the Lifts Directive 2014/33/EU. See also rough assessment of the home lift market in Task 2.

5 "LC2003.04rev1", see EC 2016

6 The Guide to Application of the Lifts Directive 2014/33/EU (May 2018) (EC 2018), based on the Blue Guide, clarifies the issue of major change of an existing lift: "A product, which has been subject to important changes or overhaul aiming to modify its original performance, purpose or type after it has been put into service, having a significant impact on its compliance with Union harmonisation legislation, must be considered as a new product. This has to be assessed on a case-by-case basis and, in particular, in view of the objective of the legislation and the type of products covered by the legislation in question. Where a rebuilt or modified product is considered as a new product, it must comply with the provisions of the applicable legislation when it is made available or put into service."

1.3. Basic concept of lifts

This section shortly presents several principles for lifts, then the two main types of lifts: hydraulic lifts and traction lifts. Finally, the system boundaries considered in this study are presented.

1.3.1. Principles for lifts

Figure 1-1 provides a rough representation of both types of lifts: traction lifts and hydraulic lifts. Section 1.3.3 presents more details.

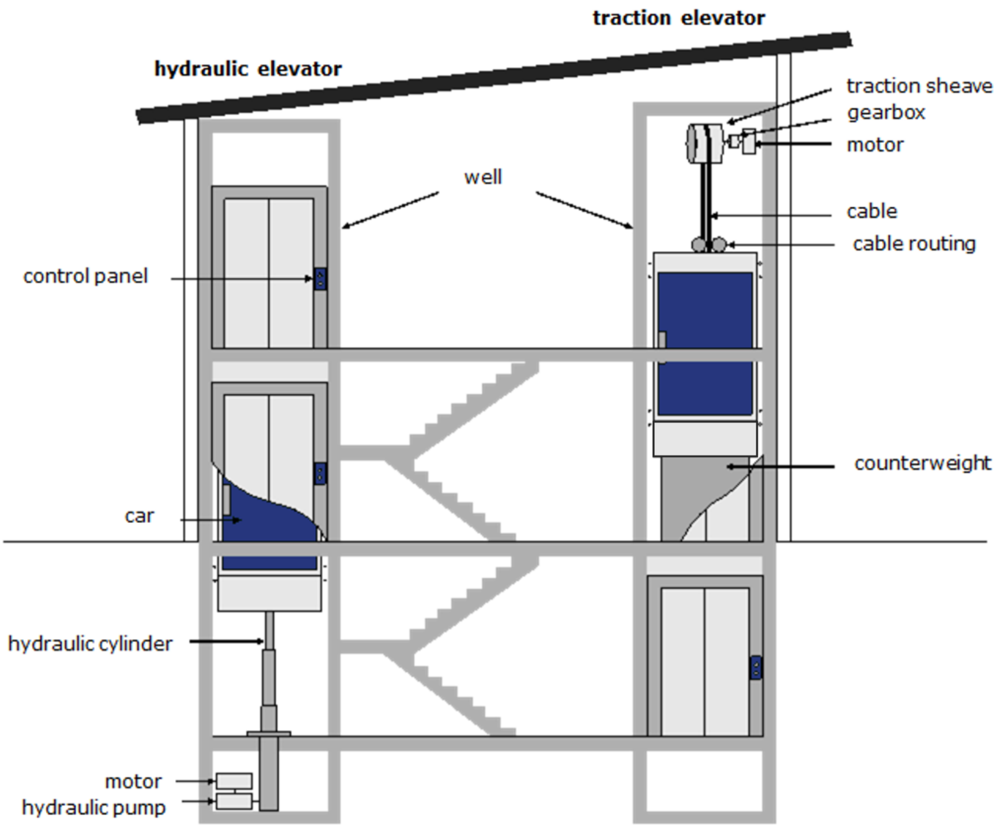

Figure 1-1: Simplified representation of an hydraulic lift (left) and a typical traction lift (right). (source: based on Hirzel/Blepp 2017)

These have the following components (see Table 1-1):

Table 1-1: Main components of a lift

Component	Function	Remark
Motor	Initiates movement and drives car	
Gearbox	Converts the torque and the speed of the traction sheave	Relevant for traction lift only
Traction sheave (or traction wheel)	Connected to drive system (motor and gearbox), transmits forces between rope grooves and rope on to the car and moves the car by rotating.	

Cable	Holds car and counterweight and pulls car or counterweight up to actuate movement	
Car	Holds transported goods or people	
Counterweight	Ensures traction. Also, it considerably reduces work of motor, since it creates certain balance	Relevant for traction lift only
Hydraulic cylinder	Oil is pumped into hydraulic cylinder. The pressure in it makes piston extend and move the car.	Relevant for hydraulic lift only

Several configurations of drive technologies and the method of integration within the shaft of the building are possible. Figure 1-2 shows some of them.

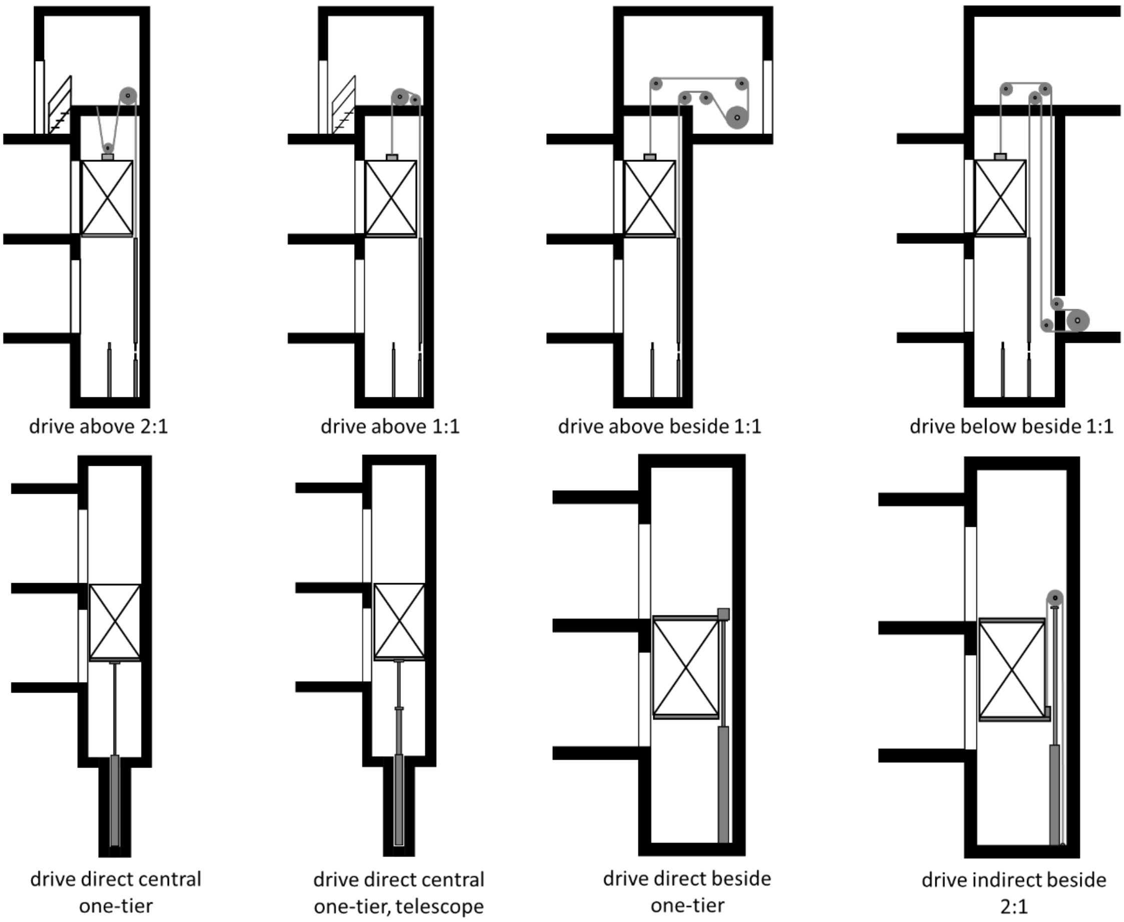

Figure 1-2: Different configurations of lifts (source: based on Neufert 2009)

1.3.2. System boundaries

As shown in Figure 1-1, a lift is a system consisting of different components and some of them are installed in the well. In this study, the term "lift" includes following components (based on ISO 25745:1 Annex A):

- lift machine: motor, gearbox, converter and brake as well as hydraulic system (cylinder, tank) if applicable
- doors, including actuators

- controller and displays
- car: including lighting, socket on the car roof, ventilator
- safety system: alarm system and telemonitoring, emergency power supply
- counterweight, traction wheel, cable, guide rails, buffers

The well itself as well as the machine room are considered as part of the building and not as components of the "lift", in the sense of this study. This is an important issue when considering aspects related to direct energy consumption (lighting) and indirect energy consumption (heat losses due to ventilation, see Task 3). Figure 1-3 provides an overview of the system boundaries.

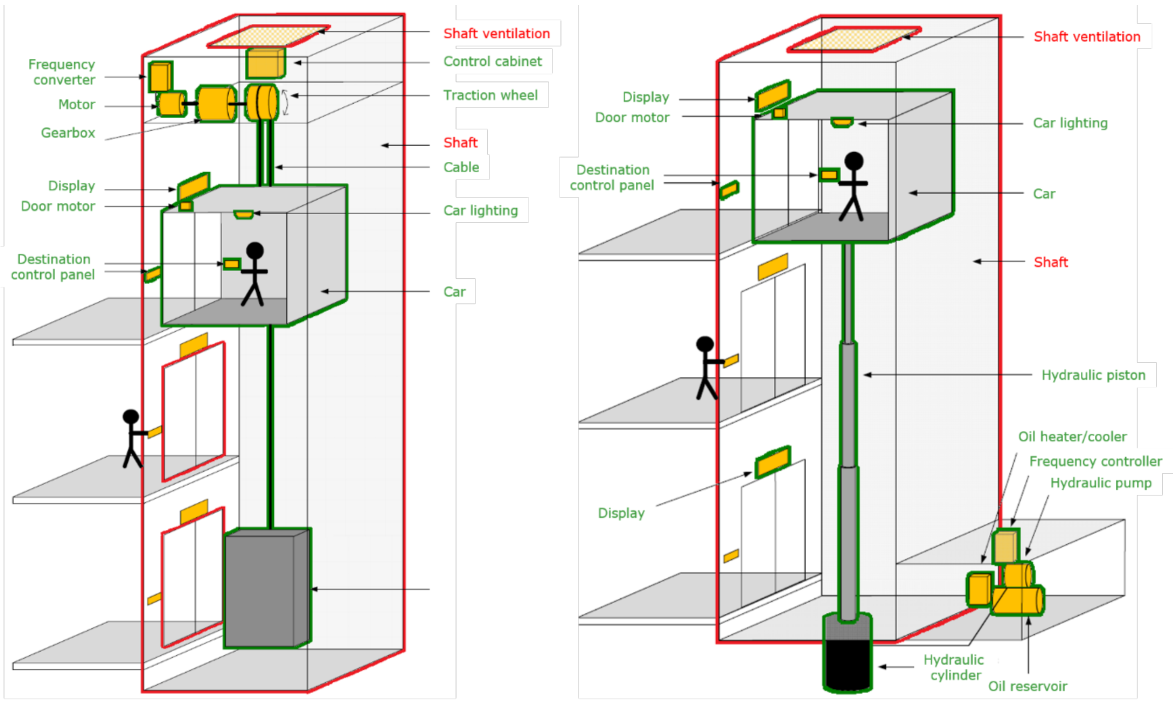

Figure 1-3: System boundaries of a lift (left: traction lift; right: hydraulic lift). (source: Fraunhofer ISI based on Almeida 2010)

1.3.3.Main types of lifts

1.3.3.1.Traction lifts

As stated in the E4-project (Almeida 2010),[7] electric traction lifts can nowadays be used in almost all applications without any major limitations regarding travel height, speed or load. A wide range of speeds is available – from 0.25 m/s to 17 m/s – as well as for

[7] E4 Project – Energy Efficient Elevators and Escalators, see: https://ec.europa.eu/energy/intelligent/projects/en/projects/e4

a broad range of loads. Some goods lifts can have rated loads exceeding 10,000 kg although they are then normally operating at very low speeds.

In traction lifts, the car is suspended by ropes wrapped around a sheave that is driven by an electric motor. The weight of the car is usually balanced by a counterweight that equals the mass of the car plus 45% to 50% of the rated load. The purpose of the counterweight is to maintain a sufficient tension in the suspension system which ensures adequate traction between ropes/belts and drive sheave. In addition, it maintains a near constant potential energy level in the system as a whole, thereby substantially reducing energy consumption.

Traditionally, electric traction lifts were equipped with DC motors due to their easy controllability, but the development of variable frequency drives led to the introduction of the now prevalent AC induction motors or permanent magnet AC motors. These drives provide excellent ride conditions, with smooth acceleration and deceleration and high levelling accuracy.

There are two main types of traction lifts: geared and gearless. Geared lifts use a reduction gear to reduce the speed of the car while in gearless lifts the sheave is directly coupled to the motor.

1.3.3.2.Hydraulic lifts

Hydraulic lifts are a common type of lift installed in low-rise applications (up to 6 or 7 floors). One of the main reasons for its wide acceptance in some European countries is its relatively low initial cost.

This type of lift uses a hydraulic cylinder to move the car. An electric motor drives a pump that forces a fluid into the cylinder. Valves control the fluid flow for a gentle descent, allowing the hydraulic fluid (usually oil) to flow back to the tank.

In some cases, the cylinder is placed in a hole in the ground. Some types of holeless hydraulic lifts can be found in the market for low-rise applications, which substantially reduce the risk of groundwater contamination. In Europe, hydraulic lifts are usually of the telescopic cylinder or roped types.

Since hydraulic lifts typically do not have a counterweight, conventional hydraulic lifts are the most inefficient, sometimes consuming three times more electricity than traction lifts in running mode. Energy is dissipated as heat as the car travels downwards.

Hydraulic lifts travel at low speeds, typically below 1 m/s. The maximum travel distance for this type of lifts is around 20 m. This is due to the fact that as travel height increases, larger diameter pistons have to be used to resist the larger buckling forces. This increases the costs of equipment, which makes the use of hydraulic lifts less attractive when there are better alternatives available.

Hydraulic lifts present some technical advantages over traction lifts, namely:

- installation is very simple and fast;
- little space is occupied by the equipment, such as controls, motor and pump and, therefore, the overhead machine room becomes unnecessary. These parts are normally located in low-cost areas of the building such as basements or below stairs;

- conventional hydraulic units do not have counterweights which enables their use in narrower wells. The absence of counterweights also diminishes the load on the building's structure;
- the force of load is transferred to the ground and not to the building's structure which translates into lower construction requirements and costs;
- emergency procedures in hydraulic lifts are relatively simple. The car can be lowered by means of a manually operated emergency valve. Likewise, a hand pump can be used to lift the car in the event of power failure or control equipment failure.

Some of the disadvantages of conventional hydraulic lifts are:

- high energy consumption since the entire weight of the car must be lifted;
- high demand on the power supply when moving up;
- limited rise, speed of operation and number of starts per hour.

Because oil viscosity changes with temperature, oil cooling or heating is sometimes required to maintain ride quality and performance.

A detailed description of the lift technologies will be provided in Task 4.

1.4. Specific definitions and characterisations

In this section, product scoping should be discussed with regard to existing classifications. For this purpose, the corresponding classifications according to the PRODCOM classification as well as according to other classifications will be briefly discussed.

1.4.1.PRODCOM classification

According to the MEErP methodology, the official European production statistics from the PRODCOM database should be used as a preferential data source for refining the scope of preparatory studies. PRODCOM consists of a survey of at least annual frequency, with the purpose of collecting and disseminating statistics on the production of various industrial (mainly manufactured) goods in the EU, mainly in terms of value and quantity. The word PRODCOM stands for the French "Production Communautaire". All products that are involved in the survey are listed in the PRODCOM lists and are given an eight-digit label. The first four digits refer to the equivalent class within the Statistical classification of economic activities in the European Community (NACE), while the subsequent two correspond to subcategories within the Statistical classification of products by activity (CPA). The PRODCOM survey results can be accessed on the Eurostat website in an extensive database containing annual production and economic data partially dating back to 1995.

The current PRODCOM database labels lifts and skip hoists together and differentiates only if they are operated electrically or not (see Table 1-2). The problem that occurs when using the PRODCOM data is that it does not provide details (e.g. category or size) on products. A more detailed analysis on the PRODCOM database is conducted in Task 2.

Table 1-2: PRODCOM statistics for lifts

PRODCOM code	Description
28.22.16.30	Electrically operated lifts and skip hoists
28.22.16.50	Lifts and skip hoists (excluding electrically operated)

1.4.2. Classification according to technology

Within the E4 study, a classification of lifts was carried out, according to the drive system (see Figure 1-4).

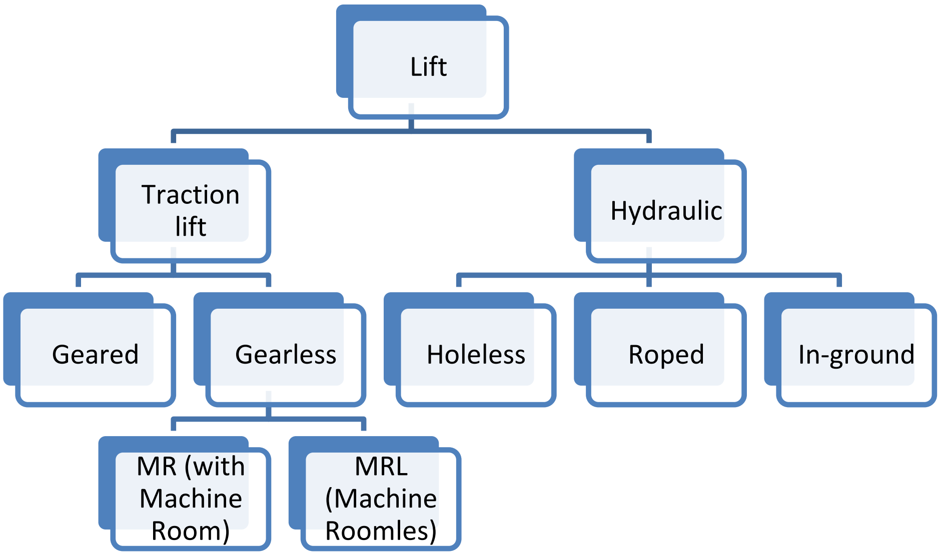

Figure 1-4: Classification of the lift "product group" (source: based on E4 project)

Task 4 will provide detailed information on the categories and sub categories presented in the above figure.

1.4.3. Classification according to drive systems and object of transportation

Furthermore, lifts can be classified with more detail, according to the type of drive and drive system, the object of transportation and other variants (see Figure 1-4):

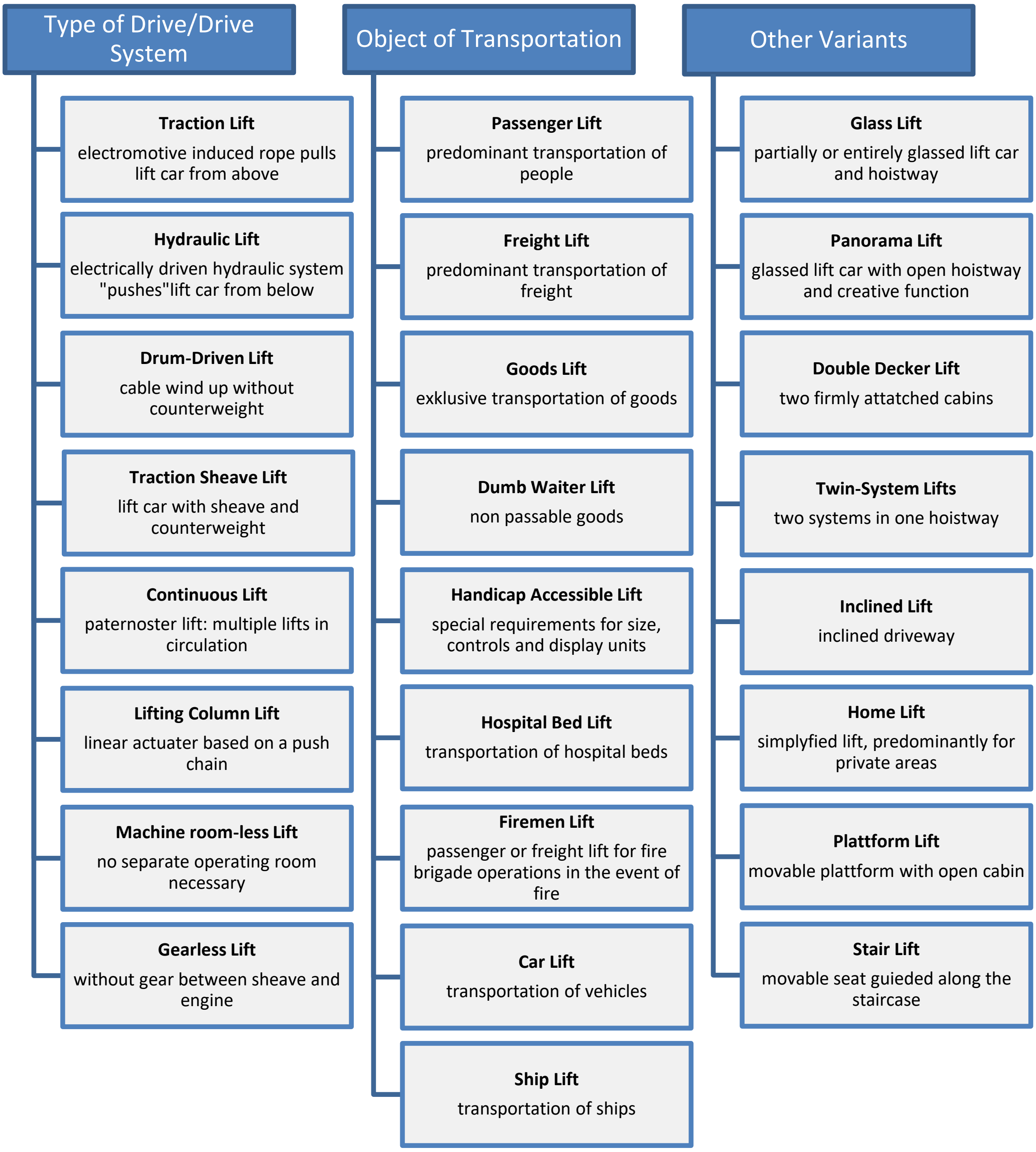

Figure 1-5: Overview of the different types of lifts (based on Lenzner/Böhm 2016)

1.4.4. Classification according to usage categories

Conception, travel demand and energy consumption of lifts highly depend on the following factors:

- frequency or intensity of use;
- average daily travel and standby time;
- the typical building type.

Therefore, when assessing the energy efficiency performance of lifts, industry has defined usage categories in the relevant standards and technical documents (more information is given in 1.6.2 and 1.6.6.1. as well as Task 3).

The standard EN ISO 25745-2 on energy consumption of lifts (see 1.6.2 International Standards) – harmonized for all EU Member States - defines 6 usage categories based on the number of trips per day. In Annex A of the standard, additional typical information is provided.

Table 1-3: Categorised number of starts per day (based on: EN ISO 25745-2:2015 Annex A)

Usage category	Number of trips per day (Typical range)	Information provided in Annex A (informative part of the standard)		
		Usage intensity / frequency	**Typical buildings and usage (operating days per year)**	**Typical rated speed**
1	**50** (≤75)	Very low	• residential buildings up to 6 dwellings (360 d) • residential care home (360 d) • small office or administrative building with few operations (260 d) • Suburban railway stations (360 d)	0.63 m/s
2	**125** (75 - <200)	Low	• residential buildings up to 20 dwellings (360 d) • small office or administrative building with 2 to 5 floors (260 d) • small hotels (360 d) • office car parks (360 d) • general car parks (360 d) • main line railway stations (360 d) • library (312 d) • entertainment centers (360 d) • stadia (intermittent)	1.00 m/s
3	**300** (200 - <500)	Medium	• residential buildings with up to 50 dwellings (360 d) • medium-sized office or administrative building with up to 10 floors (260 d) • medium-sized hotel (360 d) • airports (360 d) • university (260 d) • small hospital (360 d) • shopping center (360 d)	1.60 m/s
4	**750** (500 - <100)	High	• residential buildings with more than 50 dwellings (360 d) • large office or administrative building with more than 10 floors (260 d) • large hotel (360 d)	2.50 m/s
5	**1500** (1000 - <2000)	Very high	• very large office or administrative building over 100 m height (260 d)	5.00 m/s
6	**2500** (>2000)	Extremely high	• very large office or administrative building over 100 m height (260 d)	5.00 m/s

Due to the importance of usage categories on the type and technology of lift, usage categories as defined in EN ISO 25745 can be considered as a basis for the definition of product categories.

This approach would lead to the product categories shown in Table 1-4.

Table 1-4: Raw mapping of lift technologies according to usage category (source: own estimation)

Technology	Sector	Usage Category					
		1	2	3	4	5	6
Hydraulic	Residential	X	x	x	-	-	-
	Commercial	x	x	X	-	-	-
	Industry	x	X	X	x	X	-
Traction (electrical) - Geared	Residential	X	X	X	x	-	-
	Commercial	X	X	X	x	-	-
	Industry	X	X	X	x	X	-
Traction (electrical) - Gearless	Residential	x	x	X	X	-	-
	Commercial	x	x	X	X	X	X
	Industry	-	-	-	-	-	-

X : main application, x : minor application, - : almost no application

To provide a full information, the German guideline VDI 4707-2009 defines five usage categories (see Table 1-5) that differ in the average travel time in hours per day.

Table 1-5: Usage categories for lifts according to VDI 4707-1:2009

Usage category	Usage intensity / frequency	Average travel time in hours per day[1)]	Average standby time in hours per day	Typical types of buildings and use
1	very low very seldom	**0,2** (≤0,3)	23,8	• residential building with up to 6 dwellings • small office or administrative building with low operation
2	low seldom	**0,5** (>0,3–1)	23,5	• residential building with up to 20 dwellings • small office or administrative building with 2 to 5 floors • small hotels • goods lift with low operation
3	medium occasionally	**1,5** (>1–2)	22,5	• residential building with up to 50 dwellings • small office or administrative building with up to 10 floors • medium-sized hotels • goods lift with medium operation
4	high frequently	**3** (>2–4,5)	21	• residential building with more than 50 dwellings • tall office or administrative building with more than 10 floors • large hotel • small to medium-sized hospitals • goods lift in production process with a single shift
5	very high very frequently	**6** (>4,5)	18	• office or administrative building over 100 m in height • large hospital • goods lift in production process with several shifts

[1)] Can be determined from the average number of trips and the average trip duration.

1.4.5.Classification according to the type of support

Based on section 2.3, which presented the main principles of lifts, lifts can also be classified according to the way the lifting force is transferred to the structure of the building:

- **top support**: the car is lifted by a cable suspended from the top of the well. This requires the corresponding part of the building structure to be strong enough to support the dynamic efforts generated during the travel of the lift. Usually, top support lifts are traction lifts;

- **ground support**: the car is pushed-up, the lifting efforts are transferred to the ground of the building. Such a configuration can be the only option when the building structure (e.g. for an old building) is not stable enough to allow a top support configuration. Most ground lifts are hydraulic lifts.

Figure 1-6 shows both types of support.

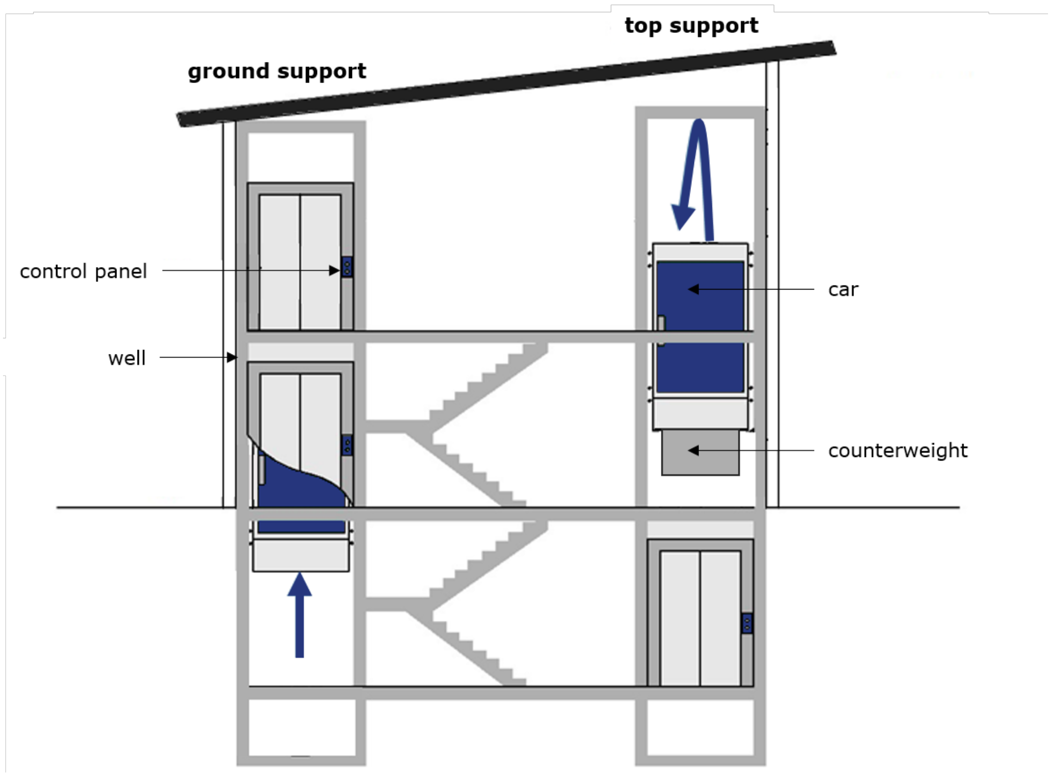

Figure 1-6: Type of supports (source: Fraunhofer ISI, based on Hirzel/Blepp 2017)

1.5.Functional unit and performance parameters

1.5.1.Functional unit

Based on the definition of the product group, lifts are used to move a carrier. The functional unit – the quantified performance of the product "lift" for use as a reference unit – can accordingly be defined as the transportation of a load over a distance travelled during the service life and expressed in [t] over [km] i.e. as [t.km]. The same definition is used in the PCR (see 1.6.3) and is calculated as followed:[8]

$$FU = \frac{Q}{1000} \cdot [\%\, from\, Table\, 3\, of\, ISO\, 25745 - 2] \cdot \frac{s_{rc} \cdot [\%\, from\, Table\, 2\, of\, ISO 27545 - 2]}{1000} \cdot n_d \cdot d_{op} \cdot RSL$$

Where:

- Q is the lift rated load [kg]
- % from Table 3 of EN ISO 25745-2 is the average car load
- % from Table 2 of EN ISO 25745-2 is the average travel distance

8 This definition might be subject to changes in the next version of the PCR (expected in October 2019)

- S_{rc} is the one-way travel distance of the reference cycle according to EN ISO 25745-1 [m] (lift height)
- n_d is the number of trips per day according to the usage category (from Table 1 in EN ISO 25745-2)
- d_{op} is the number of operating days per year
- RSL is the designed service life [years] declared for the lift.

1.5.2.Primary Performance parameters

The following primary performance parameters have been identified for lifts:

- rated load (kg): the load for which the equipment has been built (EN81-20). For passenger lifts, the load capacity can also be expressed in "persons". There is a wide range for rated load. Table 1-6 and Table 1-7 show examples of rated load for passenger lifts and for hydraulic goods passenger lifts.

Table 1-6: Rated load and maximum available car area (source: EN82-20:2014)

Rated load, mass (kg)	Maximum available car area (m^2)
100[a)]	0,37
180[b)]	0,58
225	0,70
300	0,90
375	1,10
400	1,17
450	1,30
525	1,45
600	1,60
630	1,66
675	1,75
750	1,90
800	2,00
825	2,05
900	2,20
975	2,35
1000	2,40
1050	2,50
1125	2,65
1200	2,80
1250	2,90
1275	2,95
1350	3,10
1425	3,25
1500	3,40
1600	3,65
2000	4,20
2500[c)]	5,00

[a)] **Minimum for 1 person lift**
[b)] **Minimum for 2 persons lift**
[c)] **Beyond 2500 kg add 0,16m^2 for each extra 100 kg**

For intermediate loads, the area is determined by linear interpolation

Table 1-7: Rated load and maximum available car area (for hydraulic goods passenger lifts), (source: EN82-20:2014)

Rated load, mass (kg)	Maximum available car area (m^2)
400	1,68
450	1,84
525	2,08
600	2,32
630	2,42
675	2,56
750	2,80
800	2,96
825	3,04
900	3,28
975	3,52
1000	3,60
1050	3,72
1125	3,90
1200	4,08
1250	4,20
1275	4,26
1350	4,44
1425	4,62
1500	4,80
1600[a)]	5,04

[a)] Beyond 1600 kg add 0,46m^2 for each extra 100 kg

For intermediate loads, the area is determined by linear interpolation

- rated speed (m/s): the speed in metres per second of the car for which the equipment has been built (EN81-20). According to EN ISO 25745-2:2014, it typically ranges between 0,63 m/s and 5,0 m/s.
- travel height (m): distance from the bottom terminal landing to the top terminal landing
- number of trips / day. A trip is defined as a movement from a starting (departure) landing to the next stopping (arrival) landing not including re-levelling (EN ISO 25745-2:2014). According to the ISO standard, the number of trips per day ranges from below 75 to over 2500.
- number of operating days / year
- service lifetime (years)

- energy efficiency: according to the lift (especially from the highest usage categories), the energy efficiency of a lift can be considered as an important performance parameter. So far, only EN ISO 25745 (see 1.6.2) and VDI 4707 (1.6.5) address energy performance. Both documents provide a methodology to assess the specific energy demand of a lift (taking into account running and not running operations) and a rating scheme according to seven energy efficiency classes. Both consider in their methodology the following lift specifications: nominal load, load factor, travel course, number of trips, etc., which vary a lot from lift to lift. However, so far, energy efficiency expressed as a ratio of energy consumption per energy service delivered is not directly defined nor addressed in the identified documents.

While EN ISO 25745 and VDI 4707 provide similar pragmatic methodologies to calculate the energy performance of lifts (including most of the relevant components) during travelling and not travelling operation, they don't directly address the energy efficiency dimension. For this, it is necessary to introduce the notion of "delivered energy service" which serve as the above-mentioned functional unit.

1.5.3.Secondary Performance parameters

Apart from the primary performance parameters mentioned in 1.5.2 secondary performance factors include:

- number of stops
- average acceleration (m/s^3)
- average deceleration (m/s^3)
- power in idle condition (W). According to ISO25745-1: idle condition is the condition when a lift is stationary at a floor following a run before the standby mode is entered
- power in standby mode after 5 min (Pst5) (W). According to ISO25745-1: standby condition is the condition when a lift is stationary at a floor and may have reduced the power consumption to a power level set for that particular lift
- power in standby mode after 30 min (Pst30) (W)
- time to reach standby mode (s)
- time to leave the standby mode (s)

1.6. Test standards

The general objective of this task is to describe test standards related to the product categories described within the scope of this study. Standards are documents drawn up by consensus and approved by a recognised standardisation body. A test standard describes a method of testing in which no pre-given result is required when performing the test.

1.6.1. European Standards

The Comité Européen de Normalisation (CEN) states on their website that “A European Standard (EN) is a standard that has been adopted by one of the three recognised European Standardisation Organisations (ESOs): CEN, CENELEC or ETSI. It is produced by all interested parties through a transparent, open and consensus based process." These European Standards are seen as a vital element to the Single European market, as they serve as catalysts for greater social interaction with technology as well as facilitating market exchange across industries.

The European standards available for lifts are given in Table 1-17 (see Annex). They were retrieved from the CEN website. There are plenty of European standards dealing with lifts, but most of them are focused on safety related aspects (the main one is EN 81-20) and so far none addresses energy (efficiency) issues.[9] The Technical Committee CEN/TC 10 has the task to establish safety rules for the construction and installation: - of lifts and service lifts; - of escalators and passenger conveyors. The EN 81 row is a series of European standards for the "Safety rules for the construction and installation of lifts". The most important ones are:

- EN 81-3: Safety rules for the construction and installation of lifts - Part 3: Electric and hydraulic service lifts (2011)
- EN 81-20: Safety rules for the construction and installation of lifts - Lifts for the transport of persons and goods - Part 20: Passenger and goods passenger lifts (2014)
- EN 81-21: Safety rules for the construction and installation of lifts -Lifts for the transport of persons and goods - Part 21: New passenger and goods passenger lifts in existing buildings (2014)
- EN 81-28: Safety rules for the construction and installation of lifts - Lifts for the transport of persons and goods -Part 28: Remote alarms on passenger and goods passenger lifts (2003)
- EN 81-31: Safety rules for the construction and installation of lifts - Lifts for the transport of goods only - Part 31: Accessible goods only lifts (2010)
- EN 81-40: Safety rules for the construction and installation of lifts - Special lifts for the transport of persons and goods - Part 40: Stairlifts and inclined lifting platforms intended for persons with impaired mobility (2009)
- EN 81-41: Safety rules for the construction and installation of lifts -Special lifts for the transport of persons and goods - Part 41: Vertical lifting platforms intended for use by persons with impaired mobility (2011)
- EN 81-43: Safety rules for the construction and installation of lifts - Special lifts for the transport of persons and goods - Part 43: Lifts for cranes (2010)
- EN 81-50: Safety rules for the construction and installation of lifts - Examinations and tests - Part 50: Design rules, calculations, examinations and tests of lift components (2015)
- EN 81-58: Safety rules for the construction and installation of lifts - Examination and tests - Part 58: Landing doors fire resistance test (2003)

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[9] Note that EN standards which are identical to ISO standards are not included in the analysis of this section but covered by the ISO section (see 1.6.2).

- EN 81-70: Safety rules for the construction and installation of lifts - Particular applications for passenger and goods passengers lifts - Part 70: Accessibility to lifts for persons including persons with disability (2005)
- EN 81-71: Safety rules for the construction and installation of lifts - Particular applications to passenger lifts and goods passenger lifts - Part 71: Vandal resistant lifts (2007)
- EN 81-72: Safety rules for the construction and installation of lifts - Particular applications for passenger and goods passenger lifts - Part 72: Firefighters lifts (2015)
- EN 81-73: Safety rules for the construction and installation of lifts - Particular applications for passenger and goods passenger lifts - Part 73: Behavior of lifts in the event of fire (2016)
- EN 81-77: Safety rules for the construction and installation of lifts - Particular applications for passenger and goods passenger lifts - Part 77: Lifts subject to seismic conditions (2014)
- EN 81-80: Safety rules for the construction and installation of lifts - Existing lifts - Part 80: Rules for the improvement of safety of existing passenger and goods passenger lifts (2004)

1.6.2. International Standards

According to www.iso.org, "ISO International Standards ensure that products and services are safe, reliable and of good quality. For business, they are strategic tools that reduce costs by minimizing waste and errors, and for increasing productivity. They help companies to access new markets, level the playing field for developing countries and facilitate free and fair global trade. "The ISO standards available for lifts are given in Table 1-18 (see Annex). They were retrieved from the ISO website. Standards regarding lifts are elaborated by the Technical Committee ISO/TC 178, which deals with lifts, escalators and moving walks, Working Group 10 is dedicated to energy efficiency .

The set of ISO standards dealing with lifts primarily focus on standardising safety issues for lifts. There is, however, one ISO standard that directly addresses the energy performance of lifts. EN ISO 25745 applies to passenger and goods lifts with a rated speed greater than 0,15 m/s and considers the lift's energy performance during operation. For any other type of lift (e.g. service lifts, lifting platforms, etc.), the EN ISO 25745 can be used as a reference. When industry decided to elaborate EN ISO 25745, the aim was to address lift energy efficiency and to initiate the process of an energy label for lifts. The standard consists of 3 parts:

- EN ISO 25745-1:2012: Energy performance of lifts, escalators and moving walks -- Part 1: Energy measurement and verification. EN ISO 25745-1:2012 specifies: a) methods of measuring actual energy consumption of lifts, escalators and moving walks on a single unit basis; b) methods of carrying out periodic energy verification checks on lifts, escalators and moving walks in operation. It only considers the energy performance during the operational portion of the life cycle of the lifts, escalators or moving walks.
- EN ISO 25745-2:2015: Energy performance of lifts, escalators and moving walks -- Part 2: Energy calculation and classification for lifts (elevators). The standard

specifies a method to estimate energy consumption based on measured values, calculation, or simulation, on an annual basis for traction, hydraulic and positive drive lifts on a single unit basis, and an energy classification system for new, existing, and modernized traction, hydraulic, and positive drive lifts on a single unit basis.

- EN ISO 25745-3:2015 specifies generic tools for estimating energy consumption of escalators and moving walks, and a consistent method for energy performance classification of existing, modernized, or new escalators and moving walks. It considers the energy performance during the operational portion of the life cycle of escalators and moving walks. This part of the standard is not relevant for lifts.

EN ISO 25745 Part 1 and Part 2 are applicable for hydraulic and traction lifts dedicated to the transportation of passengers and/or good lifts. Therefore, both parts of the standard are in line with the scope considered in this study.

ISO 25475-2 provides a methodology[10] and a rating scheme for:

- Performance level for running (see Table 1-8)

Table 1-8: Energy demand classes for travel (source: EN ISO 25745-2:2015)

Performance level	1	2	3	4	5	6	7
Specific running energy for the average running cycle [mWh/(kg m)]	≤0,72	≤1,08	≤1,62	≤2,43	≤3,65	≤5,47	>5,47

- Performance level for idle and standby (see Table 1-9)

Table 1-9: Performance level for idle/standby (source: EN ISO 25745-2:2015)

Performance level	1	2	3	4	5	6	7
Idle/standby power [W]	**≤50**	**≤100**	**≤200**	**≤400**	**≤800**	**≤1600**	**>1600**

- Energy performance of the lift

The energy performance of the lift is calculated as energy consumption per day [kW], it takes into account the performance in running as well as in idle/standby modes.

Six energy efficiency classes range from G (the worst) to A (the best) and are defined according to **specific** thresholds, each one depends on the abovementioned performance levels in running and in idle/standby modes (see Table 1-10).

[10] Detailed information on the standard ISO 25745 is provided in Task 3.

Table 1-10: Classification of Energy Efficiency Class (source: EN ISO 25745-2:2015)

Energy efficiency class	Energy consumption per day (Wh)
G	$E_d > 5.47 * Q * n_d * s_{av}/1000 + 1600 * t_{nr}$
F	$E_d \leq 5.47 * Q * n_d * s_{av}/1000 + 1600 * t_{nr}$
E	$E_d \leq 3.65 * Q * n_d * s_{av}/1000 + 800 * t_{nr}$
D	$E_d \leq 2.43 * Q * n_d * s_{av}/1000 + 400 * t_{nr}$
C	$E_d \leq 1.62 * Q * n_d * s_{av}/1000 + 200 * t_{nr}$
B	$E_d \leq 1.08 * Q * n_d * s_{av}/1000 + 100 * t_{nr}$
A	$E_d \leq 0.72 * Q * n_d * s_{av}/1000 + 50 * t_{nr}$

with: Q - rated load [kg], n_d - number of trips per day (according to the selected usage category), s_{av} -one-way average travel distance for target installation [m] and t_{nr} - non-running (idle and standby) time per day [h]

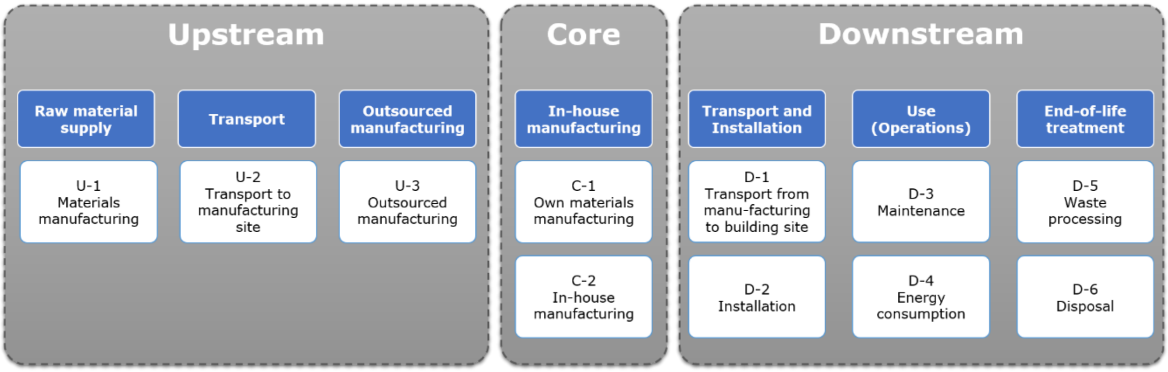
As such, EN ISO 25745-2 does not calculate the energy efficiency of the lift as the ratio of the above mentioned "energy consumption per day" [Wh] divided by the energy service delivered (e.g.: the functional unit [t.km] as defined in 1.5.1. but calculated on a daily basis).

1.6.3.Environmental Product Declaration

An Environmental Product Declaration® (EPD) is an international verified report, certified by a third party, on the environmental impact of a product or system over the entire span of its life cycle (see Figure 1-7). The International EPD System is a program to standardise, develop and publish these reports for any kind of good or service. Any declaration is created in accordance with ISO 14025 (Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures) and based on life cycle assessment (LCA) as prescribed in the standards ISO 14040 and ISO 14044.

To guarantee comparability between products of the same category general Product Category Rules (PCRs) must be agreed on. New PCRs are created in an open consultation and may be initiated by any stakeholder. They are eventually published and serve as a foundation for any stakeholder wanting to conduct an EPD for their product.

Figure 1-7: General system boundaries (source: EPD International AB 2015)



Besides any program related information EPDs contain specific product information about the product's functionality and more importantly environmental and performance related information. The LCA provides information such as resource acquisition, energy use and efficiency, various types of emissions and waste generation.

A set of stakeholders[11] came together and conducted the PCR UN CPC 4354, which was published in 2015 and is valid until 2019.[12] Together they set down the rules for lifts that are either new or modernised.

First of all, the functional unit (FU) is defined as the transportation of a load over a distance, expressed in tonne [t] over a kilometre [km] travelled, i.e. tonne kilometre [tkm]. It is then explained how to declare the content of the lift. 95% of the gross weight material must be declared and allocated into predefined categories. Further, the entire life cycle is divided into three phases: upstream (cradle-to-gate), core (gate-to-gate) and downstream (gate-to-grave). Clear instructions are given regarding which aspects have to be considered for each phase while definitions of general requirements for each phase are also provided. Then rules for the acquisition and use of generic data are given. Lastly, regulations on the environmental impact are made: A general prescription is made on which potential environmental impacts should be considered. Environmental impacts are all to be reported per FU [tkm] and the absolute figures must also be stated.

Extensive implementation of the PCRs – published in 2015 - is still awaited. ThyssenKrupp were the first to publish an EPD - for an hydraulic lift - under the

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[11] The major contributors to the paper were (in alphabetical order): Blain Hydraulics, EFESME, ELCA, GMV S.p.A, Hydroware AB, KONE, Orona, OSMA Aufzüge, Otis Elevator Company, Schindler Elevators Ltd., Schmidt+Sohn Aufzüge , ThyssenKrupp Elevator, VFA-Interlift, WITTUR Holding GmbH

[12] see all information on the PCR document and the whole process under http://environdec.com/en/PCR/Detail/?Pcr=9211 and http://gryphon.environdec.com/data/files/6/12754/epd1022%20endura%20MRL%20elevator%202017-09-15.pdf

international EPD system in March 2017[13]. Since then only a few manufacturers have followed with their own EPDs, such as KONE. However, according to stakeholders, EPDs of lifts are highly valued in the construction sector to communicate the environmental performance of lifts.

Furthermore, it is noticeable that creation of EPDs for traction lifts is more heavily pursued than for hydraulic lifts. It is also significant that the majority of stakeholders engaged in formulating EPDs are large manufacturers and that SMEs have not yet made it a priority concern.

1.6.4. National standards

So far, no national standards relevant for lift energy efficiency have been identified. However, national guidelines have been developed (see below).

1.6.5. National guidelines

In addition to international and European standards, technical standards can also be established on national level. The Association of German Engineers (VDI) has published the VDI 4707 guideline before the EN ISO 25745 has been elaborated. The motivation for elaborating the VDI 4707 was to promote energy efficiency in lifts and to initiate an energy labelling scheme for lifts.

It consists in three parts:

- VDI 4707 Part1 (2009-03): deals with the energy efficiency of lifts. This guideline aims to promote a universal and transparent understanding for the assessment of the energy efficiency of lifts based on methods for evaluating and testing their energy demand. VDI 4707 Part2 (2013-10): focuses on the energy efficiency of lift components. The target of Part 2 is to allow the assessment of the energy efficiency of a lift by choosing the appropriate components.
- VDI 4707 Part3 (2016-11, draft): Deals with lifts according to the Machinery Directive definition, which are not properly covered in VDI 4707 Part 1, since they don't have to comply with safety standard EN 81 and they are travelling at max 0,15 m/s.

VDI 4707 Part1 provides the foundation for an energy rating of lifts embedded in the framework of the overall energy efficiency of buildings, by defining energy efficiency classes for the standby mode and running mode. The classes range from G (least efficient) to A (most efficient). The energy efficiency class is determined from the energy demand values during standby and during travel. Based on the values the energy efficiency class is assigned according to Table 1-11 and Table 1-12.

Table 1-11: Energy demand classes for standby (source VDI 4707-1)

Class	A	B	C	D	E	F	G
Output [W]	≤50	≤100	≤200	≤400	≤800	≤1600	>1600

[13] see: http://environdec.com/en/News-archive/thyssenkrupp-Elevator-publish-first-EPD-of-a-lift/

Table 1-12: Energy demand classes for travel (source: VDI 4707-1)

Class	A	B	C	D	E	F	G
Specific energy consumption [mWh/(kg m)]	≤0,56	≤0,84	≤1,26	≤1,89	≤2,80	≤4,20	>4,20

The performance of the lift is expressed as a specific demand, taking into account both standby and travel modes. As for ISO25475-2, each one of the 7 energy efficiency classes consider a specific threshold (see Table **1-13**).

Table 1-13: Specific energy demand of the lift [mWh/(kg·m)], (source: VDI 4707-1)

Energy efficiency class	**Sepecific energy demand on the lift**, in mWh(kg*m)				
	Usage category				
	1	2	3	4	5
G	$> 4.2\frac{mWh}{kg*m}+\frac{1600W*23.8h*1000}{Q*v_{Nenn}*0.2h*3600}$	$> 4.2\frac{mWh}{kg*m}+\frac{1600W*23.5h*1000}{Q*v_{Nenn}*0.5h*3600}$	$> 4.2\frac{mWh}{kg*m}+\frac{1600W*22.5h*1000}{Q*v_{Nenn}*1.5h*3600}$	$> 4.2\frac{mWh}{kg*m}+\frac{1600W*21h*1000}{Q*v_{Nenn}*3h*3600}$	$> 4.2\frac{mWh}{kg*m}+\frac{1600W*18h*1000}{Q*v_{Nenn}*6h*3600}$
F	$4.2\frac{mWh}{kg*m}+\frac{1600W*23.8h*1000}{Q*v_{Nenn}*0.2h*3600}$	$4.2\frac{mWh}{kg*m}+\frac{1600W*23.5h*1000}{Q*v_{Nenn}*0.5h*3600}$	$4.2\frac{mWh}{kg*m}+\frac{1600W*22.5h*1000}{Q*v_{Nenn}*1.5h*3600}$	$4.2\frac{mWh}{kg*m}+\frac{1600W*21h*1000}{Q*v_{Nenn}*3h*3600}$	$4.2\frac{mWh}{kg*m}+\frac{1600W*18h*1000}{Q*v_{Nenn}*6h*3600}$
E	$2.8\frac{mWh}{kg*m}+\frac{800W*23.8h*1000}{Q*v_{Nenn}*0.2h*3600}$	$2.8\frac{mWh}{kg*m}+\frac{800W*23.5h*1000}{Q*v_{Nenn}*0.5h*3600}$	$2.8\frac{mWh}{kg*m}+\frac{800W*22.5h*1000}{Q*v_{Nenn}*1.5h*3600}$	$2.8\frac{mWh}{kg*m}+\frac{800W*21h*1000}{Q*v_{Nenn}*3h*3600}$	$2.8\frac{mWh}{kg*m}+\frac{800W*18h*1000}{Q*v_{Nenn}*6h*3600}$
D	$1.89\frac{mWh}{kg*m}+\frac{400W*23.8h*1000}{Q*v_{Nenn}*0.2h*3600}$	$1.89\frac{mWh}{kg*m}+\frac{400W*23.5h*1000}{Q*v_{Nenn}*0.5h*3600}$	$1.89\frac{mWh}{kg*m}+\frac{400W*22.5h*W*0}{Q*v_{Nenn}*1.5h*3600}$	$1.89\frac{mWh}{kg*m}+\frac{400W*21h*1000}{Q*v_{Nenn}*3h*3600}$	$1.89\frac{mWh}{kg*m}+\frac{400W*18h*1000}{Q*v_{Nenn}*6h*3600}$
C	$1.26\frac{mWh}{kg*m}+\frac{200W*23.8h*1000}{Q*v_{Nenn}*0.2h*3600}$	$1.26\frac{mWh}{kg*m}+\frac{200W*23.5h*1000}{Q*v_{Nenn}*0.5h*3600}$	$1.26\frac{mWh}{kg*m}+\frac{200W*22.5h*1000}{Q*v_{Nenn}*1.5h*3600}$	$1.26\frac{mWh}{kg*m}+\frac{200W*21h*1000}{Q*v_{Nenn}*3h*3600}$	$1.26\frac{mWh}{kg*m}+\frac{200W*18h*1000}{Q*v_{Nenn}*6h*3600}$
B	$0.84\frac{mWh}{kg*m}+\frac{100W*23.8h*1000}{Q*v_{Nenn}*0.2h*3600}$	$0.84\frac{mWh}{kg*m}+\frac{100W*23.5h*1000}{Q*v_{Nenn}*0.5h*3600}$	$0.84\frac{mWh}{kg*m}+\frac{100W*22.5h*1000}{Q*v_{Nenn}*1.5h*3600}$	$0.84\frac{mWh}{kg*m}+\frac{100W*21h*1000}{Q*v_{Nenn}*3h*3600}$	$0.84\frac{mWh}{kg*m}+\frac{100W*18h*1000}{Q*v_{Nenn}*6h*3600}$
A	$0.56\frac{mWh}{kg*m}+\frac{50W*23.8h**000}{Q*v_{Nenn}*0.2h*3600}$	$0.56\frac{mWh}{kg*m}+\frac{50W*23.5h*W*0}{Q*v_{Nenn}*0.5h*3600}$	$0.56\frac{mWh}{kg*m}+\frac{50W*22.5h*W*0}{Q*v_{Nenn}*1.5h*3600}$	$0.56\frac{mWh}{kg*m}+\frac{50W*21h*W*0}{Q*v_{Nenn}*3h*en}3600$	$0.56\frac{mWh}{kg*m}+\frac{50W*18h*W*0}{Q*v_{Nenn}*6h*3600}$

The result may be illustrated by attaching an energy certificate for lifts and forwarding it to the operator as a supplement to the operating documentation. The German VDI 4707 standard provides a kind of label for lift energy consumption, see Figure 1-8, on which the nominal demand per year [kWh] is also mentioned. Lift (Elevator) Energy Consumption label according to VDI 4707. This label was also promoted by manufacturers in other countries in the world. However, in the EU, the new Energy Labelling regulation 2017/1369/EU restricts the use of label that mimic the energy label.[14]

Lift energy efficiency certificate according to VDI 4707

Manufacturer:	Company
Location:	Street City
Lift model:	Series/Versions
Lift type:	electric or hydraulic operated passenger lift
Nominal load:	XX kg
Nominal speed	XX m/s
Operationg days per year:	XX
Standby demand: XX W	**Sepcific travel demand:** XX mWh/(kg*m)

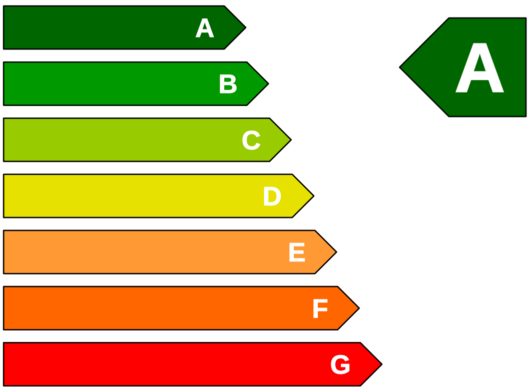
Usage category X according to VDI 4707

Comparison of energy efficiency class is only possible under equal usage

Date: dd.mm.yyyy

Reference: VDI 4707 Part 1 (issue 03-2009)

Energy efficiency class



Nominal demand per year for nominal vlaues as shown:
XX kWh

Figure 1-8: Energy certificate for a lift according to VDI 4707 Part 1

This technical guideline had the advantage of earlier publication than ISO 205745 and accordingly it has been used by manufacturers. However, the VDI guideline remains considered as a German document by many stakeholders, which limits its acceptance outside of Germany, particularly in Europe, where EN ISO 25745 is recognized in each Member State.

[14] (23) mentions: "In order for customers to retain confidence in the energy label, other labels that mimic the energy label should not be allowed to be used for energy-related products and non-energy-related products. Where energy-related products are not covered by delegated acts, Member States should be able to maintain or introduce new national schemes for the labelling of such products."

Comparison[15] of VDI4707-1 and EN ISO 25745-2

While EN ISO 25745 and VDI4707 aim at assessing the energy performance of lifts in both standby and travelling mode, they differ in a few aspects. **Table 1-14** provides an overview of these differences. In general, EN ISO 25745 is more complex than VDI4707.

Table 1-14: Comparison of VDI4707-1 and EN ISO 25745-1 (based on S. Iqdal and Fraunhofer ISI)

Topic	VDI 4707-1	EN ISO 25745-2
Measuring procedures/ (raw) data collection	§ 4.4 "[...] Details on measuring procedure are given in ISO 25745-1. [...]"	§ 4: "[...] can be obtained using the energy measurement methodologies as specified in ISO 25745-1 or by calculation or simulation. [...]"
Accuracy of measurements	ISO 25745-1, §4.1.2: "The measured value shall have accuracy of at least than +/- 10%."	ISO 25745-1, §4.1.2: "The measured value shall have accuracy of at least than +/- 10%."
Accuracy of calculations	§ 5: "[...] there may be deviations of up to +/+ 20% as a result of scatter and slight differences in settings. [...]"	§ 5.1 Note: there may be deviations between the calculated and measured value. [...] Is the deviation greater than 20%, inspections should be made"
Usage Categories	5 different categories (based on Average travel time in hours per day)	6 different categories (based on number of trips per day)
Running/ travel energy consumption of ISO 25745-1 reference cycle (Wh)	Considered for energy demand calculation (average running energy per meter)	Considered for energy demand calculation (average running energy per meter)
Running energy consumption of the short cycle (Wh)	Not considered	Considered for energy demand calculation (but can be skipped if the lift only has two stops)
One way travel distance of the short cycle (m)	Not considered	Considered for energy demand calculation (but can be skipped if the lift only has two stops)
Start/stop energy consumption for each trip (Wh)	Not explicitly considered	Considered for energy demand calculation (running energy of an average cycle with empty car)
Standby power consumption after 5 minutes of lifts inactivity (W)	Considered for energy demand calculation (daily running energy at inactivity)	Considered for energy demand calculation (daily running energy at inactivity)

15 presented for informative purpose, as ISO 25745-2 is adopted in all EU Member States

Standby power consumption after 30 minutes of lift inactivity (W)	Not considered	Considered for energy demand calculation (daily running energy at inactivity)
Idle power consumption	Considered for energy demand calculation (annual running energy)	Considered for energy demand calculation (whole daily running energy)
Energy demand classes	7 pieces (A to G), where A is the one with the lowest energy requirement Based on Specific energy consumption [mWh/(kg m)]	7 pieces (A to G), where A is the one with the lowest energy requirement Based on energy consumption per day (day)
Application range	Assessment and labeling of the energy efficiency of new passenger and goods lifts and subsequent declaration of the energy efficiency of existing lifts Basis for energetic evaluation of lifts within the overall energy efficiency of buildings (attached energy certificate)	Procedures for estimating the daily and annual energy consumption Energy classification procedure for new, existing and modernized lifts
Unaccounted	Machine room and well lighting --> only components that contribute to the operational availability or operation of the lift	Illumination of the well Device for heating/cooling in the lift car ; Illumination Machine room Heating, cooling, air conditioning of the machine room Non-lift monitoring systems Effects of a group control on energy consumption Consumption via sockets
Energy measurement	Operating power – ride Operating power – readiness and standby Auxiliary energy - ride Auxiliary energy – readiness and standby	Operating power - ride Operating power – readiness and standby Auxiliary energy - ride Auxiliary energy – readiness and standby
Inspection of energy consumption	Drive current – ride Drive current – readiness and standby Additional current - ride Additional current – readiness and standby	Drive current - ride Drive current – readiness and standby Additional current - ride Additional current – readiness and standby
Demand measurement	Power consumption at standby Power consumption in startup mode Power consumption in silent running Power consumption in no-load mode	Power consumption at standby Power consumption in startup mode Power consumption in silent running

	Power consumption of additional consumers	Power consumption in no-load mode Power consumption of additional consumers
Inspection of demand measurement	Power consumption in no-load mode	Power consumption in no-load mode
Standby demand	Power requirement when the lift is at a standby with the drive switched off Determination by measurement or summation of the individual demand values Standby demand is determined 5 minutes after the last trip	Determine by procedures of energy measurement or by calculation or simulation 5-minute standby demand 30-minute standby demand (only necessary with an energy consuming component, which switches to a lower energy level after 5 minutes)
Travel demand	Total energy demand of the lift During the journeys at fixed driving cycles With defined loading conditions -> the resulting specific demand value is based on nominal load in kilograms and distance travelled in meters -> this can be used to compare the energy efficiency of different lifts Determined for reference runs with different loadings based on nominal load according to the load spectrum according to the table	Consists of some single components: Average energy consumption per meter of ride at nominal speed Energy consumption at start/stop Energy consumption for one drive in the average cycle with an empty car Daily energy consumption for driving
Overall consumption	Specific total energy requirement (determined from standby and driving energy demand values by extrapolating standby power and energy demand for driving with average standby times and travel times to a daily requirement and then dividing by rated load and distance travelled)	Estimated daily energy consumption (sum of energy consumption when standing and energy consumption for driving) or estimated annual energy consumption
Energy demand- and efficiency classes	Energy demand classes for standby and ride, depending on requirements	Energy demand classes (Thresholds based on power levels for driving according to the table and for the standby mode as well as for standing (standby and standstill)
Overall consumption		

1.6.6. Labels

1.6.6.1. VDI 4707

The guideline VDI 4707 already presented in 1.6.5 can be considered as a voluntary energy labelling scheme.

1.6.6.2.BREEAM

BREEAM (Building Research Establishment's Environmental Assessment Method) is one of the main sustainability-rating scheme for buildings. It was developed in U.K. by BRE (Building Research Establishment) Group but is applied in more than 50 countries over the world. A certificate is delivered after the assessment of the building (see Figure 1-9 for the certification mark). BREEAM includes energy efficient transportation systems for all buildings, which can be rewarded with 2 credits (but there is no minimum standards).[16] For new construction of non-domestic buildings, the technical manual 2014 based its methodology on ISO 25745 and rewards with up to 3 credits energy-efficient transportation systems.[17]

Figure 1-9: The BREEAM certification mark (BRE 2014)

1.6.6.3.ENERGY STAR

ENERGY STAR (see Figure 1-10) is a further voluntary program launched and managed by the U.S. Environmental Protection Agency (EPA) to promote and identify energy efficient products, homes, and buildings for businesses and individuals to help save money and reduce emissions. It provides simple, credible and unbiased information for businesses and consumers for them to make well-informed decisions.

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16 http://www.breeam.com/BREEAMInt2013SchemeDocument/content/06_energy/ene_06_energy_efficient_transportation_systems.htm

17 https://www.breeam.com/BREEAMUK2014SchemeDocument/content/06_energy/ene06.htm

Figure 1-10: Energy Star Label

It has gained popularity in many other countries in the world including the European Union apart from the U.S. where it originates. Though the label covers a variety of different product categories, it does not directly include lifts. However, the Energy Star program does have certain programs dedicated to buildings that do include energy efficiency aspects of lifts:

- For commercial and industrial buildings: Energy Star has a focus on the entire building energy use.[18] It receives recognition depending on the evaluation through the Portfolio Manager tool. In order to evaluate the whole-building performance, it compares the utility bills with a reference set. A building is entitled as an ENERGY STAR building if it scores more than 75 points (of 100) in the analysis. With this approach, services like vertical transportation are taken into account, but not heavily weighted, since they are usually relatively small fractions of the total energy bill.
- For Multifamily High-Rise buildings:[19] a specific program offers a simulation path that includes lift loads.[20] It prescribes appropriate baseline technologies for units of 4–6, 7–20, and 21+ stories. In addition, it also provides a methodology to determine total energy consumption of lifts without using a lift simulation module. If the lift use is simulated, the existence of standby/idle savings can also be implied. If not included in the simulation however, savings from lighting and ventilation in the car can also be claimed as a separate performance credit arising from the stipulated baseline technology.

[18] https://www.energystar.gov/buildings/about-us

[19] https://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_multifamily_highrise

[20] Section 3.11 of ENERGY STAR 2013

1.6.6.4.LEED

As a further voluntary label, the USGBC offers the LEED[21] certification program (see Figure 1-11) for green buildings. The program has gained popularity since owners and tenants gain prestige when earning the label.

Figure 1-11: LEED Label

To earn the certification a building or project needs to meet certain prerequisites and score a number of credit points to qualify. Lifts represent a part of unregulated process loads, and therefore installing more efficient systems does not directly yield scoring credits. However, LEED offers a possibility to earn credits when demonstrating a reduction in process loads, and efficient lifts are eligible to apply for these credits. There are also other alternatives to help lifts meet LEED prerequisites and by doing so also achieve credit points. For both new construction as well as existing buildings, lifts can raise a building's energy performance over the prescribed baseline, such as ASHRAE 90.1-2016, and therefore score points in the Energy and Atmosphere category. Moreover, the materials used in constructing elevators play an important role in earning credits for the Material and Resources as well as the Indoor Environmental Quality categories. For example, recycled steel, aluminium, plastics, glass, and rubber can be used in the construction of the elevator and low VOC materials for the interior.

1.7. Existing legislation

According to the MEErP methodology, EU legislation, Member State legislation and third country legislation relevant to the product group have to have been screened and analysed.

1.7.1. European legislation

1.7.1.1.Overview

The legal environment for lifts in the EU is directly and indirectly affected by various Directives and regulations. In the following, the most relevant Directives will be discussed with regard to their impact on the product definition.

At the EU level, the relevant legislation and agreements affecting lifts are:

- Lift Directive 2014/33/EU of the EU Parliament and of the EU Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to lifts and safety components for lifts (recast). This EU regulation dedicated to lifts entered into force in April 2014 and set safety and health requirements on

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[21] Leadership in Energy and Environmental Design, see https://new.usgbc.org/leed

lifts and on safety components for lifts which are placed into the EU27 market. So far, there is no direct interaction with energy efficiency aspects. Annex I of the Directive also emphases the role of the Directive 2006/42/EC: "Where the relevant risk exists and is not dealt with in this Annex, the essential health and safety requirements of Annex I to Directive 2006/42/EC of the European Parliament and of the Council (1) apply. The essential health and safety requirements of point 1.1.2 of Annex I to Directive 2006/42/EC apply in any event".

Article 7 describes the obligations of installers, in particular with regard to the CE marking for lifts complying with the applicable essential health and safety requirements.

- Directive 2009/104/EC concerning the minimum safety and health requirements for the use of work equipment by workers at work (second individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC). It aims to encourage improvements in the safety and health of workers at work. The Directive impacts lifts, since safety and health requirements are set for the putting into operation of lifts.
- Machinery Directive 2006/42/EC of the European Parliament and Council of 17. May 2006 concerning machines and amendment to the Directive 95/16/EC (new version). The 2006/42/EC Directive regulates an uniform level of safety and accident prevention for machinery and machinery parts placed on the European market. It covers the mechanical design, electrical design, controls and the overall potential for the machinery to cause hazard.

  The Directive 2006/42/EC recasts the Directive 95/16/EC (Machinery Directive) concerning machinery and certain parts of machinery. The objective of this Directive is to ensure basic safety and health protection requirements concerning the construction and construction of transport machinery are abided by. Also the Directive promotes the free movement of machinery within the Single Market and it only applies to products that are to be placed on the EU market for the first time. For lifting appliances, the Machinery Directive has a wider scope than the Lift Directive 2014/33/EU. For example, it does not mention any speed threshold.

  Due to the definition of "lift" in this Preparatory Study, some requirements for lifts, which are explicitly addressed by the Machinery Directive, are not applicable.

In addition, the Commission Recommendation of 8 June 1995 concerning improvement of safety of existing lifts (95/216/EC) should also be mentioned. It invites Member States to take all necessary actions to ensure a satisfactory level of maintenance for existing lifts and to improve the safety of these lifts. The recommendation is not legally binding and is implemented by the Member States in light of the situation and provisions existing at national level.

- Ecodesign Directive: The Ecodesign Directive (Directive 2009/125/EC) is a framework Directive defining the principles, conditions and criteria for setting environmental requirements for energy-related products. It makes no direct provision for mandatory requirements for specific products; this is done at a later stage for given products via implementing measures, which will apply following consultations with interested parties and the conduct of an impact assessment.

This study on lifts is carried out under the provisions of the Ecodesign Directive. In the past, similar studies have been carried out for equipment that can be part of the auxiliary equipment used for lifts (Table 1-15).

However, no relevant regulations based on the Ecodesign Directive that directly addresses lifts could be identified during this work.

Table 1-15: EU regulations implementing Ecodesign Directice and/or Energy Labelling Regulation concerning lift equipment

Product	Regulation	Application		
		Lift	Well	Comments
Non-directional household lamps	244/2009/EC	x	x	
Fluorescent lamps without integrated ballast	247/2010/EC	x	x	
Directional lamps and LEDs	1194/2012/EC	x	x	
Ventilation fans	2011/327/EC	x	x	
Air conditioning	206/2012/EC	x	x	
Electrical Motor	640/2009/EC	(x)	(x)	Almost not applicable, since definition requires "continuous duty operation"
Local space heaters	EU 2015/1188 and EU 2015/1186	x	(x)	
Space and combination heaters	813/2013 and 811/2013	(x)	(x)	
air heating products, cooling products, high temperature process chillers and fan coil units	2016/2281	(x)	x	

x : impact, (x) : restricted impact

The above-mentioned product-specific EU regulations have been elaborated in line with the Ecodesign Directive and the Energy Labelling Regulation.

1.7.1.2.Energy Labelling Regulation

Originally, the Energy Labelling Directive (Directive 92/75/EC) provided a framework for the provision of product information related to energy consumption and use of other essential resources by household products. This should enable consumers to choose more energy efficient appliances. The focus of the Directive was on appliances whose aggregate use of energy is significant and which offers an adequate scope for increased efficiency.

A revised Directive on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products

(2010/30/EU) was introduced in 2010. This expanded the possible introduction of labelling requirements beyond the area of domestic appliances to energy-related products with significant direct or indirect impact on the consumption of energy. Under this Directive, the Commission has delegated power to set the labelling requirements for specific products. The 2010 version of the Directive like the Ecodesign Directive, do not apply to means of transport for persons or goods.

Means of transport

Both, the Ecodesign Directive and the Energy Labelling Regulation exclude "means of transport for persons or goods".

The Frequently Asked Questions (FAQ) on the Ecodesign Directive and its Implementing Regulations delivers a clarification on the scope of the framework regulation regarding lifts:[22]

"The Commission has in the early stage of the ecodesign process informed Member States that it considers lifts, conveyor belts and other stationary transport machinery to be included in the scope of the Directive."

Accordingly, lifts and the components can be subject to regulation within the Ecodesign Directive and the Energy Labelling Regulation.

In 2017 the Energy Labelling Directive was updated again to become the Energy Labelling Regulation (EU 2017/1369). The recast mainly aims at rescaling the energy classes of the label. However, it mentions in the introduction:

(4) It is appropriate to replace Directive 2010/30/EU by a Regulation which maintains essentially the same scope, but modifies and enhances some of its provisions in order to clarify and update their content, taking into account the technological progress for energy efficiency in products achieved over recent years. As the energy consumption of means of transport for persons or goods is directly and indirectly regulated by other Union law and policies, it is appropriate to continue to exempt them from the scope of this Regulation, including means of transport with a motor that stays in the same location during operation, such as elevators, escalators and conveyor belts.

As stated in the newest labelling regulation, the energy consumption of means of transport is excluded if it is regulated by other Union laws and policies. The example of lifts is given for means of transport. Yet it should be noted that for lifts (as whole product), there is no direct or indirect regulation of the energy efficiency by other Union law and policies. Thus, there is an inconsistency in the motivation to exclude lifts. The implications thereof goes beyond the scope of this study and remain to be further assessed.

[22] see Commission services and the Market Surveillance Authorities of Member States in 2014

1.7.1.3. Energy Efficiency Directive

The Energy Efficiency Directive (2012/27/EU) introduces new instruments to foster energy efficiency in Europe significantly. Among with the further development of measures originally laid down in the Energy Services Directive (2006/32/EC), like the national reporting on energy efficiency efforts in the National Energy Efficiency Action Plans (NEEAP), the Directive introduces some new instruments which are relevant in the context of energy-using and energy-related products.

The main new instrument is the (mandatory) introduction of energy saving obligation schemes within the Member States as laid down in Article 7. This instrument is supposed to deliver additional savings equivalent to 1.5 % of the annual energy consumption of the Member States in a reference period. The Ecodesign Directive is quoted directly as a mandatory baseline for these savings, so the savings accounted to the 1.5 % target must exceed the minimum requirements for the products under coverage of the Directive.

Instruments such as the mandatory energy audits for larger enterprises may lead to an increased demand for efficient technologies. However, there are no regulations in the Energy Efficiency Directive that directly affect lifts.

1.7.1.4. Energy Performance in Buildings Directive (EPBD)

Directive 2010/31/EU on the energy performance of buildings was elaborated in order to promote the energy performance of buildings and building units. This Directive is an updated version of the earlier 2002 EPBD which has stronger energy performance requirements and to better elucidated and concretises some of the provisions from the 2002 Directive.

The revised Directive affirms the importance of effective implementation at the Member State level, as well as the importance of community-wide and long-term collaboration and commitment and also the role of the Commission itself to foster an effective implementation.

The Commission communication in 2008 for the initial proposal suggests, buildings hold significant untapped potential for cost effective energy savings “which, if realized, would mean that in 2020 the EU will consume 11 % less final energy.” The considerable magnitude of the savings potential compels that every effort must be made to achieve it (Build Up 2010).

This Directive includes requirements for the application of minimum requirements to the energy performance of technical building systems whenever they are installed, replaced or upgraded. According to Article 2.3. (amended on 30 May 2018 by 2018/844/EU)[23]: " ‘technical building system’ means technical equipment for space heating, space cooling, ventilation, domestic hot water, built-in lighting, building automation and control, on-site electricity generation, or a combination thereof, including those systems using energy from renewable sources, of a building or building unit". Therefore, the EPBD doesn't provide currently a legal framework to set minimum requirements to lifts.

However, the EPBD does not exclude taking the energy performance of lifts into account when considering the performance requirements of buildings. Article 1: "this Directive

[23] In some drafts of the recast of the EPBD Directive, lifts were mentioned in the list of the 'technical building system'

also lays down requirements as regards the application of minimum requirements to the energy performance of new buildings and new building units", whereby Article 2.4 specifies: ‘energy performance of a building’ means the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting'.

Since lifts, unlike heating systems, are not mandatorily taken into account for setting minimum requirements of energy performance of new buildings in the Directive, it has to be checked at the national level, whether and how Member States have explicitly included the energy performance of lifts in their national building regulations (see 1.7.2).[24]

1.7.1.5.Other directive and regulations

Next to the Directives and regulations shown above, there are further items of EU legislation potentially affecting the design, installation and operation of lifts. For the product definition, they have little importance and are thus only provided for information without addressing them in detail here:

- Low Voltage Directive (73/23/EEC, 93/68/EC)

  The 73/23/EEC Directive and the amending 93/68/EC Directive lay out safety requirements for low voltage electrical equipment and regulate the mandatory CE marking of devices before being placed on the market.

  The Directive 93/68/EC modified amongst other aspects the original Low Voltage Directive 73/23/EC (electrical equipment designed for use within certain voltage limits) to include a requirement for CE marking and the creation of a technical file.

  In the Directive 73/23/EC "electrical equipment" is defined as:

  "any equipment designed for use with a voltage rating between 50 and 1000 V for alternating current (A.C.) and between 75 and 1500 V for direct current (D.C.)"

  and is therefore relevant for lifts.

- Waste Electrical and Electronic Equipment Directive (2012/19/EC)

  The 2012/19EC Directive aims to avoid waste from electrical and electronic equipment (WEEE) and to reduce such waste by reuse, recycling and other forms of recovery. It lays down minimum standards for the treatment of WEEE in the EU, so as to preserve, protect and improve the quality of the environment and to use natural resources wise and cautiously.

  The categories of electrical and electronic equipment (EEE) covered by this Directive are:

[24] some MS explicitly include or exclude (e.g. Finland) lifts from the scope, but most of them don't mention lifts

- o large household appliances
- o small household appliances
- o IT and telecommunication equipment
- o consumer equipment and photovoltaic panels
- o lighting equipment
- o electrical and electronic tools (with the exception of large-scale stationary industrial tools)
- o toys, leisure and sports equipment
- o medical devices (with the exception of all implanted and infected products)
- o monitoring and control instruments
- o automatic dispensers.

In the Directive, EEE is defined as:

- o equipment which is dependent on electric currents or electromagnetic field in order to work properly
- o equipment for the generation, transfer and measurement of such currents and fields
- o equipment designed for use with a voltage rating not exceeding 1000 V for alternating current and 1500 V for direct current.

Equipment types excluded from the Directive are:

- o equipment which is specially designed and installed as part of another type of equipment that is excluded from or does not fall within the scope of this Directive, which can fulfil its function only if it is part of the equipment
- o large-scale fixed installations, except any equipment which is not specifically designed and installed as part of those installations
- o means of transport for persons or goods, excluding electric two-wheel vehicles which are not type-approved.

- RoHS Directive (2011/65/EC)

  Directive 2011/65/EU (on the restriction of the use of certain hazardous substances in electrical and electronic equipment) restricts the "use of certain hazardous substances in electrical and electronic equipment (EEE) with a view to contributing to the protection of human health and the environment, including the environmentally sound recovery and disposal of waste EEE" by regulating their use and placing on the market. The aim is to eliminate hazardous components from electronic waste. It includes the replacing of leaded solderings and promotion of the introduction of equivalent replacement products where possible.

Member states should ensure that new products do not contain any of the following substances:

- o mercury
- o cadmium
- o hexavalent chromium
- o polybrominated biphenyls (PBB)
- o polybrominated diphenyl ethers (PBDE).

The categories of EEE covered by this Directive are (Annex 1):

- o large household appliances
- o small household appliances
- o IT and telecommunications equipment
- o consumer equipment
- o lighting equipment
- o electrical and electronic tools
- o toys, leisure and sports equipment
- o medical devices
- o monitoring and control instruments including industrial monitoring and control instruments
- o automatic dispensers
- o other EEE not covered by any of the categories above.

Most electronic components of a lift might by subject to the RoHS Directive.

- Waste Framework Directive 2008/98/EC

This Directive of the European Parliament and of the Council of 19 November 2008 sets the basic waste management definitions for the EU. Furthermore, it provides a general framework of waste management requirements.

Since the Directive covers oil waste defined as mineral or synthetic lubrication or industrial oils used as hydraulic oils, it is relevant for hydraulic lifts. Article 21 is dedicated to waste oils and requires them to be collected separately, where this is technically feasible.

1.7.2. Member State legislation

In this section, a scoping of national laws and ordinances of Member States has been performed taking into account among others the following sources:

- Odysse Mure project [25]

[25] http://www.odyssee-mure.eu/

- World Energy Council[26]
- Collaborative Labelling and Appliance Standards Program (Clasp)[27]
- Input from stakeholders

1.7.2.1.Germany

In Germany the Working Group of Mechanical and Electrical Engineering for State and Local Governments (AMEV)[28] made the recommendation "notes for planning, floating of tenders and use of lift systems in public buildings" to bring up some comprehensive and practice-oriented economic approaches for all participants especially in public buildings. The recommendation considers all legal requirements, engineering standards and technical guidelines for lifts. It stresses that the highest energy efficiency class should be chosen but recognises, that according to the usage case, lower energy efficiency class might be preferred.

1.7.2.2.Italy

Italy has integrated the consideration of lifts and escalators in its legislation for energy efficient buildings. In the Ministerial Decree of 26/06/2015 Paragraph 1[29] about National guidelines for attesting the energy performance of buildings, lifts and escalators are legally one aspect that have to be considered when calculating the overall energy performance index of the building. The decree also prescribes that lifts and escalators have to be equipped with electric motors that comply with the Ecodesign requirements set out by the European Commission in their regulation 2009/640/EC implementing their Directive 2005/32/EC.

1.7.2.3.Denmark

In the most recent buildings regulation of 2018, §248 stated that lifts in new buildings or the installation of new lifts in already existing buildings that are not solely intended for residential usage have to comply with the energy class B regulations set out in ISO 25745-2 or VDI 4707 in case the former cannot be calculated. This applies to lifts with a nominal load of up to 2,000kg. Higher energy consumption than energy class B may be accepted if equivalent compensatory energy savings are implemented.

1.7.2.4.Portugal

The decree 118/2013 in Portugal prescribes lifts in non-residential buildings to comply at least with energy class B standards from VDI 4707 since 2016.

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[26] https://wec-policies.enerdata.net/

[27] http://clasp.ngo/Tools/Tools/SLSearch

[28] see edition from 01.08.2017: https://www.amev-online.de/AMEVInhalt/Planen/Elektrotechnik/Aufzug%202017/AMEV_Aufzug_01_08_2017.pdf

[29] http://www.sviluppoeconomico.gov.it/images/stories/normativa/DM_requisiti_minimi_allegato1.pdf

1.7.3.Third country legislation

In this section, similar sources as for the section 1.7.2 have been considered.

1.7.3.1.USA

The United States have each their own codes, which regulate building energy standards. The ASHRAE 90.1, "Energy Standard for Buildings Except Low-Rise Residential Buildings" has been used as a national reference standard since 1992. Its scope covers any building except single-family houses, multifamily structures of three stories or fewer, manufactured houses (mobile homes) and buildings that neither use electricity nor fossil fuel. It provides standards for new buildings and their systems or new systems or equipment in existing buildings.

After the revision in 2010 the expanded scope also included lifts and escalators. But besides including the two in the calculations for the energy efficiency of buildings, it also specifies minimum efficiency levels for lighting and ventilation in the lift car as well as setting standby-mode requirements for them (see Table 1-16).

Table 1-16: Lift car efficiency requirements (as specified in ASHRAE 90.1-2016, Section 10.4.3)

Component	Requirement
Lighting	For the luminaires in each elevator cab, not including signals and displays, the sum of the lumens (lm) divided by the sum of the watts shall be no less than 35 lm/W.
Ventilation power limitation	Cab ventilation fans for elevators without air conditioning shall not consume over 0.33 W/cfm at maximum speed.
Standby mode	When cab is stopped and unoccupied with doors closed for over 15 minutes, cab interior lighting and ventilation shall be de-energized until required for operation

The latest ASHRAE 90.1.-2016 now requires design documents for lifts to list the usage category as well as the energy efficiency class, both as defined in ISO 25745-2.

Furthermore, a minimum threshold has not yet been defined, however, it suggests that minimum energy efficiency requirements for elevators are to be included in the future.

California, regarded as one of the more progressive states, for example has defined their own legislative requirements in their 2016 Building Energy Efficiency Standards[30] that are related to the ones set out in the ASHRAE 90.1 (Table 1-16)

1.7.3.2.Mexico

The voluntary endorsement label *Sello FIDE No. 4165*[31] (see Figure 1-12) for lifts establishes the criteria and limits of the energy characteristics that elevator models must comply with, in order to obtain the license for the use of the label of guarantee of

[30] http://www.energy.ca.gov/2015publications/CEC-400-2015-037/CEC-400-2015-037-CMF.pdf

[31] http://www.fide.org.mx/images/stories/sellofide/esp4165_01.pdf

energy efficiency, denominated "Seal FIDE". The document is based on the guideline VDI 4707.

Figure 1-12: Voluntary endorsement label Sello FIDE

1.7.3.3.Russia

The Russian Federation in the first instance has integrated lifts in their federal law order № 262 about energy efficiency for buildings and structures of various designs and purposes. On the one hand, it includes the energy consumed by lifts in the overall energy balance and on the other hand the order requires all new and repaired buildings to be equipped with a set of energy efficient appliances including lifts[32].

Secondly, the Russian federal law order № 357 about approval of rules of determination by producers and importers of the class of energy efficiency of goods and other information on its energy efficiency also includes lifts. Thereby, the method of determining the energy efficiency of lifts has been prescribed, however official energy classes and labels are still yet to be established.

1.7.3.4.Japan

The legislature of Japan in cooperation with The Energy Conservation Center Japan (ECCJ) have issued a guidebook on energy conservation for buildings that focuses on energy savings in buildings, energy management measures and provides a checklist for energy saving[33]. It includes lifts as one of a few technical equipment. However, the guideline has no obligatory character, but is merely intended to promote energy efficiency.

1.7.3.5.Hong Kong

2007 the special administrative Region of China implemented a legal code of practice on energy efficiency of lifts and escalators[34]. The code sets out minimum requirements for achieving energy efficient installations of lifts and escalators. The code calls for

[32] http://www.europarl.europa.eu/meetdocs/2009_2014/documents/d-ru/dv/dru_20131017_11_/dru_20131017_11_en.pdf

[33] http://www.asiaeec-col.eccj.or.jp/brochure/pdf/guidebook_for_buildings_2010-2011.pdf

[34] https://www.emsd.gov.hk/filemanager/en/content_724/lift_esccop_2007.pdf

maximum allowable electrical power and energy management of lifts, escalators and passenger conveyors. Additionally, it restricts the values for the total harmonic distortion and the total power factor.

1.7.3.6.Singapore

The Republic of Singapore through the Building and Construction Authority has published in 2012 the Code for Environmental Sustainability of Buildings, in order to establish environmentally friendly practices for the design and construction of buildings. The code encourages the use of energy efficient lifts and escalators.[35]

In 2014, the Building and Construction Standards Committee published the Singapore Standard SS530:2014 named "Code of practice for energy efficiency standard for building services and equipment". The document provides minimum energy-efficiency requirements for the new installation and replacement of systems and equipment in buildings – including lifts -, as well as, replacement of components of systems and equipment in buildings[36]. It covers criteria for determining compliance with these requirements.

1.7.4. Summary and conclusion on the review on legislations for lifts

A first assessment on the legislation regarding energy efficiency of lifts has revealed a lack of energy regulations. The majority of existing regulations directed to lifts predominantly cover safety aspects and no stringent requirements regarding energy efficiency could be found. This applies not only for EU Member States but also for countries worldwide.

Due to the overall shortage of legislative regulations regarding energy efficiency, more attention has been paid to the energy performance of lifts in recent years. The VDI association was the first to release a methodology (VDI 4707) to assess the energy efficiency of lifts and a scheme for a rating of their energy class. The International Organization for Standardization soon afterwards also published an international standard (EN ISO 25745) defining a similar methodology. Both EN ISO 25745 and VDI 4707 have found practical use in various voluntary labelling programs that have been established in different countries around the world.

Even though direct regulations on the energy efficiency of lifts are near non-existent, indirect regulations can be found. The energy performance of some lift components (e.g. interior lighting and ventilation) is indeed regulated by the Ecodesign Directive. Also in many countries across the world, including several EU Member States (e.g. Italy), the energy performance of lifts is taken into account for the energy efficiency of buildings. The regulations for energy efficient buildings indirectly also affect the energy performance of lifts.

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35 https://www.bca.gov.sg/envSuslegislation/others/env_Sus_Code.pdf

36 https://www.singaporestandardseshop.sg/Product/Product.aspx?ID=f7a3d234-223b-42a5-b509-45496aae20dd

1.8. Conclusions for product scoping

Based on the analysis of the documents provided, the following scoping for the subsequent analysis is considered. The scope of this study focuses only on lifts for persons and/or goods (no escalators or moving walks) with the following characteristics[37]:

- Lift definition according to the Lift Directive 2014/33/EU
- Which are new according to the Guidance on application of Directive 95/16/EC[38] still valid for the enforced 2014/33/EU.

Lifting appliances, fulfilling Machinery Directive (2006/42/EC) requirements but not those of the Lift Directive 2014/33/EU, as home lifts, are accordingly excluded from this study.

Within the context of this study on lifts:

a) 'lift' means a lifting appliance serving specific levels, having a carrier moving along guides which are rigid and inclined at an angle of more than 15 degrees to the horizontal, or a lifting appliance moving along a fixed course even where it does not move along rigid guides;

b) Any of the following elements are included:

- actuators: motor, converter and brake as well as hydraulic system (cylinder, tank) if applicable
- doors
- controller and displays
- car: including lighting, socket on the car roof, ventilator
- safety system: alarm system and telemonitoring, emergency power supply
- counterweight, gearbox, traction wheel, cable, rail

c) Lift system boundaries exclude the well and the machine rooms.

For such lifts, the energy performance of a lift is considered as defined in EN ISO 25745 including consideration of travel and not travel modes.

Product categories

Based on the review performed in 1.4 - 1.6, the energy service delivered by a lift depends mainly on three factors (see also Figure 1-13):

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[37] As Task 1 is only a preliminary scoping tasks, the details of the scoping will not be treated before Task 3 as stipulated in the MEErP methodology.

[38] "LC2003.04rev1" was approved at the meeting of the Lifts Committee held on 9th September 2004, see EC 2016

- the parameters: number of trips, number of stops, travel distance and speed are closely linked to the **usage categories** (according to EN ISO 25745)
- **load**
- **building structure**: which may or may not be able to support the dynamic charges generated by a lift

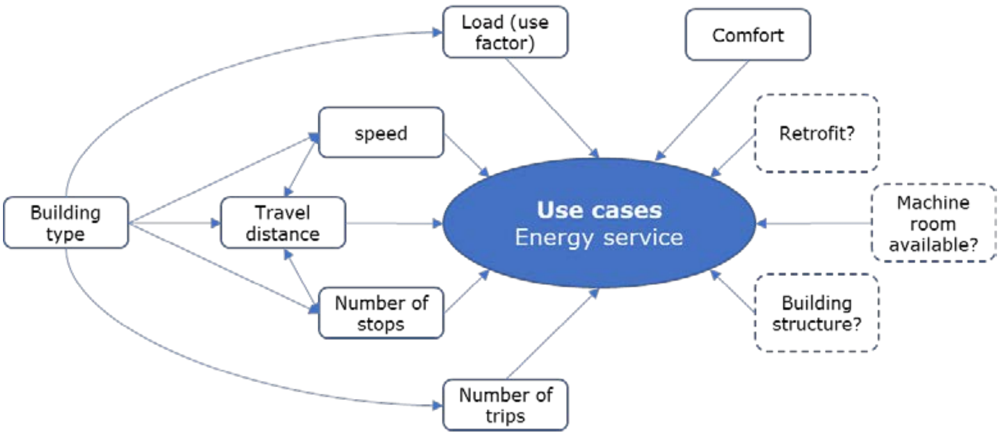

Figure 1-13: Influencing factors on use cases (source: Fraunhofer ISI)

This leads to the conclusion, that lifts can be classified according to the three-abovementioned characteristics. A rough distribution of the main lift technologies (traction and hydraulic lifts) is represented in Figure 1-14.

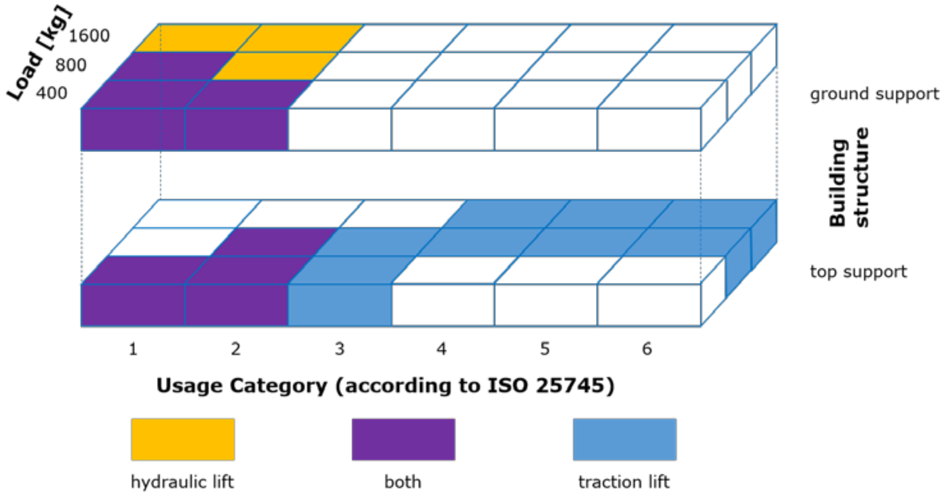

Figure 1-14: Estimated distribution of lift technologies according to the classification of this study (source: Fraunhofer ISI and ISR)

References for Task 1

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Annex

Table 1-17: European Standards (source: CEN)

Ref.	Title	Status of the document	Product Group	Main Issue	Tangent to energy issues
CEN/TR 115-3:2009	Safety of escalators and moving walks - Part 3: Correlation between EN 115:1995 and its amendments and EN 115-1:2008	published	escalator	safety	no
CEN/TR 81-10:2008	Safety rules for the construction and installation of lifts - Basics and interpretations - Part 10: System of the EN 81 series of standards	published	lifts	safety	no
CEN/TR 81-12:2014	Safety rules for the construction and installation of lifts - Basics and interpretations - Part 12: Use of EN 81-20 and EN 81-50 in specific markets	published	lifts	safety	no
CEN/TS 115-4:2015	Safety of escalators and moving walks - Part 4: Interpretations related to EN 115 family of standards	published	escalator	safety	no
CEN/TS 81-11:2011	Safety rules for the construction and installation of lifts - Basics and interpretations - Part 11: Interpretations related to EN 81 family of standards	published	lifts	safety	no
CEN/TS 81-76:2011	Safety rules for the construction and installation of lifts - Particular applications for passengers and goods passenger lifts - Part 76: Evacuation of disabled persons using lifts	published	lifts	safety, evacuation	no
CEN/TS 81-83:2009	Safety rules for the construction and installation of lifts - Existing lifts - Part 83: Rules for the improvement of the resistance against vandalism	published	lifts	protection against vandalism	no
EN 115-1:2017	Safety of escalators and moving walks - Part 1: Construction and installation	published	escalators	safety	no
EN 115-2:2010	Safety of escalators and moving walks - Part 2: Rules for the improvement of safety of existing escalators and moving walks	published	escalators	safety	no
EN 12015:2014	Electromagnetic compatibility - Product family standard for lifts, escalators and moving walks - Emission	published	lifts, escalators	electromagnetic compatibility	no
EN 12016:2013	Electromagnetic compatibility - Product family standard for lifts, escalators and moving walks - Immunity	published	lifts, escalators	electromagnetic compatibility	no
EN 12158-1:2000+A1:2010	Builders' hoists for goods - Part 1: Hoists with accessible platforms	published	cargo lifts	construction	no
EN 12158-2:2000+A1:2010	Builders' hoists for goods - Part 2: Inclined hoists with non-accessible load carrying devices	published	cargo lifts	construction	no

EN 12159:2012	Builders hoists for persons and materials with vertically guided cages	published	cargo lifts	construction	no
EN 13015:2001+A1:2008	Maintenance for lifts and escalators - Rules for maintenance instructions	published	lifts, escalators	maintenance instructions	no
EN 1570-2:2016	Safety requirements for lifting tables - Part 2: Lifting tables serving more than 2 fixed landings of a building, for lifting goods with a vertical travel speed not exceeding 0,15 m/s	published	lifting platform	safety	no
EN 627:1995	Specification for data logging and monitoring of lifts, escalators and passenger conveyors	published	lifts, escalators	monitoring	no
EN 81-20:2014	Safety rules for the construction and installation of lifts - Lifts for the transport of persons and goods - Part 20: Passenger and goods passenger lifts	published	lifts	safety, installation	no
EN 81-21:2009+A1:2012	Safety rules for the construction and installation of lifts - Lifts for the transport of persons and goods - Part 21: New passenger and goods passenger lifts in existing building	published	lifts	safety, installation	no
EN 81-22:2014	Safety rules for the construction and installation of lifts - Lifts for the transport of persons and goods - Part 22: Electric lifts with inclined path	published	lifts	safety, installation	no
EN 81-28:2003	Safety rules for the construction and installation of lifts - Lifts for the transport of persons and goods - Part 28: Remote alarm on passenger and goods passenger lifts	published	lifts	safety, installation	no
EN 81-31:2010	Safety rules for the construction and installation of lifts - Part 3: Electric and hydraulic service lifts	published	lifts	safety, installation	no
EN 81-3:2000+A1:2008	Safety rules for the construction and installation of lifts - Part 3: Electric and hydraulic service lifts	published	lifts	safety, installation	no
EN 81-3:2000+A1:2008/AC:2009	Safety rules for the construction and installation of lifts - Lifts for the transport of goods only - Part 31: Accessible goods only lifts	published	lifts	safety, installation	no
EN 81-40:2008	Safety rules for the construction and installation of lifts - Special lifts for the transport of persons and goods - Part 40: Stairlifts and inclined lifting platforms intended for persons with impaired mobility	published	lifts	safety, installation	no
EN 81-41:2010	Safety rules for the construction and installation of lifts - Special lifts for the transport of persons and goods - Part 41: Vertical lifting platforms intended for use by persons with impaired mobility	published	lifts	safety, installation	no
EN 81-43:2009	Safety rules for the construction and installation of lifts - Special lifts for the transport of persons and goods - Part 43: Lifts for cranes	published	lifts	safety, installation	no
EN 81-50:2014	Safety rules for the construction and installation of lifts - Examinations and tests - Part 50: Design rules, calculations, examinations and tests of lift components	published	lifts	safety, installation	no
EN 81-58:2003	Safety rules for the construction and installation of lifts - Examination and tests - Part 58: Landing doors fire resistance test	published	lifts	safety, installation	no
EN 81-70:2003	Safety rules for the construction and installations of lifts - Particular applications for passenger and good passengers lifts - Part 70: Accessibility to lifts for persons including persons with disability	published	lifts	safety, installation	no

EN 81-70:2003 / A1:2004	Safety rules for the construction and installations of lifts - Particular applications for passenger and good passengers lifts - Part 70: Accessibility to lifts for persons including persons with disability	published	lifts	safety, installation	no
EN 81-71:2005 +A1:2006	Safety rules for the construction and installation of lifts - Particular applications to passenger lifts and goods passenger lifts - Part 71: Vandal resistant lifts	published	lifts	safety, installation	no
EN 81-72:2015	Safety rules for the construction and installation of lifts - Particular applications for passenger and goods passenger lifts - Part 72: Firefighters lifts	published	lifts	safety, installation	no
EN 81-73:2016	Safety rules for the construction and installation of lifts - Particular applications for passenger and goods passenger lifts - Part 73: Behaviour of lifts in the event of fire	published	lifts	safety, installation	no
EN 81-77:2013	Safety rules for the construction and installations of lifts - Particular applications for passenger and goods passenger lifts - Part 77: Lifts subject to seismic conditions	published	lifts	safety, installation	no
EN 81-80:2003	Safety rules for the construction and installation of lifts - Existing lifts - Part 80: Rules for the improvement of safety of existing passenger and goods passenger lifts	published	lifts	safety, installation	no
EN 81-82:2013	Safety rules for the construction and installation of lifts - Existing lifts - Part 82: Rules for the improvement of the accessibility of existing lifts for persons including persons with disability	published	lifts	safety, installation	no
EN 16719:2017	Transport platforms	Approved	transport platforms	construction	no
EN 81-21:2017	Safety rules for the construction and installation of lifts - Lifts for the transport of persons and goods - Part 21: New passenger and goods passenger lifts in existing building	Approved	lifts	safety, installation	no
EN 81-58:2017	Safety rules for the construction and installation of lifts - Examination and tests - Part 58: Landing doors fire resistance test	Approved	lifts	safety, installation	no
EN 81-70:2017	Safety rules for the construction and installation of lifts - Particular applications for passenger and goods passenger lift - Part 70: Accessibility to lifts for persons including persons with disability	Under Approval	lifts	safety, installation	no
EN 81-71:2017	Safety rules for the construction and installation of lifts - Particular applications to passenger lifts and goods passenger lifts - Part 71: Vandal resistant lifts	Under Approval	lifts	safety, installation	no

Table 1-18: International Standards (source: ISO)

Ref.	Title	Status of the document	Product Group	Main Issue	Tangent to energy issues
ISO 4190-1:2010	Lift (Elevator) installation -- Part 1: Class I, II, III and VI lifts	published	residential lifts	construction/disabled people	no
ISO 4190-2:2001	Lift (US: Elevator) installation -- Part 2: Class IV lifts	published	residential lifts	construction/disabled people	no
ISO 4190-3:1982	Passenger lift installations -- Part 3: Service lifts class V	published	residential lifts	construction/disabled people	no
ISO 4190-5:2006	Lift (Elevator) installation -- Part 5: Control devices, signals and additional fittings	published	residential lifts	construction/disabled people	no
ISO 4190-6:1984	Lifts and service lifts (USA : elevators and dumbwaiters) -- Part 6: Passenger lifts to be installed in residential buildings -- Planning and selection	published	residential lifts	construction	no
ISO 7465:2007	Passenger lifts and service lifts -- Guide rails for lift cars and counterweights -- T-type	published		quality, dimensional characteristics	no
ISO/TR 8100-24:2016	Safety requirements for lifts (elevators) -- Part 24: Convergence of lift requirements	published		safety	no
ISO 8383:1985	Lifts on ships -- Specific requirements	published	lifts on ships	safety, installation	no
ISO 9386-1:2000	Power-operated lifting platforms for persons with impaired mobility -- Rules for safety, dimensions and functional operation -- Part 1: Vertical lifting platforms	published	lifting platform	safety, function	no
ISO 9386-2:2000	Power-operated lifting platforms for persons with impaired mobility -- Rules for safety, dimensions and functional operation -- Part 2: Powered stairlifts for seated, standing and wheelchair users moving in an inclined plane	published	lifting platform	safety, function	no
ISO 9589:1994	Escalators -- Building dimensions	published	escalators	building dimensions	no
ISO/TR 11071-1:2004	Comparison of worldwide lift safety standards -- Part 2: Hydraulic lifts (elevators)	published	lifts	safety	no
ISO 14798:2009	Lifts (elevators), escalators and moving walks -- Risk assessment and reduction methodology	published	lifts	safety	no

Task 1

ISO/TR 14799-1:2015	Comparison of worldwide escalator and moving walk safety standards -- Part 1: Rule by rule comparison	published	escalators	safety comparison	no
ISO/TR 14799-2:2015	Comparison of worldwide escalator and moving walk safety standards -- Part 2: Abbreviated comparison and comments	published	escalators	safety comparison	no
ISO/TR 16764:2003	Lifts, escalators and passenger conveyors -- Comparison of worldwide standards on electromagnetic interference/electromagnetic compatibility	published	lifts, escalators	electromagnetic compatibility	no
ISO/TR 16765:2003	Comparison of worldwide safety standards on lifts for firefighters	published	lifts for firefighters	safety	no
ISO 18738-1:2012	Measurement of ride quality -- Part 1: Lifts (elevators)	published	lifts	ride quality	no
ISO 18738-2:2012	Measurement of ride quality -- Part 2: Escalators and moving walks	published	escalators	ride quality	no
ISO/TS 18870:2014	Lifts (elevators) -- Requirements for lifts used to assist in building evacuation	published	lifts	building evacuation	no
ISO 22199:2009	Electromagnetic compatibility -- Product family standard for lifts, escalators and moving walks -- Emission	published	lifts	electromagnetic compatibility	no
ISO 22200:2009	Electromagnetic compatibility -- Product family standard for lifts, escalators and moving walks -- Immunity	published	escalators	electromagnetic compatibility	no
ISO 22201-1:2017	Lifts (elevators), escalators and moving walks -- Programmable electronic systems in safety-related applications -- Part 1: Lifts (elevators) (PESSRAL)	published	lifts (PESSRAL)	safety	no
ISO 22201-2:2013	Lifts (elevators), escalators and moving walks -- Programmable electronic systems in safety related applications -- Part 2: Escalators and moving walks (PESSRAE)	published	escalators (PESSRAE)	safety	no
ISO/TR 22201-3:2016	Lifts (elevators), escalators and moving walks -- Programmable electronic systems in safety related applications -- Part 3: Life cycle guideline for programmable electronic systems related to PESSRAL and PESSRAE	published	lifts, escalators	life cycle guideline	no
ISO 22559-1:2014	Safety requirements for lifts (elevators) -- Part 1: Global essential safety requirements (GESRs)	published	lifts	safety	no
ISO/TS 22559-2:2010)	Safety requirements for lifts (elevators) -- Part 2: Safety parameters meeting the global essential safety requirements (GESRs)	published	lifts	safety	no
ISO/TS 22559-3:2011	Safety requirements for lifts (elevators) -- Part 3: Global conformity assessment procedures (GCAP) -- Prerequisites for certification of conformity of lift systems, lift components and lift functions	published	lifts	safety	no
ISO/TS 22559-4:2011	Safety requirements for lifts (elevators) -- Part 4: Global conformity assessment procedures (GCAP) -- Certification and accreditation requirements	published	lifts	safety	no

Task 1

ISO/TS 25740-1:2011	Safety requirements for escalators and moving walks -- Part 1: Global essential safety requirements (GESR	published	escalators	safety	no
ISO/TR 25741:2008	Lifts and escalators subject to seismic conditions -- Compilation report	published	lifts, escalators	safety	no
ISO/TR 25743:2010	Lifts (elevators) -- Study of the use of lifts for evacuation during an emergency	published	lifts	use during emergency	no
ISO 25745-1:2012	Energy performance of lifts, escalators and moving walks -- Part 1: Energy measurement and verification	published	lifts, escalators	energy measurement	yes
ISO 25745-2:2015	Energy performance of lifts, escalators and moving walks -- Part 2: Energy calculation and classification for lifts (elevators)	published	lifts, escalators	energy measurement	yes
ISO 25745-3:2015	Energy performance of lifts, escalators and moving walks -- Part 3: Energy calculation and classification of escalators and moving walks	published	escalators	energy measurement	yes

Ecodesign preparatory study for lifts implementing the Ecodesign Working Plan 2016 -2019

Task 2 report: Markets

Reference:
N° 617/PP/GR(MMA/17/1131/9709 for the conclusion of a specific contract in application of the Framework Contract No 409/PP/2014/FC Lot 2 with reopening of competition

Client:
European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

31th October 2019

Team:
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Project website: https://www.eco-lifts.eu/

This study was ordered and paid for by the European Commission, Directorate-General for Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (GROW).

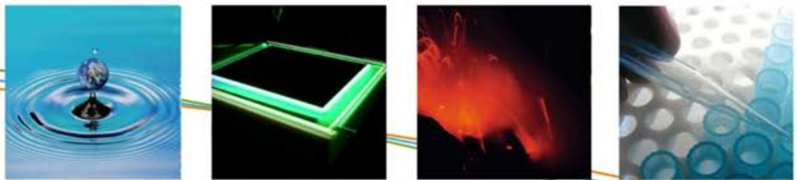


Table of contents: Task 2

List of Figures

List of Tables

2. Task 2- Markets

2.0 Task introduction

General objective of Task 2:

The objective of Task 2 is to present an economic and market analysis of lifts according to the definition presented in 1.2.1. The aims are:

- to place lifts (according to the definition provided in 1.2.1) within the context of EU industry and trade policy (subtask 2.1);
- to provide market size and cost inputs for the EU-wide environmental impact assessment of the product group (subtask 2.2);
- to provide insight into the latest market trends to help assess the impact of potential Ecodesign measures with regard to market structures and ongoing trends in product design (subtask 2.3, also relevant for the impact analyses in Task 3); and finally,
- to provide a practical data set of prices and rates to be used for Life Cycle Cost (LCC) calculations (subtask 2.4).

2.1. Subtask 2.1- Generic economic data

General objective of subtask 2.1:

In the MEErP generic economic data refers to data that is available in official EU statistics (e.g. PRODCOM) and the aim is to identify and report the 'EU apparent consumption' which is defined as 'EU production + EU import – EU export'. Also the average value of each product is verified. The information required for this subtask should be derived from official EU statistics so as to be coherent with official data used in EU industry and trade policy.

Approach:

This task first looks at generic data for lift stock and sales mainly based on data from ELA[1], ELCA and the E4 Project. Data from PRODCOM concerning lifts can be found under the codes:

- 28221630 for electrically operated lifts and hoists;
- 28221650 for other lifts and skip hoists.

Since the data associated with these codes also include hoists, it might also include products which are outside the scope of Task 1.

The indicators available within the PRODCOM codes are displayed in Table 2-1. Besides these indicators, it is also important to acquire data concerning the volume of imports and exports. Since they are not available from PRODCOM, one option would be to derive it from other related data.

[1] Definition from ELA can be found in Annex B

Table 2-1: Indicators available at PRODCOM

Data field	Definition
EXPVAL	Value of exports in Euro, derived from the External Trade statistics.
IMPVAL	Value of imports in Euro, derived from the External Trade statistics.
PQNTBASE	For EU totals, this gives the rounding base used: • If PROD_QUANTITY is rounded or contains a rounded element. PROD_QUANTITY should be interpreted as lying between PROD_QUANTITY - PROD_QUANTITY_BASE and PROD_QUANTITY + PROD_QUANTITY_BASE. • When no rounding is applied, PROD_QUANTITY_BASE is set to zero.
PQNTFLAG	This field indicates the availability of the volume data: 'R' the data has been rounded using the rounding base given in PROD_QUANTITY_BASE, Additional flags are used to indicate that a total has been constructed: e.g. EU27-EU02(R) indicates that the EU25 total has been constructed from the EU 27 minus the rounded sum of Bulgaria and Romania.
PRODQNT	Volume of production in the unit indicated in UNIT.
PRODVAL	Value of production in Euro.

The PRODCOM data is publicly available and is a direct source of market information (see Table 2-2). However, sometimes the information may slightly differ when collected in different dates due to possible updates. Moreover the information does not directly fit into the categories defined in 1.4.1 besides the existence of possible problems in the prices reported.
According to the Lift Directive (2014/33/EU), point (4), 'The lifts covered by this Directive only come into existence as finished products once they have been permanently installed in buildings or constructions'. Consequently, from a legal perspective, lifts cannot be imported into the European Union (EU) and/or the European Economic Area (EEA) but are only placed on the market once installed. The main elements or components to be used in a lift however could still be imported.

Note that 'The Blue Guide on the implementation of EU product rules in 2016 (Notice-2016/C 272/01)' explains when Union Harmonisation Legislation on Products applies (p. 15) and requires that a product, which has been subject to important changes or overhaul aiming to modify its original performance, purpose or type after it has been put into service, having a significant impact on its compliance with Union Harmonisation Legislation, must be considered as a new product (section 2.1 from Notice- 2016/C 272/01). Therefore this CE legislation limits the possibilities of repaired Lifts when they change characteristics because the full CE marking procedure might have to be redone including new technical documentation, EU DoC, serial number, etc. Consequently such overhauls could be considered as new products but with recycled components. For very old Lifts that did not yet have a CE marking there are no such limitations in principle. Nevertheless local installation requirements might require CE marked lifts to be used hence we do not assume this is a relevant issue.

Table 2-2 : Extract of PRODCOM data code 28221630 for electrically operated lifts and hoists in 2015

INDICATORS	EXPVAL	IMPVAL	PQNTBASE	PQNTFLAG	PRODQNT	PRODVAL
EU27 TOTALS	963 372 440	50 933 710	200	EU28(R)-HR	127 795	2 026 240 309
EU28 TOTALS	957 854 930	51 051 960	20 000	:R	120 000	2 024 649 741

Reliability of PRODCOM data is not 100% according to feedback from stakeholders. Apparent consumption of lifts in 2015 was 127 795 units according to PRODCOM, which fits well with data reported by ELA (Figure 2-4). However, the computed average manufacturer lift prices from PRODCOM data (13 889 euro) seems too low. It might be that the price computed excludes installation costs.

PRODCOM data does not give any direct information about the total number of installed lifts in use in the different countries, nor information about their energy consumption. This means that other detailed information will need to be derived and extracted from other sources for these indicators (section 2.2).

In the context of lifts used within buildings this study looked at indirect generic market data that are relevant for lifts, namely:

- building statistics[2] (Figure 2-1);
- economic indicators (GDP - Figure 2-3);
- demographic growth (Figure 2-2).

The rationale is that lifts are often part of the building and therefore these statistics can reveal important use and installation data. On the other hand, demographic growth can also be useful, together with GDP trends, to make educated assumptions to derive construction growth rates if needed and consequently has an impact on the number of lifts sold and installed.

EU28

	Source	Unit	2011	2012	2013	2014	2015
Number of non residential buildings		thousand	-	-	-	-	-
Number of offices		thousand	-	-	-	-	-
Number of private offices		thousand	-	-	-	-	-
Number of public offices		thousand	-	-	-	-	-
Number of wholesale and retail trade buildings	Estimation	thousand	5,712.46	5,719.08	5,714.17	-	-
Number of hotels and restaurants	Estimation	thousand	1,155.88	1,175.64	1,168.15	-	-
Number of health care buildings	Estimation	thousand	572.52	583.50	592.02	-	-
Number of educational buildings	Estimation	thousand	769.21	781.63	784.40	-	-

No values mean non-available or non-relevant information

Figure 2-1: Building stock by type EU28- incomplete data (source: https://ec.europa.eu/energy/en/eu-buildings-database)

[2] https://ec.europa.eu/energy/en/eu-buildings-database : This database is supposed to contain disaggregated information according to building type, stock by age, floor area, new construction, annual share of residential buildings undergoing major renovation, etc.
Downloading data from this source directly to excel is not working and some data is yet not available. Also it does not contain for the moment a lot of historical data.

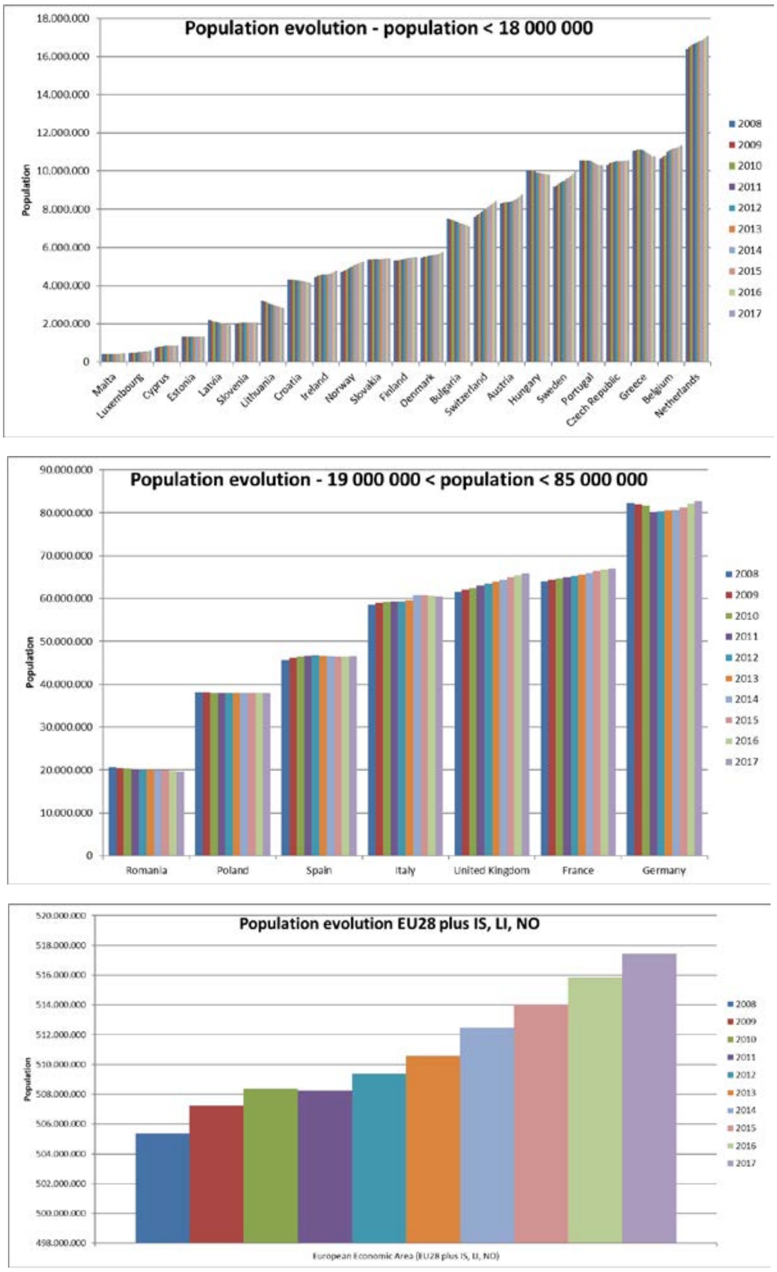


Figure 2-2: Evolution in European population (Source: Eurostat)

Task 2

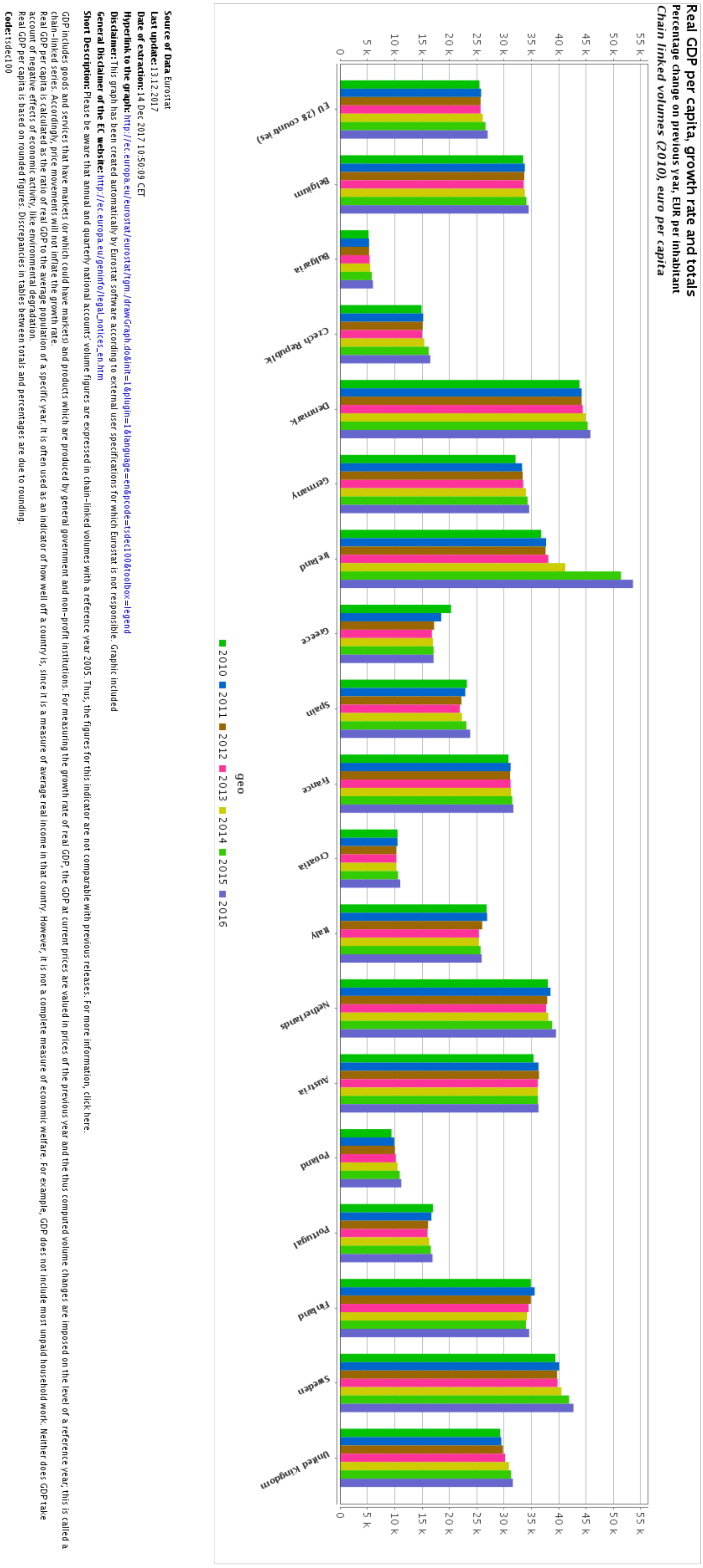


Figure 2-3: Real GDP per capita, growth rate and totals (Source: Eurostat)

2.2. Subtask 2.2- Market and stock data

General objective of subtask 2.2:

The objective is to compile market and stock data in physical units for the EU, for each of the product categories defined in Task 1.1 and for the stock (1990-2015), combined with a forecast 2020-2050. Therefore the following parameters need to be identified:

- installed base ('stock');
- annual new product sales growth rate (% or physical units);
- average economic product life (in years), in service, and a rough indication of the spread (e.g. standard deviation);
- total new product sales / real EU-consumption;
- replacement or renovation lift sales (derived);
- new building lift sales (derived).

2.2.1. How to define the average 'product life' and what are 'New product sales'

For the purposes of Task 2 we will consider the 'product life' as 'the economic life time of new products which are placed on the market or put into service for the first time' according to the Lift Directive (2014/33/EU) and in line with The Blue Guide on the implementation of EU products rules 2016 (Notice- 2016/C 272/01)'. These '**new product or lift sales'** can be either in a new building as '**new building lift sales'** or within an existing building for as '**new replacement lift sales'**, for example for renovation. This, therefore, excludes repaired lifts or maintenance[3]. It is important to highlight that a new lift might have a long product life, linked to the building life. However, during that time the lift might require a number of modernizations (improvement of the lift including the replacement of some equipment but not constituting a full replacement).

2.2.2. Discussion of useful data sources

2.2.2.1. Brief description of the data sources

The European Lift & Lift Component Association (ELCA) represents several lifts and lifts components manufacturers in Europe. Information available on their website includes the number of existing lifts and employees in the sector disaggregated by country.

The European Lift Association (ELA) "represents the lifts, escalators and moving walks associations active in the European Union (EU) or the European Free Trade Area (EFTA) and their components manufacturers". Available data in their website and presentations comprise:

- Number of new lifts in 2014, 2015 and 2016 disaggregated per country and type of lift;

---

[3] http://ec.europa.eu/growth/sectors/mechanical-engineering/lifts/
New lifts, subject to the provisions of Directive 95/16/EC, include the following:
- lifts installed in new buildings;
- lifts installed in existing buildings;
- lifts installed in existing wells for replacement of existing lifts, including when the existing guide rails and their fixings or the fixings alone are retained.

- Value (k€) of new lifts in 2013, 2014 and 2015 disaggregated per country and type of lift and Estimated value for modernization (k€) for 2013, 2014 and 2015 disaggregated by country (which is important for section 2.4).

The European Elevator Association (EEA) makes available on their website some general figures concerning the number of existing lifts in Europe (5 700 000) and the average number of new units per year (≈125 000). These numbers are in accordance with the numbers from the ELA.

Eurostat is the statistical office of the European Union and contains several indicators which might be useful for this study and used to derive possible missing data:

- PRODCOM statistics - Sold production, exports and imports by PRODCOM list;
- Population indicators (can be useful to estimate growth rates).

The EU Building Stock Observatory gathers some data on stock, areas, shares of buildings by type, etc. Nevertheless, there is a high degree of data missing from their database.

Accordingly, useful information gathered until now comes from several sources:

- http://www.elca-eu.org/main-figure-for-europe-in-the-world.php
- http://www.elca-eu.org/links.php
- http://www.ela-aisbl.org
- http://eea-eeig.eu/pdf/EEA%20General%20Brochure%202015%20v3.pdf
- http://economie.fgov.be/nl/ondernemingen/securite_produits_et_services/Liften/Modernisering_bestaande_liften/#.Wk3QLbenGHv
- http://ec.europa.eu/eurostat/web/prodcom/data/excel-files-nace-rev.2
- http://ec.europa.eu/eurostat/web/prodcom/data/database?p_p_id=NavTreeportletprod_WAR_NavTreeportletprod_INSTANCE_iSpjsGQt409q&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&p_p_col_id=column-2&p_p_col_count=1
- http://ec.europa.eu/eurostat/web/population-demography-migration-projections/population-data/database
- https://ec.europa.eu/energy/en/eu-buildings-database
- https://ec.europa.eu/energy/en/data-analysis/building-stock-observatory.
- http://www.iea.org/etp/buildings/
- http://www.kone.com/en/Images/KONE_Annual_Review_2016_tcm17-37391.pdf
- https://www.schindler.com/content/dam/web/com/pdfs/presentations/Schindler_Annual_Results_Presentation_2016.pdf

A more detailed discussion is included in the subsequent sections.

2.2.2.2.ELA data and E4 project

To attain the information required (see general objective of subtask 2.2), direct market data will be sourced from manufacturers' associations but also indirect market data will be investigated (e.g., relevant building data). This is deemed necessary because the lift market is heavily dependent on the construction industry, which in turn depends on general economic growth. This dependency was reflected in a large sales drop after 2007 caused by the global financial crisis. The European lift market has been slowly recovering from the low 2009 levels with an estimated growth outlook in line with GDP growth.

The European Lift Association (ELA) provides aggregated market data (shown in Figure 2-4 and Figure 2-5). This can be compared with generic data and other market sources on construction statistics to build a market model with replacement sales and new sales forecasts for the respective categories defined in Task 1.

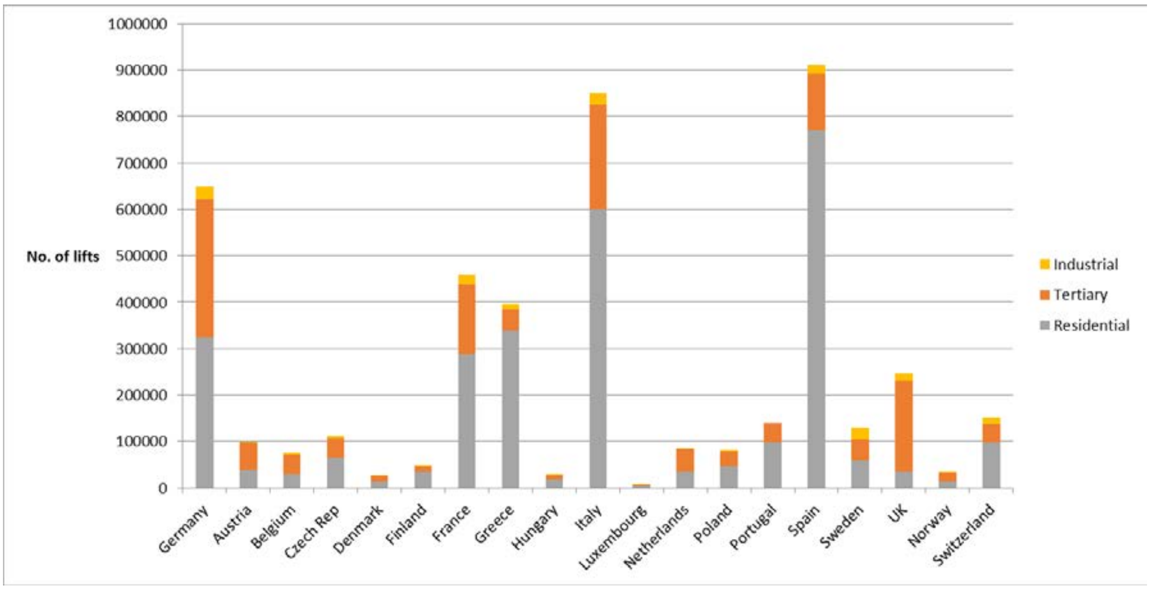


Figure 2-4: Lift distribution by sector in 2009 (source: ELA)

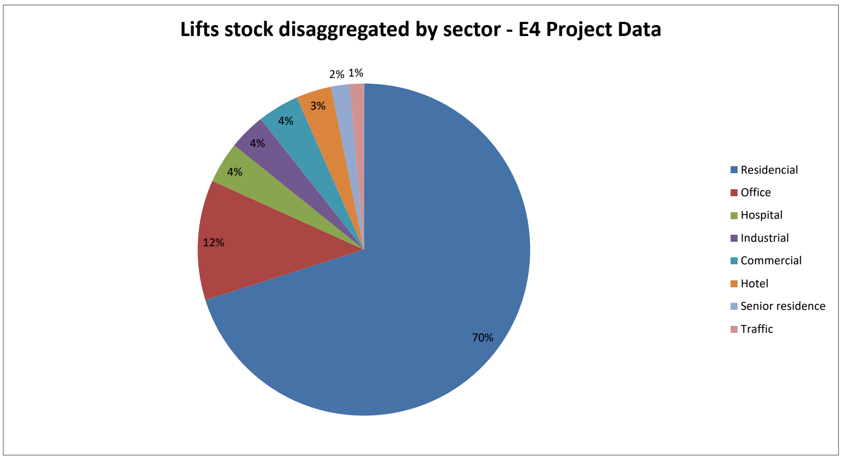


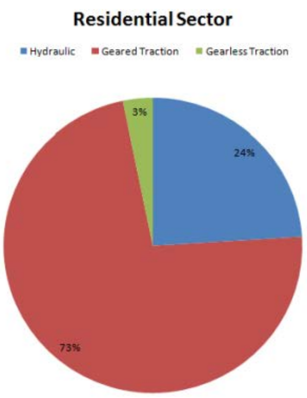
Figure 2-5: Lift Distribution according to building type in 2009 (source: E4 Project[4])

The number of lifts installed per country according to ELA is shown in Table 2-3. Although the information in the E4 project is not disaggregated by lift and building type, it provides more insights such as distribution per sector, typical number of trips per year, etc (see Figure 2-4, Figure 2-5, Figure 2-6, Table 2-4 and original data from the E4 Project in the Annex A Figure 2-16). E4 project data is used in order to have indicative values for the lifts stock using as base case the year 2009.

[4] https://ec.europa.eu/energy/intelligent/projects/en/projects/e4

Table 2-3: Lifts - estimated stock (source: ELA)

	2014	2015	2016
Austria	110.300	112.871	115.689
Belgium	95.845	99.645	103.308
Bulgaria	84.000	84.000	84.000
Cyprus	19.000	19.106	19.106
Czech Republic	133.200	134.000	134.500
Denmark	36.800	37.810	38.320
Estonia	5.050	5.170	5.170
Finland	59.900	61.300	61.800
France	545.000	550.000	560.000
Germany	704.900	720.000	736.400
Greece	416.200	417.255	420.000
Hungary	36.950	37.500	38.250
Ireland	30.000	30.000	30.517
Italy	946.000	951.000	958.000
Latvia	6.160	6.210	6.210
Lituania	8.580	8.640	8.640
Luxemburg	11.000	11.498	11.800
Netherlands	90.000	95.000	97.000
Norway	37.050	37.950	37.370
Poland	98.810	103.397	107.950
Portugal	150.000	150.900	151.900
Romania	44.000	44.609	45.759
Slovakia	45.000	46.500	46.500
Slovenia	10.195	10.276	10.401
Spain	1.010.852	1.022.229	1.033.010
Sweden	115.787	117.664	123.281
Switzerland	232.000	240.000	245.700
Turkey	378.000	406.000	424.900
United Kingdom	284.000	286.600	292.500
Total EU28	**5.329.529**	**5.403.180**	**5.485.711**
Total countries with 2000 data	**4.877.834**	**4.939.224**	**5.011.778**
TOTAL	**5.744.579**	**5.847.130**	**5.947.981**



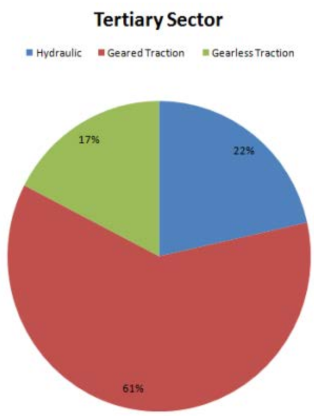


Figure 2-6: Distribution of lifts stock according to the technology used in 2009 (source: E4 Project)

Table 2-4: Average characteristics of European lifts as estimated in 2009 (source: E4 Project[5])

Sector	Technology	No. Units	Load (kg)	Rise (m)	Speed (m/s)	Motor power (kW)	Trips/year
Residential	Hydraulic	699 340	461	16	0.8	8.70	44 900
	Geared	2118 866	392	17	1	4.80	623 000
	Gearless	9 431	608	22	1	6.00	131 000
Office	Hydraulic	176 515	693	23	0.9	16.70	164 000
	Geared	330 323	703	25	1.4	12.70	232 000
	Gearless	12 157	760	33	1.6	11.70	242 000
Hospital	Hydraulic	29 712	1 264	12	0.7	11.80	278 000
	Geared	14 741	1 258	17	1.1	11.80	382 000
	Gearless	2 605	1 275	28	1.3	19.40	565 000
Industrial	Hydraulic	52 914	1 817	13	0.6	24.50	43 000
	Geared	134 547	112	12	0.6	15.00	73 000
	Gearless	241	116	8	1	17.90	276 000
Commercial	Hydraulic	57 314	963	14	1.1	15.20	142 000
	Geared	169 035	920	12	1.1	14.60	192 000
	Gearless	15 822	945	11	1.3	11.90	2240 000
Hotel	Hydraulic	30 926	1 024	15	0.6	16.30	86 000
	Geared	114 232	873	18	0.9	10.30	199 000
	Gearless	23 702	1 114	24	1.6	15.40	220 000
Other	Hydraulic	20 173	1 024	14	0.67	8.00	144 000
	Geared	11 441	873	20	1.1	8.00	298 000
	Gearless	59 739	1 114	21	1.4	15.00	493 000

Original data from the E4 Project is displayed in Annex A in Figure 2-16.

[5] https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/e4_publishable_report_en.pdf

2.2.2.3. Data from ELCA and cross-check with ELA and E4 Project Data

According to ELCA[6] there are between 100 000 and 120 000 new lifts installed each year. However, the ELA provides a slightly higher figure[7] of around 124 000 new lifts. In 2015, according to the ELA the number of new units was 127 000. Cross-checking the information from these two sources (Figure 2-7 and Table 2-5), we can see there has been an increase in the number of new lifts installed between 2012 and 2015.

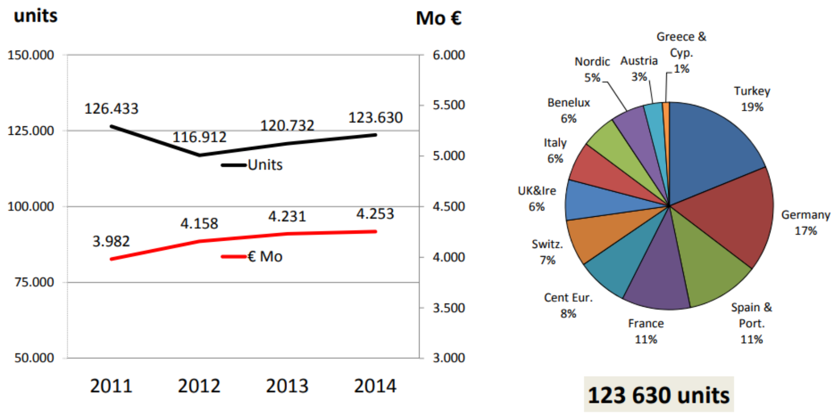


Figure 2-7: New lifts - data 2014 (source: ELA)

Stock data from ELA and ELCA are available from the year 2000 on (see Table 2-5 and Figure 2-8). To gather stock data from ELA and ELCA for the years prior to 2000 is not easy. For that reason, stock data from the E4 project is used, compared with ELA and ELCA stock data and extrapolated to the desired years.

[6] http://www.elca-eu.org/main-figure-for-europe-in-the-world.php

[7] http://www.vfa-interlift.de/images/vfa/akademie/VFA-Forum_2015_Vortr%C3%A4ge/10_International_Markets_Europe_Focus_on_SNEL_SNEE_Jean-Pierre_Jacobs_ELA_ENGL.pdf

1 **Table 2-5: Stock Data (Source: ELA and ELCA)**

	2000	2001	2002	2006	2014	2015	2016	Growth 2000-2001	Growth 2000-2002	Growth 2000-2006	Growth 2000-2014	Growth 2000-2015	Growth 2000-2016
Austria	59 700	62 100	64 500	76 180	110 300	112 871	115 689	4.02%	8.04%	27.60%	84.76%	89.06%	93.78%
Belgium	70 500	72 000	73 500	77 500	95 845	99 645	103 308	2.13%	4.26%	9.93%	35.95%	41.34%	46.54%
Bulgaria					84 000	84 000	84 000						
Cyprus					19 000	19 106	19 106						
Czech Republic	112 860	114 055			133 200	134 000	134 500	1.06%			18.02%	18.73%	19.17%
Denmark	20 000	20 000	26 763	27 530	36 800	37 810	38 320	0.00%	33.82%	37.65%	84.00%	89.05%	91.60%
Estonia					5 050	5 170	5 170						
Finland	46 000	46 500	47 500	50 710	59 900	61 300	61 800	1.09%	3.26%	10.24%	30.22%	33.26%	34.35%
France	420 000	420 000	420 000	485 570	545 000	550 000	560 000	0.00%	0.00%	15.61%	29.76%	30.95%	33.33%
Germany	580 000	590 000	600 000	650 000	704 900	720 000	736 400	1.72%	3.45%	12.07%	21.53%	24.14%	26.97%
Greece	300 000	308 200		317 000	416 200	417 255	420 000	2.73%		5.67%	38.73%	39.09%	40.00%
Hungary				33 760	36 950	37 500	38 250						
Ireland					30 000	30 000	30 517						
Italy	720 000	735 000	750 000	850 000	946 000	951 000	958 000	2.08%	4.17%	18.06%	31.39%	32.08%	33.06%
Latvia					6 160	6 210	6 210						
Lituania					8 580	8 640	8 640						
Luxemburg				7 920	11 000	11 498	11 800						
Netherlands			72 000	81 730	90 000	95 000	97 000						
Norway	18 000	18 000	18 913	29 390	37 050	37 950	37 370	0.00%	5.07%	63.28%	105.83%	110.83%	107.61%
Poland				71 700	98 810	103 397	107 950						

Portugal	96 000	100 000	104 950	110 500	150 000	150 900	151 900	4.17%	9.32%	15.10%	56.25%	57.19%	58.23%
Romania					44 000	44 609	45 759						
Slovakia					45 000	46 500	46 500						
Slovenia					10 195	10 276	10 401						
Spain	578 050	609 949	630 000	711 160	1 010 852	1 022 229	1 033 010	5.52%	8.99%	23.03%	74.87%	76.84%	78.71%
Sweden	105 000	105 000	106 000	109 430	115 787	117 664	123 281	0.00%	0.95%	4.22%	10.27%	12.06%	17.41%
Switzerland	152 000	136 252	148 481	170 670	232 000	240 000	245 700	-10.36%	-2.32%	12.28%	52.63%	57.89%	61.64%
Turkey					378 000	406 000	424 900						
United Kingdom	209 000	216 000	223 400	249 600	284 000	286 600	292 500	3.35%	6.89%	19.43%	35.89%	37.13%	39.95%
Total EU28	**3 469 110**	**3 535 056**	**3 267 094**	**4 080 960**	**5 329 529**	**5 403 180**	**5 485 711**						
Total countries with 2000 data	3 487 110	3 553 056	3 214 007	3 915 240	4 877 834	4 939 224	5 011 778	1.89%	-7.83%	12.28%	39.88%	41.64%	43.72%
TOTAL	3 487 110	3 553 056	3 286 007	4 110 350	5 744 579	5 847 130	5 947 981	-	-	-	-	-	-
Data from ELA and ELCA available at "Evaluation of the application of the Lifts Directive (95/16/EC) - Final Report - Appendices"													

2

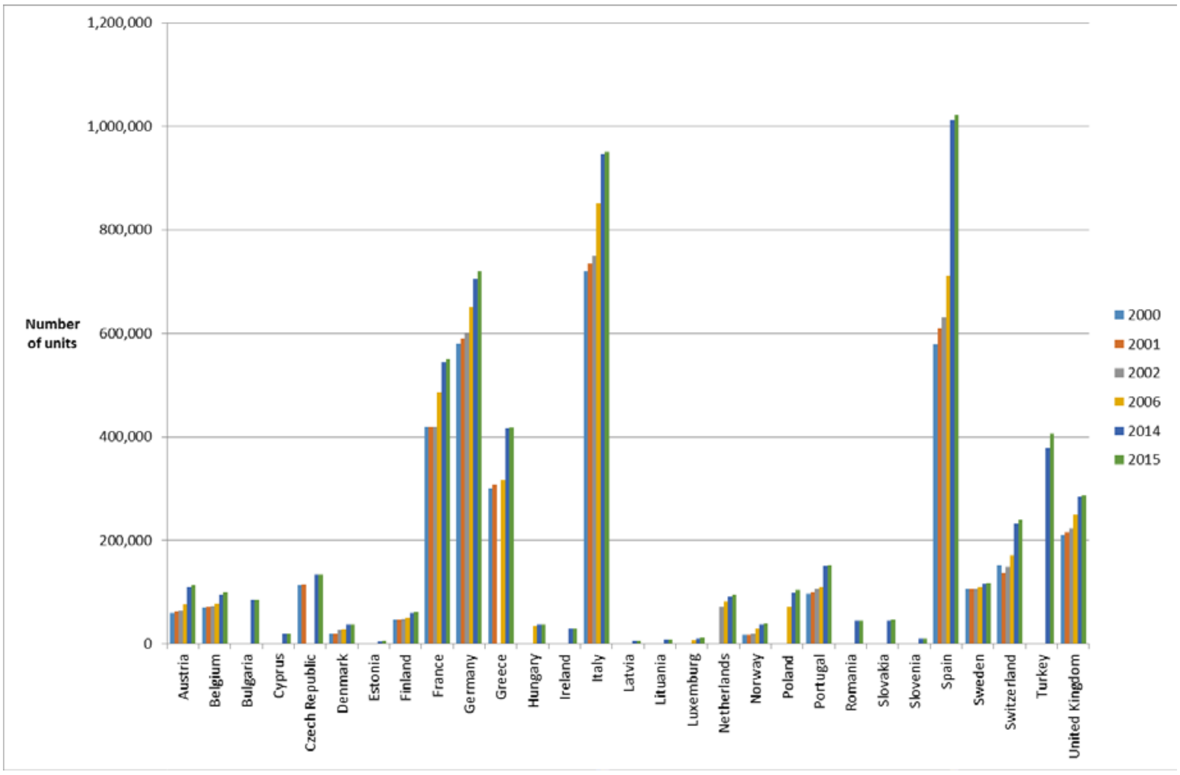


Figure 2-8: Stock Data (Source: ELA and ELCA)

2.2.2.4. Various data on economic life time and new lift sales

While some lifts may need upgrading and modifications after 10 years to prevent safety issues, others can operate satisfactorily for 30 to 40 years. Accordingly the technical life cycle of a lift can be estimated between 20 to 25 years (as discussed in section 3.4).

According to [8] it may take on average 15-30 years before a major repair is necessary due to component failure. These figures are a bit high when compared with the technical life cycle of a lift presented in section 3.4.
However, it is recognised that over the economic life time of a lift, repairs will be needed (Table 2-6).

Due to changes in regulation (e.g. door safety) sometimes technical upgrades are needed. These upgrades might change technical characteristics over the lift economic life time. A new CE mark is required, and permitted, only if the lift is completely replaced, within some very precise limits of reuse of some existing metalwork.

As explained before new lift sales can be either for new building lift sales, in new buildings, or new replacement lift sales, in existing buildings.

[8] Sachs, Harvey M. (2005): Opportunities for Elevator Energy Efficiency Improvements. ACEEE

Table 2-6: Expected lifetime of lifts components (source: http://www.elevatorsource.com/elevator_life_expectancy.htm)

Equipment type	Expected useful life in years	Recommended action
Electrical Switchgear	50+	Retain
Electrical Wiring	30	Replace
Controller, dispatcher	20 -25	Replace
Cab Interior	15	Refurbish Interior
Machinery	30	Replace
Shaft Doors	20 - 30	Replace Gibs & Rollers
Shaftways	N/A	N/A
Hoist rails	25	Realign rails
Cables	20	Replace
Traveling Cables	20	Replace
Hydraulic Piston	25	Replace / Resleeve Piston
Elevator Call Station	15	Replace
Elevator Car Operating Panel	20	Replace

Note: lifetime assuming elevator maintenance is performed on a routine basis and equipment is manufactured by a major OEM. Typical lifetimes of lift components are only indicative and depend largely on the level of professional maintenance as well as the actual use of the lift and thus, may vary greatly.

Regular safety checks, maintenance cycles and/or upgrades have an impact on resource consumption related to replacement or maintenance parts.

According to the 2016 annual report of Schindler[9] over 50% of all installed units in Europe are older than 20 years and therefore candidates for renovation. Consequently the average life time should be above 20 years.

Lifts are often part of the building and therefore statistics on building stock will reveal important use and installation data for lifts.

Recently, the services of the European Commission started the building stock observatory[10] that contains a building stock database. From this data some annual stock growth rates can already be deducted see Table 2-7 and Table 2-8).

Table 2-7: Total floor area of non-residential buildings in the EU and derived annual stock growth rates

	Unit	2011	2012	2013	2014	2015	Average
EU28	Mm^2	6 828	6 950	7 013	-	-	
Annual growth	%		1.8%	0.9%			**1.3%**

9 https://www.schindler.com/content/dam/web/com/pdfs/presentations/Schindler_Annual_Results_Presentation_2016.pdf

10 https://ec.europa.eu/energy/en/data-analysis/building-stock-observatory

Table 2-8: Total floor area for multi-family dwelling of some EU countries with available annual statistics and the associated derived annual stock growth rates

	Unit	2011	2012	2013	2014	2015	Average
EU stock per year of countries with annual statistics	Mm^2	4 953	4 985	5 052	5 120		
Annual growth	%		0.7%	1.3%	1.4%		**1.1%**

Also the International Energy Agency (IEA) published a report[11] on 'Transition to Sustainable Buildings - Strategies and Opportunities to 2050' which contains a forecast on service and residential area growth until 2050. From this data the corresponding annual growth rates(%) can be reverse calculated, see Table 2-9.

Table 2-9 Indicators for energy demand in EU (27) buildings sector and the derived growth rates (source: IEA (2013)[11], p,74, Table 2.4.1).

Indicator	**2010**	**2020**	**2030**	**2040**	**2050**
Population	497	508	512	512	508
Service floor area (Mm^2)	8096	9039	10107	10571	11007
Residential floor area (Mm^2)	20063	21714	23173	24264	25087
Number of households (million)	210	224	235	240	242
Occupancy rate (people per household)	3.4	2.3	2.2	2.1	2.1
Average house size (m^2/house)	95.7	97	98.8	101	103.5
Derived growth rates for use in this study and verification of data					
Period	**2010-20**	**2020-30**	**2030-40**	**2040-50**	
Growth rate service area (calculated)	1.1%	1.1%	0.5%	0.5%	
Calculated service area from growth rate (Mm^2)		9 032	10 076	1 0591	11 133
Growth rate residential area (calculated)	0.8%	0.7%	0.5%	0.3%	
Calculated service area from growth rate (Mm^2)		21 727	23 297	24 488	25 233

2.2.2.5.Typical usage category and sector of Lifts

Data on the installed lifts per type of non-residential building sector can also be deducted from the data on their floor area. The floor area values used in the 2016 Ecodesign preparatory study on Lighting Systems Lot 37[12] are shown in Table 2-10.

[11] IEA (2013): 'Transition to Sustainable Buildings - Strategies and Opportunities to 2050' (ISBN: 978-92-64-20241-2)

[12] http://ecodesign-lightingsystems.eu/documents

Table 2-10: Estimate of the relative share of non-residential floor area across the EU (source: Lot 37).

Sector	Mm²	share [´%]
Education	1 302	11%
Hotels & Restaurants	754	6%
Hospitals (&HealthCare)	907	8%
Retail (&Wholesale)	2 382	20%
Offices	2 115	18%
Sports	544	5%
Industry	2 461	21%
Other	1 308	11%
Total Non-Residential	11 773	100%

The lift stock in 2009 categorised by sector and usage categories according to ISO 25745-2:2015 is **not available but could be derived** (Table 2-11) **from the lift stock per sector data available from the E4 Project**[13]. This is, however, an indicative distribution. The original data from the E4 Project was already segmented, in most of the cases, by:

- country;
- sector;
- decade of installation;
- type of elevator;
- nominal load;
- speed;
- rise;
- number of stops;
- number of trips per year
- power on motor plate.

Based on the **number of trips per year** available in the E4 Project (original data in Annex, Figure 2-16) it was **possible** to **calculate** the average number of trips per day and consequently the **usage categories** for the year **2009** (Table 2-13).

[13] https://ec.europa.eu/energy/intelligent/projects/en/projects/e4

Table 2-11: Lifts stock in 2009 per sector and derived usage categories according to ISO 25745-2:2015 (Source: E4 Project)

	Usage categories for lifts according to ISO 25745-2:2015							
	1	2	3	4	5	6	Unidentified category	
Residential	15 000	1 870 212	791 223	50 000			124 810	
Office		3 000	136 850	292 510			43 444	
Hospital		6 300	62 150	43 900	16 472	20 950	13 764	
Commercial	2 850		26 750	127 329			6 754	
Hotel		1 000	40 250	93 200	600		4 105	
Traffic		54 204					2 037	
Industrial	17 500	56 307	66 430				5 026	
Sector not disaggregated	30 428	37 417	31 417	196 248	4 000		46 374	
Total	65 778	2 028 440	1 155 070	803 187	21 072	20 950	246 314	**4 340 811**

NOTE: Countries included: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Luxembourg, Netherlands, Poland, Portugal, Spain, Sweden, UK

2.2.3. Summary of the 2020-2050 market stock of installed elevators

2.2.3.1. Summary of the 2009 and 2015 stock

The lift stock for 2009 and 2015 was calculated using a simplified model and displayed in Figure 2-9 categorized by:

- Load range;
- Type of building support
- Type of lift;
- Usage category
- residential versus non-residential.

Load (kg)	**Installation (due to building structure)**	**Main Type**	**Usage Category *(according to ISO 25745)***	**2009**		**2015**		**Source**
				residential	**non-residential**	**residential**	**non-residential**	
<=400	Ground support	HYD	1	0	0	0	0	calculated
			2	78711	33596	84793.687	36192.01637	calculated
			3	0	0	0	0	calculated
			4	0	0	0	0	calculated
			5	0	0	0	0	calculated
			6	0	0	0	0	calculated
]400, 800]			1	33386	14250	35966.181	15351.24453	calculated

Load (kg)	Installation (due to building structure)	Main Type	Usage Category *(according to ISO 25745)*	2009		2015		Source
			2	216059	92219	232755.82	99345.87043	calculated
			3	204438	87259	220235.95	94002.08278	calculated
			4	0	0	0	0	calculated
			5	0	0	0	0	calculated
			6	0	0	0	0	calculated
]800, 1600]			1	25357	10823	27316.087	11659.17306	calculated
			2	4226	1804	4552.6812	1943.19551	calculated
			3	129424	55241	139425.86	59510.36248	calculated
			4	17961	7666	19348.895	8258.580916	calculated
			5	16904	7215	18210.725	7772.782038	calculated
			6	0	0	0	0	calculated
>=1600			1	1479	631	1593.4384	680.1184283	calculated
			2	22081	9425	23787.759	10153.19654	calculated
			3	8452	3608	9105.3623	3886.391019	calculated
			4	0	0	0	0	calculated
			5	0	0	0	0	calculated
			6	0	0	0	0	calculated
<=400	Top support		1	0	0	0	0	calculated
			2	8746	3733	9421.5208	4021.335152	calculated
			3	0	0	0	0	calculated
			4	0	0	0	0	calculated
			5	0	0	0	0	calculated
			6	0	0	0	0	calculated
]400, 800]			1	3710	1583	3996.2424	1705.693836	calculated
			2	24007	10247	25861.758	11038.43005	calculated
			3	22715	9695	24470.661	10444.67586	calculated
			4	0	0	0	0	calculated
			5	0	0	0	0	calculated
			6	0	0	0	0	calculated
]800, 1600]			1	2817	1203	3035.1208	1295.463673	calculated
			2	470	200	505.85346	215.9106122	calculated
			3	14380	6138	15491.762	6612.262498	calculated
			4	1996	852	2149.8772	917.6201017	calculated
			5	1878	802	2023.4139	863.6424487	calculated
			6	0	0	0	0	calculated
>=1600			1	164	70	177.04871	75.56871426	calculated
			2	2453	1047	2643.0843	1128.132949	calculated
			3	939	401	1011.7069	431.8212243	calculated
			4	0	0	0	0	calculated
			5	0	0	0	0	calculated
			6	0	0	0	0	calculated

Task 2

Load (kg)	Installation (due to building structure)	Main Type	Usage Category *(according to ISO 25745)*	2009		2015		Source
<=400	Ground support	TRT	1	0	0	0	0	calculated
			2	67038	28613	72218.423	30824.5865	calculated
			3	6444	2750	6941.8271	2962.941331	calculated
			4	0	0	0.2529267	0.107955306	calculated
			5	0	0	0	0	calculated
			6	0	0	0	0	calculated
]400, 800]			1	7320	3124	7885.7496	3365.830533	calculated
			2	28089	11989	30259.142	12915.341	calculated
			3	58443	24945	62958.775	26872.34275	calculated
			4	43752	18675	47133.402	20117.6872	calculated
			5	188	80	202.34139	86.36424487	calculated
			6	0	0	0	0	calculated
]800, 1600]			1	1432	611	1542.8531	658.5273671	calculated
			2	740	316	796.7192	340.0592142	calculated
			3	15754	6724	16971.384	7243.801038	calculated
			4	31907	13619	34372.743	14671.1261	calculated
			5	1033	441	1112.8776	475.0033468	calculated
			6	4919	2099	5298.815	2261.663663	calculated
>=1600			1	0	0	0	0	calculated
			2	188	80	202.34139	86.36424487	calculated
			3	0	0	0	0	calculated
			4	0	0	0	0	calculated
			5	0	0	0	0	calculated
			6	0	0	0	0	calculated
<=400	Top support		1	0	0	0	0	calculated
			2	603341	257521	649965.8	277421.2785	calculated
			3	57995	24754	62476.444	26666.47198	calculated
			4	2	1	2.2763406	0.971597755	calculated
			5	0	0	0	0	calculated
			6	0	0	0	0	calculated
]400, 800]			1	65881	28119	70971.747	30292.4748	calculated
			2	252797	107900	272332.28	116238.069	calculated
			3	525983	224502	566628.97	241851.0847	calculated
			4	393771	168071	424200.62	181059.1848	calculated
			5	1690	722	1821.0725	777.2782038	calculated
			6	0	0	0	0	calculated
]800, 1600]			1	12890	5502	13885.678	5926.746304	calculated
			2	6656	2841	7170.4728	3060.532928	calculated
			3	141786	60518	152742.45	65194.20935	calculated
			4	287164	122568	309354.69	132040.1349	calculated
			5	9297	3968	10015.899	4275.030121	calculated

Load (kg)	Installation (due to building structure)	Main Type	Usage Category *(according to ISO 25745)*	2009		2015		Source
			6	44268	18895	47689.335	20354.97296	calculated
>=1600			1	0	0	0	0	calculated
			2	1690	722	1821.0725	777.2782038	calculated
			3	0	0	0	0	calculated
			4	0	0	0	0	calculated
			5	0	0	0	0	calculated
			6	0	0	0	0	calculated
					5 015 591.00		5 403 180.00	

Figure 2-9: Excel sheet used to disaggregate lifts stock data (usage categories derived according to ISO 25745-2:2015)

To derive these figures some assumptions were done combining the original data gathered in the E4 Project, ELA and ELCA.

2.2.3.2.Assumptions made for the stock model

Data from the E4 Project contained information from 17 countries (total stock of 4 340 814 units). So, the total lift stock was lower than the one reported by ELA and ELCA (Table 2-5 - 5403180 units in 2015). We calculated the factor between the two values and multiplied the E4 stock data by it to upscale to the EU28 $\left({}^{5403180}/_{4340814} = 1{,}245\right)$.

Concerning the segmentation between ground and top supported, the percentages in Figure 2-10 were used. The segmentation between residential and non-residential was based on the percentages displayed in Figure 2-5.

Disaggregation between top and ground supported		
type lift	type support	%
HYD	ground	90%
	top	10%
TRT	ground	10%
	top	90%

Figure 2-10: Percentages used to disaggregate the lift type into ground and top supported

Although more elaborated approaches were tried, this simplified method seems to provide acceptable values.

The table presented in Figure 2-9 will be used as the working basis for the stock model forecaster (section 2.2.4).

2.2.4. Summary of the market sales forecast and estimation of the future and past stock

The 2015 stock data (see Figure 2-9) and sales data (see 2.2.3) combined with the IEA building stock growth rates (see Table 2-9) combined with the estimate of relative share of residential and non-residential building lifts (see Figure 2-5) allows us to elaborate a sales forecast model, see Table 2-13.

From this data the average life time can be calculated which is 68 years equivalent to a sales rate of 1,46 %. This is called the baseline sales scenario. Calculations are presented in Table 2-13. Input data are presented in Table 2-12. In the recast of the EPBD Directive[14] it is said renovation at an average rate of 3% annually is needed in order to cost-effectively accomplish the Union's ambitions for energy efficiency. For this reason also an 'accelerated renovation scenario' is added in Table 2-14 that can be used in a sensitivity analysis in Task 7.

Table 2-12 Input data for sales forecast calculations (baseline and accelerated scenario)

	2010	2015
share of residential (source E4 project)	**70%**	**70.3%**
share of non residential (source E4 project)	30%	**29.7%**
total sales 2015 (source ELA)		*127 000*
total stock 2015 (source ELA)		*5 403 180*
total stock residential 2015 (calculated)		*3 799 036*
total stock non residential 2015 (calculated)		*1 604 144*
residential new building sales rate (calculated from IEA)		*30 392*
non residential new building sales (calculated from IEA)		*17 646*
total sales for new buildings		*48 038*
total sales rate (calculated from ELA stock)		2.350%
residential new buildings sales rate (per sector) (source IEA-2015)		0.800%
non residential new buildings sales rate (per sector) (source IEA-2015)		1.100%
total sales for renovation (caclulated)		*78 962*
residential renovation sales (calculated from IEA)		*55 519*
non residential renovation sales (calculated from IEA)		*23 443*
residential renovation sales rate (calculated)		*1.461%*
non residential renovation sales rate (calculated)		*1.461%*

14 http://www.europarl.europa.eu/legislative-train/theme-resilient-energy-union-with-a-climate-change-policy/file-energy-performance-of-buildings-directive-review

Table 2-13 Summary of sales forecast (2045) and backward calculation of the stock (1995) baseline scenario

	1995	2005	2015	2025	2035	2045
non residential new building sales rate	1.100%	1.100%	1.1000%	1.100%	0.500%	0.500%
non residential renovation sales rate(assumption)	1.461%	1.461%	1.4614%	*1.461%*	*1.461%*	*1.461%*
residential new building sales rate	0.800%	0.800%	0.8000%	0.700%	0.500%	0.300%
residential renovation sales rate(assumption)	1.461%	1.461%	1.4614%	*1.461%*	*1.461%*	*1.461%*
lifts stock non residential	1288903	1437911	1604144	1789596	1881116	1977317
lifts stock residential	3239386	3508068	3799036	4073503	4281823	4412026
total stock of lifts	4528289	4945979	5403180	5863099	6162939	6389342
non residential new building sales	14178	15817	17646	19686	9406	9887
non residential renovation sales(assumption)	18836	21014	23443	26146	27483	28889
residential new building sales	25915	28065	30392	28515	21409	13236
residential renovation sales(assumption)	47340	51267	55519	59514	62557	64460
total annual sales	106269	116162	127000	133860	120855	116471
total renovation sales	66176	72281	78962	85660	90041	93348
total new building sales	40093	43882	48038	48200	30815	23123
total new building sales rate (backward looking period)	NA	0.85%	0.85%	0.85%	0.50%	0.35%
total stock (with new data)	4561750	4964671	5403181	5880423	6181148	6400928
replacement sales calculated of stock	1.45%	1.46%	1.46%	1.46%	1.46%	1.46%
average unit price installed elevator(source:Belgian FOD Economy)	*41250*	*41250*	*41250*	*41250*	*41250*	*41250*
Estimated annual turn over in EU28 for new lift sales (MEURO)	4384	4792	5239	5522	4985	4804
turnover withs service cost (source: upscaled from kone (32%)	6446	7047	7704	8120	7331	7065
Estimated annual turnover service in EU28 (MEURO)	2063	2255	2465	2598	2346	2261

Table 2-14 Summary of sales forecast (2045) and backward calculation of the stock (1995) accelerated renovation scenario due to EPBD

	1995	2005	2015	2025	2035	2045
non residential new building sales rate	1.100%	1.100%	1.1000%	1.100%	0.500%	0.500%
non residential renovation sales rate(assumption)	1.461%	1.461%	1.4614%	*3.000%*	*2.500%*	*2.000%*
residential new building sales rate	0.800%	0.800%	0.8000%	0.700%	0.500%	0.300%
residential renovation sales rate(assumption)	1.461%	1.461%	1.4614%	*3.000%*	*2.500%*	*2.000%*
lifts stock non residential	1288903	1437911	1604144	1789596	1881116	1977317
lifts stock residential	3239386	3508068	3799036	4073503	4281823	4412026
total stock of lifts	4528289	4945979	5403180	5863099	6162939	6389342
non residential new building sales	14178	15817	17646	19686	9406	9887
non residential renovation sales(assumption)	18836	21014	23443	53688	47028	39546
residential new building sales	25915	28065	30392	28515	21409	13236
residential renovation sales(assumption)	47340	51267	55519	122205	107046	88241
total annual sales	106269	116162	127000	224093	184888	150910
total renovation sales	66176	72281	78962	175893	154073	127787
total new building sales	40093	43882	48038	48200	30815	23123
total new building sales rate (backward looking period)	NA	0.85%	0.85%	0.85%	0.50%	0.35%
total stock (with new data)	4561750	4964671	5403181	5880423	6181148	6400928
replacement sales calculated of stock	1.45%	1.46%	1.46%	2.99%	2.49%	2.00%
average unit price installed elevator(source:Belgian FOD Economy)	*41250*	*41250*	*41250*	*41250*	*41250*	*41250*
Estimated annual turn over in EU28 for new lift sales (MEURO)	4384	4792	5239	9244	7627	6225
turnover withs service cost (source: upscaled from kone (32%)	6446	7047	7704	13594	11216	9154
Estimated annual turnover service in EU28 (MEURO)	2063	2255	2465	4350	3589	2929

2.2.5. The market for home lifts

Home lifts are not the target of this study.

Market data for home lifts is difficult to find, however, a rough estimate is now presented.

It can be assumed that only detached or semi-detached houses with a second floor can benefit from a home lift. According to the Impact accounting data from 2014[15], it can therefore be estimated as a fraction of 34M detached houses (since not all of them have more than one floor) and most likely all 39M semi-detached houses in the EU. Not all

[15] R. Kemna, J. Acedo, Average EU building heat load for HVAC equipment. Specific contract No. ENER/C3/412-2010/15/FV2014-558/SI2.680138 with reference to Framework Contract ENER/C3/412-2010, 2014, Table 14

detached houses have floors that can benefit from a lift and in the absence of other data it can be assumed that 50% can benefit. As a result of this a maximum of 36.5M houses could benefit, i.e. 0.5 x (34 +39)M, from home lifts.

Of course not all the population wants a lift. An estimate of those that do can be made by analysing age and preference data. In 2017 19.2% habitants were aged above 65 years old, while a survey[16] done in 2015 assessed how many of these people would like a lift. The survey reported that 33.9% of respondents answered the statement “I go up the stairs and (almost) always use a walking aid, e.g., a walking stick or a Crutch” positively. The combination of the information shows that there is some potential for the installation of home/stair lifts. Hence 6,5 % of the population can be estimated as potential home lift buyers, i.e. 33.9% x 19.2%.

Combining house data (36.5M) with population data (6.5 %) results in a maximum EU28 market estimate of 2 373 M home lifts.

Considering the maximum EU power consumption per lift of 8760 h/y x 0.024 kW= 210 kWh/y, these home lifts would represent an energy consumption of 210kWh/y x 2,375M or 498 GWh/y only.

Since there is not a solid basis to support these figures and to check it, home lifts were not recommended for further consideration in this study.

2.3.Subtask 2.3- Market trends

General objective of subtask 2.3:

The purpose of this task is to identify market trends such as:

- general market trends (growth/ decline, if applicable per segment), trends in product-design and product-features;
- market channels and production structure; identification of the major players (associations, large companies, share SMEs, employment);
- trends in product design/ features, illustrated by recent consumer association tests (valuable, but not necessarily fully representative of the diversity of products put on the market).

As it was already mentioned, modernization (and also refurbishment) are also linked to building renovation, hence there is a need to collect data related to renovations. The installation of new lifts is linked to new construction.

ELA also provides some information about the modernization of lifts and estimated market value per country (Figure 2-11).

[16] R. Mustafaoglu, B. Unver, V. Karatosun, Evaluation of stair climbing in elderly people, J. Back Musculoskelet. Rehabil. 28 (2015) 509–516. doi:10.3233/BMR-140549.

Value (1000€)	2013	2014	2015	2016	
	Estimated Value for modernization (*)	Estimated Value for modernization (*)	Estimated Value for modernization (*)	Estimated Value for modernization (*)	16/15 in %
Austria	62.489	67.055	49.632	47.810	-4
Belgium	69.693	68.295	63.265	73.669	16
Bulgaria**					
Croatia			646	808	25
Czech Republic	20.308	15.046	14.057	10.287	-27
Denmark	17.428	18.948	15.618	18.000	15
Estonia**					
Finland	27.539	11.431	11.008	15.588	42
France	392.071	255.895	221.768	210.405	-5
Germany	238.737	240.341	259.877	270.301	4
Greece	1.462	7.972	7.200	20.000	178
Hungary	3.770	4.384	6.840	4.829	-29
Ireland	4.617	5.451	5.002	4.160	-17
Italy	106.295	92.356	115.907	119.491	3
Latvia**					
Lithuania**					
Luxembourg	3.592	2.339	3.149	3.961	26
Malta**					
Norway	15.968	12.283	19.359	12.822	-34
Poland	13.760	14.557	33.204	7.903	-76
Portugal	19.625	18.192	19.098	19.522	2
Romania		1.078	5.761	7.043	22
Slovakia**					
Slovenia**					
Spain	143.723	158.000	185.779	140.403	-24
Sweden	148.862	88.554	73.650	80.816	10
Switzerland	98.930	104.200	116.837	120.863	3
The Netherlands	84.619	90.786	83.923	87.217	4
Turkey	35.000	50.000	147.899	160.000	8
United Kingdom	256.883	201.216	225.832	212.374	-6
Total for the countries for which data is provided in the above table	**1.765.371**	**1.528.379**	**1.685.311**	**1.648.272**	**-2**
Total EU(**)			**1.709.481**	**1.693.766**	

(*) Estimates based on consolidated data obtained from independent third party collector and/or national associations
(**) Total EU consolidated figures including Bulgaria, Estonia, Latvia, Lithuania, Malta, Slovakia, Slovenia
(***) Market change is calculated without Croatia

Figure 2-11: Lifts modernization values (source: ELA)

2.3.1.New replacement lift sales can be driven by safety requirements from the Lifts Directive (Directive 95/16/EC) and/or Directive 2014/33/EU on lifts (safety)

Lifts may be replaced when they fail to comply with safety checks and could trigger new sales in the future.

2.3.2. New replacement lift sales driven by building renovation in the context of energy saving measures

Lifts (and escalators) are neither explicitly mentioned nor explicitly covered by the current Energy Performance of Buildings Directive (EPBD) and thus there is room for Member State interpretation regarding how they should be treated. However, most Member States have policies in place to stimulate energy efficient renovation which is part of the Energy Efficiency Directive.

2.3.3. New building lifts sales for increased demand for apartments

Demographic trends can have an impact upon the sales of lifts in Europe, especially the trend towards urbanisation and larger cities.

2.3.4. New building lifts sales for increased/decreased demand in non-residential buildings

Increases or decreases in demand for non-residential buildings can impact the trend in the number of lifts installed across Europe, especially a trend towards urbanisation and growing cities.

2.3.5. Ageing population with ambient assisted living and need for wheel chair access can drive the need to retrofit new lifts sales

With an ageing population a growing need for convenience can be expected to fuel a rise in the number of lifts installed in Europe. For example, small stair-lifts, although not in the scope of this study according to Task 1, are often retrofit in residential houses for elderly people unable to use the staircase. Additionally, a growing awareness of accessibility issues will foster the need for more lifts, for example, to facilitate access of wheelchairs in public buildings.

According to Commission Services (DG ECFIN) and Eurostat (EUROPOP2013)[17], the share of people older than 65 will rise from 18% (2015) to 28% (2060).

2.3.6. Lift manufactures and trade associations

Four European manufacturers have the majority of the lift market not only in Europe (55% of revenues) but worldwide, namely: Otis Elevator, KONE, Schindler and ThyssenKrupp (Figure 2-12). Other major manufacturers include Fujitec, Mitsubishi Electric, and Toshiba Elevator. Besides these larger companies there are also many mid-size and small companies operating in the market, mainly with regional focus or producing specialised products.

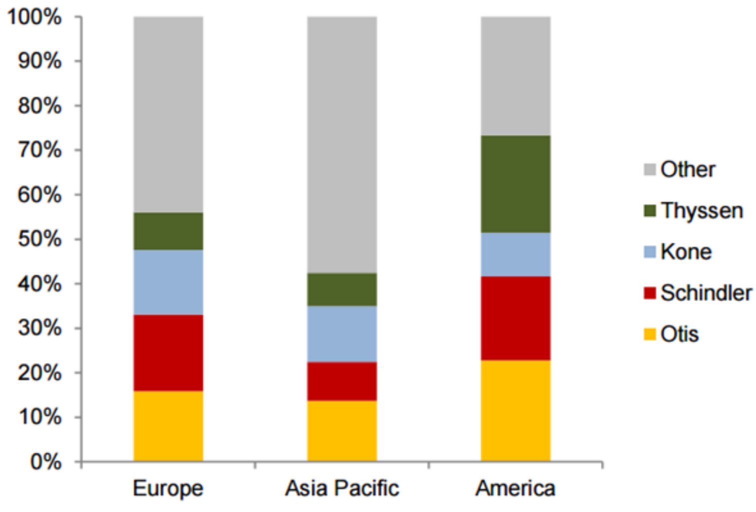


Figure 2-12: Regional Lift and Escalator Market share by value, 2014 (source: Credit Suisse)

[17] http://www.vfa-interlift.de/images/vfa/akademie/VFA-Forum_2015_Vortr%C3%A4ge/26_Homelifts_-_An_Ideal_Solution_for_Transportation_in_Low_Rise_Buildings__Lazaros_Asvestopoulos_Kleemann_ENGL.pdf

2.3.6.1. Market actors and the role of installers, maintenance companies and inspection

As further explored in Task 3, several market actors are involved in the decision-making process of buying, retrofitting or modernising a lift installation. More often than not, lift buyers tend to select complete package solutions so manufacturers often act as full service companies, offering everything from support in planning and choosing a new installation up to repair and maintenance and finally retrofitting. Often, manufacturers rely on the support of contracted companies for the installation of new equipment – thus adding an additional economic actor.

Architects, construction engineers as well as lift consultants may be involved in dimensioning and situating lifts and escalators, for the building developer. After the building is completed and the lift put into service, building managers, operators and administrators play a major role in monitoring and possibly improving the energy consumption of an existing installation as well as when initiating a retrofit.

A significant role is played by notified bodies, which have a role defined by the Lifts Directive i.e. in relation to the conformity of new lifts and do not initiate retrofit. as well as market surveillance agencies. Notified bodies like the German and Austrian TÜV and the Dutch Liftinstituut are involved, as they are certified to check the safety of installed equipment. The trade association British SAFed is certified to check the safety of installed equipment and may thereby initiate a retrofit.

The maintenance and servicing of lifts plays an important role in the industry, with all major manufacturers offering service contracts that generate additional revenue after installation. In developed markets such as Europe the revenues from service and maintenance work can represent as much as 70% of the total revenues. Finally, end-users expect a smooth, comfortable and fast ride, with minimum travel and waiting times.

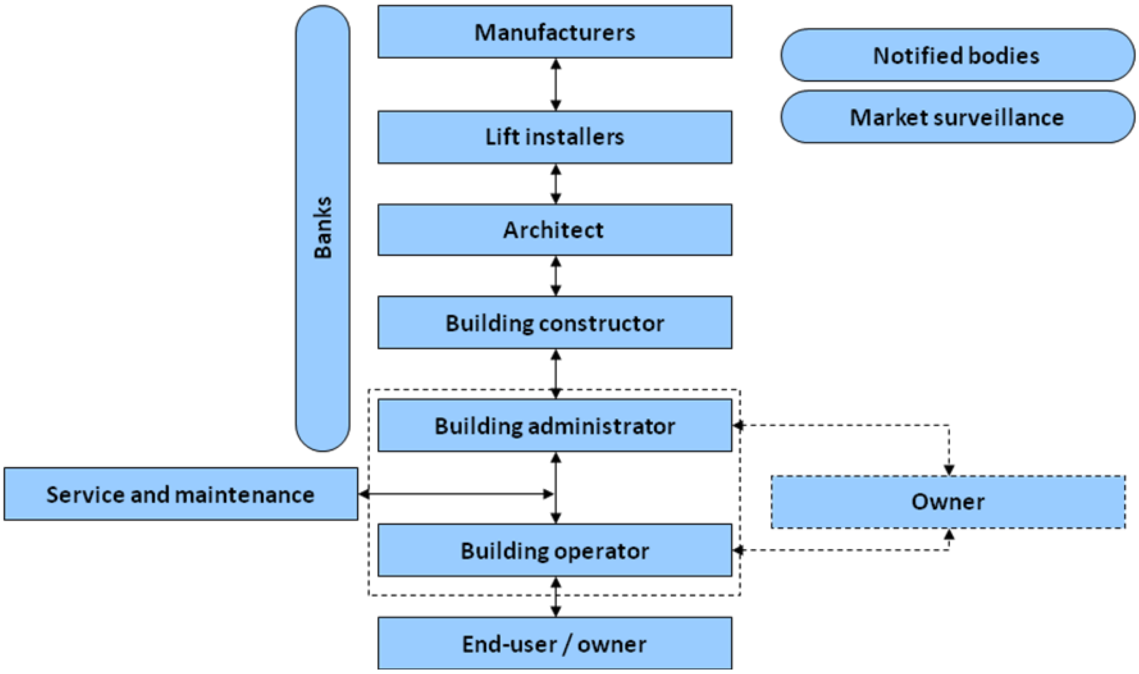


Figure 2-13: Overview of stakeholders and actors involved in the installation and operation of a lift or escalator (Source: E4-Project)

2.4. Subtask 2.4- Consumer expenditure base data

General objective of subtask 2.4:

This task will define:

- average EU consumer prices, incl. VAT (for consumer prices; street price)/ excl. VAT (for B2B products), in euros;
- consumer prices of consumables;
- repair and maintenance costs (euro/product life);
- installation costs (for installed appliances only);
- indicative disposal tariffs/ taxes (euro/product).

For electricity, fossil fuel, water, interest, inflation and discount rates this task will use values from the MEErP methodology, including the average annual price increases mentioned therein. Also an approach will be elaborated for regional differentiation of consumer prices that can be used in a sensitivity analysis in Task 7.

Data

Although price information on lifts and related components is not easily accessible, the Belgian Federal Public Service (FPS) forS Economy was able to gather indicative price information concerning lifts modernization for Belgium (see Table 2-15 and Table 2-16). The prices originate from surveys of different modernization companies conducted end of 2011. Lifts built after 1996 should already comply with safety rules and hence are not included. It is important to emphasise that the values are merely indicative since they strongly dependent on the specifics of each case (e.g., number of floors, type of installation, size and maximum load, amongst other factors).

The average manufacturer PRODCOM product price for a lift for the EU28 (=PRODVAL/PRODQNT) was already presented in subtask 2.1 and pointed out as being too low (13,889 euro). This is much lower than the Belgian Indicative prices for installed elevators, see Table 2-15. For that reason, PRODCOM data, probably about new elevators only, will not be taken into account.

Table 2-15: Prices in €, excluding tax, for total modernization of a lift considering its year of construction (source: Federal Public Service Economy- FPS Economy[18])

Year of construction	minimum	maximum	median
<1958	15 500	50 000	41 250
1958 - 1984	6 600	32 000	20 000
1984 - 1996	3 350	16 000	8 000

[18] http://economie.fgov.be/nl/binaries/2012.06.05_Gemiddelde_prijzen_modernisatie_liften_tcm325-179642.pdf

Table 2-16: Prices in €, excluding tax, for some important lifts' component repairs or upgrades (source: FPS Economy)

Component	minimum	maximum	median
Car door	1 750	10 000	4 900
Drive control (frequency)	3 000	20 000	10 000
New door lock	300	1 200	550
Electronic light curtain / lamps for safety	1 000	4 000	/

According to ELA, there were 139000 new units installed in 2016 which corresponds to a market value of €5,1 billion, or on average 36690 euro per elevator.

In general the service cost is important part of the elevator cost and business. This can be concluded from the Kone 2016 annual review report[19] which is an important manufacturer, see Table 2-17. In Europe the share of service sales could be higher due to the importance of the aged stock, but this level of detailed market share data is not available.

Table 2-17 Global annual sales data by business from Kone (2016)

Business		**Sales MEUR**		**Share**
New Lift Sales		4793		55%
Service Sales		3991		45%
	Maintenance		2773	32%
	Modernization		1219	14%
Total sales		8784		

Annual inspection cost per elevator is around 150 euro according to the Vito building service department.

Due to their high scrap metals content Lifts still have value at their End-of-Life (EoL). Consequently, this is a driver for recycling and/or repair. The current metal scrap values, or so-called secondary commodity prices, are indicated in Table 2-18. Copper, in particular, has a high scrap value. Copper mostly maintains its value when scrapped (i.e. €4.2/kg as scrap compared with €5.49/kg when new) whereas aluminium loses most of its value (€0.085/kg scrap compared to €2.47/kg when new). These are market scrap values used at the point of delivery, which is most commonly available[20], even for particular clients. Hence, investing for example in a copper lift might be more economic from a life cycle cost (LCC) perspective when its EoL value is taken into account. Note that the metal scrap value is not the same as the total end of life cost because apart from

[19] http://www.kone.com/en/Images/KONE_Annual_Review_2016_tcm17-37391.pdf

[20] For example day trade price: http://oudijzer-prijs.com/dag-prijs/

the scrap metal value there is also the dismantling cost for disconnecting, transport and disassembly which is included in the renovation cost (Table 2-15).

Table 2-18 Current (2/2/2017) scrap value[21]

Scrap value (2/2/2017)	
Cast Iron (€/kg)	0,175
Steel plate (€/kg)	0,096
Copper (€/kg)	4,200
Aluminium (€/kg)	0,085

Lifts have a long lifetime (25-70 years) and hence when modelling the life cycle cost the forward looking electricity price assumptions are important; however, electricity prices fluctuate and there are many uncertainities. The most accepted source currently available for such projections is the 'EU Reference Scenario 2016 Energy, transport and GHG emissions Trends to 2050'[22] elaborated by the European Commission. This study explains how today's electricity price is composed of several components, see Figure 2-14 . Not all components can be taken into account, especially fixed costs that cannot be avoided by energy savings, because there will be a rebound effect in the cost per kWh when the costs have to be distributed across fewer kWh sales. In this model the grid and sales costs increase over time due to the increasing share of RES, and particularly variable distributed RES. Hence it is reasonable to take part of the grid cost into account due to the cost avoidance effect that more efficient transformers will produce.

Therefore further tasks can use the PRIMES forecasted average end user prices for Households and the service sector as indicated in see Figure 2-14.

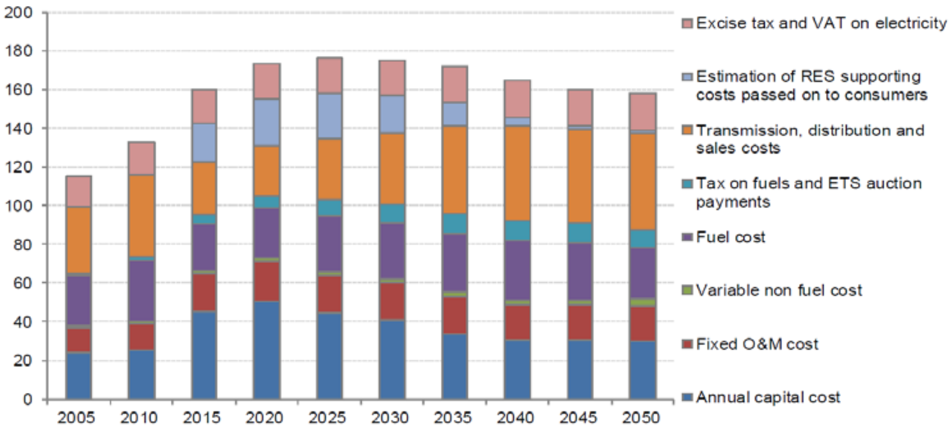


Figure 2-14: Decomposition of electricity generation costs and prices (€ per MWh) historical and forecast values (source: PRIMES)

[21] http://www.tijd.be/grondstoffen/secundaire_grondstoffen/

[22] EU Reference Scenario 2016 Energy, transport and GHG emissions Trends to 2050, Main results (2016), available at: https://ec.europa.eu/energy/sites/ener/files/documents/20160712_Summary_Ref_scenario_MAIN_RESULTS%20%282%29-web.pdf

	Prices reference Year 2015									
	END USER PRICE (in €/toe)									
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Electricity										
Average price	12,0	13,9	14,7	15,6	16,1	16,4	16,9	16,8	16,7	16,6
Industry	8,6	9,9	9,8	10,0	10,1	10,2	10,3	10,4	10,3	10,3
Households(HH)	15,9	17,5	19,4	20,7	21,3	21,7	22,1	22,0	21,5	21,3
Services	12,9	15,1	16,0	17,4	18,0	18,3	18,7	18,6	18,4	18,2
average (HH/service)			17,7	19,1	19,6	20,0	20,4	20,3		

Figure 2-15: Decomposition of electricity generation costs and prices (€ per MWh) historical and forecast values (source: based in PRIMES with data supplied by the EC services)

2.5.Subtask 2.5- Recommendations

General objective of subtask 2.5:

This task makes recommendations with regard to a refined product scope from an economical/ commercial perspective (e.g. exclude niche markets) and identify barriers and opportunities for Ecodesign from the economical/ commercial perspective.

General conclusion:

This task report reconfirmed annual sales of new lifts according to the Lifts Directive (2014/33/eu) of about 125000 units per year. Paragraph 2 of Article 15 of the Ecodesign Directive 2009/125/EC however suggest indicatively more than 200000 units a year for being relevant for Ecodesign. Therefore the significance of future policy (Task 7) is a point of attention. Note however that the Ecodesign 2015-2017 working plan study[23] identified 8,0 TWh Primary Energy Saving potential by 2030 for lifts, which is relevant and therefore this study was initiated. Indeed, with a Primary Energy Factor[24] of 2,5 this equals 3,2 TWh/y and this could be for example achieved by the cumulative saving of 876 kWh/y per new lift installed in the EU28 from 2020 until 2030. Therefore the purpose of further tasks will be to investigate the feasibly of this.

Based on this market data further reduction of the scope is certainly not recommended because it would water down impact and significance. Due to demographic changes a future runner up could be home lifts, which are manufactured according to the Machinery Directive (2006/42/EC), which are passenger lifts traveling at speeds equal or below 0.15 m/s. Precise market data of such lifts is not available and therefore also hard evidence of significance is not yet available. It is also a clearly different product group that should not constitute a loophole in any further policy for lifts according to the Lifts Directive(2014/33/EU). Nevertheless Task 4 could look if home lifts have similarities in stand by energy loss reduction and this could serve for further policy recommendations in Task 7 to anticipate on a future trend.

[23] http://ec.europa.eu/growth/industry/sustainability/ecodesign_nl

[24] Energy Efficiency Directive (2012/27/EU)

Task 2

The task 2 market data is already structured and segmented according to the user data in Task 3 and in line with Task 1.

Annex A – lift stock data from the E4 project

2009							
country	number of units	[electromechanic (EM), electronic (EC)]	[geared traction (GT), gearless traction (GLT), hydro (HYD)]	nominal load [kg]	number of trips per year	No. Trips per day	Usage Category (deducted)
Austria	38,090			320.00	40,000	110	2
Austria	17,580			630.00	200,000	548	4
Austria	937			1200.00	700,000	1918	5
Austria	3,281			1600.00	40,000	110	2
Austria	6,094			750.00	200,000	548	4
Austria						0	
Austria	7,500			2000.00	300,000	822	4
Austria	26,950			630.00	60,000	164	2
Austria	100,432					0	
Belgium	30,000	EM	HYD	320.00	35,000	96	2
Belgium		EM	GT	320.00	60,000	164	2
Belgium		EC	GLT	630.00	70,000	192	2
Belgium	26,250	EM	GT	630.00	340,000	932	4
Belgium		EC	GLT	800.00	100,000	274	3
Belgium	3,750	EC	HYD	2000.00	35,000	96	2
Belgium		EC	GT	1800.00	250,000	685	4
Belgium		EC	GLT	1800.00	250,000	685	4
Belgium	3,750	EC	HYD	2500.00	45,000	123	2
Belgium		EC	HYD	1600.00	35,000	96	2
Belgium	3,750	EC	GLT	800.00	180,000	493	3
Belgium		EC	GT	630.00	300,000	822	4
Belgium	3,750	EC	GT	630.00	100,000	274	3
Belgium		EC	GLT	630.00	100,000	274	3
Belgium	3,750	EC			300,000	822	4
Belgium	75,000					0	
Czech Republic	64,810					0	
Czech Republic	19,444					0	
Czech Republic	4,764					0	
Czech Republic	6,755					0	
Czech Republic	4,105					0	
Czech Republic	3,809					0	
Czech Republic	2,037					0	
Czech Republic	1,248					0	

Czech Republic	5,026					0	
Czech Republic	112,000					0	
Denmark	13,765			320.00	40,000	110	2
Denmark	6,353			630.00	200,000	548	4
Denmark	338			1200.00	700,000	1918	5
Denmark	1,185			1600.00	40,000	110	2
Denmark	2,202			750.00	200,000	548	4
Denmark						0	
Denmark	2,710			2000.00	300,000	822	4
Denmark	974			630.00	60,000	164	2
Denmark	27,527					0	
Finland	8,000	EM	GT	240.00	50,000	137	2
Finland	2,000	EM	HYD	320.00	40,000	110	2
Finland	18,000	EM	GT	320.00	60,000	164	2
Finland	7,000	EC	GLT	630.00	70,000	192	2
Finland	1,500	EM	GT	630.00	100,000	274	3
Finland	3,000	EC	GLT	630.00	120,000	329	3
Finland	500	EM	HYD	1300.00	40,000	110	2
Finland	500	EM	GT	630.00	150,000	411	3
Finland	1,500	EC	GLT	1600.00	250,000	685	4
Finland	1,000	EC	GLT	1600.00	250,000	685	4
Finland	800	EM	GT	5000.00	45,000	123	2
Finland	700	EM	HYD	5000.00	20,000	55	1
Finland	1,000	EC	GLT	1600.00	250,000	685	4
Finland	2,000	EC	GT	900.00	300,000	822	4
Finland	500	EC	GLT	800.00	150,000	411	3
Finland	500	EC	GT	630.00	150,000	411	3
Finland	1,000	EM	HYD	2500.00	50,000	137	2
Finland	49,500					0	
France	28,000	EM	HYD	630.00	100,000	274	3
France	211,000	EM	GT	630.00	150,000	411	3
France	50,000	EC	GLT	630.00	200,000	548	4
France	30,400	EM	GT	1000.00	250,000	685	4
France	11,000	EC	GLT	1000.00	350,000	959	4
France	28,500	EM	GT	1000.00	200,000	548	4
France	8,000	EC	GLT	1250.00	300,000	822	4
France	5,000	EM	HYD	630.00	150,000	411	3
France	17,200	EM+EC	GT	400.00	150,000	411	3
France	4,000	EM	HYD	2000.00	150,000	411	3
France	19,000	EM+EC	GT	1000.00	200,000	548	4
France	1,000	EM	HYD	1000.00	150,000	411	3

France	16,000	EM+EC	GT	630.00	200,000	548	4
France	7,000	EC	GLT	1250.00	350,000	959	4
France	23,900			630.00	150,000	411	3
France	460,000					0	
Germany	422,500				40,000	110	2
Germany	78,000				200,000	548	4
Germany	6,500				700,000	1918	5
Germany	32,500				40,000	110	2
Germany	26,000				200,000	548	4
Germany	---					0	
Germany	58,500				300,000	822	4
Germany	26,000				60,000	164	2
Germany	650,000					0	
Greece	70,000	EM	GT	300.00	30,000	82	2
Greece	57,000	EM	GT	300.00	30,000	82	2
Greece	60,000	EM	GT	300.00	30,000	82	2
Greece	56,000	EM	GT	450.00	30,000	82	2
Greece	50,000	EC	HYD	450-630	30,000	82	2
Greece	46,000	EC	HYD	450-630	30,000	82	2
Greece	2,000	EM	GT	630.00	100,000	274	3
Greece	3,000	EM	GT	630.00	100,000	274	3
Greece	2,500	EM	GT	630.00	100,000	274	3
Greece	3,000	EC	GT+HYD	630-1000	150,000	411	3
Greece	2,000	EC	GT+HYD	630-1001	150,000	411	3
Greece	1,000	EM	GT	1000 - 2000	100,000	274	3
Greece	2,000	EM	GT	1000 - 2000	100,000	274	3
Greece	2,000	EM	GT	1000 - 2000	100,000	274	3
Greece	2,500	EM	GT	1000 - 2000	100,000	274	3
Greece	2,500	EC	GT+HYD	1000 - 2000	150,000	411	3
Greece	1,500	EC	GT+HYD	1000 - 2000	150,000	411	3
Greece	1,000	EM	GT	200-3000	30000-100000	274	3
Greece	2,000	EM	GT	200-3000	30000-100000	274	3
Greece	2,000	EM	GT	200-3000	30000-100000	274	3
Greece	2,500	EM	GT	200-3000	30000-100000	274	3
Greece	2,500	EC	HYD	200-3000	30000-100000	274	3
Greece	2,000	EC	HYD	200-3000	30000-100000	274	3
Greece	2,000	EM	GT	600-2500	30000-150000	411	3

Greece	2,000	EM	GT	600-2500	30000-150000	411	3
Greece	2,500	EM	GT	600-2500	30000-150000	411	3
Greece	2,000	EM	GT	600-2500	30000-150000	411	3
Greece	2,500	EC	GT+HYD	600-2500	30000-150000	411	3
Greece	2,000	EC	HYD	600-2500	30000-150000	411	3
Greece	1,000	EM	GT	600-2000	60000-150000	411	3
Greece	2,000	EM	GT	600-2000	60000-150000	411	3
Greece	2,000	EM	GT	600-2000	60000-150000	411	3
Greece	1,500	EM	GT	600-2000	60000-150000	411	3
Greece	1,500	EC	GT+HYD	600-2000	60000-150000	411	3
Greece	1,000	EC	GT+HYD	600-2000	60000-150000	411	3
Greece						0	
Greece	397,000					0	
Hungary	150	EM	HYD	320.00	38,000	104	2
Hungary	100	EC	HYD	320.00	38,000	104	2
Hungary	650	EM	GT	320.00	98,000	268	3
Hungary	1,600	EM	GT	320.00	125,000	342	3
Hungary	1,700	EM	GT	320.00	125,000	342	3
Hungary	450	EM	GT	320.00	105,000	288	3
Hungary	300	EM	GT	320.00	84,000	230	3
Hungary	800	EM	GT	480.00	125,000	342	3
Hungary	4,850	EM	GT	480.00	125,000	342	3
Hungary	3,850	EM	GT	480.00	64,000	175	2
Hungary	850	EC	GLT	480.00	79,000	216	3
Hungary	400	EM	GT	630.00	79,000	216	3
Hungary	1,350	EC	GLT	630.00	79,000	216	3
Hungary	450	EM	GT	800.00	116,000	318	3
Hungary	1,100	EM	GT	630.00	135,000	370	3
Hungary	50	EM	GT	1000.00	292,000	800	4
Hungary	50	EM	GT	1250.00	317,000	868	4
Hungary	950	EC	GLT	630.00	135,000	370	3
Hungary	550	EC	GLT	1000.00	118,000	323	3
Hungary	600	EM	GT	500.00	65,000	178	2
Hungary	100	EM	GT	630.00	110,000	301	3
Hungary	50	EM	GT	800.00	110,000	301	3
Hungary	200	EM	GT	1000.00	68,000	186	2
Hungary	400	EM	GT	1600.00	69,000	189	2
Hungary	350	EC	GLT	1000.00	71,000	195	2
Hungary	300	EM	GT	500.00	35,000	96	2

Hungary	450	EM	GT	1000.00	33,000	90	2
Hungary	600	EM	GT	1600.00	31,000	85	2
Hungary	150	EM	HYD	500.00	17,000	47	1
Hungary	350	EM	HYD	1000.00	17,000	47	1
Hungary	250	EM	HYD	1600.00	19,000	52	1
Hungary	50	EC	HYD	1600.00	19,000	52	1
Hungary	450	EM	HYD	500.00	18,000	49	1
Hungary	150	EM	HYD	1000.00	17,000	47	1
Hungary	200	EM	HYD	1600.00	16,000	44	1
Hungary	500	EC	GT	500.00	23,000	63	1
Hungary	600	EC	GT	1000.00	25,000	68	1
Hungary	500	EC	GT	1600.00	25,000	68	1
Hungary	450	EC	GLT	800.00	27,000	74	1
Hungary	150	EC	GT	500.00	170,000	466	3
Hungary	100	EC	GT	630.00	170,000	466	3
Hungary	50	EC	GT	800.00	210,000	575	4
Hungary	100	EC	GT	1000.00	200,000	548	4
Hungary	100	EC	GT	1600.00	210,000	575	4
Hungary	450	EC	GLT	630.00	190,000	521	4
Hungary	400	EM	GT	300.00	35,000	96	2
Hungary	500	EM	GT	500.00	42,000	115	2
Hungary	700	EM	GT	1000.00	33,000	90	2
Hungary	50	EM	GT	1600.00	32,000	88	2
Hungary	100	EC	GLT	630.00	110,000	301	3
Hungary	200	EM	HYD	630.00	15,000	41	1
Hungary	29,800					0	
Italy	240,000	EM		325	50,000	137	2
Italy	180,000	EM+EC		325-400	50,000	137	2
Italy	180,000	EM+EC		400	40,000	110	2
Italy	30,000	EM		630-1500	130,000	356	3
Italy	40,000	EM		900-1500	250,000	685	4
Italy	10,000	EM		630	85,000	233	3
Italy	15,000	EM+EC		630-1500	130,000	356	3
Italy	20,000	EM		900-1500	150,000	411	3
Italy	10,000	EM		1000	50,000	137	2
Italy	15,000	EC		1000-2500	75,000	205	3
Italy	50,000	EM+EC		900-1500	200,000	548	4
Italy	20,000	EM		630.00	200,000	548	4
Italy	40,000	EM		1250	300,000	822	4
Italy	850,000					0	
Luxembourg	3,960			320.00	40,000	110	2

Luxembourg	1,827			630.00	200,000	548	4
Luxembourg	97			1200.00	700,000	1918	5
Luxembourg	341			1600.00	40,000	110	2
Luxembourg	633			750.00	200,000	548	4
Luxembourg						0	
Luxembourg	779			2000.00	300,000	822	4
Luxembourg	280			630.00	60,000	164	2
Luxembourg	7,917					0	
Netherlands	9,100	EM	GT	450-900	85,000	233	3
Netherlands	20,550	EC	HYD	1000.00	85,000	233	3
Netherlands	6,050	EC	GKT	1000.00	85,000	233	3
Netherlands	3,800	EM	GT	630.00	180,000	493	3
Netherlands	15,950	EC	HYD	630-1000	180,000	493	3
Netherlands	4,050	EC	GLT	1000.00	180,000	493	3
Netherlands	5,950	EC	GT	1600-2500	950,000	2603	6
Netherlands	1,700	EM+EC	HYD	2000.00	35,000	96	2
Netherlands	5,400	EC	GT+GLT	1000.00	250,000	685	4
Netherlands	4,250	EC	GT+GLT	1000.00	120,000	329	3
Netherlands	8,500	EM	HYD	1000.00	250,000	685	4
Netherlands	85,300					0	
Poland	55	EM	GT	320.00	50,000	137	2
Poland	716	EM	GT	320.00	40,000	110	2
Poland	203	EM	GT	320.00	60,000	164	2
Poland	2	EM	GT	320.00	70,000	192	2
Poland	871	EM	GT	320.00	100,000	274	3
Poland	4,511	EM	GT	320.00	120,000	329	3
Poland	3,155	EM	GT	320.00	40,000	110	2
Poland	164	EM	GT	320.00	150,000	411	3
Poland	1	EM	GT	320.00	250,000	685	4
Poland	2,484	EM	GT	500.00	250,000	685	4
Poland	9,386	EM	GT	500.00	45,000	123	2
Poland	30,228	EM	GT	500.00	20,000	55	1
Poland	1,410	EM	GT	500.00	250,000	685	4
Poland	108	EM	GT	500.00	300,000	822	4
Poland	1,871	EC	GT	630.00	150,000	411	3
Poland	9,030	EC	GT	630.00		0	
Poland	7,273	EC	GT	630.00		0	
Poland	881	EC	GT	630.00		0	
Poland	133	EC	GT	630.00		0	
Poland	779	EC	GT+GLT+HYD	1000.00	50,000	137	2
Poland	4,522	EC	GT+GLT+HYD	1000.00	50,000	137	2
Poland	3,538	EC	GT+GLT+HYD	1000.00	50,000	137	2

Poland	330	EC	GT+GLT+HYD	1000.00	50,000	137	2
Poland	32	EC	GT+GLT+HYD	1000.00	50,000	137	2
Poland	81,683					0	
Portugal	5,000	EM	HYD	320.00	30,000	82	2
Portugal	2,500	EM	HYD	450.00	30,000	82	2
Portugal	68,000	EM	GT	320.00	60,000	164	2
Portugal	12,000	EM	GT	450.00	60,000	164	2
Portugal	7,500	EC	GLT	450.00	70,000	192	2
Portugal	2,500	EC	GLT	630.00	70,000	192	2
Portugal	2,000	EM	HYD	450.00	50,000	137	2
Portugal	1,000	EM	HYD	630.00	50,000	137	2
Portugal	10,000	EM	GT	630.00	220,000	603	4
Portugal	4,000	EM	GT	800.00	220,000	603	4
Portugal	2,000	EC	GT	1000.00	220,000	603	4
Portugal	1,000	EC	GLT	630.00	250,000	685	4
Portugal	500	EC	GLT	800.00	360,000	986	4
Portugal	500	EC	GLT	1000.00	360,000	986	4
Portugal	500	EM	HYD	1000.00	40,000	110	2
Portugal	1,500	EM	GT	800.00	360,000	986	4
Portugal	3,000	EM	GT	1000.00	360,000	986	4
Portugal	400	EC	GT	1600.00	360,000	986	4
Portugal	300	EC	GLT	800.00	420,000	1151	5
Portugal	200	EC	GLT	1000.00	420,000	1151	5
Portugal	100	EC	GLT	1600.00	420,000	1151	5
Portugal	750	EM	HYD	1000.00	30,000	82	2
Portugal	250	EC	HYD	2000.00	30,000	82	2
Portugal	400	EM	GT	1000.00	60,000	164	2
Portugal	100	EC	GLT	1000.00	80,000	219	3
Portugal	750	EM	HYD	800.00	73,000	200	3
Portugal	250	EM	HYD	1000.00	73,000	200	3
Portugal	500	EM	GT	800.00	260,000	712	4
Portugal	1,000	EM	GT	1000.00	260,000	712	4
Portugal	250	EC	GT	1250.00	260,000	712	4
Portugal	100	EC	GLT	800.00	300,000	822	4
Portugal	100	EC	GLT	1000.00	300,000	822	4
Portugal	50	EC	GLT	1250.00	300,000	822	4
Portugal	750	EM	HYD	630.00	50,000	137	2
Portugal	250	EM	HYD	1000.00	50,000	137	2
Portugal	1,500	EM	GT	630.00	360,000	986	4
Portugal	7,500	EM	GT	800.00	360,000	986	4
Portugal	500	EC	GT	1000.00	360,000	986	4
Portugal	300	EC	GLT	630.00	500,000	1370	5
Portugal	200	EC	GLT	800.00	500,000	1370	5

Portugal	100	EC	GLT	1000.00	500,000	1370	5
Portugal	140,100					0	
Spain	68,239	EC		630.00	200,000	548	4
Spain	41,744	HYD		630.00	200,000	548	4
Spain	523	other		630.00	200,000	548	4
Spain	421,863	EC		630.00	100,000	274	3
Spain	79,765	HYD		630.00	100,000	274	3
Spain	1,945	other		630.00	100,000	274	3
Spain	222,401	EC		480.00	40,000	110	2
Spain	42,942	HYD		480.00	40,000	110	2
Spain	954	other		480.00	40,000	110	2
Spain	11,507	EC		1600.00	100,000	274	3
Spain	6,305	HYD		1600.00	100,000	274	3
Spain	318	other		1600.00	100,000	274	3
Spain	4,079	EC		630.00	50,000	137	2
Spain	7,952	HYD		630.00	50,000	137	2
Spain	18	other		630.00	50,000	137	2
Spain	910,555					0	
Sweden	36,000		HYD			0	
Sweden	24,000		GT			0	
Sweden	8,000		HYD			0	
Sweden	16,000		GT			0	
Sweden	3,000		HYD			0	
Sweden	6,000		GT			0	
Sweden	12,000		HYD			0	
Sweden	12,000		GT			0	
Sweden	117,000					0	
UK	10,000	EC	GT	630.00	43,800	120	2
UK	7,500	EM	HYD	630.00	21,000	58	1
UK	10,000	EC	GT	630.00	43,800	120	2
UK	7,500	EM	HYD	630.00	21,000	58	1
UK	29,000	EC	GT	630.00	288,000	789	4
UK	34,000	EM	HYD	800.00	144,000	395	3
UK	34,000	EC	GT	630.00	288,000	789	4
UK	29,000	EM	HYD	800.00	144,000	395	3
UK	7,500	EC	GT	1600.00	788,400	2160	6
UK	4,000	EM	HYD	1600.00	394,000	1079	5
UK	7,500	EC	GT	1600.00	788,400	2160	6
UK	4,000	EM	HYD	1600.00	384,000	1052	5
UK	2,000	EC	GT	1500.00	26,500	73	1
UK	6,000	EM	HYD	1500.00	5,300	15	1
UK	3,000	EC	GT	1500.00	26,500	73	1

UK	5,000	EM	HYD	1500.00	5,300	15	1
UK	6,500	EC	GT	1000.00	240,000	658	4
UK	4,500	EM	HYD	1000.00	120,000	329	3
UK	6,500	EC	GT	1000.00	240,000	658	4
UK	3,500	EM	HYD	1000.00	120,000	329	3
UK	6,500	EC	GT	1000.00	175,000	479	3
UK	4,500	EM	HYD	1000.00	88,000	241	3
UK	6,500	EC	GT	1000.00	175,000	479	3
UK	4,500	EM	HYD	1000.00	88,000	241	3
UK	2,500	EC	GLT	1600.00	480,000	1315	5
UK	1,500	EM	GLT	1600.00	480,000	1315	5
UK	247,000					0	
TOTAL	4,340,814						

Figure 2-16: Original E4 Project Data (calculated values in orange)

Annex B – definitions from ELA

New lifts (units + value)

The number of new lifts are gathered from the number of orders for new lifts and their value; not the lifts invoiced, because invoicing can happen much later.

Full replacement

A full replacement is a new lift installed in an existing building, where the old lift is completely pulled out. Full replacement implies a new CE-mark.

Modernization

The line for “modernization” should include a total figure for the total value of modernization work for lifts and escalators excluding complete full replacements, maintenance and repair work. Modernization implies an improvement of the lift or escalator.

European Commission

Ecodesign preparatory study for lifts implementing the Ecodesign Working Plan 2016-2019

Task 3 report: Users

Reference:
N° 617/PP/GR(MMA/17/1131/9709 for the conclusion of a specific contract in application of the Framework Contract No 409/PP/2014/FC Lot 2 with reopening of competition

Client:
European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

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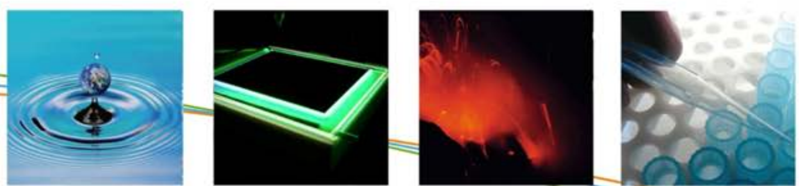

Table of contents: Task 3

List of Figures

List of tables

List of Abbreviations and Acronyms

BfE	Bundesamt für Energie (Switzerland)
e4	European project “energy-efficient elevators and escalators”
EC	European Commission
ELA	European Lift Association
EN	European Standard
EU	European Union
EU28	28 Member States of the European Union
ISO	International Organization for Standardization
MEERP	Methodology for Ecodesign of Energy-related Products
GSM	Global System for Mobile Communications
VDI	Association of German Engineers
ZVEI	Zentralverband Elektrotechnik- und Elektronikindustrie (Germany)

3. Task 3 - Users (product demand side) – for Ecodesign and Energy labelling

User behaviour is particularly relevant for the environmental impact of lifts as it directly determines their utilisation. This task therefore deals with the influence of users on the life-cycle performance of lifts. The aim of this discussion is two-fold: on the one hand, its aim is to discuss barriers and restrictions to potential Ecodesign measures due to infrastructural, social and cultural aspects. On the other hand, it also aims at quantifying user-parameters with influence on the environmental impact differing from the standard test conditions as described in Task 1.2.

3.1. Preliminaries

As a starting point for reviewing user impact on the environmental performance of lifts, it is helpful to get an overview of different stakeholders involved in the life cycle of lifts, to further define "lifts users" among them and to describe the impact of the stakeholder setting for lift performance in general.

3.1.1. Stakeholders involved in the life cycle of lifts

Unlike typical commodity products such as white goods, lifts are customized products usually based on selecting and adjusting standard components. Lift manufacturers make a selection of suitable components, combine them and if necessary modify them according to the individual customer requirements. For special lift installations, e.g. for specific industrial applications and large office buildings, individually tailored components may also be part of the lift installation.

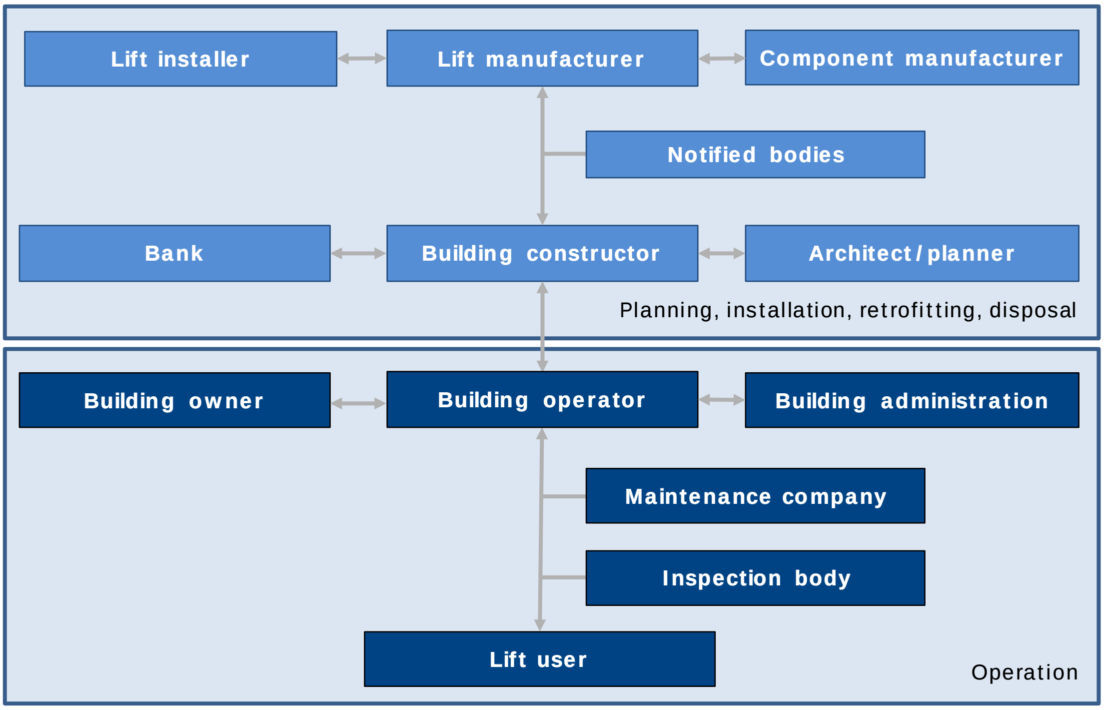

Figure 3-1: Overview of stakeholders involved in the life cycle of lifts (source: modified from Hirzel/Blepp 2017 and Dütschke/Hirzel 2010)

Figure 3-1 provides an overview of the different groups of stakeholders involved in the life-cycle of lifts. The upper part of the illustration shows major stakeholder groups mainly involved in the planning, installation, retrofitting and disposal phase of a lift project. It should be noted that the relevance of the different groups of stakeholders varies over time. The lower part illustrates stakeholders involved during the operation phase. The individual groups and their influence on the environmental performance can be summarized as follows:

- **Lift manufacturers:** Lift manufacturers basically design, manufacture and assemble lifts to suit the specific customer requirements , i.e. from the constructor of the building, a planner or an architect. Depending on the extent of the details given by the design specification and in view of existing regulation (see Task 1.7), manufacturers have a varying degree of freedom with regard to lift design. Within this freedom of action and limits in terms of budget, they may choose to manufacture or implement more or less efficient components and they thus affect the environmental performance of lifts.

- **Component manufacturers:** In addition to lift manufacturers, there are usually smaller manufacturers of components that focus on offering specific components for lifts such as control systems, brakes, motors, door movers, guide rollers, etc. As these components are part of the lift, they have an impact on the overall environmental performance of the lift.

- **Lift installers:** The task of lift installers is to assemble and install the lift on location, i.e. in the lift shaft/machine room of a building. This work is often carried out by lift manufacturers as part of the sales process. As the installation quality may affect the environmental performance of lifts (e.g. due to poorly installed guiding rails), lift installers may have an impact on the environmental performance, as well.

- **Notified bodies:** Notified bodies are organizations that verify the conformity of products with existing legal requirements before they are placed on the European market. As their task is to focus on assessing the conformity of lifts and their safety components, they have little direct impact on the overall performance of lifts and beyond to ensure that the lift is suitably equipped with all necessary safety precautions, e.g. light curtains.

- **Building constructors:** Building constructors develop the idea and set the conditions for building construction and rehabilitation projects. They give the impetus for such projects and contract architects and planners for detailed project planning. They might also set requirements on the design and operation of the building and its lifts.

- **Bank:** This group usually provides funding on the level of entire building projects, i.e. for constructing new buildings or for retrofitting existing ones. Banks typically focus on construction projects in their entirety and rarely deal with individual details such as lifts. Yet they may indirectly have an impact on the environmental performance of lifts by setting budgeting limits, by defining requirements to the project or by setting minimum requirements in terms of environmental impact or energy performance, thereby potentially also affecting lifts. Yet in sum, their direct impact on the environmental performance of lifts is rather limited.

- **Architects/planners:** Architects and planners define the layout of building projects and thereby also influence the need for vertical mobility. Thus, they determine many aspects relevant for the environmental performance of lifts, for example by setting the framework conditions which influence the number, size or usage of lifts.

- **Building owner:** Owners of the buildings are stakeholders that own the lift respectively the building where the lift is located. Building owners are usually identical to the constructor if buildings are not sold after completion of the building. Depending on the situation, building owners may mainly view the building including its lifts as an investment opportunity. Operational tasks may be delegated to an independently operating building administration.

- **Building administration:** The building administration mainly deals with financial and organizational aspects of building operation, e.g. renting of space, organizing maintenance, invoicing, etc. Regular maintenance works may be delegated to a building operator. Building administrators influence the performance of lifts by establishing maintenance and retrofitting schedules for the lifts, for example.

- **Building operator:** Building operators, e.g. caretakers, can be considered as stakeholders dealing with all organizational on-site aspects. They are responsible for ensuring the proper operation of the building including its technical equipment such as lifts. They usually ensure that the lift is working properly, for example, by performing routine checks. They may influence the performance of lifts among other means by identifying malfunctions of the equipment, e.g. based on unusual noise or contamination of the equipment. They may also respond to operational needs, e.g. by modifying standby modes.

- **Maintenance company:** Lifts need regular maintenance and inspection. Therefore, maintenance companies regularly intervene on any lift installation. The inspection intervals vary depending on several factors, among others their utilisation. Typical maintenance intervals are in the range of 1 to 3 months for many installations, yet it has been pointed out by stakeholders that an interval of 1 month while some lifts are not maintained on a regular basis at all. Proper maintenance can help to improve the environmental performance of lifts, e.g. by ensuring proper lubrication, replacement of worn components, ensure proper equipment setting etc. Maintenance work is provided by specialized independent companies, but also by large lift manufacturers.

- **Inspection body:** The safe operation of lifts is ensured by regular inspections of third party inspection bodies. Their impact on the environmental performance of lifts is mainly focused on pointing out faulty equipment or non-conformity with existing regulations.

- **Lift users:** Lift users are actually all those who use lifts for vertical transportation. Thereby, they directly affect the energy consumption of lifts as the power reading in the phase of operation is higher than it is in standby. In residential buildings, a large group of the lift users are the inhabitants of the buildings. They typically “pay for the lift”. Either the investments are covered by the rent or they are allocated to the owners as a function of their ownership of floor space or a similar measure. The operational costs for operation, especially energy and maintenance, are usually payed as part of the reoccurring costs of the building.

Though some of the previously mentioned stakeholder groups may overlap, it becomes evident that many groups affect the overall environmental performance of lifts. Due to the interaction of several types of stakeholders, barriers to energy efficiency have been identified as a relevant topic for lifts.

3.1.2. Barriers for lifts

Following the definition of Sorrell et al. (2004), a barrier can be perceived as a mechanism that inhibits a decision or behaviour that is both energy-efficient and economically efficient. A structured in-depth investigation on barriers for lifts (and escalators) was carried as part of the e4-project (Dütschke/Hirzel 2010). This investigation was based on a triangulation process combining the results of 13 expert interviews, a written survey with 10 additional participants and an intermediate and subsequent discussion of preliminary results with industrial representatives. The results were presented along five categories of potential barriers, i.e. a) information and transaction costs, b) split incentives, c) bounded rationality, d) capital and e) risk and uncertainty. In the following text and in Figure 3-2, the main results for these categories are summarized.

3.1.2.1. Findings on information and transaction costs

Findings on information and transaction costs indicate that a regular monitoring of energy consumption in lifts is rather uncommon. Usually, no technical means were installed that would allow such monitoring. Consequently, it has been concluded that energy consumption of lifts could not be discerned from other equipment in a building. This has been perceived as related to the observation that operators and users are seldom aware of the energy consumption of equipment. Due to this lack of sensitivity on the topic, no measurement equipment is installed and due to the lack of data, individuals hardly become aware of potentials to increase energy efficiency in the case of existing installations.

Obtaining information on energy-efficient technology was not perceived as especially difficult, yet limited to information from manufacturers and their sales representatives. However, it has been pointed out that sales representatives were not necessarily familiar with a broad spectrum of possible solutions beyond those offered by their own company.[1] It has also been found that clients were largely ignorant about energy-related topics of lifts, as well, and that they thus could not ask specific questions about the topic.

3.1.2.2. Findings on split incentives

Concerning split incentives, it has been found that they are considered as barriers to energy efficiency between general contractors or building constructors, lift owners as well as those who pay for the energy consumption of the lifts. In the residential sector, the latter group usually consists of the inhabitants of the building and they are not necessarily identical to the building owners. It has also been pointed out that constructors often do not pay particular attention to the energy consumption of lifts. In addition, the end-users are generally not aware of the costs related to the energy consumption of lifts.

3.1.2.3. Findings on bounded rationality

A lack of time for the selection of equipment was not identified as relevant with the exception of cases of equipment breakdown where quick replacement was needed. A focus on the initial investments as opposed to life-cycle costs, however, has been identified as a relevant barrier.

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[1] Given that additional sources of information, e.g. the findings from the e4-project, have been made publicly available since conducting the study, this issue can be considered as less relevant. It should also be noted that the more widespread use of energy labels for lifts might also have affected the ease of obtaining information on energy consumption. It seems plausible that there is more awareness among specifiers, lift companies and suppliers on energy-related issues in lifts.

3.1.2.4. Findings on capital

A general lack of capital was not identified as a barrier. Rather, the willingness to make bigger initial investments for energy-efficient equipment was seen as a challenge, particularly in the case where split incentives were relevant. Yet some experts also pointed out in this context that energy-efficient technologies were not substantially more expensive than default components. Furthermore, no barriers due to budgeting laws or regulations for public buildings were identified.

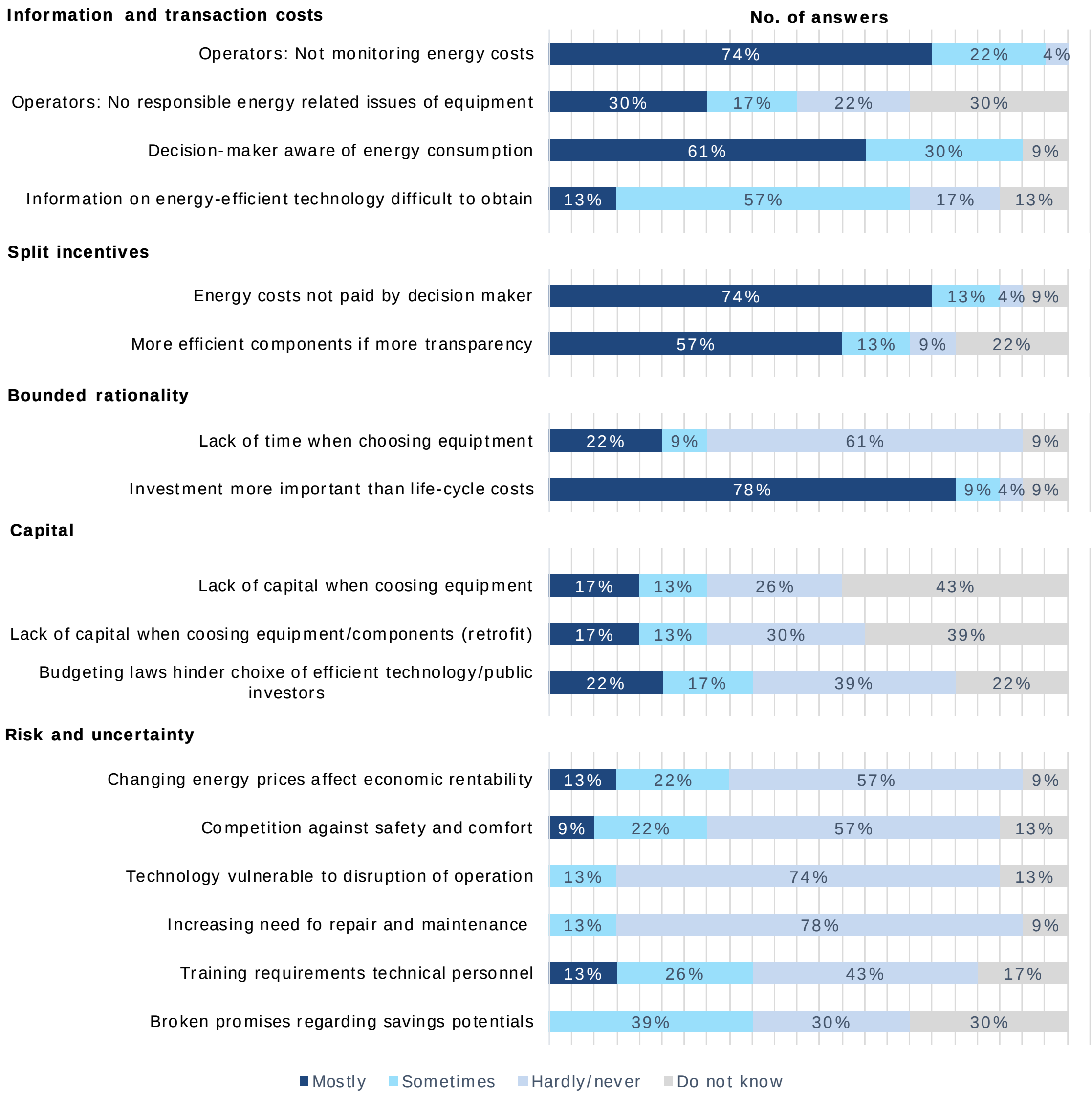

Figure 3-2: Overview of the results of the 23 expert interviews/questionnaires about the relevance of barriers to energy efficiency for lifts (and escalators) from Dütschke/Hirzel (2010)

3.1.2.5. Findings on risks and uncertainties

Risks and uncertainties could neither be identified as major barriers for the utilization of energy-efficient technologies for lifts. Neither has more efficient technology been identified as more susceptible to disruption of operations, nor has it been found to increase needs for repairs and maintenance or to increase substantially training requirements for technical personnel. Comfort or safety issues or uncertainties about promised/potential energy saving were not seen as barriers, either.

3.1.2.6. Conclusions from the analysis in 2010

Based on these findings, the analysis in Dütschke/Hirzel (2010) gave the following main conclusions:

- Major barriers to energy-efficient technologies identified were related to information and awareness. A lack of monitoring of energy consumption and a lack of awareness about energy-efficient technologies especially with the operators/users has been identified. An important role was further attributed to the situation that a main source of information were manufacturers and their sales departments, encouraging situations where installations where usually chosen without any detailed assessment of energy demand or its life cycle impact.

- Split incentives were furthermore discussed as a challenge for implementing energy-efficient solutions. This is particularly the case when several building users/inhabitants share the overall energy costs of a lift, especially since only a minor share of electricity demand of a building is caused by a lift. While manufacturers rather intensively discussed energy demand/energy efficiency, other stakeholders were not engaged by the discussion and investors focus on low investment costs

- Other barriers, next to those related to information and split incentives, were only identified as playing a minor role. A general lack of capital was not identified as a barrier, yet a focus on investments could be observed and the economic efficiency of energy-efficient technologies was the subject of a controversial debate.

3.2. Subtask 3.1 - System aspects in the use phase affecting direct energy consumption

The aim of this subtask is to report on the **direct impact** of lifts on the environment and resources during the use phase. Direct impact means here any impact that is directly related to the lift itself. The analysis is based on different scoping levels, starting with at the strict product scope, and then extending this perspective to an extended product approach, thereafter proceeding to a technical system approach and finally discussing lifts from a functional system approach. For the remainder of Task 3, the “lift users” are considered as main “users” in the sense of the MEERP methodology.

These different scoping levels can be sketched as follows (Figure 3-3):

- **Strict product approach:** In the strict product approach, the system boundary just contains the lift installation with its components. The operating conditions are nominal as defined in traditional standards.

- **Extended product approach:** In the extended product approach, the influence of lift usage and real-life deviations from the test standard will be discussed.

- **Technical system approach:** When viewed from the technical system perspective, the lift is embedded in the surrounding building system.
- **Functional approach:** In the functional system approach, the basic function of a lift, i.e. vertical transportation of goods or people in buildings, is maintained, yet other ways to satisfy this basic function are reviewed, as well.

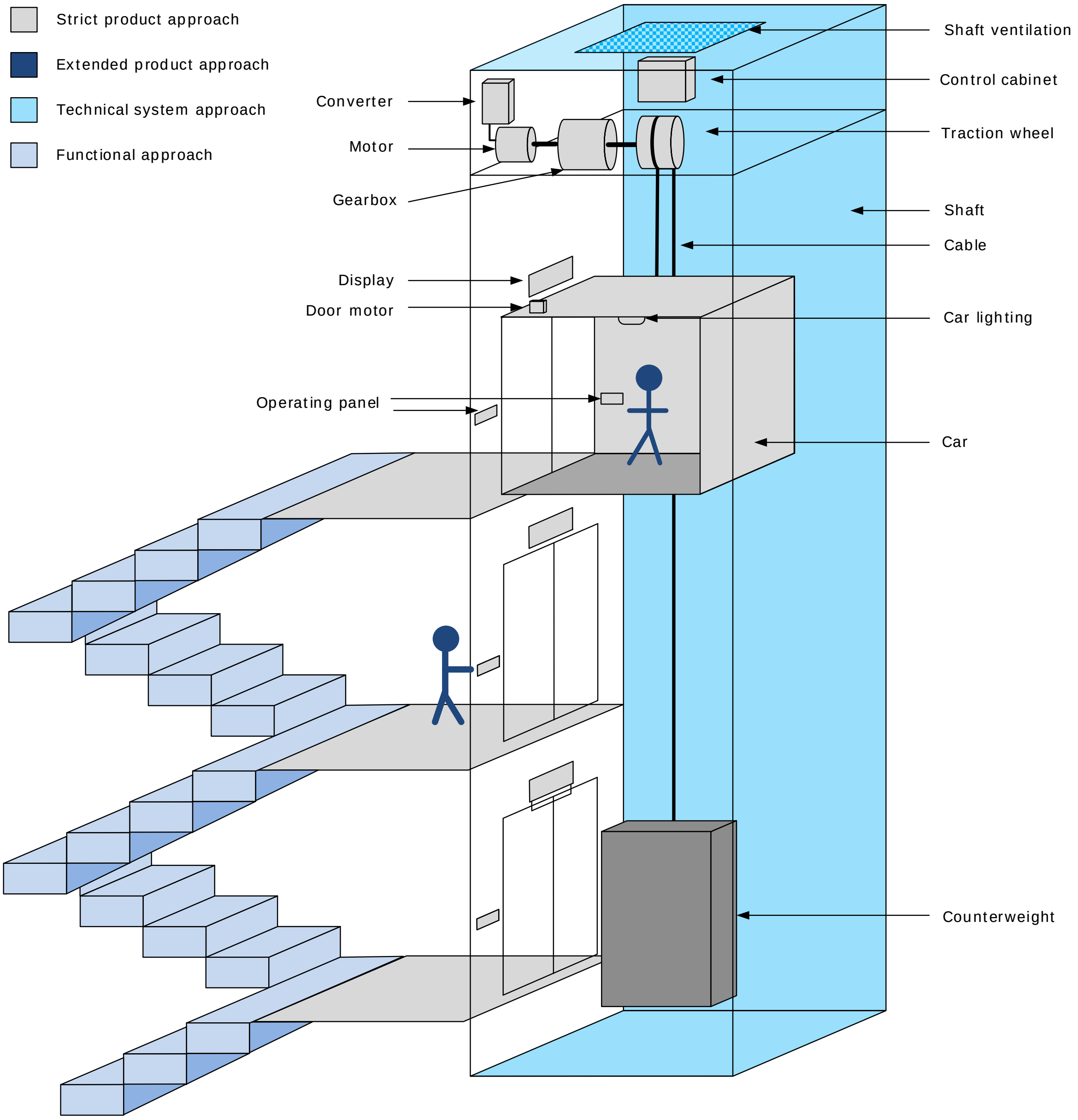

Figure 3-3: Illustration of the different scoping levels in this study (source: Fraunhofer ISI).

3.2.1. Strict product/component scope

The strict product approach is the most restrictive point of view with regard to user influence on product performance as it is based on nominal operating conditions as defined in energy-related standards. The review of existing standards in Task 1 shows that there are two families of standards for assessing the energy performance of typical lifts Both sets focus on the usage phase. The EN ISO 25745 family is a set of global standards concerning the energy efficiency of lifts and escalators. In addition, there is the family of national German VDI 4707 guideline documents which also deals with energy efficiency in lifts. The first VDI4707-1 was officially published a few years earlier than the corresponding EN ISO 25745 standards. Therefore, it has been used in some countries as a reference to analyse the energy performance of lifts prior to the release of EN ISO 25745. To provide a full picture, this section relates both to the ISO standards but also to the methodology of VDI.

Presenting VDI and ISO in this section does not mean that both lines of documents have the same relevance. The EN ISO 25745 standards clearly takes precedence over the VDI guidelines for considerations across the EU as carried out within this preparatory study. Furthermore, stakeholders have pointed out that VDI 4707-1 is to be fully harmonized with EN ISO 25745 in an upcoming revision.[2]

The aim of the following analysis is to point out the underlying assumptions concerning the role of the user both in the ISO and VDI documents. Due to the broad range of different lifts and utilizations, these standards require simplifications and assumptions to be made. This section focuses only on the simplifications that concern user behaviour. For general descriptions of the standards, the reader is referred to Task 1. Note that both VDI 4707-1 and EN ISO 25745-2 refer to the measuring procedures laid down in EN ISO 25745-1. These technical procedures will not be dealt with here.

To understand the impact of user behaviour on energy demand of a lift according to both standards, it is helpful to review how they calculate energy consumption. In the following text, a brief summary of the calculation procedures for determining energy demand according to VDI 4707-1 and EN ISO 25745-2 are given first. Thereafter, the simplifying assumptions on user behaviour are further discussed.

Note that some of the nomenclature has been modified from the standards to facilitate reading and to allow a better comparison of VDI and ISO calculation models. Note further that where necessary, some unit conversions have been added to ensure consistency of the equations.

3.2.1.1. Energy demand calculation according to VDI 4707-1:2009

Generally, VDI 4707 specifies two general types of energy demand values: On the one hand annual energy demand values help to indicate how much electric energy is required to operate the lift per year. On the other hand, specific energy and power consumption values are used to compute an energy label for the lift.

In VDI 4707-1, the overall annual energy demand E_{year} in kWh/year is computed from a daily energy demand E_{day} in Wh/day multiplied by a factor n which accounts for the 365 days in a year. Thus:

$$E_{year} = E_{day} \cdot n \cdot 0.001 \frac{kWh}{Wh}$$

The daily energy demand E_{day} consists of the daily energy demand in standby mode $E_{standby}$ in Wh/day and the daily demand for travelling E_{travel}, also in Wh/day:

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[2] More specifically it has been pointed out that VDI 4707-1 is expected to be transformed into an application guideline for calculations according to EN ISO 25745. The publication of the draft for this revision is expected soonest by the end of 2018.

$$E_{day} = E_{standby} + E_{travel}$$

Daily standby $E_{standby}$ is determined by measuring the average standby power $P_{standby}$ in W multiplied by the daily standby within the period $t_{standby}$ expressed in h/day:

$$E_{standby} = P_{standby} \cdot t_{standby}$$

The daily standby is computed based on the 24 h/day minus the travelling time t_{travel} in h/day:

$$t_{standby} = 24\,\frac{h}{day} - t_{travel}$$

The daily energy demand E_{travel} is computed from the specific travel demand $E_{travel,spec}$ in mWh/(kg·m) multiplied by the daily travel distance s_{travel} in m/day and the nominal load m_{load} of the lift in kg:

$$E_{travel} = E_{travel,spec} \cdot s_{travel} \cdot m_{load}$$

The daily travel distance s_{travel} is based on the nominal travelling speed of the lift v_{travel} in m/s and the daily duration of use t_{travel} in hours/day.

$$s_{travel} = v_{travel} \cdot t_{travel} \cdot 3600\frac{s}{h}$$

The specific travel demand $E_{travel,spec}$ is derived from the measured energy demand for an average reference trip E_{cycle} in Wh divided by twice the lifting height $s_{lifting}$ in m, i.e. the travelled distance during one cycle, and the nominal load m_{load}.

$$E_{travel,spec} = 0.5 \cdot \frac{E_{cycle}}{m_{load} \cdot s_{lifting}} \cdot 1000\,\frac{mWh}{Wh}$$

The previous equation assumes that the energy consumption for the reference trip is measured for a car loaded with a predefined load spectrum. As a simplification for certain types of lifts, it is possible to measure the car empty and then scale the energy demand using a dimensionless adjustment factor k as follows:

$$E_{travel,spec} = 0.5 \cdot k \cdot \frac{E_{cycle}}{m_{load} \cdot s_{lifting}} \cdot 1000\,\frac{mWh}{Wh}$$

For the sake of completeness, the calculation of the specific energy demand required for determining the energy label is briefly described. Based on the previously mentioned variables, the specific travel demand $E_{travel,spec}$ and the standby power $P_{standby}$ are merged into an overall specific energy demand value E_{spec} in mWh/(kg·m):

$$E_{spec} = E_{travel,spec} + \frac{P_{standby}}{v_{travel} \cdot m_{load}} \cdot \frac{t_{standby}}{t_{travel}} \cdot \frac{1000\,\frac{mW}{W}}{3600\,\frac{s}{h}}$$

For determining the labelling value, this result is compared to maximum admissible values which depend on lift usage (i.e. $t_{standby}$ and t_{travel}) and maximum load (i.e. m_{load}).

An overview of the calculation scheme for the overall annual energy demand is given in Figure 3-4. All eight input variables necessary to perform the calculation are highlighted in blue.

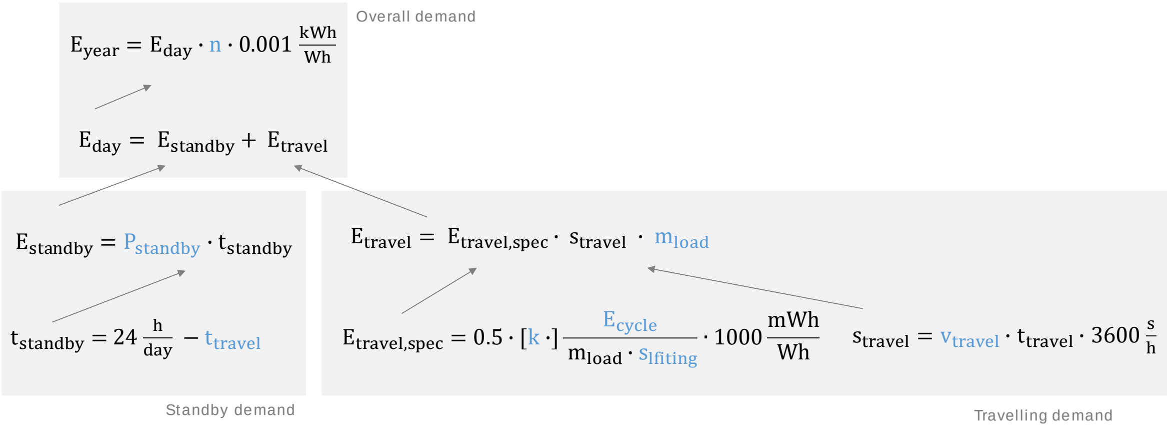


Figure 3-4: Overview of the calculation scheme for annual energy demand based on VDI 4707-1:2009 with input variables marked in blue (factor k in square brackets depends on configuration)

3.2.1.2. Energy demand calculation according to EN ISO 25745-2:2012

In terms of how to determine energy demand, EN ISO 25745 and VDI 4707 are similar. Yet EN ISO 25745-2 offers a more sophisticated calculation model for energy demand as will be outlined in the following discussion. Like in the previous subsection, some of the nomenclature has been modified to facilitate reading.

According to EN ISO 25745, the overall annual energy demand $E_{year}$is expressed in Wh/year and is computed from the daily energy demand E_{day} expressed in Wh/day multiplied by the number of operating days n per year. Thus:

$$E_{year} = E_{day} \cdot n$$

The daily energy demand E_{day} is again split into the daily energy demand in standby mode $E_{standby}$ in Wh/day and the daily demand for travelling E_{travel} in Wh/day:

$$E_{day} = E_{standby} + E_{travel}$$

The standby demand $E_{standby}$ is derived from standby readings in different modes of operation. More specifically, three standby values are distinguished: The standby power in idle mode $P_{<5min}$ in W covers the 5 minute period after the last movement, the 5 minute standby $P_{5-30min}$ in W covers the standby between 5 and 30 minutes after the last movement and the 30 minute standby power $P_{>30min}$ in W covers the period thereafter. Each of the phases is weighted by a typical share $r_{<5min}$, $r_{5-30min}$ and $r_{>30min}$ in percent. This weighted value is multiplied by the standby duration $t_{standby}$ in h/day:

$$E_{standby} = t_{standby} \cdot (P_{<5min} \cdot r_{<5min} + P_{5-30min} \cdot r_{5-30min} + P_{>30min} \cdot r_{>30min})$$

The standby time $t_{standby}$ in h/day is the time with the car stopped while the doors are opened and users enter or leave the car or while the doors are closed and the lift is in one of the non-running modes. It is usually equal to 24 h/day minus the travelling time t_{travel} in h/day:

$$t_{standby} = 24\ \frac{h}{day} - t_{travel}$$

The overall travelling time t_{travel} depends on the average travel time per trip t_{trip} in s and the number of trips n_{trip} per day.

$$t_{travel} = n_{trip} \cdot t_{trip} \cdot \frac{1}{3600}\frac{h}{s}$$

The variable t_{trip} is based on the sum of the following variables: The time for the door movements including keeping the doors open t_{door} in s, the average travel distance per trip s_{trip} in m divided by the nominal speed of the lift v_{travel} in m/s, the nominal speed divided by the nominal acceleration $a_{nominal}$ in m/s² and the nominal acceleration divided by the average jerk j_{travel} in m/s³:

$$t_{trip} = t_{door} + \frac{s_{trip}}{v_{travel}} + \frac{v_{travel}}{a_{travel}} + \frac{a_{travel}}{j_{travel}}$$

The average travel distance per trip s_{trip} is derived from the lifting height $s_{lifting}$ in m multiplied by an average adjustment factor i as a percentage:

$$s_{trip} = i \cdot s_{lifting}$$

With regard to travelling consumption, the daily energy demand E_{travel} is computed from the dimensionless load factor k, the number of trips n_{trip} per day and the energy demand for an average cycle E_{cycle} in Wh:

$$E_{travel} = 0.5 \cdot E_{cycle} \cdot k \cdot n_{trip}$$

The average energy demand per cycle E_{cycle} is twice the specific average consumption $E_{travel,spec}$ in Wh/m multiplied by the average trip distance s_{trip} plus the energy demand for each start and stop $E_{start-stop}$ in Wh:

$$E_{cycle} = 2 \cdot s_{trip} \cdot E_{travel,\,spec} + 2 \cdot E_{start-stop}$$

The specific average travel consumption $E_{travel,spec}$ is computed as an average from the specific energy demand of a reference cycle minus the energy demand of a short cycle. For the calculation, the energy consumption for a reference cycle E_{run} in Wh according to EN ISO 25745-1 is diminished by the consumption for a short cycle E_{short} in Wh and divided by the travel distance of the car during the reference cycle $s_{lifting}$ in m, i.e. the lifting height, minus the travel distance in the short cycle s_{short} in m:

$$E_{travel,spec} = 0.5 \cdot \left(\frac{E_{run} - E_{short}}{s_{lifting} - s_{short}}\right)$$

This means that the specific energy consumption per meter is an average value for steady-state operation where the standing, start and stop parts of the reference cycle are eliminated from the specific consumption by subtracting the demand for a short cycle, this means only the steady-state running consumption is used here. Note the difference with the consumption value in VDI 4707, which is specific per weight and also includes other parts of the cycle next to steady state operation as part of the running consumption, i.e. acceleration/deceleration, door movements and loading/unloading).

The average energy consumption for each start and stop $E_{start-stop}$ is based on the energy demand for the reference cycle E_{run}, the average travel consumption $E_{travel,spec}$ and the lifting height $s_{lifting}$ of the car during the reference cycle:

$$E_{start-stop} = 0.5 \cdot (E_{run} - 2 \cdot E_{travel,spec} \cdot s_{lifting})$$

This means that the consumption for the constant movement is removed from the cycle consumption, thus leaving the acceleration and deceleration parts as well as the door movements in the overall energy demand value for start and stop.

The load factor k for determining the travel demand is a function of the average load l expressed as a percentage of nominal load as well as a type-specific dimensionless adjustment factor k^* that depends on the balancing load:

$k = 1 - l \cdot k^*$ (traction lifts)
$k = 1 + l \cdot k^*$ (hydraulic lifts)

The energy label is then attributed based on the daily energy consumption. This is based on a comparison with maximum admissible energy values per class which depend on the nominal load m_{load}, the number of trips n_{trip}, the average travel distance s_{trip} and the time in standby $t_{standby}$.

An overview of the calculation scheme for the overall annual energy demand for EN ISO 25745-2 is given in Figure 3-9 with the input variables highlighted in blue. The ISO calculation model requires 18 distinct input variables and thus more than twice as many as VDI 4707-1 with its simplified calculation scheme.

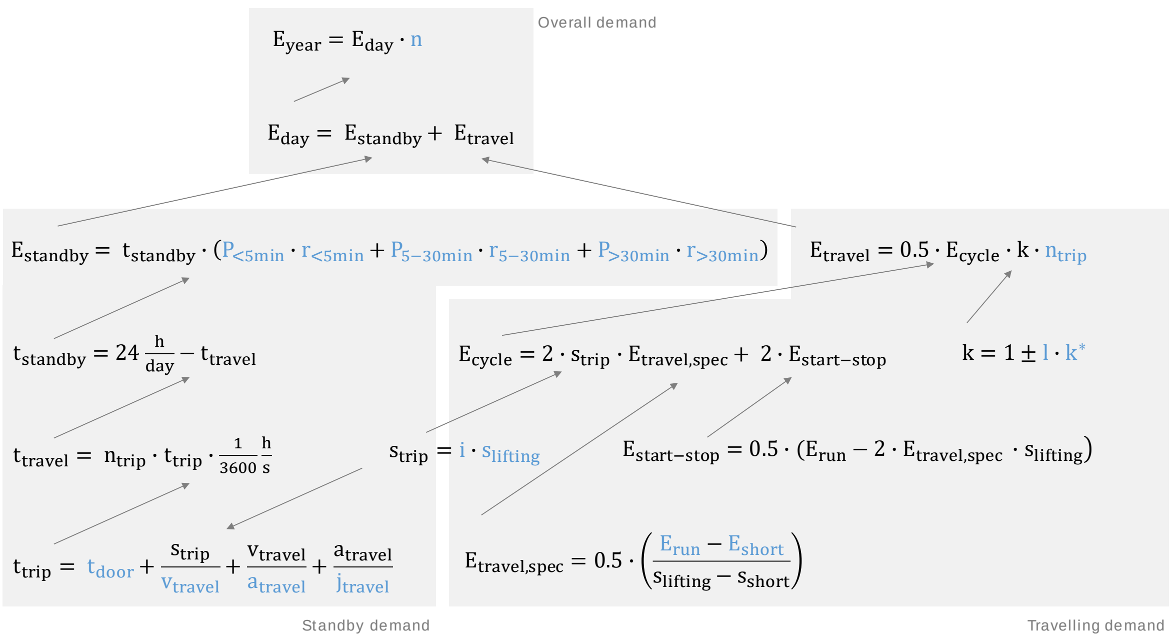


Figure 3-5: Overview of the calculation scheme for annual energy demand based on EN ISO 25745-2:2012 with input variables marked in blue.

An overview of all input variables used in EN ISO 25745-2 and VDI 4707-1 is given in Table 3-1. Note that not all variables match exactly but they have been denoted with similar letters to underline the similarities of the approaches.

Table 3-1: Overview of variables used in EN ISO 25745 and VDI 4707. Note that the delineation of variables may vary between the standards.

Variable	Description	EN ISO 25745	VDI 4707
E_{year}	Overall annual energy demand	Wh/year	kWh/year
E_{day}	Daily energy demand	Wh/day	Wh/day
E_{travel}	Daily travelling demand	Wh/day	Wh/day
$E_{standby}$	Daily standby demand	Wh/day	Wh/day
E_{cycle}	Energy demand for a cycle[1)]	Wh	Wh
E_{run}	Running demand for reference cycle	Wh	-
E_{short}	Energy demand for a short cycle	Wh	-
$E_{travel,spec}$	Specific travel demand[2)]	Wh/m	mWh/(kg·m)
$E_{start-stop}$	Energy demand for each start and stop	Wh	-
E_{spec}	Specific energy demand for VDI label	-	mWh/(kg·m)
n	Number of operating days per year[3)]	day/year	day/year
n_{trip}	Number of trips per day	1/day	-
$t_{standby}$	Daily standby time	h/day	h/day
t_{travel}	Daily travel time	h/day	h/day
t_{trip}	Average travel time per trip	s	-
t_{door}	Time for the door movements	s	-
$P_{standby}$	Standby power	-	W
$P_{<5min}$	Standby up to 5 minutes after stopping	W	-
$P_{5-30min}$	Standby 5 to 30 minutes after stopping	W	-
$P_{>30min}$	Standby 30 minutes after stopping	W	-
$r_{<5min}$	Standby share up to 5 minutes	%	-
$r_{5-30min}$	Standby share 5 to 30 minutes	%	-
$r_{>30min}$	Standby share after 30 minutes	%	-
s_{travel}	Daily travel distance	-	m/day
$s_{lifting}$	Lifting height	m	m
s_{trip}	Average travel distance per trip	m	-
s_{short}	Short cycle travelling distance	m	-
m_{load}	Nominal load of the lift	-	kg
v_{travel}	Nominal speed	m/s	m/s
a_{travel}	Average acceleration	m/s^2	-
j_{travel}	Average jerk	m/s^3	-
i	Adjustment factor for average trip distance	[1=100%]	-
k	Adjustment factor for empty car measurement[4)]	[1=100%]	[1=100%]
k^*	Type-specific constant for different load situations	const	-
l	Average load as share of nominal load	[1=100%]	-

1) Note that in VDI 4707-1, the cycle is measured for the full length of the shaft while in EN ISO 25745-2, the cycle is an averaged value.
2) Note that the specific travel demand in VDI 4707-1 is given as specific consumption per kg and m and also contains variable travelling shares whereas EN ISO 25745-2 gives a consumption value per m and only for steady-state travelling.
3) Note that VDI 4707-1 defines a default of 365 operating days whereas EN ISO 25745-2 suggests to use the number of operating days.
4) Note that the adjustment factors are defined differently in the standards and that the application domain varies too.

3.2.1.3. Review of the input variables in the strict product definition case

In the following discussion, the highlighted input variables according to the standard are discussed to clarify how they are treated in the models. Due to the general similarities in VDI 4707-1 and EN ISO 25745-2, the input variables for both standards will be discussed together.

3.2.1.4. Usage categories

Usage categories are not explicitly used as input variables in the previous calculation models for annual energy demand. Yet they are fundamental as they define typical values for several of the key parameters determining the overall energy calculation. Usage categories define several classes of lifts based amongst other factors on building characteristics, intensity and frequency of use or number of trips as well as typical running and standby times for the categories concerned.

The usage categories defined in VDI 4707-1 are shown in Table 3-2. Here, different types of buildings are defined with a rough description of their typical setting, e.g. small residential buildings as well as large and high office buildings. The bold variables are directly used as input variables in the calculation model while others mainly serve as orientation for the selection of the appropriate categories. In case of energy demand calculations specified according to the VDI standard, these categories determine the travel time t_{travel}.

The usage categories for EN ISO 25745-2 are given in Table 3-3. Similar to the VDI standard, different building categories and their typical usage intensities are described here. Variables directly depending on these usage categories are the number of trips per day n_{trip} and the number of operating days n per year marked in bold, while the others may be considered as mainly serving for the selection of the appropriate usage categories.

Table 3-2: Usage categories according to VDI 4707-1.

Usage category	**Usage intensity / frequency**	Average travel time in hours per day[1)]	**Average standby time in hours per day**	**Typical types of buildings and use**
1	very low very seldom	**0.2** (≤0,3)	23.8	• residential building with up to 6 dwellings • small office or administrative building with few operation
2	low seldom	**0.5** (>0,3–1)	23.5	• residential building with up to 20 dwellings • small office or administrative building with 2 to 5 floors • small hotels • goods lift with few operation
3	medium occasionally	**1.5** (>1–2)	22.5	• residential building with up to 50 dwellings • small office or administrative building with up to 10 floors • medium-sized hotels • goods lift with medium operation
4	high frequently	**3** (>2–4.5)	21	• residential building with more than 50 dwellings • tall office or administrative building with more than 10 floors • large hotel • small to medium-sized hospitals • goods lift in production process with a single shift
5	very high very frequently	**6** (>4.5)	18	• office or administrative building over 100 m in height • large hospital • goods lift in production process with several shifts

1) Can be determined from the average number of trips and the average trip duration

Table 3-3: Usage categories according to informative Annex A – Table A.1 in EN ISO 25745-2.

Usage category	**Usage intensity / frequency**	**Number of trips per day** (Typical range)	**Typical rated speed** [m/s]	**Typical buildings and usage (operating days per year)**
1	Very low	**50** (≤75)	0.63	• residential buildings up to 6 dwellings (**360**) • residential care home (**360**) • small office or administrative building with few operations (**260**) • Suburban railway stations (**360**)
2	Low	**125** (75 - <200)	1.00	• residential buildings up to 20 dwellings (**360**) • small office or administrative building with 2 to 5 floors (**260**) • small hotels (**360**) • office car parks (**360**) • general car parks (**360**) • main line railway stations (**360**) • library (**312**) • entertainment centers (**360**) • stadia (**intermittent**)
3	Medium	**300** (200 - <500)	1.60	• residential buildings with up to 50 dwellings (**360**) • medium-sized office or administrative building with up to 10 floors (**260**) • medium-sized hotel (**360**) • airports (**360**) • university (**260**) • small hospital (**360**) • shopping center (**360**)
4	High	**750** (500 - <100)	2.50	• residential buildings with more than 50 dwellings (**360**) • large office or administrative building with more than 10 floors (**260**) • large hotel (**360**)
5	Very high	**1500** (1000 - <2000)	5.00	• very large office or administrative building over 100 m height (**260**)
6	Extremely high	**2500** (>2000)	5.00	• very large office or administrative building over 100 m height (**260**)

3.2.1.5. Number of operating days per year

In VDI 4707-1 the number of operating days per year n is assumed to have a value of 365 days. In EN ISO 25745-2 there is a possibility to adjust the number of operating days according to the actual usage of the lift. If, for example, the lift is not operated on the weekend or during holidays, the number of days can be reduced. The standard offers a range of default values in its informative Annex A (Table 3-3). The suggested operating days vary from 260 to 360 days per year. For very large office buildings, for example, the typical default usage is given at 260 operating days per year while for residential buildings up to 6 dwellings, a value of 360 days is provided.

3.2.1.6. Number of trips

The number of trips per day is only used in EN ISO 25745-2. There, the number of trips per day serve to compute the average travel time. VDI 4707-1 follows a different approach and directly uses the daily travel time as an input variable. Therefore, the number of trips is only defined in EN ISO 25745-2. As previously mentioned, default values are provided in the informative Annex A (Table 3-3).

3.2.1.7. Travel and standby time

With regard to travel and standby times, both ISO and VDI sum up both travel and standby times to a default value of 24 hours per day. EN ISO 25745-2 allows for this overall running time to be adjusted for real conditions in case the lift is completely shut-off during some parts of the day. As the travel time is computed from technical parameters in EN ISO 25745-2, this corresponds to a reduction of standby time.

In VDI 4707, the average standby and travel times are directly specified as a function of the usage categories shown in Table 3-2.

3.2.1.8. Reference and short cycle consumption

The reference cycle is a full-round trip of the lift system that is used both in VDI 4707-1 and EN ISO 25745-2. During the reference trip, an empty car starts at the lowest stop, moves to the highest stop and then moves back to the lowest floor and also carries out two complete door cycles. An illustration of the individual elements of the cycle along with the power demand in case of a traction lift is shown in Figure 3-6. Note that the consumption is higher when travelling downwards as the heavier counterweight "pulls" the empty car upwards.

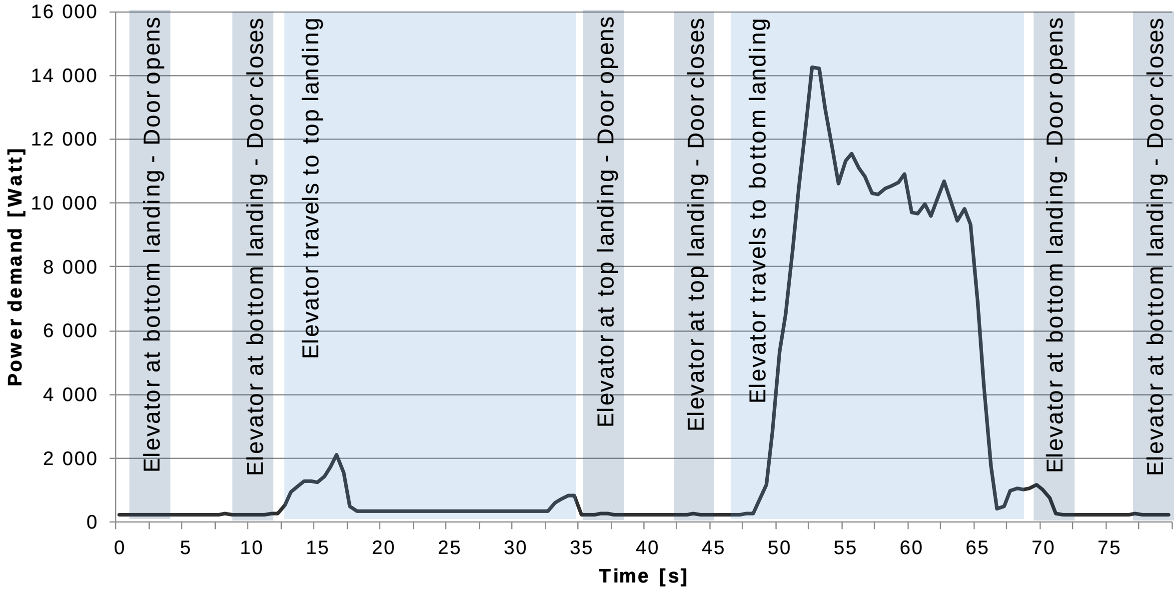


Figure 3-6: Sample diagram for the power drawn for the example of an (empty) traction lift (source: Hirzel/Dütschke 2010)

For the calculation of the specific energy demand per meter as per EN ISO 25745-1, a short cycle is used in addition to the (full) reference cycle. The short cycle is to cover at least a quarter of the full travel height while the lift shall reach the rated speed during this cycle. The short cycle is then used to compute travel consumption in the ISO standard as it is subtracted from the regular cycle, thus only leaving the steady state energy demand. An illustrative example of a short cycle is given in Figure 3-7.

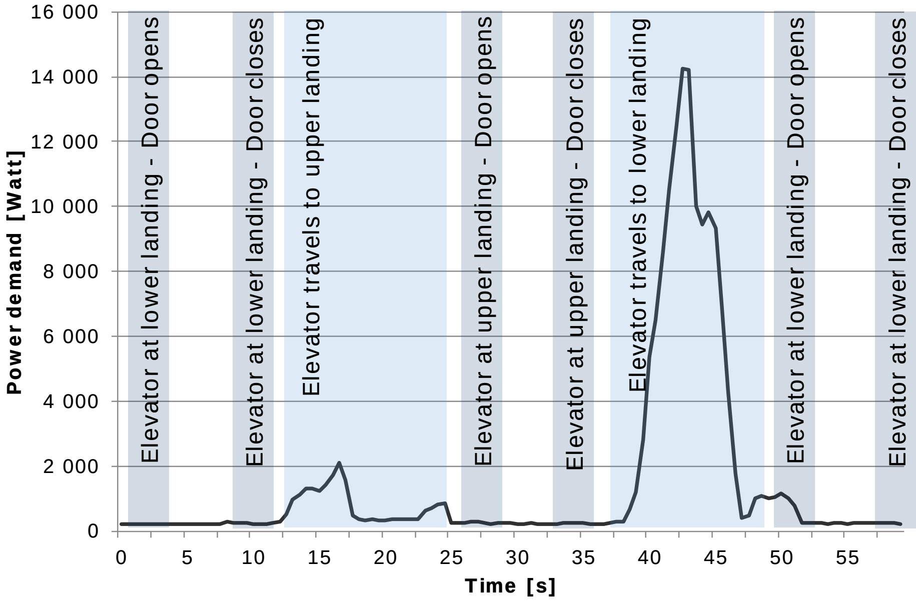


Figure 3-7: Sample illustration of a short cycle based on the previous diagram for the power drawn for the empty traction lift.

3.2.1.9. Load factors

The energy demand for travelling with a lift depends on the load to move the car and the load in the car. VDI 4707-1 characterises the car loads using the loads given in Table 3-4 and then weights the measurements with the different loads as a function of their share in the overall number of trips. As can be derived from the values, the majority of trips are expected to be carried out with relatively light loads. On average, the load spectrum implies an average of 12.5% of the nominal load. For special lift usages, a different load spectrum than given in the table can be used if this is also documented and justified.

Table 3-4: Load spectrum given in VDI 4707-1 (source: VDI 4707-1; last column own addition)

Load in % of the nominal load	**Trip ratio in %**	**Average load in % of nominal load**
0	50	0,0 %
25	30	7,5 %
50	10	5,0 %
75	0	0,0 %
100	0	0,0%

For practical reasons, the use of a load spectrum as given in Table 3-4 is not required for certain types of lifts. In this case, the consumption for the empty reference cycle is adjusted by the factor k. This simplified method can be applied for lifts with a counter-weight equal to the weight of their cars plus 40 to 50% of the nominal load and for lifts without a counterweight or a counterweight of up to 30% of the car weight. In the former case, k is 0.7 and in the latter case it is 1.2. Though not detailed in the standard, these values can be derived from the previous Table 3-4 with few additional assumptions as illustrated in the information box below.

Information box: Load factors in VDI 4707-1

The load factor k is used to scale the energy demand measures for a reference cycle with an empty car to actual load conditions. Typical traction lifts have a counterweight that balances the weight of the car plus approximately 50% of the nominal load. The counterweight reduces the amount of energy required for moving the car because only part of its mass respective to the load in the car has to be lifted.

If the car is loaded with 50% of the nominal load (“50% situation”), drive power will only be needed to accelerate/decelerate under ideal conditions, i.e. to overcome inertia. If the car is empty when it travels the cycle (“0% situation”), the energy consumption will be highest as the motor will have to lift the full weight of the counterweight, i.e. 50% of the nominal load, during the downward movement. If the car is travelling fully loaded (“100% situation”), the maximum load is also required for 50% of the nominal load as half of the car is balanced. This power will just be required when travelling upwards instead of downwards. Further assuming a linear scaling of motor power with the load means that in case of a 25% or a 75% load situation, the power required is half of the maximum power.

The following table shows this relative load compared to the empty car measurement which corresponds to 100% of energy demand. Multiplying the relative load with the trip ratio and adding up the individual components yields the value of 0.7.

Load in %	Relative load in % compared to empty	Trip ratio in %	Load factor (Relative load * Trip ratio)
0%	100%	50%	0,50
25%	50%	30%	0,15
50%	0%	10%	0,00
75%	50%	10%	0,05
100%	100%	0%	0,00
		Load factor	**0,70**
		Counterweight of nominal load:	50%
		Counterweight of car load:	100%

The same reasoning can be used for analysing a situation where the counterweight is equal to 40% of the load. In this case, the minimum power will be required to move a car that has a load of 40% of its nominal load. In case the car is fully loaded, 60% of the nominal load has to be lifted. Using the same trip ratios as for the previous calculation shows that the load factor has only slightly increased to 0.73, or rounded 0.7. If the weight of the counterweight is further decreased, the load factor will increase accordingly.

Load in %	Relative load in % compared to empty	Trip ratio in %	Load factor (Relative load * Trip ratio)
0%	100%	50%	0,50
25%	38%	30%	0,11
50%	25%	10%	0,03
75%	88%	10%	0,09
100%	150%	0%	0,00
		Load factor	**0,73**
		Counterweight of nominal load:	40%
		Counterweight of car load:	100%

Basically, the same reasoning can be applied if there is no counterweight or if only little of the actual weight of the car is balanced. Again, the energy demand for the empty car can be defined as 100%. If additional load is added to the car, the drive system will have to move both the weight of the car as well as the additional load. Consequently, more energy will be needed to move the car and its load upwards. The increase in energy demand depends on the ratio of the car weight to the additional load. Assuming that the weight of the car and the additional load are equal, this yields the results shown in the following table and a load factor of 1.2.

Load in %	Relative load in % compared to empty	Trip ratio in %	Load factor (Relative load * Trip ratio)
0%	100%	50%	0,50
25%	125%	30%	0,38
50%	150%	10%	0,15
75%	175%	10%	0,18
100%	200%	0%	0,00
		Load factor	**1,20**
		Counterweight of nominal load:	0%
		Counterweight of car load:	0%
		Weight ratio: Car/Nominal load	1:1

EN ISO 25745-2 uses a similar yet more detailed calculation principle for determining the load factor. Here the typical load factor is a function of technological properties (Table 3-5) as well as the average load in the car (Figure 3-8). Note that due to the different calculation principles, the values cannot be compared directly.

Table 3-5: Technology dependent parameter for calculating the load factor in EN ISO 25745-2

Elevator type	Balance in % of weight of car	Balance in % of nominal load	Adjustment factor
Traction	100 %	50 %	0.0164
	100 %	40 %	0.0192
	100 %	30 %	0.0197
Hydraulic	0%	0 %	0.0071
	35%	0 %	0.0010
	70%	0 %	0.0187

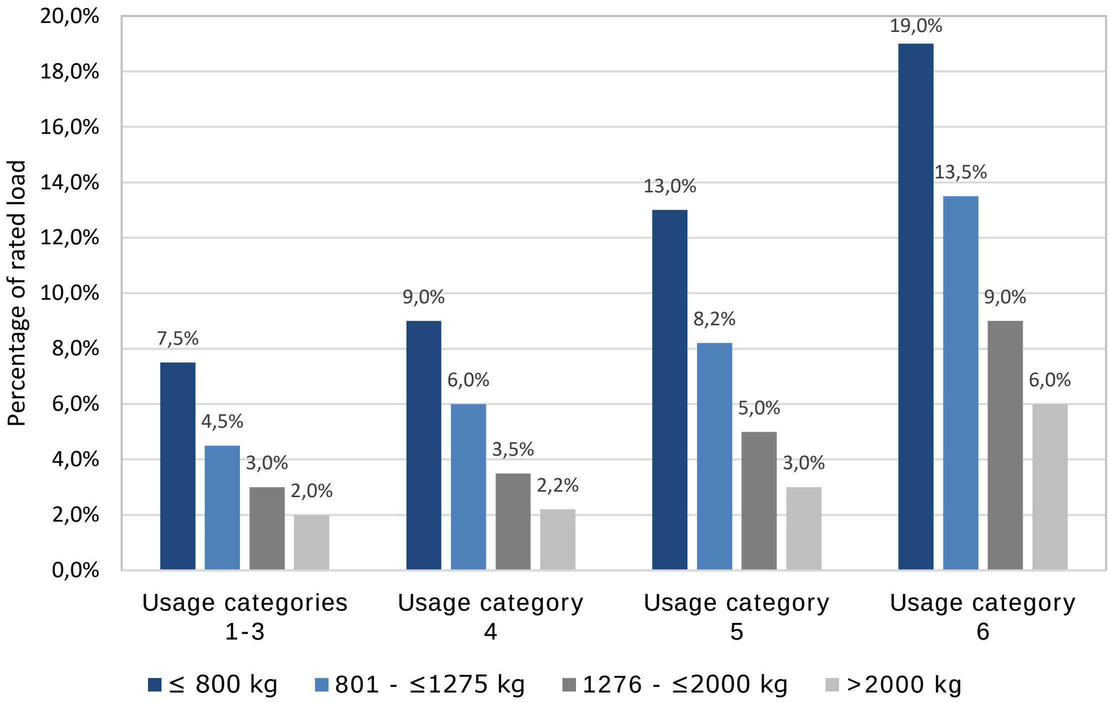


Figure 3-8: Average load by usage category and nominal load (source: based on EN ISO 25745-2)

3.2.1.10. Standby power and standby power mix

Standby power in VDI 4707-1 is defined as the consumption of the lift in standby mode and it is to be determined five minutes after the last trip has ended. Only the electrical equipment is taken into consideration that is required for the operation of the lift or needed for keeping it in standby. Shaft and machine room lighting are for example excluded when determining standby power. The determination is to be carried out under actual operating conditions, i.e. all components that are switched on during real operation must be in on mode for the determination, as well.

The determination can take place either by adding up power demand values of individual lift components if they are “sufficiently known” or it can be derived from measurements. In the case where measurements are used, they shall be taken after the main switches for the power circuit and the lighting circuits, as illustrated in (Figure 3-9). For other related sources of energy consumption required to operate the lift (the examples given are for heating and cooling), the energy consumption values also have to be determined, as well, and shall be documented separately. In case of lift groups, standby has to be added proportionally to the standby consumption of the individual lifts.

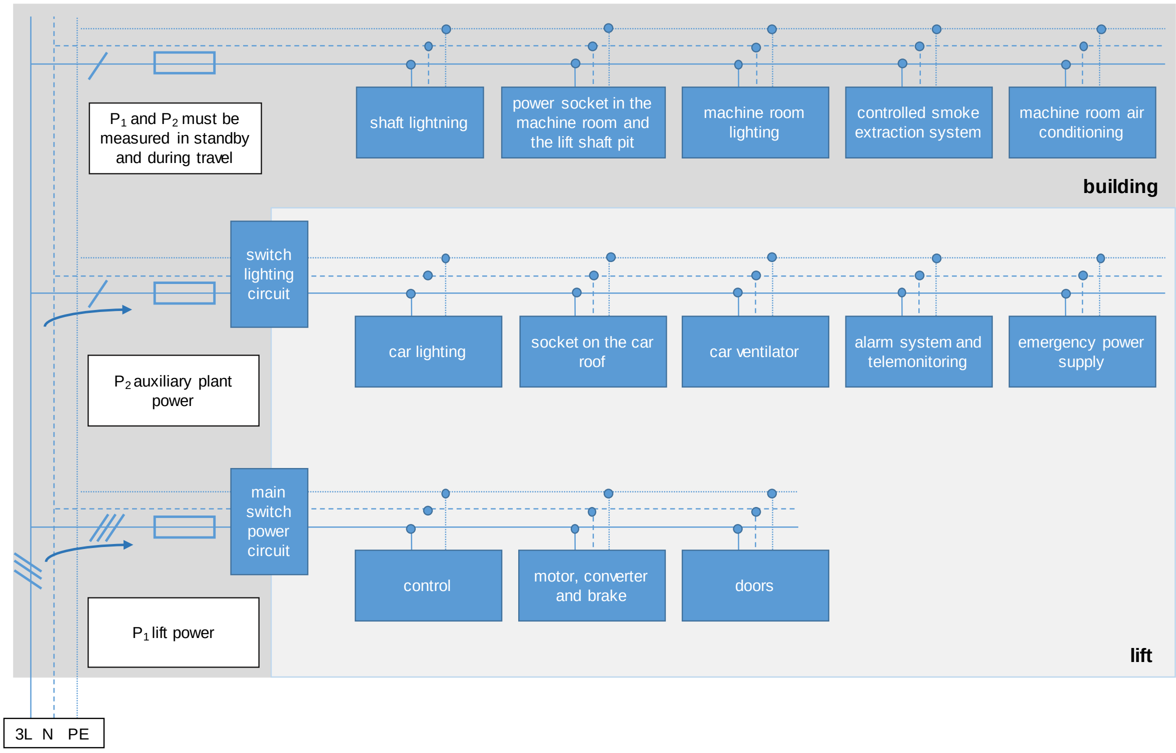


Figure 3-9: Schematic diagram for determining the energy demand of lifts according to VDI 4707 (source: own illustration based on VDI 4707-1).

Standby power in EN ISO 25745-2 requires the consideration of shutdown sequences of equipment. As shown in the previous review of the calculation model, EN ISO 25745-2 differentiates three of these non-running modes. Idle mode is the time until 5 minutes after the last movement, then there is a 5 to 30 minutes standby mode and another standby mode beyond 30 minutes. The consideration of the 30 minutes standby is only necessary if there are components that switch to a lower consumption mode after a time exceeding 5 minutes since the last movement. As in VDI 4707, the determination of annual energy demand can be based on measurements or it can be derived from calculations or simulations.

Compared to VDI 4701-1, EN ISO 25745-2 provides a more exhaustive list of items which are not be covered in energy demand considerations. These items are:

- Lifts including express zones
- Effect of lift group dispatch systems
- Heating and cooling equipment in the car
- Consumption through power sockets
- Components which are not part of the lift (e.g. non-lift display screen, surveillance cameras)
- Monitoring systems which are not part of the lift (e.g. building management)
- Hoistway lighting
- Machine room lighting, heating, ventilation, and air conditioning

Additionally, environmental conditions are not to be considered.

In addition, the ISO standard also specifies special conditions for lifts that draw energy from energy storage systems (excluding counterweights as energy storages). The basic principle for assessing energy demand for these lifts is to analyse energy demand for a

24 hour operation ensuring that the energy storage level is identical at the beginning and at the end of the analysis.

EN ISO 25745 defines a set of default shares for the three non-running modes which depend on the usage categories. The shares are shown in Figure 3-10.A general declining trend of standby between 5 and 30 minutes with higher usage can be observed. According to the introductory part of the standard, these values (and those in Figure 3-11) have been derived from "extensive research, which included the simulation of over 4 500 typical lift installations". An average standby power is calculated based on this mix of shares.

Figure 3-10: Shares in the different operation modes by usage category (based on EN ISO 25745-2 with adaptations).

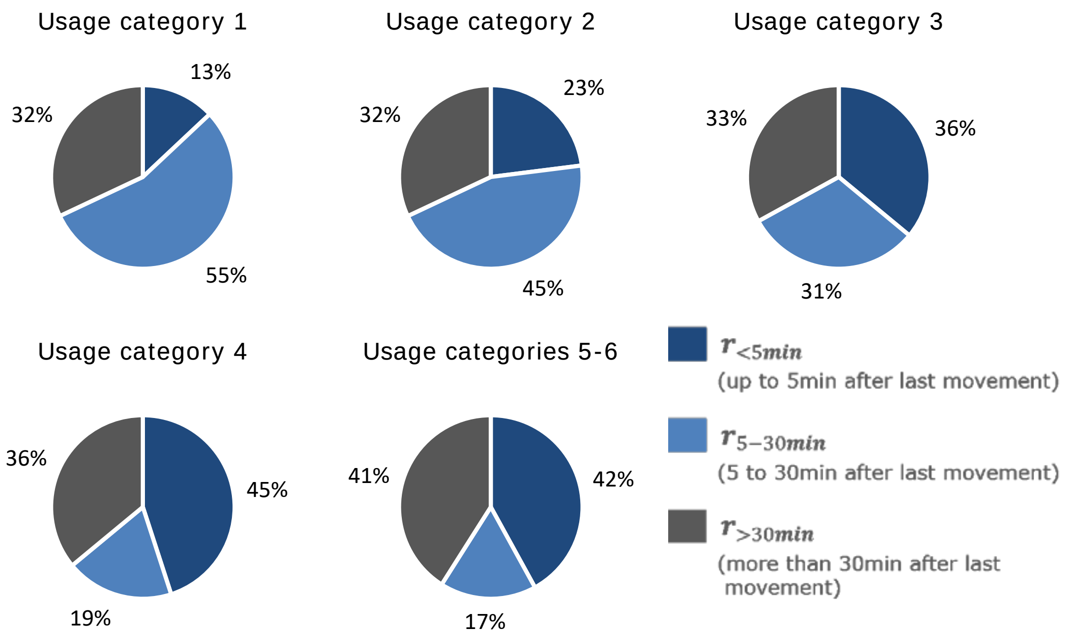
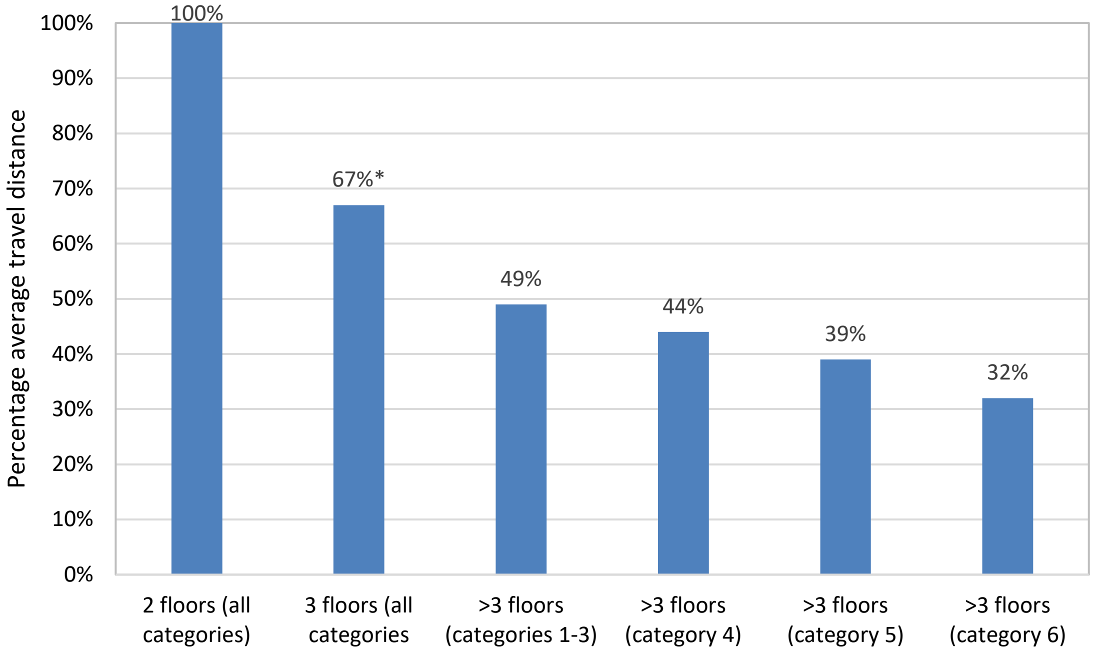


Figure 3-11: Percentage of average travel distance as a function of the number of stopping floors and the usage category (based on EN ISO 25745-2)



*For lift applications in which the traffic patterns are well known, a specific percentage of the average travel distance can be agreed between the involved parties for the assessment of the annual energy consumption. In this case, the selected percentage should be documented in Annex B.

3.2.2. Extended product approach

In the previous section a detailed review of the model for determining annual energy demand of lifts expressed in the form of the two main standards for estimating energy demand has been given. Both standards (necessarily) make simplifications of real-life lift usage through their scope, input variables and by how the variables are linked.

The aim of the extended product approach discussed in this section is to point out where real-life may deviate from the “ideal” conditions as given in the default calculation methods.

3.2.2.1. Usage categories

Usage categories are proxies to help determine the energy demand where no current information or future predictions on lift usage are available. Especially for a newly installed lift, estimating its future usage is claimed to be challenging as many factors affect the actual usage. As shown previously, usage categories are, amongst other factors, based on the properties of the buildings. Specific factors related to the users are not explicitly considered in the categories. These include among others:

- the social structure of the inhabitants (e.g. families, elderly people, handicapped people, singles, young couples, etc.)
- the local culture in the building (e.g. intensive users, preferences of stairs)
- the location of the lift in the building (e.g. directly at entrance, located in a side-corridor)
- the availability of the lift (e.g. expected waiting time for lift)

- the location of the building (city centre, outskirts, country-side, socially troubled area)

Furthermore, the usage categories imply an average constant usage per day. Yet it should be noted that in practice the utilization can vary during the day, during the week, for specific types of days as well as seasonally.

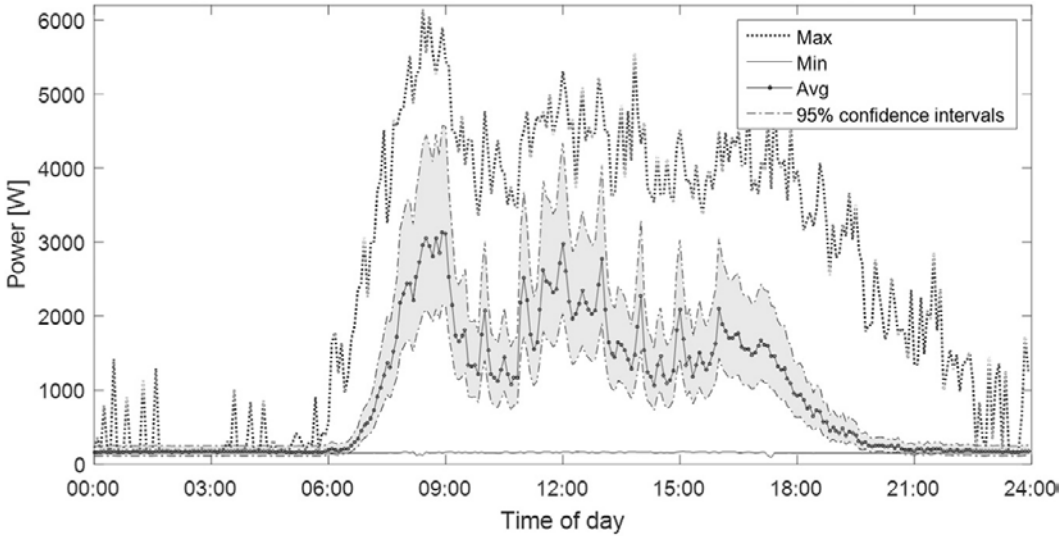


Figure 3-12: Intraday power demand by day of a lift located in a office building (source: Tukia et al. 2016).

For the purpose of illustration, Figure 3-12 shows the intraday electricity demand profile of a mid-rise office lift in Finland according to Tukia et al. (2016). It can be observed that during the early hours of the day, the average power demand is quite low while it peaks towards the beginning of office hours in the morning, peaks again around midday and finally shows some spikes later at the time the office closes.

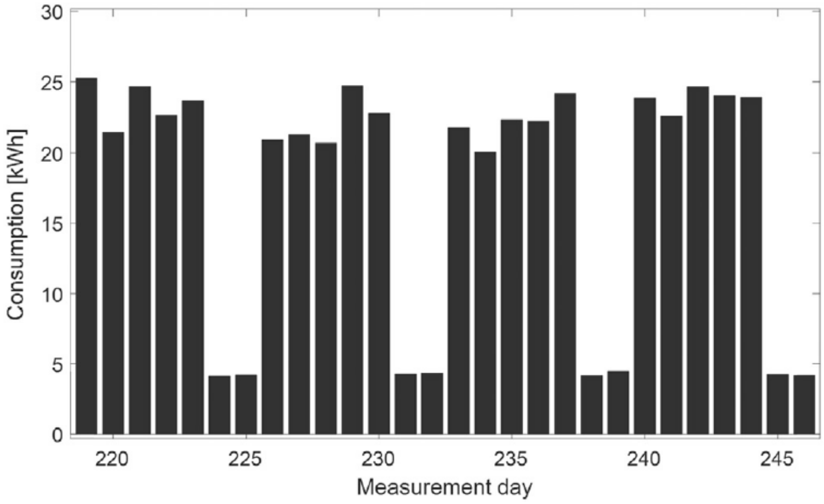


Figure 3-13: Electricity consumption by day of a lift located in a office building (source: Tukia et al. 2016).

With regard to weekly fluctuations, Figure 3-13 shows for example the energy consumption of a lift used in an office building over a period of four weeks. The low bars indicate a low usage during the week-ends while during the week-days, the overall energy consumption reaches a higher level but still shows some variation. Similar day-dependent measurement results for office buildings can for example also be found in Unholzer et al. (2015).

Further investigations by Tukia et al. 2016 illustrate the energy consumption of a lift by different types of day respectively season in the course of a year. Again, the differences between workdays and weekends can be identified. Additionally, the typology shows holidays during the week as well as the holidays in the holiday season. For both types of days, the energy consumption and thus usage tends to be considerably lower than during ordinary working days.

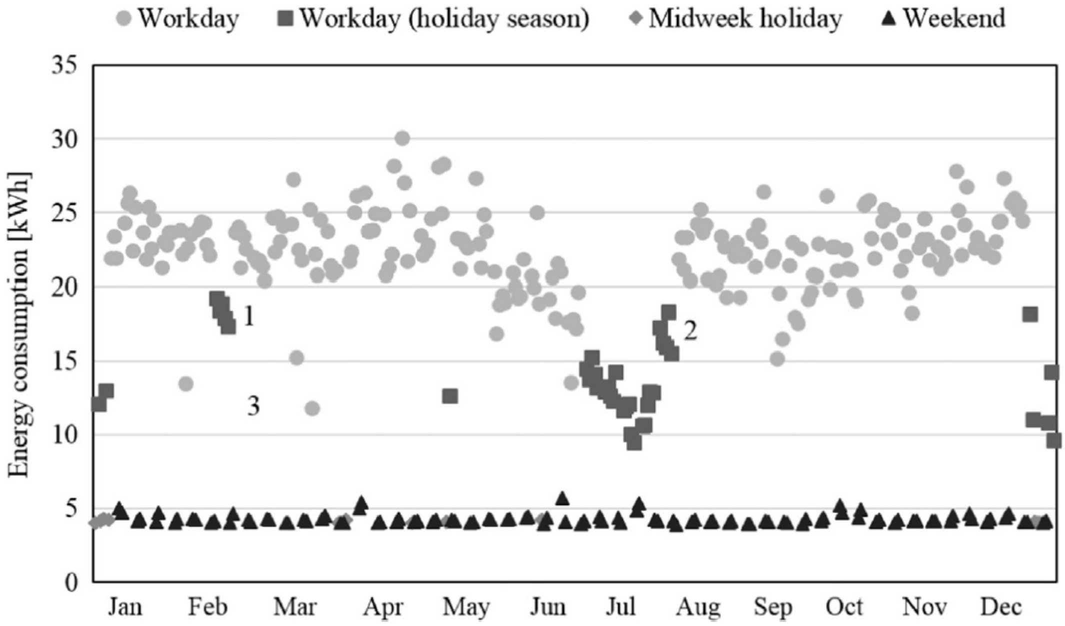


Figure 3-14: Daily energy consumption over a year by type of day (source: Tukia et al. 2016).

Though only illustrative, this underlines that the usage categories suggested in the energy demand standards are an approximation of reality. Under ideal conditions, this approximation meets well with reality or else real-life data can be used instead. For new installations, however, it is often challenging to determine the latter. Moreover, it needs to be taken into consideration that a change in building occupation (e.g. change from front-office with high number of visitors to back-office with little customer contact) may affect usage, as well.

3.2.2.2. Number of operating days per year

Closely related to the usage categories is the number of assumed operating days per year. While 365 operating days can be a reasonable default value if the lift is constantly available during the year, longer maintenance or repair periods as well temporary shutdowns (e.g. during the weekend, holiday seasons) can decrease the number of operating days.

3.2.2.3. Number of trips

A third factor related to actual lift usage next to the usage categories or the number of operating days are the number of trips. As pointed out in section 3.2.1.6, the number of trips is explicitly only relevant for the energy demand calculation in EN ISO 25745-2.

Figure 3-15 shows a comparison of the daily number of trips for the nine lifts in residential buildings as given in Annex C of VDI 4707-1 with the daily trips per category as in EN ISO 25745-2. For this illustration, only those lifts where chosen that operate in residential buildings and that had trip numbers. This overall annual trip number was divided by 360 days per year as per EN ISO 25745-2. The blue areas indicate the usage categories in the ISO standard with the default average values for each category as well as its boundary values (note that category 4 extends to 1000 trips).

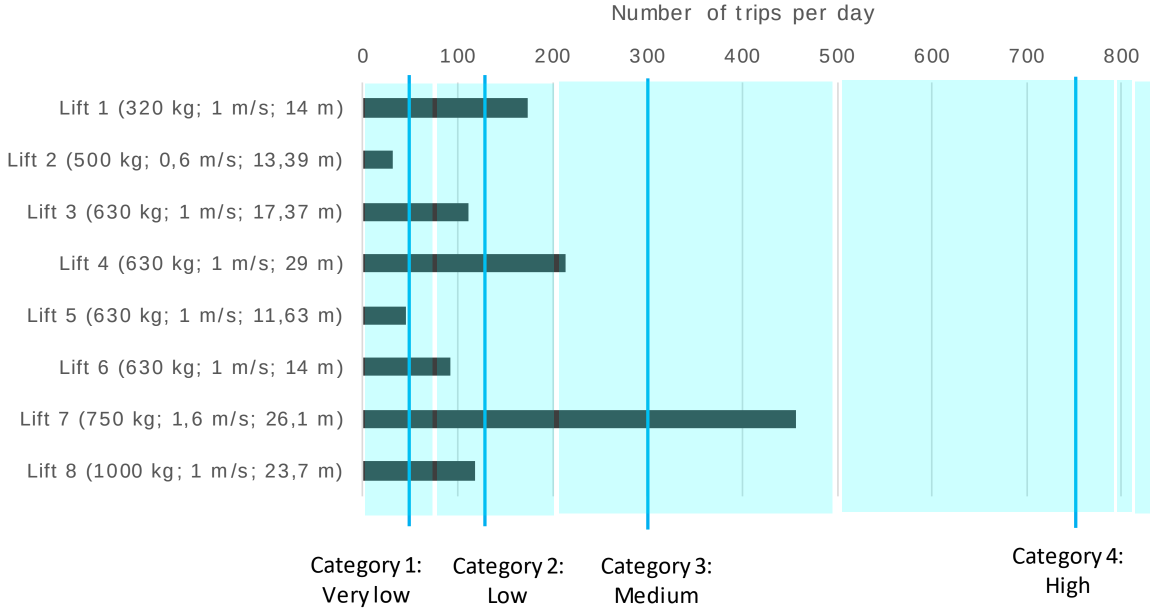


Figure 3-15: Illustration of the number of trips for nine residential lifts as compared to the usage categories according to EN ISO 25745-2 (source: own calculation based on data in Annex C of VDI 4707-1).

This illustration underlines again that there is a variation in the data and that the category averages can only be considered as proxies. Note further that the number of trips can also vary considerably for lift configurations that are quite similar in terms of size, speed and height (e.g. lifts 5 and 6 in Figure 3-15).

3.2.2.4. Travel and standby time

With regard to travel and standby times, the default assumption for both standards is 24 operating hours per day. If lifts are not in operation the entire day, e.g. if there are several lifts in an office building and only few remain on outside regular office hours, this value could also be lower than 24 hours.

3.2.2.5. Reference and short cycle consumption

Little direct impact of the user on the consumption in the reference cycle can be expected. Potential impacts might result from the operating state of additional equipment that is measured as part of the lift power demand and that can be operated from within the car (e.g. fan on the car).

The quality of maintenance can also affect the energy demand during the cycles. This includes for example the quality of lubrication. Yet the influence of the user on this is limited, unless he does not ensure proper and regular maintenance. The quality of the installation itself can also affect the energy demand (see also 3.5.3), but is also not directly affected by the user.

For the sake of completeness with regard to the consumption in the reference cycles, it should also be noted that several technical aspects affect energy consumption during the cycle. The efficiency of the drive system may vary from part-load to full-load operation. Whether the reference cycles correspond to a full-load or part-load situation depend on the actual system design. Furthermore, the lift should be measured under average temperature conditions, which do not necessarily apply regularly in all cases and can also affect the performance. In addition, the measurement equipment and power quality issues can affect the determination of energy consumption. Finally, the ability of a lift for energy recuperation can affect the energy demand in the reference cycle, as well. For these systems, EN ISO 25745-2 suggests a specific approach to determine the energy demand.

3.2.2.6. Load factors

Where the impact of users is quite low with regard to the measurement of the empty car in the reference and short cycle, user practice may affect the actual load factors of a lift. As pointed out earlier, the load factors both used in the overall energy demand calculation in VDI and ISO are based on a set of assumption concerning actual lift load. If real-life utilization is different from these assumptions, e.g. if lifts are for example mainly only used by individuals instead of groups, this may affect the overall estimate of energy demand. Furthermore, different load conditions on the motor may affect its efficiency (e.g. Watson 2017). As with the number of trips, the actual usage is difficult to predict for new systems and thus using average values seems an appropriate way to deal with the complexity of actual systems.

3.2.2.7. Standby power and standby power mix

Both ISO and VDI provide instructions on when to measure energy demand. While VDI 4707-1 requires the determination five minutes after the last trip has ended, ISO provides figures based on the usage categories.

The direct impact of the user on standby consumption is limited again. Yet he might indirectly affect the occurrence of the standby-times. As illustrated in Figure 3-12, the utilization of a lift may vary considerably during 24 hours and depends on the user. Idle periods of 5 minutes or longer will more likely happen during the night than the day. Consequently, more situations will occur in which the lift only stops briefly. During the night, substantially longer periods with no utilization can occur. Note that if components should enter a low-energy mode earlier than 5 minutes after the last stop, this might lead to an underestimation of standby demand for the overall estimation. Stakeholders pointed out that stand-by modes are implemented in modern control circuits. The actual point of time when components typically enter into a low energy-modes in practice depend on their design and the design of the system. It is expected that the durations based on EN ISO 25745-1 for idle and standby modes are used.

Note further that low-energy demand modes can cause delays in the availability of the lift. VDI 4707-2 defines several operating modes with different wake-up times. The shortened wake-up time for a component is referred to as mode S0 according to which the component should be operative after less than 250ms. In mode S1, this duration can take up to 3s. In the last mode S2, the wake-up can take up to 60s. If parts of the lift components are in S2 mode, it can thus take up to roughly 1 minute until a lift is operational again. Modern control systems allow for shutting down into a sleep mode sometime after the last trip. Yet evidence from practice suggests that these sleeping modes can be deactivated by request of the operator/user to avoid longer waiting times, especially during periods when the lift is not regularly used.

Based on the data of the e4 project (Almeida et al. 2010), an analysis of running and standby consumption for various lifts in Germany, Portugal, Poland and Italy was conducted. The analysis shows on the one hand that the electricity demand in the sample spans a considerable range from below 1 000 to more than 30 000 kWh/a. It further underlines that standby consumption varied from 15 to 710 Watts and that the relevance of standby consumption ranges from about 5 to 95% of overall electricity demand (Figure 3-16). It should be noted that analysis was conducted for elevators which were in actual operation in the period from 2008 to 2010. Further information on the state-of-the-art for new elevator installations as of the time of preparing this study is provided in later tasks.

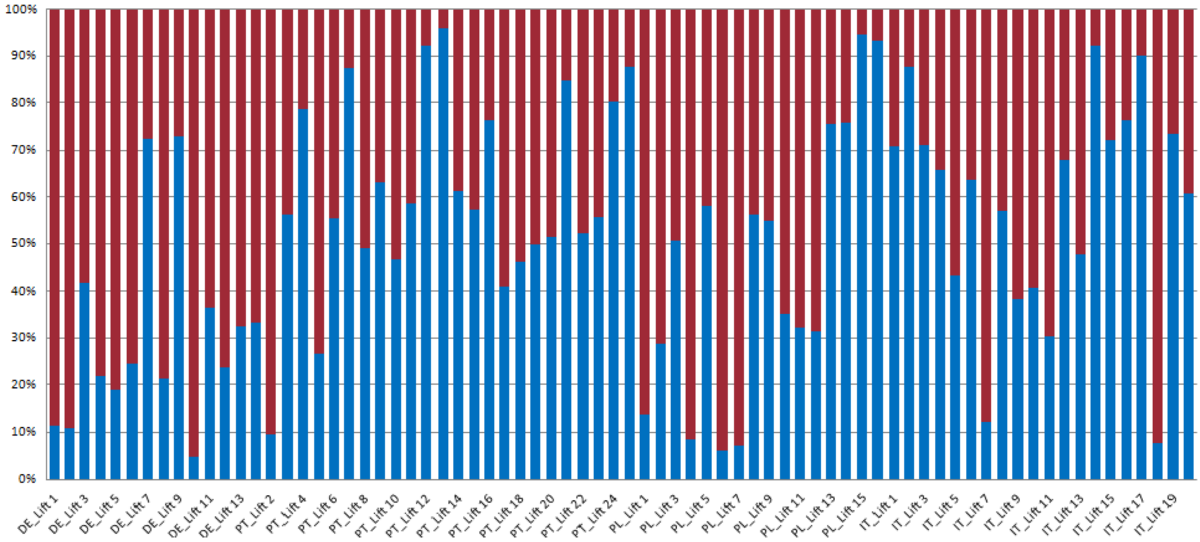


Figure 3-16: Shares in the energy demand of lifts by running (blue) and standby demand (red) (source: Almeida et al. 2010).

3.2.3. Technical systems approach

The technical system approach extends the scope of the analysis further and considers lifts as an embedded part in a building. Important aspects related to the indirect energy consumption in buildings through ventilation are discussed in section 3.3. When viewed from a technical system perspective, mainly the lift-related energy consumers excluded in the determination of energy demand can be mentioned. These include:

- Lift group dispatch systems: When several lifts are operated as a group, they can be used to optimize the operation of the vertical transportation system e.g. for throughput, energy demand or waiting times. Yet according to stakeholders, a standardized measurement, calculation and classification method is not available for lift groups. Therefore, their comparison is considered as restricted and not yet possible. The energy demand of a group is pointed out to be calculated as the sum of the individual lift energy demands

- Control strategy: The control strategy of individual lifts in a building can also affect demand, e.g. when the lift is automatically moved to some default landings to handle expected traffic/to reduce waiting times for passengers.

- Heating and cooling equipment in the car: This type of equipment is necessary, e.g. when the car is located outside the thermal shell of a building.

- Power sockets: Power sockets in the car or well can be used by maintenance personnel to operate electric tools if needed.

- Hoistway lighting: Hoistway lighting in the well is needed for maintenance purposes and to ensure safe working conditions for maintenance personnel.

- Components which are not part of the lift: Components such as non-lift display screen e.g. for information, entertainment or advertisement purposes and surveillance cameras can be energy consumers operated in or for the lift.

- Monitoring systems: Other monitoring system, e.g. for building management, might be linked to the lift system.

The use of such equipment, in turn, depends on the lift or building user/operator and/or maintenance personnel.

3.2.4. Functional systems approach

The functional systems approach is to take other means of transport into consideration that basically provide the same basic service as a lift. This functional view on lifts is to offer a broader view on the product.

There are various conceivable definitions of the "basic functions" of lifts. In a rather narrow definition, the basic function of a lift is to automatically and comfortably move people and solid or packaged goods vertically in buildings. From a broader perspective, the basic function is to ensure vertical accessibility in buildings. The former perspective has an emphasis on automated transport while the latter focuses on accessibility. Depending on which basic function is chosen, different functional alternatives to lifts can be discussed. As already mentioned in Task 1, various specific applications provide similar services to lifts but which are excluded from the Lift Directive:

- Lifting appliances whose speed is not greater than 0.15 m/s
- Construction site hoists
- Cableways, including funicular railways
- Lifts specially designed and constructed for military or police purposes
- Lifting appliances from which work can be carried out
- Mine winding gear
- Lifting appliances intended for lifting performers during artistic performances
- Lifting appliances fitted in means of transport
- Lifting appliances connected to machinery and intended exclusively for access to workstations including maintenance and inspection points of the machinery
- Rack and pinion trains
- Escalators and mechanical walkways.

Several of these applications are designed for very specific purposes. Based on the broader perspective of lifts mentioned above, a few relevant ways to ensure vertical mobility in buildings can be further discussed:

- **Lifts according to the Machinery Directive**: The Machinery Directive 2006/42/EC cover various types of lifting equipment that is different to lifts according to the Lift Directive 2014/33/EU. The distinctive criterion of these usually "simplified" lifts is their lower admitted maximum travel speed of up to 0.15 m/s. Thus, these lifts travel considerably slower than lifts according to the Lift Directive. They are therefore limited in terms of practical use to smaller buildings with few, typically up to 4 or 5 stops. These lifts are also subject to relaxed safety standards due to their lower traveling speed. There are many different types of lifts according to the Machinery Directive. Examples include home lifts, stair lifts or platform lifts. Depending on the specific configuration, these lifts are limited to one or very few persons and no or little additional goods.

- **Escalators and inclined moving walks**: Escalators and inclined moving walks are designed to transport people between a bottom and a top landing. Escalators and moving walks are especially used in commercial buildings, railway and metro stations or at airports. While escalators are mainly used for transporting people, inclined moving walks can also be used for transporting shopping carts between the two landings. Both escalators and inclined moving walks are mostly used to travel between two stories only; they are thus restricted in terms of vertical height. Note that escalators and moving walks are usually not suited for transporting larger quantities of goods and they are not suitable for transporting all kind of disabled people.

- **Fork lifts and cranes**: Fork lifts are used for sorting goods into shelves, transporting them between shelves or for loading and unloading trucks. Though they are a means of vertical transport for goods, their purpose is mainly to move heavy loads horizontally while the vertical movement is only a necessary addition. Cranes are also used to transport goods and they are mainly found on construction sites, in industrial applications or in logistics.

- **Stairs and ladders**: Stairs and in exceptional cases ladders can be used to gain access to higher stories. As opposed to the previously mentioned alternatives, they are "manually operated", i.e. the user needs to climb the stair or the ladder. Thus, it is less comfortable for the user than to use lifts and the maximum vertical distance is either limited by the height of the ladder or the fitness of the user and for longer distances, the users available time.

In sum when viewed from a functional perspective, there are no directly competing alternatives to lifts, especially when it comes to larger vertical distances: Lifts according to the Machinery Directive still come closest to lifts. Escalator and inclined moving walks are limited to special purpose buildings, forklifts or cranes are mainly used for transporting goods and stairs and ladders do not operate automatically.

3.3. Subtask 3.2 - System aspects use phase with indirect energy consumption effect

The aim of this subtask is to report on any indirect consumption effects during the use phase that impact the environment and resources. From the perspective of energy consumption, lifts may affect energy consumption in the local electrical supply grid on the one hand (see section 3.5.1) and in the heating/cooling system of the building due to ventilation on the other hand.

Ventilation of lifts concerns the car, the shaft as well as the machine room. Ventilation serves three purposes: under normal operation, it is to ensure that waste heat from the system is removed first; the second purpose is to provide the system with fresh air; the third purpose is to remove smoke in case of fire.

The harmonized safety standard EN 81-20:2014 generally assumes that the well is sufficiently ventilated according to national legislation. In its informative Annex E, further information on building interfaces are provided which also cover ventilation. Generally, it is stated there that the ventilation of the well is subject to national requirements as specific rules for lifts or general requirements are relevant for buildings.

With regard to the ventilation of the well and the car, it is pointed out in EN 81-20 that the safety and well-being of people using the car, working in the well or being enclosed in a car depends on numerous factors. These include the ambient temperature, solar radiation, dimensions of the well, and the properties of the doors and the availability of fresh air. The car itself should have a sufficient number of openings to ensure an adequate airflow in case of a fully used car. In case of normal operation, the gaps of the doors at the landings, the opening and closing operation and the pump effect of the moving car are also considered to be suitable to ensure the necessary exchange of air. Yet for technical reasons and human needs, it might be required as a case-by-case decision to ensure a permanent or on-demand ventilation aperture, forced ventilation and/or supply of fresh air. Also, in case of longer stops of the car, a sufficient ventilation needs to be ensured and lift wells are not intended to ventilate other areas of the building, among others due to safety reasons. With regard to the machine room, the role of ventilation is to ensure suitable working conditions for maintenance personnel as well as the proper function of the technical equipment (cp. in more detail EN 81-20).

Ensuring the ventilation of the shaft lies within the responsibility of the building designer. The role of the lift manufacturer is to provide the necessary data for ventilation, e.g. on heat emissions of lift components. The working conditions for personnel working in the lift well and the comfort for the passengers in the car also need to be taken into consideration. Based on this data, the building designer then can determine an energy-efficient solution (KONE 2015).

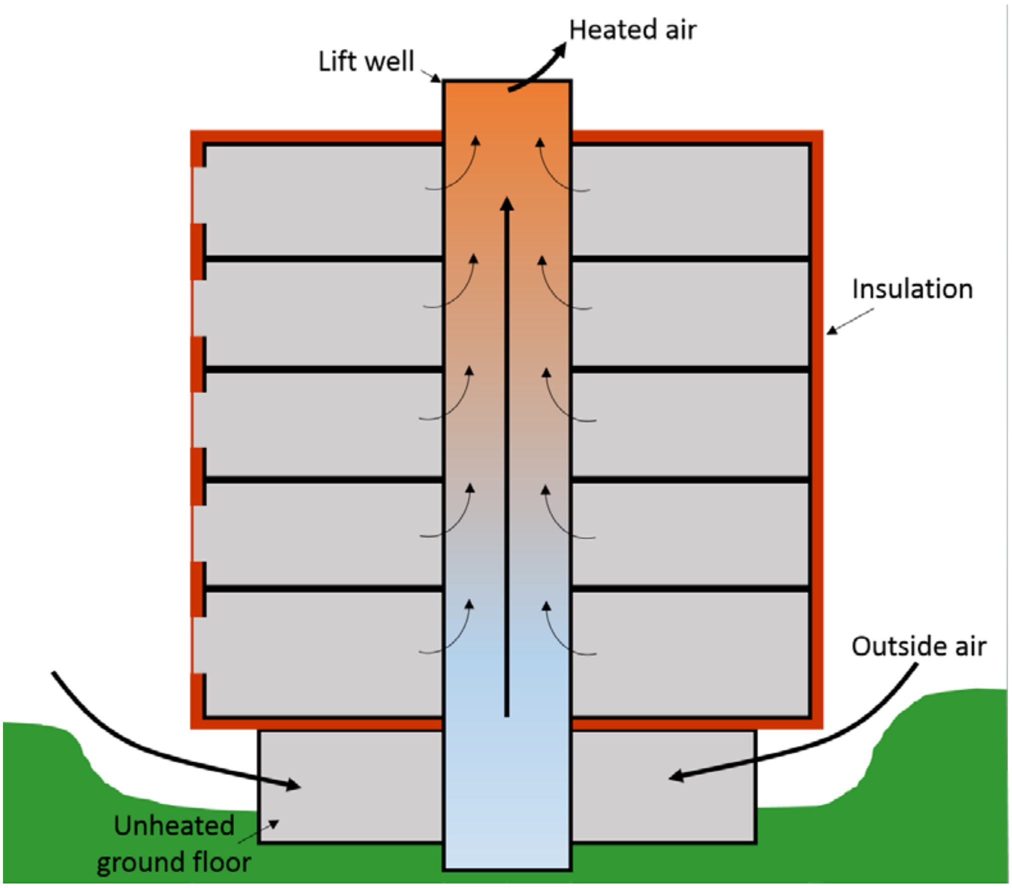


Figure 3-17: Illustration of heat losses due to uncontrolled shaft ventilation (source: with modifications from BfE 2004).

Ventilation can lead to considerable energy losses if the lift is installed within the heated area of a building, as is often the case. Lift wells have been identified as potential soft spots in building insulation when they bypass the insulation of the building. Under unfavourable circumstances, the bottom landing or air inlet is located on an unheated floor. Air flowing through leaks or open windows into the shaft is exposed to warmer walls of higher floors inside the well and then creates a draft towards the top-floor. There, the heated air leaves the shaft via ventilation openings (Figure 3-17). Traditionally, these opening have been designed as permanent holes in the building sheet, amongst other reasons to ensure that smoke can leave the shaft in case of fire and to ensure that surplus heat from the machine room can be removed from the building (BfE 2004).

To avoid these kind of losses, manually operated or automated ventilation systems have been developed. These systems allow for the ventilation shaft to be opened when needed instead of having a permanent opening to the outside of the building, e.g. by detecting temperature peaks or smoke in the well or in the machine room (see also Task 4). In Germany, the national building code, for example, requires that the building envelope is airtight in new buildings, thus requiring automated ventilation systems. Furthermore, it's been suggested to that the lowest floor level should be properly insulated (BfE 2004).

If manually operable ventilation systems are put in place this could result in a situation where users, operators or other persons in place permanently lock the systems in an opening position, e.g. due to a lack of knowledge on the operation of the system or because they forget to re-close after manual aeration. From an impact of user behaviour perspective, it has to be ensured that it is not possible to permanently override automatic operating features.

While there is no systematic analysis of heat losses due to ventilation in lifts, some examples and indications on annual heat losses have been reported in several documents:

- BfE (2004) provides an estimate of heat losses by an opening ventilation hole sized 35 x 35 cm for a lift with a 12 m well at an average outside temperature of 4°C and an average inside temperature of 20°C. The estimated thermal losses are estimated at about 3 kW or 15 000 kWh per year.

- Base (2016) as a manufacturer of ventilation solutions provides a sample calculation for a 19 m lift and a car for 1000 kg at approximately 15 500 kWh per year.

- ZVEI (2012) also gives a similar example for a 19 m lift and estimates the thermal losses at approximately 15 200 kWh per year. Furthermore, it is reported that 10 lift ventilation systems of the Süddeutsche Verlag in Munich have been equipped with modern smoke ventilation systems. Energy savings of 550 000 kWh in heating power have been achieved by closing the permanent openings accordingly.

- Nickel (2011) conducted a 93 hours measurement of thermal losses of a 17.8 m and 1000 kg lift at Lufthansa Technik in April 2011. The average losses where determined at 3.67 kW.

- Another indication of thermal losses through lift wells – though for New York in the United States with its specific legislation and situation - is presented in Urban Green Council (2015). Various buildings with six to 50 stories were investigated in 2013 and 2014, indicating considerably higher losses in these larger buildings.

It should be noted that these losses are highly dependent on the ambient conditions of the respective installations. In countries with higher ambient temperature, heat losses will be lower, yet an additional energy demand for cooling might be relevant, as well. Thermal losses due to ventilation can be considerably higher than the electrical energy demand of lifts - note, for the purpose of comparison that the limit to attribute the worst standby class for electricity demand in lifts' power is at 1.6 kW according to EN ISO 25745 and VDI 4707. In practice, lifts have been found to usually have lower standby demand values (see for example Almeida et al. 2012). This means that the indirect energy consumption from thermal "standby" losses due to ventilation seem to exceed electricity demand if no measures against heat losses are taken.

Thus, it is advisable to also consider these thermal losses in the subsequent analysis.

3.4. Subtask 3.3 - End-of-Life behaviour

The aim of this subtask is to identify, retrieve and analyse data and to report on consumer behaviour regarding end-of-life aspects from an average European perspective.

3.4.1. Product use & stock life

Generally, the lifetime of lift installations can vary considerably. Economic depreciation models assume, for example, 15 years. Estimates suggest that the technical life cycle of a lift is roughly 20 to 25 years, while some lifts may need upgrading and modifications after 10 years whilst others operate satisfactorily for 30 to 40 years (Gray 1991). Other sources indicate similarly that under normal conditions, a lift will reach the end of its cost effective live after 20 to 25 years, but that a lift that is insufficiently maintained may need renovating after 10 to 15 years (ElevatorSource 2016).

Yet there are still many considerably older lift installations in place in Europe. A survey (Lindegger 2009a) carried out among ELA member organizations during the e4 project in 2009 yielded estimates on the stock distribution in Europe. For some countries, it was possible to obtain estimates on the age distribution of lifts, as well. With regard to the situation of lifts in 2009 in residential buildings as an example, the figures indicate that roughly 20% of these residential lifts in Finland, 25% in the Netherlands and 40% in Italy where installed prior to 1970 and thus roughly at least 40 years old. For Greece for instance, the age structure was broken down even further and pointed out that approximately 20% of the residential lifts even date back to the period from 1920 to 1960. Even though this data was collected approximately 10 years before the time of elaborating this preparatory study, it has to be taken into account that the stock renewal rates are quite low (see also Task 2). It underlines that lifts can be in operation for much longer than 15 years.

The longevity of some lift installations can be explained on the one hand by their traditionally very robust design. On the other hand, lifts consist of a set of replaceable components. Upgrades and replacements of selected components that need to be replaced due to wear and tear or to respond to new safety requirements help to maintain the bulk of the remaining components. Thus, the lift is usually still counted as an old installation even though some of its parts are more recent.

With regard to product use and stock life, it can be noted that the share of electricity consumption in lifts is expected to have shifted from running consumption to standby over time. Modern electronics allowed for new comfort and safety features, thus increasing power demand while improvements in drive technologies have allowed a reduction in energy demand over time.

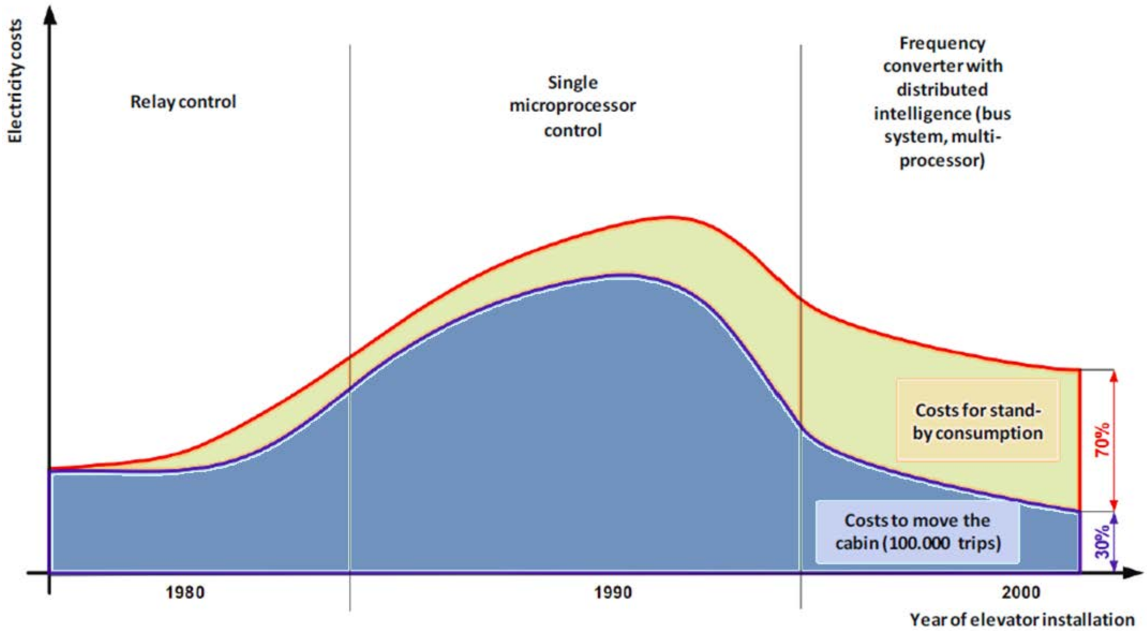


Figure 3-18: Energy consumption trends of residential lifts (source: Lindegger 2009b adapted from Hirzel et al. 2010).

3.4.2. Repair and maintenance practice

Maintenance is very important to ensure the reliable operation of lifts. Insufficiently maintained lifts can disrupt normal operations and reduce the availability of the lift. Additionally, lift components may deteriorate with a lack of proper maintenance and lose value (Unger 2015).

Maintenance activities typically include checks of the various components of the lifts (e.g. roping, brakes, doors, car, oil level, emergency intercom, control system, etc.). In many cases, maintenance takes place every 1 to 3 months.

Yet there is no general rule on the frequency of maintenance activities, there are values from experience that depend on a number of criteria such as the number of trips, the area the lift is located in (e.g. residential area, industrial area, schools), the age of the installation and the expected likelihood of disruptions. The latter usually decreases after the installation of a new lift and rises again when the lift ages beyond roughly 15 to 20 years (cp. Unger 2015). After approximately 25 years, thorough repairs beyond regular maintenance or replacements might be necessary (KONE 2017).

There are different basic types (Figure 3-9) of maintenance contracts (Hirzel/Blepp 2017; Lenzner/Böhm 2016):

- Simple maintenance: In this case, a maintenance company performs routine checks on the lift in predefined intervals (depending on the requirements e.g. on a monthly, quarterly or semi-annual basis) for a fixed price. Additional services such as the elimination of faults, repairs and spare parts are separately invoiced.

- Maintenance including elimination of faults: Beyond routine checks, this model also covers the elimination of faults as well as small spare parts up to a certain ceiling. Larger repairs and spare parts are invoiced separately.

- Full service contracts: In this case, repairs and spare parts are covered by the contract in case of proper use (excluding force majeure, vandalism and improper usage). Maintenance intervals are often defined by the maintenance company as needed here.

New lifts equipped with remote servicing capabilities enable the operating conditions of the lift to be monitored from a distance using a set of sensor feedback, e.g. motor temperature, oil levels, number of trips or operating hours. This can help to select the number of on-location checks in accordance to the actual needs. Yet there are also limits to this type of remote diagnostics capability as monitoring mechanical problems is non-trivial because it requires sensors that can detect mechanical changes (cp. Unger 2015).

Table 3-6: Design of basic maintenance contracts (own translation from Hirzel/Blepp 2017)

Aspect	Simple maintenance	Maintenance including fault elimination	Full service contract
Frequency of maintenance	Fixed time interval	Fixed time interval	Often determined as needed by the maintenance company
Routine maintenance	Yes	Yes	Yes
Elimination of faults and potentially small spare parts	No	Yes	Yes
Repairs and spare parts	No	No	Yes

Next to an increasing occurrence of technical issues, other arguments for major upgrades or replacements can also be found (KONE 2017): a) It might become more difficult to obtain spare parts, thus increasing the duration for repairs. b) Old lifts might not comply with more recent safety and accessibility regulations. c) Energy consumption could be lower with modern solutions. d) An old lift installation might be perceived as unattractive. e) New installations might offer a higher level of comfort. f) Replacements might allow for increased car sizes.

There are different kinds of repairs that can be done on lift installations (see also KONE 2017) as follows:

- Component replacements: In the case of replacing components, individual components like lighting or door operators are replaced in the lift.

- Modular modernization: In case of a modular modernization, larger parts of the lift respectively selected from its subsystems are replaced.

- Full replacement: In case of the full replacement, the entire lift installation is removed first and then replaced by a completely new installation.

The degree of the intervention depends on the condition and age of the existing lift. KONE (2017) provides an indicative lift age of more than 10 years for component upgrades, of 15 to 20 years for modular modernization and of more than 25 years for a full replacement. Yet it has to be noted that the lifetime of individual equipment items can vary considerably. Figure 3-17 provides information published by ElevatorSource (2016) for various lift components with indications on recommended action. This underlines that the expected useful lifetime not only depends on the complete lift installation but also on the different components.

Table 3-7: Table of expected lifetimes according to ElevatorSource (2016) if maintenance is performed on a routine basis and the equipment originates from a major original equipment manufacturer (abbreviated table)

Equipment type	**Expected useful life in years**	**Recommended action**
Electrical switchgear	50+	Retain
Electrical wiring	30	Replace
Controller, dispatcher	20-25	Replace
Cab interior	15	Refurbish interior
Machinery	30	Replace
Shaft Doors	20-30	Replace gibs & rollers
Shaftways	N/A	N/A
Hoist rails	25	Realign rails
Cables	20	Replace
Traveling cables	20	Replace
Hydraulic piston	25	Replace / Resleeve piston
Elevator call station	15	Replace
Elevator car operating panel	20	Replace

It has been suggested in Gray (1991) that major refurbishments could be taken into consideration during the refurbishment of buildings to avoid downtime and thus inconvenience during the normal operation of the building, especially if there is only one lift available.

For the sake of completeness, it should be noted that lifts have to undergo regular statutory inspections to ensure their safe and secure operation.

3.4.3. Collection rates and estimated second hand use

As lifts are fixed installations in buildings, there is no direct re-utilization of the entire product by moving the product to a new location.

Manual dismantling of the product is considered as an important environmental-friendly approach of recycling. It has been pointed out that the separate removal of fractions with a high polluting and resource potential (e.g. batteries, screens, circuit boards and plastics) is important in this context. It has also been suggested that passenger lifts should be constructed to ensure that different fractions can be readily separated and recycled and that hazardous components and substances (e.g. oils, batteries, electronic circuitry) can easily be removed and disposed of in an environmentally compatible manner (Blepp et al. 2011).

It should be noted that the bulk material of lifts is steel (see also Task 5) which can be readily removed and recycled. Little information, however, is available on the extent of current design and dismantling activities and their accordance with the previously mentioned suggestions for environmentally-friendly recycling.

With regard to the second hand use of lift components, little information is publicly available. Given the long lifetime of lifts and that their components become technologically obsolescent, as well as the need to ensure safe operation of lifts, the fraction of second hand use of components appears rather low and is limited due to safety and security requirements.

For the provision of environmentally friendly lifts, some requirements concerning components and construction have been provided in Blepp et al. 2011. Due to the longevity of lifts that ranges from 20 to 40 years, it has also been suggested that the availability of spare parts should be ensured. The reason for this is that the use of non-original spare parts may lead to a deterioration of the lift, an increase in energy demand, shorter lifetimes and higher safety risks.

3.5. Subtask 3.4 - Local infra-structure

The aim of this subtask is to identify, retrieve and analyse data and thereby to report on barriers and opportunities relating to the local infrastructure needed for the operation of lifts.

3.5.1. Electric interface

As with many electric and electronic devices, the main issues with regard to the electric interfaces are the safe and secure operation of lifts. On the one hand, this concerns the electromagnetic immunity of lifts, i.e. their ability to operate normally in a given electromagnetic environment. On the other hand, this relates to electromagnetic emissions of lifts, i.e. their ability to minimise their impact on other devices so that these can operate normally in the environment of the lift.

Any electric and electronic devices that generate or transfer non-sinusoidal signals may cause electromagnetic distortions. Lifts have to comply with the European Electromagnetic Compatibility Directive 2014/30/EU. Specific interpretations for lifts in terms of electromagnetic compatibility are defined in EN 12015:2014 for emissions and in EN 2016:2013 for immunity.

Electromagnetic emissions within lifts primarily affect the control system of lifts, control signals on the control lines or the bus system. Consequences include a bad ride quality or aborted movements. Emissions from lifts may affect the operation of mobile phones, radio and TV devices, computers, medical equipment, etc. (cp. Lenzner/Böhm 2016). In lift construction, frequency converters with modern power electronics are seen as a main source of electromagnetic disturbances (Lenzner/Böhm 2016).

Various measures can be taken to avoid electromagnetic disturbances from lifts. They include for example proper shielding of cables and conductors, ensuring sufficient distances of cables and conductors running in parallel, the utilisation of filters before frequency converters and the control system (cp. in further detail Lenzner/Böhm 2016).

The drive system, which incorporates the lifts motor, is the component with the highest power demand. As pointed out in Almeida et al. (2014), the use of drive systems with reduced power demand may lead to a reduction in supply side electrical infrastructure and losses. Increases in harmonic distortions due to power electronics may increase losses while on the other hand, lower power demand may reduce the demand in transformers, cables and other transmission components. The utilization of soft-starting technology can reduce peak demand and it can offset the need for additional equipment in the case of local capacity constraints in the electricity distribution system.

With regard to the electrical interface, no major barriers have been identified if lifts are installed in line with existing regulations. Evidently, measures to minimise the electro-magnetic compatibility of lifts may increase their costs, yet as these are legally compelling in any case, these do not seems to justify more in-depth considerations on barriers and opportunities with regard to the electric interface of the local infrastructure.

3.5.2. Telecommunications

Telecommunication equipment as a part of the local infrastructure is required in case of a lift malfunction. If a lift car is stuck with passengers inside the car, there is a need for a means to signal that the passenger are unable to leave the car.

A simple means to signal that passengers are trapped in a lift car in older lift installations is an acoustic device, e.g. a bell, that is located outside the lift and which can be activated from within the car. It has to be ensured that someone on the location outside the lift can hear and respond to this type of emergency signal.

The default approach today is an emergency intercom that is basically a phone device integrated into the lift car, which is connected to an emergency contact e.g. an emergency call centre or a person located nearby who is instructed for rescuing passengers from the car. While traditional solutions for emergency phone devices are based on a connection to the cable-based landline in the buildings, modern solutions allow for the use of a mobile GSM connection for emergency calls.

To ensure that emergency systems are also available in case of a loss of the electric supply in the building, lifts need to be equipped with an emergency electric supply to operate the communication system, i.e. a battery, unless it is based on an old analogue telephone line supplied by a telecommunication operator.

In terms of overall relevance, the telecommunication device itself including its power supply contributes to the idle consumption of a lift, but due to its relatively low power demand, it does not need to be explicitly considered further in this study. In addition, no specific barriers are known which can be considered as barriers relating to local infrastructure.

3.5.3. Installation

In the process of installing a lift, an interface between the building and the lift is created. The installation quality can affect the performance of lifts, both with regard to the comfort of use as well as the environmental performance.

Improperly installed guide rails, for example, may lead to lift cars travelling ungently with jolts and vibrations. Such unsteady movements and maladjusted guiderails requiring higher forces than necessary may also increase power demand on the drive system and thus affect the overall energy demand of lifts (see also ELA 2013). The quality of installation is also seen as having an important impact on lift energy demand in VDI 4707-2.

3.6. Subtask 3.5 - Recommendations

Based on the analysis in this task, several main observations can be made:

- First, lifts can be characterised as technical goods that are closely related to building operation. The planning and operation of lifts are thus influenced by many stakeholders. Findings on barriers to energy efficiency for lifts suggest that especially users and operators often lack information on the environmental performance of lifts and that they also tend to pay little attention to the topic. Furthermore, split incentive problems are identified as a challenge to the energy-efficient operation of lifts.

- Second, the lift utilisation of users strongly influences the energy demand and thus the environmental performance of lifts. Depending on this usage, both standby in infrequently operated lifts or running-mode consumption in intensively used installations can dominate the overall energy demand. The standards take these different usages into consideration by introducing different default classifications. As shown above, the underlying assumptions do not necessarily correspond in detail to specific situations, but on an aggregate level, they can be considered as a means to deal with the complexity of the real-life situation.
- Third, lifts are generally characterised by a relatively long lifetime. Unlike products such as white goods, they are subject to regular repairs and upgrades. Thus, measures to improve the environmental performance of new lift installations will only gradually impact the stock of installed lifts.
- Fourth, the ventilation of shafts has been identified as a particularly relevant consideration with regard to the indirect energy demand of lifts.

Based on these observations, the following conclusions for the scoping and subsequent analysis can be derived:

- First, the analysis and discussion of the energy-related standards have shown that lift usage considerably influences the environmental impact of lifts. This confirms the need to consider user behaviour next to functional parameters in the product categories as defined in Task 1.
- Second, given the relevance of barriers to the implementation of energy-efficient lifts, the encouragement of a demand-pull mechanism for energy-efficient equipment may be challenging. Doing so would entail giving users more information but also requires finding a means to overcome the existing split incentive problems. Furthermore, the annual energy costs for lift operation are rather limited, especially when the operation is financed by several parties, e.g. inhabitants. A further discussion of the policy implication of this observation will be part of later tasks.
- Third, ventilation has been identified as a relevant topic. Even if ventilation is not part of the product definition, available data suggests that it seems to be a non-negligible issue.

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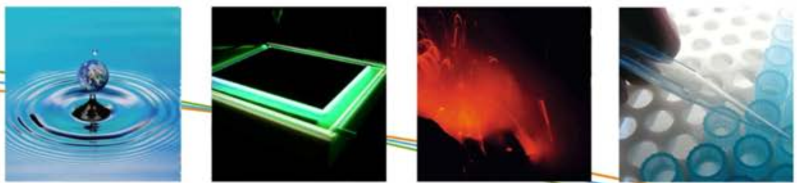

Table of contents: Task 4

List of Figures

List of tables

List of Abbreviations and Acronyms

AC	Alternating Current
BAT	Best Available Technologies
BNAT	Best Not-yet Available Technologies
BLDC	Brushless Direct Current
BOM	Bill-Of-Materials
BS	British Buildings Standards
CEN	Comité Européen de Normalisation
DC	Direct Current
DD	Double-Deck
Dy	Dysprosium
EC	European Commission
EC	Electronically Controlled
EE	Energy Efficiency
EN	European Standard
EPS	External Power Supplies
EU	European Union
E4	Energy-Efficienct Elevators and Escalators
GaN	Gallium Nitride
GSM	Global System for Mobile Communications
IGBT	Insulated Gate Bipolar Transistors
I/O	Input/Output
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
MEErP	Methodology for Ecodesign of Energy-related Products
MEPS	Minimum Energy Performance Standards
MOSFET	Metal Oxide Semiconductor Field-Effect Transistor
PLC	Programmable Logic Controller
PM	Permanent Magnet
PMSM	Permanent Magnet Synchronous Motors
rpm	Rotations per minute
SiC	Silicon Carbide
UPS	Uninterruptable Power Supply
VDI	Verein Deutscher Ingenieure e.V. (Association of German Engineers)

VSD	Variable Speed Drive
VVVF	Variable Voltage Variable Frequency
WEEE	Waste Electrical and Electronic Equipment

4. Task 4- Technologies

This task, which is structured in accordance with the MEErP Task4, presents the processes involved in the functional performance of lifts via a brief and simple technological description and analysis. This is conducted for technologies that are already on the market and that will become the basis for the base cases, but also for Best Available Technologies (BAT) and state-of-the-art Best Not-yet Available Technologies (BNAT). The analysis addresses both the product level and the component level as well as assessing improvement potentials.

The aim of this task is also to collect a comprehensive dataset across the whole product life cycle on which to undertake the analysis of the life cycle environmental impact and economics in the subsequent tasks of this preparatory study.

4.1. Subtask 4.1- Technical product description

In this task a comprehensive technical analysis of the products present in the market is carried out. Besides the base case technologies, which are intended to represent the average product entering the market today, BAT and BNAT (in terms of environmental improvement potential) are also assessed. The assessment of the BAT and BNAT provides the input for the identification of the improvement potentials reported in Task 6.

4.1.1. Existing products (working towards definition of BaseCases)

In this preparatory study, the definition of "lifts" used in the recent Directive 2014/33/EU is used (see Task 1 Scope).

Lifts can be divided into two main technology categories: hydraulic and traction. In hydraulic lifts an electric motor drives a pump that forces a fluid into a cylinder. A piston travelling inside the cylinder pushes the lift car upwards, either directly or indirectly through a rope (see section 4.1.4.1). In traction lifts, the car is suspended from above by ropes wrapped around a sheave that is driven by an electric motor. Traction lifts can be further subdivided into two categories: geared and gearless. Geared lifts use a reduction gear to reduce the speed of the car while in gearless lifts the sheave is directly coupled to the motor.

All lifts have common elements, independently of their working principle, including: motor and controls, cars (also called a "cage" or "cab”), car lights, car ventilation, doors, guide rails, buffers, ropes, and fixtures (e.g. buttons, indicators and switches), see Figure 4-1. The car travels within an enclosed space called the shaft or hoist-way [1] [2]. The next sections describe the lift components commonly used in lifts today from a technical perspective.

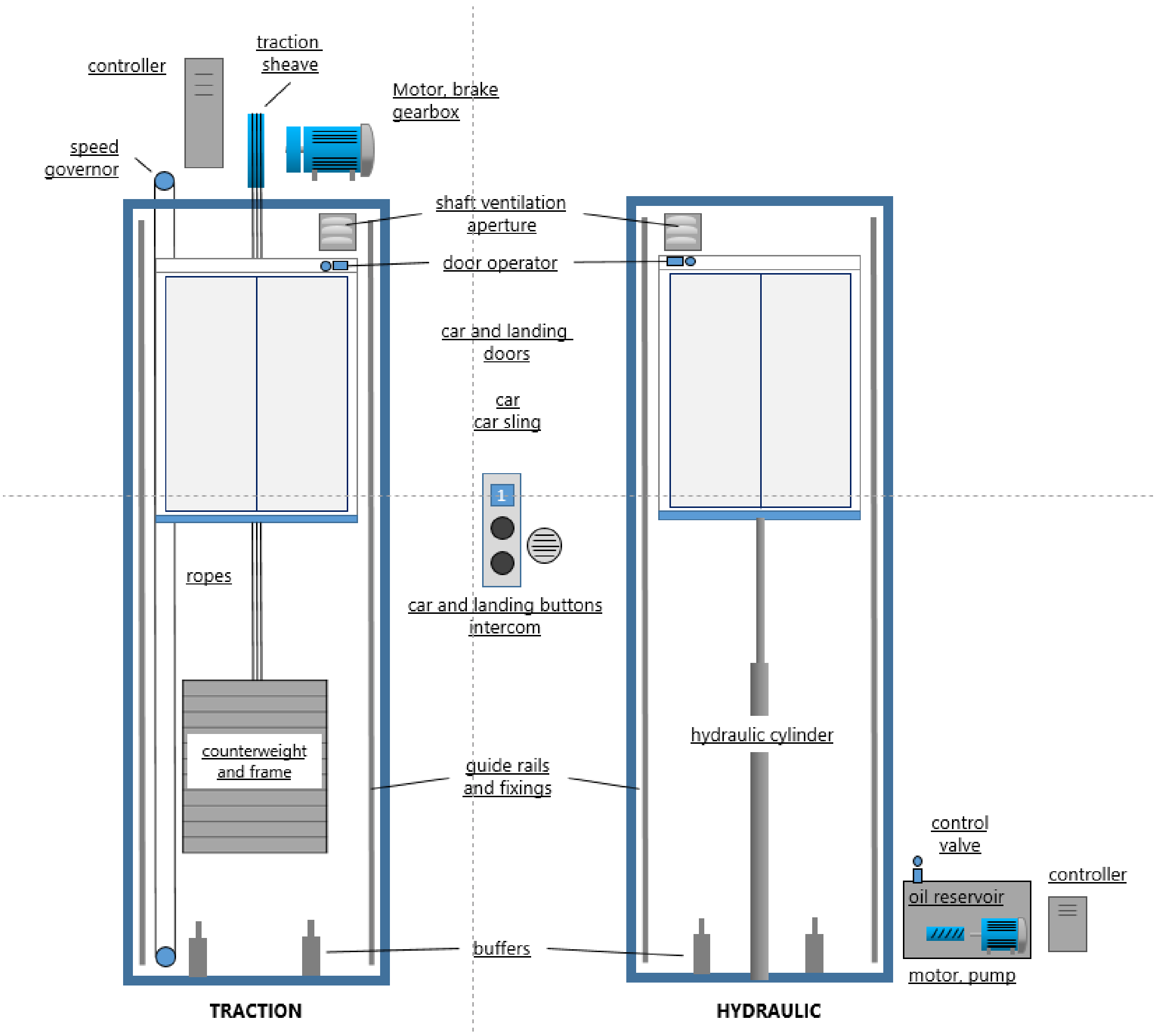

Figure 4-1: Lift main components

4.1.2. Traction lifts

4.1.2.1. Hoisting machine

The hoisting machine in traction lifts consists of a motor, a gearbox (when present), a traction sheave and a brake, which are now described in turn.

Motor

Several motor technologies have been used up to now and the choice of the drive has historically been motivated by factors such as travel speed, levelling accuracy and comfort. Nowadays the most widely used options are:

- AC induction motor
- AC Permanent Magnet Synchronous Motor

Electric motors have a fixed part, or stator, and a rotor that spins with a carefully engineered air gap between the two.

In **AC induction motors** a rotating magnetic field is formed in the stator when a three-phase AC supply is connected to the stator windings. The rotating magnetic field induces currents in the rotor, generating the motor torque; hence the name – induction motor.

In **Permanent Magnet Motors** the stator is a classic three-phase stator like that of an induction motor and the rotor has permanent magnets which create the rotor's magnetic field without incurring excitation losses. Motors using permanent magnets are significantly more efficient than induction motors because they do not have the secondary windings in their rotors and thus, almost completely eliminate electric and magnetic losses in the rotor.

Lift motors have special operating characteristics and are designed to provide the high starting torque necessary as well as to withstand the high number of start-stops required in a given period (via, for example, lower rotor inertia, higher insulation class) e.g. sometimes over 100 are needed per hour. Since they are not rated for continuous duty, these motors are out of the scope of Ecodesign regulation EC 640/2009 [3] that sets energy/ecodesign performance requirements for many types of electric motor.

Reduction Gear

The use of a reduction gear allows the use of smaller, less expensive motors that can thus work at higher speeds and thereby produce the desired torque.

Figure 4-2: Worm gear

Typically, worm gears (see Table 4-2) have been the prevalent choice for the reduction of speed since they provide good shock absorption, quiet operation, and high resistance to reversed shaft rotation. However, because of their higher sliding velocity and high contact surface their efficiency is lower than for other gear configurations (e.g. helical gears – see also section 4.1.5.). The efficiency of worm gears depends heavily on its speed-reduction ratio since higher ratio units have a smaller gear-tooth lead angle, which causes more surface contact between them. For typical lift applications, with gear ratios in the range of 70:1 – 30:1, the efficiency is around 60% - 70% and the efficiency in reverse rotation is significantly lower than in the forward direction. Other factor that affect the efficiency of the gear train are the lead angle of the gears, the coefficient of friction of the gear materials, type of bearings and lubrication. The efficiency also depends on the operating parameters of the gear train (e.g. speed and load).

Traction Sheave

A sheave is essentially a pulley with grooves around the circumference. Its role is to ensure sufficient traction to hoist the car, by moving the ropes as the sheave rotates, while maintaining a long rope operating life span. The rope speed is equal to the circumference of the drive sheave multiplied by the rotational speed (rpm) of the motor.

Brake

For emergency stopping and to hold the lift car stationary during loading and unloading a brake is needed. It is typically mounted between the motor and gearbox (when present) or between the motor and drive sheave. They are usually of a drum type, actuated by spring force and held open electrically. The force generated by an electromagnetic field is used to neutralise the braking action caused by the spring force. A power failure will cause the brake to engage and prevent the lift from falling. In higher rise, higher speed lifts they can also be of a disc and calliper type.

4.1.2.2.Overspeed governor and safety gear

An overspeed governor (see Figure 4-3) is a device which acts as a detection device in case the lift runs beyond a specified speed. This device must be installed in roped lifts.

The overspeed governor consists of a centrifugal switch. When the car gains speed, the governor does too and centrifugal forces push the fly-wheel weights outward. However, if the speed becomes too great the weights hit a safety switch activating a rope clamping device that grips the governor rope while simultaneously activating the safety gear.

The safety gear will grip the guide rails and bring the lift car to a stop even if the suspension ropes break.

Additionally, triggering the overspeed governor removes the power from the machine motor and brake.

Figure 4-3: Overspeed governor

4.1.2.3.Counterweight

In traction lifts the weight of the car is typically balanced by a counterweight (see Figure 4-4) that equals the mass of the car plus 40 to 50% of the rated load. The purpose of the counterweight is to make sure a sufficient tension is maintained in the suspension system so as to ensure adequate traction is developed between ropes/belts and drive sheave. In addition, it maintains a near constant potential energy level in the system as a whole, heavily reducing energy consumption.

The counterweight is composed of a steel frame that can be filled with small weights, known as filler weights, made from steel, cast iron or concrete.

Sliding or roller guide shoes at the top and bottom of the counterweight frame, guide it smoothly along the rails.

Figure 4-4: Lift counterweight

4.1.3. Hydraulic lifts

4.1.3.1.Hydraulic lift power unit

An hydraulic lift power unit (see Figure 4-5) consists of an/a:

- electric motor
- pump
- flow control valve.

It may be installed in a location remote from the lift or beneath the lowest stop, inside or outside of the hoist-way.

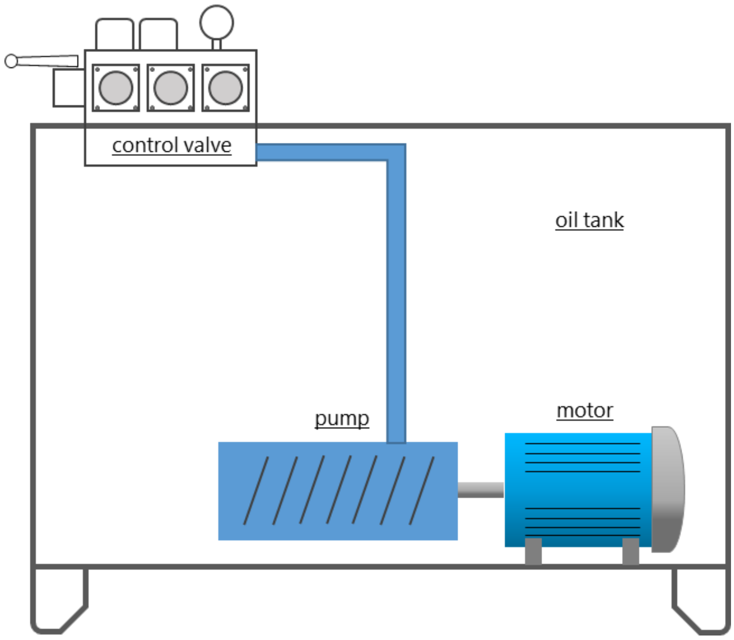

Figure 4-5: Hydraulic Power unit

Electric motor

An electric motor is needed to provide mechanical power to the pump which moves the hydraulic fluid. The most commonly used motor in hydraulic lifts is the single speed induction motor, flange mounted to the pump. Nowadays, most hydraulic lift pump motors are equipped with either a star-delta starter or a soft-starter to reduce the starting current demand. These motors have special operating characteristics and are designed to provide the high starting torque necessary as well as to withstand the high number of start-stops required in a given period (via, for example, lower rotor inertia, higher insulation class) e.g. sometimes over 100 are needed per hour. Since they are not rated for continuous duty, these motors are out of the scope of Ecodesign regulation EC 640/2009.

Pump

A submersible screw pump is the most widely used type of pump in hydraulic lifts power unit. A screw pump is a positive-displacement pump that uses one or several screws to move fluids or solids along the screw axis. The screws take in fluid then push it out from the other side while increasing its pressure. They are used mainly because of their ability to provide high flow rates in high viscosity fluids.

Flow control valve

The flow control valve in a hydraulic lift power unit plays an important role in regulating the flow of oil to and from the cylinder moving the cabin up and down. As hydraulic lift power units typically use fixed speed pumps that deliver the oil at constant flow, a control valve to control the flow of oil is necessary. The valve block will allow either all the oil to flow to the cylinder or divert some back into the tank depending on the lift speed required. The most commonly used type are on/off solenoid valves, which deliver pre-adjusted flows without feedback from the system. This configuration also means that the amount of oil pumped is constant and that the oil that is not used to move the car is fed-back into the reservoir.

4.1.3.2.Hydraulic cylinder

In hydraulic lifts movement is transmitted to the car by a cylinder piston arrangement. The main parts are the cylinder, piston, seals and collar.

The cylinder and piston are made from steel tubing and may be assembled in several sections depending on its length. Obviously the higher the lift travel, the stronger and heavier the piston will become and this may require solid piston sections. Between each section there should be a seal to retain the oil.

There are two main types of hydraulic cylinders (also called jack, ram, plunger or piston): push-type and pull-type.

Push type cylinders, as the name implies, are used to directly push the car and are, therefore, subjected to compressive loading.

Pull-type cylinders are used with a counterweight system. Here, the hydraulic fluid pushes the piston in the cylinder downwards for the lift to go up. They are subjected to tensile loading rather than compressive loading.

4.1.3.3.Hydraulic cooling / heating

Friction produced when the oil travels through the pipes and valves, added to the heat of the potential energy dissipated during the lift's downward travel, causes the oil in hydraulic lifts to heat. The oil will get hotter with an increasing number of trips. When the oil in the hydraulic system becomes too hot, its viscosity decreases which degrades the travel performance of the lift. High oil temperatures may also lead to the premature failure of some components such as seals. To prevent oil overheating some hydraulic lifts with periods of high traffic may require the installation of an oil cooler, consisting of an oil circulator and radiator.

When hydraulic lifts are installed in cold climates, it may be necessary to install an oil heater in the reservoir to prevent the hydraulic fluid to fall below recommended temperatures of operation during long periods of nonoperation (e.g. overnight).

4.1.4. Components used by both types of lift

4.1.4.1.Ropes

Suspension ropes used on traction type lifts are attached to the car, looping over the sheave and then down to the counter weights.

Some hydraulic lifts can be roped (also called indirect acting) systems. In this case, the end of the piston is connected to a rope that goes over a pulley and connects to the top of the car. The main advantages are that this configuration avoids the need for an in-ground hole and allows for a different transmission ratio according to the roping configurations (e.g. 2:1).

Steel ropes used for hoisting lift cars are of standard construction with each strand consisting of a number of wires. Strength, diameter, Young's modulus and permissible speed are the most important properties.

The strength is obtained by the use of a steel with a high carbon content while flexibility is provided by the stranded construction. The following types of ropes are used:

- **Suspension ropes**: These types of ropes are designed to support and move the car and counterweight. The choice of the grade of steel and number of strands will depend on the load requirements and speed.
- **Governor ropes**: These ropes are used in overspeed governor systems (see 4.1.1.2)
- **Compensating ropes**: These are used in conjunction with hoist ropes, suspended from below the car and below the counterweight. They are frequently used on high-rise lifts (over 30 meters or heavy duty freight lifts). Compensating ropes work to offset the weight imbalance that happens when a lot of hoist rope is used on the car side or on the counterweight side. No matter where the car is in the hoist-way, this equal distribution is critical in maintaining balance between the two. One end of the compensating rope attaches to the bottom of the sling while the other attaches to the bottom of the counterweight frame. The same effect can also be achieved by the use of chains.

A variety of roping systems can be employed dependant on the particular conditions of each installation (e.g. machine positioning, rated load and speed, available space, etc.). Examples of commonly used roping systems are shown in Figure 4-6. Other roping systems may be used depending on the installation requirements (e.g. machine position, available space, load and speed).

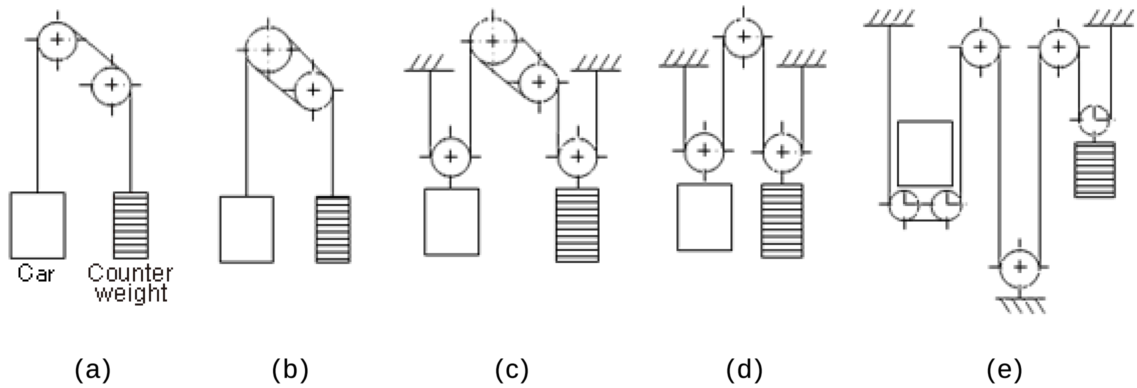

Figure 4-6: Examples of roping systems (source: [1])

a	1:1	Single wrap	Mid-, low-speed lifts
b	1:1	Double wrap	High-speed lifts
c	2:1	Double wrap	High-speed lifts, freight lifts
d	2:1	Single wrap	Freight lifts, Machine-room-less lifts
e	2:1	Single wrap	Machine-room-less lifts

In lifts that use 1:1 roping schemes, the car travels a distance equivalent to the perimeter of the sheave, for each revolution. In Europe, however, most of the lifts are roped 2:1, which means that the sheave must turn twice as much for the car to travel the same distance as in a 1:1 roped lift. With the 2:1 roping scheme, however, the motor is only required to produce half of the torque of the 1:1 roping scheme. The 2:1 roping scheme, therefore, requires a smaller motor to generate the torque required to move the car. Typically, 2:1 roping applications are limited to speeds up to 4 m/s.

4.1.4.2. Guide rails

Lift guide rails are necessary to ensure that both the lift car and counterweight (when present) travel in an uniform path.

According to standard EN 81-20 “The car, counterweight or balancing weight will be guided by at least two rigid steel guide rails”. T section steel rail is now used almost exclusively for this purpose.

The most common configuration used is two rails for the car and two for the counter-weight but there is no real upper limit on the number that can be used depending on the loads and the size of the rails.

Under normal travel conditions guide rails are only subjected to relatively low loads, however, under some circumstances guide rails must withstand significant forces. These situations can occur:

- when there are unevenly distributed loads
- during loading and unloading
- when the safety gear is activated.

Standard EN 81-50 provides the methods to calculate the forces acting on the guide rails and thereby facilitate selection of the rail size.

Guide rails are fixed to the hoist-way by means of clips connected to steel brackets. All buildings expand, contract and move to some degree and rail alignment obtained during initial installation should be maintained while this occurs.

Guide rail alignment is of major importance as it affects ride quality and efficiency and also because poor alignment can lead to premature failure of lift components.

4.1.4.3. Car

Most lift cars today consist of two distinct assemblies: the sling or car frame and the car itself

The sling is a steel frame, which provides a structure that supports the car itself. Guide shoes or rollers are provided at each of the four corners of the frame to guide it along the rails. Ropes may be attached directly to the frame or pass around sheaves placed above or below it. Safety gear as defined in standard EN 81-20 is also secured to the car frame.

The car provides separation and protection between passengers and the hoist-way. It can have different construction and components depending on the comfort and aesthetic requirements of the installation. Normally, the car floor, walls and roof are made of steel and sometimes covered, entirely or partially, with glass, wood laminates, mirrors, etc. mostly for aesthetic reasons.

4.1.4.4. Doors

Lift doors are available in two major types, manual and automatic.

Manual doors are normally hinged and in the car may be of a manual sliding scissor gate type. They can pose accessibility issues since they are difficult to open for persons in wheelchairs or elderly or disabled people and, therefore, they cannot be used in new installations due to existing accessibility and/or building regulations (e.g. EN81-70).

Automatic doors are the most common option in lifts today powered by a door operator located in the car frame. Usually, they form a couple between car doors and landing doors.

The most frequently used power-operated door for passenger lifts are horizontal sliding doors which can be (see Figure 4-7):

- single slide (a)
- two-panel side-opening (b)
- single-panel centre-opening (c)
- three-panel side-opening (d)
- four-panel centre-opening (e)

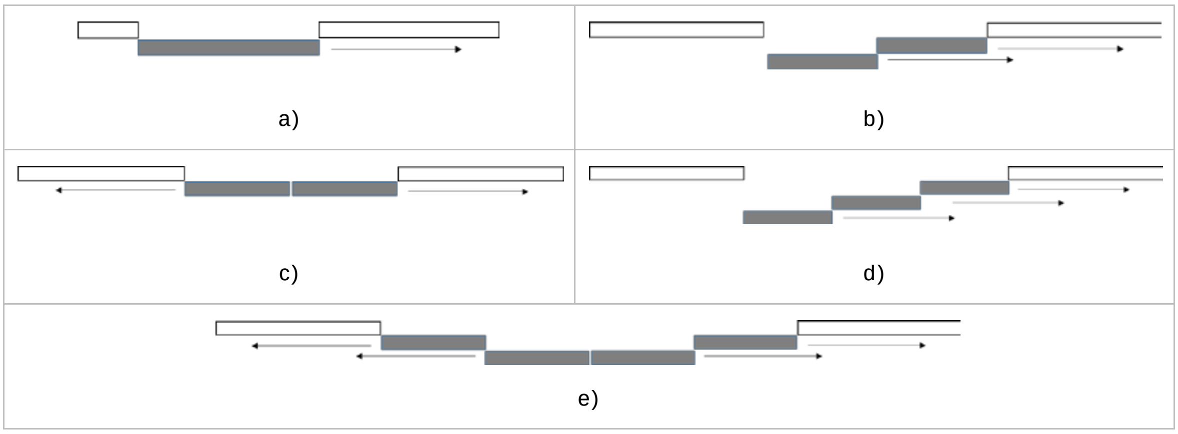

Figure 4-7: Door operating configurations

In multi-panel doors, while panels close simultaneously, the leading panel travels at double or triple the speed of the trailing panel, meaning that, they cover the different travel distances in the same time.

EN 81-20 sets limits on the closing force and kinetic energy of moving doors and these may have a bearing on the materials selected for the door. Most doors are made from steel or stainless steel with either a painted or applied skin finish.

To reduce the risk of doors striking passengers while they are entering or exiting the car, the updated standards require lifts to incorporate a curtain of light mechanism – a non-contact detection system that is designed to prevent the doors from closing if an obstruction is detected.

To prevent entrapped passengers from accidentally falling into the lift shaft standard EN 81-20:2014 requires lifts to incorporate a restrictor mechanism that keeps the door locked, that aims to prevent the doors from being opened from inside when the car is not close to the landing doors. This is also a requirement of the EU Lifts Directive.

4.1.4.5. Door operators

The function of the door operator is to automatically open and close the lift doors. When the lift arrives at a floor a mechanical device couples the car doors to the landing doors. As the car doors open they also pull open the landing doors.

Door movement is achieved by coupling an electric motor with a mechanical linkage that converts the rotational motion of the motor to linear movement of the doors.

Electric motors for door operators can be of the following types:

- DC motor
- PM motor (including EC motors)
- AC induction motor

These motors can be operated with or without a gearbox and with or without a VSD depending on the configuration.

The faster the door operation the better because it saves time in loading and unloading passengers. However, there are limits to the speed of a closing door to reduce the risk of injury to passengers, set by EN 81-20. Additionally, passenger detection devices are necessary for the safety and comfort of lift users and to provide controller inputs for the operation of the doors and the lift drive.

The most usual arrangement is to have the operator mounted on the top of the lift car. When the car arrives at a landing the car door locks to the landing door and the motor is able to operate both door simultaneously.

Additionally, lift landing doors require a mechanism to prevent the door from being open unless the car is present.

4.1.4.6.Car and landing fixtures

Information displays and buttons for input from the user exist inside the car and on the landing floor (see Figure 4-8). Different information can be displayed:

- Call acknowledgement
- Travel direction
- Car position

In their simplest form, this is achieved by LED indicators and backlit buttons that inform users that their call has been registered. Dot matrix displays are also common due to their flexibility and TFT displays are becoming more common.

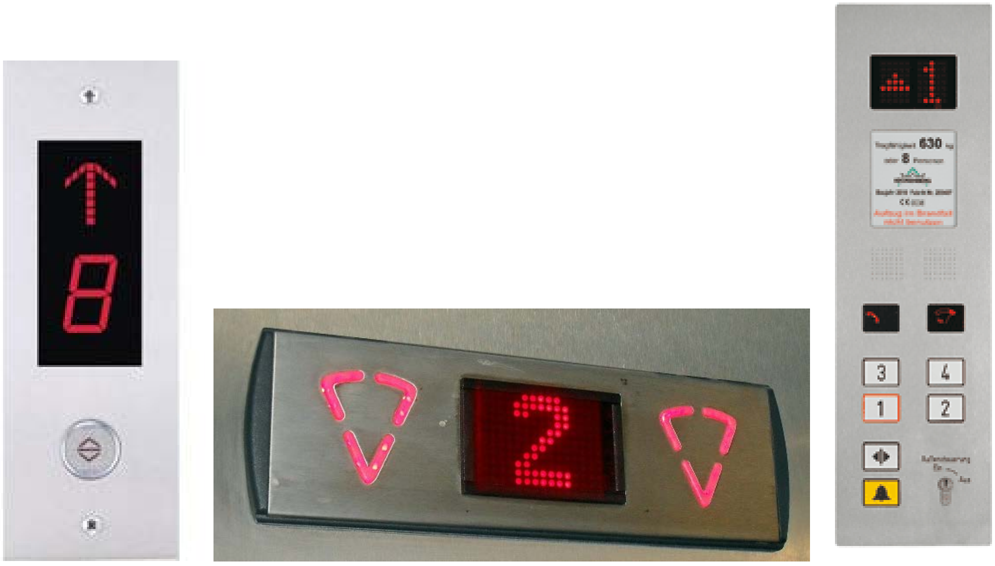

Figure 4-8: Car and landing indicators.

The connection between the car, all landing fixtures and the controller is made using copper wiring.

Minimal requirements for fixtures are defined in EN 81-20 and EN 81-70

4.1.4.7. Car Lighting

The EN 81-20:2014 standard requires certain levels of lighting for the car interior and the shaft, with the aim to enhance passenger safety and accessibility. In-car lighting must now provide an illumination intensity of 100 lux, measured at 1 meter from the car floor, instead of 50 lux, measured at the floor level. Emergency in-car lighting is required to be kept at 5 lux for one hour instead of 1W for one hour. To enhance safety for service engineers, the new requirement for emergency lighting on the car roof is now 5 lux for one hour. The new requirements for shaft lighting are as follows:

- minimum of 50 lux 1 metre above the car roof within its vertical projection
- minimum of 50 lux 1 metre above the pit floor everywhere a person can stand, work, and/or move between the working areas
- minimum of 20 lux outside of the locations defined above, excluding shadows created by car or components.

Currently, new lift installations normally come equipped with LED light fixtures and typically have a function to automatically turn of the car light (and car fan) with an adjustable time after a car is parked and the doors are closed.

4.1.4.8. Buffers

Buffers are safety devices placed at the base of the lift shaft to stop the car or counterweight in the case that one of them over-travels into the lift pit. The number of buffers will vary according to the design capacity of the buffers and the load to be stopped.

There are two basic types of buffers: energy accumulation types using springs or rubber, and energy dissipation types such as hydraulic buffers.

4.1.4.9.Lift Controller

The controller cabinet contains the equipment necessary to control and monitor the operation of the lift installation.

Lift controllers have two main objectives:

- command the car to move up or down and to stop at the appropriate landings, and command the opening and closing of the lift doors
- efficiently serve passengers demands and, in a lift group, coordinate the operation of the individual cars in order to make efficient use of the lift group

The controller receives several inputs, such as landing and car calls, the cars' position, direction of travel and load, and produces a number of outputs to operate the doors, motor drive and signalling devices. Generally, the more information the controller has, the better it will perform.

Three basic controller technologies have been used:

- electromagnetic relays
- solid-state logic
- programmable logic controllers (PLCs) based systems.

Today, lift controllers are PLC based systems due to their capabilities and flexibility of use. Different control algorithms can be applied to the movement of lifts, either when operating individually or within a group. The main objective defines the strategy used [11] i.e. to:

- minimise passenger waiting time
- minimise passenger journey time
- minimise the variance in passenger waiting time
- maximise the handling capacity
- minimise the energy consumption.

Typically, lift controllers are programmed to minimise passenger waiting time while maximising the handling capacity. Of course, the main objective of the controller is to assure safe and reliable operation of the lift system.

4.1.4.10. Motor speed control

Accurate control of the motor speed acceleration and deceleration are essential to achieving good ride quality while delivering the passengers swiftly to their destination in an efficient manner. Lift drives are also required to accurately align the car with the landing floor at each stop (levelling).

Several methods have been used to control the motor speed, such as, DC motor with Ward Leonard set, DC motor with solid state controller, two-speed AC motor.

Today, the most widely used motor speed control method is the Variable Voltage Variable Frequency (VVVF) drive (in the context of this report the term Variable Speed Drive (VSD) or simply drive is used to refer to this type of motor controller).

It relies on the fundamental principle that the speed of an induction motor is directly linked with the supply frequency applied to the stator windings. By varying the frequency and by keeping the voltage / frequency ratio constant, the speed-torque curve is moved, maintaining a constant pull-out torque and the same slope of the linear operation region of the curve (Figure 4-9). VVVF drives are used with both induction and permanent magnet motors.

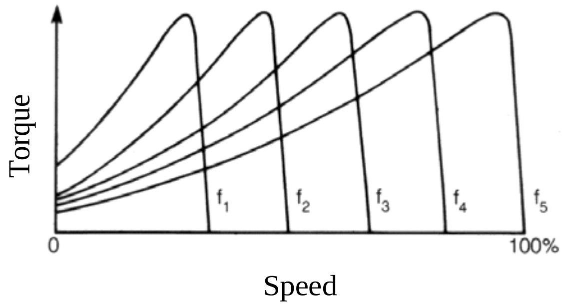

Figure 4-9: Speed-Torque Curves for an Induction Motor ($f_1<f_2<f_3<f_4<f_5$ and $f_5=50Hz$) (source: ISR-UC)

4.1.4.11. Safety and emergency requirements related equipment

Some of the requirements of the Lifts Directive 2014/33/EU and of parts of the European Standard EN 81 series - *Safety rules for the construction and installation of lifts - Lifts for the transport of persons and goods*, require the use of additional equipment that, although not being essential to the normal operation of lifts, have important implications in their energy consumption, in particular during standby.

Both the Lift Directive and standard EN 81-28:2018 - *Remote alarm on passenger and goods passenger lifts*, state that lift cars must be fitted with two-way means of communication allowing permanent contact with a rescue service. These systems should include features such as an auto-dialler designed to provide trapped passengers with easy hands-free connection to emergency help. The trapped passenger simply presses the emergency button inside the lift car and the auto-dialler automatically connects to pre-programmed emergency telephone numbers. The communication can be made through a land line or GSM network. Nevertheless, communication must be ensured even during a power outage, which means the equipment must have a secondary power supply (typically batteries).

Additionally, cars must be designed and constructed to ensure sufficient ventilation for passengers, even in the event of a prolonged stoppage, and be equipped with emergency lighting, working even without the normal power supply. Their period of operation should be long enough to allow normal operation of the rescue procedure.

In the event of a power outage, lifts may be equipped with a system that returns the lift, either to the closest floor or to the ground floor. In the first case, the system uses the unbalanced weight of the lift (car or counterweight) to move the lift to the nearest floor in the lowest weight direction - controlling the speed via the motor brake. The system may be fully automatic, requiring a secondary power supply, or require human interaction. Depending on accessibility, the brake operation may be done manually (machine room applications) or electrically (machine room less applications)also requiring a secondary power supply. The need for a secondary power supply (typically batteries) impacts energy consumption especially in standby.

In emergency situations such as a fire, building occupants are normally evacuated using the staircase. However, in public buildings, lifts may be required to assist in the evacuation of disabled people as defined in CEN/TS 81-76. In such a case the lift would have to be put in use by an authorised person, familiarised with the evacuation procedures, via a lock key.

Additionally, national (local) building codes require that buildings of a certain size have fire-fighting lifts. For example, in the UK, British Buildings Standard BS 9999 requires fire-fighting lifts in buildings that are >18 metres tall, or have basements >10 metres deep. A firefighter lift is a passenger lift that may be used by firefighters to safely travel between floors in the event of a fire. As expected, the requirements for this type of lift are very demanding and the secondary power supply must ensure at least two hours of operation.

To ensure these safety functions one or more secondary independent power supply is required. The supply may be ensured via a generator or an Uninterruptable Power Supply (UPS) of the required capacity, depending on the level of service required.

The main battery technology for existing UPS products is lead acid. It is typically of a sealed, valve-regulated lead acid battery type.

4.1.4.12.Standby power consumption

The energy consumed by lifts when not carrying passengers constitutes a standby load, which is often a significant contribution to the overall energy consumption of the lift. It can represent more than 80% of the total energy consumption in lifts [1]having a low number of daily trips (usage category 1 of ISO 25745-2.) The consumption is attributable to equipment, as described above, that is constantly working, such as control systems, security systems, lighting, ventilation, power supplies, floor displays and operating consoles in each floor and inside the lift cabin.

As can be seen in Figure 4-10 the standby energy consumption of lifts can vary a lot and is independent of the age of equipment. Nevertheless, it is important to note that while loads such as lighting have been reducing substantially in recent years due to technological advances (LEDs), other equipment are increasing their energy consumption due to increased capabilities (e.g. controllers). New safety requirements also lead to the use of equipment that was not present in older installations such as intercom systems and UPSs, which also contribute to increased standby loads.

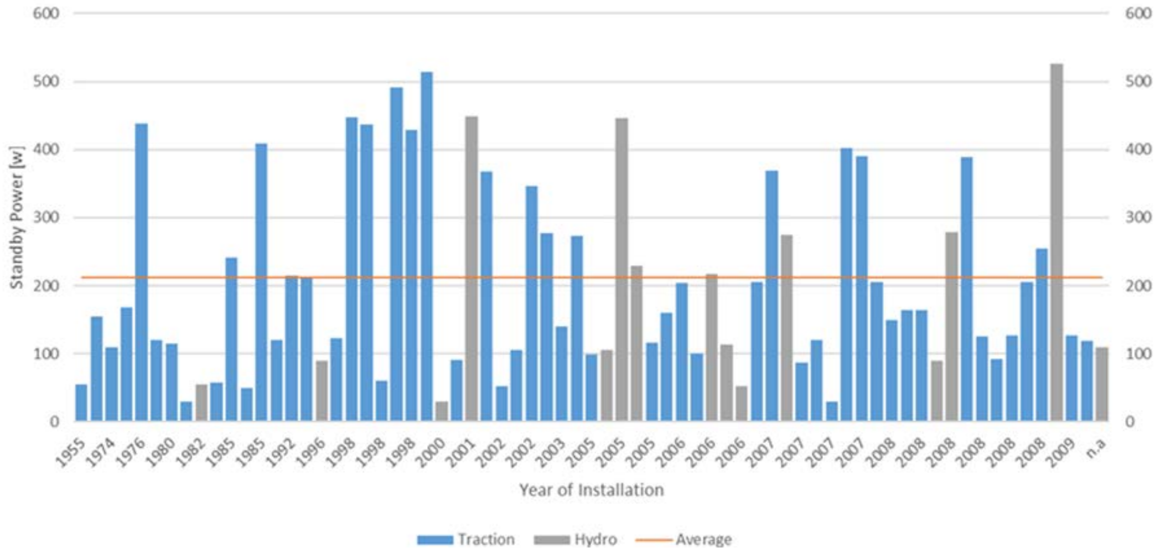

Figure 4-10: Standby consumption of the lifts audited during the E4 monitoring campaign

4.1.5. Products with standard improvement (design) options

Concern with regard to the environmental performance of lifts has grown over the last decade, in particular with regards to their energy consumption. Manufacturers have identified the main causes for inefficiencies in lifts and have developed a number of components with improvements that reduce these inefficiencies [14]. The main design options identified are shown in Figure 4-11 and described in this section.

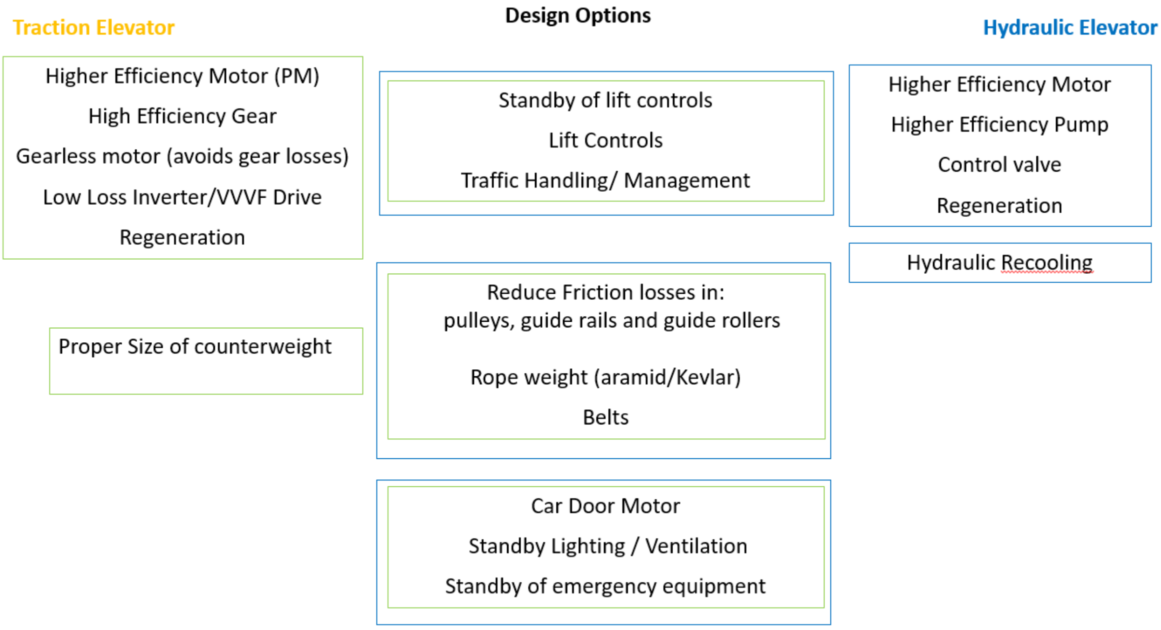

Figure 4-11: Examples of improvement options in Lifts (PM: Permanent magnet; VVVF: Variable Voltage Variable Frequency)

It should be noted that some of the design options described in this section may be proprietary and, therefore, not have widespread availability.

Electric motors

Inductions motors are the most widely used motor technology in lifts today. Several strategies can be used to increase the efficiency of induction motors: advances in motor design (namely thermal and winding design); tighter tolerances; the use of superior magnetic materials; larger copper/aluminium cross-section in the stator and rotor to reduce resistance; and use of copper rotors, are just some of the techniques that contribute to lowering the losses in induction motors and allowing them to reach very high efficiency levels (see Figure 4-12). Because higher efficiency electric motors use more materials, they may be larger in size than lower efficiency motors.

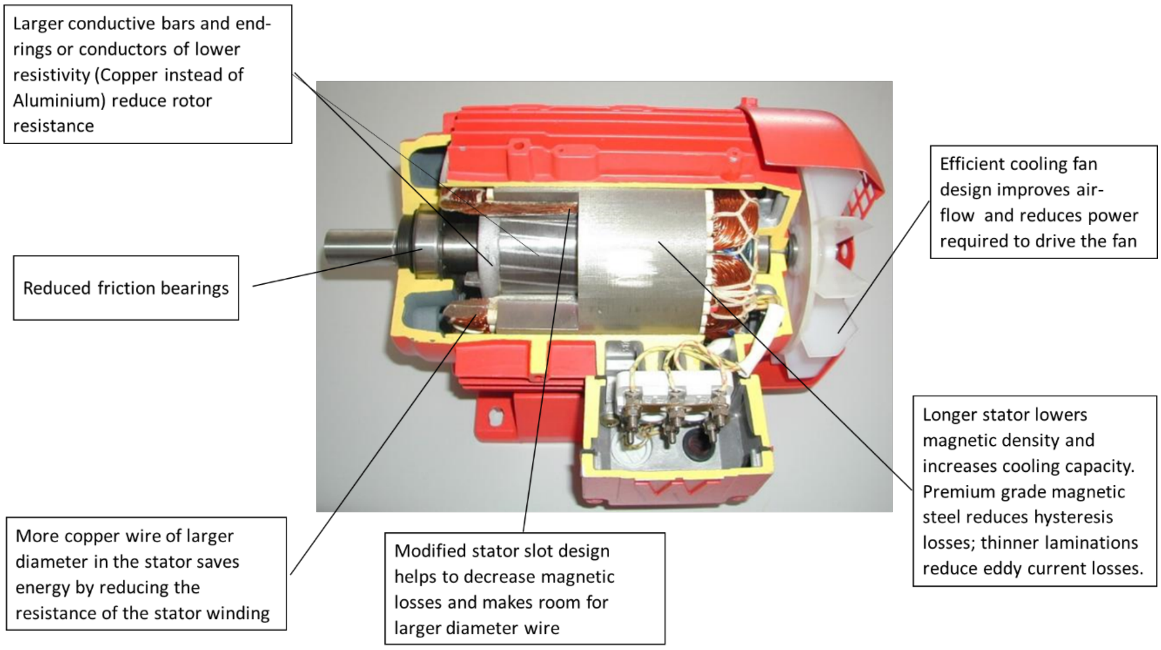

Figure 4-12: Strategies to increase induction motor efficiency.

Permanent Magnet Synchronous Motors (PMSM) are becoming the main alternative to induction motors in lift applications due to their rivaling induction motors in reliability and excelling in efficiency. Since these motors operate at synchronous speed and due to the permanent magnet configuration, they do not have losses in the rotor and are, therefore, capable of achieving even higher efficiency. Typically, a loss reduction at 100% torque / 100% speed compared to induction motors of around 15-20% is achieved, depending on motor output power.

Furthermore, permanent magnets allow the implementation of a very high number of poles, with a speed reduction with the same voltage and a torque increase with the same current. The result is a more compact, higher efficiency high torque / low speed machine ideal for direct drive lift applications with additional advantages in terms of efficiency, overall dimensions, cost, reliability and control precision [9].

The compactness of PMSMs and the use of direct drive coupling allows for the elimination of the machine room, above or adjacent to the hoist-way. The motor and control systems are mounted within the hoist-way itself. The absence of a machine room leads to lower construction costs and frees highly valuable space normally occupied by lift support systems [10]. Gearless systems typically have a 20-30% lower energy consumption when compared to similar geared systems [1].

One drawback is that permanent magnets often use rare-earth materials for their advanced capabilities. The production of rare-earth alloy permanent magnets causes the following well known problems:

- price instability / uncertainty due to concentrated production of Rare Earths in China,
- the limited supply of Dysprosium (Dy),
- the environmental impact of mining and refining these elements.

To avoid these problems, some motor manufacturers have started production of motors using alternative materials and technologies, such as:

- reduced-Dy magnet technology (e.g. Hitachi's dysprosium vapor deposition diffusion technology)
- recycling (limited by economic feasibility)
- development of new magnetic materials (some not yet commercially available): Iron Nitride, Samarium Iron Nitride, Cerium and Manganese-based compositions, magnetic nanoparticles and Iron Lithium Nitride.
- much less costly and widely available ferrite magnets.

Brake

For the calliper of the brake to open and remain open it needs to be energised. One option to reduce the brake energy consumption is to energise the brake in two stages: the first to open the brake calliper, which would require a higher current, and a second stage to maintain the brake in an open position requiring a lower excitation current (but for a longer time period).

Motor controls (Voltage Variable Frequency (VVVF) Drive)

The most widely used method of controlling the motor speed in lifts today is the Variable Voltage Variable Frequency (VVVF) Drive.

VVVF drives energy consumption depends on the losses in the control circuits: motor control, network connection, Input/Output (I/Os), logic controllers and particularly in the output-switches (30-50%). These losses may vary depending on the capabilities of the VVVF drive.

The main operating factors affecting VVVF drives losses are the switching frequency (the higher the switching frequency, the higher the losses in the drive) and the output current (which depends on output power and load). Higher losses also increase the heat load in the drive enclosure or controller cabinet, and may require additional cooling. However, low switching frequency leads to higher harmonic currents in the driven motor, which increases its losses, and can cause torque ripple, leading to higher acoustic noise. The switching frequency of the drive must be carefully considered to balance these effects, taking into account the application requirements.

Thyristors in VVVF drive circuits have been nearly completely replaced by transistors - IGBTs (Insulated Gate Bipolar Transistors) and MOSFETs (Field Effect Transistors) – bringing a significant reduction in overall losses and costs and resulting in an increasingly competitive product. Developments in power semiconductor technology and materials, such as GaN (Gallium Nitride) and SiC (Silicon Carbide), can reduce the losses in VVVF drives (both switching and conduction) even further (by over 50%).

The most efficient VVVF drives present in the market today have 50% lower losses than the average product on the market. Improved control algorithms also contribute to the increase in efficiency of these devices.

One major contribution to the overall energy consumption of VSDs is their standby power consumption which can also vary widely as can be seen in Figure 4-13.

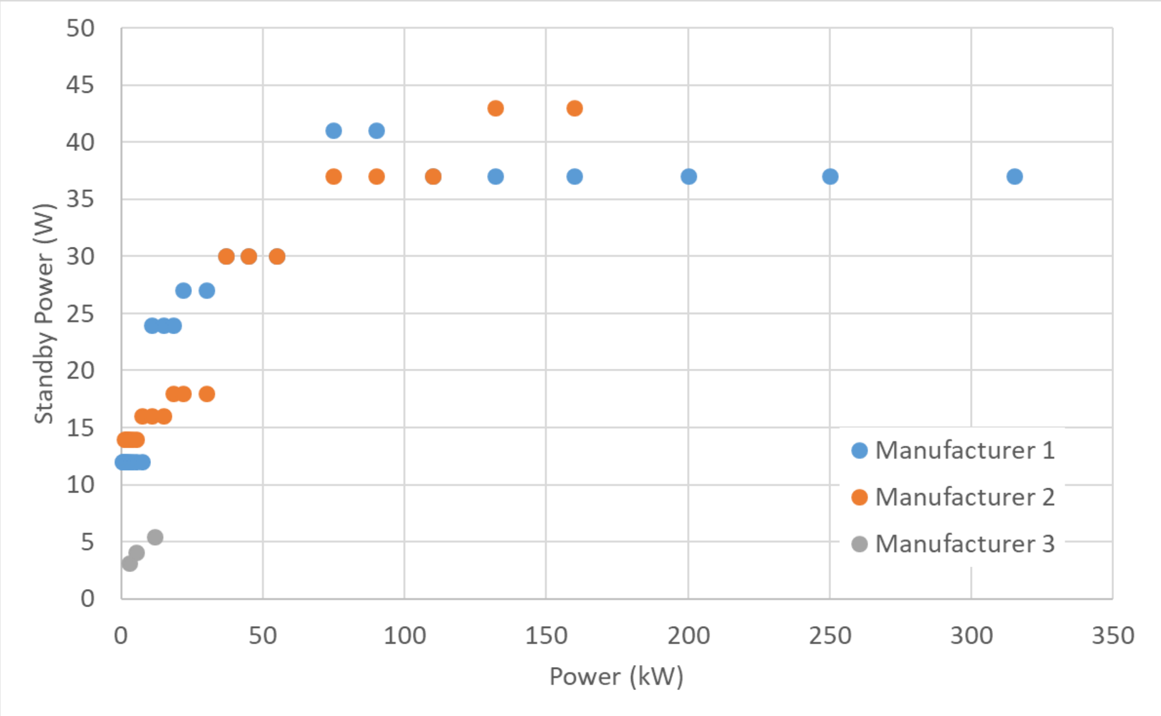

Figure 4-13: VSD Standby Losses (manufacturers' data, 2017)

Another important aspect is the acceleration process. As it can be seen in Figure 4-14 if the motor is simply turned on (situation (a)), without any speed control, the rotor losses will be higher than with a pole changeable motor (situation (b)). A more efficient acceleration technique uses a VVVF drive (situation (c)), that will significantly reduce energy consumption compared to the other techniques mentioned.

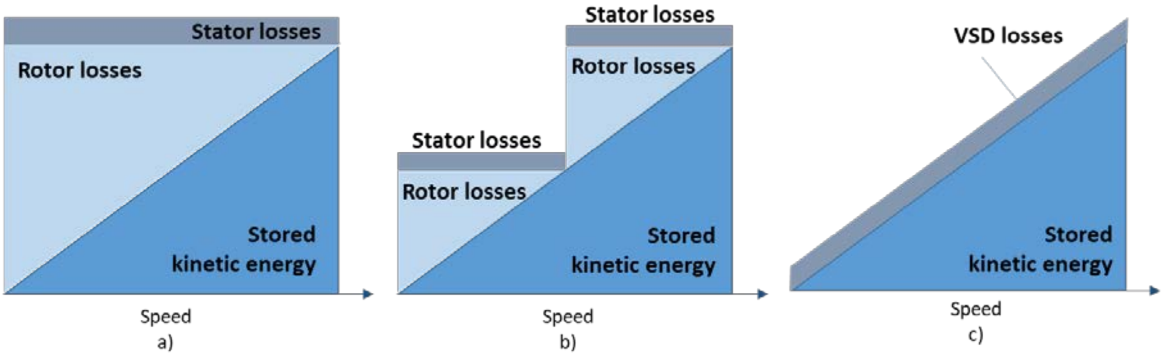

Figure 4-14: Energy-Consumption for an acceleration period: (a) Standard Motor; (b) Pole Changeable Motor; (c) VVVF drive(source: adapted from De Almeida et al. 2005).

The use of a VVVF drive with regeneration capabilities can be used to harness the energy transferred when a lift is travelling downwards when full (or upwards when empty). In this case, the electric motor is decelerating and/or braking and so is operating as a generator. When a regenerative drive is used to control the motor, the kinetic energy and/or the gravitational potential energy stored in a system may be reused, instead of being dissipated in a power resistance installed in the DC bus of the non-regenerative VSD. The energy generated by the motor can be reused in three different forms, namely: (i) injected directly into the AC grid; (ii) injected into a common DC bus; (iii) stored in super-capacitors and/or batteries, for later use.

The amount of regenerated energy is higher in PM gearless systems due to their higher efficiency and because friction losses in the gears are eliminated.

Generally, a regenerative drive can reduce lift energy consumption up to 40% [7] for lifts with high speed, high traffic, long travel heights or higher loads.

High Efficiency Gears

Helical gears have higher efficiency (typically 98% per reduction stage) than the most widely used worm gears. The higher efficiency is due to the smaller contact areas between gears, which reduces friction and heat.

Planetary gears are also used by some of the equipment manufacturers to replace the low efficiency worm gears. They have the additional advantage, over helical gears, of occupying less space.

Lift controls

Control options in lifts have a major impact on energy consumption. By efficiently delivering passengers with the least amount of trips, starts and stops, and number of lifts used, the energy consumed is significantly reduced. Additionally, some specific control strategies can help reduce the energy consumption of lifts. Nevertheless, passenger comfort should not be compromised, as well as waiting and travel times. Such strategies include [1]:

Shutting down lifts in a lift group during periods of low traffic demand

Lift groups are designed to respond optimally to heavy traffic demand situations, such as during up- or down-peak demand. During inter-floor traffic, the capacity of the installation is never fully used. Therefore, it may make sense to disable some of the lifts in the installation during these low demand periods, without significantly affecting the system's traffic handling performance. By itself this would produce considerable energy savings, but it has one side effect that further enhances the energy efficiency of the installation. By reducing the number of lifts in use, the car load is increased, moving closer to the counterbalancing ratio.

Appropriate zoning arrangements

In high-rise buildings, it is possible to group the lifts to serve particular zones of floors. This creates the need for people travelling to floors within that zone to use the same lifts, thereby reducing the number of start / stop cycles made and avoiding unnecessary energy losses. Appropriate zoning arrangement will not only improve the energy performance of the lift installation, but will also improve the handling capacity and the quality of the service due to a shorter Round Trip Time.

Use of advanced algorithms

Employing advanced algorithms that track where each lift is located, to consider the potential energy available from its car and counterweight locations.

Monitoring devices

Modern controllers have logging capabilities which are indispensable for maintenance purposes. They register data related to failures, but can also provide additional data that can be used to improve the performance of the system. By logging information on the energy consumption of lifts a means of conducting energy audits is also provided. The availability of information improves the awareness of building owners / managers on the energy consumed by the system. This information may also be combined with other information logged by the controller (e.g. traffic patterns, idle times, and load) and used to improve the energy performance of the installation.

Hall call allocation

Hall call control systems work by replacing the conventional up or down buttons near the lift doors with consoles located in the building's lobby. Passengers enter their destination as they go in the building and are immediately dispatched to a lift servicing their destination. Passengers are thus grouped by destination, significantly reducing starts/stops and travel time. Since the controller has broader information on the variables at stake, it is able to make more intelligent decisions.

The use of hall call allocation enables the system to assign the number of passengers that is more likely to match the counterbalancing ratio of the lift, thus minimising the energy used. This is especially pertinent in low traffic periods, when it is less important that lifts travel at their maximum capacity.

Double-deck lifts

One solution to improve the traffic handling capabilities of a lift system in very high-rise buildings is to use Double-Deck (DD) lifts. This system consists of two individual cars that travel together, the upper one serving odd floors and the lower one even floors. Both cars travel using the same shaft and drive system, saving space and resources [12]. Modern double-deck systems use sophisticated controls to ensure that the best deck is allocated to calls minimising waiting times, travel time and number of stops.

Door operators

Direct drive motors, either AC induction motors or PM motors, using closed-loop electronic control of speed, torque and door position are the most advanced solution having high-efficiency and eliminating the transmission losses. Additionally, they minimise opening and closing door times and may adjust their speed to different levels of passenger traffic with resulting improvement of the traffic handling capacity of the lift.

The weight of the doors has an important influence on the energy consumption of door operators. Nevertheless, door weight reduction should be used without compromising safety requirements.

Also, side opening doors have to open the whole width of the doorway, which will take more time. Where centre opening doors can be fitted, faster door operation is achieved and, therefore, the energy consumption of this type of doors is less.

Some door operators keep the lift door closed by keeping the motor energised. This constitutes a major standby load that can easily be avoided by having an alternative method (e.g. mechanical) of locking the lift door.

Lighting

Although LED lighting is used in most new lift installations, the technology has been subject to great improvements over the last few years, now reaching efficacies of over 150 lm/W. However, the quality of the products in the market, may vary substantially. Additional advantages are its long lifetime.

Ventilation

Ventilation in lift cars is most often ensured by natural ventilation, passively. When the requirements cannot be ensured by natural ventilation, fans must be installed. The development of motor technology combined with a global reduction in the cost of electronics and power electronics over the last few years have made it possible to achieve electronically controlled (EC) fan prices that are now broadly comparable to the costs of similar solutions involving the use of AC induction motors. Electronically controlled permanent magnet motors (EC motors) can achieve very high efficiencies and competitive prices in variable speed applications (see Figure 4-15).

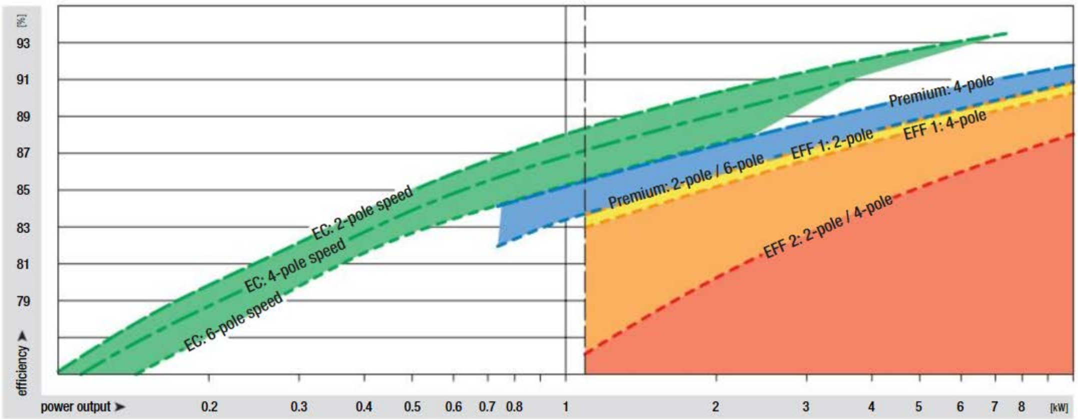

Figure 4-15: Efficiency of EC/BLDC motors (source: EBM-Papst)

Especially with fans, setting the operating point to meet the required flow has a noticeable impact on energy consumption, as the power consumed changes with the third power of the speed. Good speed control is also an important factor in regard to acoustic noise and vibrations.

Ventilation units are regulated by Regulation1253/2014 of the Ecodesign Directive and have to fulfil a minimum efficiency and need to have at least a multispeed control.

Power supplies

Many of the lift components require a power supply to convert alternating current (AC) power input from the mains power source input into lower voltage direct current (DC). Such equipment include lift car fixtures, door operator controllers, intercom systems, etc. Power supplies can have significant losses which are particularly important during standby mode.

Commission Regulation (EC) No 278/2009 sets minimum energy performance standards for external power supplies, both in active mode and in no load condition, which are shown, alongside the requirements in the USA, in Figure 4-16 and Figure 4-17. However, the regulation only covers power supplies in electric and electronic goods used in the household and the office, and therefore does not apply to lift equipment. Nevertheless, the requirements of the regulation can serve as a good indicator of the cost-effective efficiency improvement that are possible for this equipment. The best available technology medium-power EPS could have around 95% average efficiency, across a wide range of output powers, from 10 to 100% load, with a no load standby level as low as 0.01W.

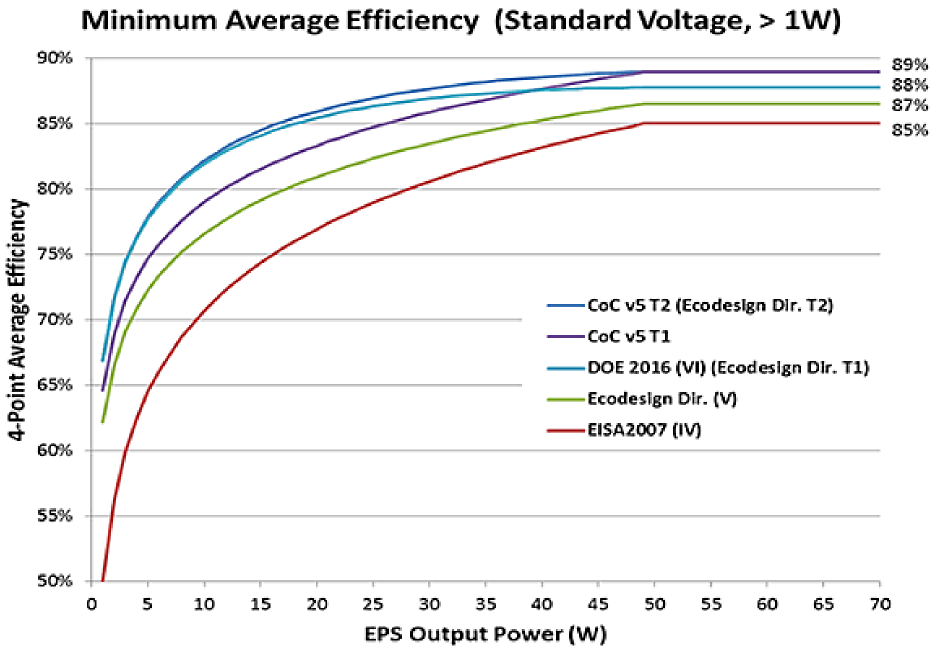

Figure 4-16: U.S. and European EPS MEPS for average active efficiency

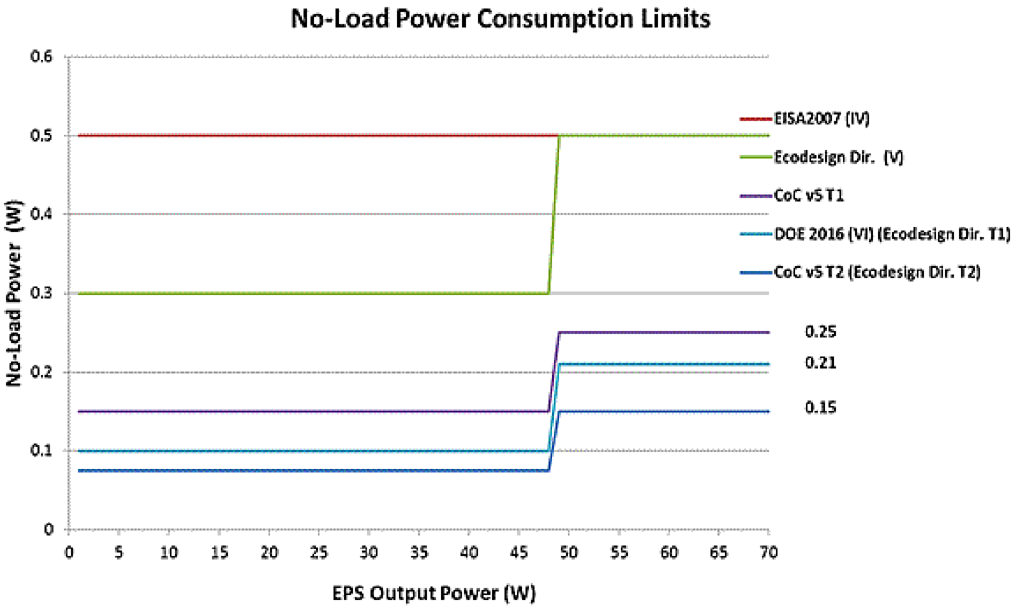

Figure 4-17: U.S. and European EPS MEPS no-load condition

Guide rails and shoes

Another cause for inefficiencies are the guide rails and shoes that ensure travel in a uniform vertical direction. Correct installation and maintenance (e.g. alignment, lubrication) should be guaranteed to minimise the losses in these components. Furthermore, when correctly maintained, the use of roller guides is preferred to the use of sliding guides. Tests show an effective coefficient of friction for roller guides of 0.03. With sliding guides, this friction can easily be 10 times as much, especially if the lubrication is not well maintained. Sliding guides can easily cause over 100 kg (1.000 N) of frictional losses in the system if car and/or counterweight are not well balanced, or if the 4 guides and rails are not perfectly co-planar. Even with perfect balance, loads can be placed in the car off centre, causing frictional losses at the guides. In roller guides, imbalances can also cause flat spots, creating noise and reducing ride quality.

Standby loads

There are two ways of reducing the standby consumption of lifts.

The first is to use the most efficient equipment i.e., that equipment which uses the least energy to perform the same function. One example is to use mechanical door locks instead of electrical door locks that keep the lock energised in order to keep the door closed. Another example is to minimise the no-load losses of power supplies which can be very low (under 1 Watt as shown above).

The second way is to turn off the equipment that is not being used. Most manufacturers now offer two standby modes. The first one does not imply an addition to the passenger waiting time as only components that can be instantly turned on would be completely or partially disabled (e.g. lighting, ventilation, and car displays). The second standby mode shuts down further components (e.g. after 30 seconds of idle time), but the system may take a longer time to reboot due to the nature of the equipment switched-off (e.g. drive units, door operators, car electronics, light curtains / door detectors).

Rebooting the idle equipment can have an impact in passenger waiting time. However, recent technological developments in microprocessor capabilities (driven mainly by mobile, battery powered, consumer products such as smartphones or laptops) have reduced the rebooting times to seconds, with very low standby consumption in sleep mode or hibernation.

Frequent restarting of the equipment may have an adverse effect on the lifetime of some electronic components, which would potentially increase the environmental impact of the lift.

4.1.5.1. Options specific to traction elevators

Traction sheave and pulleys

The weight of the sheave and pulleys also has an effect on the energy consumption of lifts. As the speed increases, the traction sheave and rope pulleys also revolve faster so that they have an increasingly greater influence on the starting output. The diameters of the traction sheave and rope pulleys cannot be reduced indefinitely, but it is possible to use polyamide instead of cast iron for the rope pulleys, thus reducing the moment of inertia by a ratio of approximately 1:5.

Ropes and Belts

Some new materials are available to replace conventional steel wire rope with significant advantages that are also reflected in the energy efficiency of lifts.

Aramid fibre (Kevlar®) ropes are one solution. They are four times lighter than conventional steel ropes for the same tensile strength. The synthetic rope has higher fatigue strength under reverse bending stress than steel ropes, which allows bends to have a smaller radius. Furthermore, they do not require lubrication throughout their lifetime [6].

Coated steel ropes are also a new technology that has recently entered the market. They consist of a high tensile steel wire elevator rope covered with a thermoplastic coating. The combination of these properties results in a lighter, thinner and more durable high traction steel wire rope. Because they are thinner, they can also be bent to a smaller radius allowing for a smaller traction sheave.

Another option is the use of belts. These belts consist of a band comprised of ultra-thin steel cables encapsulated in a polyurethane sheath.

Because these ropes or belts allow for a smaller bending ratio, smaller sheaves can be used along with smaller motors because a smaller torque requirement is necessary (see Figure 4-18).

For example, flat belts allow the use of a 80 mm diameter sheave instead of the commonly used 320 mm diameter sheave. In this way, at a given lift speed, the smaller sheave rotates 4 times as quickly as a 320 mm sheave, so a smaller motor can deliver more torque to the load. Furthermore, it avoids the use of a gearbox which results in supplementary energy savings.

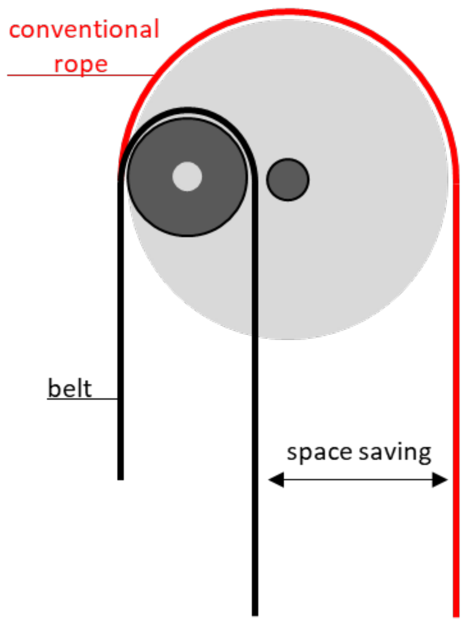

Figure 4-18: Traction Belts vs Steel cables

The weight of the ropes is becoming an increasingly important concern as building heights increase at a fast pace. Rope weight increases exponentially with height and can reach several tons to move just a few passengers in a high-rise building [8].

Another weight saving solution is belt-like ropes fabricated via pultrusion with carbon fibre, with a polyurethane coating.

Optimised dimension of counterweight

Lifts are normally counterbalanced at 40 to 50% of rated load. This means that the mass of the counterweight equals the mass of the car plus 40 to 50% of the rated load. The least energy consumption occurs for the situation when the counterweight mass equals the mass of the car plus its passengers, i.e., car and counterweight are perfectly balanced. But this situation seldom occurs and different lifts in different buildings will have different typical load rates. A residential lift will often carry very few passengers and, therefore, it makes sense that it is counterweighted at less than 40%. Optimal sizing of the counterweight to the average load of the car can lead to savings of up to 50% of the running energy consumption when compared to the conventional counterweight [16]. Dimensioning the counterweight based on traffic analysis offers a very cost-effective opportunity of improving the energy efficiency of lifts.

4.1.5.2. Options specific to hydraulic elevators

Control valve

Closed-loop, electronically controlled, proportional solenoid valves, can react to the real-time signals from the flow, temperature and, sometimes, pressure sensors, thus compensating for variations in oil viscosity and pressure. The use of these valves greatly increases the travel comfort, and the starting and stopping accuracy. Because of the increased speed control, they reduce both the levelling time and the overall travel time. Therefore, pump run times are reduced and less heat is generated, improving efficiency. Additionally, the need for supplementary cooling of the hydraulic fluid is avoided.

Variable Voltage Variable Frequency control

The most energy-efficient solution is to combine the use of a VVVF drive with an appropriate control valve. By varying the speed of the pump, only the amount of oil necessary to move the lift is supplied as opposed to conventional systems where the amount of oil pumped is constant and partially fed-back into the tank. Another advantage is that the starting current is reduced by decreasing the demand on the power supply. Because the heat losses are reduced, additional oil cooling is not necessary in most applications.

Regenerative hydraulic drives

In VVVF driven hydraulic lifts, provided the drive has regenerative capability, the pump can turn backwards during car downwards travel and the motor act as a generator. Energy can be stored in a battery, super-capacitor or fed directly into the building grid [15].

Counterweight

The absence of a counterweight in hydraulic lifts means that they have to lift the entire car load. This is the major cause for the higher travel energy consumption of hydraulic lifts when compared to traction lifts.

However, although not common, there are roped hydraulic lifts with a counterweight. Instead of pushing the car directly, the piston pulls on the counterweight in order to move the car upwards. The use of a counterweight allows for a motor with a smaller power rating to be used when compared to conventional hydraulic lifts. They have the additional advantage of being hole-less. Disadvantages include the need for additional components (e.g. guide rails, ropes, pulleys) increasing the maintenance requirements; increasing the load on the building structure; and the additional space required for the counterweight.

Another possibility is the use of hydraulic pressure accumulators that act as a counterweight. These bladder type components store the potential energy during down travel releasing it during the up cycle. This way a smaller motor can be used saving energy and reducing the power supply demand. Since the potential energy is transferred to the accumulator instead of being dissipated as heat, cooling is no longer necessary, which results in additional energy savings.

The potential exists to reduce hydraulic energy use in the range of 50% with proven, available approaches [5].

4.1.6. Best Available Technology BAT (i.e. the best products on the market)

Lifts are very complex products that must be individually designed for each application and, therefore, no single BAT products exist. The best products on the market are the products that best combine the design options described above to effectively and efficiently fulfil the requirements of the specific installation they are designed for.

As described in Task 1, ISO 25745-2 defines a methodology for the energy efficiency classification of lifts [13]. This methodology takes into account the installation characteristics and final use of the lift. Most lift manufacturers offer lifts with Class A according to the ISO classification standard.

Best available products on the market cover the following aspects:

- energy efficient gearless motors
- regeneration capability, both in traction and hydraulic systems, in high usage lifts
- energy efficient control
- efficient LED lighting
- use of biodegradable hydraulic fluids (relevant for LCA, not EE)
- improvement of the pump, drive and flow control valve for hydraulic lifts
- lighter moving components
- low stand-by modes.

With the combination of different, ever efficient components, lifts are becoming more efficient with each new product on the market.

As an example, a low rise (4 floors), residential traction lift can have idle and standby consumption as low as 30W and specific energy consumption as low as 0.3 mWh/(kg.m).

4.1.7. Best Not yet Available Technology BNAT

Existing the lift technologies are fairly mature and, therefore, no new technological developments that translate into major breakthroughs in the near future are expected. What is expected is that existing technologies continue to be developed with increasing efficiency.

Thyssen-Krupp has developed a lift that, using linear motor technology, dispenses the use of ropes being able to travel sideways inside a building. By having multiple cars travelling inside the same shafts it can increase the passenger throughput while taking up less space in the building.

The internet of things (IoT), may also bring advantages to the lift industry by delivering information on not only maintenance needs, but also on lift usage patterns that can be used to improve the energy performance of lifts. Data on energy use can also be collected digitally, in real-time, and used by energy managers. It will also be possible for a user to call a lift from his smartphone and for the lift to collect data on waiting and travelling times from the users and use that information to improve passenger throughput.

4.2. Subtask 4.2- Production, distribution and end of life

4.2.1. Product weight and Bills-of-Materials (BOMs), preferably in EcoReport format

The bill of materials (BOMs) for the lifts is intended to represent the average products on the market today. The values are derived from stakeholder input, product catalogues, existing environmental product declarations and other LCA studies for lift products or components.

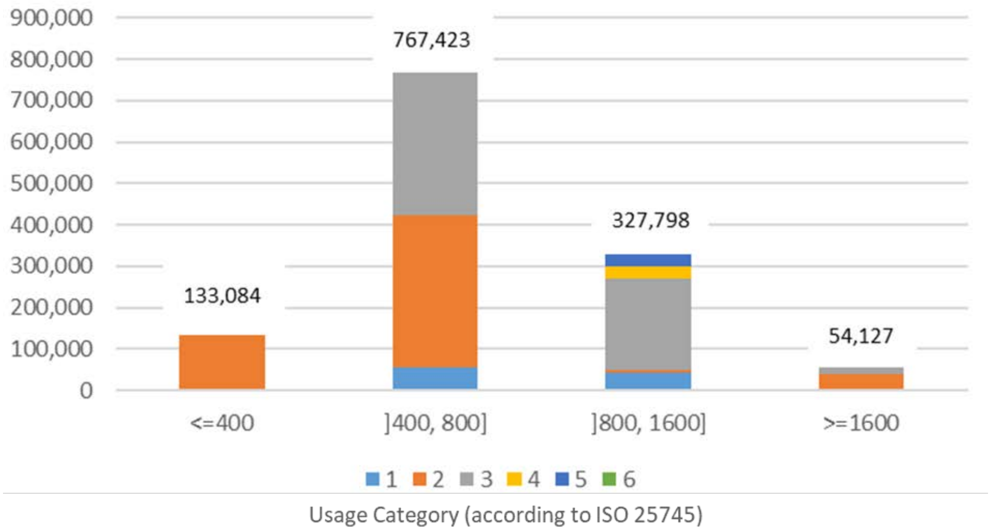

Figure 4-19: Hydraulic motor market according to nominal load (in kg), 2015 (based on Task 2)

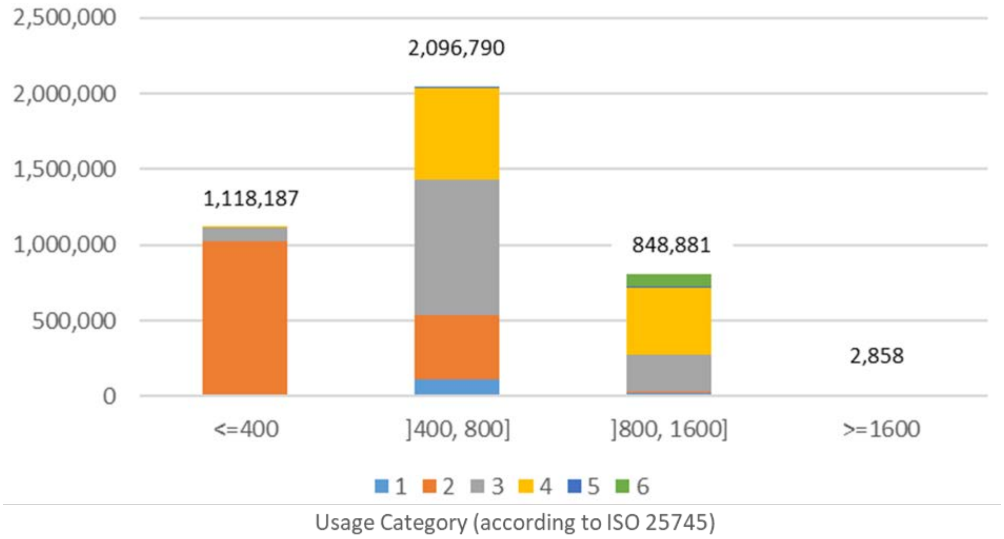

Figure 4-20: Traction motor market according to nominal load (in kg), 2015 (based on Task 2)

The values presented were derived from the lift stock per sector data available from the E4 Project. The available market data was not sufficiently disaggregated to be categorised by sector and usage categories according to ISO 25745-2:2015. This is thus only an indicative distribution using the available data. The numbers in there cannot be seen as the total number of existent lifts in the several user categories. The values in that table used the number of trips per year available from the E4 project to calculate the average number of trips per day and consequently the usage categories. The final stock model also considers data from ELCA and ELA and not only from the E4 Project. Although not totally accurate it gives an indication of the lift distribution by usage category.

In line with the MEERP methodology, the analysis of this study has to be carried out using Base-cases. These base cases represent average lifts (and not specific ones) put onto the market. The results of the previous Tasks lead to a definition of six Base-cases for this study. They are based on the most important market segments as shown in Figure 4-19 and Figure 4-20. Because of the incompleteness of the data available, stakeholder input was also considered in the definition of the BaseCases. The main characteristics of the Base-cases are given in Table 4-1.

Table 4-1: Overview of the base cases.

Base Case ID	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
Type	traction	hydraulic	traction	hydraulic	traction	traction
Rated load in [kg]	450	450	630	630	1000	1250
Rise [m]	12	12	12	12	21	30
Number of floors [-]	4	4	4	4	7	10
Nominal speed [m/s]	1	0,7	1	0.63	1	1.6
Acceleration [m/s^2]	0.5	0.5	0.5	0.5	0.5	0.5
Jerk	1	1	1	1	1	1
Roping	2:1	n.a.	2:1	n.a.	2:1	2:1
Usage Category	1	1	2	2	3	4
Daily trips [-]	50	50	125	125	300	750
Average travel distance [%]	49%	49%	49%	49%	49%	44%
Average car load [%]	7.5%	7,5%	7.5%	7.5%	4.5%	6.0%
Counterbalancing [%]	50.0%		50.0%	-	50.0%	50.0%
Number of operating days per year [d/a]	360	365	360	360	360	360
Designed service life [a]	25	25	25	25	25	25
FU [tkm]	89.3	89.3	312.6	312.6	1250.2	6682.5

The aggregated BOMs for the base cases is provided in Table 4-2. These figures are based on expertise and desk research of the project team. Furthermore, for the technical data, feedback was requested from manufacturers via the associations ELA, ELCA and EFEMSE on an Excel-sheet (focusing on technical data without prices) published on the project website. A detailed BOM for each base case is provided in the Appendix. In Task 5, the BOM is presented according to the EcoReport template.

Table 4-2: Overview of aggregated BOM.

Base Case ID		Base Case 1A					Base Case 1B				
	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
Lift: Entire system	Both	2.133	-	25	17.000	100%	1.414			15.500	100%
Electric Motor	**Both**	116,8	Motor [3kW	30	1.360	8,0%	60,3	Motor [6kW	30	1.211	7,8%
Traction sheave	Traction	25,0		30	680	4,0%					
Brake	Traction	9,0		30	1.360	8,0%					
Speed governor	Traction	14,2		30	680	4,0%					
Bedplate	Traction	30,0	steel		680	4,0%					
Controller	Both	72,3		20	2.040	12,0%	75,2		20	1.816	11,7%
Guide rails	Both	457,1		25	2.040	12,0%	376,9		25	1.816	11,7%
Car	Both	327,5			2.720	16,0%	327,5			2.422	15,6%
Car Door	Both	60,0	steel sheet	20	408	2,4%	60,0	steel sheet	20	363	2,3%
Landing Doors	Both	300,0	steel sheet	20	680	4,0%	300,0	steel sheet	20	605	3,9%
Car Door Operators	Both	3,7		20	408	2,4%	3,7		20	363	2,3%
Diverter pulleys	Both	30,0	cast iron	20	408	2,4%			20	363	2,3%
Ropes	Both	45,5	steel	20	680	4,0%	0,0		20	605	3,9%
Landing indicators and buttons	Both	1,0		15	680	4,0%	1,0		15	605	3,9%
Car indicators and buttons	Both	8,8		15	408	2,4%	8,8		15	363	2,3%
Counterweight	Traction	632,0		30	408	2,4%					
Cylinder/Piston	Hydraulic						108,0	steel tube [9	25	1.816	11,7%
Pump	Hydraulic						5,8		30	1.816	11,7%
Control Valve	Hydraulic						18,0	cast iron	25	605	3,9%
Cabinet	Hydraulic						10,0	steel sheet	30	363	2,3%
Oil	Hydraulic						58,5	hydraulic fluid		363	2,3%
Buffer	Both	14,0	steel				14,0	steel			
Hoistway Wiring	Both	40,0	copper wire				40,0	copper wire			

Base Case ID		Base Case 2A					Base Case 2B				
	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
Lift: Entire system	Both	2.668			21.500	100%	1.784			19.000	100%
Electric Motor	**Both**	153,7	Motor [4.5k\	30	1.720	8,0%	93,0	Motor 9.5kW	30	1.484	7,8%
Traction sheave	Traction	50,0		30	860	4,0%		240mm			
Brake	Traction	13,1		30	1.720	8,0%					
Speed governor	Traction	14,2		30	860	4,0%					
Bedplate	Traction	35,0	steel		860	4,0%					
Controller	Both	72,3		20	2.580	12,0%	75,2		20	2.227	11,7%
Guide rails	Both	674,0		25	2.580	12,0%	462,1		25	2.227	11,7%
Car	Both	450,6			3.440	16,0%	450,6			2.969	15,6%
Car Door	Both	70,0	steel sheet	20	516	2,4%	70,0	steel sheet	20	445	2,3%
Landing Doors	Both	350,0	steel sheet	20	860	4,0%	350,0	steel sheet	20	742	3,9%
Car Door Operators	Both	3,7		20	516	2,4%	3,7		20	445	2,3%
Diverter pulleys	Both	30,0	cast iron	20	516	2,4%			20	445	2,3%
Ropes	Both	66,7		20	860	4,0%	0,0		20	742	3,9%
Landing indicators and buttons	Both	1,0		15	860	4,0%	1,0		15	742	3,9%
Car indicators and buttons	Both	8,8		15	516	2,4%	8,8		15	445	2,3%
Counterweight	Traction	675,0		30	516	2,4%					
Cylinder/Piston	Hydraulic						144,0	steel tube	25	2.227	11,7%
Pump	Hydraulic						7,6		30	2.227	11,7%
Control Valve	Hydraulic						18,0	cast iron	25	742	3,9%
Cabinet	Hydraulic						10,0	steel sheet	30	445	2,3%
Oil	Hydraulic						90,0	hydraulic fluid		445	2,3%
Buffer	Both	15,0	steel				15,0	steel			
Hoistway Wiring	Both	40,0	copper wire				40,0	copper wire			2,3%

Base Case ID		Base Case 3					Base Case 4				
	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
Lift: Entire system	Both	4.641			28.500	100%	5.990			45.000	100%
Electric Motor	**Both**	204,5	Motor [8kW	30	2.280	8,0%	250,2	268 kg [13k\	30	3.913	8,7%
Traction sheave	Traction	50,0		30	1.140	4,0%	30,0		30	1.957	4,3%
Brake	Traction	13,1		30	2.280	8,0%	23,5		30	3.913	8,7%
Speed governor	Traction	14,2		30	1.140	4,0%	14,2		30	1.957	4,3%
Bedplate	Traction	35,0	steel		1.140	4,0%		steel		1.957	4,3%
Controller	Both	72,3		20	3.420	12,0%	99,5		20	5.870	13,0%
Guide rails	Both	1.228,9		25	3.420	12,0%	1.754,2		25	5.870	13,0%
Car	Both	640,8			4.560	16,0%	719,0			7.826	17,4%
Car Door	Both	110,0	steel sheet	20	684	2,4%	120,0		20	1.174	2,6%
Landing Doors	Both	880,0	steel sheet	20	1.140	4,0%	1.320,0	steel sheet	20	1.957	4,3%
Car Door Operators	Both	4,2		20	684	2,4%	7,4		20	1.174	2,6%
Diverter pulleys	Both	60,0	cast iron	20	684	2,4%	100,0	cast iron	20	1.174	2,6%
Ropes	Both	146,6		20	1.140	4,0%	223,0		20	1.957	4,3%
Landing indicators and buttons	Both	1,8		15	1.140	4,0%	2,6		15	1.957	4,3%
Car indicators and buttons	Both	10,0		15	684	2,4%	12,8		15	1.174	2,6%
Counterweight	Traction	1.170,0		30	684	2,4%	1.314,0		30	1.174	2,6%
Cylinder/Piston	Hydraulic										
Pump	Hydraulic										
Control Valve	Hydraulic										
Cabinet	Hydraulic										
Oil	Hydraulic										
Buffer	Both	15,0	steel				17,0	steel			
Hoistway Wiring	Both	70,0	copper wire				100,0	copper wire			

4.2.2. Materials flow and collection effort at end-of-life (secondary waste), to landfill/ incineration/ recycling/ re-use (industry perspective)

At the end of life the lift is dismantled. Lifts are mainly built with metals that are recyclable and that have a very high value (e.g. steel, aluminium, copper). For these materials the end-of-life treatment of the lift entails multi-metal scrap recycling. Plastic content is either recycled, used for energy recovery or landfilled.

Typical packaging materials for lift components are wood or plywood for larger equipment and cardboard and occasionally plastic for smaller components.

Lifts are excluded from the scope of the WEEE Directive (recital 9). However, any equipment which is not specifically designed and installed as part of those installations, and which can fulfil its function even if it is not part of those installations, should be included in the scope of the Directive. This includes components such as lighting equipment, electronic controls and batteries.

Batteries also fall under the scope of Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators

Waste oils are governed by the Waste Framework Directive 2008/98/EC, especially by Article 21, on waste oils. The Directive states that waste oils must be collected separately, where this is technically feasible and preferably regenerated. This applies to both lubricant oils and hydraulic fluids in lifts.

4.3. Subtask 4.3- Recommendations

4.3.1. Refined product scope from the technical perspective (e.g. exclude special applications for niche markets)

Lift products excluded from the Lift Directive 2014/33/EU listed in its Article 1 (2), are considered niche markets with technical specificities and should also be excluded from proposed Ecodesign regulation.

4.3.2. Barriers and opportunities for Ecodesign from a technical perspective

Lifts are complex systems that are individually engineered for each installation, making it difficult to come up with a straightforward, one-size-fits-all solution. However a standardised methodology for the measurement and classification of the energy consumption of lifts is already developed – ISO25745 parts 1 and 2 – and , therefore, this major hurdle can be more easily overcome. Furthermore, the standard defines usage categories that can be used to compare the performance of lifts in similar applications.

4.3.3. The typical design cycle for this product and thus approximately appropriate timing of measures

Lifts are assemblies of different technologies that are very mature and it is unlikely that a disruptive breakthrough will happen and move the market in a radically different direction, causing a major reduction in energy consumption or environmental impact.

On the contrary, improvements in the environmental performance of lifts will most likely be the outcome of small incremental improvements in the performance of individual components. Because the life-cycle of lifts is very long it reflects in the relatively low pressure lift manufacturers have to put new products on the market, when compared to other products with shorter life-span. The design cycle of lift components is estimated at 3-5 years.

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4.5. Appendix

Table 4-3: Detailed BOM for BaseCase1A – Part 1 (source: project team with input from stakeholders)

Base Case ID	Both	Base Case 1A
Type		traction
Rated load (Q) in [kg]		320
Rise [m]		12
Number of floors [-]		4
Nominal speed (m/s)		0,7
Roping		1:1
Nb of daily trips (nd) [-]		50
Usage Category		1
Average travel distance [-]		49%
Average car load [-]		7,5%
Number of operating days per year [days/year]		365
Designed service life [years]		25
FU [tkm]		64,4

	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
Lift: Entire system	Both	1.977	-	25	17.000	100%
Electric Motor	**Both**	45,1	Motor [3-phase AC Induction]	30	1.360	8,0%
stator / rotor	Both	18,0	electrical steel			0,0%
bearings, shaft, fan shroud	Both	4,5	steel			0,0%
Frame	Both	16,0	cast iron			0,0%
rotor bars, end rings	Both	1,8	aluminium			0,0%
windings, leads	Both	4,0	copper			0,0%
terminal board, winding insulation	Both	0,1	insulation			0,0%
winding impregnation	Both	0,1	impregnation resin			0,0%
fan	Both	0,5	plastic			0,0%
paint	Both	0,2	paint			0,0%
permanent magnets	Both	0,0	[not used for this base case]			0,0%
Gear box	Traction	22,3		30	1.360	8,0%
worm shaft	Traction	4,5	steel alloy			0,0%
worm wheel	Traction	2,5	bronze			0,0%
bearings	Traction	3,0	alloy steel			0,0%
encasing	Traction	7,0	cast iron			0,0%
seals	Traction	0,2	rubber			0,0%
oil	Traction	5,0	synthetic gear oil [5.5L dens.=0.9]			0,0%
paint	Traction	0,2	paint			0,0%
Traction sheave	Traction	25,0		30	680	4,0%
sheave shaft	Traction	10,0	steel alloy			0,0%
sheave	Traction	15,0	cast iron			0,0%
Brake	Traction	9,0		30	1.360	8,0%
frame	Traction	3,0	cast iron			0,0%
electromagnetic coil	Traction	1,0	copper winding			0,0%
springs	Traction	0,5	steel			0,0%
brake drum	Traction	2,0	steel			0,0%
brake shoe	Traction	1,0				0,0%
other	Traction	1,5	steel			0,0%
Speed governor	Traction	14,2		30	680	4,0%
mount	Traction	6,0	steel			0,0%
sheave	Traction	6,0	cast iron			0,0%
spring	Traction	0,2	steel			0,0%
other	Traction	2,0	steel			0,0%
Bedplate	Traction	30,0	steel	30	680	4,0%
Controller	Both	72,3		20	2.040	12,0%
cabinet	Both	24,0	sheet steel			0,0%
paint	Both	1,2	paint			
Electronics	Both	35,0	PCB, SMDs, Chips			0,0%
Wiring	Both	7,0	copper/plastic			
electromechanichal switches	Both	5,0	plastic			0,0%
electromechanichal switches	Both	0,1	copper			0,0%
Guide rails	Both	457,1		25	2.040	12,0%
rails car	Both	211,9	steel (T70) [8.83kg/m]			0,0%
rails counterweight	Traction	80,2	steel (T45) [3.34kg/m]			0,0%
brackets (every 2m)	Both	165,0	steel			0,0%
Car	Both	315,5		30	2.720	16,0%
car sling structure	Both	40,0	steel			0,0%
guide Shoes	Both	20,0	cast iron			0,0%
car walls / roof	Both	175,0	Stainless steel sheet [den. 8kg/dm3]			0,0%
platform	Both	40,0	steel			0,0%

Table 4-4: Detailed BOM for BaseCase1A – Part 2 (source: project team with input from stakeholders)

Base Case ID		Base Case 1A
Type		traction
Rated load (Q) in [kg]		320
Rise [m]		12
Number of floors [-]		4
Nominal speed (m/s)		0,7
Roping		1:1
Nb of daily trips (nd) [-]		50
Usage Category		1
Average travel distance [-]		49%
Average car load [-]		7,5%
Number of operating days per year [days/year]		365
Designed service life [years]		25
FU [tkm]		64,4

	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
glass/mirror	Both	5,0	glass			0,0%
hand rail	Both	5,0	steel tube			0,0%
floor	Both		vinyl/stone			0,0%
lighting	Both	0,5	LED [LED Spots, 0.130 each]			0,0%
other (e.g. decorations, nuts and bolts, linings, etc)	Both	30,0	What is the main material of this sub-category?			0,0%
Car Door	Both	60,0	steel sheet	20	408	2,4%
Landing Doors	Both	240,0	steel sheet [x4]	20	680	4,0%
Car Door Operators	Both	3,7		20	408	2,4%
motor	Both	1,5	will be completed by the study team			0,0%
belt	Both	0,2	rubber			0,0%
pulleys	Both	0,5	abs plastic			0,0%
controller	Both	1,5	pcb			0,0%
Diverter pulleys	Both	15,0	cast iron	20	408	2,4%
Ropes	Both	16,5	steel	20	680	4,0%
hoisting (4x15mx d8mm) single wrap	Both	13,2	steel			0,0%
governor	Both	3,3	steel			0,0%
Landing indicators and buttons	Both	1,0		15	680	4,0%
LEDs	Both		LED			0,0%
buttons	Both	0,1	plastic			0,0%
panel	Both	0,5	steel sheet			0,0%
PCB (Printed Circuit Board)	Both	0,2	PCB			0,0%
SMDs (Surface Mounted Devices)	Both		SMD			0,0%
wiring	Both	0,2	copper			0,0%
Car indicators and buttons	Both	8,8		15	408	2,4%
LEDs	Both		LED			0,0%
buttons	Both	1,0	plastic			0,0%
panel	Both	7,0	steel sheet			0,0%
PCB	Both	0,5	PCB			0,0%
SMDs	Both		SMD			0,0%
wiring	Both	0,3	copper			0,0%
Counterweight	Traction	587,0		30	408	2,4%
counterweight frame	Traction	30,0	steel			
counterweights	Traction	557,0	cast iron /concrete			
Cylinder/Piston	Hydraulic					
Pump	Hydraulic					
casing	Hydraulic					
shaft	Hydraulic					
screw	Hydraulic					
bearings	Hydraulic					
Control Valve	Hydraulic					
Cabinet	Hydraulic					
Oil	Hydraulic					
Buffer	Both	14,0	steel	25		
Hoistway Wiring	Both	40,0	copper wire	30		
Intercom	Both	1,0		20		

Table 4-5: Detailed BOM for BaseCase1B – Part 1 (source: project team with input from stakeholders)

Base Case ID		Base Case 1B
Type		hydraulic
Rated load (Q) in [kg]		320
Rise [m]		12
Number of floors [-]		4
Nominal speed (m/s)		0,7
Roping		n.a.
Nb of daily trips (nd) [-]		50
Usage Category		1
Average travel distance [-]		49%
Average car load [-]		7,5%
Number of operating days per year [days/year]		365
Designed service life [years]		25
FU [tkm]		64,4

	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
Lift: Entire system	Both	1.397			15.500	100%
Electric Motor	Both	60,3	Motor [3-phase AC Induction]	30	1.211	7,8%
stator / rotor	Both	26,4	electrical steel			0,0%
bearings, shaft, fan shroud	Both	5,5	steel			0,0%
Frame	Both	20,5	cast iron			0,0%
rotor bars, end rings	Both	2,0	aluminium			0,0%
windings, leads	Both	4,9	copper			0,0%
terminal board, winding insulation	Both	0,1	insulation			0,0%
winding impregnation	Both	0,1	impregnation resin			0,0%
fan	Both	0,6	plastic			0,0%
paint	Both	0,3	paint			0,0%
permanent magnets	Both	0,0	[not used for this base case]			0,0%
Gear box	Traction					
worm shaft	Traction					0,0%
worm wheel	Traction					0,0%
bearings	Traction					0,0%
encasing	Traction					0,0%
seals	Traction					0,0%
oil	Traction					0,0%
paint	Traction					0,0%
Traction sheave	Traction					
sheave shaft	Traction					0,0%
sheave	Traction					0,0%
Brake	Traction					
frame	Traction					0,0%
electromagnetic coil	Traction					0,0%
springs	Traction					0,0%
brake drum	Traction					0,0%
brake shoe	Traction					0,0%
other	Traction					0,0%
Speed governor	Traction					
mount	Traction					0,0%
sheave	Traction					0,0%
spring	Traction					0,0%
other	Traction					0,0%
Bedplate	Traction					
Controller	Both	75,2		20	1.816	11,7%
cabinet	Both	38,0	sheet steel			0,0%
paint	Both	1,2	paint			
Electronics	Both	23,9	PCB, SMDs, Chips			0,0%
Wiring	Both	6,0	copper/plastic			
electromechanichal switches	Both	5,0	plastic			0,0%
electromechanichal switches	Both	0,1	copper			0,0%
Guide rails	Both	376,9		25	1.816	11,7%
rails car	Both	211,9	steel (T70) [8.83kg/m]			0,0%
rails counterweight	Traction					0,0%
brackets (every 2m)	Both	165,0	steel			0,0%
Car	Both	315,5		30,0	2.422	15,6%
car sling structure	Both	40,0	steel			0,0%
guide Shoes	Both	20,0	cast iron			0,0%
car walls / roof	Both	175,0	Stainless steel sheet			0,0%
platform	Both	40,0	steel			0,0%

Table 4-6: Detailed BOM for BaseCase1B – Part 2 (source: project team with input from stakeholders)

Base Case ID		Base Case 1B
Type		hydraulic
Rated load (Q) in [kg]		320
Rise [m]		12
Number of floors [-]		4
Nominal speed (m/s)		0,7
Roping		n.a.
Nb of daily trips (nd) [-]		50
Usage Category		1
Average travel distance [-]		49%
Average car load [-]		7,5%
Number of operating days per year [days/year]		365
Designed service life [years]		25
FU [tkm]		64,4

	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
glass/mirror	Both	5,0	glass			0,0%
hand rail	Both	5,0	steel tube			0,0%
floor	Both		vinyl/stone			0,0%
lighting	Both	0,5	LED [LED Spots, 0.130 each]			0,0%
other (e.g. decorations, nuts and bolts, linings, etc)	Both	30,0	What is the main material of this sub-category?			0,0%
Car Door	Both	60,0	steel sheet	20	363	2,3%
Landing Doors	Both	240,0	steel sheet [x4]	20	605	3,9%
Car Door Operators	Both	3,7		20	363	2,3%
motor	Both	1,5	will be completed by the study team			0,0%
belt	Both	0,2	rubber			0,0%
pulleys	Both	0,5	abs plastic			0,0%
controller	Both	1,5	pcb			0,0%
Diverter pulleys	Both				363	2,3%
Ropes	Both	0,0		20	605	3,9%
hoisting (4x15mx d8mm) single wrap	Both					0,0%
governor	Both					0,0%
Landing indicators and buttons	Both	1,0		15	605	3,9%
LEDs	Both		LED			0,0%
buttons	Both	0,1	plastic			0,0%
panel	Both	0,5	steel sheet			0,0%
PCB (Printed Circuit Board)	Both	0,2	PCB			0,0%
SMDs (Surface Mounted Devices)	Both		SMD			0,0%
wiring	Both	0,2	copper			0,0%
Car indicators and buttons	Both	8,8		15	363	2,3%
LEDs	Both		LED			0,0%
buttons	Both	1,0	plastic			0,0%
panel	Both	7,0	steel sheet			0,0%
PCB	Both	0,5	PCB			0,0%
SMDs	Both		SMD			0,0%
wiring	Both	0,3	copper			0,0%
Counterweight	Traction					
counterweight frame	Traction					0,0%
counterweights	Traction					0,0%
Cylinder/Piston	Hydraulic	108,0	steel tube [9kg/m]	25	1.816	11,7%
Pump	Hydraulic	5,8		30	1.816	11,7%
casing	Hydraulic	2,5	cast iron			0,0%
shaft	Hydraulic	1,0	steel			0,0%
screw	Hydraulic	1,8	steel			0,0%
bearings	Hydraulic	0,5	steel			0,0%
Control Valve	Hydraulic	18,0	cast iron	25	605	3,9%
Cabinet	Hydraulic	10,0	steel sheet	30	363	2,3%
Oil	Hydraulic	58,5	hydraulic fluid	10	363	2,3%
Buffer	Both	14,0	steel	25		
Hoistway Wiring	Both	40,0	copper wire	30		
Intercom	Both	1,0		20		

Table 4-7: Detailed BOM for BaseCase2A – Part 1 (source: project team with input from stakeholders)

Base Case ID		Base Case 2A
Type		traction
Rated load (Q) in [kg]		630
Rise [m]		12
Number of floors [-]		4
Nominal speed (m/s)		0,7
Roping		1:1
Nb of daily trips (nd) [-]		125
Usage Category		2
Average travel distance [-]		49%
Average car load [-]		7,5%
Number of operating days per year [days/year]		365
Designed service life [years]		25
FU [tkm]		316,9

	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
Lift: Entire system	Both	2.552			21.500	100%
Electric Motor	**Both**	82,5	Motor [3-phase AC Induction]	30	1.720	8,0%
stator / rotor	Both	35,5	electrical steel			0,0%
bearings, shaft, fan shroud	Both	7,5	steel			0,0%
Frame	Both	28,6	cast iron			0,0%
rotor bars, end rings	Both	2,8	aluminium			0,0%
windings, leads	Both	6,5	copper			0,0%
terminal board, winding insulation	Both	0,1	insulation			0,0%
winding impregnation	Both	0,2	impregnation resin			0,0%
fan	Both	0,9	plastic			0,0%
paint	Both	0,4	paint			0,0%
permanent magnets	Both	0,0	[not used for this base case]			0,0%
Gear box	Traction	28,0		30	1.720	8,0%
worm shaft	Traction	5,5	steel alloy			0,0%
worm wheel	Traction	3,8	bronze			0,0%
bearings	Traction	3,0	alloy steel			0,0%
encasing	Traction	9,0	cast iron			0,0%
seals	Traction	0,2	rubber			0,0%
oil	Traction	6,3	Oil			0,0%
paint	Traction	0,2	paint			0,0%
Traction sheave	Traction	50,0		30	860	4,0%
sheave shaft	Traction	20,0	steel alloy			0,0%
sheave	Traction	30,0	cast iron			0,0%
Brake	Traction	13,1		30	1.720	8,0%
frame	Traction	4,0	steel			0,0%
electromagnetic coil	Traction	2,0	copper winding			0,0%
springs	Traction	0,8	steel			0,0%
brake drum	Traction	3,0	steel			0,0%
brake shoe	Traction	1,5				0,0%
other	Traction	1,8	steel			0,0%
Speed governor	Traction	14,2		30	860	4,0%
mount	Traction	6,0	steel			0,0%
sheave	Traction	6,0	cast iron			0,0%
spring	Traction	0,2	steel			0,0%
other	Traction	2,0	steel			0,0%
Bedplate	Traction	35,0	steel	30	860	4,0%
Controller	Both	72,3		20	2.580	12,0%
cabinet	Both	24,0	sheet steel			0,0%
paint	Both	1,2	paint			
Electronics	Both	35,0	PCB, SMDs, Chips			0,0%
Wiring	Both	7,0	copper/plastic			
electromechanichal switches	Both	5,0	plastic			0,0%
electromechanichal switches	Both	0,1	copper			0,0%
Guide rails	Both	674,0		25	2.580	12,0%
rails car	Both	297,1	steel (T89) [12.38kg/m]			0,0%
rails counterweight	Traction	211,9	steel (T70) [8.83kg/m]			0,0%
brackets (every 2m)	Both	165,0	steel			0,0%
Car	Both	450,6		30	3.440	16,0%
car sling structure	Both	61,8	steel			0,0%
guide Shoes	Both	20,0	cast iron			0,0%
car walls / roof	Both	150,0	Stainless steel sheet			0,0%
platform	Both	130,0	steel			0,0%

Table 4-8: Detailed BOM for BaseCase2A – Part 2 (source: project team with input from stakeholders)

Base Case ID		Base Case 2A
Type		traction
Rated load (Q) in [kg]		630
Rise [m]		12
Number of floors [-]		4
Nominal speed (m/s)		0,7
Roping		1:1
Nb of daily trips (nd) [-]		125
Usage Category		2
Average travel distance [-]		49%
Average car load [-]		7,5%
Number of operating days per year [days/year]		365
Designed service life [years]		25
FU [tkm]		316,9

	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
glass/mirror	Both	10,0	glass			0,0%
hand rail	Both	8,0	steel tube			0,0%
floor	Both	30,0	vinyl/stone			0,0%
lighting	Both	0,8	LED (6x)			0,0%
other (e.g. decorations, nuts and bolts, linings, etc)	Both	40,0	What is the main material of this sub-category?			0,0%
Car Door	Both	70,0	steel sheet	20	516	2,4%
Landing Doors	Both	280,0	steel sheet	20	860	4,0%
Car Door Operators	Both	3,7		20	516	2,4%
motor	Both	1,5				0,0%
belt	Both	0,2	rubber			0,0%
pulleys	Both	0,5	abs plastic			0,0%
controller	Both	1,5	pcb			0,0%
Diverter pulleys	Both	15,0	cast iron	20	516	2,4%
Ropes	Both	23,1		20	860	4,0%
hoisting (4x15mx d8mm) single wrap	Both	19,8	steel			0,0%
governor	Both	3,3	steel			0,0%
Landing indicators and buttons	Both	1,0		15	860	4,0%
LEDs	Both		LED			0,0%
buttons	Both	0,1	plastic			0,0%
panel	Both	0,5	steel sheet			0,0%
PCB (Printed Circuit Board)	Both	0,2	PCB			0,0%
SMDs (Surface Mounted Devices)	Both		SMD			0,0%
wiring	Both	0,2	copper			0,0%
Car indicators and buttons	Both	8,8		15	516	2,4%
LEDs	Both		LED			0,0%
buttons	Both	1,0	plastic			0,0%
panel	Both	7,0	steel sheet			0,0%
PCB	Both	0,5	PCB			0,0%
SMDs	Both		SMD			0,0%
wiring	Both	0,3	copper			0,0%
Counterweight	Traction	675,0		30	516	2,4%
counterweight frame	Traction	50,0	steel			
counterweights	Traction	625,0	cast iron /concrete			
Cylinder/Piston	Hydraulic					
Pump	Hydraulic					
casing	Hydraulic					
shaft	Hydraulic					
screw	Hydraulic					
bearings	Hydraulic					
Control Valve	Hydraulic					
Cabinet	Hydraulic					
Oil	Hydraulic					
Buffer	Both	15,0	steel	25		
Hoistway Wiring	Both	40,0	copper wire	30		
Intercom	Both	1,0		20		

Table 4-9: Detailed BOM for BaseCase2B – Part 1 (source: project team with input from stakeholders)

Base Case ID		Base Case 2B
Type		hydraulic
Rated load (Q) in [kg]		630
Rise [m]		12
Number of floors [-]		4
Nominal speed (m/s)		0,7
Roping		n.a.
Nb of daily trips (nd) [-]		125
Usage Category		2
Average travel distance [-]		49%
Average car load [-]		7,5%
Number of operating days per year [days/year]		365
Designed service life [years]		25
FU [tkm]		316,9

	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
Lift: Entire system	Both	1.770			19.000	100%
Electric Motor	**Both**	93,0	Motor [3-phase AC Induction]	30	1.484	7,8%
stator / rotor	Both	40,7	electrical steel			0,0%
bearings, shaft, fan shroud	Both	8,5	steel			0,0%
Frame	Both	31,6	cast iron			0,0%
rotor bars, end rings	Both	3,1	aluminium			0,0%
windings, leads	Both	7,5	copper			0,0%
terminal board, winding insulation	Both	0,1	insulation			0,0%
winding impregnation	Both	0,2	impregnation resin			0,0%
fan	Both	0,9	plastic			0,0%
paint	Both	0,4	paint			0,0%
permanent magnets	Both	0,0	[not used for this base case]			0,0%
Gear box	Traction					
worm shaft	Traction					0,0%
worm wheel	Traction					0,0%
bearings	Traction					0,0%
encasing	Traction					0,0%
seals	Traction					0,0%
oil	Traction					0,0%
paint	Traction					0,0%
Traction sheave	Traction					
sheave shaft	Traction					0,0%
sheave	Traction					0,0%
Brake	Traction					
frame	Traction					0,0%
electromagnetic coil	Traction					0,0%
springs	Traction					0,0%
brake drum	Traction					0,0%
brake shoe	Traction					0,0%
other	Traction					0,0%
Speed governor	Traction					
mount	Traction					0,0%
sheave	Traction					0,0%
spring	Traction					0,0%
other	Traction					0,0%
Bedplate	Traction					
Controller	Both	75,2		20	2.227	11,7%
cabinet	Both	38,0	sheet steel			0,0%
paint	Both	1,2	paint			
Electronics	Both	23,9	PCB, SMDs, Chips			0,0%
Wiring	Both	6,0	copper/plastic			
electromechanichal switches	Both	5,0	plastic			0,0%
electromechanichal switches	Both	0,1	copper			0,0%
Guide rails	Both	462,1		25	2.227	11,7%
rails car	Both	297,1	steel (T89) [12.38kg/m]			0,0%
rails counterweight	Traction					0,0%
brackets (every 2m)	Both	165,0	steel			0,0%
Car	Both	450,6		30	2.969	15,6%
car sling structure	Both	61,8	steel			0,0%
guide Shoes	Both	20,0	cast iron			0,0%
car walls / roof	Both	150,0	Stainless steel sheet			0,0%
platform	Both	130,0	steel			0,0%

Table 4-10: Detailed BOM for BaseCase2B – Part 2 (source: project team with input from stakeholders)

Base Case ID	Base Case 2B
Type	hydraulic
Rated load (Q) in [kg]	630
Rise [m]	12
Number of floors [-]	4
Nominal speed (m/s)	0,7
Roping	n.a.
Nb of daily trips (nd) [-]	125
Usage Category	2
Average travel distance [-]	49%
Average car load [-]	7,5%
Number of operating days per year [days/year]	365
Designed service life [years]	25
FU [tkm]	316,9

	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
glass/mirror	Both	10,0	glass			0,0%
hand rail	Both	8,0	steel tube			0,0%
floor	Both	30,0	vinyl/stone			0,0%
lighting	Both	0,8	LED (6x)			0,0%
other (e.g. decorations, nuts and bolts, linings, etc)	Both	40,0	What is the main material of this sub-category?			0,0%
Car Door	Both	70,0	steel sheet	20	445	2,3%
Landing Doors	Both	280,0	steel sheet	20	742	3,9%
Car Door Operators	Both	3,7		20	445	2,3%
motor	Both	1,5				0,0%
belt	Both	0,2	rubber			0,0%
pulleys	Both	0,5	abs plastic			0,0%
controller	Both	1,5	pcb			0,0%
Diverter pulleys	Both				445	2,3%
Ropes	Both	0,0		20	742	3,9%
hoisting (4x15mx d8mm) single wrap	Both		steel			0,0%
governor	Both		steel			0,0%
Landing indicators and buttons	Both	1,0		15	742	3,9%
LEDs	Both		LED			0,0%
buttons	Both	0,1	plastic			0,0%
panel	Both	0,5	steel sheet			0,0%
PCB (Printed Circuit Board)	Both	0,2	PCB			0,0%
SMDs (Surface Mounted Devices)	Both		SMD			0,0%
wiring	Both	0,2	copper			0,0%
Car indicators and buttons	Both	8,8		15	445	2,3%
LEDs	Both		LED			0,0%
buttons	Both	1,0	plastic			0,0%
panel	Both	7,0	steel sheet			0,0%
PCB	Both	0,5	PCB			0,0%
SMDs	Both		SMD			0,0%
wiring	Both	0,3	copper			0,0%
Counterweight	Traction					
counterweight frame	Traction					0,0%
counterweights	Traction					0,0%
Cylinder/Piston	Hydraulic	144,0	steel tube	25	2.227	11,7%
Pump	Hydraulic	7,6		30	2.227	11,7%
casing	Hydraulic	3,2	cast iron			0,0%
shaft	Hydraulic	1,5	steel			0,0%
screw	Hydraulic	2,2	steel			0,0%
bearings	Hydraulic	0,7	steel			0,0%
Control Valve	Hydraulic	18,0	cast iron	25	742	3,9%
Cabinet	Hydraulic	10,0	steel sheet	30	445	2,3%
Oil	Hydraulic	90,0	hydraulic fluid	10	445	2,3%
Buffer	Both	15,0	steel	25		
Hoistway Wiring	Both	40,0	copper wire	30		2,3%
Intercom	Both	1,0		20		

Table 4-11: Detailed BOM for BaseCase3 – Part 1 (source: project team with input from stakeholders)

Base Case ID	Base Case 3
Type	traction
Rated load (Q) in [kg]	630
Rise [m]	21
Number of floors [-]	7
Nominal speed (m/s)	1
Roping	1:1
Nb of daily trips (nd) [-]	300
Usage Category	3
Average travel distance [-]	49%
Average car load [-]	7,5%
Number of operating days per year [days/year]	365
Designed service life [years]	25
FU [tkm]	1331,0

	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
Lift: Entire system	Both	3.306			28.500	100%
Electric Motor	**Both**	82,5	Motor [3-phase AC Induction]	30	2.280	8,0%
stator / rotor	Both	35,5	electrical steel			0,0%
bearings, shaft, fan shroud	Both	7,5	steel			0,0%
Frame	Both	28,6	cast iron			0,0%
rotor bars, end rings	Both	2,8	aluminium			0,0%
windings, leads	Both	6,5	copper			0,0%
terminal board, winding insulation	Both	0,1	insulation			0,0%
winding impregnation	Both	0,2	impregnation resin			0,0%
fan	Both	0,9	plastic			0,0%
paint	Both	0,4	paint			0,0%
permanent magnets	Both	0,0	[not used for this base case]			0,0%
Gear box	Traction	28,0		30	2.280	8,0%
worm shaft	Traction	5,5	steel alloy			0,0%
worm wheel	Traction	3,8	bronze			0,0%
bearings	Traction	3,0	alloy steel			0,0%
encasing	Traction	9,0	cast iron			0,0%
seals	Traction	0,2	rubber			0,0%
oil	Traction	6,3	Oil			0,0%
paint	Traction	0,2	paint			0,0%
Traction sheave	Traction	50,0		30	1.140	4,0%
sheave shaft	Traction	20,0	steel alloy			0,0%
sheave	Traction	30,0	cast iron			0,0%
Brake	Traction	13,1		30	2.280	8,0%
frame	Traction	4,0	steel			0,0%
electromagnetic coil	Traction	2,0	copper winding			0,0%
springs	Traction	0,8	steel			0,0%
brake drum	Traction	3,0	steel			0,0%
brake shoe	Traction	1,5				0,0%
other	Traction	1,8	steel			0,0%
Speed governor	Traction	14,2		30	1.140	4,0%
mount	Traction	6,0	steel			0,0%
sheave	Traction	6,0	cast iron			0,0%
spring	Traction	0,2	steel			0,0%
other	Traction	2,0				0,0%
Bedplate	Traction	35,0	steel	30	1.140	4,0%
Controller	Both	72,3		20	3.420	12,0%
cabinet	Both	24,0	sheet steel			0,0%
paint	Both	1,2	paint			
Electronics	Both	35,0	PCB, SMDs, Chips			0,0%
Wiring	Both	7,0	copper/plastic			
electromechanichal switches	Both	5,0	plastic			0,0%
electromechanichal switches	Both	0,1	copper			0,0%
Guide rails	Both	1.178,8		25	3.420	12,0%
rails car	Both	520,0	steel (T89) [12.38kg/m]			0,0%
rails counterweight	Traction	370,9	steel (T70) [8.83kg/m]			0,0%
brackets (every 2m)	Both	288,0	steel			0,0%
Car	Both	450,6		30	4.560	16,0%
car sling structure	Both	61,8	steel			0,0%
guide Shoes	Both	20,0	cast iron			0,0%
car walls / roof	Both	150,0	Stainless steel sheet			0,0%
platform	Both	130,0	steel			0,0%

Table 4-12: Detailed BOM for BaseCase3 – Part 2 (source: project team with input from stakeholders)

Base Case ID		Base Case 3
Type		traction
Rated load (Q) in [kg]		630
Rise [m]		21
Number of floors [-]		7
Nominal speed (m/s)		1
Roping		1:1
Nb of daily trips (nd) [-]		300
Usage Category		3
Average travel distance [-]		49%
Average car load [-]		7,5%
Number of operating days per year [days/year]		365
Designed service life [years]		25
FU [tkm]		1331,0

	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
glass/mirror	Both	10,0	glass			0,0%
hand rail	Both	8,0	steel tube			0,0%
floor	Both	30,0	vinyl/stone			0,0%
lighting	Both	0,8	LED (6x)			0,0%
other (e.g. decorations, nuts and bolts, linings, etc)	Both	40,0	What is the main material of this sub-category?			0,0%
Car Door	Both	70,0	steel sheet	20	684	2,4%
Landing Doors	Both	490,0	steel sheet	20	1.140	4,0%
Car Door Operators	Both	3,7		20	684	2,4%
motor	Both	1,5				0,0%
belt	Both	0,2	rubber			0,0%
pulleys	Both	0,5	abs plastic			0,0%
controller	Both	1,5	pcb			0,0%
Diverter pulleys	Both	15,0	cast iron	20	684	2,4%
Ropes	Both	35,0		20	1.140	4,0%
hoisting (4x15mx d8mm) single wrap	Both	30,4	steel			0,0%
governor	Both	4,6	steel			0,0%
Landing indicators and buttons	Both	1,8		15	1.140	4,0%
LEDs	Both		LED			0,0%
buttons	Both	0,2	plastic			0,0%
panel	Both	0,9	steel sheet			0,0%
PCB (Printed Circuit Board)	Both	0,4	PCB			0,0%
SMDs (Surface Mounted Devices)	Both		SMD			0,0%
wiring	Both	0,4	copper			0,0%
Car indicators and buttons	Both	10,0		15	684	2,4%
LEDs	Both		LED			0,0%
buttons	Both	1,2	plastic			0,0%
panel	Both	8,0	steel sheet			0,0%
PCB	Both	0,5	PCB			0,0%
SMDs	Both		SMD			0,0%
wiring	Both	0,3	copper			0,0%
Counterweight	Traction	670,0		30	684	2,4%
counterweight frame	Traction	50,0	steel			
counterweights	Traction	620,0				
Cylinder/Piston	Hydraulic					
Pump	Hydraulic					
casing	Hydraulic					
shaft	Hydraulic					
screw	Hydraulic					
bearings	Hydraulic					
Control Valve	Hydraulic					
Cabinet	Hydraulic					
Oil	Hydraulic					
Buffer	Both	15,0	steel	25		
Hoistway Wiring	Both	70,0	copper wire	30		
Intercom	Both	1,0		20		

Table 4-13: Detailed BOM for BaseCase4 – Part 1 (source: project team with input from stakeholders)

Base Case ID		Base Case 4
Type		traction
Rated load (Q) in [kg]		1200
Rise [m]		30
Number of floors [-]		10
Nominal speed (m/s)		1,6
Roping		2:1
Nb of daily trips (nd) [-]		750
Usage Category		4
Average travel distance [-]		44%
Average car load [-]		6,0%
Number of operating days per year [days/year]		365
Designed service life [years]		25
FU [tkm]		6504,3

	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
Lift: Entire system	Both	5.968			45.000	100%
Electric Motor	**Both**	268,0	268 kg [T32L.400.16]	30	3.913	8,7%
stator / rotor	Both	110,7	electrical steel			0,0%
bearings, shaft, fan shroud	Both	23,4	steel			0,0%
Frame	Both	89,2	cast iron			0,0%
rotor bars, end rings	Both	8,7	aluminium			0,0%
windings, leads	Both	20,3	copper			0,0%
terminal board, winding insulation	Both	0,4	insulation			0,0%
winding impregnation	Both	0,5	impregnation resin			0,0%
fan	Both	2,7	plastic			0,0%
paint	Both	1,3	paint			0,0%
permanent magnets	Both	10,7	NeFeB			0,0%
Gear box	Traction		Gearless		0	
worm shaft	Traction					0,0%
worm wheel	Traction					0,0%
bearings	Traction					0,0%
encasing	Traction					0,0%
seals	Traction					0,0%
oil	Traction					0,0%
paint	Traction					0,0%
Traction sheave	Traction	30,0		30	1.957	4,3%
sheave shaft	Traction	12,0	steel alloy			0,0%
sheave	Traction	18,0	cast iron			0,0%
Brake	Traction	23,5		30	3.913	8,7%
frame	Traction	8,0	steel			0,0%
electromagnetic coil	Traction	3,5	copper winding			0,0%
springs	Traction	1,2	steel			0,0%
brake drum	Traction	6,0	steel			0,0%
brake shoe	Traction	3,0				0,0%
other	Traction	1,8	steel			0,0%
Speed governor	Traction	14,2		30	1.957	4,3%
mount	Traction	6,0	steel			0,0%
sheave	Traction	6,0	cast iron			0,0%
spring	Traction	0,2	steel			0,0%
other	Traction	2,0				0,0%
Bedplate	Traction	70,0	steel	30	1.957	4,3%
Controller	Both	99,5		20	5.870	13,0%
cabinet	Both	38,0	sheet steel			0,0%
paint	Both	1,5	paint			
Electronics	Both	45,0	PCB, SMDs, Chips			0,0%
Wiring	Both	9,0	copper/plastic			
electromechanichal switches	Both	5,0	plastic			0,0%
electromechanichal switches	Both	1,0	copper			0,0%
Guide rails	Both	1.754,2		25	5.870	13,0%
rails car	Both	812,4	steel (T90) [13.54kg/m]			0,0%
rails counterweight	Traction	529,8	steel (T70) [8.83kg/m]			0,0%
brackets (every 2m)	Both	412,0	steel			0,0%
Car	Both	719,0		30	7.826	17,4%
car sling structure	Both	98,0	steel			0,0%
guide Shoes	Both	30,0	cast iron			0,0%
car walls / roof	Both	300,0	Stainless steel sheet [den. 8kg/dm3]			0,0%
platform	Both	200,0	steel			0,0%

Table 4-14: Detailed BOM for BaseCase4 – Part 2 (source: project team with input from stakeholders)

Base Case ID		Base Case 4
Type		traction
Rated load (Q) in [kg]		1200
Rise [m]		30
Number of floors [-]		10
Nominal speed (m/s)		1,6
Roping		2:1
Nb of daily trips (nd) [-]		750
Usage Category		4
Average travel distance [-]		44%
Average car load [-]		6,0%
Number of operating days per year [days/year]		365
Designed service life [years]		25
FU [tkm]		6504,3

	Lift type	Weight [kg]	Material	Technical Lifetime [years]	Hardware Price [EUR]	Price Share [%]
glass/mirror	Both	10,0	glass			0,0%
hand rail	Both	10,0	steel tube			0,0%
floor	Both	30,0	vinyl/stone			0,0%
lighting	Both	1,0	LED (8x)			0,0%
other (e.g. decorations, nuts and bolts, linings, etc)	Both	40,0	What is the main material of this sub-category?			0,0%
Car Door	Both	120,0		20	1.174	2,6%
Landing Doors	Both	1.200,0	steel sheet	20	1.957	4,3%
Car Door Operators	Both	7,4	[127.81kg]	20	1.174	2,6%
motor	Both	3,0	[5kg (each) x 10]			0,0%
belt	Both	0,4	rubber			0,0%
pulleys	Both	1,0	abs plastic			0,0%
controller	Both	3,0	pcb			0,0%
Diverter pulleys	Both	100,0	cast iron	20	1.174	2,6%
Ropes	Both	115,0		20	1.957	4,3%
hoisting (4x15mx d8mm) single wrap	Both	108,0	steel			0,0%
governor	Both	7,0	steel			0,0%
Landing indicators and buttons	Both	2,5		15	1.957	4,3%
LEDs	Both		LED			0,0%
buttons	Both	0,3	plastic			0,0%
panel	Both	1,3	steel sheet			0,0%
PCB (Printed Circuit Board)	Both	0,5	PCB			0,0%
SMDs (Surface Mounted Devices)	Both		SMD			0,0%
wiring	Both	0,5				0,0%
Car indicators and buttons	Both	12,8		15	1.174	2,6%
LEDs	Both		LED			0,0%
buttons	Both	1,0	plastic			0,0%
panel	Both	11,0	steel sheet			0,0%
PCB	Both	0,5	PCB			0,0%
SMDs	Both		SMD			0,0%
wiring	Both	0,3	copper			0,0%
Counterweight	Traction	1.314,0		30	1.174	2,6%
counterweight frame	Traction	80,0	steel			
counterweights	Traction	1.234,0				
Cylinder/Piston	Hydraulic					
Pump	Hydraulic					
casing	Hydraulic					
shaft	Hydraulic					
screw	Hydraulic					
bearings	Hydraulic					
Control Valve	Hydraulic					
Cabinet	Hydraulic					
Oil	Hydraulic					
Buffer	Both	17,0	steel	25		
Hoistway Wiring	Both	100,0	copper wire	30		
Intercom	Both	1,0		20		

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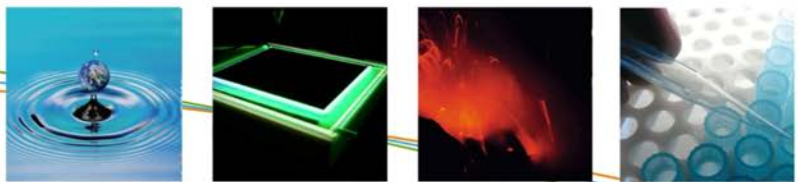

Table of contents: Task 5

List of Figures

List of Tables

List of Abbreviations and Acronyms

BC	Base-Case
BOM	Bill-of-Materials
EEA	European Elevator Association
ELA	European Lift Association
EPD	Environmental Product Declaration
EU	European Union
EU27	27 Member States of the European Union
EU28	28 Member States of the European Union
FU	Functional unit
GHG	Greenhous Gases
GWP	Global Warming Potential
LCA	Life Cycle Analysis
LCC	Life Cycle Costs
MEErP	Methodology for Ecodesign of Energy-related Products
NPV	Net Present Value
PAH	Polycyclic Aromatic Hydrocarbons
PAM	Particulate Matter
PCR	Product Category Rules
POP	Persistent Organic Pollutants
UPS	Uninterruptible Power Supply
VAT	Value Added Tax
VOC	Volatile Organic Compounds

5. Task 5 – Introduction

5.1. General objective of Task 5

The current Task 5 involves undertaking an environmental and economic assessment of the Base-Cases identified in Task 4 using the EcoReport tool (VHK, 2014). The EcoReport tool developed as part of the Methodology for the Ecodesign of Energy Related Products (MEErP) is used in all Ecodesign Preparatory Studies. The tool provides a streamlined life cycle assessment of the product, together with a life cycle cost assessment. The purpose of this assessment is to provide an indication of the representative environmental impacts of a typical product across the different life cycle phases. This allows the importance of a range of different environmental impacts and at different life cycle stages to be analysed. The EcoReport tool includes a set of parameters and calculations and a set of product specific inputs have been developed in order to generate the environmental and cost assessment outputs.

Task 5 comprises the following subtasks:

- Subtask 5.1 - Product specific inputs
- Subtask 5.2 - Base-Case Environmental Impact Assessment (using EcoReport 2014)
- Subtask 5.3 - Base-Case Life Cycle Cost for consumers
- Subtask 5.4 - EU totals

Task 5 collects from the previous tasks the most appropriate information for each of the Base-Cases. Using the EcoReport tool and the above inputs, the emission/resources categories in MEErP format are calculated for the different life cycle stages of a lift and for the different Base-Cases. In addition, the Life Cycle Costs for consumers are calculated. Subsequently the Base-Case environmental impact data and the Life Cycle Cost data will be aggregated to EU-28 level, using stock and market data from Task 2.

5.2. Subtask 5.1- Product specific inputs

This section collects all the relevant quantitative Base-Case information from previous tasks which is needed for the life cycle assessment and life cycle costing.

5.2.1. Selection of Base-Cases

In total 6 Bases-Cases have been selected, which cover almost the entire market. An overview of the 6 Base-Cases is available in Table 5-3.

The functional unit (FU) has been calculated according to the requirements of the Product Category Rules (PCR) for lifts (environdec, 2015). The functional unit aims to quantify the performance of the product "lift" for use as a reference unit. It can accordingly be defined as the transportation of a load over a distance travelled during the service life and expressed in mass [t] multiplied with distance [km] i.e. as [t.km]. More details about the calculation of the FU are available in Task 1.

Table 5-1: Overview of selected Base-Case lifts

	Base-Case 1A	Base-Case 1B	Base-Case 2A	Base-Case 2B	Base-Case 3	Base-Case 4
Type	Gearless traction	hydraulic	Gearless traction	hydraulic	Gearless traction	Gearless traction
Rated load (Q) in [kg]	450	450	630	630	1000	1 250
Rise [m]	12	12	12	12	21	30
Number of floors [-]	4	4	4	4	7	10
No. of daily trips (nd) [-]	50	50	125	125	300	750
Usage category	1	1	2	2	3	4
Average travel distance [-]	49%	49%	49%	49%	49%	44%
Average car load [-]	7.5%	7.5%	7.5%	7.5%	4.5%	6.0%
Number of operating days per year [days/year]	360	360	360	360	360	360
Designed service life [years]	25	25	25	25	25	25
FU [tkm]	89.3	89.3	312.6	312.6	1 250.2	6 682.5

5.2.2. The most appropriate standards from Task 1

The standard used for the calculations of energy demand in use and idle mode is the ISO 25745-2:2015: Energy performance of lifts, escalators and moving walks -- Part 2: Energy calculation and classification for lifts (elevators).

5.2.3. Economic parameters and product service life from Task 2

5.2.3.1. Sales, stock and product service life

Sales

The apparent consumption of lifts in 2015 was 127 795 units according to PRODCOM, which fits well with the data reported by ELA (see task 2).

Stock

According to EEA (European Elevator Association), the number of existing lifts (stock) in Europe is 5 700 000 units (EEA – see task 2 report), while ELA (European Lift Association) estimates the stock in 2016 at 5 947 982 units (source ELA – see task 2 – table 2-4). The stock model, compiled in task 2, gives a stock of 5 403 180 units for the year 2015. The value for the European stock used in the calculations of task 5 is the value used in the stock model of task 2 (5 403 180 units).

Product service life

A product service life of 25 years has been used for the LCA and LCC calculations[1].

Table 5-4 gives an overview of sales, stock and service life for the six Base-Cases.

The stock model also contains types of lifts which are not covered by any of the Base-Cases. These are hydraulic lifts of usage category 3, 4 and 5 and traction lifts of usage category 5 and 6. Out of the 2015 stock of 5 403 180 units, 738 545 units are lift types different to any of the six Base-Cases.

Sales per Base-Case are calculated based on the stock share of the Base-Cases. The total sales considered for this calculation is 127 795 units. In analogy with the stock, 17 468 units are not covered by any of the defined Base-Cases.

[1] Remark: the stock model in task 2 revealed a current service life of 68 years.

Table 5-2: Overview of sales, stock and service life for the 6 Base-Cases

Base-Case	Sales	Stock (2015)	Service life (LCA and LCC)
1A	3 182	134 530	25
1B	2 433	102 851	25
2A	34 920	1 476 430	25
2B	12 970	548 360	25
3	29 317	1 239 511	25
4	27 506	1 162 953	25
Total	110 327	4 664 635	

5.2.3.2.Purchase price and repair and maintenance cost

The average computed manufacturer lift prices from PRODCOM data (13 889 euro) seem too low (see task 2). This is probably explicable because the price excludes installation costs. According to ELA, there were 139 000 new units installed in 2016 which corresponds to a market value of €5,1 billion, or on average 36 690 euro per elevator (see task 2 report).

PRODCOM values have not been used in this study. The authors made estimates of hardware prices and installation prices for the different Base-Cases. The estimates are provided in Table 5-5. Estimates of hardware price and installation costs have been made available to stakeholders for feedback. Due to the competition and anti-trust laws stakeholders were not able to provide feedback on prices.

Table 5-5 contains estimates of maintenance (including inspection and repairs) of the lifts during the 25 years life span of the lifts. For Base-Case 1A, 1B, 2A and 2B, two inspections per year have been considered. This number is based on the Belgian Royal Decree for lifts (KB 9 March 2003 concerning the security of lifts (modified decree of 10 December 2011). Article 6 mentions that maintenance should be performed according to the instructions of the manufacturer. If no instructions are available, a preventive maintenance should take place at least once every year for privately owned lifts and two times a year for other lifts. A preventive inspection should take place once a year plus an additional inspection checking a few points. Mandatory in total are at least 1 maintenance and 1 inspection + additional inspection on a few points. It has been assumed that the minimum amount of service trips applies to Base-Cases 1 and 2. The additional inspection on a few points is assumed to be included in the cost for the inspection.

For Base-Case 3 and 4 respectively four and six inspections per year have been considered. The average cost of an inspection is estimated at 400 euro for Base-Case 1A, 1B, 2A and 2B; 600 euro for Base-Case 3 and 800 euro for Base-Case 4. These are estimates from the authors.

The overall cost for repair, maintenance and inspections is provided in the last column of Table 5-5. A more detailed breakdown of the repair and maintenance costs is available in Annex A. The repair, maintenance and inspection costs presented in this table are total costs, not Net Present Values.

Table 5-3: Estimated purchase price, installation cost and repair and maintenance cost for the lift Base-Cases (not discounted)

Base-Case	Price (hardware) [€]	Installation cost [€]	Repair, maintenance and inspection cost [€]	EoL decommissioning and scrap value [€]
1A	17 000	15 000	35 270	11 538
1B	15 500	15 000	32 394	11 647
2A	21 500	17 000	41 067	11 476
2B	19 000	17 000	38 060	11 918
3	28 500	17 000	91 093	11 800
4	45 000	22 000	165 014	10 750

5.2.3.3. Other economic parameters

The electricity prices applied in the analysis are based on PRIMES (see Task 2, paragraph 2.4).

The PRIMES series of electricity prices since 2015 (year 1) are provided in Figure 5-1.

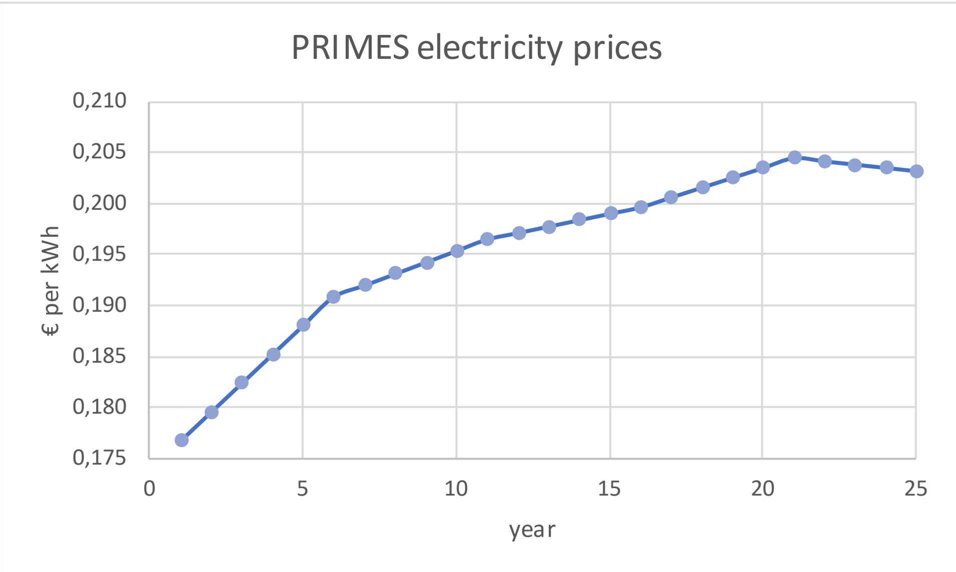

Figure 5-1: PRIMES electricity prices

The discount rate is set at 4%, following the rules for EU impact assessments.

5.2.4. Use phase aspects taken from Task 3

The energy demand for each Base-Case is calculated according to the method set out in ISO 25745-2:2015.

Some of the necessary parameters for the energy demand calculation are made available in Table 5-3. The remaining parameters, necessary for the calculation of energy consumption in standby mode and during travel are presented in Annex B.

The number of operating days per year is 360 days for each of the Base-Cases (see Table 5-3).

Table 5-6 gives an overview of the energy consumption per Base-Case.

Table 5-4: Daily non-running energy consumption, daily running energy consumption and total annual energy consumption

Base-Case	Daily running-mode energy consumption [Wh]	Daily non-running-mode [idle/standby] energy consumption [Wh]	Annual energy consumption [kWh]
1A	202	1 339	555
1B	476	1 340	654
2A	693	1 868	922
2B	1 672	1 868	1 274
3	3 261	2 277	1 994
4	12 920	2 459	5 536

5.2.5.Product life cycle information from Task 4

5.2.5.1. Production phase

The material fractions of lift components (BOMs) for the lifts representing the average products on the market in the reference year 2015 are presented in Task 4. The values are derived from stakeholder input, product catalogues, existing environmental product declarations and other LCA studies on lift products or components.

The lift components and their estimated weight and life time per Base-Case are provided in Table 5-7. A detailed overview of the materials used in each of the components, their weight and the eco-indicator used to model the materials with, is provided in Annex C.

A product service life of 25 years has been considered for the LCA and LCC calculations. Components with a lower technical life time need replacement during the product service life. These components are:

- Controller - partly (1x)
- Car door operators (1x)
- Diverter pulleys (1x)
- Ropes (1x to 3x depending on the Base-Case)
- Landing indicators and buttons (1x)
- Car indicators and buttons (1x)

- Oil (2x)
- Intercom (1x)

Table 5-7 provides the weight of one component per Base-Case. The components which need one replacement during the 25 years life span are considered twice in the calculations for the LCA. Oil is replaced every 10 years and the necessary amount of oil is thus considered 3 times. The ropes are replaced once in Base-Cases 1 and 2, two times in Base-Case 3 and three times in Base-Case 4. The controller is only partly replaced, only the PWB and electromechanical switches are replaced.

The final weight considered for each of the components is provided in Annex C.

Batteries and accumulators are not considered in this study. They have been investigated in the preparatory study on Uninterruptible Power Supplies (DG Energy, 2014)

Table 5-5: Overview of component weight and technical life time per Base-Case

Base case:	1A		1B		2A		2B		3		4	
Component	Weight [kg]	Technical lifetime	Weight [kg]	Technical lifetime	Weight [kg]	Technical lifetime	Weight [kg]	Technical lifetime	Weight [kg]	Technical lifetime	Weight [kg]	Technical lifetime
Electric Motor	117	30	60	30	154	30	93	30	205	30	250	30
Traction sheave	25	30	-	-	50	30	-	-	50	30	30	30
Brake	9	30	-	-	13	30	-	-	13	30	24	30
Speed governor	14	30	-	-	14	30	-	-	14	30	14	30
Bedplate	30	30	-	-	35	30	-	-	35	0	0	0
Controller	72	20	75	20	72	20	75	20	72	20	100	20
Guide rails	457	25	377	25	674	25	462	25	1.229	25	1.754	25
Car	328	30	328	30	451	30	451	30	641	30	719	30
Car Door	60	30	60	20	70	20	70	20	110	20	120	20
Landing Doors	300	30	300	20	350	20	350	20	880	20	1.320	20
Car Door Operators	4	20	4	20	4	20	4	20	4	20	7	20
Diverter pulleys	30	20	-	-	30	20	-	-	60	20	100	20
Ropes	46	20	-	-	67	20	-	-	147	10	223	7
Landing indicators and buttons	1	15	1	15	1	15	1	15	2	15	3	15
Car indicators and buttons	9	15	9	15	9	15	9	15	10	15	13	15
Counterweight	632	30	-	-	675	30	-	-	1.170	30	1.314	30
Cylinder/Piston	-	-	108	25	-	-	144	25	-	-	-	-
Pump	-	-	6	30	-	-	8	30	-	-	-	-
Control Valve	-	-	18	25	-	-	18	25	-	-	-	-
Cabinet	-	-	10	30	-	-	10	30	-	-	-	-
Oil	-	-	59	10	-	-	90	10	-	-	-	-
Buffer	14	25	14	25	15	25	15	25	15	25	17	25
Hoistway Wiring	40	30	40	30	40	30	40	30	70	30	100	30
Intercom	1	0	1	20	1	20	1	20	1	20	1	20
Total Weight [kg]	2.188		1.469		2.724		1.840		4.727		6.108	

5.2.5.2.Manufacturing phase

The EcoReport tool contains fixed impacts on weight basis for manufacturing of components. These data have been used in the study. The only variable that can be edited in this section is the percentage of sheet metal scrap. The default value given by the EcoReport tool is 25%. This value is reduced to 10%, which is a recommended value for folded sheets mentioned in the MEErP methodology report.

5.2.5.3. Distribution phase

For the distribution phase the EcoReport tool requires the volume of the final packaged product to be entered as an input. Based on this volume, the impact of transport of the product to the site of installation is calculated. The packaging volume of Base-Case 1A and 1B is 10 m^3, for 2A and 2B, the considered volume is 12.5 m^3, for Base-Case 3, the considered volume is 21.8 m^3 and for Base-Case 4, 28.1 m^3.

As can be seen in the environmental profile in section 5.3.1, the distribution phase is not very important, except for the impact category particulate matter.

5.2.5.4. Use phase

The main input for this phase is the electricity use during the 25 years technical life time of the lift. The estimated electrical energy consumption is provided in Table 5-6.

In addition to the electricity use, the MEErP also requires information to be input on the number of service trips during the 25 years technical life time of the lift and the average distance travelled during such a service trip. The assumptions on the number of inspection/maintenance visits are the same as considered in the LCC (see paragraph 5.2.3.2; two service trips per year for BC 1A, 1B, 2A and 2B; four service trips per year for BC 3 and six service trips per year for BC 4). The average travel distance for one service trip has been taken from an LCA study commissioned by ELCA and performed by ITA – Innova (2017). This study assumes an average travel distance of 30 km per service trip. This distance is used for all the considered Base-Cases.

MEErP assumes that the impact of spare parts is 1% of the impact of production of the materials and manufacturing of the components. This default assumption has not been changed for the current study.

Components which needs to be replaced are considered in the production phase (see sub-section 5.2.5.1).

Some use phase aspects are not covered by this study. The study does not cover possible effects of oil leakage to soil and effects and effects of direct VOC emissions from guide rail cleaning. It also does not consider accidental pollutions, as for example the possible leakage of oil during floods.

5.2.5.5. End-of-life

The default values from the MEErP EcoReport tool have been used for end-of-life modelling.

The main raw material used in lifts is steel, for which the fraction sent for recycling, which is taken to be 94% as the default value in the EcoReport tool, cannot be adapted as a function of the product considered.

The default values from the MEErP tool are kept for the fractions going to re-use, recycling, heat recovery, non-recoverable incineration, landfill.

5.3. Subtask 5.2 – Base-Case Environmental Impact Assessment (using EcoReport 2014)

5.3.1. Cradle-to-grave life cycle assessment

Life cycle environmental impacts have been calculated for the 6 Base-Cases using the EcoReport tool 2014. The data used are listed in the previous section (section 5.2). Two materials (hydraulic oil and permanent magnet) could not be modelled with the standard materials provided in the EcoReport tool and have now been added to it. The life cycle inventory data used to model these materials are described in Annex D.

Emission and resource use have been expressed in the impact categories which are required by the MEErP methodology for the life cycle stages:

- Raw Materials Use and Manufacturing;
- Distribution;
- Use phase;
- End-of-Life Phase.

In the sub-sections below the results are expressed as relative values (contribution of the life cycle phase to the total environmental impact). Absolute results for each Base-Case are provided in Annex E.

The graphs in the sub-sections below, show the environmental impact profile of the different Base-Cases. On the X-axis of the graphs the environmental impact categories to be considered in MEErP studies are given. The environmental impact categories have different units, so it is not possible to show the absolute values in one graph per Base-Case. In the graphs, the total environmental impact is set at 100% (production, distribution, use and end-of-life) per impact category. The bar is then split into the different life cycle stages and shows the importance of the life cycle stages per environmental indicator.

In this kind of graphs all impact categories look equally important to the product group, while this might not be the case.

5.3.1.1.1. Results for Base-Cases 1A and 1B: usage category 1

Figure 5-2 shows the environmental impact profile of the Base-Case 1A (traction lift, usage category 1). The use phase is the most important life cycle stage in the impact categories ‘Total energy’ and ‘VOC’. The impact in the use phase comes almost entirely from the electricity use during operation and standby of the lift. Idle-mode electricity use for this usage category is much higher than electricity use during operation (see Table 5-6). Other impacts which occur during the use phase are due to maintenance and repair. The impact of maintenance and repair is 1% of the impact of the production (default assumption MEErP EcoReport tool). So, the impact of the use phase from Base-Case 1A is almost fully attributed to the idle-mode electricity use.

The production phase is the most important life cycle phase for the impact categories ‘Global Warming Potential’, ‘Water’, ‘Waste (hazardous and non-hazardous)’, ‘Acidification’, ‘Persistent Organic Pollutants’ (POPs), ‘Heavy metals to air’, ‘Heavy metals to water’, ‘PAHs’ and ‘Eutrophication’.

POPs mainly come from the steel and iron parts. Per kg of material, ferrite has the highest amount of POP emissions (39 ng i-Teq), then the galvanized steel sheet (26 ng i-Teq), next the steel tube (12 ng i-Teq) and finally cast iron (6 ng i-Teq). The impact on POP will decrease if more cast iron is used instead of ferrite, galvanized steel or steel tube.

The impact from heavy metals to air, heavy metals to water and eutrophication mainly comes from the car walls and roof. They are made of stainless steel, which has a very high contribution per kg to this impact categories.

The distribution phase is the most important life cycle stage in the impact category ‘Particulate matter’. The impact in the distribution phase comes from transport of the packaged product.

Due to the recyclability of metals, the end-of-life phase has a positive contribution to the environmental profile.

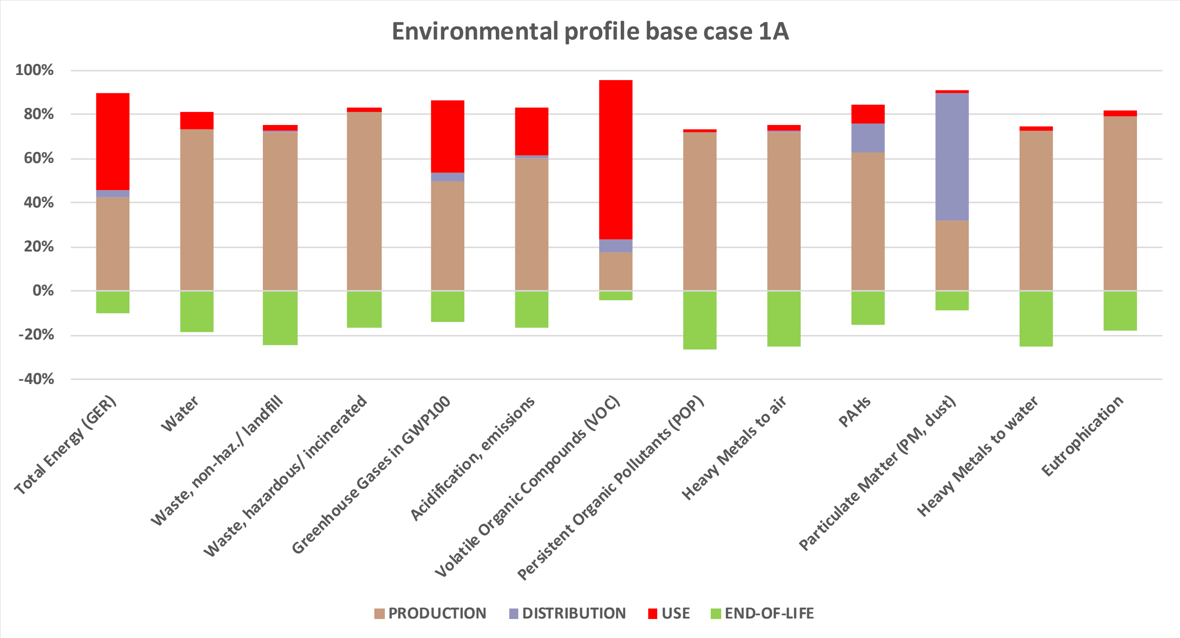

Figure 5-2: Environmental profile of Base-Case 1A

Figure 5-3 shows the environmental profile for Base-Case 1B (hydraulic lift, usage category 1). The same trends are observed as for Base-Case 1A.

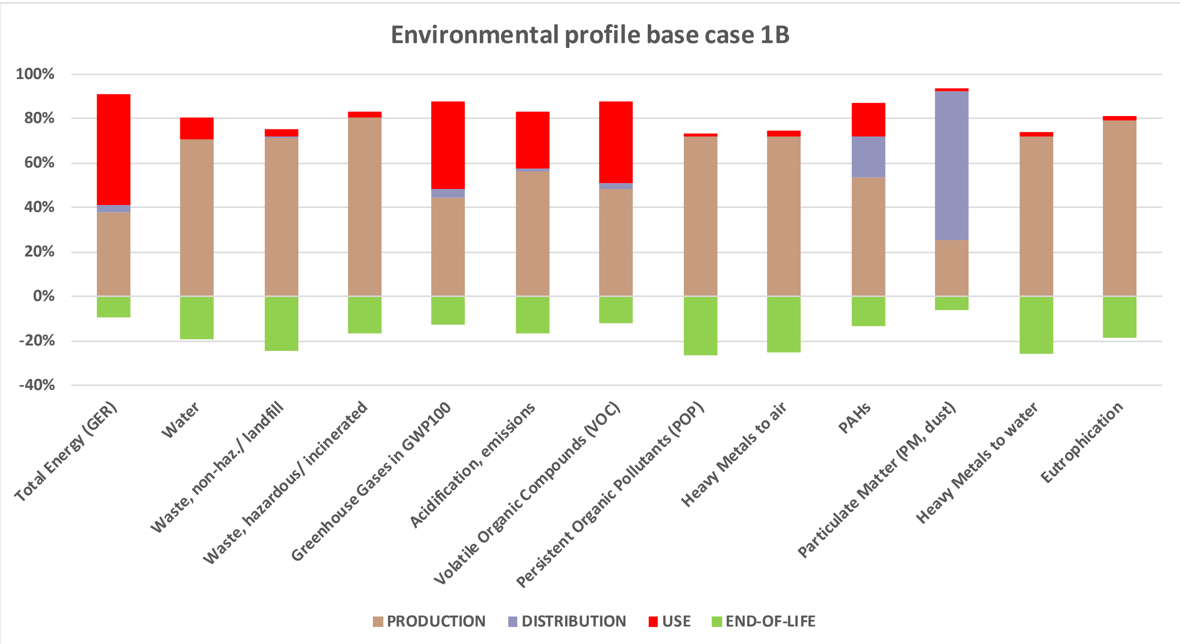

Figure 5-3: Environmental profile of Base-Case 1B

Both Base-Cases have the same calculated functional unit (see section 5.2.1). The environmental profiles of both Base-Cases can thus be compared. Figure 5-4 shows the comparative environmental profile.

The environmental impact of the Base-Case with the highest contribution to the impact category is set at 100%. The impact of the other Base-Case is shown relative to this highest scoring Base-Case.

From Figure 5-4 it can be concluded that the environmental profile of both Base-Cases does not show substantial differences.

The hydraulic lift (1B) has a higher impact in the impact categories ‘Volatile organic compounds (VOC)’, ‘Heavy metals to air’, ‘Heavy metals to water’ and ‘Eutrophication’. In the impact category ‘Volatile organic compounds (VOC)’ this is due to the use of hydraulic oil. In the impact categories ‘Heavy metals to air’, ‘Heavy metals to water’ and ‘Eutrophication’, this is due to the use of stainless steel for the cylinder/piston. For the impact category eutrophication, it is also due to the use of hydraulic oil. The hydraulic oil is a substance that has been added by the team to the MEErP EcoReport tool. It is observed that impacts on eutrophication for the materials which are already contained in the MEErP EcoReport tool are in general lower than impacts obtained today for the newly added materials. If extra materials have been added to the MEErP tool and are part of the bill of materials of the investigated product (which is the case for mineral oil in Base-Case 1B) the results on the impact category eutrophication might not be reliable.

The traction lift (1A) has a higher impact in the impact categories ‘Waste’, ‘Persistent organic pollutants (POP)’, ‘PAHs’ and ‘Particulate matter (PM)’.

In the impact categories ‘Total energy’, ‘Greenhouse gases’ and ‘Acidification’, both technologies obtain an almost equal result.

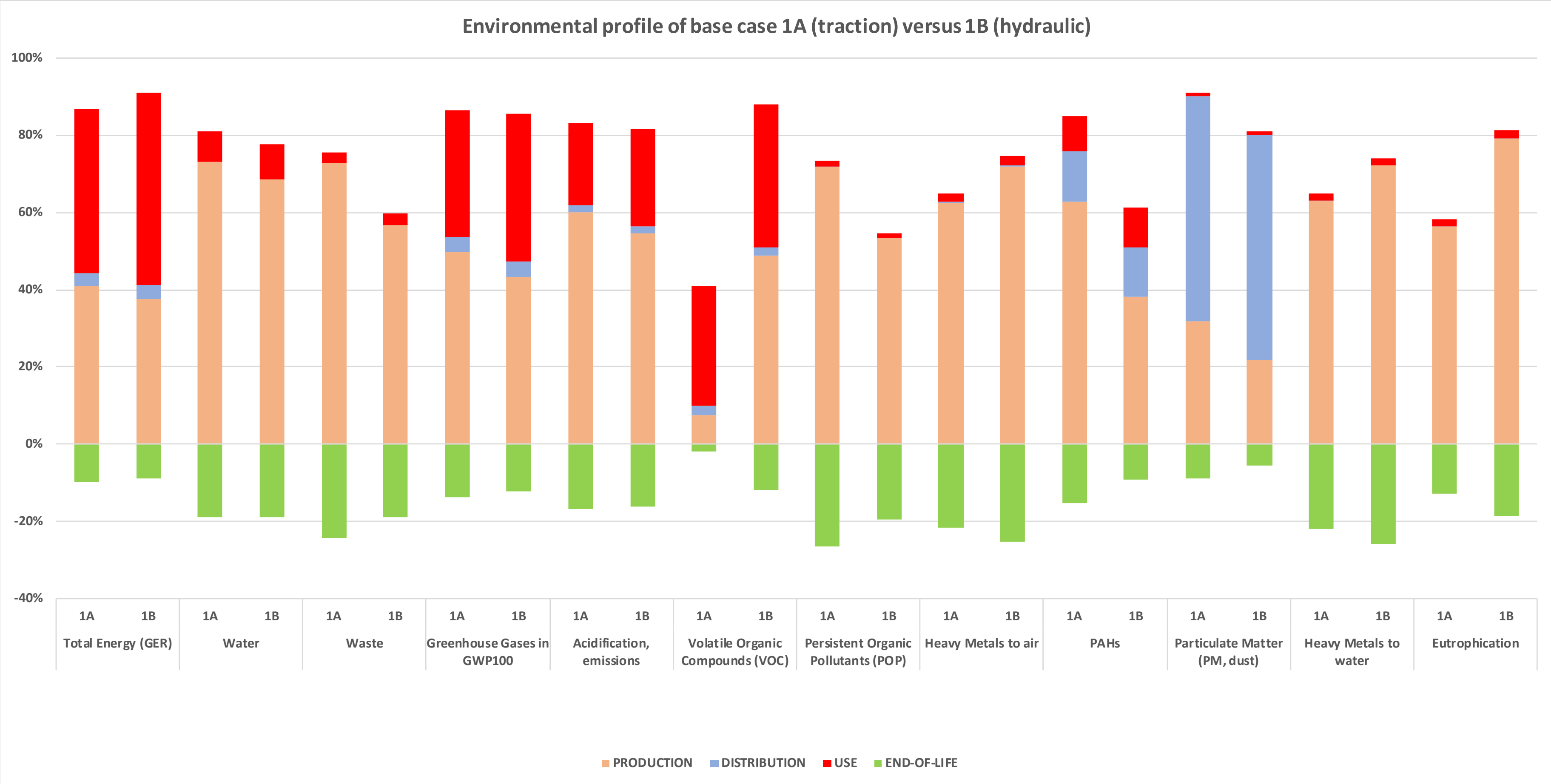

Figure 5-4: Environmental profile of Base-Case 1A (traction) and Base-Case 1B (hydraulic)[2]

[2] Per impact category the product with the highest contribution to the impact category has been set at 100%. The impact of the other product is scaled to the impact of the highest contributing product.

5.3.1.1.2. Results for Base-Case 2A and 2B: usage category 2

Figure 5-5 shows the environmental profile of Base-Case 2A (traction lift, usage category 2).

The use phase is the most important life cycle stage in the impact categories 'Total energy' and 'VOC'. The impact in the use phase comes almost entirely from the electricity use during operation and standby mode of the lift. The idle-mode electricity use for this usage category is much higher than the electricity used during operation (see Table 5-6). Other impacts which occur during the use phase are due to maintenance and repair. The impact of maintenance and repair is 1% of the impact of the lift's production (default assumption MEErP EcoReport tool). So, the impact of the use phase from Base-Case 2A is almost entirely attributed to the idle-mode electricity use.

The production phase is most important in the impact categories 'Global warming', 'Water', 'Waste, (non-hazardous and hazardous', 'Acidification', 'Persistent Organic Pollutants', 'Heavy metals to air', 'Heavy metals to water', PAHs' and 'Eutrophication'.

POPs mainly come from the steel and iron parts. Per kg of material, ferrite has the highest amount of POP emissions (39 ng i-Teq), then the galvanized steel sheet (26 ng i-Teq), next the steel tube (12 ng i-Teq) and finally cast iron (6 ng i-Teq). The impact on POP will decrease if more cast iron is used instead of ferrite, galvanized steel or steel tubing.

The impact from heavy metals to air, heavy metals to water and eutrophication mainly comes from the car walls and roof. They are made of stainless steel which has a very high contribution per kg to this impact category.

The distribution phase has a significant contribution to the impact category particulate matter. The impact in the distribution phase comes from transport of the packaged product.

Due to the recyclability of metals, the end-of-life phase has a positive contribution to the environmental profile.

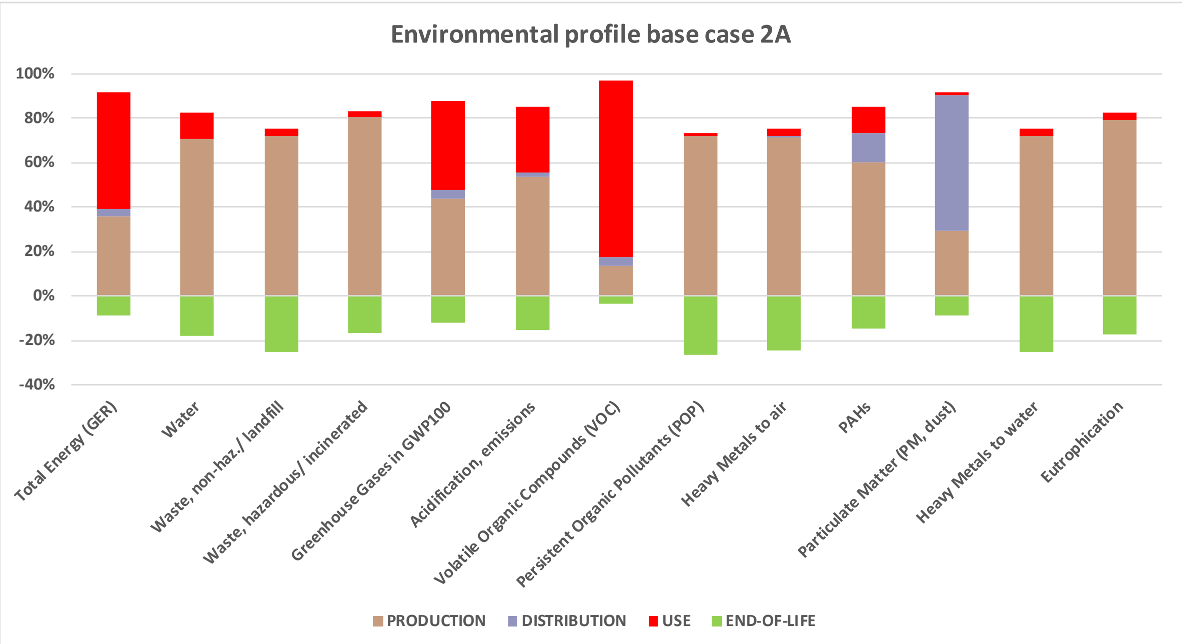

Figure 5-5: Environmental profile of Base-Case 2A

Figure 5-6 provides the environmental profile for Base-Case 2B (hydraulic lift, usage category 2). The same trends are observed as for Base-Case 2A. In case of the hydraulic lift, the use phase is the most important life cycle phase in the impact category 'Global Warming'.

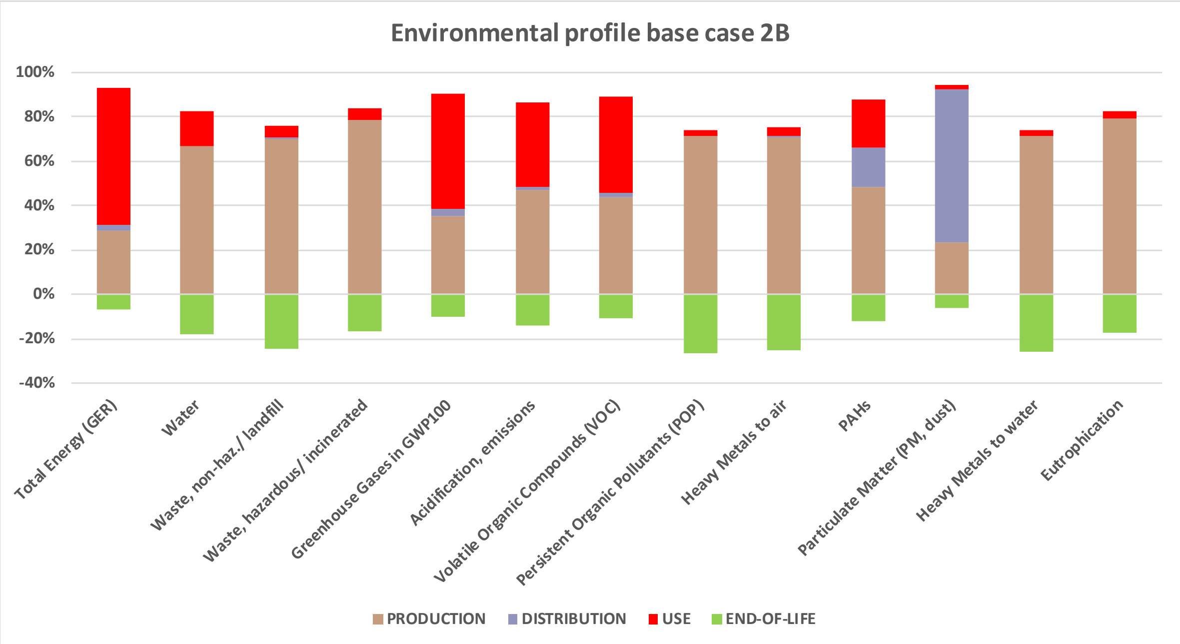

Figure 5-6: Environmental profile of Base-Case 2B

Both Base-Cases have the same calculated functional unit (see section 5.2.1). The environmental profiles of both Base-Cases can thus be compared to each other.

Figure 5-7 shows the comparative environmental profile.

In terms of energy consumption and GHG emissions, Base-Case 2A has a slightly lower impact than Base-Case 2B. The difference is mainly due to the use-phase. The energy consumption of Base-Case 2A is lower than the energy consumption of Base-Case 2B.

The impacts from the production phase is the most relevant phase for many of the other environmental impacts for Base-Case 2 as it was for Base-Case 1.

A comparison at component level of both Base-Cases is added in Annex F. The total global warming potential coming from the components for the traction lift is 8009 kg CO2 eq and for the hydraulic lift it is 7003 kg CO2 eq. The total weight of components (including replacements) for the traction lift is 2724 kg and for the hydraulic lift 1840 kg. The comparison in Annex F explains why the difference between both Base-Cases in contribution to GWP is lower than the difference in weight.

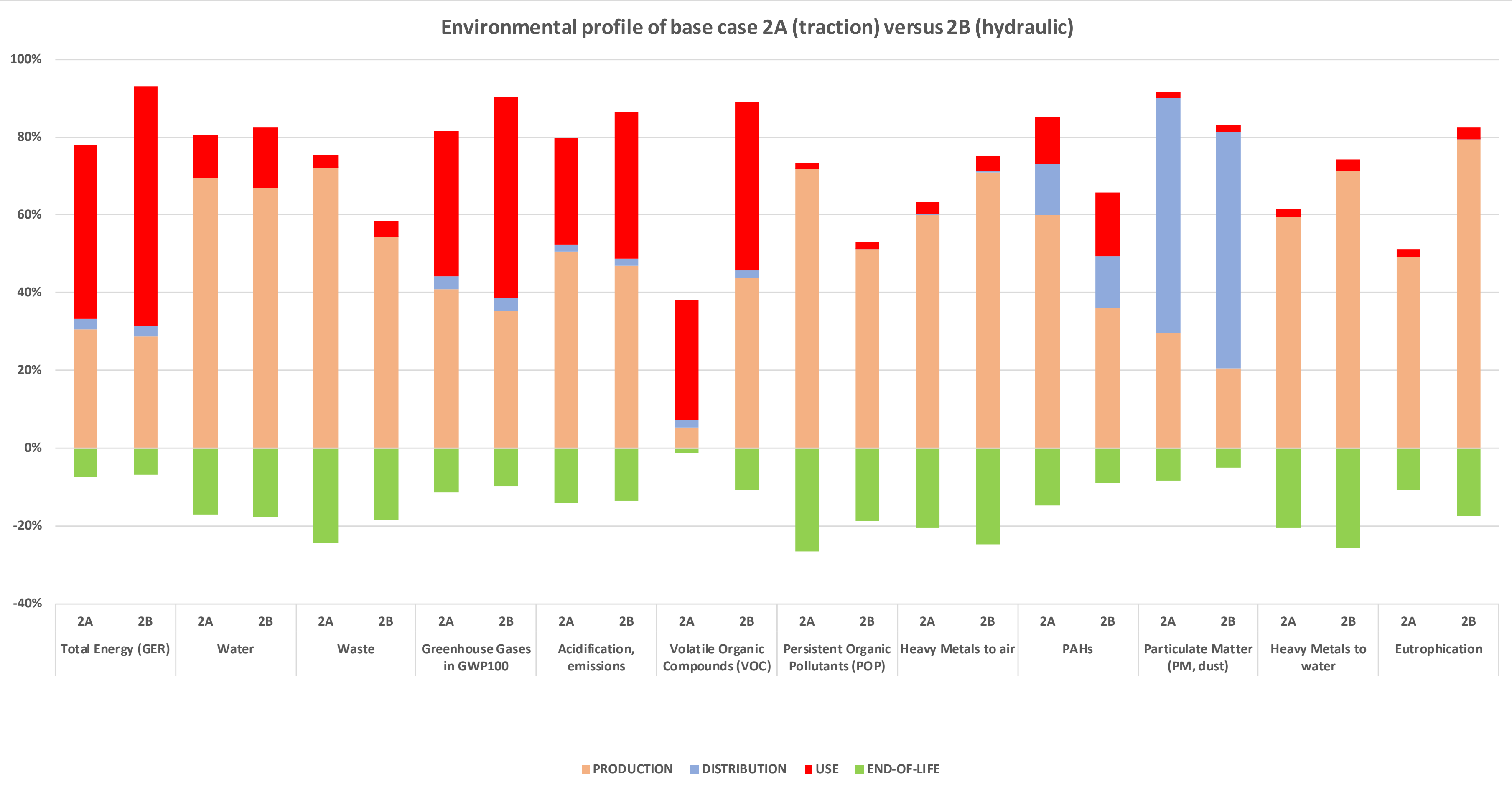

Figure 5-7: Environmental profile of Base-Case 2A (traction) and Base-Case 2B (hydraulic)3

3 Per impact category the product with the highest contribution to the impact category has been set at 100%. The impact of the other product is scaled to the impact of the highest contributing product.

5.3.1.1.3. Results for Base-Case 3: usage category 3

Figure 5-8 shows the environmental profile of Base-Case 3 (traction lift, usage category 3).

For Base-Case 3, the use phase is the most important life cycle stage for the impact categories ‘Total energy’, ‘Global Warming Potential’ and ‘VOC’. The impact of the use phase comes almost entirely from the electricity use during operation and standby mode of the lift. Other impacts which occur during the use phase are due to maintenance and repair. The impact of maintenance and repair is 1% of the impact of the production (default assumption MEErP EcoReport tool), which is negligible compared to the impact generated by the electricity consumption.

For the production phase, distribution phase and end-of-life phase, the conclusions made for Base-Case 1A and 2A are valid for Base-Case 3 as well.

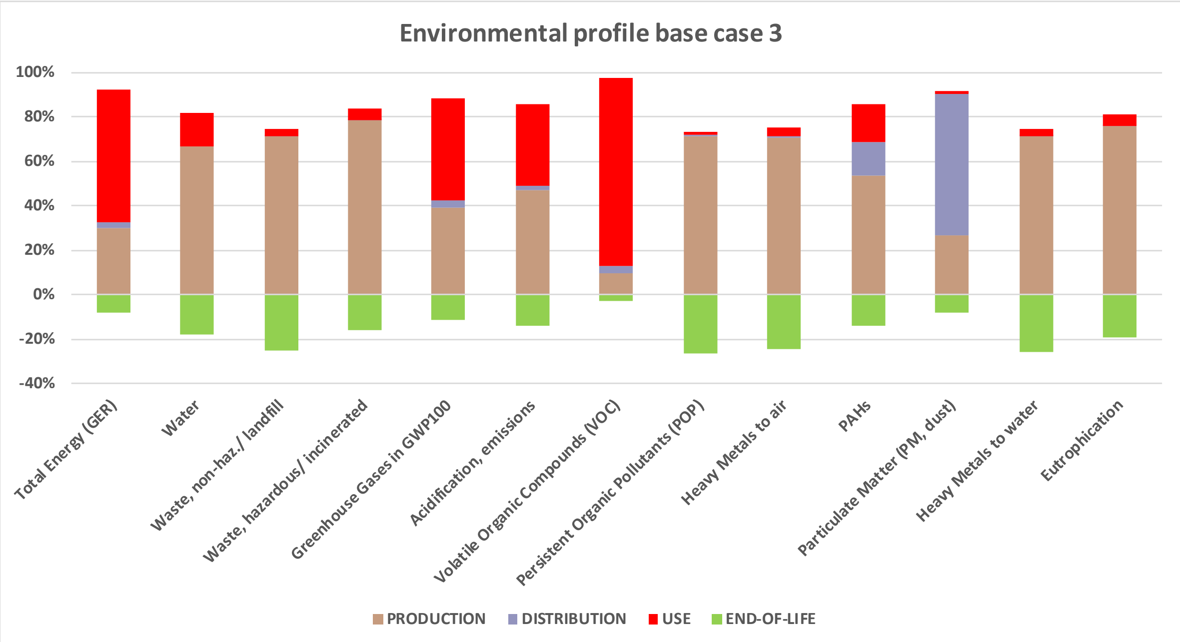

Figure 5-8: Environmental profile of Base-Case 3

5.3.1.1.4. Results for Base-Case 4: usage category 4

Figure 5-9 shows the environmental profile of Base-Case 4.

The use phase is the most important life cycle stage in the impact categories ‘Total energy’, ‘Global Warming Potential’ and ‘VOC’. For Base-Case 4 the use phase is also the most important life cycle stage for the impact category ‘Acidification’.

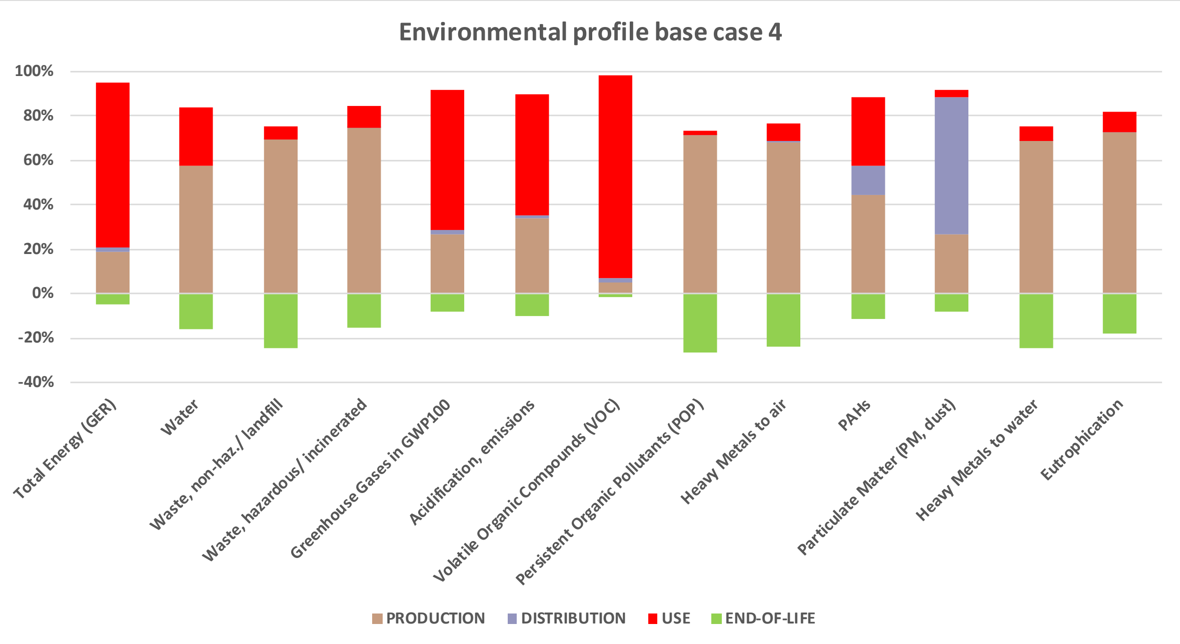

Figure 5-9: Environmental profile of Base-Case 4

5.3.2. Cross-check of obtained results with existing literature

In this section the obtained results are compared to results available in literature. This section is meant to cross-check the overall conclusions of the previous section.

The previous section revealed that little differences are determined between the environmental profile of traction lifts and hydraulic lifts. When looking at the impact category global warming, the use phase is the most important life cycle stage for Base-Case 2B, 3 and 4. For other impact categories, either the product stage or the use stage is the most important life cycle stage.

Other life cycle assessments of lifts reveal the use phase and the production phase are the most important life cycle stages. Salmelin et al. and Schindler calculated a single score environmental impact. In Salmelin et al. the use phase accounts for 81% and materials for 11% of the life cycle impact. Schindler reports in a share of 75% for the use phase and 15% for the materials.

Thyssenkrupp and Kone have EPDs available according to the PCR for lifts (environdec, 2015). In the EPD from Kone (2017) and from Thyssenkrupp (2017) the upstream life cycle phase (material production and transport) is the most important life cycle stage for all the considered environmental impact categories.

ITA INNOVA performed a study for ELCA comparing the LCA of traction lifts with hydraulic lifts (ITA INNOVA, 2017), which was presented at Elevcon 2018. The ITA INNOVA study considered Base-cases with 450 kg rated load, 10 m rise, operated according to 3 different usage categories (1, 2 and 3) so that they are close to the Base-Cases 1A and 1B of this study. This study also concluded that there is little difference in the environmental profile of a traction and hydraulic lift.

5.3.3. Aspects related to the circular economy

In the communication from the Commission from 30th of November 2016 on the Ecodesign Working Plan 2016-2019, it is emphasized that, Ecodesign should make a more significant contribution to the circular economy, for example by more systematically tackling material efficiency issues such as durability and recyclability.

This study makes use of the EcoReport tool version 2014, which considers the results of the project "Material-efficiency Ecodesign Report and Module to the Methodology for the Ecodesign of Energy-related Products (MEErP) (BIO Intelligence, 2013 a and b)". This project identifies from available evidence the most significant parameters regarding material efficiency that may be used in MEErP. The parameters selected as most suitable are:

- recyclability benefit rates (describing the "potential output" for future recycling);
- recycled content (describing the "input" of materials with origin on waste);
- lifetime (a mechanism to display impacts not only as a total over the whole lifespan, but also per year of use, allowing an easier comparison of products with different lifetimes or analysing the effect of lifetime extension); and
- Critical Raw Material Index.

The following paragraphs discuss these parameters for the product group 'lifts'.

5.3.3.1.Recyclability benefit rates

Within the EcoReport tool the recyclability benefit rate is calculated only for bulk and technical plastics. To avoid double counting, the recyclability of metals is not considered in the EcoReport tool. As the major part of the lift consists of metals, the calculation of the recyclability benefit rate using the EcoReport tool is considered as not useful for this product group.

5.3.3.2.Recycled content

This parameter is focused on the manufacturing phase of the life cycle, defining the origin of materials used for a product (different than the recyclability benefit rate which depends on the end-of-life treatment). Assumptions for recycled content of metals are incorporated in the EcoReport tool 2014 and have been used in this study. They differ per material category.

5.3.3.3.Lifetime

Lifts are products with a long life time. As revealed by the LCA analyses, the product stage is an important life cycle stage in many of the impact categories. Extending the life time of a lift will thus decrease environmental (impacts calculated per year). Some aspects which might lead to a longer life time are standardization and reparability.

Standardization of lift components, e.g. doors and car interior panels will facilitate easy modernization and repair. The intercom is often changed with a change of service provider. Standardization of the intercom might overcome this and reduce overall environmental impacts.

Aspects which might facilitate repair and which are amongst others relevant to lifts:

- The availability of spare parts
- Unrestricted access to information on repair
- Easy access to key components to allow for non-destructive repair
- Use of removable fasteners

JRC currently works on the development of a scoring system for repair and upgrade of products (JRC, 2018). The examples used to test the scoring system are smaller consumer products with a shorter life time than lifts (laptops, vacuum cleaners and washing machines). However, the scoring framework could be (partly) applied to lifts as well.

5.3.3.4. Critical Raw Material Index

MEErP also uses a CRM (Critical Raw Material) indicator to quantify the use of CRM in the product. The CRM indicator is not an environmental indicator as such. It describes the scarcity of a material from economic perspective. It is part of the MEErP because also in this field there might be improvement options for certain product groups. MEErP provides characterization factors for 14 critical raw materials. The characterization factors are based on the following aspects (Kemna, 2011b)

- High import dependency (ratio of EU imports vs. consumption)
- Limited possibilities to find substitutes for the same or similar performance (“substitutability”)
- No or very limited recycling rate (ratio of recycled old scrap vs. production)

The lift components which include critical raw materials are:

- LEDs
    - LED contain Gallium and Indium
- Permanent magnet motor (in traction lifts)
    - Contains rare earth element neodymium
- Printed circuit boards and electronic components
    - Several critical raw materials
- Steel parts
    - Niobium in high strength steel
    - Tungsten in steel alloys

Stakeholders mentioned following improvement options for replacement of (high strength) steel (alloys) and the critical raw materials contained therein:

- Aluminium-plywood honeycomb composite of high stiffness for structural car elements, eventually replacing high strength steel.
- Car interior decoration panels made from fire-resistant natural fibres, biopolymers, and bio composites potentially replacing panels made from steel alloys.

In addition, stakeholders mentioned that information on the presence of rare earth magnets in the permanent magnet motor can facilitate future recycling practices.

The draft standard prEN45558[4] provides a general method to declare the use of critical raw materials in energy related products. If CRM content is defined as an improvement option, reference can be made to this standard for declaration of CRM content.

5.4. Subtask 5.3: Base-Case life cycle cost for the consumer

The lifecycle costs for consumers have been calculated using the MEErP EcoReport tool.

The inputs used to calculate the Life Cycle Costs are:

[4] prEN 45558 – General method to declare the use of critical raw materials in energy related products.

- the prices for hardware, installation and maintenance and repair mentioned in Table 5-5
- the considered electricity price is 0.196 euro/kWh (average price over 25 years based on PRIMES – see section)
- a life time of 25 years.

The tables below present the life cycle costs (LCC) per Base-Case. Furthermore, to compare the discounted net present value (NPV) of the running costs --which is the specific viewpoint of Life Cycle Costing-- with the actual expenditure today, the second column also gives the total consumer expenditure in the EU-28 per year.

Detailed LCC calculations per Base-Case are available in Annex G.

5.4.1. LCC results for Base-Case 1A

As Table 5-8 shows, every year all EU consumers spend € 247 million for the purchase and operation of lifts (Base-Case 1A). And each time a consumer makes a buying decision, the decision is not just on a purchase price (for product and installation) of € 32 000 but also on the total Life Cycle Costs (LCC) of the product --including running costs discounted to their net present value-- of on average € 58 906.

With the LCC the product acquisition is responsible for 54 % and the running costs of energy and other consumables for around 4 %. Repair, maintenance & EoL make up the rest of the total. In terms of annual expenditure, the EU-28 running costs amount to 0.1 billion Euro and the purchase and installation costs make up around 0.1 billion Euro.

Table 5-6: Life cycle costs Base-Case 1A

	Table . Life Cycle Costs per product and Total annual expenditure (2015) in the EU-28				
	Base case 1A Item	LCC new product		total annual consumer expenditure in EU28	
D	Product price	17000	€	54	mln.€
E	Installation/acquisition costs (if any)	15000	€	48	mln.€
F	Fuel (gas, oil, wood)	0	€	0	mln.€
F	Electricity	2716	€	15	mln.€
G	Water	0	€	0	mln.€
H	Aux. 1: None	0	€	0	mln.€
I	Aux. 2 :None	0	€	0	mln.€
J	Aux. 3: None	0	€	0	mln.€
K	Repair & maintenance costs	24190	€	130	mln.€
	Total	**58906**	€	**247**	mln.€

5.4.2.LCC results for Base-Case 1B

As Table 5-9 shows, every year all EU consumers spend € 183 million for the purchase and operation of lifts (Base-Case 1B). And each time a consumer makes a buying decision, the decision is not just on a purchase price (for product and installation) of € 30 500 but also on the total Life Cycle Costs (LCC) of the product --including running costs discounted to their net present value-- of on average € 56 989.

With the LCC the product acquisition is responsible for 53 % and the running costs of energy and other consumables for around 5 %. Repair, maintenance & EoL make up the rest of the total. In terms of annual expenditure, the EU-28 running costs amount to 0.1 billion Euro and the purchase and installation costs make up around 0.1 billion Euro.

Table 5-7: Life cycle costs Base-Case 1B

	Table . Life Cycle Costs per product and Total annual expenditure (2015) in the EU-28				
	Base case 1B Item	LCC new product		total annual consumer expenditure in EU28	
D	Product price	15500	€	38	mln.€
E	Installation/acquisition costs (if any)	15000	€	36	mln.€
F	Fuel (gas, oil, wood)	0	€	0	mln.€
F	Electricity	3199	€	13	mln.€
G	Water	0	€	0	mln.€
H	Aux. 1: None	0	€	0	mln.€
I	Aux. 2 :None	0	€	0	mln.€
J	Aux. 3: None	0	€	0	mln.€
K	Repair & maintenance costs	23291	€	96	mln.€
	Total	**56989**	€	**183**	mln.€

5.4.3.LCC results for Base-Case 2A

As Table 5-10 shows, every year all EU consumers spend € 3194 million for the purchase and operation of lifts (Base-Case 2A). And each time a consumer makes a buying decision, the decision is not just on a purchase price (for product and installation) of € 38 500 but also on the total Life Cycle Costs (LCC) of the product --including running costs discounted to their net present value-- of on average € 69 822.

With the LCC the product acquisition is responsible for 55 % and the running costs of energy and other consumables for around 6 %. Repair, maintenance & EoL make up the rest of the total. In terms of annual expenditure, the EU-28 running costs amount to 1.8 billion Euro and the purchase and installation costs make up around 1.3 billion Euro.

Table 5-8: Life cycle costs Base-Case 2A

Table . Life Cycle Costs per product and Total annual expenditure (2015) in the EU-28					
	Base case 2A Item	LCC new product		total annual consumer expenditure in EU28	
D	Product price	21500	€	**751**	mln.€
E	Installation/acquisition costs (if any)	17000	€	**594**	mln.€
F	Fuel (gas, oil, wood)	0	€	**0**	mln.€
F	Electricity	4510	€	**266**	mln.€
G	Water	0	€	**0**	mln.€
H	Aux. 1: None	0	€	**0**	mln.€
I	Aux. 2 :None	0	€	**0**	mln.€
J	Aux. 3: None	0	€	**0**	mln.€
K	Repair & maintenance costs	26813	€	**1583**	mln.€
	Total	**69822**	€	**3194**	mln.€

5.4.4. LCC results for Base-Case 2B

As Table 5-11 shows, every year all EU consumers spend € 1 173 million for the purchase and operation of lifts (Base-Case 2B). And each time a consumer makes a buying decision, the decision is not just on a purchase price (for product and installation) of € 36 000 but also on the total Life Cycle Costs (LCC) of the product --including running costs discounted to their net present value-- of on average € 68 212.

With the LCC the product acquisition is responsible for 52 % and the running costs of energy and other consumables for around 9 %. Repair, maintenance & EoL make up the rest of the total. In terms of annual expenditure, the EU-28 running costs amount to 0.7 billion Euro and the purchase and installation costs make up around 0.5 billion Euro.

Table 5-9: Life cycle costs Base-Case 2B

Table . Life Cycle Costs per product and Total annual expenditure (2015) in the EU-28					
	Base case 2B Item	LCC new product		total annual consumer expenditure in EU27	
D	Product price	19000	€	**246**	mln.€
E	Installation/acquisition costs (if any)	17000	€	**220**	mln.€
F	Fuel (gas, oil, wood)	0	€	**0**	mln.€
F	Electricity	6235	€	**137**	mln.€
G	Water	0	€	**0**	mln.€
H	Aux. 1: None	0	€	**0**	mln.€
I	Aux. 2 :None	0	€	**0**	mln.€
J	Aux. 3: None	0	€	**0**	mln.€
K	Repair & maintenance costs	25978	€	**570**	mln.€
	Total	**68213**	€	**1173**	mln.€

5.4.5. LCC results for Base-Case 3

As Table 5-12 shows, every year all EU consumers spend € 4 650 million for the purchase and operation of lifts (Base-Case 3). And each time a consumer makes a buying decision, the decision is not just on a purchase price (for product and installation) of € 45 500 but also on the total Life Cycle Costs (LCC) of the product --including running costs discounted to their net present value-- of on average € 112 390.

With the LCC the product acquisition is responsible for 40 % and the running costs of energy and other consumables for around 8 %. Repair, maintenance & EoL make up the rest of the total. In terms of annual expenditure, the EU-28 running costs amount to 3.3 billion Euro and the purchase and installation costs make up around 1.3 billion Euro.

Table 5-10: Life cycle costs Base-Case 3

Table . Life Cycle Costs per product and Total annual expenditure (2015) in the EU-28

	Base case 3 Item	LCC new product		total annual consumer expenditure in EU28	
D	Product price	28500	€	836	mln.€
E	Installation/acquisition costs (if any)	17000	€	498	mln.€
F	Fuel (gas, oil, wood)	0	€	0	mln.€
F	Electricity	9754	€	484	mln.€
G	Water	0	€	0	mln.€
H	Aux. 1: None	0	€	0	mln.€
I	Aux. 2 :None	0	€	0	mln.€
J	Aux. 3: None	0	€	0	mln.€
K	Repair & maintenance costs	57136	€	2833	mln.€
	Total	**112390**	€	**4650**	mln.€

5.4.6. LCC results for Base-Case 4

As Table 5-13 shows, every year all EU consumers spend € 7 838 million for the purchase and operation of lifts (Base-Case 4). And each time a consumer makes a buying decision, the decision is not just on a purchase price (for product and installation) of € 67 000 but also on the total Life Cycle Costs (LCC) of the product --including running costs discounted to their net present value-- of on average € 195 883.

With the LCC the product acquisition is responsible for 34 % and the running costs of energy and other consumables for around 13 %. Repair, maintenance & EoL make up the rest of the total. In terms of annual expenditure, the EU-28 running costs amount to 6 billion Euro and the purchase and installation costs make up around 1.8 billion Euro.

Table 5-11: Life cycle costs Base-Case 4

Table . Life Cycle Costs per product and Total annual expenditure (2015) in the EU-28

	Base case 4 Item	LCC new product		total annual consumer expenditure in EU28	
D	Product price	45000	€	1238	mln.€
E	Installation/acquisition costs (if any)	22000	€	605	mln.€
F	Fuel (gas, oil, wood)	0	€	0	mln.€
F	Electricity	27084	€	1260	mln.€
G	Water	0	€	0	mln.€
H	Aux. 1: None	0	€	0	mln.€
I	Aux. 2 :None	0	€	0	mln.€
J	Aux. 3: None	0	€	0	mln.€
K	Repair & maintenance costs	101800	€	4736	mln.€
	Total	**195884**	€	**7838**	mln.€

5.5. Subtask 5.4: EU totals

This section contains the EU total energy use per year.

The total energy use is calculated per Base-Case using the following formula:

*EU total energy use = stock * energy use per year*

Table 5-14 shows the how the energy use for the EU has been calculated. Elevators in the EU-28 consume in 2015 about 12.9 TWh of electrical energy per year.

Table 5-12: EU totals[5]

Base-Case	Stock 2015 (units)	Energy use per year (kWh)	TWh/y for Europe
1A	134530	550	0.075
1B	102851	654	0.07
2A	1476430	922	1.36
2B	548360	1274	0.70
3	1239511	1994	2.47
4	1162953	5536	6.44
Total	4664635		11.11
Total including stock not covered by any of the Base-Cases	5403180		12.9

Almeida et al. (2012) calculated that elevators in the EU-27 consume about 18.4 TWh of electrical energy per year. Values on running and stand-by energy consumption have been updated compared to the study performed in 2012 by Almeida et al.

5.6. Conclusion

Based on the Bill-of-Materials (see Task 4), a LCA analysis was carried out for all Base-cases. An overview of all Base-Cases is provided in Table 5-15 (see Annex E for details).

[5] Assumptions have been made for the energy use calculations. Other assumptions may lead to other results on energy use per year.

Table 5-13: Overview of life cycle impact for all Base-Cases

Parameter	Unit	1A	1B	2A	2B	3	4
Total Energy (GER)	**MJ**	228827	243427	329810	402853	640065	1510789
Water (process and cooling)	**liter**	46607	44161	55136	56170	86184	146746
Waste, non-haz./ landfill	**g**	1575070	1260575	2042671	1613919	3927589	6078794
Waste, hazardous/ incinerated	**g**	100402	69765	101908	72170	105836	146685
Greenhouse Gases in GWP100	**kg CO2 eq.**	12064	12194	16812	19234	32181	71255
Acidification, emissions	**g SO2 eq.**	75082	74169	95253	105560	166418	345541
Volatile Organic Compounds (VOC)	**g**	3528	6843	5491	11669	11287	29497
Persistent Organic Pollutants (POP)	**ng i-Teq**	19840	14911	26319	19185	52808	79875
Heavy Metals to air	**mg Ni eq.**	34777	39519	37579	44207	65712	95481
PAHs	**mg Ni eq.**	2385	1785	2942	2367	4482	7312
Particulate Matter (PM, dust)	**g**	48446	44623	58566	54881	97591	129838
Heavy Metals to water	**mg Hg/20**	22193	24843	22790	26953	35135	46584
Eutrophication	**g PO4**	832	1152	902	1450	1258	1661

The results reveal that the use phase is very important in the impact categories Total Energy and VOC for all Base-Cases. For Base-Case 3 and 4 the use phase is also the most important life cycle phase in the impact category global warming. The production phase is the most relevant life cycle phase in many of the other environmental impact categories.

For Base-Cases 1 and 2 both a hydraulic and a traction lift were considered. The hydraulic lift had a higher impact in the impact categories 'Volatile organic compounds (VOC)', 'Heavy metals to air', 'Heavy metals to water' and 'Eutrophication'. The traction lift (1A) has a higher impact in the impact categories 'Waste', 'Persistent organic pollutants (POP)', 'PAHs' and 'Particulate matter (PM)'. For Base-case 1, the impact of the two lift types is almost equal in the impact categories 'Total energy', 'Greenhouse gases' and

'Acidification'. The traction lift has a slightly lower environmental impact these impact categories for Base-Case 2.

Furthermore, a LCC analysis was carried out in this task. Table 5-16 provides an overview.

Table 5-14: Overview of the Life Cycle Costs for all Base-Cases

Category	Subcategory	BC 1A	BC 1B	BC 2A	BC 2B	BC 3	BC 4
New product [NPV in €]	Product	17 000	15 500	21 500	19 000	28 500	45 000
	Installation	15 000	15 000	17 000	17 000	17 000	22 000
	Electricity	2 716	3 199	4 510	6 235	9 754	27 084
	Repair & Maint./Insp. & EoL	24 190	23 291	26 813	25 978	57 136	101 800
	Total	58 904	56 989	69 822	68 213	112 390	195 884
Total annual consumer expenditure [in million €]	Product	54	38	751	246	836	1 238
	Installation	48	36	594	220	498	605
	Electricity	15	13	266	137	484	1 260
	Repair & Maint./Insp. & EoL	130	96	1 583	570	2 833	4 736
	Total	247	183	3 194	1 173	4 650	7 838

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Annex A: Input data LCC Base-Cases

Base-Case 1A : Gearless traction		
	value	*year*
Economic life time of application (Tapp) (y)	25	
Electricity cost (incl. VAT) (€/kWh)	PRIMES	
r (discount rate = interest - inflation)	4%	
Reference year for NPV in LCC	2015	
CAPEX lift (€)	32.000,00	1
CAPEX for decomissioning (€)	12.000,00	25
scrap value cast iron (€)	- 86,03	25
scrap value steel plate (€)	- 126,47	25
scrap value copper (€)	- 249,51	25
scrap value aluminium (€)	- 0,39	25
OPEX inspection visit (€/service)	400,00	twice each year
OPEX replacement brakes (€)	/	not replaced
OPEX replacement controller (€)	3.000,00	20
OPEX replacement car door (€)	1.750,00	not replaced
OPEX replacement landing door (€)	8.750,00	not replaced
OPEX replacement car door operators (€)	2.000,00	20
OPEX replacement diverter pulleys (€)	4.500,00	20
OPEX replacement ropes (€)	1.770,00	20
OPEX replacement landing indicators and buttons (€)	2.500,00	15
OPEX replacement car indicators and buttons (€)	1.000,00	15
OPEX replacement intercom (€)	500,00	15

Base-Case 1B : hydraulic		
	value	*year*
Economic life time of application (Tapp) (y)	25	
Electricity cost (incl. VAT) (€/kWh)	PRIMES	
r (discount rate = interest - inflation)	4%	
Reference year for NPV in LCC	2015	
CAPEX lift (€)	30.500,00	1
CAPEX for decomissioning (€)	12.000,00	25
scrap value cast iron (€)	- 18,55	25
scrap value steel plate (€)	- 114,36	25
scrap value copper (€)	- 219,47	25
scrap value aluminium (€)	- 0,18	25
OPEX inspection visit (€/service)	400,00	twice each year
OPEX replacement brakes (€)	/	not replaced
OPEX replacement controller (€)	3.000,00	20
OPEX replacement car door (€)	1.750,00	not replaced
OPEX replacement landing door (€)	8.750,00	not replaced
OPEX replacement car door operators (€)	2.000,00	20
OPEX replacement landing indicators and buttons	2.500,00	15
OPEX replacement car indicators and buttons	1.000,00	15
OPEX replacement hydraulic oil	1.696,88	10 and 20
OPEX replacement intercom	500,00	15

Base-Case 2A : Gearless traction		
	value	*year*
Economic life time of application (Tapp) (y)	25	
Electricity cost (incl. VAT) (€/kWh)	PRIMES	
r (discount rate = interest - inflation)	4%	
Reference year for NPV in LCC	2015	
CAPEX lift (€)	38.500,00	1
CAPEX for decomissioning (€)	12.000,00	25
scrap value cast iron (€)	- 95,65	25
scrap value steel plate (€)	- 167,36	25
scrap value copper (€)	- 260,73	25
scrap value aluminium (€)	- 0,44	25
OPEX inspection visit (€/service)	400,00	twice each year
OPEX replacement brakes (€)	/	not replaced
OPEX replacement controller (€)	8.666,67	20
OPEX replacement car door (€)	4.500,00	not replaced
OPEX replacement landing door (€)	22.500,00	not replaced
OPEX replacement car door operators (€)	2.000,00	20
OPEX replacement diverter pulleys (€)	4.500,00	20
OPEX replacement ropes (€)	1.900,20	20
OPEX replacement landing indicators and buttons (€)	2.500,00	15
OPEX replacement car indicators and buttons (€)	1.000,00	15
OPEX replacement intercom (€)	500,00	15

Base-Case 2B : hydraulic		
	value	*year*
Economic life time of application (Tapp) (y)	25	
Electricity cost (incl. VAT) (€/kWh)	PRIMES	
r (discount rate = interest - inflation)	4%	
Reference year for NPV in LCC	2015	
CAPEX lift (€)	36.000,00	1
CAPEX for decomissioning (€)	12.000,00	25
scrap value cast iron (€)	- 0,56	25
scrap value steel plate (€)	- 37,77	25
scrap value copper (€)	- 42,61	25
scrap value aluminium (€)	- 0,66	25
OPEX inspection visit (€/service)	400,00	twice each year
OPEX replacement brakes (€)	/	not replaced
OPEX replacement controller (€)	8.666,67	20
OPEX replacement car door (€)	4.500,00	not replaced
OPEX replacement landing door (€)	22.500,00	not replaced
OPEX replacement car door operators (€)	2.000,00	20
OPEX replacement landing indicators and buttons	2.500,00	15
OPEX replacement car indicators and buttons	1.000,00	15
OPEX replacement hydraulic oil	1.696,88	10 and 20
OPEX replacement intercom	500,00	15

Base-Case 3 : Gearless traction		
	value	*year*
Economic life time of application (Tapp) (y)	25	
Electricity cost (incl. VAT) (€/kWh)	PRIMES	
r (discount rate = interest - inflation)	4%	
Reference year for NPV in LCC	2015	
CAPEX lift (€)	45.500,00	1
CAPEX for decomissioning (€)	12.000,00	25
scrap value cast iron (€)	- 1,20	25
scrap value steel plate (€)	- 150,20	25
scrap value copper (€)	- 46,64	25
scrap value aluminium (€)	- 1,79	25
OPEX inspection visit (€/service)	600,00	4 times per year
OPEX replacement brakes (€)	/	not replaced
OPEX replacement controller (€)	14.333,33	20
OPEX replacement car door (€)	7.250,00	not replaced
OPEX replacement landing door (€)	36.250,00	not replaced
OPEX replacement car door operators (€)	2.000,00	20
OPEX replacement diverter pulleys (€)	5.000,00	20
OPEX replacement ropes (€)	2.879,60	10 and 20
OPEX replacement landing indicators and buttons (€)	2.500,00	15
OPEX replacement car indicators and buttons (€)	1.000,00	15
OPEX replacement intercom (€)	500,00	15

Base-Case 4 : Gearless traction		
	value	*year*
Economic life time of application (Tapp) (y)	25	
Electricity cost (incl. VAT) (€/kWh)	PRIMES	
r (discount rate = interest - inflation)	4%	
Reference year for NPV in LCC	2015	
CAPEX lift (€)	67.000,00	1
CAPEX for decomissioning (€)	12.000,00	25
scrap value cast iron (€)	- 178,99	25
scrap value steel plate (€)	- 466,41	25
scrap value copper (€)	- 603,83	25
scrap value aluminium (€)	- 0,60	25
OPEX inspection visit (€/service)	800,00	6 times per year
OPEX replacement brakes (€)	/	not replaced
OPEX replacement controller (€)	20.000,00	20
OPEX replacement car door (€)	10.000,00	not replaced
OPEX replacement landing door (€)	50.000,00	not replaced
OPEX replacement car door operators (€)	2.000,00	20
OPEX replacement diverter pulleys (€)	6.000,00	20
OPEX replacement ropes (€)	4.338,00	7, 14 and 20
OPEX replacement landing indicators and buttons (€)	2.500,00	15
OPEX replacement car indicators and buttons (€)	1.000,00	15
OPEX replacement intercom (€)	500,00	15

Annex B: Parameters for energy use calculations per base-case

Energy demand calculation according to ISO 25745-2:2012							
Base Case ID		**Base Case 1A**	**Base Case 1B**	**Base Case 2A**	**Base Case 2B**	**Base Case 3**	**Base Case 4**
Type		traction	hydraulic	traction	hydraulic	traction	traction
Q [kg]	rated load	450	450	630	630	1000	1250
one-way travel distance for target installation [m]		12	12	12	12	21	30
Number of stopping floors [-]		4	4	4	4	7	10
nd [-]	the number of trips per day	50	50	125	125	300	750
Usage Category		1	1	2	2	3	4
% of average travel distance [-]		49%	49%	49%	49%	49%	44%
%Q [-]	% of average car load	7.5%	7.5%	7.5%	7.5%	4.5%	6.0%
dop [-]	Number of operating days per year [days	360	360	360	360	360	360
Designed service life [years]		25	25	25	25	25	25
FU [tkm]		74.42	74.42	312.56	312.56	1131.17	6361.74
Type number {0=traction; 1=hybrid}		0	1	0	1	0	0
Nominal load category: {1= "<=800kg", 2= "801-<=1275kg"; 3= "1276-<=2000kg"; 4= ">2000kg"}		1	1	1	1	2	2
Usage Category + Nominal load category		1+1	1+1	2+1	2+1	3+2	4+2
Missing Parameters		**Base Case 1A**	**Base Case 1B**	**Base Case 2A**	**Base Case 2B**	**Base Case 3**	**Base Case 4**
Determination E_standby							
P_id [W]	power use in idle mode	100.0	100.0	130.0	130.0	150.0	165.0
P_st5 [W]	standby power used after 5 min	50.0	50.0	65.0	65.0	75.0	82.5
P_st30 [W]	standby power sued after 30 min	50.0	50.0	65.0	65.0	75.0	82.5
t_d [s]	time for the opening, opened and closing	10.0	9.0	10.0	10.0	10.0	8.0
a [m/s²]	average accelaration	0.5	0.5	0.5	0.5	0.5	1.0
J [m/s³]	average jerk	1.0	1.0	1.0	1.0	1.0	1.3
Determination E_travel							
Erc [Wh]	running energy of reference cycle accord	19.0	37.0	26.0	52.0	51.0	87.0
Esc [Wh]	running energy of the short cycle	0.0					
ssc [m]	one-way travel distance of the short cycl	0.0					
Counterbalancing		0.5	0.0	0.5		0.5	0.5
k_L		0.9	1.1	0.9	1.1	0.9	0.9
Calculation							
E_y [kWh/a]	**annual energy consumption**	**556**	**654**	**922**	**1 274**	**1 984**	**5 838**
E_d [Wh]	**total daily energy consumption**	**1 542**	**1 816**	**2 561**	**3 540**	**5 538**	**16 378**
E_nr [Wh]	**daily non running [idle/standby] ener**	**1 339**	**1 340**	**1 888**	**1 888**	**2 277**	**2 458**
P_id [W]	power use in idle mode	100.00	100	130	130	150	165
R_id [%]	ratio of idle time consuming P_id	0.13	0.13	0.23	0.23	0.36	0.45
P_st5 [W]	standby power used after 5 min	50	50	65	65	75	82.5
R_st5 [%]	ratio of 5 min time consuming P_st5	0.55	0.55	0.45	0.45	0.31	0.19
P_st30 [W]	standby power sued after 30 min	50	50	65	65	75	82.5
R_st30 [%]	ratio of 30 min time consuming P_st30	0.32	0.32	0.32	0.32	0.33	0.36
t_nr [h]	*non-running [idle and standby] time per d*	23.71	23.72	23.36	23.36	22.32	20.55
t_rd [h]	*running time per day*	0.29	0.28	0.64	0.64	1.68	3.45
n_d	number of trips per day	50	50	125	125	300	750
t_av [s]	*time to travel the average travel distance*	21.08	20.08	18.38	18.38	20.13	16.55
t_d	time for the opening, opened and closing	10.00	9	10	10	10	8
s_av [m]	*one-way average travel distance for targe*	5.88	5.88	5.88	5.88	10.29	13.2
v [m/s]	rated speed	0.63	0.63	1	1	1.6	2.5
a [m/s²]	average accelaration	0.5	0.5	0.5	0.5	0.5	1
J [m/s³]	average jerk	1.00	1.00	1.00	1.00	1.00	1.30
E_rd [Wh]	**daily running energy consumption**	**202**	**476**	**693**	**1 672**	**3 261**	**12 920**
n_d	number of trips per day	50	50	125	125	300	750
k_L	*load factor*	87.0%	105.0%	87.0%	105.0%	87.0%	90.0%
%Q	average car load	7.5%	7.5%	7.5%	7.5%	4.5%	6.0%
E_rav [Wh]	*running energy consumption of an averag*	8.31	18.13	12.74	26.48	24.88	38.28
s_av [m]	one-way average travel distance for targe	5.88	5.88	5.88	5.88	10.29	13.2
l [%]		49%	49%	49%	49%	49%	44%
s_rc [m]	one-way travel distance of reference cycl	12	12	12	12	21	30
E_ssc [Wh]	*start/stop energy consumption for each t*	0	0	0	0	3.55271E-15	0
E_rm [Wh/m]	*average running energy consumption per*	0.791666667	1.541666667	1.083333333	2.166666667	1.214285714	1.45
E_rc [Wh]	running energy of reference cycle accord	19.00	37	26	52	51	87
E_sc [Wh]	running energy of the short cycle	0.00	0	0	0	0	0
s_sc [m]	one-way travel distance of the short cycle	0.00	0.00	0.00	0.00	0.00	0.00
aditionally							
E_spc [mWh/(kg m)]		1.53	3.60	1.50	3.61	1.08	1.04
k_L		0.87	1.05	0.87	1.05	0.87	0.9
E_rav [Wh]		8.31	18.13	12.74	26.48	24.88	38.28
Q [kg]		450.00	450.00	630.00	630.00	1000.00	1250.00
s_av [m]		5.88	5.88	5.88	5.88	10.29	13.2
E_spr [mWh/(kg m)]							
E_rc [Wh]		19.00	37.00	26.00	52.00	51.00	87.00
Q [kg]		450.00	450.00	630.00	630.00	1000.00	1250.00
s_rc [m]		12.00	12.00	12.00	12.00	21.00	30.00

Annex C: Detailed bill of materials per Base-Case and MEErP eco-indicator

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EcoReport 2014: INPUTS Assessment of Environmental Impact

ECO-DESIGN OF ENERGY RELATED/USING PRODUCTS

Nr	Product name: Base case 1A Products	Date 07/02/2019	Author VITO

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
	Electric Motor - Motor [3kW PM]				
1	stator / rotor - electrical steel	45000,0	3-Ferro	25 -Ferrite	Yes
2	bearings, shaft, fan shroud - steel	11250,0	3-Ferro	26 -Stainless 18/8 coil	Yes
3	Frame - cast iron	40000,0	3-Ferro	24 -Cast iron	Yes
4	rotor bars, end rings - aluminium	4500,0	4-Non-ferro	28 -Al diecast	Yes
5	windings, leads - copper	10000,0	4-Non-ferro	30 -Cu wire	Yes
6	terminal board, winding insulation - insulation	220,0	2-TecPlastics	15 -Epoxy	No
7	winding impregnation - impregnation resin	275,0	2-TecPlastics	15 -Epoxy	No
8	fan - plastic	1125,0	1-BlkPlastics	11 -ABS	No
9	paint - paint	500,0	5-Coating	40 -powder coating	No
10	permanent magnets - NeFeB magnet	3900,0	8-Extra	105-Permanent magnet	Yes
11	-				
12	**Gear box**				
13	worm shaft - steel alloy	0,0	3-Ferro	24 -Cast iron	Yes
14	worm wheel - bronze	0,0	4-Non-ferro	32 -CuZn38 cast	Yes
15	bearings - alloy steel	0,0	3-Ferro	26 -Stainless 18/8 coil	Yes
16	encasing - cast iron	0,0	3-Ferro	24 -Cast iron	Yes
17	seals - rubber	0,0	1-BlkPlastics	9 -SAN	No
18	oil - Synthetic Gear Oil [5.5L dens.=0.9]	0,0	8-Extra	102-Mineral oil	No
19	paint - paint	0,0	5-Coating	40 -powder coating	No
20	-				
21	**Traction sheave -**				
22	sheave shaft - steel alloy	10000,0	3-Ferro	26 -Stainless 18/8 coil	Yes
23	sheave - cast iron	15000,0	3-Ferro	24 -Cast iron	Yes
24	-				
25	**Brake -**				
26	frame - cast iron	3000,0	3-Ferro	24 -Cast iron	Yes
27	electromagnetic coil - copper winding	1000,0	4-Non-ferro	29 -Cu winding wire	Yes
28	springs - steel	500,0	3-Ferro	23 -St tube/profile	Yes
29	brake drum - steel	2000,0	3-Ferro	25 -Ferrite	Yes
30	brake shoe -	1000,0	1-BlkPlastics	9 -SAN	
31	other - steel	1500,0	3-Ferro	25 -Ferrite	Yes
32	-				
33	**Speed governor -**				
34	mount - steel	6000,0	3-Ferro	25 -Ferrite	Yes
35	sheave - cast iron	6000,0	3-Ferro	24 -Cast iron	Yes
36	spring - steel	170,0	3-Ferro	23 -St tube/profile	Yes
37	other - steel	2000,0	3-Ferro	25 -Ferrite	Yes
38	-				
39	**Bedplate - steel**	30000,0	3-Ferro	22 -St sheet galv.	Yes
40					

Task 5

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
	Controller -				
41	cabinet - sheet steel	24000,0	3-Ferro	22 -St sheet galv.	Yes
42	paint - paint	1200,0	5-Coating	40 -powder coating	No
43	Electronics - PCB, SMDs, Chips	70000,0	6-Electronics	50 -PWB 1/2 lay 3.75kg/m2	No
44	Wiring - copper/plastic	7000,0	4-Non-ferro	30 -Cu wire	No
45	electromechanichal switches - plastic	10000,0	1-BlkPlastics	2 -HDPE	No
46	electromechanichal switches - copper	150,0	4-Non-ferro	31 -Cu tube/sheet	Yes
47	-				
48	**Guide rails -**				
49	rails car - steel (T70) [8.83kg/m]	211900,0	3-Ferro	23 -St tube/profile	Yes
50	rails counterweight - steel (T45) [3.34kg/m]	80200,0	3-Ferro	23 -St tube/profile	Yes
51	brackets (every 2m) - steel	165000,0	3-Ferro	23 -St tube/profile	Yes
52	-				
53	**Car -**				
54	car sling structure - steel	52000,0	3-Ferro	23 -St tube/profile	Yes
55	guide Shoes - cast iron	20000,0	3-Ferro	24 -Cast iron	Yes
56	car walls / roof - Stainless steel sheet [den. 8kg/dm3]	175000,0	3-Ferro	26 -Stainless 18/8 coil	Yes
57	platform - steel	40000,0	3-Ferro	22 -St sheet galv.	Yes
58	glass/mirror - glass	5000,0	7-Misc.	55 -Glass for lamps	Yes
59	hand rail - steel tube	5000,0	3-Ferro	23 -St tube/profile	Yes
60	floor - vinyl/stone	0,0	1-BlkPlastics	8 -PVC	No
61	lighting - LED [LED Spots, 0.130 each]	520,0	6-Electronics	49 -SMD/ LED's avg.	No
62	other (e.g. decorations, nuts and bolts, linings, etc) - What	30000,0	3-Ferro	24 -Cast iron	Yes
63	-				
64	**Car Door - steel sheet**	60000,0	3-Ferro	22 -St sheet galv.	Yes
65	-				
66	**Landing Doors - steel sheet**	300000,0	3-Ferro	22 -St sheet galv.	Yes
67	-				
68	**Car Door Operators -**				
69	stator / rotor - electrical steel	1156,1	3-Ferro	25 -Ferrite	Yes
70	bearings, shaft, fan shroud - steel	289,0	3-Ferro	26 -Stainless 18/8 coil	Yes
71	Frame - cast iron	1027,7	3-Ferro	24 -Cast iron	Yes
72	rotor bars, end rings - aluminium	115,6	4-Non-ferro	28 -Al diecast	Yes
73	windings, leads - copper	256,9	4-Non-ferro	30 -Cu wire	Yes
74	terminal board, winding insulation - insulation	5,7	2-TecPlastics	15 -Epoxy	No
75	winding impregnation - impregnation resin	7,1	2-TecPlastics	15 -Epoxy	No
76	fan - plastic	28,9	1-BlkPlastics	11 -ABS	No
77	paint - paint	12,8	5-Coating	40 -powder coating	No
78	belt - rubber	300,0	1-BlkPlastics	9 -SAN	No
79	pulleys - abs plastic	1000,0	1-BlkPlastics	11 -ABS	No
80	controller - pcb	3000,0	6-Electronics	98 -controller board	No
81	-				
82	**Diverter pulleys - cast iron**	60000,0	3-Ferro	24 -Cast iron	Yes
83	-				
84	**Ropes - steel**				
85	hoisting - steel	84400,0	3-Ferro	25 -Ferrite	Yes
86	governor - steel	6600,0	3-Ferro	24 -Cast iron	Yes
87	-				

Task 5

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
88					
89	**Landing indicators and buttons -**				
90	LEDs - LED	0,0	6-Electronics	49 -SMD/ LED's avg.	No
91	buttons - plastic	250,0	1-BlkPlastics	2 -HDPE	No
92	panel - steel sheet	1000,0	3-Ferro	22 -St sheet galv.	Yes
93	PCB (Printed Circuit Board) - PCB	400,0	6-Electronics	98 -controller board	No
94	SMDs (Surface Mounted Devices) - SMD	0,0	6-Electronics	49 -SMD/ LED's avg.	No
95	wiring - copper	400,0	4-Non-ferro	30 -Cu wire	Yes
96	-				
97	**Car indicators and buttons -**				
98	LEDs - LED	0,0	6-Electronics	49 -SMD/ LED's avg.	No
99	buttons - plastic	2000,0	1-BlkPlastics	2 -HDPE	No
100	panel - steel sheet	14000,0	3-Ferro	22 -St sheet galv.	Yes
101	PCB - PCB	1000,0	6-Electronics	98 -controller board	No
102	SMDs - SMD	0,0	6-Electronics	49 -SMD/ LED's avg.	No
103	wiring - copper	600,0	4-Non-ferro	30 -Cu wire	Yes
104	-				
105	**Counterweight -**				
106	counterweight frame - steel	40000,0	3-Ferro	23 -St tube/profile	Yes
107	counterweights - cast iron /concrete	296000,0	3-Ferro	24 -Cast iron	Yes
108	counterweights - cast iron /concrete	296000,0	7-Misc.	59 -Concrete	Yes
109					
110	**Cylinder/Piston -**				
111	-	0,0			
112	**Pump -**				
113	casing -	0,0			
114	shaft -	0,0			
115	screw -	0,0			
116	bearings -	0,0			
117	-				
118	**Control Valve -**	0,0			
119	-				
120	**Cabinet -**	0,0			
121	-				
122	**Oil -**	0,0			
123	-				
124	**Buffer - steel**	14000,0	3-Ferro	24 -Cast iron	Yes
125	-				
126	**Hoistway Wiring - copper wire**	40000,0	4-Non-ferro	30 -Cu wire	Yes
127	-				
128	**Intercom -**	2000,0	6-Electronics	98 -controller board	
129	-				
130					
131					
132					
133					
134					

ECO-DESIGN OF ENERGY RELATED/USING PRODUCTS	EcoReport 2014: INPUTS Environmental Impact		Assessment of
Nr	Product name: Base case 1B Products	Date 07/02/2019	Author VITO

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
	Electric Motor - Motor [6kW AC Induction]				
1	stator / rotor - electrical steel	26400,0	3-Ferro	25 -Ferrite	Yes
2	bearings, shaft, fan shroud - steel	5500,0	3-Ferro	26 -Stainless 18/8 coil	Yes
3	Frame - cast iron	20500,0	3-Ferro	24 -Cast iron	Yes
4	rotor bars, end rings - aluminium	2000,0	4-Non-ferro	28 -Al diecast	Yes
5	windings, leads - copper	4862,0	4-Non-ferro	30 -Cu wire	Yes
6	terminal board, winding insulation - insulation	88,0	2-TecPlastics	15 -Epoxy	No
7	winding impregnation - impregnation resin	110,0	2-TecPlastics	15 -Epoxy	No
8	fan - plastic	550,0	1-BlkPlastics	11 -ABS	No
9	paint - paint	275,0	5-Coating	40 -powder coating	No
10	permanent magnets - [not used for this base case]	0,0	8-Extra	105-Permanent magnet	Yes
11	-				
12	**Gear box**				
13	worm shaft - steel alloy	0,0	3-Ferro	24 -Cast iron	Yes
14	worm wheel - bronze	0,0	4-Non-ferro	32 -CuZn38 cast	Yes
15	bearings - alloy steel	0,0	3-Ferro	26 -Stainless 18/8 coil	Yes
16	encasing - cast iron	0,0	3-Ferro	24 -Cast iron	Yes
17	seals - rubber	0,0	1-BlkPlastics	9 -SAN	No
18	oil - Synthetic Gear Oil [5.5L dens.=0.9]	0,0	8-Extra	102-Mineral oil	No
19	paint - paint	0,0	5-Coating	40 -powder coating	No
20	-				
21	**Traction sheave -**				
22	sheave shaft -	0,0	3-Ferro	26 -Stainless 18/8 coil	Yes
23	sheave -	0,0	3-Ferro	24 -Cast iron	Yes
24	-				
25	**Brake -**				
26	frame -	0,0	3-Ferro	24 -Cast iron	Yes
27	electromagnetic coil -	0,0	4-Non-ferro	29 -Cu winding wire	Yes
28	springs -	0,0	3-Ferro	23 -St tube/profile	Yes
29	brake drum -	0,0	3-Ferro	25 -Ferrite	Yes
30	brake shoe -	0,0	1-BlkPlastics	9 -SAN	
31	other -	0,0	3-Ferro	25 -Ferrite	Yes
32	-				
33	**Speed governor -**				
34	mount -	0,0	3-Ferro	25 -Ferrite	Yes
35	sheave -	0,0	3-Ferro	24 -Cast iron	Yes
36	spring -	0,0	3-Ferro	23 -St tube/profile	Yes
37	other -	0,0	3-Ferro	25 -Ferrite	Yes
38	-				
39	**Bedplate -**	0,0	3-Ferro	22 -St sheet galv.	Yes
40					

Task 5

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
	Controller -				
41	cabinet - sheet steel	39000,0	3-Ferro	22 -St sheet galv.	Yes
42	paint - paint	1200,0	5-Coating	40 -powder coating	No
43	Electronics - PCB, SMDs, Chips	47800,0	6-Electronics	50 -PWB 1/2 lay 3.75kg/m2	No
44	Wiring - copper/plastic	6000,0	4-Non-ferro	30 -Cu wire	No
45	electromechanichal switches - plastic	10000,0	1-BlkPlastics	2 -HDPE	No
46	electromechanichal switches - copper	150,0	4-Non-ferro	31 -Cu tube/sheet	Yes
47	-				
48	**Guide rails -**				
49	rails car - steel (T70) [8.83kg/m]	211900,0	3-Ferro	23 -St tube/profile	Yes
50	rails counterweight -	0,0	3-Ferro	23 -St tube/profile	Yes
51	brackets (every 2m) - steel	165000,0	3-Ferro	23 -St tube/profile	Yes
52	-				
53	**Car -**				
54	car sling structure - steel	52000,0	3-Ferro	23 -St tube/profile	Yes
55	guide Shoes - cast iron	20000,0	3-Ferro	24 -Cast iron	Yes
56	car walls / roof - Stainless steel sheet	175000,0	3-Ferro	26 -Stainless 18/8 coil	Yes
57	platform - steel	40000,0	3-Ferro	22 -St sheet galv.	Yes
58	glass/mirror - glass	5000,0	7-Misc.	55 -Glass for lamps	Yes
59	hand rail - steel tube	5000,0	3-Ferro	23 -St tube/profile	Yes
60	floor - vinyl/stone	0,0	1-BlkPlastics	8 -PVC	No
61	lighting - LED [LED Spots, 0.130 each]	520,0	6-Electronics	49 -SMD/ LED's avg.	No
62	other (e.g. decorations, nuts and bolts, linings, etc) - What	30000,0	3-Ferro	24 -Cast iron	Yes
63	-				
64	**Car Door - steel sheet**	60000,0	3-Ferro	22 -St sheet galv.	Yes
65	-				
66	**Landing Doors - steel sheet**	300000,0	3-Ferro	22 -St sheet galv.	Yes
67	-				
68	**Car Door Operators -**				
69	stator / rotor - electrical steel	1313,8	3-Ferro	25 -Ferrite	Yes
70	bearings, shaft, fan shroud - steel	273,7	3-Ferro	26 -Stainless 18/8 coil	Yes
71	Frame - cast iron	1020,2	3-Ferro	24 -Cast iron	Yes
72	rotor bars, end rings - aluminium	99,5	4-Non-ferro	28 -Al diecast	Yes
73	windings, leads - copper	242,0	4-Non-ferro	30 -Cu wire	Yes
74	terminal board, winding insulation - insulation	4,4	2-TecPlastics	15 -Epoxy	No
75	winding impregnation - impregnation resin	5,5	2-TecPlastics	15 -Epoxy	No
76	fan - plastic	27,4	1-BlkPlastics	11 -ABS	No
77	paint - paint	13,7	5-Coating	40 -powder coating	No
78	belt - rubber	300,0	1-BlkPlastics	9 -SAN	No
79	pulleys - abs plastic	1000,0	1-BlkPlastics	11 -ABS	No
80	controller - pcb	3000,0	6-Electronics	98 -controller board	No
81	-				
82	**Diverter pulleys -**	0,0	3-Ferro	24 -Cast iron	Yes
83	-				
84	**Ropes -**				
85	hoisting -	0,0	3-Ferro	25 -Ferrite	Yes
86	governor -	0,0	3-Ferro	24 -Cast iron	Yes
87	-				

Task 5

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
88					
89	**Landing indicators and buttons -**				
90	LEDs - LED	0,0	6-Electronics	49 -SMD/ LED's avg.	No
91	buttons - plastic	250,0	1-BlkPlastics	2 -HDPE	No
92	panel - steel sheet	1000,0	3-Ferro	22 -St sheet galv.	Yes
93	PCB (Printed Circuit Board) - PCB	400,0	6-Electronics	98 -controller board	No
94	SMDs (Surface Mounted Devices) - SMD	0,0	6-Electronics	49 -SMD/ LED's avg.	No
95	wiring - copper	400,0	4-Non-ferro	30 -Cu wire	Yes
96	-				
97	**Car indicators and buttons -**				
98	LEDs - LED	0,0	6-Electronics	49 -SMD/ LED's avg.	No
99	buttons - plastic	2000,0	1-BlkPlastics	2 -HDPE	No
100	panel - steel sheet	14000,0	3-Ferro	22 -St sheet galv.	Yes
101	PCB - PCB	1000,0	6-Electronics	98 -controller board	No
102	SMDs - SMD	0,0	6-Electronics	49 -SMD/ LED's avg.	No
103	wiring - copper	600,0	4-Non-ferro	30 -Cu wire	Yes
104	-				
105	**Counterweight -**				
106	counterweight frame -	0,0	3-Ferro	23 -St tube/profile	Yes
107	counterweights -	0,0	3-Ferro	24 -Cast iron	Yes
108	counterweights -	0,0	7-Misc.	59 -Concrete	Yes
109					
110	**Cylinder/Piston - steel tube [9kg/m]**	108000,0	3-Ferro	26 -Stainless 18/8 coil	Yes
111	-				
112	**Pump -**				
113	casing - cast iron	2500,0	3-Ferro	24 -Cast iron	Yes
114	shaft - steel	1000,0	3-Ferro	23 -St tube/profile	Yes
115	screw - steel	1800,0	3-Ferro	23 -St tube/profile	Yes
116	bearings - steel	500,0	3-Ferro	23 -St tube/profile	Yes
117	-				
118	**Control Valve - cast iron**	18000,0	3-Ferro	24 -Cast iron	Yes
119	-				
120	**Cabinet - steel sheet**	10000,0	3-Ferro	22 -St sheet galv.	Yes
121	-				
122	**Oil - hydraulic fluid**	175500,0	8-Extra	102-Mineral oil	No
123	-				
124	**Buffer - steel**	14000,0	3-Ferro	24 -Cast iron	Yes
125	-				
126	**Hoistway Wiring - copper wire**	40000,0	4-Non-ferro	30 -Cu wire	Yes
127	-				
128	**Intercom -**	2000,0	6-Electronics	98 -controller board	
129	-				
130					
131					
132					
133					
134					

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ECO-DESIGN OF ENERGY RELATED/USING PRODUCTS

EcoReport 2014: INPUTS
Environmental Impact

Assessment of

Nr	Product name: Base case 2A Products	Date 07/02/2019	Author VITO

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
	Electric Motor - Motor [4.5kW PM]				
1	stator / rotor - electrical steel	63900,0	3-Ferro	25 -Ferrite	Yes
2	bearings, shaft, fan shroud - steel	13500,0	3-Ferro	26 -Stainless 18/8 coil	Yes
3	Frame - cast iron	51480,0	3-Ferro	24 -Cast iron	Yes
4	rotor bars, end rings - aluminium	5040,0	4-Non-ferro	28 -Al diecast	Yes
5	windings, leads - copper	11700,0	4-Non-ferro	30 -Cu wire	Yes
6	terminal board, winding insulation - insulation	252,0	2-TecPlastics	15 -Epoxy	No
7	winding impregnation - impregnation resin	306,0	2-TecPlastics	15 -Epoxy	No
8	fan - plastic	1530,0	1-BlkPlastics	11 -ABS	No
9	paint - paint	756,0	5-Coating	40 -powder coating	No
10	permanent magnets - NeFeB magnet	5200,0	8-Extra	105-Permanent magnet	Yes
11	-				
12	**Gear box**				
13	worm shaft - steel alloy	0,0	3-Ferro	24 -Cast iron	Yes
14	worm wheel - bronze	0,0	4-Non-ferro	32 -CuZn38 cast	Yes
15	bearings - alloy steel	0,0	3-Ferro	26 -Stainless 18/8 coil	Yes
16	encasing - cast iron	0,0	3-Ferro	24 -Cast iron	Yes
17	seals - rubber	0,0	1-BlkPlastics	9 -SAN	No
18	oil - Synthetic Gear Oil [5.5L dens.=0.9]	0,0	8-Extra	102-Mineral oil	No
19	paint - paint	0,0	5-Coating	40 -powder coating	No
20	-				
21	**Traction sheave -**				
22	sheave shaft - steel alloy	20000,0	3-Ferro	26 -Stainless 18/8 coil	Yes
23	sheave - cast iron	30000,0	3-Ferro	24 -Cast iron	Yes
24	-				
25	**Brake -**				
26	frame - steel	4000,0	3-Ferro	24 -Cast iron	Yes
27	electromagnetic coil - copper winding	2000,0	4-Non-ferro	29 -Cu winding wire	Yes
28	springs - steel	800,0	3-Ferro	23 -St tube/profile	Yes
29	brake drum - steel	3000,0	3-Ferro	25 -Ferrite	Yes
30	brake shoe -	1500,0	1-BlkPlastics	9 -SAN	
31	other - steel	1800,0	3-Ferro	25 -Ferrite	Yes
32	-				
33	**Speed governor -**				
34	mount - steel	6000,0	3-Ferro	25 -Ferrite	Yes
35	sheave - cast iron	6000,0	3-Ferro	24 -Cast iron	Yes
36	spring - steel	170,0	3-Ferro	23 -St tube/profile	Yes
37	other - steel	2000,0	3-Ferro	25 -Ferrite	Yes
38	-				
39	**Bedplate - steel**	35000,0	3-Ferro	22 -St sheet galv.	Yes
40					

Task 5

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
	Controller -				
41	cabinet - sheet steel	24000,0	3-Ferro	22 -St sheet galv.	Yes
42	paint - paint	1200,0	5-Coating	40 -powder coating	No
43	Electronics - PCB, SMDs, Chips	70000,0	6-Electronics	50 -PWB 1/2 lay 3.75kg/m2	No
44	Wiring - copper/plastic	7000,0	4-Non-ferro	30 -Cu wire	No
45	electromechanichal switches - plastic	10000,0	1-BlkPlastics	2 -HDPE	No
46	electromechanichal switches - copper	150,0	4-Non-ferro	31 -Cu tube/sheet	Yes
47	-				
48	**Guide rails -**				
49	rails car - steel (T89) [12.38kg/m]	297120,0	3-Ferro	23 -St tube/profile	Yes
50	rails counterweight - steel (T70) [8.83kg/m]	211920,0	3-Ferro	23 -St tube/profile	Yes
51	brackets (every 2m) - steel	165000,0	3-Ferro	23 -St tube/profile	Yes
52	-				
53	**Car -**				
54	car sling structure - steel	61800,0	3-Ferro	23 -St tube/profile	Yes
55	guide Shoes - cast iron	20000,0	3-Ferro	24 -Cast iron	Yes
56	car walls / roof - Stainless steel sheet	150000,0	3-Ferro	26 -Stainless 18/8 coil	Yes
57	platform - steel	130000,0	3-Ferro	22 -St sheet galv.	Yes
58	glass/mirror - glass	10000,0	7-Misc.	55 -Glass for lamps	Yes
59	hand rail - steel tube	8000,0	3-Ferro	23 -St tube/profile	Yes
60	floor - vinyl/stone	30000,0	1-BlkPlastics	8 -PVC	No
61	lighting - LED (6x)	780,0	6-Electronics	49 -SMD/ LED's avg.	No
62	other (e.g. decorations, nuts and bolts, linings, etc) - What	40000,0	3-Ferro	24 -Cast iron	Yes
63	-				
64	**Car Door - steel sheet**	70000,0	3-Ferro	22 -St sheet galv.	Yes
65	-				
66	**Landing Doors - steel sheet**	350000,0	3-Ferro	22 -St sheet galv.	Yes
67	-				
68	**Car Door Operators -**				
69	stator / rotor - electrical steel	1247,5	3-Ferro	25 -Ferrite	Yes
70	bearings, shaft, fan shroud - steel	263,6	3-Ferro	26 -Stainless 18/8 coil	Yes
71	Frame - cast iron	1005,0	3-Ferro	24 -Cast iron	Yes
72	rotor bars, end rings - aluminium	98,4	4-Non-ferro	28 -Al diecast	Yes
73	windings, leads - copper	228,4	4-Non-ferro	30 -Cu wire	Yes
74	terminal board, winding insulation - insulation	4,9	2-TecPlastics	15 -Epoxy	No
75	winding impregnation - impregnation resin	6,0	2-TecPlastics	15 -Epoxy	No
76	fan - plastic	29,9	1-BlkPlastics	11 -ABS	No
77	paint - paint	14,8	5-Coating	40 -powder coating	No
78	belt - rubber	300,0	1-BlkPlastics	9 -SAN	No
79	pulleys - abs plastic	1000,0	1-BlkPlastics	11 -ABS	No
80	controller - pcb	3000,0	6-Electronics	98 -controller board	No
81	-				
82	**Diverter pulleys - cast iron**	60000,0	3-Ferro	24 -Cast iron	Yes
83	-				
84	**Ropes -**				
85	hoisting - steel	126720,0	3-Ferro	25 -Ferrite	Yes
86	governor - steel	6600,0	3-Ferro	24 -Cast iron	Yes
87	-				

Task 5

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
88					
89	**Landing indicators and buttons -**				
90	LEDs - LED	0,0	6-Electronics	49 -SMD/ LED's avg.	No
91	buttons - plastic	250,0	1-BlkPlastics	2 -HDPE	No
92	panel - steel sheet	1000,0	3-Ferro	22 -St sheet galv.	Yes
93	PCB (Printed Circuit Board) - PCB	400,0	6-Electronics	98 -controller board	No
94	SMDs (Surface Mounted Devices) - SMD	0,0	6-Electronics	49 -SMD/ LED's avg.	No
95	wiring - copper	400,0	4-Non-ferro	30 -Cu wire	Yes
96	-				
97	**Car indicators and buttons -**				
98	LEDs - LED	0,0	6-Electronics	49 -SMD/ LED's avg.	No
99	buttons - plastic	2000,0	1-BlkPlastics	2 -HDPE	No
100	panel - steel sheet	14000,0	3-Ferro	22 -St sheet galv.	Yes
101	PCB - PCB	1000,0	6-Electronics	98 -controller board	No
102	SMDs - SMD	0,0	6-Electronics	49 -SMD/ LED's avg.	No
103	wiring - copper	600,0	4-Non-ferro	30 -Cu wire	Yes
104	-				
105	**Counterweight -**				
106	counterweight frame - steel	50000,0	3-Ferro	23 -St tube/profile	Yes
107	counterweights - cast iron /concrete	312500,0	3-Ferro	24 -Cast iron	Yes
108	counterweights - cast iron /concrete	312500,0	7-Misc.	59 -Concrete	Yes
109					
110	**Cylinder/Piston -**		3-Ferro	26 -Stainless 18/8 coil	Yes
111	-	0,0			
112	**Pump -**				
113	casing -	0,0	3-Ferro	24 -Cast iron	Yes
114	shaft -	0,0	3-Ferro	23 -St tube/profile	Yes
115	screw -	0,0	3-Ferro	23 -St tube/profile	Yes
116	bearings -	0,0	3-Ferro	23 -St tube/profile	Yes
117	-				
118	**Control Valve -**	0,0	3-Ferro	24 -Cast iron	Yes
119	-				
120	**Cabinet -**	0,0	3-Ferro	22 -St sheet galv.	Yes
121	-				
122	**Oil -**	0,0	8-Extra	102-Mineral oil	No
123	-				
124	**Buffer - steel**	15000,0	3-Ferro	24 -Cast iron	Yes
125	-				
126	**Hoistway Wiring - copper wire**	40000,0	4-Non-ferro	30 -Cu wire	Yes
127	-				
128	**Intercom -**	2000,0	6-Electronics	98 -controller board	
129	-				
130					
131					
132					
133					
134					

Version 3.06 VHK for European Commission 2011, modified by IZM for european commission 2014			Document subject to a legal notice (see below)	
ECO-DESIGN OF ENERGY RELATED/USING PRODUCTS		EcoReport 2014: INPUTS Environmental Impact		Assessment of

Nr	Product name: Base case 2B Products	Date 07/02/2019	Author VITO

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
	Electric Motor - Motor 9.5kW [AC Induction]				
1	stator / rotor - electrical steel	40700,0	3-Ferro	25 -Ferrite	Yes
2	bearings, shaft, fan shroud - steel	8500,0	3-Ferro	26 -Stainless 18/8 coil	Yes
3	Frame - cast iron	31600,0	3-Ferro	24 -Cast iron	Yes
4	rotor bars, end rings - aluminium	3100,0	4-Non-ferro	28 -Al diecast	Yes
5	windings, leads - copper	7500,0	4-Non-ferro	30 -Cu wire	Yes
6	terminal board, winding insulation - insulation	140,0	2-TecPlastics	15 -Epoxy	No
7	winding impregnation - impregnation resin	170,0	2-TecPlastics	15 -Epoxy	No
8	fan - plastic	850,0	1-BlkPlastics	11 -ABS	No
9	paint - paint	420,0	5-Coating	40 -powder coating	No
10	permanent magnets - [not used for this base case]	0,0	8-Extra	105-Permanent magnet	Yes
11	-				
12	**Gear box**				
13	worm shaft - steel alloy	0,0	3-Ferro	24 -Cast iron	Yes
14	worm wheel - bronze	0,0	4-Non-ferro	32 -CuZn38 cast	Yes
15	bearings - alloy steel	0,0	3-Ferro	26 -Stainless 18/8 coil	Yes
16	encasing - cast iron	0,0	3-Ferro	24 -Cast iron	Yes
17	seals - rubber	0,0	1-BlkPlastics	9 -SAN	No
18	oil - Synthetic Gear Oil [5.5L dens.=0.9]	0,0	8-Extra	102-Mineral oil	No
19	paint - paint	0,0	5-Coating	40 -powder coating	No
20	-				
21	**Traction sheave - 240mm**				
22	sheave shaft -	0,0	3-Ferro	26 -Stainless 18/8 coil	Yes
23	sheave -	0,0	3-Ferro	24 -Cast iron	Yes
24	-				
25	**Brake -**				
26	frame -	0,0	3-Ferro	24 -Cast iron	Yes
27	electromagnetic coil -	0,0	4-Non-ferro	29 -Cu winding wire	Yes
28	springs -	0,0	3-Ferro	23 -St tube/profile	Yes
29	brake drum -	0,0	3-Ferro	25 -Ferrite	Yes
30	brake shoe -	0,0	1-BlkPlastics	9 -SAN	
31	other -	0,0	3-Ferro	25 -Ferrite	Yes
32	-				
33	**Speed governor -**				
34	mount -	0,0	3-Ferro	25 -Ferrite	Yes
35	sheave -	0,0	3-Ferro	24 -Cast iron	Yes
36	spring -	0,0	3-Ferro	23 -St tube/profile	Yes
37	other -	0,0	3-Ferro	25 -Ferrite	Yes
38	-				
39	**Bedplate -**	0,0	3-Ferro	22 -St sheet galv.	Yes
40					

Task 5

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
	Controller -				
41	cabinet - sheet steel	39000,0	3-Ferro	22 -St sheet galv.	Yes
42	paint - paint	1200,0	5-Coating	40 -powder coating	No
43	Electronics - PCB, SMDs, Chips	47800,0	6-Electronics	50 -PWB 1/2 lay 3.75kg/m2	No
44	Wiring - copper/plastic	6000,0	4-Non-ferro	30 -Cu wire	No
45	electromechanichal switches - plastic	10000,0	1-BlkPlastics	2 -HDPE	No
46	electromechanichal switches - copper	150,0	4-Non-ferro	31 -Cu tube/sheet	Yes
47	-				
48	**Guide rails -**				
49	rails car - steel (T89) [12.38kg/m]	297120,0	3-Ferro	23 -St tube/profile	Yes
50	rails counterweight -	0,0	3-Ferro	23 -St tube/profile	Yes
51	brackets (every 2m) - steel	165000,0	3-Ferro	23 -St tube/profile	Yes
52	-				
53	**Car -**				
54	car sling structure - steel	61800,0	3-Ferro	23 -St tube/profile	Yes
55	guide Shoes - cast iron	20000,0	3-Ferro	24 -Cast iron	Yes
56	car walls / roof - Stainless steel sheet	150000,0	3-Ferro	26 -Stainless 18/8 coil	Yes
57	platform - steel	130000,0	3-Ferro	22 -St sheet galv.	Yes
58	glass/mirror - glass	10000,0	7-Misc.	55 -Glass for lamps	Yes
59	hand rail - steel tube	8000,0	3-Ferro	23 -St tube/profile	Yes
60	floor - vinyl/stone	30000,0	1-BlkPlastics	8 -PVC	No
61	lighting - LED (6x)	780,0	6-Electronics	49 -SMD/ LED's avg.	No
62	other (e.g. decorations, nuts and bolts, linings, etc) - What	40000,0	3-Ferro	24 -Cast iron	Yes
63	-				
64	**Car Door - steel sheet**	70000,0	3-Ferro	22 -St sheet galv.	Yes
65	-				
66	**Landing Doors - steel sheet**	350000,0	3-Ferro	22 -St sheet galv.	Yes
67	-				
68	**Car Door Operators -**				
69	stator / rotor - electrical steel	1313,2	3-Ferro	25 -Ferrite	Yes
70	bearings, shaft, fan shroud - steel	274,3	3-Ferro	26 -Stainless 18/8 coil	Yes
71	Frame - cast iron	1019,6	3-Ferro	24 -Cast iron	Yes
72	rotor bars, end rings - aluminium	100,0	4-Non-ferro	28 -Al diecast	Yes
73	windings, leads - copper	242,0	4-Non-ferro	30 -Cu wire	Yes
74	terminal board, winding insulation - insulation	4,5	2-TecPlastics	15 -Epoxy	No
75	winding impregnation - impregnation resin	5,5	2-TecPlastics	15 -Epoxy	No
76	fan - plastic	27,4	1-BlkPlastics	11 -ABS	No
77	paint - paint	13,6	5-Coating	40 -powder coating	No
78	belt - rubber	300,0	1-BlkPlastics	9 -SAN	No
79	pulleys - abs plastic	1000,0	1-BlkPlastics	11 -ABS	No
80	controller - pcb	3000,0	6-Electronics	98 -controller board	No
81	-				
82	**Diverter pulleys -**	0,0	3-Ferro	24 -Cast iron	Yes
83	-				
84	**Ropes -**				
85	hoisting - steel	0,0	3-Ferro	25 -Ferrite	Yes
86	governor - steel	0,0	3-Ferro	24 -Cast iron	Yes
87	-				

Task 5

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
88					
89	**Landing indicators and buttons -**				
90	LEDs - LED	0,0	6-Electronics	49 -SMD/ LED's avg.	No
91	buttons - plastic	250,0	1-BlkPlastics	2 -HDPE	No
92	panel - steel sheet	1000,0	3-Ferro	22 -St sheet galv.	Yes
93	PCB (Printed Circuit Board) - PCB	400,0	6-Electronics	98 -controller board	No
94	SMDs (Surface Mounted Devices) - SMD	0,0	6-Electronics	49 -SMD/ LED's avg.	No
95	wiring - copper	400,0	4-Non-ferro	30 -Cu wire	Yes
96	-				
97	**Car indicators and buttons -**				
98	LEDs - LED	0,0	6-Electronics	49 -SMD/ LED's avg.	No
99	buttons - plastic	2000,0	1-BlkPlastics	2 -HDPE	No
100	panel - steel sheet	14000,0	3-Ferro	22 -St sheet galv.	Yes
101	PCB - PCB	1000,0	6-Electronics	98 -controller board	No
102	SMDs - SMD	0,0	6-Electronics	49 -SMD/ LED's avg.	No
103	wiring - copper	600,0	4-Non-ferro	30 -Cu wire	Yes
104	-				
105	**Counterweight -**				
106	counterweight frame -	0,0	3-Ferro	23 -St tube/profile	Yes
107	counterweights -	0,0	3-Ferro	24 -Cast iron	Yes
108	counterweights -	0,0	7-Misc.	59 -Concrete	Yes
109					
110	**Cylinder/Piston - steel tube**	144000,0	3-Ferro	26 -Stainless 18/8 coil	Yes
111	-				
112	**Pump -**				
113	casing - cast iron	3200,0	3-Ferro	24 -Cast iron	Yes
114	shaft - steel	1500,0	3-Ferro	23 -St tube/profile	Yes
115	screw - steel	2200,0	3-Ferro	23 -St tube/profile	Yes
116	bearings - steel	700,0	3-Ferro	23 -St tube/profile	Yes
117	-				
118	**Control Valve - cast iron**	18000,0	3-Ferro	24 -Cast iron	Yes
119	-				
120	**Cabinet - steel sheet**	10000,0	3-Ferro	22 -St sheet galv.	Yes
121	-				
122	**Oil - hydraulic fluid**	270000,0	8-Extra	102-Mineral oil	No
123	-				
124	**Buffer - steel**	15000,0	3-Ferro	24 -Cast iron	Yes
125	-				
126	**Hoistway Wiring - copper wire**	40000,0	4-Non-ferro	30 -Cu wire	Yes
127	-				
128	**Intercom -**	2000,0	6-Electronics	98 -controller board	
129					
130					
131					
132					
133					
134					

Version 3.06 VHK for European Commission 2011, modified by IZM for european commission 2014				Document subject to a legal notice (see below)	
ECO-DESIGN OF ENERGY RELATED/USING PRODUCTS		EcoReport 2014: INPUTS Environmental Impact		Assessment of	
Nr	Product name: Base case 3 Products	Date 07/02/2019	Author VITO		
Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
	Electric Motor - Motor [8kW PM]				
1	stator / rotor - electrical steel	97625,0	3-Ferro	25 -Ferrite	Yes
2	bearings, shaft, fan shroud - steel	18480,0	3-Ferro	26 -Stainless 18/8 coil	Yes
3	Frame - cast iron	51200,0	3-Ferro	24 -Cast iron	Yes
4	rotor bars, end rings - aluminium	6710,0	4-Non-ferro	28 -Al diecast	Yes
5	windings, leads - copper	20600,0	4-Non-ferro	30 -Cu wire	Yes
6	terminal board, winding insulation - insulation	300,0	2-TecPlastics	15 -Epoxy	No
7	winding impregnation - impregnation resin	330,0	2-TecPlastics	15 -Epoxy	No
8	fan - plastic	1320,0	1-BlkPlastics	11 -ABS	No
9	paint - paint	770,0	5-Coating	40 -powder coating	No
10	permanent magnets - NeFeB magnet	7200,0	8-Extra	105-Permanent magnet	Yes
11	-				
12	**Gear box**				
13	worm shaft - steel alloy	0,0	3-Ferro	24 -Cast iron	Yes
14	worm wheel - bronze	0,0	4-Non-ferro	32 -CuZn38 cast	Yes
15	bearings - alloy steel	0,0	3-Ferro	26 -Stainless 18/8 coil	Yes
16	encasing - cast iron	0,0	3-Ferro	24 -Cast iron	Yes
17	seals - rubber	0,0	1-BlkPlastics	9 -SAN	No
18	oil - Synthetic Gear Oil [5.5L dens.=0.9]	0,0	8-Extra	102-Mineral oil	No
19	paint - paint	0,0	5-Coating	40 -powder coating	No
20	-				
21	**Traction sheave -**				
22	sheave shaft - steel alloy	20000,0	3-Ferro	26 -Stainless 18/8 coil	Yes
23	sheave - cast iron	30000,0	3-Ferro	24 -Cast iron	Yes
24	-				
25	**Brake -**				
26	frame - steel	4000,0	3-Ferro	24 -Cast iron	Yes
27	electromagnetic coil - copper winding	2000,0	4-Non-ferro	29 -Cu winding wire	Yes
28	springs - steel	800,0	3-Ferro	23 -St tube/profile	Yes
29	brake drum - steel	3000,0	3-Ferro	25 -Ferrite	Yes
30	brake shoe -	1500,0	1-BlkPlastics	9 -SAN	
31	other - steel	1800,0	3-Ferro	25 -Ferrite	Yes
32	-				
33	**Speed governor -**				
34	mount - steel	6000,0	3-Ferro	25 -Ferrite	Yes
35	sheave - cast iron	6000,0	3-Ferro	24 -Cast iron	Yes
36	spring - steel	170,0	3-Ferro	23 -St tube/profile	Yes
37	other -	2000,0	3-Ferro	25 -Ferrite	Yes
38	-				
39	**Bedplate - steel**	35000,0	3-Ferro	22 -St sheet galv.	Yes
40					

Task 5

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
	Controller -				
41	cabinet - sheet steel	24000,0	3-Ferro	22 -St sheet galv.	Yes
42	paint - paint	1200,0	5-Coating	40 -powder coating	No
43	Electronics - PCB, SMDs, Chips	70000,0	6-Electronics	50 -PWB 1/2 lay 3.75kg/m2	No
44	Wiring - copper/plastic	7000,0	4-Non-ferro	30 -Cu wire	No
45	electromechanichal switches - plastic	10000,0	1-BlkPlastics	2 -HDPE	No
46	electromechanichal switches - copper	150,0	4-Non-ferro	31 -Cu tube/sheet	Yes
47	-				
48	**Guide rails -**				
49	rails car - steel (T90) [13.54kg/m]	570000,0	3-Ferro	23 -St tube/profile	Yes
50	rails counterweight - steel (T70) [8.83kg/m]	370860,0	3-Ferro	23 -St tube/profile	Yes
51	brackets (every 2m) - steel	288000,0	3-Ferro	23 -St tube/profile	Yes
52	-				
53	**Car -**				
54	car sling structure - steel	87000,0	3-Ferro	23 -St tube/profile	Yes
55	guide Shoes - cast iron	25000,0	3-Ferro	24 -Cast iron	Yes
56	car walls / roof - Stainless steel sheet	260000,0	3-Ferro	26 -Stainless 18/8 coil	Yes
57	platform - steel	180000,0	3-Ferro	22 -St sheet galv.	Yes
58	glass/mirror - glass	10000,0	7-Misc.	55 -Glass for lamps	Yes
59	hand rail - steel tube	8000,0	3-Ferro	23 -St tube/profile	Yes
60	floor - vinyl/stone	30000,0	1-BlkPlastics	8 -PVC	No
61	lighting - LED (6x)	780,0	6-Electronics	49 -SMD/ LED's avg.	No
62	other (e.g. decorations, nuts and bolts, linings, etc) - What	40000,0	3-Ferro	24 -Cast iron	Yes
63	-				
64	**Car Door - steel sheet**	110000,0	3-Ferro	22 -St sheet galv.	Yes
65	-				
66	**Landing Doors - steel sheet**	880000,0	3-Ferro	22 -St sheet galv.	Yes
67	-				
68	**Car Door Operators -**				
69	stator / rotor - electrical steel	1909,2	3-Ferro	25 -Ferrite	Yes
70	bearings, shaft, fan shroud - steel	361,4	3-Ferro	26 -Stainless 18/8 coil	Yes
71	Frame - cast iron	1001,3	3-Ferro	24 -Cast iron	Yes
72	rotor bars, end rings - aluminium	131,2	4-Non-ferro	28 -Al diecast	Yes
73	windings, leads - copper	402,9	4-Non-ferro	30 -Cu wire	Yes
74	terminal board, winding insulation - insulation	5,9	2-TecPlastics	15 -Epoxy	No
75	winding impregnation - impregnation resin	6,5	2-TecPlastics	15 -Epoxy	No
76	fan - plastic	25,8	1-BlkPlastics	11 -ABS	No
77	paint - paint	15,1	5-Coating	40 -powder coating	No
78	belt - rubber	300,0	1-BlkPlastics	9 -SAN	No
79	pulleys - abs plastic	1000,0	1-BlkPlastics	11 -ABS	No
80	controller - pcb	3000,0	6-Electronics	98 -controller board	No
81	-				
82	**Diverter pulleys - cast iron**	120000,0	3-Ferro	24 -Cast iron	Yes
83	-				
84	**Ropes -**				
85	hoisting - steel	426000,0	3-Ferro	25 -Ferrite	Yes
86	governor - steel	13800,0	3-Ferro	24 -Cast iron	Yes
87	-				

Task 5

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
88					
89	**Landing indicators and buttons -**				
90	LEDs - LED	0,0	6-Electronics	49 -SMD/ LED's avg.	No
91	buttons - plastic	400,0	1-BlkPlastics	2 -HDPE	No
92	panel - steel sheet	1800,0	3-Ferro	22 -St sheet galv.	Yes
93	PCB (Printed Circuit Board) - PCB	700,0	6-Electronics	98 -controller board	No
94	SMDs (Surface Mounted Devices) - SMD	0,0	6-Electronics	49 -SMD/ LED's avg.	No
95	wiring - copper	700,0	4-Non-ferro	30 -Cu wire	Yes
96	-				
97	**Car indicators and buttons -**				
98	LEDs - LED	0,0	6-Electronics	49 -SMD/ LED's avg.	No
99	buttons - plastic	2400,0	1-BlkPlastics	2 -HDPE	No
100	panel - steel sheet	16000,0	3-Ferro	22 -St sheet galv.	Yes
101	PCB - PCB	1000,0	6-Electronics	98 -controller board	No
102	SMDs - SMD	0,0	6-Electronics	49 -SMD/ LED's avg.	No
103	wiring - copper	600,0	4-Non-ferro	30 -Cu wire	Yes
104	-				
105	**Counterweight -**				
106	counterweight frame - steel	72000,0	3-Ferro	23 -St tube/profile	Yes
107	counterweights -	549000,0	3-Ferro	24 -Cast iron	Yes
108	counterweights -	549000,0	7-Misc.	59 -Concrete	Yes
109					
110	**Cylinder/Piston -**	0,0	3-Ferro	26 -Stainless 18/8 coil	Yes
111	-				
112	**Pump -**				
113	casing -	0,0	3-Ferro	24 -Cast iron	Yes
114	shaft -	0,0	3-Ferro	23 -St tube/profile	Yes
115	screw -	0,0	3-Ferro	23 -St tube/profile	Yes
116	bearings -	0,0	3-Ferro	23 -St tube/profile	Yes
117	-				
118	**Control Valve -**	0,0	3-Ferro	24 -Cast iron	Yes
119	-				
120	**Cabinet -**	0,0	3-Ferro	22 -St sheet galv.	Yes
121	-				
122	**Oil -**	0,0	8-Extra	102-Mineral oil	No
123	-				
124	**Buffer - steel**	15000,0	3-Ferro	24 -Cast iron	Yes
125	-				
126	**Hoistway Wiring - copper wire**	70000,0	4-Non-ferro	30 -Cu wire	Yes
127	-				
128	**Intercom -**	2000,0	6-Electronics	98 -controller board	
129					
130					
131					
132					
133					
134					

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EcoReport 2014: INPUTS Assessment of Environmental Impact

ECO-DESIGN OF ENERGY RELATED/USING PRODUCTS

Nr	Product name: Base case 4 Products	Date 07/02/2019	Author VITO

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
	Electric Motor - 268 kg [13kW PM]				
1	stator / rotor - electrical steel	130340,0	3-Ferro	25 -Ferrite	Yes
2	bearings, shaft, fan shroud - steel	17080,0	3-Ferro	26 -Stainless 18/8 coil	Yes
3	Frame - cast iron	57400,0	3-Ferro	24 -Cast iron	Yes
4	rotor bars, end rings - aluminium	6930,0	4-Non-ferro	28 -Al diecast	Yes
5	windings, leads - copper	27020,0	4-Non-ferro	30 -Cu wire	Yes
6	terminal board, winding insulation - insulation	300,0	2-TecPlastics	15 -Epoxy	No
7	winding impregnation - impregnation resin	308,0	2-TecPlastics	15 -Epoxy	No
8	fan - plastic	1540,0	1-BlkPlastics	11 -ABS	No
9	paint - paint	770,0	5-Coating	40 -powder coating	No
10	permanent magnets - NeFeB magnet	8500,0	8-Extra	105-Permanent magnet	No
11	-				
12	**Gear box**				
13	worm shaft - steel alloy	0,0	3-Ferro	24 -Cast iron	Yes
14	worm wheel - bronze	0,0	4-Non-ferro	32 -CuZn38 cast	Yes
15	bearings - alloy steel	0,0	3-Ferro	26 -Stainless 18/8 coil	Yes
16	encasing - cast iron	0,0	3-Ferro	24 -Cast iron	Yes
17	seals - rubber	0,0	1-BlkPlastics	9 -SAN	No
18	oil - Synthetic Gear Oil [5.5L dens.=0.9]	0,0	8-Extra	102-Mineral oil	No
19	paint - paint	0,0	5-Coating	40 -powder coating	No
20	-				
21	**Traction sheave -**				
22	sheave shaft - steel alloy	12000,0	3-Ferro	26 -Stainless 18/8 coil	Yes
23	sheave - cast iron	18000,0	3-Ferro	24 -Cast iron	Yes
24	-				
25	**Brake -**				
26	frame - steel	8000,0	3-Ferro	24 -Cast iron	Yes
27	electromagnetic coil - copper winding	3500,0	4-Non-ferro	29 -Cu winding wire	Yes
28	springs - steel	1200,0	3-Ferro	23 -St tube/profile	Yes
29	brake drum - steel	6000,0	3-Ferro	25 -Ferrite	Yes
30	brake shoe -	3000,0	1-BlkPlastics	9 -SAN	
31	other - steel	1800,0	3-Ferro	25 -Ferrite	Yes
32	-				
33	**Speed governor -**				
34	mount - steel	6000,0	3-Ferro	25 -Ferrite	Yes
35	sheave - cast iron	6000,0	3-Ferro	24 -Cast iron	Yes
36	spring - steel	170,0	3-Ferro	23 -St tube/profile	Yes
37	other -	2000,0	3-Ferro	25 -Ferrite	Yes
38	-				
39	**Bedplate - steel**	0,0	3-Ferro	22 -St sheet galv.	Yes
40					

Task 5

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
	Controller -				
41	cabinet - sheet steel	38000,0	3-Ferro	22 -St sheet galv.	Yes
42	paint - paint	1500,0	5-Coating	40 -powder coating	No
43	Electronics - PCB, SMDs, Chips	90000,0	6-Electronics	50 -PWB 1/2 lay 3.75kg/m2	No
44	Wiring - copper/plastic	9000,0	4-Non-ferro	30 -Cu wire	No
45	electromechanichal switches - plastic	10000,0	1-BlkPlastics	2 -HDPE	No
46	electromechanichal switches - copper	2000,0	4-Non-ferro	31 -Cu tube/sheet	Yes
47	-				
48	**Guide rails -**				
49	rails car - steel (T90) [13.54kg/m]	812400,0	3-Ferro	23 -St tube/profile	Yes
50	rails counterweight - steel (T70) [8.83kg/m]	529800,0	3-Ferro	23 -St tube/profile	Yes
51	brackets (every 2m) - steel	412000,0	3-Ferro	23 -St tube/profile	Yes
52	-				
53	**Car -**				
54	car sling structure - steel	98000,0	3-Ferro	23 -St tube/profile	Yes
55	guide Shoes - cast iron	30000,0	3-Ferro	24 -Cast iron	Yes
56	car walls / roof - Stainless steel sheet [den. 8kg/dm3]	300000,0	3-Ferro	26 -Stainless 18/8 coil	Yes
57	platform - steel	200000,0	3-Ferro	22 -St sheet galv.	Yes
58	glass/mirror - glass	10000,0	7-Misc.	55 -Glass for lamps	Yes
59	hand rail - steel tube	10000,0	3-Ferro	23 -St tube/profile	Yes
60	floor - vinyl/stone	30000,0	1-BlkPlastics	8 -PVC	No
61	lighting - LED (8x)	1000,0	6-Electronics	49 -SMD/ LED's avg.	No
62	other (e.g. decorations, nuts and bolts, linings, etc) - What	40000,0	3-Ferro	24 -Cast iron	Yes
63	-				
64	**Car Door -**	120000,0	3-Ferro	22 -St sheet galv.	Yes
65	-				
66	**Landing Doors - steel sheet**	1320000,0	3-Ferro	22 -St sheet galv.	Yes
67	-				
68	**Car Door Operators -**				
69	stator / rotor - electrical steel	3125,8	3-Ferro	25 -Ferrite	Yes
70	bearings, shaft, fan shroud - steel	409,6	3-Ferro	26 -Stainless 18/8 coil	Yes
71	Frame - cast iron	1376,6	3-Ferro	24 -Cast iron	Yes
72	rotor bars, end rings - aluminium	166,2	4-Non-ferro	28 -Al diecast	Yes
73	windings, leads - copper	648,0	4-Non-ferro	30 -Cu wire	Yes
74	terminal board, winding insulation - insulation	7,2	2-TecPlastics	15 -Epoxy	No
75	winding impregnation - impregnation resin	7,4	2-TecPlastics	15 -Epoxy	No
76	fan - plastic	36,9	1-BlkPlastics	11 -ABS	No
77	paint - paint	18,5	5-Coating	40 -powder coating	No
78	belt - rubber	800,0	1-BlkPlastics	9 -SAN	No
79	pulleys - abs plastic	2000,0	1-BlkPlastics	11 -ABS	No
80	controller - pcb	6000,0	6-Electronics	98 -controller board	No
81	-				
82	**Diverter pulleys - cast iron**	200000,0	3-Ferro	24 -Cast iron	Yes
83	-				
84	**Ropes -**				
85	hoisting - steel	864000,0	3-Ferro	25 -Ferrite	Yes
86	governor - steel	28000,0	3-Ferro	24 -Cast iron	Yes
87	-				

Task 5

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
88					
89	**Landing indicators and buttons -**				
90	LEDs - LED	0,0	6-Electronics	49 -SMD/ LED's avg.	No
91	buttons - plastic	600,0	1-BlkPlastics	2 -HDPE	No
92	panel - steel sheet	2500,0	3-Ferro	22 -St sheet galv.	Yes
93	PCB (Printed Circuit Board) - PCB	1000,0	6-Electronics	98 -controller board	No
94	SMDs (Surface Mounted Devices) - SMD	0,0	6-Electronics	49 -SMD/ LED's avg.	No
95	wiring -	1000,0	4-Non-ferro	30 -Cu wire	Yes
96	-				
97	**Car indicators and buttons -**				
98	LEDs - LED	0,0	6-Electronics	49 -SMD/ LED's avg.	No
99	buttons - plastic	2000,0	1-BlkPlastics	2 -HDPE	No
100	panel - steel sheet	22000,0	3-Ferro	22 -St sheet galv.	Yes
101	PCB - PCB	1000,0	6-Electronics	98 -controller board	No
102	SMDs - SMD	0,0	6-Electronics	49 -SMD/ LED's avg.	No
103	wiring - copper	600,0	4-Non-ferro	30 -Cu wire	Yes
104	-				
105	**Counterweight -**				
106	counterweight frame - steel	80000,0	3-Ferro	23 -St tube/profile	Yes
107	counterweights -	617000,0	3-Ferro	24 -Cast iron	Yes
108	counterweights -	617000,0	7-Misc.	59 -Concrete	Yes
109					
110	**Cylinder/Piston -**	0,0	3-Ferro	26 -Stainless 18/8 coil	Yes
111	-				
112	**Pump -**				
113	casing -	0,0	3-Ferro	24 -Cast iron	Yes
114	shaft -	0,0	3-Ferro	23 -St tube/profile	Yes
115	screw -	0,0	3-Ferro	23 -St tube/profile	Yes
116	bearings -	0,0	3-Ferro	23 -St tube/profile	Yes
117	-				
118	**Control Valve -**	0,0	3-Ferro	24 -Cast iron	Yes
119	-				
120	**Cabinet -**	0,0	3-Ferro	22 -St sheet galv.	Yes
121	-				
122	**Oil -**	0,0	8-Extra	102-Mineral oil	No
123	-				
124	**Buffer - steel**	17000,0	3-Ferro	24 -Cast iron	Yes
125	-				
126	**Hoistway Wiring - copper wire**	100000,0	4-Non-ferro	30 -Cu wire	Yes
127	-				
128	**Intercom -**	2000,0	6-Electronics	98 -controller board	
129	-				
130					
131					
132					
133					
134					

Annex D: Materials added to the MEErP EcoReport tool

Two materials have been added to the MEErP EcoReport tool: a hydraulic oil and a permanent magnet. The background data (life cycle inventory) used to model these two materials with, are described below.

Hydraulic oil:

Hydraulic oil is modelled with the Ecoinvent record: 'Lubricating oil {GLO}| market for | Cut-off, U'. The main raw material for this oil is diesel.

The calculated environmental impact per kg oil is given in the table below:

nr	Name material	Recycle %*	Primairy Energy (MJ)	Electr energy (MJ)	feedstock	water proces	Water cool	waste haz	waste non
unit	New Materials production phase (category '**Extra**')	%	MJ	MJ	MJ	L	L	g	g
102	**Mineral oil**		66,72			14,86		0,03	117,00

nr	Name material	Recycle %*	GWP	AD	VOC	POP	Hma	PAH	PM	HMw	EUP
unit	New Materials production phase (category '**Extra**')	%	kg CO2 eq.	g SO2 eq.	mg	ng i-Teq	mg Ni eq.	mg Ni eq.	g	mg Hg/20	mg PO4
102	**Mineral oil**		1,42	8,76	22,57	0,32	6,06	1,53	2,17	0,40	2680,94

Due to the structure of the life cycle inventory, it is not possible to distinguish between process water and cooling water. The water input mentioned under process water is an input for both cooling and process water.

Permanent magnet:

The permanent magnet is modelled with the Ecoinvent dataset 'Permanent magnet, for electric motor {GLO}| production | Cut-off, U'. This record represents a rough approximation for the production of a permanent magnet based on liquid aluminium technology (for energy use, production facility). The material inputs (boric oxide, pig iron and neodymium oxide) are based on stoichiometric calculations.

The calculated environmental impact per kg of permanent magnet is given in the table below:

nr	Name material	Recycle %*	Primairy Energy (MJ)	Electr energy (MJ)	feedstock	water proces	Water cool	waste haz	waste non
unit	New Materials production phase (category '**Extra**')	%	MJ	MJ	MJ	L	L	g	g
105	**Permanent magnet**		832,73			0,49		1,04	4129,26

nr	Name material	GWP	AD	VOC	POP	Hma	PAH	PM	HMw	EUP
unit	New Materials production phase (category '**Extra**')	kg CO2 eq.	g SO2 eq.	mg	ng i-Teq	mg Ni eq.	mg Ni eq.	g	mg Hg/20	mg PO4
105	**Permanent magnet**	45,43	255,23	23,81	28,54	182,88	222,23	121,06	37,41	35610,48

The results were compared to results obtained by Sprecher et al. (2014). Only one impact category used by the MEErP is also reported in the referenced publication, being global warming.

Sprecher et al. (2014) investigated three different scenarios: a high-tech scenario, a baseline (current technology) scenario and a low tech scenario. The result obtained for global warming obtained with the abovementioned Ecoinvent record (45.5 kg CO_2 eq/ kg permanent magnet) corresponds to the low tech scenario result (41 kg CO_2 eq/ kg permanent magnet) from the paper. The technology used in the Ecoinvent record might thus be outdated and results should be interpreted with care.

Annex E: LCA results per Base-Case

Nr	Life cycle Impact per product:	Reference year	Author
0	Base case 1A	2015	VITO

Nr	Life Cycle phases --> Resources Use and Emissions		PRODUCTION Material	PRODUCTION Manuf.	PRODUCTION Total	DISTRI-BUTION	USE	END-OF-LIFE Disposal	END-OF-LIFE Recycl.	END-OF-LIFE Stock	TOTAL
	Materials	**unit**									
1	Bulk Plastics	g			**15.704**		**157**	8.724	7.137	0	**0**
2	TecPlastics	g			**508**		**5**	282	231	0	**0**
3	Ferro	g			**1.853.993**		**18.540**	93.627	1.778.906	0	**0**
4	Non-ferro	g			**64.023**		**640**	3.233	61.430	0	**0**
5	Coating	g			**1.713**		**17**	86	1.643	0	**0**
6	Electronics	g			**76.920**		**769**	38.068	39.621	0	**0**
7	Misc.	g			**301.000**		**3.010**	103.363	200.647	0	**0**
8	Extra	g			**3.900**		**0**	1.536	2.403	0	**-39**
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**2.317.760**		**23.139**	248.919	2.092.018	0	**-39**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	97.542	23.987	**121.529**	**10.174**	**125.873**	1.516	-30.264		**228.827**
12	of which, electricity (in primary MJ)	MJ	30.032	9.032	**39.064**	**28**	**125.197**	0	-7.302		**156.987**
13	Water (process)	ltr	36.350	973	**37.323**	**0**	**364**	0	-11.257		**26.430**
14	Water (cooling)	ltr	10.852	6.512	**17.364**	**0**	**5.660**	0	-2.846		**20.177**
15	Waste, non-haz./ landfill	g	2.188.050	65.943	**2.253.993**	**4.589**	**86.244**	31.940	-801.696		**1.575.070**
16	Waste, hazardous/ incinerated	g	122.180	287	**122.467**	**91**	**3.192**	0	-25.349		**100.402**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	6.795	1.476	**8.270**	**657**	**5.399**	6	-2.269		**12.064**
18	Acidification, emissions	g SO2 eq.	60.867	7.093	**67.960**	**2.010**	**24.200**	131	-19.219		**75.082**
19	Volatile Organic Compounds (VOC)	g	535	149	**684**	**206**	**2.795**	0	-157		**3.528**
20	Persistent Organic Pollutants (POP)	ng i-Teq	29.647	870	**30.517**	**26**	**588**	13	-11.303		**19.840**
21	Heavy Metals	mg Ni eq.	47.915	2.090	**50.005**	**233**	**1.742**	98	-17.300		**34.777**
22	PAHs	mg Ni eq.	1.935	216	**2.151**	**443**	**311**	0	-519		**2.385**
23	Particulate Matter (PM, dust)	g	17.204	1.616	**18.820**	**34.181**	**672**	306	-5.533		**48.446**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	32.519	65	**32.585**	**7**	**863**	26	-11.288		**22.193**
25	Eutrophication	g PO4	977	56	**1.033**	**0**	**33**	71	-306		**832**

Nr	Life cycle Impact per product:		Reference year	Author
0	Base case 1B		2015	VITO

Nr	Life Cycle phases --> Resources Use and Emissions	unit	PRODUCTION Material	PRODUCTION Manuf.	PRODUCTION Total	DISTRI-BUTION	USE	END-OF-LIFE Disposal	END-OF-LIFE Recycl.	END-OF-LIFE Stock	TOTAL
	Materials	unit									
1	Bulk Plastics	g			**14.127**		**141**	7.848	6.421	0	**0**
2	TecPlastics	g			**208**		**2**	115	94	0	**0**
3	Ferro	g			**1.323.708**		**13.237**	66.847	1.270.097	0	**0**
4	Non-ferro	g			**54.353**		**544**	2.745	52.152	0	**0**
5	Coating	g			**1.489**		**15**	75	1.428	0	**0**
6	Electronics	g			**54.720**		**547**	27.081	28.186	0	**0**
7	Misc.	g			**5.000**		**50**	1.717	3.333	0	**0**
8	Extra	g			**175.500**		**0**	69.129	108.126	0	**-1.755**
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**1.629.105**		**14.536**	175.558	1.469.838	0	**-1.755**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	92.227	19.763	**111.989**	**10.174**	**148.030**	1.495	-28.262		**243.427**
12	of which, electricity (in primary MJ)	MJ	26.563	8.139	**34.703**	**28**	**147.373**	0	-6.564		**175.540**
13	Water (process)	ltr	37.146	694	**37.841**	**0**	**371**	0	-11.877		**26.335**
14	Water (cooling)	ltr	8.054	5.330	**13.384**	**0**	**6.619**	0	-2.177		**17.826**
15	Waste, non-haz./ landfill	g	1.705.911	58.850	**1.764.761**	**4.589**	**92.869**	24.872	-626.515		**1.260.575**
16	Waste, hazardous/ incinerated	g	83.679	198	**83.877**	**91**	**3.158**	0	-17.360		**69.765**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	6.001	1.199	**7.200**	**657**	**6.340**	5	-2.007		**12.194**
18	Acidification, emissions	g SO2 eq.	56.311	5.672	**61.984**	**2.010**	**28.350**	109	-18.284		**74.169**
19	Volatile Organic Compounds (VOC)	g	4.281	104	**4.385**	**206**	**3.328**	0	-1.077		**6.843**
20	Persistent Organic Pollutants (POP)	ng i-Teq	21.783	841	**22.624**	**26**	**561**	10	-8.310		**14.911**
21	Heavy Metals	mg Ni eq.	55.434	2.000	**57.434**	**233**	**2.042**	101	-20.290		**39.519**
22	PAHs	mg Ni eq.	1.153	149	**1.303**	**443**	**355**	0	-316		**1.785**
23	Particulate Matter (PM, dust)	g	11.682	1.231	**12.913**	**34.181**	**705**	274	-3.450		**44.623**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	37.150	63	**37.213**	**7**	**1.005**	23	-13.404		**24.843**
25	Eutrophication	g PO4	1.411	39	**1.450**	**0**	**42**	103	-443		**1.152**

Nr	Life cycle Impact per product:	Reference year	Author
0	Base case 2A	2015	VITO

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	g			**46.610**		**466**	25.892	21.184	0	**0**
2	TecPlastics	g			**569**		**6**	316	259	0	**0**
3	Ferro	g			**2.353.826**		**23.538**	118.868	2.258.496	0	**0**
4	Non-ferro	g			**67.217**		**672**	3.394	64.495	0	**0**
5	Coating	g			**1.971**		**20**	100	1.891	0	**0**
6	Electronics	g			**77.180**		**772**	38.196	39.755	0	**0**
7	Misc.	g			**322.500**		**3.225**	110.747	214.979	0	**0**
8	Extra	g			**5.200**		**0**	2.048	3.204	0	**-52**
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**2.875.072**		**28.699**	299.561	2.604.262	0	**-52**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	113.864	28.753	**142.617**	**12.655**	**208.540**	1.682	-35.684		**329.810**
12	of which, electricity (in primary MJ)	MJ	32.750	11.835	**44.586**	**35**	**207.729**	0	-8.102		**244.248**
13	Water (process)	ltr	38.542	1.017	**39.559**	**0**	**385**	0	-11.948		**27.997**
14	Water (cooling)	ltr	13.077	7.796	20.872	0	9.349	0	-3.082		27.139
15	Waste, non-haz./ landfill	g	2.821.851	83.725	**2.905.576**	**5.701**	**135.099**	39.551	-1.043.256		**2.042.671**
16	Waste, hazardous/ incinerated	g	122.381	289	**122.670**	**113**	**4.496**	0	-25.372		**101.908**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	8.010	1.743	**9.753**	**817**	**8.933**	7	-2.698		**16.812**
18	Acidification, emissions	g SO2 eq.	65.120	8.253	**73.373**	**2.500**	**39.827**	138	-20.585		**95.253**
19	Volatile Organic Compounds (VOC)	g	635	152	**786**	**257**	**4.638**	0	-191		**5.491**
20	Persistent Organic Pollutants (POP)	ng i-Teq	39.302	1.090	**40.392**	**32**	**877**	17	-15.000		**26.319**
21	Heavy Metals	mg Ni eq.	50.057	2.602	**52.659**	**289**	**2.598**	103	-18.070		**37.579**
22	PAHs	mg Ni eq.	2.276	219	**2.495**	**550**	**507**	0	-610		**2.942**
23	Particulate Matter (PM, dust)	g	19.063	1.796	**20.859**	**42.557**	**1.020**	323	-6.194		**58.566**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	32.822	82	**32.904**	**9**	**1.221**	27	-11.371		**22.790**
25	Eutrophication	g PO4	1.033	58	**1.092**	**0**	**50**	79	-318		**902**

Nr	Life cycle Impact per product:		Reference year	Author
0	Base case 2B		2015	VITO

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	g			**44.427**		**444**	24.679	20.192	0	**0**
2	TecPlastics	g			**320**		**3**	178	145	0	**0**
3	Ferro	g			**1.623.927**		**16.239**	82.008	1.558.158	0	**0**
4	Non-ferro	g			**58.092**		**581**	2.934	55.739	0	**0**
5	Coating	g			**1.634**		**16**	82	1.567	0	**0**
6	Electronics	g			**54.980**		**550**	27.210	28.320	0	**0**
7	Misc.	g			**10.000**		**100**	3.434	6.666	0	**0**
8	Extra	g			**270.000**		**0**	106.353	166.347	0	**-2.700**
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**2.063.380**		**17.934**	246.878	1.837.136	0	**-2.700**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	110.065	24.007	**134.072**	**12.733**	**287.833**	1.785	-33.570		**402.853**
12	of which, electricity (in primary MJ)	MJ	28.708	10.634	**39.342**	**36**	**287.019**	0	-7.144		**319.253**
13	Water (process)	ltr	40.823	734	**41.556**	**0**	**408**	0	-12.947		**29.018**
14	Water (cooling)	ltr	10.264	6.474	**16.738**	**0**	**12.846**	0	-2.433		**27.152**
15	Waste, non-haz./ landfill	g	2.115.833	74.615	**2.190.448**	**5.736**	**168.921**	30.261	-781.447		**1.613.919**
16	Waste, hazardous/ incinerated	g	83.876	200	**84.076**	**114**	**5.363**	0	-17.382		**72.170**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	7.004	1.437	**8.441**	**822**	**12.310**	6	-2.345		**19.234**
18	Acidification, emissions	g SO2 eq.	61.327	6.705	**68.032**	**2.515**	**54.774**	118	-19.879		**105.560**
19	Volatile Organic Compounds (VOC)	g	6.455	107	**6.562**	**259**	**6.468**	1	-1.620		**11.669**
20	Persistent Organic Pollutants (POP)	ng i-Teq	27.757	1.033	**28.789**	**32**	**947**	12	-10.596		**19.185**
21	Heavy Metals	mg Ni eq.	59.688	2.446	**62.134**	**291**	**3.496**	110	-21.824		**44.207**
22	PAHs	mg Ni eq.	1.350	152	**1.501**	**554**	**683**	0	-371		**2.367**
23	Particulate Matter (PM, dust)	g	12.998	1.392	**14.390**	**42.822**	**1.277**	290	-3.897		**54.881**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	39.479	78	**39.557**	**9**	**1.629**	24	-14.266		**26.953**
25	Eutrophication	g PO4	1.725	41	**1.767**	**0**	**71**	138	-526		**1.450**

Nr	Life cycle Impact per product:		Reference year	Author
0	Base case 3		2015	VITO

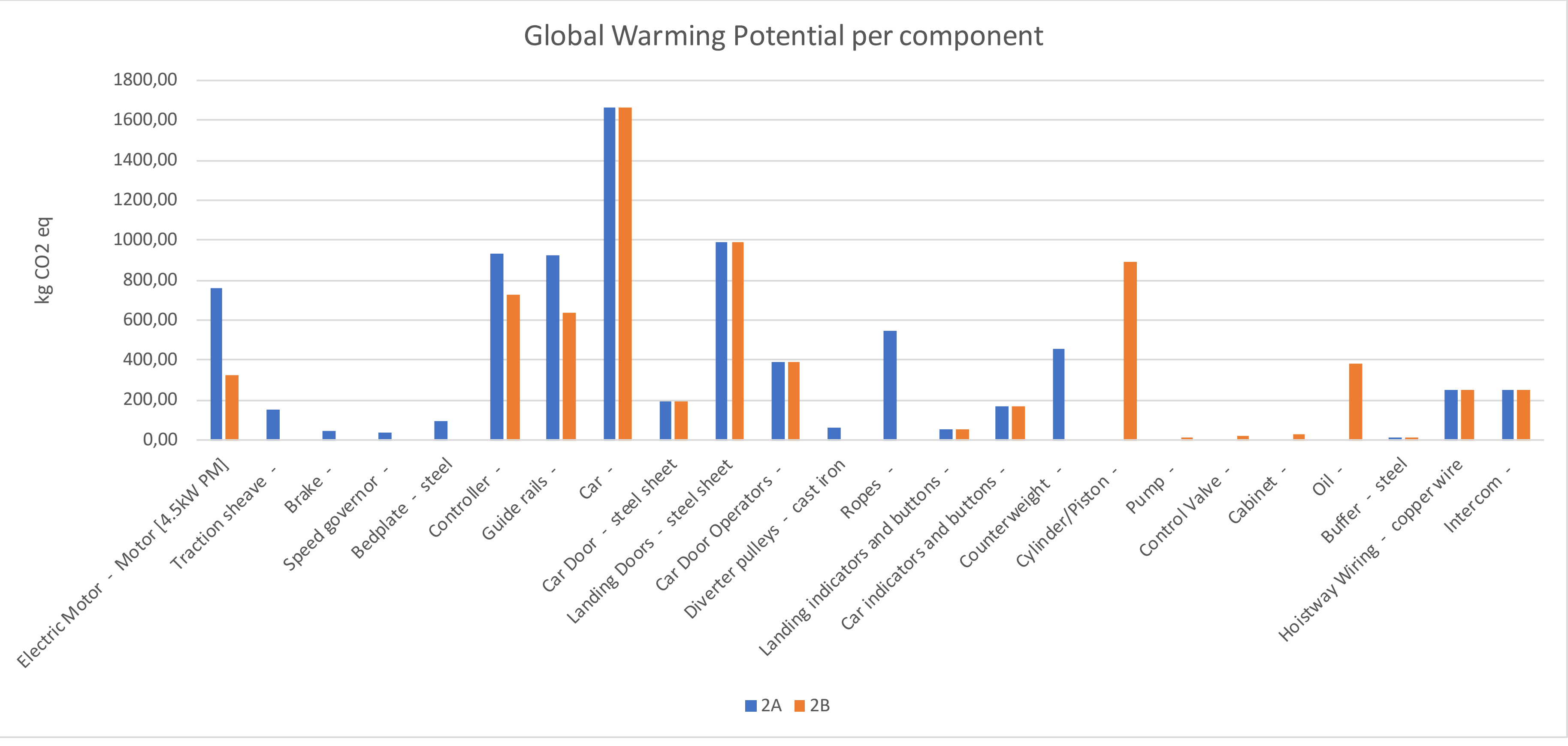
Nr	Life Cycle phases --> Resources Use and Emissions		PRODUCTION Material	PRODUCTION Manuf.	PRODUCTION Total	DISTRI-BUTION	USE	END-OF-LIFE Disposal	END-OF-LIFE Recycl.	END-OF-LIFE Stock	TOTAL
	Materials	**unit**									
1	Bulk Plastics	g			**46.946**		**469**	26.078	21.337	0	**0**
2	TecPlastics	g			**642**		**6**	357	292	0	**0**
3	Ferro	g			**4.335.807**		**43.358**	218.958	4.160.207	0	**0**
4	Non-ferro	g			**108.294**		**1.083**	5.469	103.908	0	**0**
5	Coating	g			**1.985**		**20**	100	1.905	0	**0**
6	Electronics	g			**77.480**		**775**	38.345	39.910	0	**0**
7	Misc.	g			**559.000**		**5.590**	191.961	372.629	0	**0**
8	Extra	g			**7.200**		**0**	2.836	4.436	0	**-72**
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**5.137.354**		**51.302**	484.104	4.704.624	0	**-72**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	179.199	46.954	**226.153**	**21.924**	**450.376**	1.969	-60.357		**640.065**
12	of which, electricity (in primary MJ)	MJ	39.770	22.546	**62.316**	**61**	**448.982**	0	-10.696		**500.663**
13	Water (process)	ltr	60.912	1.170	**62.082**	**0**	**609**	0	-20.504		**42.188**
14	Water (cooling)	ltr	15.202	12.600	27.802	0	20.089	0	-3.894		43.996
15	Waste, non-haz./ landfill	g	5.459.738	156.039	**5.615.777**	**9.855**	**285.768**	69.825	-2.053.636		**3.927.589**
16	Waste, hazardous/ incinerated	g	122.426	296	**122.722**	**196**	**8.302**	0	-25.383		**105.836**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	13.477	2.768	**16.245**	**1.415**	**19.283**	8	-4.770		**32.181**
18	Acidification, emissions	g SO2 eq.	95.725	12.684	**108.409**	**4.329**	**85.690**	157	-32.168		**166.418**
19	Volatile Organic Compounds (VOC)	g	960	162	**1.122**	**446**	**10.028**	0	-309		**11.287**
20	Persistent Organic Pollutants (POP)	ng i-Teq	78.760	2.244	**81.004**	**56**	**1.834**	34	-30.121		**52.808**
21	Heavy Metals	mg Ni eq.	86.261	5.281	**91.542**	**500**	**5.398**	143	-31.871		**65.712**
22	PAHs	mg Ni eq.	3.083	225	**3.308**	**953**	**1.078**	0	-856		**4.482**
23	Particulate Matter (PM, dust)	g	28.555	2.475	**31.030**	**73.856**	**2.080**	383	-9.756		**97.591**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	50.687	169	**50.855**	**16**	**2.438**	32	-18.206		**35.135**
25	Eutrophication	g PO4	1.478	65	**1.543**	**0**	**100**	94	-479		**1.258**

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	BUTION		Disposal	Recycl.	**Stock**	
	Materials	**unit**									
1	Bulk Plastics	g			**49.977**		**500**	27.762	22.715	0	**0**
2	TecPlastics	g			**623**		**6**	346	283	0	**0**
3	Ferro	g			**6.011.602**		**60.116**	303.586	5.768.132	0	**0**
4	Non-ferro	g			**150.864**		**1.509**	7.619	144.754	0	**0**
5	Coating	g			**2.288**		**23**	116	2.196	0	**0**
6	Electronics	g			**101.000**		**1.010**	49.985	52.025	0	**0**
7	Misc.	g			**627.000**		**6.270**	215.312	417.958	0	**0**
8	Extra	g			**8.500**		**0**	3.348	5.237	0	**-85**
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**6.951.854**		**69.434**	608.073	6.413.300	0	**-85**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	251.275	65.760	**317.036**	**28.314**	**1.248.136**	2.657	-85.353		**1.510.789**
12	of which, electricity (in primary MJ)	MJ	54.916	32.149	**87.064**	**79**	**1.246.172**	0	-14.805		**1.318.510**
13	Water (process)	ltr	87.158	1.549	**88.707**	**0**	**872**	0	-29.683		**59.896**
14	Water (cooling)	ltr	18.355	17.606	**35.961**	**0**	**55.545**	0	-4.656		**86.850**
15	Waste, non-haz./ landfill	g	8.058.270	222.759	**8.281.030**	**12.719**	**722.494**	101.381	-3.038.829		**6.078.794**
16	Waste, hazardous/ incinerated	g	157.479	382	**157.862**	**253**	**21.228**	0	-32.657		**146.685**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	18.920	3.863	**22.783**	**1.827**	**53.361**	11	-6.726		**71.255**
18	Acidification, emissions	g SO2 eq.	129.015	17.625	**146.640**	**5.591**	**236.575**	209	-43.473		**345.541**
19	Volatile Organic Compounds (VOC)	g	1.302	212	**1.514**	**576**	**27.832**	0	-425		**29.497**
20	Persistent Organic Pollutants (POP)	ng i-Teq	117.253	3.281	**120.534**	**72**	**4.079**	51	-44.860		**79.875**
21	Heavy Metals	mg Ni eq.	116.046	7.709	**123.755**	**645**	**13.755**	193	-42.867		**95.481**
22	PAHs	mg Ni eq.	3.950	291	**4.241**	**1.231**	**2.946**	0	-1.106		**7.312**
23	Particulate Matter (PM, dust)	g	37.970	3.384	**41.354**	**95.432**	**5.362**	537	-12.847		**129.838**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	62.753	247	**63.000**	**20**	**5.989**	40	-22.466		**46.584**
25	Eutrophication	g PO4	1.780	85	**1.865**	**0**	**253**	116	-574		**1.661**

Annex F: Base-Case 2A and 2B comparison at component level

This annex explains why that the production of lifts with large difference in overall weight might still have a comparable environmental impact. The graph below shows the contribution of each of the lift components to Global Warming Potential. The highest contributions to GWP come from the Car and Landing doors. These components have an equal weight in both lift types. The counterweight in the traction lift has a weight of 675 kg (materials: steel tube, cast iron, concrete), while the hydraulic oil in the hydraulic lift has a weight of 180 kg (incl replacement). There is a big difference in weight, but the contribution to GWP is almost equal. The figure also shows the importance of the Cylinder/Piston and oil for the hydraulic lift. For the traction lift, the Ropes and counterweight have a high contribution. The contribution of the electric motor, controller and guide rails is also higher for the traction lift compared to the hydraulic lift. The total global warming potential coming from the components for the traction lift is 8009 kg CO_2 eq and for the hydraulic lift it is 7003 kg CO_2 eq. The total weight of components (including replacements) for the traction lift is 2724 kg and for the hydraulic lift 1840 kg .

Task 5


Global Warming Potential per component
kg CO2 eq
1800,00
1600,00
1400,00
1200,00
1000,00
800,00
600,00
400,00
200,00
0,00
Electric Motor - Motor [4.5kW PM]
Traction sheave -
Brake -
Speed governor -
Bedplate - steel
Controller -
Guide rails -
Car -
Car Door - steel sheet
Landing Doors - steel sheet
Car Door Operators -
Diverter pulleys - cast iron
Ropes -
Landing indicators and buttons -
Car indicators and buttons -
Counterweight -
Cylinder/Piston -
Pump -
Control Valve -
Cabinet -
Oil -
Buffer - steel
Hoistway Wiring - copper wire
Intercom -
2A
2B

Annex G: LCC results per Base-Case

Base-case 1A: OPEX and CAPEX processing based on LCC inputdata										
event	Year	elec. PRIMES euro/kWh	CAPEX euro	inspection visits OPEX euro	Replacements OPEX euro	electricity OPEX euro	OPEX NPV	NPV OPEX+CAPEX euro/y	energy consumption running kWh	energy consumption non-running kWh
purchase lift	0		32.000 €					32.000,00 €		
(2015-reference year for NPV)	1	0,177		800,00 €		98,10 €	769,23 €	867,33 €	72,90	482,20
	2	0,180		800,00 €		99,66 €	739,64 €	839,31 €	72,90	482,20
	3	0,182		800,00 €		101,23 €	711,20 €	812,43 €	72,90	482,20
	4	0,185		800,00 €		102,79 €	683,84 €	786,64 €	72,90	482,20
	5	0,188		800,00 €		104,36 €	657,54 €	761,90 €	72,90	482,20
	6	0,191		800,00 €		105,93 €	632,25 €	738,18 €	72,90	482,20
	7	0,192		800,00 €		106,55 €	607,93 €	714,49 €	72,90	482,20
	8	0,193		800,00 €		107,18 €	584,55 €	691,73 €	72,90	482,20
	9	0,194		800,00 €		107,80 €	562,07 €	669,87 €	72,90	482,20
	10	0,195		800,00 €		108,43 €	540,45 €	648,88 €	72,90	482,20
	11	0,196		800,00 €		109,06 €	519,66 €	628,72 €	72,90	482,20
	12	0,197		800,00 €		109,40 €	499,68 €	609,08 €	72,90	482,20
	13	0,198		800,00 €		109,75 €	480,46 €	590,21 €	72,90	482,20
	14	0,198		800,00 €		110,10 €	461,98 €	572,08 €	72,90	482,20
REPL landing indicators, car indicators, intercom	15	0,199		800,00 €	4.000,00 €	110,45 €	2.665,27 €	2.775,72 €	72,90	482,20
	16	0,200		800,00 €		110,80 €	427,13 €	537,92 €	72,90	482,20
	17	0,201		800,00 €		111,33 €	410,70 €	522,03 €	72,90	482,20
	18	0,202		800,00 €		111,87 €	394,90 €	506,77 €	72,90	482,20
	19	0,202		800,00 €		112,40 €	379,71 €	492,11 €	72,90	482,20
REPL controller, door operators, diverter pulleys, ropes	20	0,203		800,00 €	11.270,00 €	112,93 €	5.508,59 €	5.621,52 €	72,90	482,20
	21	0,204		800,00 €		113,47 €	351,07 €	464,53 €	72,90	482,20
	22	0,204		800,00 €		113,29 €	337,56 €	450,85 €	72,90	482,20
	23	0,204		800,00 €		113,11 €	324,58 €	437,69 €	72,90	482,20
	24	0,203		800,00 €		112,94 €	312,10 €	425,03 €	72,90	482,20
EoL decomissioning and scrap value	25	0,203		800,00 €	11.538 €	112,76 €	4.628,04 €	4.740,80 €	72,90	482,20
Total						2.715,69 €	24.190,15 €	58.905,84 €		

Base-case 1B: OPEX and CAPEX processing based on LCC inputdata											
event	Year	other PWF ratio	elec. PRIMES euro/kWh	CAPEX euro	inspection visits OPEX euro	Replacements OPEX euro	electricity OPEX euro	OPEX NPV	NPV OPEX+CAPEX euro/y	energy consumption running kWh	energy consumption non-running kWh
purchase lift	0	1,000		30.500 €					30.500,00 €		
(2015-reference year for NPV)	1	0,962	0,177		800,00 €		115,54 €	769,23 €	884,77 €	171,33	482,48
	2	0,925	0,180		800,00 €		117,39 €	739,64 €	857,03 €	171,33	482,48
	3	0,889	0,182		800,00 €		119,23 €	711,20 €	830,43 €	171,33	482,48
	4	0,855	0,185		800,00 €		121,07 €	683,84 €	804,92 €	171,33	482,48
	5	0,822	0,188		800,00 €		122,92 €	657,54 €	780,46 €	171,33	482,48
	6	0,790	0,191		800,00 €		124,76 €	632,25 €	757,02 €	171,33	482,48
	7	0,760	0,192		800,00 €		125,50 €	607,93 €	733,44 €	171,33	482,48
	8	0,731	0,193		800,00 €		126,24 €	584,55 €	710,79 €	171,33	482,48
	9	0,703	0,194		800,00 €		126,98 €	562,07 €	689,04 €	171,33	482,48
REPL oil	10	0,676	0,195		800,00 €	1.696,88 €	127,71 €	1.686,80 €	1.814,51 €	171,33	482,48
	11	0,650	0,196		800,00 €		128,45 €	519,66 €	648,11 €	171,33	482,48
	12	0,625	0,197		800,00 €		128,86 €	499,68 €	628,54 €	171,33	482,48
	13	0,601	0,198		800,00 €		129,27 €	480,46 €	609,73 €	171,33	482,48
	14	0,577	0,198		800,00 €		129,68 €	461,98 €	591,66 €	171,33	482,48
REPL landing indicators, car indicators, intercom	15	0,555	0,199		800,00 €	4.000,00 €	130,09 €	2.665,27 €	2.795,36 €	171,33	482,48
	16	0,534	0,200		800,00 €		130,50 €	427,13 €	557,63 €	171,33	482,48
	17	0,513	0,201		800,00 €		131,13 €	410,70 €	541,83 €	171,33	482,48
	18	0,494	0,202		800,00 €		131,76 €	394,90 €	526,66 €	171,33	482,48
	19	0,475	0,202		800,00 €		132,39 €	379,71 €	512,10 €	171,33	482,48
REPL controller, door operators, oil	20	0,456	0,203		800,00 €	6.696,88 €	133,02 €	3.421,48 €	3.554,49 €	171,33	482,48
	21	0,439	0,204		800,00 €		133,65 €	351,07 €	484,71 €	171,33	482,48
	22	0,422	0,204		800,00 €		133,44 €	337,56 €	471,00 €	171,33	482,48
	23	0,406	0,204		800,00 €		133,23 €	324,58 €	457,81 €	171,33	482,48
	24	0,390	0,203		800,00 €		133,02 €	312,10 €	445,12 €	171,33	482,48
EoL decomissioning and scrap value	25	0,375	0,203		800,00 €	11.647 €	132,81 €	4.669,24 €	4.802,05 €	171,33	482,48
Total							3.198,63 €	23.290,59 €	56.989,21 €		

Base-case 2A: OPEX and CAPEX processing based on LCC inputdata											
event	Year	other PWF ratio	elec. PRIMES euro/kWh	CAPEX euro	inspection visits OPEX euro	Replacements OPEX euro	electricity OPEX euro	OPEX NPV	NPV OPEX+CAPEX euro/y	energy consumption running kWh	energy consumption non-running kWh
purchase lift	0	1,000		38.500 €					38.500,00 €		
(2015-reference year for NPV)	1	0,962	0,177		800,00 €		162,90 €	769,23 €	932,13 €	249,39	672,40
	2	0,925	0,180		800,00 €		165,50 €	739,64 €	905,14 €	249,39	672,40
	3	0,889	0,182		800,00 €		168,10 €	711,20 €	879,29 €	249,39	672,40
	4	0,855	0,185		800,00 €		170,70 €	683,84 €	854,54 €	249,39	672,40
	5	0,822	0,188		800,00 €		173,30 €	657,54 €	830,84 €	249,39	672,40
	6	0,790	0,191		800,00 €		175,90 €	632,25 €	808,15 €	249,39	672,40
	7	0,760	0,192		800,00 €		176,94 €	607,93 €	784,87 €	249,39	672,40
	8	0,731	0,193		800,00 €		177,98 €	584,55 €	762,53 €	249,39	672,40
	9	0,703	0,194		800,00 €		179,02 €	562,07 €	741,09 €	249,39	672,40
	10	0,676	0,195		800,00 €		180,06 €	540,45 €	720,51 €	249,39	672,40
	11	0,650	0,196		800,00 €		181,10 €	519,66 €	700,76 €	249,39	672,40
	12	0,625	0,197		800,00 €		181,67 €	499,68 €	681,35 €	249,39	672,40
	13	0,601	0,198		800,00 €		182,25 €	480,46 €	662,71 €	249,39	672,40
	14	0,577	0,198		800,00 €		182,83 €	461,98 €	644,81 €	249,39	672,40
REPL landing indicators, car indicators, intercom	15	0,555	0,199		800,00 €	4.000,00 €	183,41 €	2.665,27 €	2.848,68 €	249,39	672,40
	16	0,534	0,200		800,00 €		183,99 €	427,13 €	611,12 €	249,39	672,40
	17	0,513	0,201		800,00 €		184,88 €	410,70 €	595,57 €	249,39	672,40
	18	0,494	0,202		800,00 €		185,76 €	394,90 €	580,66 €	249,39	672,40
	19	0,475	0,202		800,00 €		186,65 €	379,71 €	566,36 €	249,39	672,40
REPL controller, door operators, diverter pulleys, ropes	20	0,456	0,203		800,00 €	17.066,87 €	187,53 €	8.154,20 €	8.341,74 €	249,39	672,40
	21	0,439	0,204		800,00 €		188,42 €	351,07 €	539,49 €	249,39	672,40
	22	0,422	0,204		800,00 €		188,13 €	337,56 €	525,69 €	249,39	672,40
	23	0,406	0,204		800,00 €		187,83 €	324,58 €	512,41 €	249,39	672,40
	24	0,390	0,203		800,00 €		187,54 €	312,10 €	499,64 €	249,39	672,40
EoL decomissioning and scrap value	25	0,375	0,203		800,00 €	11.476 €	187,25 €	4.604,87 €	4.792,11 €	249,39	672,40
Total							4.509,62 €	26.812,59 €	69.822,21 €		

Base-case 2B: OPEX and CAPEX processing based on LCC inputdata

event	Year	other PWF ratio	elec. PRIMES euro/kWh	CAPEX euro	inspection visits OPEX euro	Replacements OPEX euro	electricity OPEX euro	OPEX NPV	NPV OPEX+CAPEX euro/y	energy consumption running kWh	energy consumption non-running kWh
purchase lift	0	1,000	0,177	36.000 €					36.000,00 €		
(2015-reference year for NPV)	1	0,962	0,177		800,00 €		225,20 €	769,23 €	994,43 €	601,97	672,40
	2	0,925	0,180		800,00 €		228,80 €	739,64 €	968,44 €	601,97	672,40
	3	0,889	0,182		800,00 €		232,39 €	711,20 €	943,59 €	601,97	672,40
	4	0,855	0,185		800,00 €		235,99 €	683,84 €	919,83 €	601,97	672,40
	5	0,822	0,188		800,00 €		239,59 €	657,54 €	897,13 €	601,97	672,40
	6	0,790	0,191		800,00 €		243,18 €	632,25 €	875,43 €	601,97	672,40
	7	0,760	0,192		800,00 €		244,62 €	607,93 €	852,55 €	601,97	672,40
	8	0,731	0,193		800,00 €		246,06 €	584,55 €	830,61 €	601,97	672,40
	9	0,703	0,194		800,00 €		247,49 €	562,07 €	809,56 €	601,97	672,40
REPL oil	10	0,676	0,195		800,00 €	1.696,88 €	248,93 €	1.686,80 €	1.935,73 €	601,97	672,40
	11	0,650	0,196		800,00 €		250,36 €	519,66 €	770,03 €	601,97	672,40
	12	0,625	0,197		800,00 €		251,16 €	499,68 €	750,84 €	601,97	672,40
	13	0,601	0,198		800,00 €		251,96 €	480,46 €	732,42 €	601,97	672,40
	14	0,577	0,198		800,00 €		252,76 €	461,98 €	714,74 €	601,97	672,40
REPL landing indicators, car indicators, intercom	15	0,555	0,199		800,00 €	4.000,00 €	253,56 €	2.665,27 €	2.918,83 €	601,97	672,40
	16	0,534	0,200		800,00 €		254,36 €	427,13 €	681,49 €	601,97	672,40
	17	0,513	0,201		800,00 €		255,59 €	410,70 €	666,29 €	601,97	672,40
	18	0,494	0,202		800,00 €		256,82 €	394,90 €	651,72 €	601,97	672,40
	19	0,475	0,202		800,00 €		258,04 €	379,71 €	637,75 €	601,97	672,40
REPL controller, door operators, oil	20	0,456	0,203		800,00 €	12.363,54 €	259,27 €	6.007,67 €	6.266,93 €	601,97	672,40
	21	0,439	0,204		800,00 €		260,49 €	351,07 €	611,56 €	601,97	672,40
	22	0,422	0,204		800,00 €		260,09 €	337,56 €	597,65 €	601,97	672,40
	23	0,406	0,204		800,00 €		259,68 €	324,58 €	584,26 €	601,97	672,40
	24	0,390	0,203		800,00 €		259,27 €	312,10 €	571,37 €	601,97	672,40
EoL decomissioning and scrap value	25	0,375	0,203		800,00 €	11.918 €	258,87 €	4.770,89 €	5.029,75 €	601,97	672,40
Total							6.234,54 €	25.978,42 €	68.212,96 €		

Base-case 3: OPEX and CAPEX processing based on LCC inputdata

event	Year	other PWF ratio	elec. PRIMES euro/kWh	CAPEX euro	inspection visits OPEX euro	Replacements OPEX euro	electricity OPEX euro	OPEX NPV	NPV OPEX+CAPEX euro/y	energy consumption running kWh	energy consumption non-running kWh
purchase lift	0	1,000		45.500 €					45.500,00 €		
(2015-reference year for NPV)	1	0,962	0,177		2.400,00 €		352,32 €	2.307,69 €	2.660,02 €	1174,03	819,68
	2	0,925	0,180		2.400,00 €		357,95 €	2.218,93 €	2.576,88 €	1174,03	819,68
	3	0,889	0,182		2.400,00 €		363,58 €	2.133,59 €	2.497,17 €	1174,03	819,68
	4	0,855	0,185		2.400,00 €		369,20 €	2.051,53 €	2.420,73 €	1174,03	819,68
	5	0,822	0,188		2.400,00 €		374,83 €	1.972,63 €	2.347,45 €	1174,03	819,68
	6	0,790	0,191		2.400,00 €		380,45 €	1.896,75 €	2.277,21 €	1174,03	819,68
	7	0,760	0,192		2.400,00 €		382,70 €	1.823,80 €	2.206,50 €	1174,03	819,68
	8	0,731	0,193		2.400,00 €		384,95 €	1.753,66 €	2.138,60 €	1174,03	819,68
	9	0,703	0,194		2.400,00 €		387,19 €	1.686,21 €	2.073,40 €	1174,03	819,68
REPL ropes	10	0,676	0,195		2.400,00 €	2.879,60 €	389,44 €	3.566,71 €	3.956,15 €	1174,03	819,68
	11	0,650	0,196		2.400,00 €		391,69 €	1.558,99 €	1.950,68 €	1174,03	819,68
	12	0,625	0,197		2.400,00 €		392,94 €	1.499,03 €	1.891,97 €	1174,03	819,68
	13	0,601	0,198		2.400,00 €		394,19 €	1.441,38 €	1.835,57 €	1174,03	819,68
	14	0,577	0,198		2.400,00 €		395,44 €	1.385,94 €	1.781,38 €	1174,03	819,68
REPL landing indicators, car indicators, intercom	15	0,555	0,199		2.400,00 €	4.000,00 €	396,69 €	3.553,69 €	3.950,39 €	1174,03	819,68
	16	0,534	0,200		2.400,00 €		397,95 €	1.281,38 €	1.679,33 €	1174,03	819,68
	17	0,513	0,201		2.400,00 €		399,86 €	1.232,10 €	1.631,96 €	1174,03	819,68
	18	0,494	0,202		2.400,00 €		401,78 €	1.184,71 €	1.586,49 €	1174,03	819,68
	19	0,475	0,202		2.400,00 €		403,70 €	1.139,14 €	1.542,84 €	1174,03	819,68
REPL controller, door operators, diverter pulleys, ropes	20	0,456	0,203		2.400,00 €	24.212,93 €	405,62 €	12.145,80 €	12.551,41 €	1174,03	819,68
	21	0,439	0,204		2.400,00 €		407,53 €	1.053,20 €	1.460,73 €	1174,03	819,68
	22	0,422	0,204		2.400,00 €		406,90 €	1.012,69 €	1.419,59 €	1174,03	819,68
	23	0,406	0,204		2.400,00 €		406,26 €	973,74 €	1.380,00 €	1174,03	819,68
	24	0,390	0,203		2.400,00 €		405,62 €	936,29 €	1.341,92 €	1174,03	819,68
EoL decomissioning and scrap value	25	0,375	0,203		2.400,00 €	11.800 €	404,99 €	5.326,72 €	5.731,71 €	1174,03	819,68
Total							9.753,77 €	57.136,31 €	112.390,08 €		

Base-case 4: OPEX and CAPEX processing based on LCC inputdata

event	Year	other PWF ratio	elec. PRIMES euro/kWh	CAPEX euro	inspection visits OPEX euro	Replacements OPEX euro	electricity OPEX euro	OPEX NPV	NPV OPEX+CAPEX euro/y	energy consumption running kWh	energy consumption non-running kWh
purchase lift	0	1,000		67.000 €					67.000,00 €		
(2015-reference year for NPV)	1	0,962	0,177		4.800,00 €		978,33 €	4.615,38 €	5.593,71 €	4651,02	885,08
	2	0,925	0,180		4.800,00 €		993,95 €	4.437,87 €	5.431,82 €	4651,02	885,08
	3	0,889	0,182		4.800,00 €		1.009,57 €	4.267,18 €	5.276,75 €	4651,02	885,08
	4	0,855	0,185		4.800,00 €		1.025,19 €	4.103,06 €	5.128,25 €	4651,02	885,08
	5	0,822	0,188		4.800,00 €		1.040,81 €	3.945,25 €	4.986,06 €	4651,02	885,08
	6	0,790	0,191		4.800,00 €		1.056,43 €	3.793,51 €	4.849,94 €	4651,02	885,08
REPL ropes	7	0,760	0,192		4.800,00 €	4.338,00 €	1.062,67 €	6.944,13 €	8.006,80 €	4651,02	885,08
	8	0,731	0,193		4.800,00 €		1.068,91 €	3.507,31 €	4.576,23 €	4651,02	885,08
	9	0,703	0,194		4.800,00 €		1.075,15 €	3.372,42 €	4.447,57 €	4651,02	885,08
	10	0,676	0,195		4.800,00 €		1.081,39 €	3.242,71 €	4.324,10 €	4651,02	885,08
	11	0,650	0,196		4.800,00 €		1.087,63 €	3.117,99 €	4.205,62 €	4651,02	885,08
	12	0,625	0,197		4.800,00 €		1.091,11 €	2.998,07 €	4.089,17 €	4651,02	885,08
	13	0,601	0,198		4.800,00 €		1.094,58 €	2.882,76 €	3.977,34 €	4651,02	885,08
REPL ropes	14	0,577	0,198		4.800,00 €	4.338,00 €	1.098,06 €	5.276,97 €	6.375,03 €	4651,02	885,08
REPL landing indicators, car indicators, intercom	15	0,555	0,199		4.800,00 €	4.000,00 €	1.101,54 €	4.886,33 €	5.987,86 €	4651,02	885,08
	16	0,534	0,200		4.800,00 €		1.105,01 €	2.562,76 €	3.667,77 €	4651,02	885,08
	17	0,513	0,201		4.800,00 €		1.110,33 €	2.464,19 €	3.574,53 €	4651,02	885,08
	18	0,494	0,202		4.800,00 €		1.115,66 €	2.369,41 €	3.485,07 €	4651,02	885,08
	19	0,475	0,202		4.800,00 €		1.120,98 €	2.278,28 €	3.399,27 €	4651,02	885,08
REPL controller, door operators, diverter pulleys, ropes	20	0,456	0,203		4.800,00 €	32.338,00 €	1.126,31 €	16.949,30 €	18.075,60 €	4651,02	885,08
	21	0,439	0,204		4.800,00 €		1.131,63 €	2.106,40 €	3.238,03 €	4651,02	885,08
	22	0,422	0,204		4.800,00 €		1.129,86 €	2.025,39 €	3.155,25 €	4651,02	885,08
	23	0,406	0,204		4.800,00 €		1.128,10 €	1.947,49 €	3.075,58 €	4651,02	885,08
	24	0,390	0,203		4.800,00 €		1.126,33 €	1.872,58 €	2.998,91 €	4651,02	885,08
EoL decomissioning and scrap value	25	0,375	0,203		4.800,00 €	10.750 €	1.124,57 €	5.833,13 €	6.957,70 €	4651,02	885,08
Total							27.084,12 €	101.799,86 €	195.883,98 €		

European Commission

Ecodesign preparatory study for lifts implementing the Ecodesign Working Plan 2016-2019

Task 6 report: Design options

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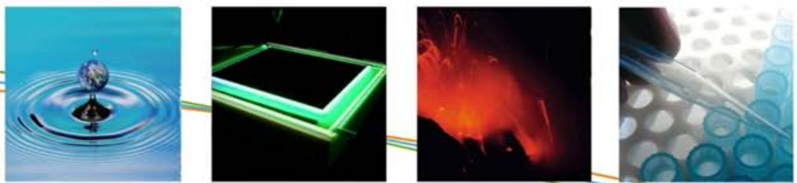

Table of contents: Task 6

List of Figures

List of Tables

List of Abbreviations and Acronyms

BAT	Best Available Technologies
BNAT	Best Not-yet Available Technologies
EOL	End of Life
ISO	International Organization for Standardization
LCC	Life Cycle Costs
LLCC	Least Life Cycle Costs
LED	Light Emitting Diode
MEErP	Methodology for Ecodesign of Energy-related Products
NPV	Net Present Value

6. Task 6 – Design Options

The base cases described in the previous tasks are baselines to be used as starting points for the assessment of improvement potentials from the use of Best Available Technologies (BAT) or Best Not-yet Available Technologies (BNAT). These potentials are to be analysed using so-called "design options", i.e. (aggregated clusters of) design measures to increase the performance of lifts.

The aim of this task is to identify and describe these options, to assess their quantitative impact on the environmental performance of lifts, to analyse their economic performance and to determine the Least Life Cycle Cost (LCC). For this purpose, this task relies on the calculation models established in the preceding tasks, especially Task 5, and complements them, where necessary.

For the interpretation of the results of this task, it should be noted that public information on the performance but especially on the costs of specific design options is scarce. Given the lack of data from publicly accessible sources, stakeholders were invited to help fill gaps. Yet, especially with regard to the disclosure of costs or prices, industry pointed out that they are subject to strict limits for sharing or discussing such data due to anti-trust laws.[1] Therefore, a draft version of the report was established using estimated values. This suggestion was then generally commented by stakeholders to verify the order of magnitude of the input values. Based on the comments received, revisions both to the base cases and the design options were made after the third stakeholder meeting in March 2019 with the results being considered as more realistic by the stakeholders when compared to the intial values. Though the study team expects the general results from this task to point in the right direction, it should not be neglected that the reliability of the input data remains uncertain.

6.1. Subtask 6.1 - Design options

The aim of this subtask is to identify and describe the design options that can improve the environmental performance of lifts. According to the MEErP methodology[2], typically 4 to 8 design options are considered as a manageable number for Ecodesign preparatory studies.

In line with this guidance, Table 6-1 provides an overview of seven design options for the six base cases. With regard to the design options, it should be noted that they could interact or have overlapping impacts. This means that combining a very efficient lighting system with procedures to switch-off components may yield lower total energy savings than the sum of savings from the design options applied individually. In the first part of this report, the design options are considered individually first, i.e. without interaction. In the second part, that serves as the basis for the subsequent analysis of scenarios

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[1] Two possible options were considered as potential remedies: a) the possibility of obtaining quotations from individual manufacturers for lift designs close to the base cases including prospective design options, and b) the possibility of obtaining data about lift designs under a confidentiality agreement. Both could not be put in practice.

[2] Kemna R. (2011): Methodology for Ecodesign of Energy-related Products, MEErP 2011, 704 Methodology report, Part 1, methods.

and policy options in Task 7, the interaction of the design options is taken into consideration.

Table 6-1: Overview of design options with a link to the performance measures.

#	Design option	Modifies			
		Running	Idle	5 min	30 min
1	Use low energy equipment		x	x	X
2	Switch off components			x	X
3	Use deep stand-by				X
4	Optimize machine / power unit	x			
5	Minimize friction	x			
6	Use regenerative drive	x			
7	Improve door operators	x			

The process of describing and analysing the environmental and energy-related impacts of the design options is achieved by linkage to the parameters used in ISO 25745[3]. More specifically, the design options are modelled to determine how they affect: the running consumption, the idle consumption, the 5 minutes standby consumption, and the 30 minutes standby consumption from the standard, or a combination of these parameters.

The design options can be described as follows:

1. **Use low energy equipment:** This design option describes the use of low-energy equipment. Among others, it includes the utilization of low energy landing and car indicators and buttons, the use of high efficiency LEDs for lighting, the use of an energy-efficient power supply and the use of low consumption controllers.
2. **Switch off components:** Within this design option, equipment such as light curtains, door controllers, lighting, ventilation and interior displays are switched off and panels are dimmed after 5 minutes of idle time.
3. **Use deep standby:** This design option affects the consumption after 30 minutes have elapsed without the lift being used - it reduces the consumption by putting the controller and the drive system in a deep sleep mode that will affect the response time to a call.
4. **Optimize machine / power unit:** This design option affects running consumption. It addresses the efficiency of the motors and other aspects of the drive systems including inverters, as well as the optimization of the counterweights in the case of traction lifts, or the use of a reduced car weight and a high efficiency

[3] ISO 25745:2015 Energy performance of lifts, escalators and moving walks -- Part 2: Energy calculation and classification for lifts (elevators)

pump system in combination with an electronically operated valve in hydraulic lifts.

5. **Minimize friction:** This design option addresses the optimization of ropes in traction lifts and the general minimisation of friction losses in the running mode.
6. **Use regenerative drive:** This design option describes the utilization of a built-in energy recuperation unit. This design option reduces the energy consumption in the running mode.
7. **Improve door operators:** This design options decreases the energy demand in running mode by using more efficient door operators.

6.2. Subtask 6.2 - Impacts of the design options

The aim of this subtask is to describe the impacts of applying the design options on the environmental performance of the base cases. With regard to the analysis of impacts, it should be noted that the analysis is done from a perspective where the design options are directly “designed and built-into” new lifts (as opposed to a situation where components in existing systems are replaced and upgraded separately).

6.2.1. Impact on Energy demand

To determine the impact of the design options on energy demand and costs, detailed information on their technological properties and costs is required. A screening of the best products on manufacturer websites provided some indication of the available performance levels. Yet public data on the impact on energy demand of individual design options is quite limited. Therefore, a starting point and guiding principle for the analysis of the impact on energy demand was the assumption that an overall class A according to ISO 25745 can be achieved technically when a combination of design options is applied.

Table 6-2 provides an overview of the study’s assumptions concerning the individual design options (lower part) and the specific consumption values that result from these assumptions (upper part). It should be noted that these values describe the situation if the design options were applied individually to a lift. If design options are combined, then the sum of the resulting savings will generally be lower than the sum of savings of the options when applied individually due to some measures having overlapping effects (“interaction”).

Table 6-2: Details of the assumed effect on the energy consumption parameters used in ISO 25745-2 per design option for the different base cases

#	Measures		Base case 1A				Base case 1B				Base case 2A				Base case 2B				Base case 3				Base case 4			
			Running [Wh]	Idle [W]	5 min [W]	30 min [W]	Running [Wh]	Idle [W]	5 min [W]	30 min [W]	Running [Wh]	Idle [W]	5 min [W]	30 min [W]	Running [Wh]	Idle [W]	5 min [W]	30 min [W]	Running [Wh]	Idle [W]	5 min [W]	30 min [W]	Running [Wh]	Idle [W]	5 min [W]	30 min [W]
0	Base case demand	Absolute consumption or power	19	100	50	50	37	100	50	50	26	130	65	65	52	130	65	65	51	150	75	75	87	165	83	83
1	Use low energy equipment	Absolute consumption or power	19	78	39	39	37	78	39	39	26	96	48	48	52	96	48	48	51	108	54	54	87	119	59	59
2	Switch off components	Absolute consumption or power	19	100	50	25	37	100	50	25	26	130	65	33	52	130	65	33	51	150	75	38	87	165	83	41
3	Use deep standby	Absolute consumption or power	19	100	50	25	37	100	50	25	26	130	65	33	52	130	65	33	51	150	75	38	87	165	83	41
4	Optimize machine / power unit	Absolute consumption or power	15	100	50	50	22	100	50	50	20	130	65	65	31	130	65	65	48	150	75	75	82	165	83	83
5	Minimize friction	Absolute consumption or power	17	100	50	50	36	100	50	50	24	130	65	65	51	130	65	65	48	150	75	75	82	165	83	83
6	Use regenerative drive	Absolute consumption or power	15	100	50	50	30	100	50	50	21	130	65	65	42	130	65	65	33	150	75	75	57	165	83	83
7	Improve door operators	Absolute consumption or power	19	100	50	50	37	100	50	50	26	130	65	65	51	130	65	65	50	150	75	75	86	165	83	83
1	Use low energy equipment	Savings as compared to base case		-22%	-22%	-22%		-22%	-22%	-22%		-26%	-26%	-26%		-26%	-26%	-26%		-28%	-28%	-28%		-28%	-28%	-28%
2	Switch off components	Savings as compared to base case				-50%				-50%				-50%				-50%				-50%				-50%
3	Use deep standby	Savings as compared to base case				-50%				-50%				-50%				-50%				-50%				-50%
4	Optimize ma-chine / power unit	Savings as compared to base case	-22%				-40%				-22%				-40%				-6%				-6%			
5	Minimize friction	Savings as compared to base case	-10%				-2%				-9%				-2%				-6%				-6%			
6	Use regenerative drive	Savings as compared to base case	-20%				-20%				-20%				-20%				-35%				-35%			
7	Improve door operators	Savings as compared to base case	-1%				-1%				-1%				-1%				-1%				-1%			

For the purpose of orientation, Table 6-3 gives an overview of the energy efficiency classes according to ISO 25745 which would result when applying all of these design options collectively after considering their interactions. Interaction effects cause the savings of 75% due to a deep standby mode to be reduced by half, for example, if components were previously switched off and if the 50% savings in energy demand due to switch-off measures are achieved.

In sum, it can be seen that the application of the design options results in a shift from the energy efficiency classes B or C in the base cases to classes A or B.

Table 6-3: Illustration of the energy efficiency classes in the base cases before and after all potential design options are applied and the impact of interaction effects has been accounted for

Situation	Value	Base case 1A	Base case 1B	Base case 2A	Base case 2B	Base case 3	Base case 4
No options (Base case configu-ration)	Stand-by	2	2	2	2	3	3
	Running	3	5	3	5	2	2
	Total	**B**	**B**	**B**	**C**	**B**	**B**
All options (BAT)	Stand-by	1	1	1	1	2	2
	Running	2	4	2	4	1	1
	Total	**A**	**A**	**A**	**B**	**A**	**A**

The impact of the individually applied design options on the annual energy demand of the base cases is shown in Table 6-4.

Table 6-4: Impact of the individually applied design options on the annual energy demand in kWh per year according to ISO 25745 for each base case

#	Design option	Base case 1A	Base case 1B	Base case 2A	Base case 2B	Base case 3	Base case 4
0	Base case demand	555	654	922	1 274	1 994	5 536
1	Use low energy equipment	449	548	747	1 100	1 764	5 288
2	Switch off components	487	585	834	1 187	1 894	5 426
3	Use deep standby	487	585	834	1 187	1 894	5 426
4	Optimize machine / power unit	539	585	867	1 034	1 923	5 257
5	Minimize friction	548	650	899	1 262	1 923	5 257
6	Use regenerative drive	541	620	872	1 154	1 583	3 908
7	Improve door operators	554	652	919	1 268	1 982	5 490

To further illustrate the impact of the design options on the overall energy demand, Figure 6-1 and Figure 6-2 show the relative changes and the absolute changes in annual energy demand. In general, the design options that affect standby energy demand have a stronger impact on the base cases with low utilization while the options addressing running consumption have a stronger impact on the base cases having higher usage. This essentially reflects that in the former cases, standby consumption is more dominant while in the latter, running consumption is more important.

Figure 6-1: Relative change in energy demand by design option compared to the energy demand of the base case

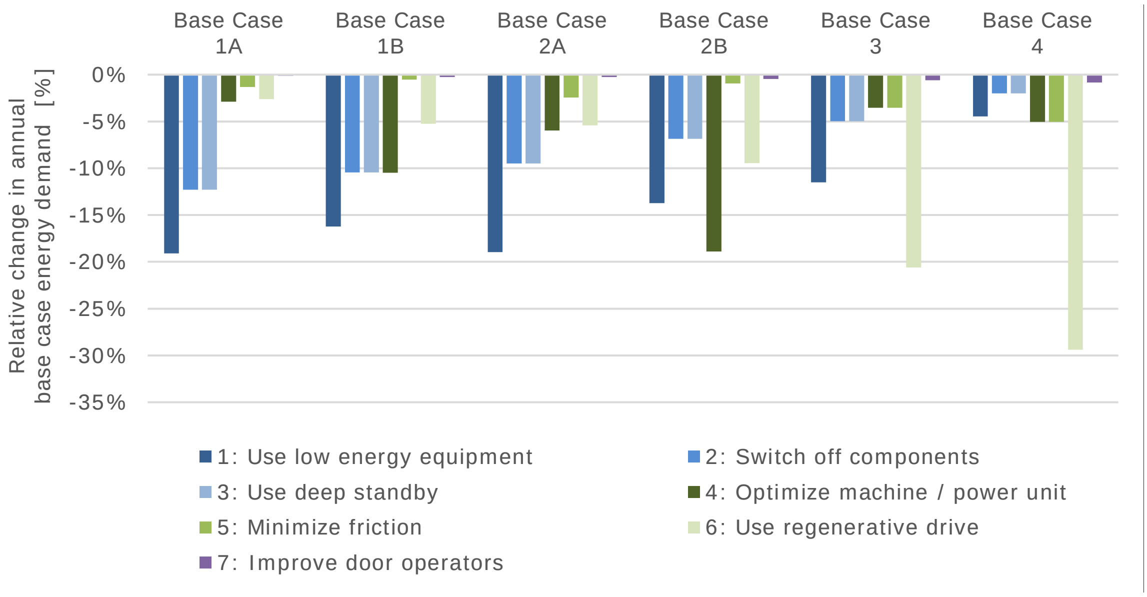
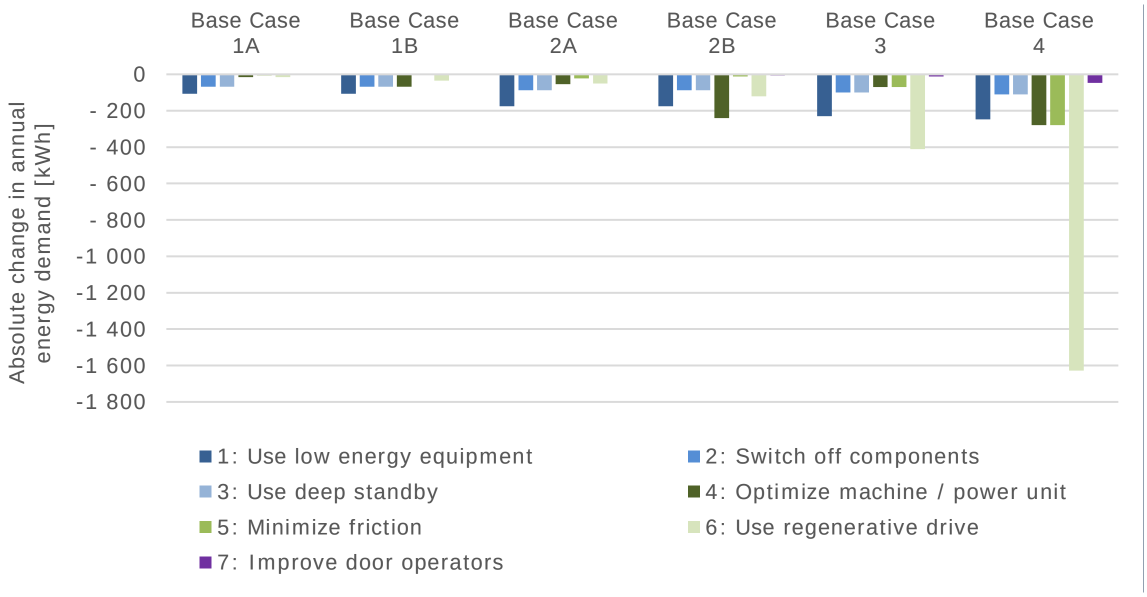


Figure 6-2: Absolute change in energy demand by design option compared to the energy demand of the base case



6.2.2. Impact on other environmental parameters

Next to the assessment on energy demand, the MEErP methodology also requires an analysis of the impact of the design options on other environmental impact parameters. Changes should be reported if substantial impacts occur due to the design options.

Most of the design options only require marginal modifications to the bill of materials. Exceptions include the optimization of the machine design option that includes the utilization of a more efficient motor. Generally, improvements in motor efficiency entail the utilization of more material in the motor. Yet at the same time, the design option includes an optimization that could allow for a reduction of the motor size. It has been assumed that both effects even themselves out. Furthermore, in the case of the regenerative drive design option, the use of additional material for the regeneration unit was considered for the hydraulic lift base cases.

Overall, however, modifications in energy demand are the main environmental impact of the design options considered and changes to other environmental impact parameters are modest and only entail small changes in material usage when compared to the overall mass of the lifts. To avoid overburdening this part of the report with additional tables and graphs, an overview of the resulting changes is provided in Appendix A of this report.

6.3. Subtask 6.3 – Costs

The aim of this subtask is to estimate the price increase due to the implementation of these options. According to the MEErP methodology, this analysis should either be carried out based on an assessment of the market prices of the products, i.e. lifts, and/or by applying a production cost model with sector-specific margins. When assessing the viability of these approaches, the latter was deemed to be unsuitable in the context of this study, because industrial sector stakeholders are generally reluctant to provide information on prices/costs and technologies, in particular when the number of market actors is limited. As pointed out in the introduction, the constraints seem to be especially relevant with regard to lifts.[4] Therefore, the product-based market price approach seems to be more suitable.

Yet, the same limitations as noted with regard to the data on achievable savings also apply here. Therefore, the breakdown of the lift costs from the bill of materials in Task 4 was used and combined with estimated mark-ups for different more efficient components as a starting point. These mark-ups were again derived from a combination of available evidence, information from related studies on components, and estimations and plausibility assumptions made by the project team. Such estimations, for example, take into account the number of stops, or the size of the lift motors. The resulting values were then subject to the revisions explained in the introduction to this task. The resulting assumptions are provided in Table 6-5. Note, the assumption is made that there is strong competition with regard to lift prices while most manufacturers, or maintenance companies make their profits from maintenance contracts. This in turn results in a situation where manufacturers would be unlikely to add a substantial profit margin to lift prices were they to apply the design options under consideration. It is more likely that they would rather focus on covering their own marginal implementation costs. Note too, the earlier remark that the costs relate to options that have been “designed and built-into” lifts. Prices for add-on solutions to existing systems therefore do not apply. Furthermore, it was pointed out by stakeholders that economies of scale and differences in prices from country to country make it difficult to determine generalized values.

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4 See also http://europa.eu/rapid/press-release_IP-07-209_en.htm.

Table 6-5: Estimates of the marginal costs of the design options by base case

#	Design option	Base case 1A	Base case 1B	Base case 2A	Base case 2B	Base case 3	Base case 4
1	Use low energy equipment	300 Euro	300 Euro	300 Euro	300 Euro	500 Euro	700 Euro
2	Switch off components	100 Euro	100 Euro	100 Euro	100 Euro	100 Euro	100 Euro
3	Use deep standby	300 Euro	200 Euro	400 Euro	200 Euro	500 Euro	800 Euro
4	Optimize machine / power unit	400 Euro	2900 Euro	500 Euro	3800 Euro	800 Euro	1300 Euro
5	Minimize friction	800 Euro	0 Euro	900 Euro	0 Euro	1300 Euro	1900 Euro
6	Use regenerative drive	1500 Euro	1500 Euro	2000 Euro	2000 Euro	2500 Euro	2500 Euro
7	Improve door operators	40 Euro	40 Euro	40 Euro	40 Euro	70 Euro	100 Euro

Based on these values for the individual design options, further analyses on lift life cycle costs can be carried out.

6.3.1. Theory: Calculation model based on the MEErP methodology

The calculation model used within the MEErP methodology distinguishes two different types of life cycle costs: The first type is from a user perspective, while the second type is from a societal perspective. Preparatory studies need to assess both types. To make the calculation methodology transparent, a brief summary of the model which was applied to lifts is now given.

The basic formula to determine the life cycle costs from the users perspective (LCC in Euro) includes: the purchase price including installation (PP in Euro), the annual operating expense (OE in Euro), the dimensionless present worth factor (PWF) and the end-of-life costs (disposal, recycling) or benefits (resale) (EOL in Euro) as follows:

$$\mathrm{LCC} = \mathrm{PP} + \mathrm{PWF} \cdot \mathrm{OE} + \mathrm{EOL}$$

Note, that while the annual operating expense is discounted to the present year, the end-of-life costs are not. This is explained by the experience that disposal costs for many products are already covered during acquisition. As this is not the case for lifts, the calculation has to be altered as follows:

$$\mathrm{LCC} = \mathrm{PP} + \mathrm{PWF} \cdot \mathrm{OE} + \frac{\mathrm{EoL}}{(1 + \mathrm{DD})^{\mathrm{NN}}}$$

The present worth factor, in turn, is calculated using the product lifetime (NN in years) and the discount rate (DD). Furthermore, price increases in operating expenses can be taken into account by DD as an escalation rate expressed as a percentage. Based on this, the calculation of the present worth factor can be written as:

$$\mathrm{PWF} = 1 - \frac{(1 + \mathrm{EE})}{(1 + \mathrm{DD})} \cdot \left(1 - \left(\frac{1 + \mathrm{EE}}{1 + \mathrm{DD}}\right)^{\mathrm{NN}}\right)$$

If several different price increases are to be assessed together (e.g. one rate for external damage, one rate for energy costs and one rate for maintenance), they should be aggregated into one compound growth rate (EE) by considering their respective shares in the overall annual costs.

In case the discount rate and the overall annual price increases are identical, the previous equation simplifies to the lifetime of the product:

$$\mathrm{PWF} = \mathrm{NN}$$

In the MEErP methodology, it has been argued that the discount rate, the external damage escalation rate and the energy growth rate were all of the order of 3 to 4 % at the time of preparing the MEErP methodology. Therefore, it has been argued that if repair and maintenance costs are insignificant, the previous simplification could be used. As shown in earlier tasks, however, the maintenance and repair costs have a substantial share in overall life cycle costs. In line with the assumptions in Task 5, the compound growth rate EE was assumed to be zero.

This yields in sum, a formula for the consumer life-cycle cost calculation for lifts that translates into the following equation:

$$\mathrm{LCC} = \mathrm{PP} + \left(1 - \frac{1}{(1+\mathrm{DD})} \cdot \left(1 - \left(\frac{1}{1+\mathrm{DD}}\right)^{\mathrm{NN}}\right)\right) \cdot \mathrm{OE} + \frac{1}{(1+\mathrm{DD})^{\mathrm{NN}}} \cdot \mathrm{EoL}$$

Extending these user-based life cycle costs**,** societal life cycle costs need to be calculated, as well. These include the costs for external damage of air emissions ($\widetilde{\mathrm{LCC}}$) based on a given list of fixed prices as given in Table 6-6. These values are to be multiplied by the total mass of emissions from the EcoReport 2011 and have to be added to the life cycle costs in the respective phases.

Table 6-6: Summary of monetary values attributed to emissions to the air based on the MEErP methodology (source: MEErP methodology)

Emissions	**Euro / kg**
Global warming potential in CO_2-eq.	0.014
Acidification potential in SO_2-eq.	16.00
Volatile organic compounds VOC	2.80
Particulate matter PM10	37.50

6.3.2. Life cycle costs of the individual design options

Based on the life cycle calculation model described above using the results from the energy and other environmental impacts analysis and the previous cost assumptions yields an overview of the life cycle costs per design option. Note again, that the design options are compared to the (unaltered) base case. Tables 6-7 to Table 6-12 show the resulting life cycle costs for the different base cases.

Table 6-7: Life cycle costs (in Euro) of the design options without considering interaction effects for base case 1A expressed as net present value

		User perspective				Societal perspective
		Purchase including installation	Operation (energy)	Operating (non-energy) incl. EOL	Life Cycle Cost	Life Cycle Cost
	Base case	32 000	2 716	24 190	58 906	60 753
1	Use low energy equipment	32 300	2 197	24 190	58 687	60 479
2	Switch off components	32 100	2 382	24 190	58 672	60 484
3	Use deep standby	32 300	2 382	24 190	58 872	60 684
4	Optimize machine / power unit	32 400	2 637	24 190	59 227	61 066
5	Minimize friction	32 800	2 680	24 190	59 670	61 514
6	Use regenerative drive	33 500	2 644	24 190	60 335	62 174
7	Improve door operators	32 040	2 712	24 190	58 942	60 789

Table 6-8: Life cycle costs (in Euro) of the design options without considering interaction effects for base case 1B expressed as net present value

		User perspective				Societal perspective
		Purchase including installation	Operation (energy)	Operating (non-energy) incl. EOL	Life Cycle Cost	Life Cycle Cost
	Base case	30 500	3 199	23 291	56 989	58 731
1	Use low energy equipment	30 800	2 679	23 291	56 770	58 458
2	Switch off components	30 600	2 864	23 291	56 755	58 462
3	Use deep standby	30 700	2 864	23 291	56 855	58 562
4	Optimize machine / power unit	33 400	2 863	23 291	59 554	61 261
5	Minimize friction	30 500	3 182	23 291	56 972	58 713
6	Use regenerative drive	32 000	3 031	23 291	58 322	60 047
7	Improve door operators	30 540	3 190	23 291	57 021	58 762

Table 6-9: Life cycle costs (in Euro) of the design options without considering inter-action effects for base case 2A expressed as net present value

		User perspective				Societal perspective
		Purchase including installation	Operation (energy)	Operating (non-energy) incl. EOL	Life Cycle Cost	Life Cycle Cost
	Base case	38 500	4 510	26 813	69 822	72 098
1	Use low energy equipment	38 800	3 654	26 813	69 267	71 453
2	Switch off components	38 600	4 082	26 813	69 494	71 725
3	Use deep standby	38 900	4 082	26 813	69 794	72 025
4	Optimize machine / power unit	39 000	4 241	26 813	70 054	72 301
5	Minimize friction	39 400	4 400	26 813	70 612	72 877
6	Use regenerative drive	40 500	4 266	26 813	71 578	73 828
7	Improve door operators	38 540	4 497	26 813	69 850	72 124

Table 6-10: Life cycle costs (in Euro) of the design options without considering inter-action effects for base case 2B expressed as net present value

		User perspective				Societal perspective
		Purchase including installation	Operation (energy)	Operating (non-energy) incl. EOL	Life Cycle Cost	Life Cycle Cost
	Base case	36 000	6 235	25 389	67 623	69 926
1	Use low energy equipment	36 300	5 379	25 389	67 068	69 281
2	Switch off components	36 100	5 807	25 389	67 295	69 553
3	Use deep standby	36 200	5 807	25 389	67 395	69 653
4	Optimize machine / power unit	39 800	5 057	25 389	70 245	72 424
5	Minimize friction	36 000	6 176	25 389	67 564	69 861
6	Use regenerative drive	38 000	5 646	25 389	69 034	71 275
7	Improve door operators	36 040	6 205	25 389	67 634	69 933

Table 6-11: Life cycle costs (in Euro) of the design options without considering inter-action effects for base case 3 expressed as net present value

		User perspective				Societal perspective
		Purchase including installation	Operation (energy)	Operating (non-energy) incl. EOL	Life Cycle Cost	Life Cycle Cost
	Base case	45 500	9 754	54 746	109 999	113 901
1	Use low energy equipment	46 000	8 631	54 746	109 377	113 160
2	Switch off components	45 600	9 267	54 746	109 613	113 463
3	Use deep standby	46 000	9 267	54 746	110 013	113 863
4	Optimize machine / power unit	46 300	9 409	54 746	110 455	114 320
5	Minimize friction	46 800	9 409	54 746	110 955	114 820
6	Use regenerative drive	48 000	7 743	54 746	110 489	114 179
7	Improve door operators	45 570	9 696	54 746	110 012	113 907

Table 6-12: Life cycle costs (in Euro) of the design options without considering inter-action effects for base case 4 expressed as net present value

		User perspective				Societal perspective
		Purchase including installation	Operation (energy)	Operating (non-energy) incl. EOL	Life Cycle Cost	Life Cycle Cost
	Base case	67 000	27 084	101 800	195 884	202 549
1	Use low energy equipment	67 700	25 872	101 800	195 372	201 909
2	Switch off components	67 100	26 547	101 800	195 446	202 055
3	Use deep standby	67 800	26 547	101 800	196 146	202 755
4	Optimize machine / power unit	68 300	25 719	101 800	195 819	202 341
5	Minimize friction	68 900	25 719	101 800	196 419	202 941
6	Use regenerative drive	67 800	19 120	101 800	190 420	196 248
7	Improve door operators	67 100	26 857	101 800	195 756	202 398

6.4. Subtask 6.4 - Analysis of least life cycle costs and BAT

The aim of this subtask is to determine the least life cycle costs (LLCC) for each base case. This analysis is carried out both from a consumer as well as from a societal per-spective.

6.4.1. Ranking of individual design options

The MEErP requires an analysis of the least life cycle costs across several steps. The first steps aims to determine the rank of the design options by sorting. For the sorting process, the difference of the life cycle costs in the case where the design options are applied compared to a situation without any design option, i.e. the pure base case, is considered. This means that economically favourable measures are ranked higher than those that are economically less attractive. The (unaltered) base case always holds the first rank “zero”.

Based on the previous data on savings, costs and performance, the ranking of the design options is given in Table 6-13. The options are ranked starting from 1 to 7 while the (unaltered) base case holds the rank 0. Note further, that the ranking of the design options is nearly identical from both the user and societal perspective across all base cases. In the cases 1A, 1B and 4, two options change their ranks from the user to the societal perspective while some change in rankings also occurs for base case 3.

Table 6-13: Ranking of the design options for the different base cases when ordered by the change in the LCC as compared to the base case (where two values are given, the first indicates the ranking from the user perspective, the second the ranking from the societal perspective)

#	Design option	Base case 1A	Base case 1B	Base case 2A	Base case 2B	Base case 3	Base case 4
	Base case	0	0	0	0	0	0
1	Use low energy equipment	2/1	2/1	1	1	1	2
2	Switch off components	1/2	1/2	2	2	2	3
3	Use deep standby	3	3	3	3	4/3	6
4	Optimize machine / power unit	5	7	5	7	5/6	5/4
5	Minimize friction	6	4	6	4	7/7	7
6	Use regenerative drive	7	6	7	6	6/5	1
7	Improve door operators	4	5	4	5	3/4	4/5

6.4.2. Possible positive or negative side effects of the individual options

Theoretically design options could potentially have positive or negative side effects beyond the direct effects captured in the life cycle analysis. The MEErP methodology requires an assessment and discussion of these effects.

In general, no relevant side effects could be identified for the individual design options with the exception of design option “3: Use deep sleep”. When a lift is put into deep sleep mode after longer idle periods (the threshold for the third “stand-by” mode is 30 minutes after the last trip according to ISO 25745), wake-up may take some time. This means that the user will have to wait until the lift is ready to operate again. This additional waiting time can be perceived as a negative side effect. Operators may therefore chose to deactivate deep-sleep settings.

For design option "2: Switch off components", industry pointed out that electric and electronic components might be sensitive to the frequency with which they are switched off and on. This might result in reduced component lifetime and could lead to early failures with negative consequences on costs and ecological performance. The study team notes that no further information on the extent of this effect was provided nor on which components would primarily be affected.

6.4.3. Estimation of the cumulative improvement and cost effect

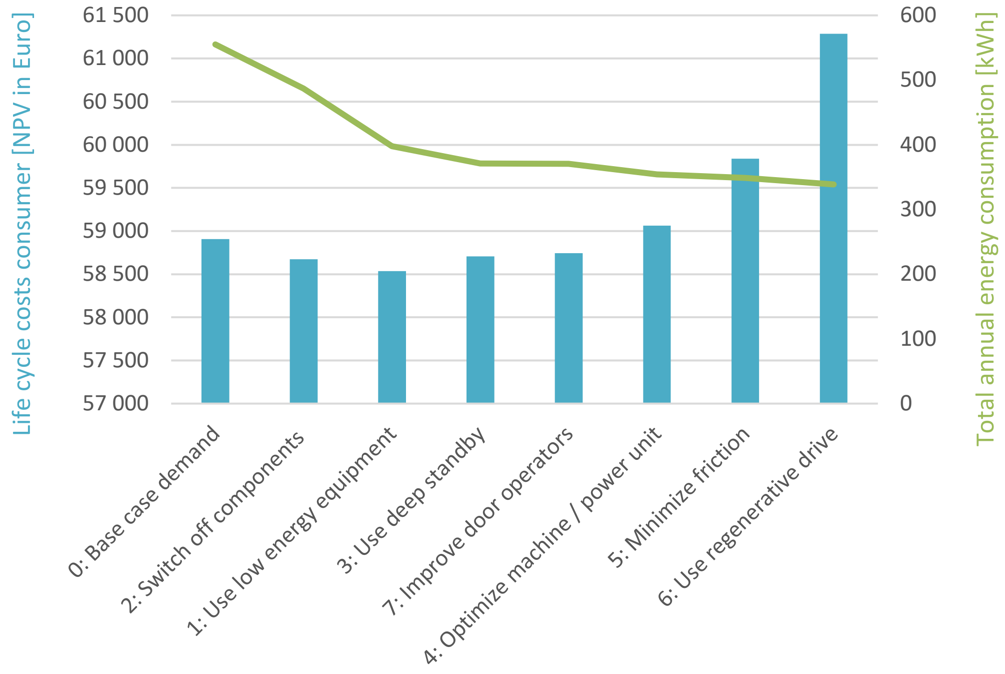
Based on the design option ranking analysis, the cumulative improvement potential and the resulting effect on costs need to be calculated. For this purpose, a life cycle cost (LCC) curve needs to be drawn.

This curve shows the design options ordered by Table 6-13, starting with rank 0 to the left and proceeding to the last option. On the first vertical axes, the net present value life cycle costs (in Euro) are shown. On the second vertical axes, the resulting energy consumption is given. In the archetypical case, the life cycle cost minimum is attained after the application of some design options after which life cycle costs rise with the increasing application of design options.

In contrast to the earlier discussion of design options, the interaction of individual options is taken into consideration for this analysis because the options are implemented successively. The life cycle costs are reported from the user perspective.

The leftmost column in Figure 6-3, for example, shows the base case situation with the consumption values for a situation without applying any design option. The rightmost column shows the situation when all identified design options are implemented; it corresponds to the use of best available technology (BAT).[5]

Figure 6-3: LCC curve for base case 1A



[5] Please note that despite the sorting in order of life cycle costs, the options are not necessarily strictly ordered in a decreasing and then again increasing order in some cases (e.g. base case 2b). This is due to a methodological issue from the MEErP methodology where the ranking of the option is done without consideration of interactions.

Figure 6-4: LCC curve for base case 1B

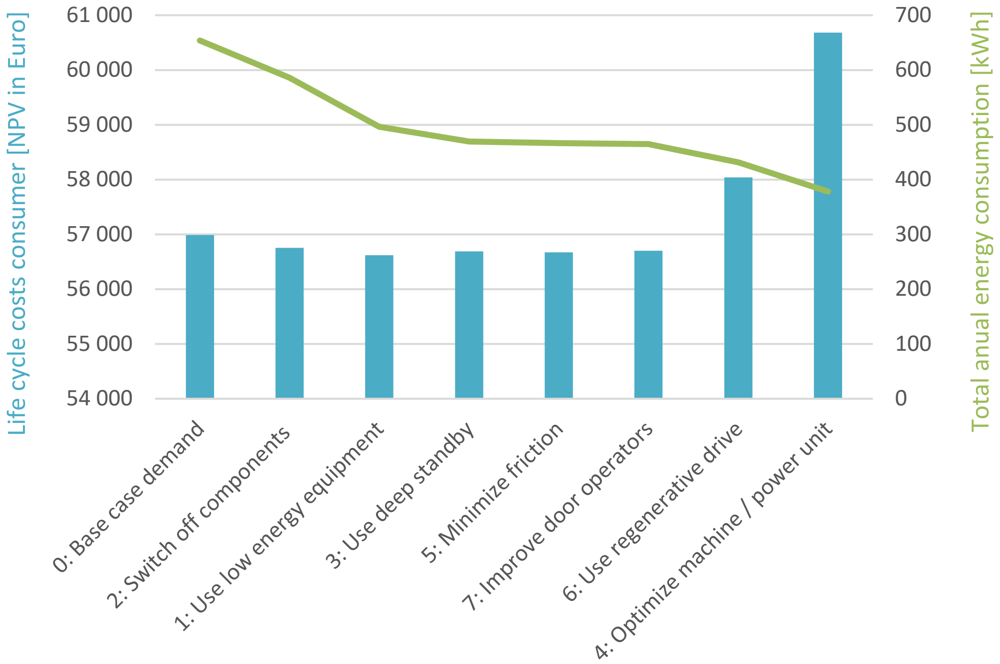


Figure 6-5: LCC curve for base case 2A

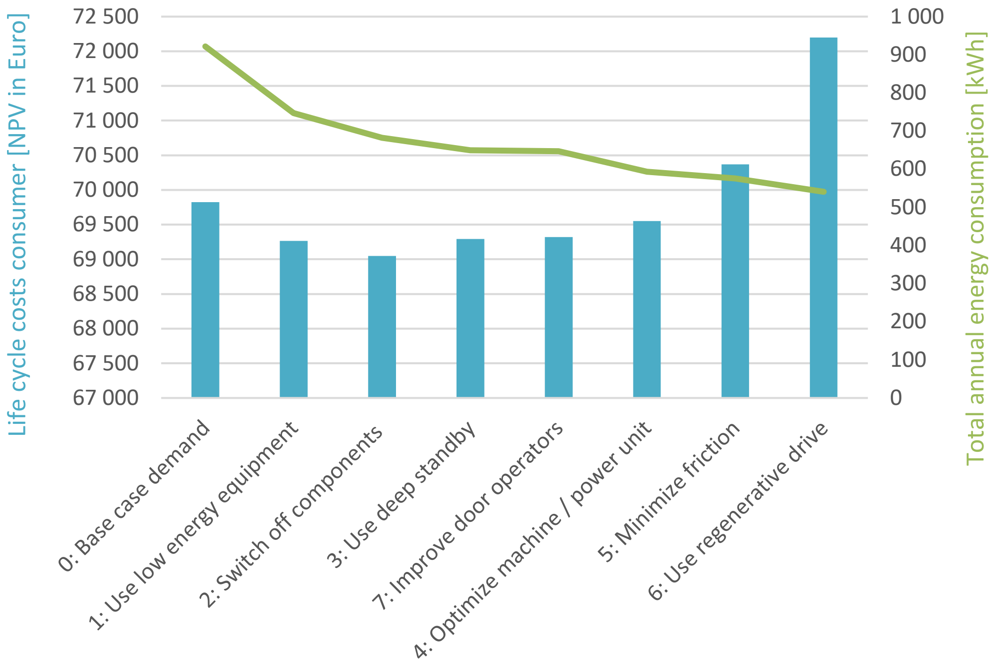


Figure 6-6: LCC curve for base case 2B

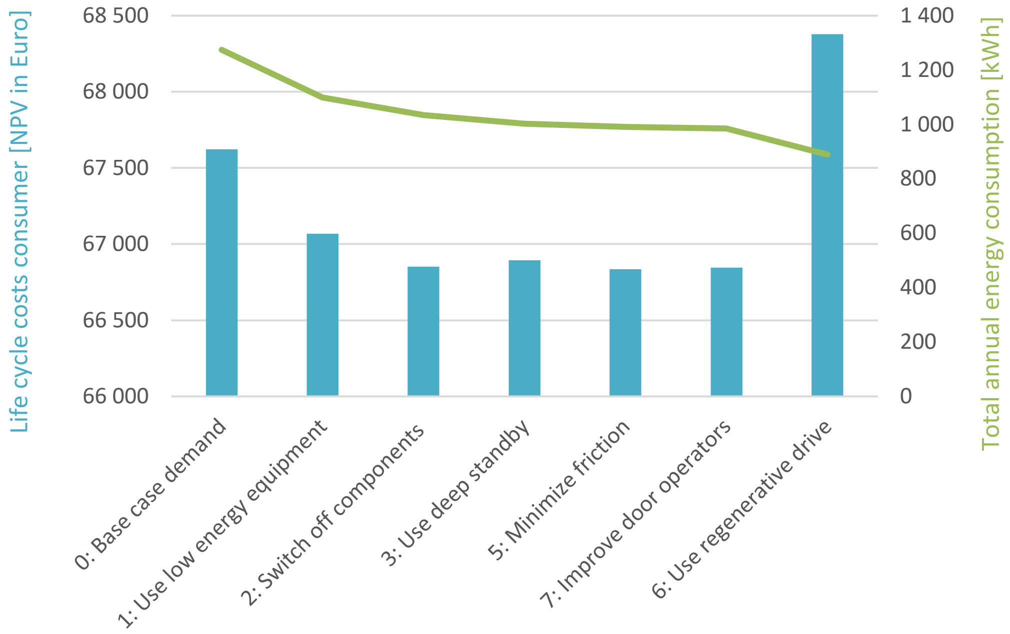


Figure 6-7: LCC curve for base case 3

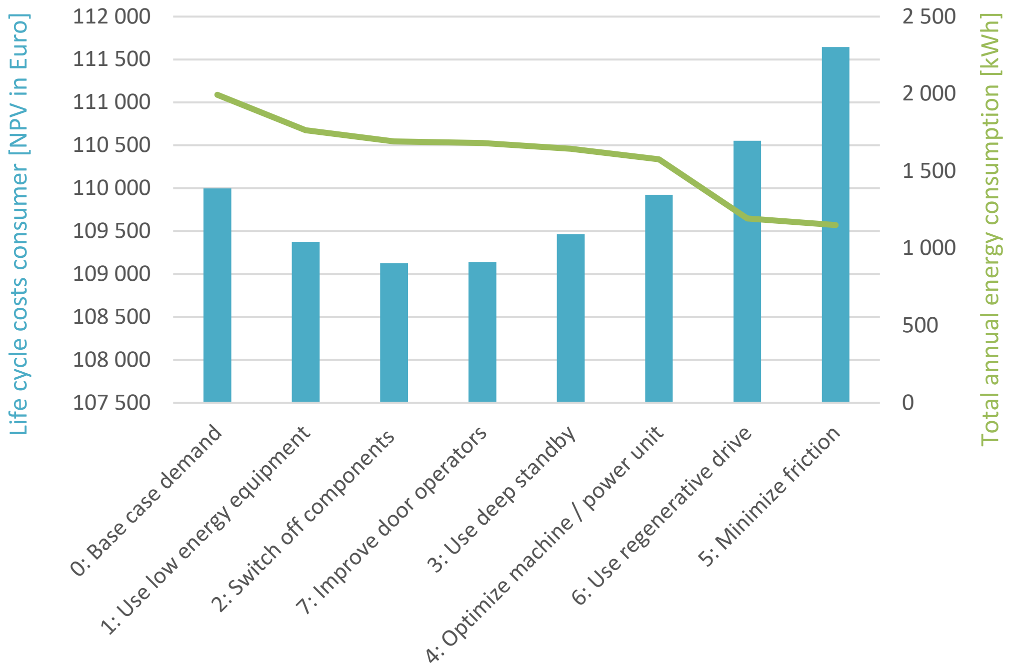
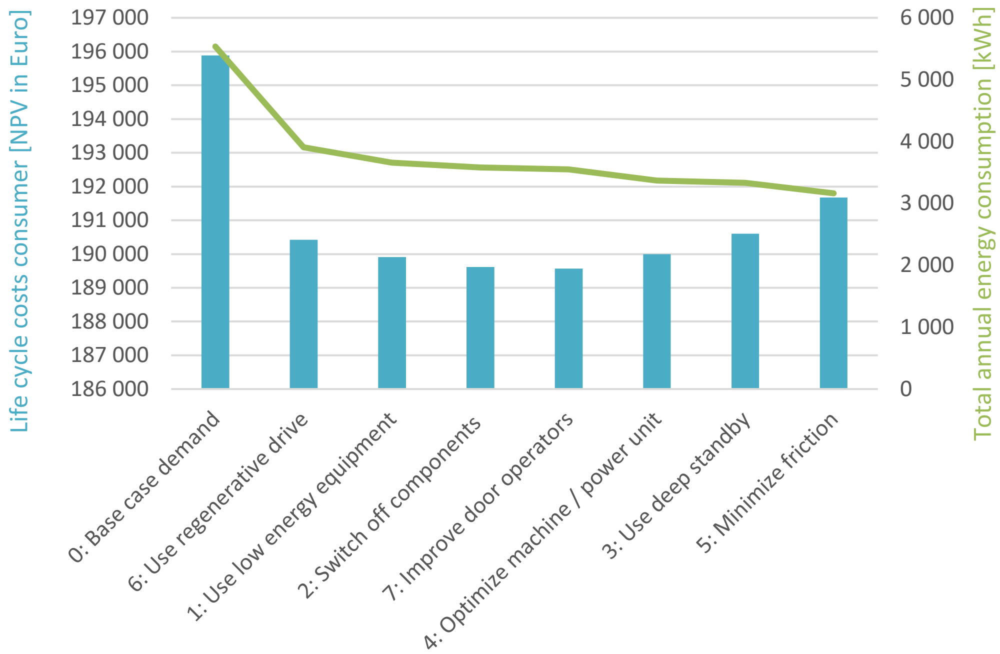


Figure 6-8: LCC curve for base case 4



6.5. Subtask 6.5 - Long term targets and system analysis

The aim of this final subtask within Task 6 is two-fold. It shall look beyond the specific design options that are available as BAT in the long term. First, the long-term technical potentials as best not yet available technologies (BNAT), are to be discussed based on the assessment of applied and fundamental research which still address the context of the present product archetype. Second, the long-term potential based on changes to the total system to which the present archetypal product belongs shall be discussed.

6.5.1. Long-term technical potentials based on BNAT

Based on the analysis of resources in the context of setting up the design options, no fundamentally different BNAT design options could be identified for the currently dominant lift designs. The majority of improvements in terms of environmental impact points to further incremental improvements of existing concepts and components (i.e. more efficient motors). Yet this does not take developments of entirely different lift designs into account, e.g. designs based on linear motors[6] that could allow for horizontal movement in buildings next to vertical transportation. Yet their impacts on environmental performance are not yet known and today's energy-related test standards would have to be revised to be able to address horizontal movement.

With regard to design options that could yield additional benefits for today's technologies, new traffic management systems could be mentioned. Their benefit for individual lifts remains difficult to quantify as they depend on the individual settings and their impact usually concerns groups of several lifts. Thus, they will mainly be used for areas with heavier traffic, or for larger buildings that translates into lifts falling under the higher usage categories of ISO 25745.

6 See for example https://multi.thyssenkrupp-elevator.com/de/.

6.5.2. Long-term changes to the total system

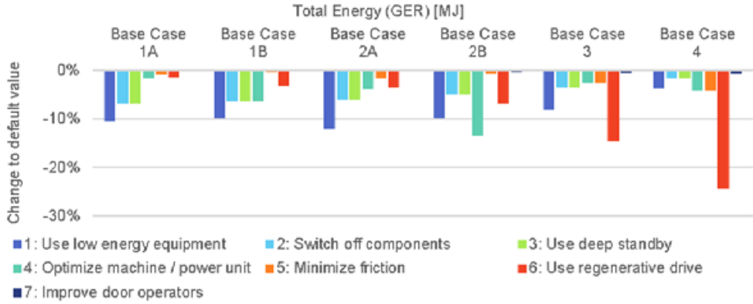
The essential service performed by lifts is to make the different floors of buildings accessible in the first place and/or ensure a comfortable access. Changing demand for comfort in buildings, ageing society and urbanization may increase the demand for lifts in the future. Yet long-term changes in such societal transitions, product-service substitutions or dematerialisation will foreseeably not bring any fundamental changes to the basic structure of buildings, as we know them today. As discussed in Task 3, there are no directly competing technological alternatives to lifts for vertical transportation in buildings with the exception of a few cases applicable to specific types of locations (e.g. escalators across a few stories in certain types of buildings, see also Task 3). Therefore, no major long-term changes to the total system are expected in the sense that lifts could be substituted by other technological alternatives.

6.6. Annex A: Detailed impact of the design options on the environmental performance

Energy, water and waste

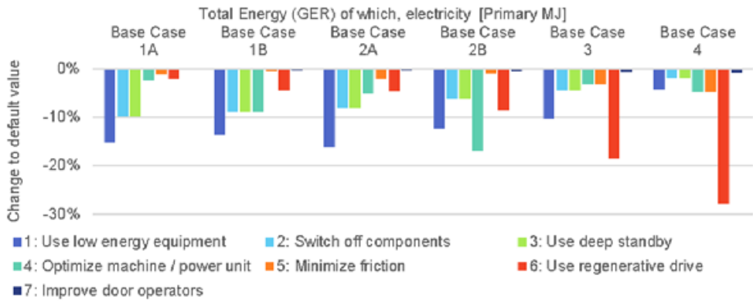
Total Energy (GER) — **MJ**

	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	228 827	243 427	329 870	402 945	640 221	1 510 958
1: Use low energy equipment	204 958	219 544	290 534	363 610	588 581	1 455 197
2: Switch off components	213 465	228 056	310 190	383 266	617 846	1 486 236
3: Use deep standby	213 465	228 056	310 190	383 266	617 846	1 486 236
4: Optimize machine / power unit	225 219	228 035	317 525	348 806	624 372	1 448 169
5: Minimize friction	227 187	242 656	324 820	400 237	624 372	1 448 169
6: Use regenerative drive	225 547	235 745	318 647	375 894	547 766	1 144 690
7: Improve door operators	228 663	243 042	329 309	401 591	637 579	1 500 493



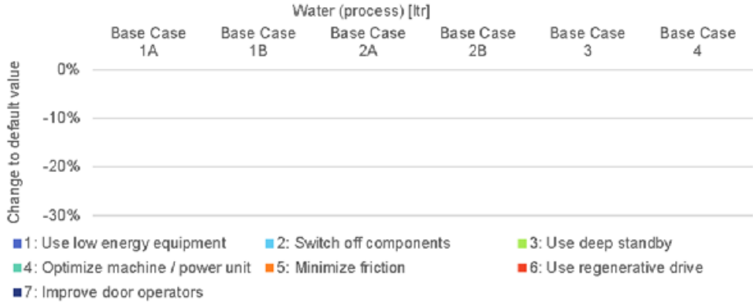
Total Energy (GER) of which, electricity Primary MJ

	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	156 987	175 540	244 249	319 253	500 663	1 318 511
1: Use low energy equipment	133 118	151 657	204 913	279 918	449 024	1 262 751
2: Switch off components	141 625	160 169	224 569	299 573	478 288	1 293 790
3: Use deep standby	141 625	160 169	224 569	299 573	478 288	1 293 790
4: Optimize machine / power unit	153 379	160 127	231 904	265 085	484 814	1 255 722
5: Minimize friction	155 347	174 769	239 199	316 544	484 814	1 255 722
6: Use regenerative drive	153 707	167 837	233 026	292 173	408 209	952 243
7: Improve door operators	156 823	175 155	243 687	317 898	498 022	1 308 046

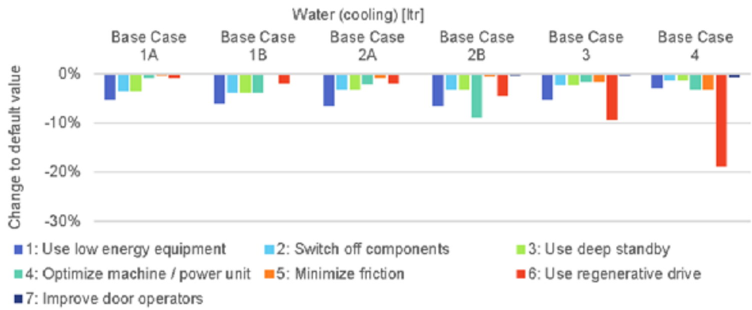


Water (process) — **ltr**

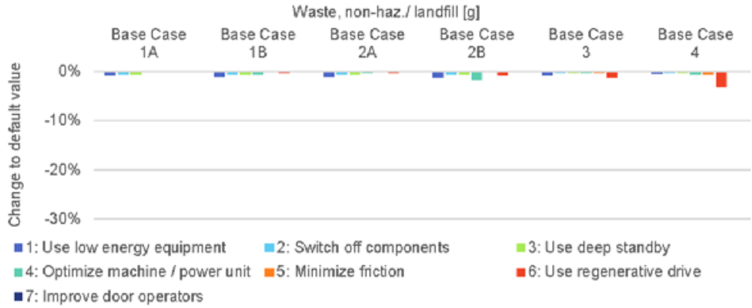
	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	26 430	26 335	27 997	29 018	42 188	59 896
1: Use low energy equipment	26 430	26 335	27 997	29 018	42 188	59 896
2: Switch off components	26 430	26 335	27 997	29 018	42 188	59 896
3: Use deep standby	26 430	26 335	27 997	29 018	42 188	59 896
4: Optimize machine / power unit	26 430	26 336	27 997	29 019	42 188	59 896
5: Minimize friction	26 430	26 335	27 997	29 018	42 188	59 896
6: Use regenerative drive	26 430	26 336	27 997	29 019	42 188	59 896
7: Improve door operators	26 430	26 335	27 997	29 018	42 188	59 896



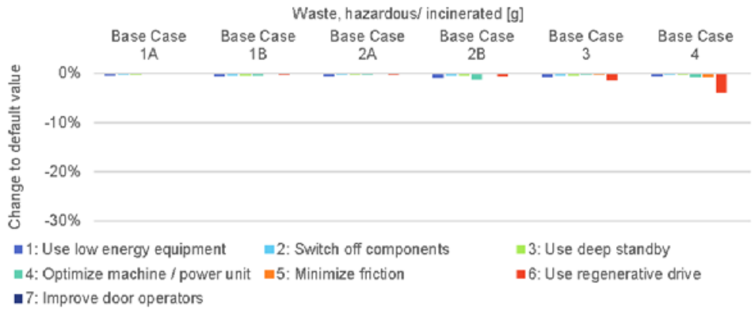
Water (cooling)	ltr					
	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	20 177	17 826	27 139	27 152	43 996	86 850
1: Use low energy equipment	19 117	16 764	25 391	25 404	41 701	84 372
2: Switch off components	19 495	17 143	26 265	26 277	43 002	85 751
3: Use deep standby	19 495	17 143	26 265	26 277	43 002	85 751
4: Optimize machine / power unit	20 017	17 144	26 591	24 749	43 292	84 059
5: Minimize friction	20 105	17 792	26 915	27 031	43 292	84 059
6: Use regenerative drive	20 032	17 487	26 641	25 953	39 887	70 571
7: Improve door operators	20 170	17 809	27 114	27 092	43 879	86 385



Waste, non-haz./ landfill	g					
	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	1 575 070	1 260 575	2 042 698	1 613 960	3 927 659	6 078 870
1: Use low energy equipment	1 562 769	1 248 267	2 022 427	1 593 690	3 901 047	6 050 135
2: Switch off components	1 567 153	1 252 654	2 032 556	1 603 819	3 916 128	6 066 130
3: Use deep standby	1 567 153	1 252 654	2 032 556	1 603 819	3 916 128	6 066 130
4: Optimize machine / power unit	1 573 210	1 253 732	2 036 336	1 587 498	3 919 491	6 046 513
5: Minimize friction	1 574 224	1 260 178	2 040 095	1 612 564	3 919 491	6 046 513
6: Use regenerative drive	1 573 379	1 257 705	2 036 915	1 601 458	3 880 014	5 890 120
7: Improve door operators	1 574 985	1 260 376	2 042 409	1 613 262	3 926 297	6 073 477



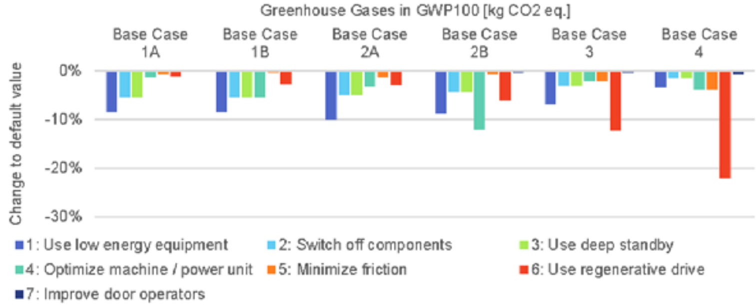
Waste, hazardous/ incinerated	g					
	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	100 402	69 765	101 908	72 171	105 838	146 687
1: Use low energy equipment	100 025	69 389	101 288	71 551	105 023	145 807
2: Switch off components	100 159	69 523	101 598	71 861	105 485	146 297
3: Use deep standby	100 159	69 523	101 598	71 861	105 485	146 297
4: Optimize machine / power unit	100 345	69 522	101 713	71 316	105 588	145 696
5: Minimize friction	100 376	69 753	101 829	72 128	105 588	145 696
6: Use regenerative drive	100 350	69 644	101 731	71 744	104 379	140 908
7: Improve door operators	100 399	69 759	101 899	72 150	105 796	146 522



Emissions (Air)

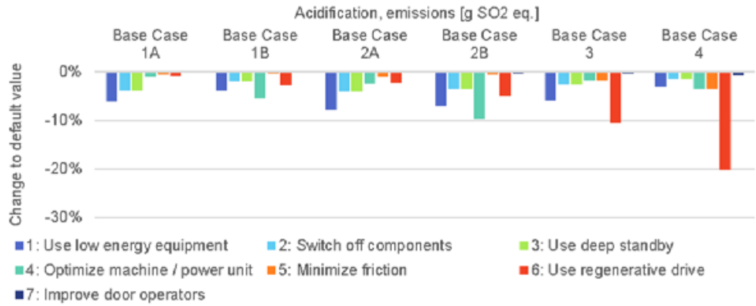
Greenhouse Gases in GWP100 — kg CO2 eq.

	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	12 064	12 194	16 816	19 240	32 191	71 266
1: Use low energy equipment	11 045	11 175	15 137	17 561	29 987	68 886
2: Switch off components	11 408	11 538	15 976	18 400	31 236	70 211
3: Use deep standby	11 408	11 538	15 976	18 400	31 236	70 211
4: Optimize machine / power unit	11 910	11 539	16 289	16 930	31 515	68 586
5: Minimize friction	11 994	12 162	16 601	19 124	31 515	68 586
6: Use regenerative drive	11 924	11 868	16 337	18 087	28 245	55 631
7: Improve door operators	12 057	12 178	16 792	19 182	32 079	70 819



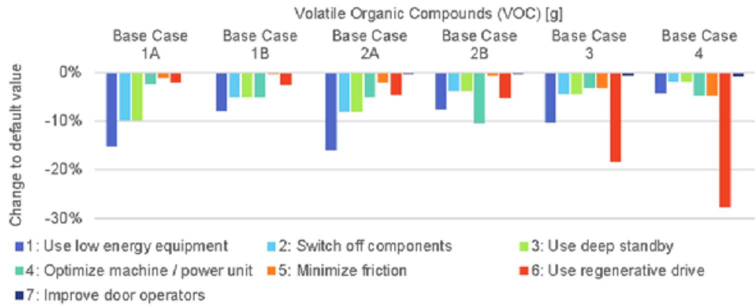
Acidification, emissions — g SO2 eq.

	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	75 082	2 371	95 265	105 579	166 449	345 575
1: Use low energy equipment	70 574	2 279	87 835	98 149	156 695	335 042
2: Switch off components	72 181	2 325	91 548	101 861	162 222	340 905
3: Use deep standby	72 181	2 325	91 548	101 861	162 222	340 905
4: Optimize machine / power unit	74 401	2 245	92 933	95 354	163 455	333 714
5: Minimize friction	74 773	2 365	94 311	105 067	163 455	333 714
6: Use regenerative drive	74 463	2 308	93 145	100 471	148 985	276 391
7: Improve door operators	75 051	2 368	95 159	105 323	165 950	343 598

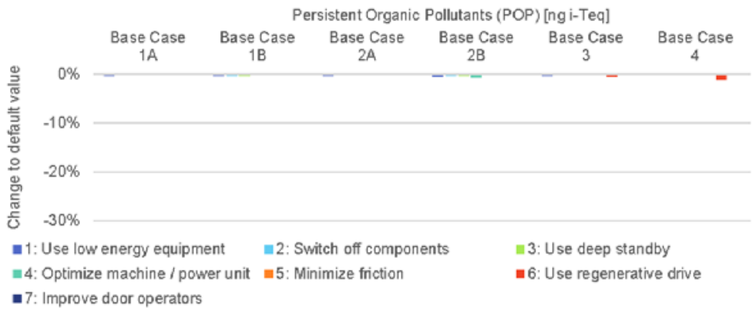


Volatile Organic Compounds (VOC) — g

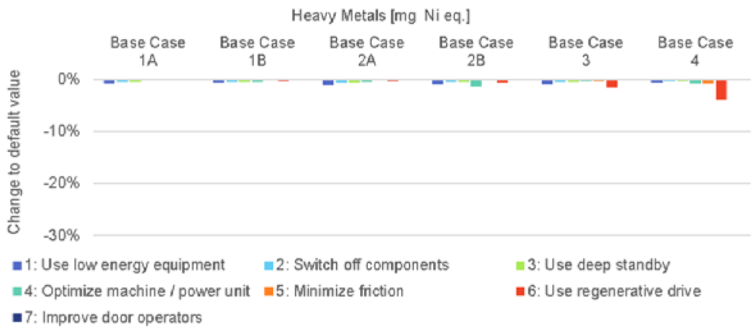
	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	3 528	6 843	5 492	11 671	11 290	29 501
1: Use low energy equipment	2 995	6 310	4 613	10 792	10 137	28 256
2: Switch off components	3 185	6 500	5 052	11 231	10 791	28 949
3: Use deep standby	3 185	6 500	5 052	11 231	10 791	28 949
4: Optimize machine / power unit	3 447	6 499	5 216	10 461	10 936	28 099
5: Minimize friction	3 491	6 826	5 379	11 610	10 936	28 099
6: Use regenerative drive	3 454	6 671	5 241	11 066	9 225	21 321
7: Improve door operators	3 524	6 834	5 479	11 641	11 231	29 267



Persistent Organic Pollutants (POP)	ng i-Teq					
	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	19 840	14 911	26 319	19 185	52 808	79 875
1: Use low energy equipment	19 785	14 855	26 227	19 093	52 688	79 745
2: Switch off components	19 804	14 875	26 273	19 139	52 756	79 818
3: Use deep standby	19 804	14 875	26 273	19 139	52 756	79 818
4: Optimize machine / power unit	19 832	14 892	26 290	19 081	52 771	79 729
5: Minimize friction	19 837	14 909	26 307	19 179	52 771	79 729
6: Use regenerative drive	19 833	14 910	26 293	19 145	52 592	79 021
7: Improve door operators	19 840	14 910	26 317	19 182	52 802	79 851

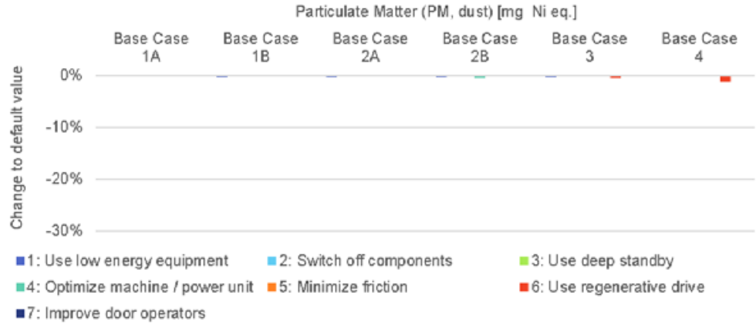


Heavy Metals	mg Ni eq.					
	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	34 777	39 519	37 581	44 209	65 715	95 485
1: Use low energy equipment	34 536	39 278	37 183	43 811	65 193	94 921
2: Switch off components	34 622	39 364	37 382	44 010	65 489	95 235
3: Use deep standby	34 622	39 364	37 382	44 010	65 489	95 235
4: Optimize machine / power unit	34 741	39 368	37 456	43 667	65 555	94 850
5: Minimize friction	34 761	39 511	37 530	44 181	65 555	94 850
6: Use regenerative drive	34 744	39 446	37 467	43 940	64 780	91 781
7: Improve door operators	34 776	39 515	37 575	44 195	65 688	95 379



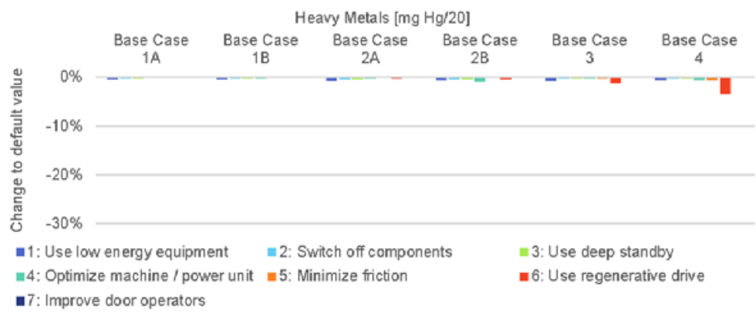
PAHs	g					
	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	2 385	1 785	2 944	2 371	4 489	7 319
1: Use low energy equipment	2 330	1 729	2 853	2 279	4 368	7 189
2: Switch off components	2 350	1 749	2 898	2 325	4 437	7 261
3: Use deep standby	2 350	1 749	2 898	2 325	4 437	7 261
4: Optimize machine / power unit	2 377	1 749	2 916	2 245	4 452	7 173
5: Minimize friction	2 382	1 783	2 933	2 365	4 452	7 173
6: Use regenerative drive	2 378	1 767	2 918	2 308	4 273	6 464
7: Improve door operators	2 385	1 784	2 943	2 368	4 483	7 295

Particulate Matter (PM, dust)	mg Ni eq.					
	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	48 446	44 623	58 766	55 193	98 117	130 408
1: Use low energy equipment	48 351	44 528	58 608	55 036	97 911	130 185
2: Switch off components	48 385	44 562	58 687	55 114	98 028	130 309
3: Use deep standby	48 385	44 562	58 687	55 114	98 028	130 309
4: Optimize machine / power unit	48 432	44 574	58 716	54 995	98 054	130 157
5: Minimize friction	48 440	44 620	58 746	55 182	98 054	130 157
6: Use regenerative drive	48 433	44 604	58 721	55 104	97 748	128 943
7: Improve door operators	48 446	44 622	58 763	55 188	98 107	130 366

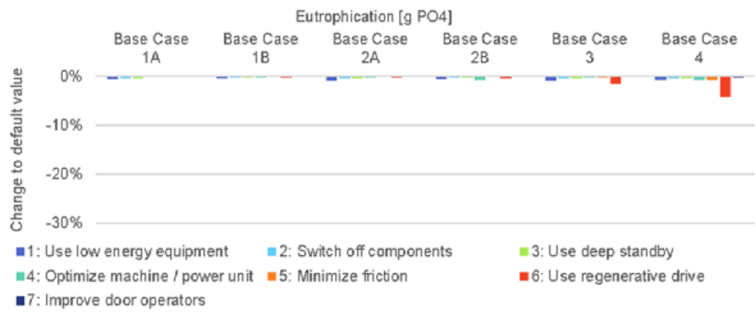


Emissions (Water)

Heavy Metals	mg Hg/20					
	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	22 193	24 843	22 790	26 953	35 135	46 584
1: Use low energy equipment	22 090	24 741	22 621	26 783	34 913	46 344
2: Switch off components	22 127	24 777	22 706	26 868	35 039	46 478
3: Use deep standby	22 127	24 777	22 706	26 868	35 039	46 478
4: Optimize machine / power unit	22 178	24 779	22 737	26 723	35 067	46 314
5: Minimize friction	22 186	24 840	22 769	26 941	35 067	46 314
6: Use regenerative drive	22 179	24 813	22 742	26 839	34 737	45 008
7: Improve door operators	22 192	24 842	22 788	26 947	35 124	46 539



Eutrophication	g PO4					
	Base Case 1A	Base Case 1B	Base Case 2A	Base Case 2B	Base Case 3	Base Case 4
0: Base case demand	832	1 152	902	1 450	1 258	1 661
1: Use low energy equipment	827	1 148	895	1 443	1 248	1 650
2: Switch off components	829	1 149	898	1 447	1 254	1 656
3: Use deep standby	829	1 149	898	1 447	1 254	1 656
4: Optimize machine / power unit	831	1 149	900	1 440	1 255	1 649
5: Minimize friction	831	1 152	901	1 450	1 255	1 649
6: Use regenerative drive	831	1 151	900	1 445	1 241	1 592
7: Improve door operators	832	1 152	902	1 450	1 258	1 659



6.7. Annex B: Detailed tables on least life cycle costs of the cumulative design options

Base Case 1A

Design option	Annual energy consumption	Purchase price including installation	Operation expense (energy)	Operating expense (non-energy) incl. EOL	Life Cycle Cost (Consumer)
	[kWh]	[NPV Euro]	[NPV Euro]	[NPV Euro]	[NPV Euro]
0: Base case demand	555	32 000	2 716	24 190	58 906
2: Switch off components	487	32 100	2 382	24 190	58 672
1: Use low energy equipment	396	32 400	1 936	24 190	58 526
3: Use deep standby	369	32 700	1 806	24 190	58 696
7: Improve door operators	368	32 740	1 802	24 190	58 732
4: Optimize machine / power unit	353	33 140	1 725	24 190	59 055
5: Minimize friction	347	33 940	1 697	24 190	59 827
6: Use regenerative drive	337	35 440	1 648	24 190	61 278

Base Case 1B

Design option	Annual energy consumption	Purchase price including installation	Operation expense (energy)	Operating expense (non-energy) incl. EOL	Life Cycle Cost (Consumer)
	[kWh]	[NPV Euro]	[NPV Euro]	[NPV Euro]	[NPV Euro]
0: Base case demand	654	30 500	3 199	23 291	56 989
2: Switch off components	585	30 600	2 864	23 291	56 755
1: Use low energy equipment	494	30 900	2 419	23 291	56 609
3: Use deep standby	468	31 100	2 288	23 291	56 679
5: Minimize friction	464	31 100	2 272	23 291	56 662
7: Improve door operators	463	31 140	2 263	23 291	56 694
6: Use regenerative drive	429	32 640	2 101	23 291	58 031

Base Case 2A

Design option	Annual energy consumption	Purchase price including installation	Operation expense (energy)	Operating expense (non-energy) incl. EOL	Life Cycle Cost (Consumer)
	[kWh]	[NPV Euro]	[NPV Euro]	[NPV Euro]	[NPV Euro]
0: Base case demand	922	38 500	4 510	26 813	69 822
1: Use low energy equipment	747	38 800	3 654	26 813	69 267
2: Switch off components	682	38 900	3 338	26 813	69 050
3: Use deep standby	650	39 300	3 179	26 813	69 292
7: Improve door operators	647	39 340	3 167	26 813	69 320
4: Optimize machine / power unit	593	39 840	2 901	26 813	69 554
5: Minimize friction	576	40 740	2 817	26 813	70 369
6: Use regenerative drive	541	42 740	2 645	26 813	72 198

Base Case 2B

Design option	Annual energy consumption [kWh]	Purchase price including installation [NPV Euro]	Operation expense (energy) [NPV Euro]	Operating expense (non-energy) incl. EOL [NPV Euro]	Life Cycle Cost (Consumer) [NPV Euro]
0: Base case demand	1 274	36 000	6 235	25 389	67 623
1: Use low energy equipment	1 100	36 300	5 379	25 389	67 068
2: Switch off components	1 035	36 400	5 063	25 389	66 851
3: Use deep standby	1 002	36 600	4 904	25 389	66 893
5: Minimize friction	990	36 600	4 845	25 389	66 834
7: Improve door operators	984	36 640	4 816	25 389	66 845
6: Use regenerative drive	889	38 640	4 350	25 389	68 379

Base Case 3

Design option	Annual energy consumption [kWh]	Purchase price including installation [NPV Euro]	Operation expense (energy) [NPV Euro]	Operating expense (non-energy) incl. EOL [NPV Euro]	Life Cycle Cost (Consumer) [NPV Euro]
0: Base case demand	1 994	45 500	9 754	54 746	109 999
1: Use low energy equipment	1 764	46 000	8 631	54 746	109 377
2: Switch off components	1 693	46 100	8 281	54 746	109 126
7: Improve door operators	1 681	46 170	8 223	54 746	109 139
3: Use deep standby	1 645	46 670	8 048	54 746	109 464
4: Optimize machine / power unit	1 575	47 470	7 707	54 746	109 923
6: Use regenerative drive	1 193	49 970	5 836	54 746	110 552
5: Minimize friction	1 150	51 270	5 628	54 746	111 643

Base Case 4

Design option	Annual energy consumption [kWh]	Purchase price including installation [NPV Euro]	Operation expense (energy) [NPV Euro]	Operating expense (non-energy) incl. EOL [NPV Euro]	Life Cycle Cost (Consumer) [NPV Euro]
0: Base case demand	5 536	67 000	27 084	101 800	195 884
6: Use regenerative drive	3 908	69 500	19 120	101 800	190 420
1: Use low energy equipment	3 660	70 200	17 908	101 800	189 908
2: Switch off components	3 581	70 300	17 521	101 800	189 621
7: Improve door operators	3 551	70 400	17 373	101 800	189 573
4: Optimize machine / power unit	3 372	71 700	16 494	101 800	189 994
3: Use deep standby	3 332	72 500	16 301	101 800	190 601
5: Minimize friction	3 163	74 400	15 475	101 800	191 675

Ecodesign preparatory study for lifts implementing the Ecodesign Working Plan 2016-2019

Task 7 report: Scenarios

Reference:
N° 617/PP/GR(MMA/17/1131/9709 for the conclusion of a specific contract in application of the Framework Contract No 409/PP/2014/FC Lot 2 with reopening of competition

Client:
European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

31th October 2019

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Project website: https://www.eco-lifts.eu/

This study was ordered and paid for by the European Commission, Directorate-General for Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (GROW).

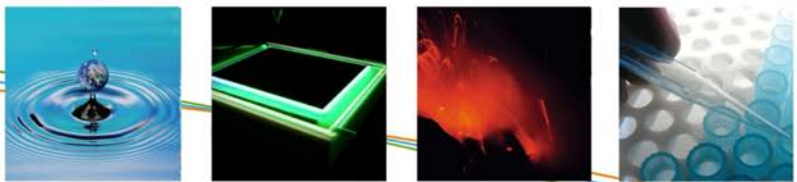

Table of contents: Task 7

List of Figures

List of tables

List of Abbreviations and Acronyms

ANACAM	Associazione Nazionale Imprese di Costruzione e Manutenzione Ascensori
BAT	Best Available Technology
BAU	Business-as-Usual
B2B	Business-to-Business
BEP	Break-Even Point
BNAT	Best not yet available technology
BOM	Bill of Materials
ECOS	European Environmental Citizens Organisation for Standardisation
EFESME	European Federation for Elevator Small and Medium-sized Enterprises
ELA	European Lift Association
ELCA	European Lift Component Association
EN	European Standard
EP	European Parliament
EPBD	Energy Performance Building Directive
EPD	Environmental Product Declaration
EU	European Union
FU	functional unit
HH	Household
ISO	International Organization for Standardization
LCA	life cycle assessment
LLCC	Least Life Cycle Cost
MEErP	Methodology for Ecodesign of Energy-related Products
MEPS	Minimum Energy Performance Standard
PCR	Product Category Rule
PRODCOM	Production Community
VA	Voluntary Agreement

VDI	Verein Deutscher Ingenieure
VDMA	Verband Deutscher Maschinen- und Anlagenbau e. V.
WTO	World Trade Organization

7. Task 7 - Scenarios

The purpose of this task is to provide an understanding of the impacts of future scenarios in line with policy measures that could be introduced at EU-level. This is a key task as it requires the combination of the results of all previous tasks to derive estimates of the impacts of different Ecodesign policy measures and design options, and thereby is aimed at providing an analytical basis in support of the Ecodesign decision-making process. A set of quantitative scenarios are provided of the market penetration levels of various lift technologies and the consequences for the environment, users and industry.
To this end, a stock model has been developed to estimate future sales and stocks of lifts under different policy scenarios. The outcomes are then compared with the Business-as-Usual scenario.

It has to be kept in mind that the conclusions drawn here are preliminary and solely represent the view of the consortium. They do not reflect the opinion of the European Commission in any way. Unlike the Task 1-6 reports, which serve to provide the baseline data for future work conducted by the European Commission (impact assessment, further discussions in the Consultation Forum and the development of implementing measures, if any), Task 7 serves to provide a summary of policy implications as seen by the consortium. Furthermore, some elements of this task may be analyzed further in greater depth during the impact assessment.

7.1. Analysis of policies

Based on the review of the policies and standards which have already been implemented (see Task 1), the position of the European Commission and the main stakeholders and on the cost-optimized technical improvement potential of the technologies (see Task 6), this task identifies and discusses policy options aimed at fostering the energy efficiency of lifts and reducing their impacts on the environment.

Such policy options include:

- Ecodesign requirements setting minimum (or maximum) limits and/or information requirements
- labelling or rating, which might be dynamic (if the market will need time to be prepared), in combination with incentive programmes (e.g. public procurement specifications), or
- alternative policy options such as self-regulation e.g. a voluntary agreement.

Furthermore, this task includes identification and discussion of measurement and product standards addressing installation and user information.

Drawing upon the previous tasks, clearly defined sets of policy options for new products are developed. These options are then translated into impacts on new products entering the stock which are input into the stock model.

To support this, the stakeholders' positions were summarised and taken into account as well as the barriers to the market penetration of efficient lifts. Existing standards and legislation are included and modelled together with different additional policy options.

7.1.1. Stakeholder consultation during the preparatory study

During the Ecodesign preparatory study, stakeholders were invited and encouraged by the project team and the European Commission to contribute to the study by providing inputs and their views. In this way stakeholders had the opportunity to actively engage in the process and to improve the preparatory study and the quality its of outcomes.

Stakeholder meetings are a crucial element for exchange in Ecodesign preparatory studies. Stakeholders had the opportunity to provide written comments on the Task Reports prior to and after each of these meetings, which took place in the following sequence:

- Stakeholder Meeting 1: The first meeting was organized on 21st February 2018 in Brussels. The discussion covered the scope (Task 1), the market analysis (Task 2) and the users (Task 3). The following stakeholders attended the meeting: UK (Member State), ANACAM, ECOS, EFESME, ELA, ELCA, Hydroware A.B., Kollmorgen Steuerungstechnik GmbH, Schindler Elevators Ltd., VDMA e.V., Viegand Maagoe A/S, Finland (Member State). The meeting minutes are published on the project website.[1]
- Stakeholder Meeting 2: A second stakeholder meeting took place on 17th September 2018 in Brussels. The following stakeholders attended the meeting: ANACAM, ECOS, EFESME, ELCA, Hydroware AB, Kollmorgen Steuerungstechnik GmbH, Schindler Elevators Ltd., VDMA, Finland (Member State), ELA, OTIS, KONE, ThyssenKrupp and UK (Member State). The meeting minutes are published on the project website.[2] During the second stakeholder meeting, stakeholders were actively encouraged to express their position on possible requirements in line with the Ecodesign Directive.
- Stakeholder Meeting 3: A third and final stakeholder meeting took place on 11th March 2019 in Brussels. The following stakeholders attended the meeting: ANACAM, ECOS, EFESME, ELCA, Hydroware AB, Kollmorgen Steuerungstechnik GmbH, Schindler Elevators Ltd., VDMA, Finland (Member State), ELA, OTIS, KONE, ThyssenKrupp, Matrix Liften, Danfoss, ubeon and UK (Member State). The meeting minutes are published on the project website.[3]

In addition to these meetings, other meetings (in person or via a teleconference) were held with industry associations and/or manufacturers. Examples include:

- A meeting held during the Interlift[4] in October 2017 with several EU associations and some manufacturers;

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1 https://www.eco-lifts.eu/eco-lifts-wAssets/docs/Reports_Stakeholder_Meeting_1/Eco-design_PrepStudy_Lifts_Stakeholder_Meeting_1_20180221_Minutes_Corrected.pdf

2 https://www.eco-lifts.eu/eco-lifts-wAssets/docs/Reports_Stakeholder_Meeting_2/Stakeholder_Meeting_2_20180917_Minutes_update.pdf

3 https://www.eco-lifts.eu/eco-lifts-wAssets/docs/Reports_Stakeholder_Meeting_3/Ecodesign_PrepStudy_Lifts_SM3_minutes_20190425_final.pdf

4 Interlift is one of the major trade fairs for lift in the world, see https://www.interlift.de/en/.

- A phone conference in June 2018 with the EU associations (ELA, ELCA and EFESME) to gather information on the Base Cases and the bill of materials (BOM).

Within this process, stakeholders contributed to improve the definition of the Base Cases and to validate or improve input used for the BOM. One of the main points of discussion during the third stakeholder meeting was the assumption with regard to the energy efficiency classes and costs assumed for the BC level as well as the set of design options. Following this discussion, the project team decided to update these parameters and to offer stakeholders the possibility to comment on the revised figures.[5] Feedback suggested that the revised figures are considered more realistic and the reports for Tasks 5, 6 and 7 have been updated accordingly.

However, it is important to stress, that confidentiality restrictions limited the possibility to gather information on prices and efficient technologies even at an aggregate level (see Task 6 report).

<u>The positions of the main stakeholders can be summarized as follows:</u>

1) ELA (European Lift Association)

The ELA Members elaborated a common position which was communicated by the ELA Board to the consortium in December 2018. Their position is:

- They do not support voluntary agreement (as an alternative to Ecodesign regulatory measures) for the setting of requirements for lifts since they consider voluntary agreement to not be suitable for the lifts industry.
- They could support "possible regulatory measures (if at all deemed necessary (i) based on correct data, (ii) based on realistic and significant energy saving potential estimates, and (iii) based on current state-of-the-art products and technologies). Possible additional regulation must:
    - Address the complete lift system (the product is the lift);
    - Take into account the internationally established and recognised EN ISO 25745 standards on the energy performance of lifts, escalators and moving walks;
    - Be based on realistic definitions of standard configurations, excluding optional equipment as required by the customer;
    - Bonus options would be supported where available functionalities[6] contribute to the overall reduction of energy consumption."
- "Energy Efficiency Class "C" according to EN ISO 25745-2:2015 seems a realistic minimum target taking into account external regulatory influences (e.g. accessibility, alarm) and customer/user specific (other than extraordinary, such as TV screen or stone floor) application requirements."
- Support the idea to efficiently promote the energy efficiency classification. ELA wrote "in any event, should an Ecodesign regulation be considered, a new label, applicable to lifts, would need to be created to efficiently promote the energy

[5] https://www.eco-lifts.eu/eco-lifts-wAssets/docs/Reports_Stakeholder_Meeting_3/Eco-design_PrepStudy_lifts_UPDATE_ASSUMPTIONS_20190425.pdf

[6] In lift groups

efficiency classification, or the exclusion of the Energy Labelling Regulation would need to be lifted" .

- "EPBD should not be ignored as possible suitable tool to regulate the energy performance of lifts. While lifts operate in buildings and contribute to their overall energy performance, they are currently not formally included in the scope of the EPBD. Realistic figures relating to the energy performance of buildings should include all energy demanding devices, including lifts."

In general, ELA would be in favour of an Energy Label for lifts to efficiently promote the energy efficiency classification but is aware of the restrictions within the current energy labelling regulation.

2) ELCA (European Lift Component Association)

ELCA declared its position early in the process :

- The association is opposed to Ecodesign requirements, as long as the analysis is not done based on LCA.
- It supports a voluntary agreement as an alternative to potential Ecodesign regulations. In the case of lifts, the use of LCAs should be the key priority.

3) EFESME (European Federation for Elevator Small and Medium-sized Enterprises)

EFESME considers that lifts are not a product suitable to be submitted to rules such as those which need to be implemented for compliance with the requirements of the Ecodesign Directive.

In general, lift (components) manufacturer associations and their members consider:

- that lifts are a complex and special product, since they are put together and installed in the final building. This is indeed a difference compared to white goods but in fact is not new issue for many other B2B products subject to Ecodesign requirements, see for example power transformers (Regulation (EU) 548/2014) or electric motors (Regulation (EU) 4/2014),
- that manufacturers have improved on a voluntary basis the energy efficiency of their products during the last decade, and that
- LCA should be more taken into account for requirements, since lifts have a long lifetime and can be repaired and upgraded along the lifetime.

4) ECOS (European Environmental Citizens Organisation for Standardisation)

ECOS did not provide concrete Ecodesign nor energy labelling proposals, but supported basically both approaches for lifts. Also, the NGO provided valuable inputs regarding the circular economy and reparability:

- To decrease the maintenance costs and/or the LCA impact, the adopting the following requirements would help to improve the current situation: a requirement that spare parts should be availabile for a fixed number of years that is representative of the expected lifetime of the product: All spare parts should be available during the average product lifetime, or the lifetime of the necessary spare parts.

- Ensure unrestricted access to repair and maintenance information from the date the product is placed on the market.
- Other factors to consider include disassembly requirements, disassembly sequence, the cost of spare parts, software update availability, etc.[7]
- Restrictions on the use of plastics/polymers that impede adequate recycling, such as non-compatibility for recycling polymer blends, incompatible coatings, very dark plastics that have no recycling routes, etc.
- Marking of plastics and additives according to the relevant ISO standards, particularly marking content including flame retardants.
- In the case of Permanent Magnet Motors: a mandatory and standardised marking of products containing rare earth magnets above a certain minimum weight (e.g. > 10 g) can significantly facilitate future recycling practices.
- Information on the presence of rare earth material in magnets, their localisation, as well as their extraction process allowing safe and cost-effective recycling.
- Consider specific requirements for how these permanent magnets can be integrated in the motor to maximise cost effectiveness of reuse and recovery process (e.g. no glue and no welding hampering the extraction/recovery of rare earths elements; or imposing a maximum non-destructive disassembly time to foster the reuse of the magnets rather than the mere recovery of rare earths).

7.1.2. Barriers and opportunities for Ecodesign measures

Many lifts are mainly B2B products. They are being used in several types of buildings and for various usage needs (cf. Task 2 and 3). Also, they are part of a building, and impact its energy consumption (cf. Task 3). The heterogeneity of applications has the consequence that configurations of lifts vary. Nevertheless standardized usage categories for lifts exist (cf. Task 3), with six usage categories established according to EN ISO 2575-2:2015. Following installation, the parameter setting of the lift control unit may have a large impact on the energy consumption of a lift. To sum up, the following circumstances apply to the nature of trade for lifts:

- Lifts are being configured in accordance to the Lift Directive (2014/33/EU) and national building regulations and customer needs. Nevertheless, internationally accepted usage categories exist.
- The planning and procurement of lifts is accompanied by sales departments of lift manufacturers or installers.
- Buildings and consequently their lifts have long life times - identified in Task 2 as >60 years. Also, lifts are regularly inspected maintained, repaired and eventually upgraded.

Among other factors, the following barriers were identified (mainly based on Task 3):

- Information and awareness constraints are the major barriers to energy-efficient technologies identified in the course of the study. A lack of monitoring of energy consumption and a lack of awareness about energy-efficient technologies especially among the operators/users has been identified. In addition, as manufacturers and their sales departments are the main source of information, it encourages situations where installations are commonly chosen without any detailed assessment of energy demand or its life cycle impact. Currently, an investor does not necessarily have access to information about the energy performance of the lift he wants to choose, or he has access to the information relatively late in the lift selection process. An energy efficiency class makes it easier for the investor

[7] See e.g. proposals in KU LEUVEN 2018

to assess the efficiency of the lift and to choose a less energy-consuming product. EN ISO 25745 provides a methodology to assess the energy performance and the energy class, but the standard is not mandatory at the EU level[8]. Accordingly, the information it requires is not systematically provided to the potential customers/planner.

- Split incentives were also discussed as a challenge for implementing energy-efficient solutions. This is particularly the case when several building users/inhabitants share the overall energy costs of a lift. While manufacturers rather intensively discussed energy demand/energy efficiency, other stakeholders are not usually engaged in the discussion and investors focus on low investment costs in preference to optimised life-cycle costs. Also, at the time of purchase the monthly energy cost of the lift is not visible because it is kept out of the Energy Performance Certificate (EPC) as part of the EPBD (2010/31/EU).
- Other barriers, beyond those related to information and split incentives, were identified as only playing a minor role. A general lack of capital was not identified as a barrier, yet a focus on minimizing investments can be observed and the economic efficiency of energy-efficient technologies was the subject of a controversial debate (cf. Task3, section 3.1.2.6).

Among several other factors, the energy consumption of a lift is also driven by factors resulting from customer requirements and/or by the technician in charge of the maintenance / repair of a lift (cf. Task 3). As stated in Task 4, energy can be saved by shutting down some components (e.g. after 30 seconds of idle time), but in some cases this may negatively impact passenger waiting time. If the users complain about the waiting time, the technical staff might change the standby parameter setting of the lift controller. As a result, the energy consumption of the lift will increase.

The system boundaries within which Ecodesign could be imposed on are limited to the product yet as already mentioned in Task 3, studies for lifts indicate that there are large potentials to save energy linked to lifts outside of the product itself i.e. via measures that concern the shaft; however, this is outside the system boundary set for this study. Nevertheless the lifts guideline VDI 4707[9] presents various measures to increase the efficiency of the lift itself. Many of these measures seem to be well known by manufacturers and building engineering companies as they are being advertised in planning manuals and guidelines. Most of these measures are covered in Task 6 where it is shown that they are beneficial in terms of Life Cycle Cost from the users perspective.

The study found that it was hard to obtain data on the energy consumption of lifts. This means that there is an opportunity to provide owners and user with better data on before and after installation. A lack of monitoring of energy consumption and a lack of awareness about energy-efficient technologies especially among the operators/users have been identified as commonplace in the course of this study. In addition, as manufacturers and their sales departments are the main source of information, it encourages situations where installations were commonly chosen without any detailed assessment of energy demand or its life cycle impact. Currently, an investor does not necessarily have access to information about the energy performance of the lift he/she wants to choose, or he/she has access to the information relatively late in the lift selection process. EN ISO 25745 offers an opportunity to fill this gap. It enables estimation of the

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[8] ISO 25475-2 is already mandatory in Portugal (legal enforcement pending) and Denmark for certain building types as part of the national transposition of the EPBD

[9] See Influencing factors for lift components, recommendations for manufacturers in Annex B (VDI 4007:1-2009)

annual energy consumption of lifts based on a set of parameters and also includes energy classes graded from G to A. In addition, the study also found that brake energy recovery systems can be economical when there is intensive daily use.

To sum up, the following barriers and opportunities for Ecodesign measures result from the product and characteristics of its application:

Barriers to energy efficiency:

- The barrier of the split incentive between the interests of the project developer and the life-cycle costs of the end user cost.
- Lack of upfront information on lift energy performance prevents market actors from taking informed procurement decisions.

Barriers to Ecodesign measures:

- Energy efficiency improvements can be adversely affected by the parameter setting of the lift control unit which could occur during maintenance.
- Shutting down components may also adversely affect the lifetime of electrical components and their LCA impact.

Opportunities:

- **Several technical solutions** exist to increase the energy efficiency of lifts (cf. Task 6). Some **may be retrofitted afterwards**, including brake energy recovery or readjusting the counterweights relative to the average load in real use.
- As detailed **metering information** on electricity use and the trips taken is most **often missing** were these to be made available it would enable the retrofits summarised above to be acted upon.
- The potential to increase efficiency of lifts is well known (at least by manufacturers) and options are offered as sales variants as well as advertised in several building guidelines.
- **Information barriers could be partly overcome by requiring the input parameters for the EN ISO 25745 to be provided as a mandatory information requirement. This would** allow calculation of the annual energy costs and for the **energy use of lifts to be included in building EPCs**. Article 11 of the Ecodesign Directive permits the specification of information requirements for components and sub-assemblies. In this case a lift is a subassembly of a building.

Furthermore, Article 15 of the Ecodesign Directive specifies criteria to be fulfilled for setting implementing measures, as follows:[10]

a. "the product shall represent a significant volume of sales and trade, indicatively more than 200 000 units a year within the Community according to the most recently available figures": According to the Task 2 Report, the sales in 2015 accounted for 127 000 lifts/ year. By 2025, sales are expected to increase to 133 883 lifts/year or 224 093 lifts/year depending on the scenario considered. Therefore, it can be assumed that a sufficiently significant volume of lifts are placed on the EU market.

b. "the product shall, considering the quantities placed on the market and/or put into service, have a significant environmental impact within the Community":

[10] See 2009/125/EC Art.15 §2

according to this report and to Ecodesign 2015-2017 working plan study, lifts were responsible in 2010 for an estimated overall electricity demand of about 19 TWh.[11]

c. "the product shall present significant potential for improvement in terms of its environmental impact without entailing excessive costs": satisfaction of this condition is confirmed in the Task 6 report, since many of the identified design options to reduce the environmental impact (mainly the energy consumption) are cost-effective. Depending on the Base Case, for example, Task 6 shows that the Break-Even Point (BEP) level lies between 21% and 43% below the Business-as-Usual (BAU) level.

7.1.3. Potential policy measures

The pros and cons of applying Ecodesign measures arise directly from the barriers and opportunities of Ecodesign measures for lifts. As already mentioned in the previous section the environmental performance of a lift is dependent on several factors driven by customer requirements. The most important are the usage category of the lift and the drive technology (especially for buildings where hydraulic lift technology is applicable). With this background, we discuss the pros and cons of prospective policy measures as listed below:

1) Prospective implementing measures
   a) Applying Minimum Energy Performance Requirements for lifts and setting information requirements (including energy efficiency classification);
   b) Requirements to improve specific aspects of lift (expressed as specific energy performance requirements);
   c) Applying a Labelling Scheme (within the Energy Labelling Regulation (EU) 2017/1369);
   d) Requiring the input parameters for the EN ISO 25745 parameters as well as for the results of the energy assessment itself as an mandatory information requirements.
   e) Applying a combination of MEPS and Energy Labelling.

2) Voluntary agreement.

Based on the work of this preparatory study, the following policies could be considered:

1.a) Applying Minimum Energy Performance Standards (MEPS) for lifts under Article 15 of the Ecodesign Directive:

EN ISO 25745:2012 provides a methodology to assess the performance of lifts in stand-by mode ($E_{standby}$ in Wh/day) and in travel mode (E_{travel} in Wh/day) as well as the overall annual energy demand (E_{year} expressed in Wh/year) (see Task 3). Having in mind that for some usage categories (especially 1 and 2), lifts are most of the time in stand-by mode (cf. Task 3), the stand-by mode might be subject to MEPS.

[11] Figure based on E4 Project – Energy Efficient Elevators and Escalators, see: https://ec.europa.eu/energy/intelligent/projects/en/projects/e4

However:

- The setting of MEPS requires an in depth technical analysis of the energy performance of lifts. In this preparatory study just such an analysis has been conducted for the six typical new lift types placed on the market (so called "base cases"), but was constrained due to confidentiality restrictions limiting the availability of input data. Additional analyses on lifts could be carried out in the Impact Assessment study, depending on the involvement of manufacturers.
- An update of the performance test standard (EN ISO 25745-2:2015) might be necessary:
    - o The standard does not consider the impact of improved traffic management with the lift controller. In case this feature cannot properly be taken into account in the coming update of the standard, the calculation of the MEPS requirements might include a bonus awarded to lifts equipped with smart controllers or a malus for lifts not equipped with this feature.[12]
    - o It has been pointed out by manufacturers, that typical lifts currently placed on the market have undergone considerable progress during the last few years in terms of their energy performance. In addition, a large share of the lifts placed on the EU market already fulfil the requirements for the energy efficiency classes C or B, while lifts fulfilling and even exceeding the requirements for the highest energy efficiency class A are already in the portfolio of most of the traction lift manufacturers.[13] The energy efficiency classification in the standard therefore seems to no longer be appropriate, as rescaling the energy efficiency classes would allow for more differentiation among the most efficient lifts. Currently, the threshold for the most inefficient stand-by class 7 is 1600 Watt while the most efficient class 1 consumes less than 50 Watts. Consequently, there is a factor of 32 between the highest and lowest standby loads. For the running classes, the corresponding factor is 7.6.

Regarding implementing measures, the Ecodesign Directive[14] mentions that "there shall be no significant negative impact on consumers in particular as regards the affordability and the life cycle cost of the product". Taking into account the time required to elaborate and implement any regulation, the scenario analysis assumes that such MEPS regulations would enter into force in 2022.

In addition to the performance requirements, market transparency could be improved within the Ecodesign Directive by including technical documentation (in line with "information requirements" of the Ecodesign Directive). Such a technical documentation might include:

- The energy performance of the lift expressed in accordance with ISO 25745:2012 so that the overall annual energy demand E_{year} is expressed in Wh/year, as well as the performance of lifts in standby mode ($E_{standby}$ in Wh/day) and in travel mode (E_{travel} in Wh/day).

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12 See page 16 of the MEErP methodology.

13 However, please note that customization (customer requirements, options selected,...) requested by investors leads to an increase of the energy consumption of a lift compared its basic configuration. Impact of the digitalization in the lift sector might also increase the energy consumption of lifts.

14 See EC 2009/125/EC Article 15 5.c.

- The parameters identified as primary and secondary performance parameters (see the Task 1 Report).
- All input parameters required for the calculation of the energy performance.[15]
- The energy class: Here, the energy classes might be based on the EN ISO 25745-2:2015 classification, although, the classes of the standard need to be rescaled (to include higher efficiency levels and/or be more stringent)[16]. Unlike an energy label[17], the energy class could be shown in the technical documentation without any colour.[18] Thus, the energy class stated in the technical documentation would not be considered as a mimic of an energy label.

The technical documentation can be considered as an extended version of the lift report in accordance with EN ISO 25745-2:2015 with the major difference that assessment based on measurement or calculation under this standard would be mandatory. Doing so, will ensure that the energy performance of a lift under certain conditions (the usage category) is known.

According to the Ecodesign Directive, the technical documentation "should be given on the product itself wherever possible". Since lifts are purchased before having been manufactured, planners and investors would require the information related to the energy efficiency performance earlier in the process[19].

Accordingly, information on the energy efficiency class of a lift shall also be provided e.g. on websites, in catalogues or in tender documents. The information should be based on the selected lift configuration but for running demand, as it cannot take into account the impact of the installation quality of the lift. Such a requirement would help investors and personnel involved in planning and procurement to better select a lift based on its energy performance, and would thereby alleviate one of the barriers to energy efficiency improvements.

In the next section, the scenarios that include MEPS also include the information requirements.

Note, that in the next sections minimum requirements are proposed for information and metering, yet as the availability of data for use in the study was limited and this may well have constrained the ability to propose more ambitious requirements, it is recommended that two years after any regulation comes into effect a more ambitious requirement is considered based on the measured data collected. Market surveillance authorities should also be encouraged to collect a suitable set of data to support this process.

1.b) Requirements to improve specific aspects of lifts under Article 15 of the Ecodesign Directive:

The energy and environmental performance of certain parts of the lift duty cycle can be treated and analysed independently of the whole reference cycle according to the EN

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[15] In the case that the lift is subject to major upgrade or is to be assigned to a different usage category, the re-assessment of the energy performance of the lift would be possible.

[16] See explanation earlier in this section.

[17] Where the energy class is assessed and shown according to a scale between A (green) and G (red).

[18] For information: the lift energy efficiency certificate according to VDI 4707 includes a pictogram for the energy efficiency class, which might be considered as a mimic of a label and therefore, this certificate might be forbidden in the EU.

[19] Following a calculation approach

ISO 25745-2:2015 and could be eligible for specific energy performance requirements which target that part of the duty cycle to improve the environmental balance of lifts. This type of analysis was conducted under Task 6.

The advantage of applying requirements set for specific parts of the cycle is that not all possible configurations of lifts have to be examined in detail. To derive such requirements it is necessary to have examined the following factors:

- the extent to which the improvement options (and their associated design options) cost effective in terms of life cycle costs
- the extent to which there may be restrictions or negative side effects (e.g. extended waiting time)
- the extent to which the application of design options may be restricted from a technical perspective.

The prospective design features, which have been identified as being cost effective – are (see Task 6):

- regenerative drives for lifts of the usage category 3 or higher, since this design option saves energy and is cost-effective for these lifts
- optimized standby mode achieved by implementing low energy equipment, deep standby and switch off of components, since this design option saves energy and is cost-effective for these lifts. If applicable with a function that limits the modification of the controller setting.

Accordingly, it should be possible to set technology neutral performance specifications that address maximum permitted energy consumption in running mode and while in standby mode.

As analysed in Task 5, the environmental impact of BC1b and BC2b is partly caused by the hydraulic oil. As an alternative to mineral oil, biodegradable oil can be used, but the overall environmental impact does not show a clear benefit (see Annex): while under certain conditions biodegradable oil scores better than mineral oil for GHG and energy indicators, the order is reversed for the other indicators. Consequently, biodegradable oil may not be appropriate as a potential mandatory measure or requirement.

In general is it is also deemed useful to mandate that all new installed lifts have a digital submeter for electricity use and a trip counter, the data from which would be accessible to the users/owners of the lift. The display of these meters should be installed in a place which is visible to the maintenance personnel and have also an S0 pulse count output that complies with EN IEC 62053-31[20].

1.c) Applying a Labelling Scheme (under Energy Labelling regulation)

The energy label is one of the key instruments to foster energy efficiency of products (in particular for B2C products) and is usually used in combination with Ecodesign requirements. However, due to the restriction in the current energy labelling regulation (2017/1369/EU, see Task 1), lifts are most likely not eligible for inclusion under the auspices of the Energy Labelling Regulation.

Accordingly, an Energy Labelling scheme will not be assessed in the policy scenario section.

[20] In order to enable them to connect the all kind of Building Automation and Control System (BACS) with an interoperable interface. Other types of interfaces can be added but this is deemed a basic requirement.

In order to improve the market transparency of energy performance in the lift sector, the relevant information might be included in technical documentation and other information might also be provided before the lift is installed (see 1.a.).

1.d) Mandatory minimum information requirements under Article 11 of the Ecodesign Directive

The study identified that there is a substantial lack of information and awareness about lift energy performance among the market actors responsible for procuring and owning lifts. Also lift energy consumption heavily depends on the usage pattern but this is often unknown in an early stages of a building's design. Were such data to become available it would enable inclusion of lift energy consumption information in future EPCs for buildings. Therefore it is proposed to specify all the input parameters of EN ISO 25745 as well as for the results of the energy assessment itself as minimum information requirements to allow lift energy consumption to be estimated.

2) Voluntary agreement

The introduction of voluntary agreement (VA) is permitted within the Ecodesign Directive. However, this would require a strong commitment from and the support of the lifts industry, which has to be a driver for the process. During the 2nd stakeholder meeting, the project team presented the key requirements of a VA[21] and DG Grow requested that stakeholders should think about the possibility of a VA, as a potentially interesting option for manufacturers. So far ELA - which is a major European association of lift manufacturers - has communicated, that it does not support the notion of VA to promote energy efficiency for lifts. Therefore, the criterion of "representativeness" which is a necessary condition for voluntary agreement to be adopted within the Ecodesign framework cannot be fulfilled, even if ELCA supports the VA approach. Consequently, VA is not an option for the lift market and will not be included within the policy scenarios nor considered further in this task.

An overview of the pros/cons of the different policy instruments is provided in Table 7-1.

Table 7-1: Overview of the pros/cons of the different policy instruments

Pros	Cons
1.a. Applying Minimum Energy Performance Standards and information requirements for lifts	
• Transparency for customers is assured through mandatory information requirements on the energy performance (efficiency class & consumption)	• Further technical evaluation of lifts might be necessary • Some potential EE improvement options are limited by technical aspects

[21] Based on the Guideline for self-regulation measures concluded by industry under Directive 2009/125/EC (EC 2016)

Pros	Cons
• EN ISO 25745:2-2015 includes a clear methodology to calculate the energy efficiency of a lift • Least efficient products are removed from the market • To be reviewed two years after the regulation comes into place based on the proposal for information requirements	
1.b. Applying requirements to improve specific aspects of lifts (expressed as specific performance requirements)	
• Efficiency improvement options target specific features • Information transparency for customers improved • Efficiency improvement options target specific features • Metering requirements can result in efficiency upgrades in future.	
1.c. Applying a labelling scheme for lifts (within the Energy Labelling regulatory framework)	
• Would improve the visibility of energy efficiency for investors, planners and for users • EN ISO 25745 includes a clear methodology for the energy efficiency rating of a lift (including energy classes) • There is already some experience of a lift energy label (see VDI4707) • ELA supports the idea of an Energy Label for Lifts	• Applying an Energy Label for lifts at the EU level within the Energy Labelling Regulation is most likely not permitted (see Task 1) • Even mimicking an energy label outside the Energy Labelling Regulation is subject to the same restrictions • Lifts are B2B products and the added value of a label for display, wherever it would be, might be limited. Provision of the parameters to calculate the energy use might be more useful (see information requirements)
1.d Mandatory minimum information requirements	
• Ameliorates information barrier and will eventually provide more evidence that will facilitate future review of the proposed MEPS	• The impact is indirect and difficult to quantify.

Pros	Cons
• Data can be used in building EPCs and enable lifts to be treated in future reviews of the EPBD	
2. Voluntary agreement (coordinated by the industry association).	
• Cost effective framework possible due to personnel / know-how.	• Representativeness criteria not met: • Not enough industrial stakeholders support the idea

7.1.4. Policy measures for further analysis

In section 7.2 the following policy measures will be considered in the analysis:

- Minimum energy performance requirements corresponding to the Break-Even Point (BEP) level combined with information requirements. The break-even point is defined in the MEErP methodology as the highest energy efficiency level for which the Life Cycle Costs (LCC) do not exceed those of the Base Case configuration
- Minimum energy performance requirements corresponding to the Least Life Cycle Cost level (LLCC)
- Minimum energy performance requirements corresponding to the Best Available Technology (BAT).

It is not really possible to quantify the impact of an Ecodesign information requirement, therefore this policy measure (as a standalone policy) is not assessed in section 7.2 of the report.

7.2. Scenario analysis

Subtask 7.2 establishes scenarios according to the policy measures described in subtask 7.1. To this end, the analyses on the previous tasks have been extended to the defined scenarios in comparison with the Business-as-Usual (BAU) scenario and the Best Available Technology (BAT) scenario.

7.2.1. Scenarios overview

Different scenarios have been drawn up to illustrate quantitatively the improvements that can be achieved at the EU level by 2045 with suitable Ecodesign policy actions against the Business-as-Usual scenario. Taking into account the time needed to elaborate and implement any regulation, the regulatory provisions are assumed to enter into force in 2022 for each policy scenario.

The reference case and main technical improvement option scenarios based on the findings of Task 6 are defined as follows:

- **BAU scenario**: the products placed on the EU market have the same level of performance as the Base Case defined in Task 4.
- **LLCC (Least Life Cycle Cost) scenario**: from year 2022, all new lifts placed on the market comply with the LLCC performance level as assessed in Task 6.

- **Break-Even Point (BEP) scenario**: from year 2022, all new lifts placed on the market comply with the break-even point performance level assessed in Task 6. The break-even point is defined in the MEErP methodology as the highest energy efficiency level for which the Life Cycle Costs (LCC) do not exceed those of the Base Case configuration. In this scenario, the energy savings are maximized without increasing the total costs.
- **Best Available Technology (BAT) scenario**: from year 2022, all new lifts placed on the market comply with the BAT performance level as assessed in Task 6.

Table 7-2: Illustration of the energy efficiency classes for the base cases in the BAU scenario

Situation	Value	Base case 1A	Base case 1B	Base case 2A	Base case 2B	Base case 3	Base case 4
No options (Base case configu-ra-tion)	Stand-by	2	2	2	2	3	3
	Running	3	5	3	5	2	2
	Total	**B**	**B**	**B**	**C**	**B**	**B**

Table 7-3 provides an overview of the main assumptions of new products placed on the market from 2022 for each product Base Case and scenario. The figures are derived from the results of Tasks 4, 5 and 6.

Table 7-3: Overview of the parameters, for the lifts considered, according to the scenario and product Base Case

Base Case	Level of Performance / Scenario	Design options implemented	Total year energy consumption	Purchase Cost	Installation Cost	Maintenance	Maintenance yearly
			[kWh/a]	[Euro]	[Euro]	[Euro]	[Euro]
1a	BAU	no	555	17,000	15,000	35,270	1,411
1a	BAT	all	337	20,440	15,000	35,270	1,411
1a	LLCC	2, 1	396	17,400	15,000	35,270	1,411
1a	BEP	2, 1, 3 , 7	368	17,740	15,000	35,270	1,411
1b	BAU	no	654	15,500	15,000	32,394	1,296
1b	BAT	all	378	20,540	15,000	32,394	1,296
1b	LLCC	2, 1	494	15,900	15,000	32,394	1,296
1b	BEP	2, 1, 3, 5, 7	463	16,140	15,000	32,394	1,296
2a	BAU	no	922	21,500	17,000	41,067	1,643
2a	BAT	all	541	25,740	17,000	41,067	1,643
2a	LLCC	1, 2	682	21,900	17,000	41,067	1,643
2a	BEP	1, 2, 3, 7, 4	593	22,840	17,000	41,067	1,643
2b	BAU	no	1,274	19,000	17,000	38,060	1,522
2b	BAT	all	775	25,440	17,000	38,060	1,522
2b	LLCC	1, 2, 4, 5	990	19,600	17,000	38,060	1,522
2b	BEP	1, 2, 3, 5, 7	984	19,640	17,000	38,060	1,522
3	BAU	no	1,994	28,500	17,000	91,093	3,644
3	BAT	all	1,150	34,270	17,000	91,093	3,644
3	LLCC	1, 2	1,693	29,100	17,000	91,093	3,644
3	BEP	1, 2, 7, 3, 4	1,575	30,470	17,000	91,093	3,644
4	BAU	no	5,536	45,000	22,000	165,014	6,601
4	BAT	all	3,163	50,700	22,000	165,014	6,601
4	LLCC	6, 1, 2, 7	3,551	46,700	22,000	165,014	6,601
4	BEP	all	3,163	50,700	22,000	165,014	6,601

7.2.2. Approach

For the purpose of producing the quantified scenario impact analyses under subtask 7.2, an Excel based stock-model was developed for the lift product group. The structure of the model is shown in Figure 7-1.

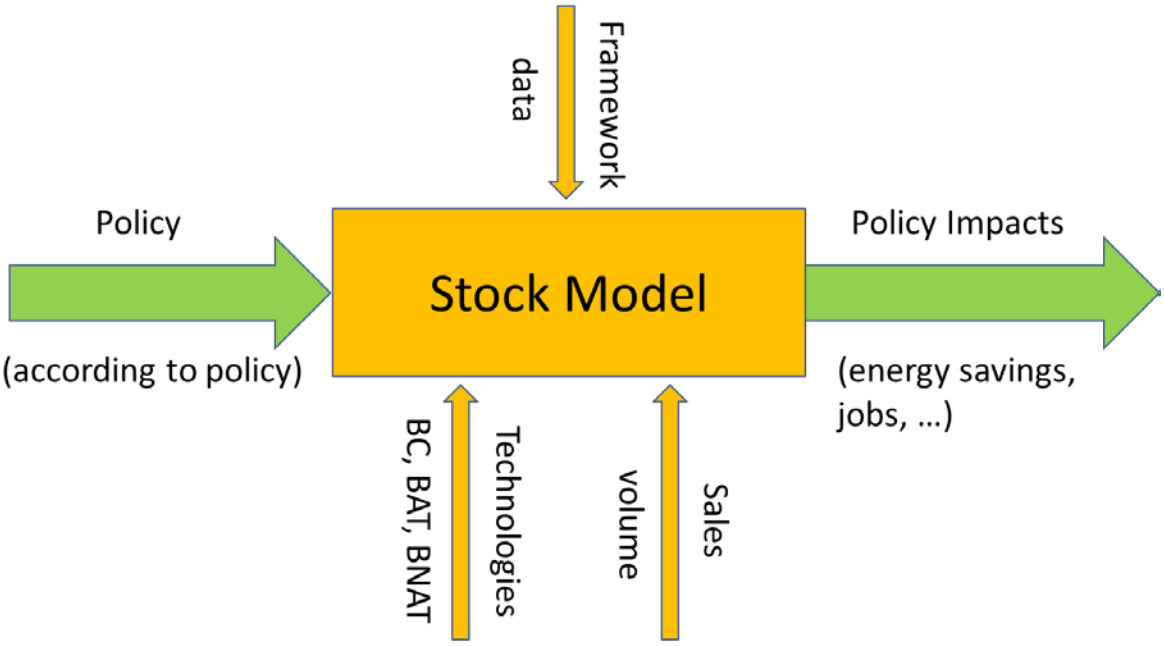

Figure 7-1: Simplified overview of the model (Source: Fraunhofer ISI)

With:

- Technologies and policies: an overview of the main data for each Base Case according to the level of technology considered was provided in Table 7-3
- Framework data: electricity (see Table 7-4) and socio-economical figures from the lift sector (see Table 7-5)

Table 7-4: Electricity prices and related GHG emissions (based on PRIMES)

Parameter	Unit	2015	2020	2025	2030	2035	2040	2045
Electricity tariff (Households, Services) (price reference Year = 2015)	[€/kWh]	0.17	0.19	0.20	0.20	0.20	0.20	0.20
Electricity GHG emission	[kg CO2eq/kWh]	0.40	0.38	0.36	0.34	0.32	0.30	0.28

Table 7-5: Framework data

Variable name and unit	Value	Source
ProductLife[22] [a]	60	based on sales & stock

[22] Lifetime of a lift as considered in the stock model

WholeMargin[23] [-]	14%	EBIT margin, KONE[24]
Jobs Industry ([1/mln euros revenue*]	4	calibrated, based on KONE[25] & ELA[26]
Jobs Install [1/mln euros revenue*]	19	calibrated, based on KONE[27] & ELA[28]
Jobs Maint [1/mln euros revenue*]	5	calibrated, based on KONE[29] & ELA[30]
Jobs Energy Companies [1/mln euros energy]	1	Impact Assessment Lot 15 (EC 2015)

*including EBIT

- Sales and stock:

The model used is a stock model, wherein:

$$stock_{BC_i,y} = \sum_{j=y-lifetime+1}^{y} sales_{BC_i,j}$$

$$stock_{lift,y} = \sum_{i=1}^{4} stock_{BC_i,y}$$

Where:

- Y = year
- lifetime = 60 years
- BC = Base Case
- i = index of the BC

Also, sales figures can be calculated based on stock figures:

$$sales_{BC_i,y} = stock_{BC_i,y} - stock_{BCi,y-1} + sales_{BC_i,y-lifetime+1}$$

The market volume consists in the stock increase and in the replacement of old lifts, which have reached the technical lifetime.

Due to the very long technical lifetime (around 60 years) of lifts, it is important to run the model and to analyse the results over a long period. Since policy options discussed in this task will address new installations and not the existing stock, the effect of such new policy options will not be perceptible from the first year and thus requires the scenario analysis to cover the time window of 2019-2045.

25 See KONE 2017a and KONE 2017b
26 See https://www.ela-aisbl.org/ (accessed: 15.11.2018)
27 See KONE 2017a and KONE 2017b
28 See https://www.ela-aisbl.org/ (accessed: 15.11.2018)
29 See KONE 2017a and KONE 2017b
30 See https://www.ela-aisbl.org/ (accessed: 15.11.2018)

Task 2 provides sales and stock figures for the EU lift markets and the same data are used in the stock model.[31] In addition, the historical data had to be estimated by back casting the sales for the period prior to 2015, considering the commercial lifetime of a lift.

Table 7-6 and Figure 7-2 provide an overview of the evolution of sales over time (based on the findings from the Task 2 report). The stock figures are provided in Table 7-7 and Figure 7-3.

Table 7-6: Sales evolution of lifts per Base Case (EU-28) (no. of units per base case)

	2005	2010	2015	2020	2025	2030	2035	2040	2045
1a	3,350	3,518	3,686	3,774	3,861	3,674	3,486	3,423	3,360
1b	2,562	2,690	2,818	2,885	2,952	2,809	2,666	2,617	2,569
2a	36,767	38,608	40,449	41,412	42,376	40,318	38,260	37,566	36,872
2b	13,656	14,340	15,024	15,381	15,739	14,975	14,210	13,953	13,695
3	30,867	32,413	33,959	34,768	35,576	33,849	32,121	31,539	30,956
4	28,961	30,411	31,861	32,620	33,379	31,758	30,137	29,590	29,044
All	116,162	121,979	127,796	130,840	133,883	127,382	120,880	118,688	116,497
of that, stock growth	70,663	72,452	73,885	72,156	70,004	57,847	45,189	36,296	26,810
of that, replacement	45,499	49,527	53,911	58,684	63,880	69,535	75,691	82,392	89,686

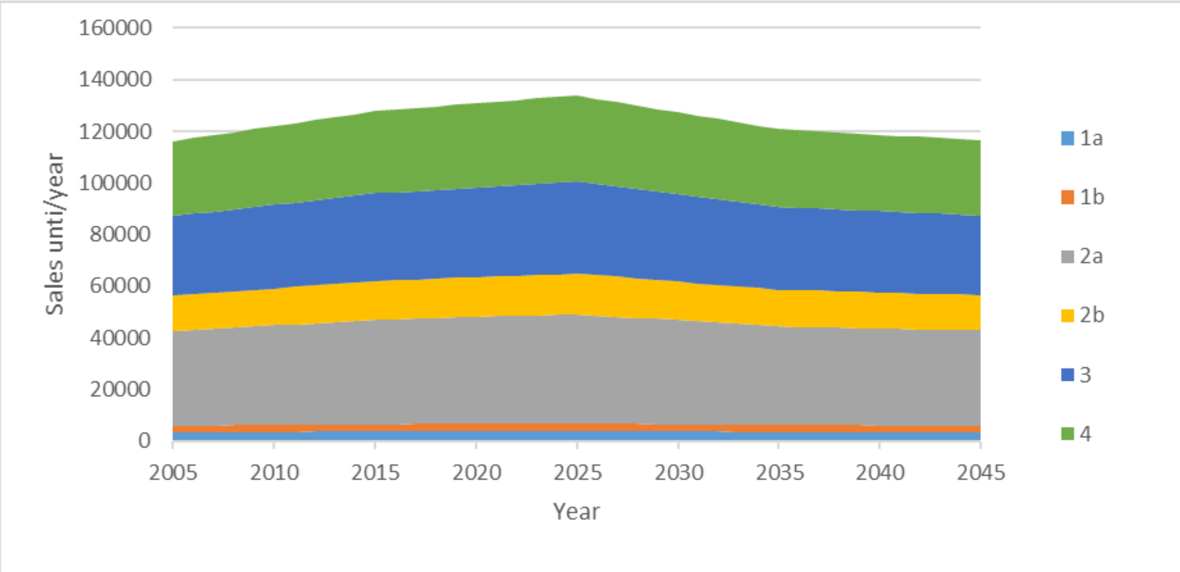

Figure 7-2: Sales evolution of lifts per Base Case (EU-28)

[31] Based on Task 2; however, due to the modelling approach in the Task 7 stock model, there might be a few deviations between the figures presented here and those reported in Task 2.

Table 7-7: Evolution of the lift stock per Base Case (EU-28) (no. of units)

	2005	2010	2015	2020	2025	2030	2035	2040	2045
1a	136,405	146,754	157,330	167,840	178,064	187,113	194,366	200,119	204,540
1b	104,297	112,210	120,297	128,333	136,150	143,069	148,615	153,014	156,394
2a	1,496,943	1,610,513	1,726,580	1,841,916	1,954,119	2,053,421	2,133,013	2,196,155	2,244,667
2b	555,995	598,177	641,287	684,125	725,800	762,682	792,245	815,697	833,715
3	1,256,754	1,352,102	1,449,546	1,546,376	1,640,576	1,723,944	1,790,766	1,843,776	1,884,504
4	1,179,121	1,268,579	1,360,003	1,450,852	1,539,232	1,617,451	1,680,145	1,729,881	1,768,093
All	4,729,516	5,088,336	5,455,044	5,819,442	6,173,941	6,487,680	6,739,149	6,938,642	7,091,912

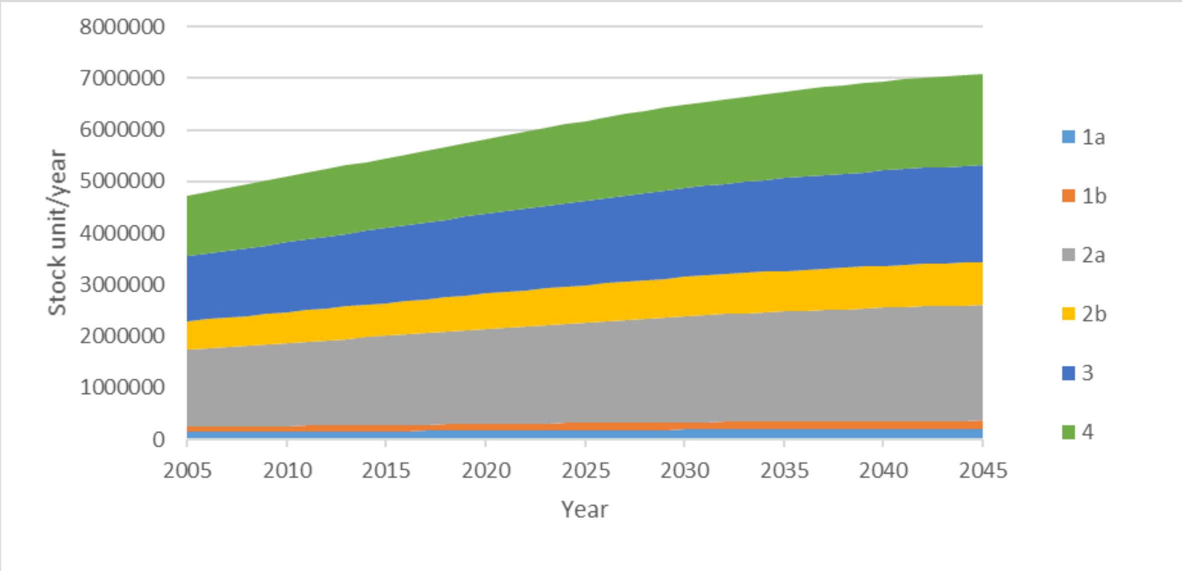

Figure 7-3: Evolution of the lift stock per Base Case (EU-28)

7.2.3. Environmental impacts

Figure 7-4 and Table 7-8 show there is a substantial reduction in the electricity consumption of the total lift stock under the design option scenarios thanks to the introduction of improved products compared to the BAU scenario. The decrease occurs for all design option scenarios although at a different pace depending on the scenario considered. Compared to the BAU scenario the decrease starts with the systematic introduction of the improved technologies (in 2022) and carries on until all lifts are replaced by improved lifts.[32] The BAT scenario and the BEP scenario have very similar results, since most of the assumptions are the same[33]. Between 2020 and 2045, the energy demand remains almost constant (around 18.8 TWh) in the BAU scenario. Under the BAT and BEP scenarios there is an absolute decrease in lift stock energy demand, such that the total consumption is projected to be 15.73 and 16.19 TWh respectively by 2045.

[32] In year 2082 considering the implementation year of the policies (2022) and the lifetime of a lift (60 years).

[33] The only difference is that hydraulic lifts do not have optimized machine/power drives nor regenerative drives in the BEP scenario.

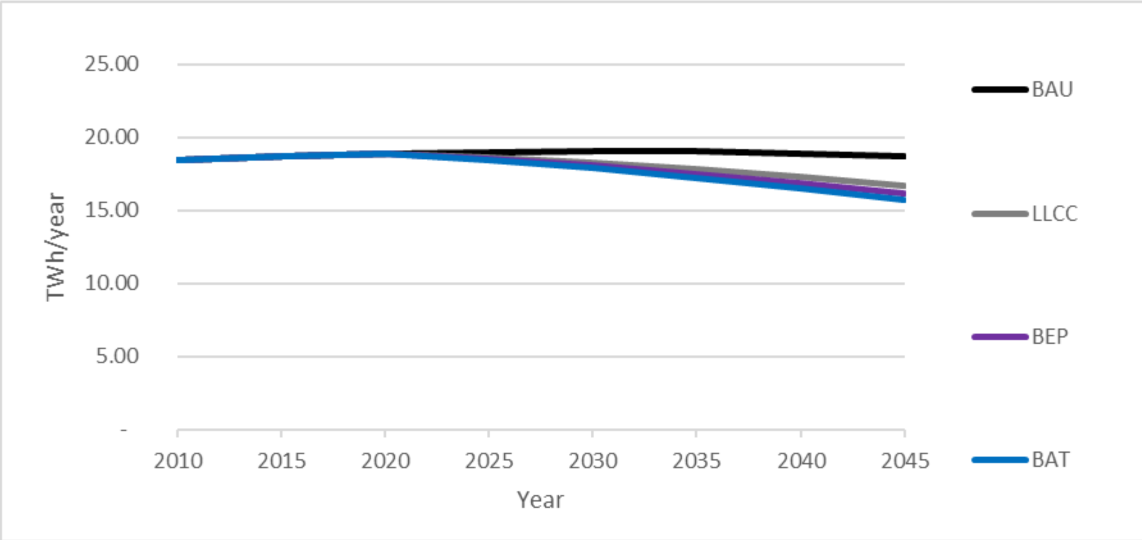

Figure 7-4: Electricity consumption in TWh/year (EU-28 lift stock)

Table 7-8: Electricity consumption in TWh/year (EU-28 lift stock)

Electricity, in TWh/year	2010	2015	2020	2025	2030	2035	2040	2045
BAU	18.45	18.67	18.83	18.98	19.06	19.03	18.91	18.73
BAT	18.45	18.67	18.83	18.44	17.87	17.22	16.50	15.73
BEP	18.45	18.67	18.83	18.53	18.06	17.50	16.87	16.19
LLCC	18.45	18.67	18.83	18.61	18.24	17.78	17.25	16.67
Absolute difference to BAU								
BAU	-	-	-	-	-	-	-	-
BAT	-	-	-	- 0.54	- 1.19	- 1.81	- 2.42	- 3.01
BEP	-	-	-	- 0.45	- 1.01	- 1.53	- 2.04	- 2.54
LLCC	-	-	-	- 0.37	- 0.82	- 1.25	- 1.66	- 2.07
Relative difference to BAU								
BAU	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BAT	0.0%	0.0%	0.0%	-2.8%	-6.2%	-9.5%	-12.8%	-16.0%
BEP	0.0%	0.0%	0.0%	-2.4%	-5.3%	-8.0%	-10.8%	-13.6%
LLCC	0.0%	0.0%	0.0%	-1.9%	-4.3%	-6.5%	-8.8%	-11.0%

Figure 7-5 and Table 7-9 present the GHG emissions according to the scenarios. Due to the decarbonisation of the electricity mix in the EU, the GHG emissions are expected to decrease in the BAU scenario from 6.83 MtCO2 in 2025 to 5.25 MtCO2 in 2045. Compared to the BAU scenario, the largest GHG reductions are achieved in the scenario BAT (-16%) and BEP (-13.6%).

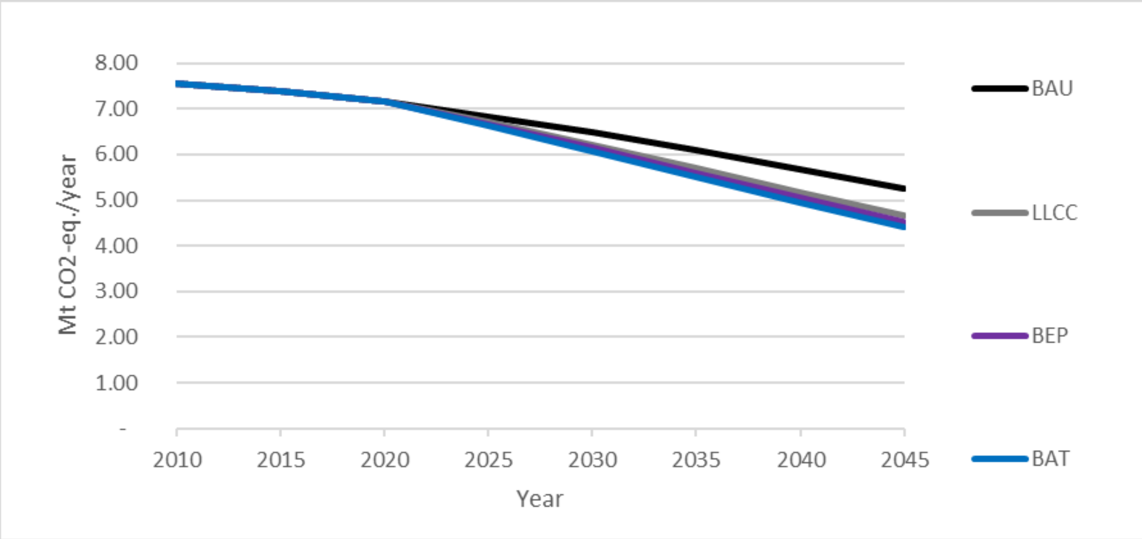

Figure 7-5: GHG emissions in Mt CO2eq/year (EU-28 lift stock)

Table 7-9: GHG emissions in Mt CO2eq/year (EU-28 lift stock)

GHG, in Mt CO2-eq./year	2010	2015	2020	2025	2030	2035	2040	2045
BAU	7.57	7.38	7.16	6.83	6.48	6.09	5.67	5.25
BAT	7.57	7.38	7.16	6.64	6.08	5.51	4.95	4.40
BEP	7.57	7.38	7.16	6.67	6.14	5.60	5.06	4.53
LLCC	7.57	7.38	7.16	6.70	6.20	5.69	5.18	4.67
Absolute difference to BAU								
BAU	-	-	-	-	-	-	-	-
BAT	-	-	-	- 0.19	- 0.40	- 0.58	- 0.72	- 0.84
BEP	-	-	-	- 0.16	- 0.34	- 0.49	- 0.61	- 0.71
LLCC	-	-	-	- 0.13	- 0.28	- 0.40	- 0.50	- 0.58
Relative difference to BAU								
BAU	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BAT	0.0%	0.0%	0.0%	-2.8%	-6.2%	-9.5%	-12.8%	-16.0%
BEP	0.0%	0.0%	0.0%	-2.4%	-5.3%	-8.0%	-10.8%	-13.6%
LLCC	0.0%	0.0%	0.0%	-1.9%	-4.3%	-6.5%	-8.8%	-11.0%

7.3. Impact analysis industry and consumers

Impacts on consumers

Table 7-10 show the purchase costs incurred by investors under the different scenarios. The total purchase costs decrease since the number of new lifts placed on the market decreases slightly after 2025.[34] The LLCC scenario has a low impact on the purchase costs while the BAT scenario produces an 18.4% increase.

[34] The EU stock keeps growing

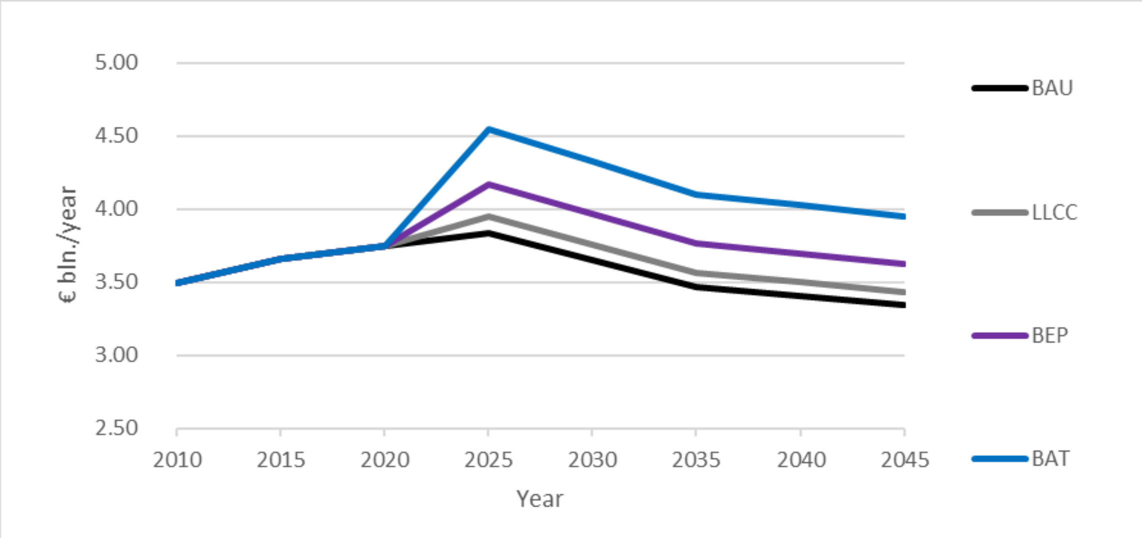

Figure 7-6: Purchase costs in Bln. € (EU-28 lift stock).[35]

Table 7-10: Purchase costs in Bln. € (EU-28 lift stock)

of that, purchase costs, in €	2010	2015	2020	2025	2030	2035	2040	2045
BAU	3.50	3.66	3.75	3.84	3.65	3.46	3.40	3.34
BAT	3.50	3.66	3.75	4.54	4.32	4.10	4.03	3.95
BEP	3.50	3.66	3.75	4.17	3.97	3.76	3.70	3.63
LLCC	3.50	3.66	3.75	3.94	3.75	3.56	3.50	3.43
Absolute difference to BAU								
BAU	-	-	-	-	-	-	-	-
BAT	-	-	-	0.70	0.67	0.64	0.62	0.61
BEP	-	-	-	0.33	0.32	0.30	0.29	0.29
LLCC	-	-	-	0.11	0.10	0.10	0.10	0.09
Relative difference to BAU								
BAU	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BAT	0.0%	0.0%	0.0%	18.4%	18.4%	18.4%	18.4%	18.4%
BEP	0.0%	0.0%	0.0%	8.7%	8.7%	8.7%	8.7%	8.7%
LLCC	0.0%	0.0%	0.0%	2.8%	2.8%	2.8%	2.8%	2.8%

For lifts, installation costs are relevant. Figure 7-7 presents the evolution of lift installation costs in the EU over time, which depend on the number of new lifts installed.

35 please note that the Y-axis is truncated

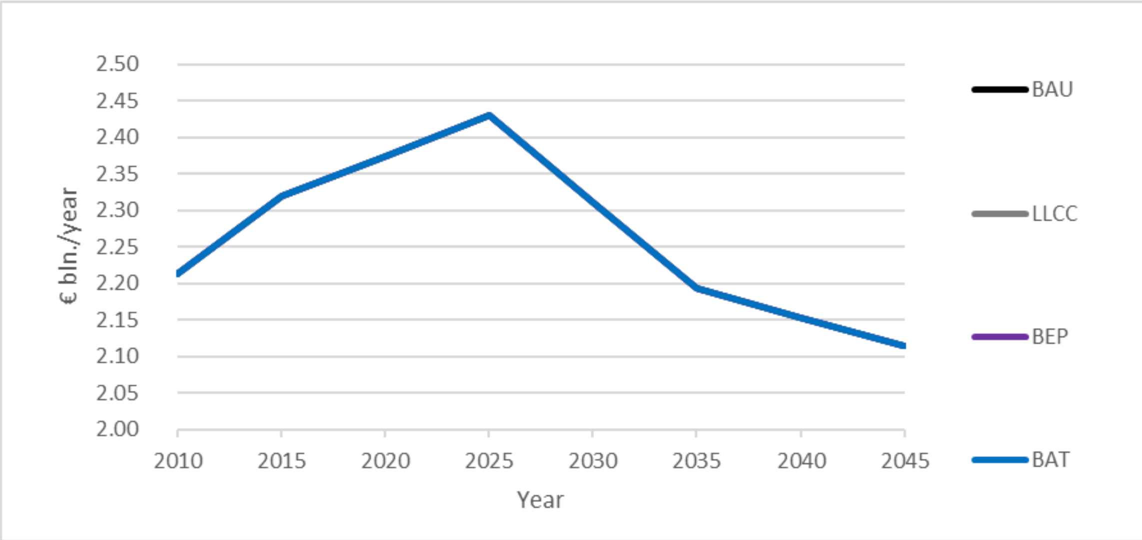

Figure 7-7: Installation costs in Bln. € (EU-28 lift stock)[36]

Figure 7-8 shows the evolution of maintenance costs (incl. repair and inspection) for lifts in the EU over time, which depend on the number of lifts in service. As already stated in the previous tasks of this preparatory study, maintenance costs account for a large share of the lifecycle costs of a lift. They are expected to increase from around 20 Bln. € in 2020 to 24 Bln. € in 2045.

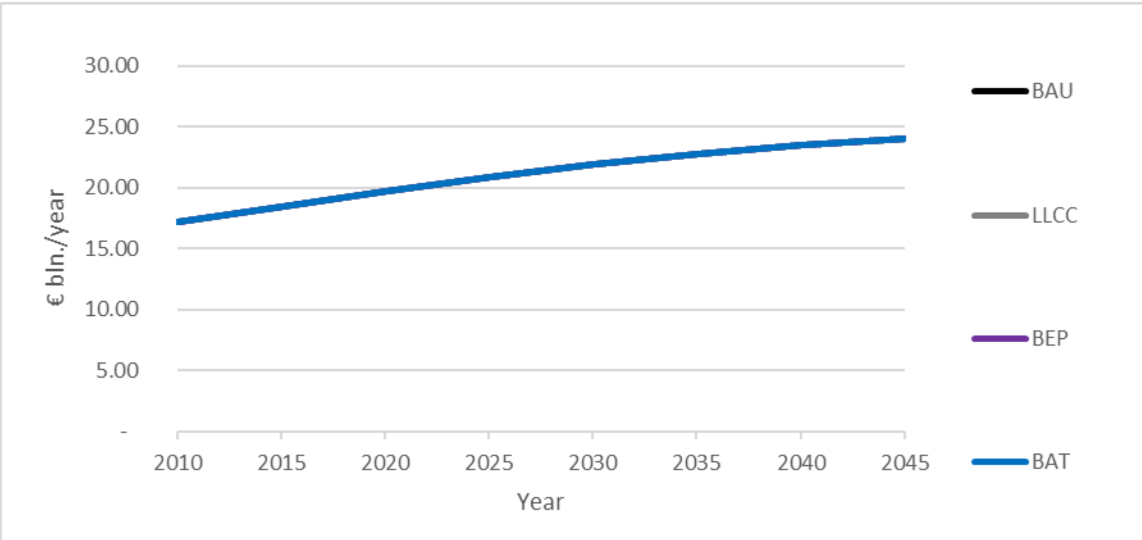

Figure 7-8: Maintenance costs in Bln. € (EU-28 lift stock)

The energy costs (bills) are presented in Figure 7-9 and Table 7-11 for the whole EU lift stock. As expected, the BAT and BEP scenarios achieve the largest savings in terms of energy costs (respectively -16% and -13.6% in 2045 compared to BAU). Although the

[36] please note that the Y-axis is truncated

EU stock increases, the overall energy costs keep stable and even start to decline after 2035.

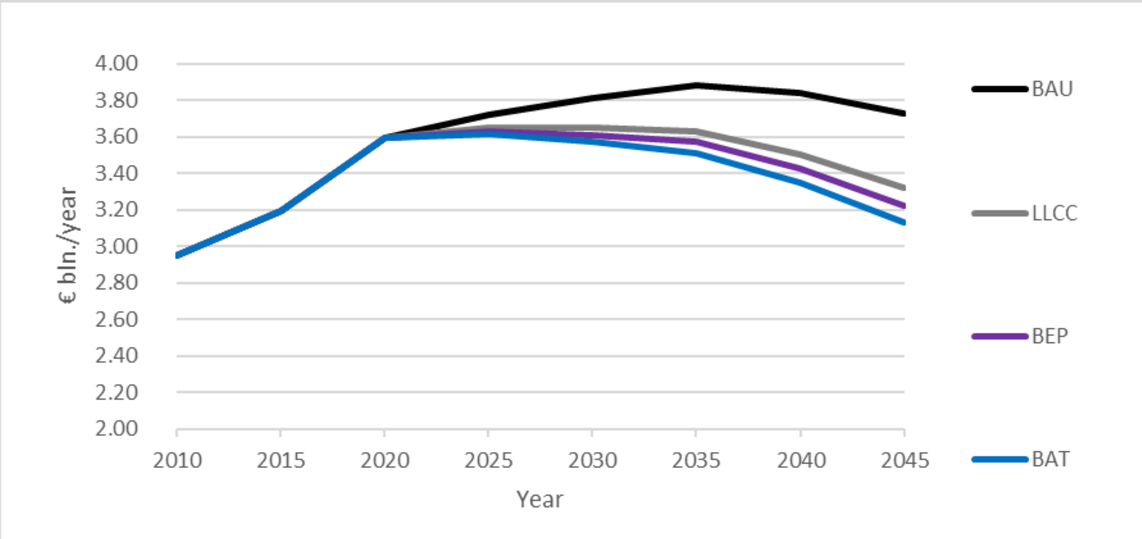

Figure 7-9: Energy costs in Bln. €/year (EU-28 lift stock)[37]

Table 7-11: Energy costs in Bln. €/year (EU-28 lift stock)

of that, energy costs, in € bl	2010	2015	2020	2025	2030	2035	2040	2045
BAU	2.95	3.19	3.60	3.72	3.81	3.88	3.84	3.73
BAT	2.95	3.19	3.60	3.62	3.57	3.51	3.35	3.13
BEP	2.95	3.19	3.60	3.63	3.61	3.57	3.43	3.22
LLCC	2.95	3.19	3.60	3.65	3.65	3.63	3.50	3.32
Absolute difference to BAU								
BAU	-	-	-	-	-	-	-	-
BAT	-	-	-	- 0.11	- 0.24	- 0.37	- 0.49	- 0.60
BEP	-	-	-	- 0.09	- 0.20	- 0.31	- 0.41	- 0.51
LLCC	-	-	-	- 0.07	- 0.16	- 0.25	- 0.34	- 0.41
Relative difference to BAU								
BAU	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BAT	0.0%	0.0%	0.0%	-2.8%	-6.2%	-9.5%	-12.8%	-16.0%
BEP	0.0%	0.0%	0.0%	-2.4%	-5.3%	-8.0%	-10.8%	-13.6%
LLCC	0.0%	0.0%	0.0%	-1.9%	-4.3%	-6.5%	-8.8%	-11.0%

Finally, the total expenditure is presented in Figure 7-10 and Table 7-12. The figures include: purchase costs (sales), installation costs (sales), maintenance costs (stock) and energy costs (stock). In the BAU scenario, the expenditure is expected to increase from 29.40 Bln. € in 2020 to 33.17 Bln. € in 2045, since the lift stock will increase in the EU. In general, the impact of the choice of scenario on the total expenditure is limited with the greatest difference compared to the BAU being a 1.9% increase in 2025 for the BAT scenario. The LLCC scenario is the least costly path, leading to an overall reduction of the LCC of 1% in 2045.

[37] please note that the Y-axis is truncated

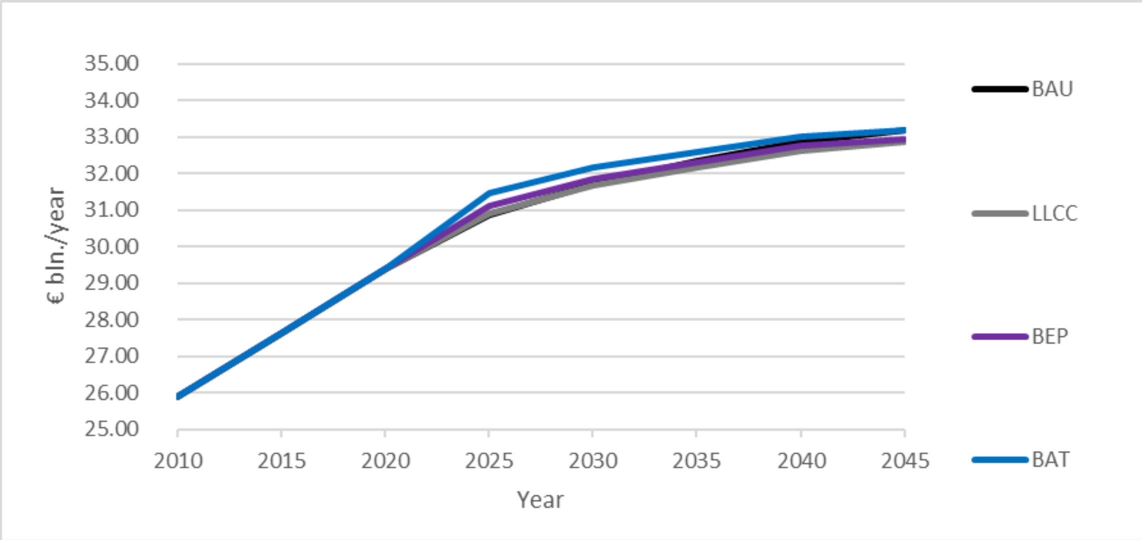

Figure 7-10: Expenditure in Bln. €/year (EU-28 lift stock)[38]

Table 7-12: Expenditure in Bln. €/year (EU-28 lift stock)

Expenditure, in € bln./year	2010	2015	2020	2025	2030	2035	2040	2045
BAU	25.87	27.62	29.40	30.87	31.72	32.33	32.86	33.17
BAT	25.87	27.62	29.40	31.47	32.15	32.60	33.00	33.18
BEP	25.87	27.62	29.40	31.11	31.83	32.32	32.74	32.95
LLCC	25.87	27.62	29.40	30.90	31.65	32.17	32.62	32.85
Absolute difference to BAU								
BAU	-	-	-	-	-	-	-	-
BAT	-	-	-	0.60	0.43	0.27	0.13	0.01
BEP	-	-	-	0.24	0.11	-0.01	-0.12	-0.22
LLCC	-	-	-	0.04	-0.06	-0.16	-0.24	-0.32
Relative difference to BAU								
BAU	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BAT	0.0%	0.0%	0.0%	1.9%	1.4%	0.8%	0.4%	0.0%
BEP	0.0%	0.0%	0.0%	0.8%	0.4%	0.0%	-0.4%	-0.7%
LLCC	0.0%	0.0%	0.0%	0.1%	-0.2%	-0.5%	-0.7%	-1.0%

Figure 7-11 and Figure 7-12 show the how the price of an average new lift placed on the EU market varies with time according to the scenario considered.

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[38] please note that the Y-axis is truncated

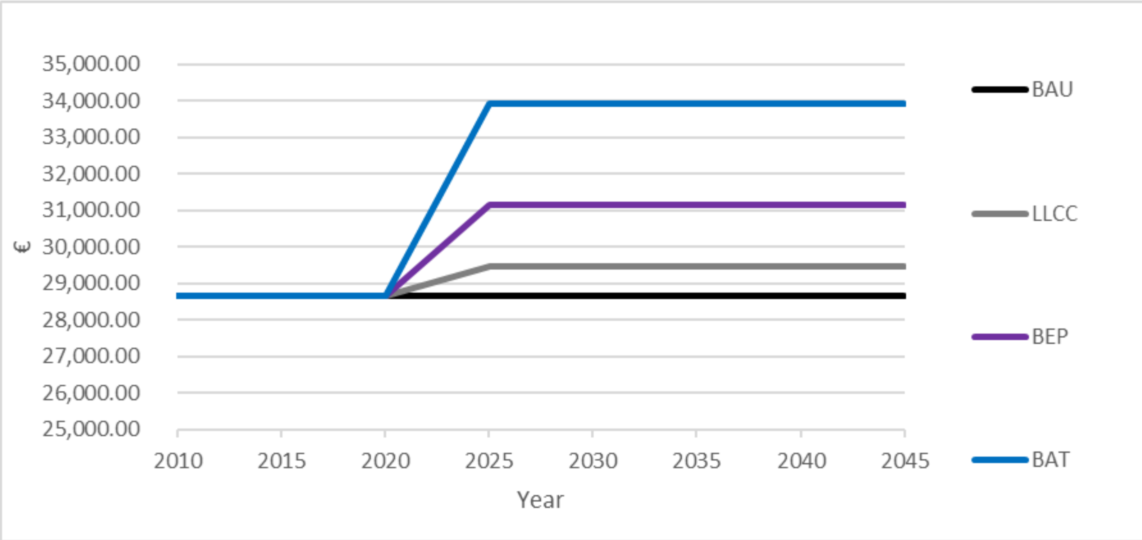

Figure 7-11: Average price of a new lift placed on the EU-28 market[39]

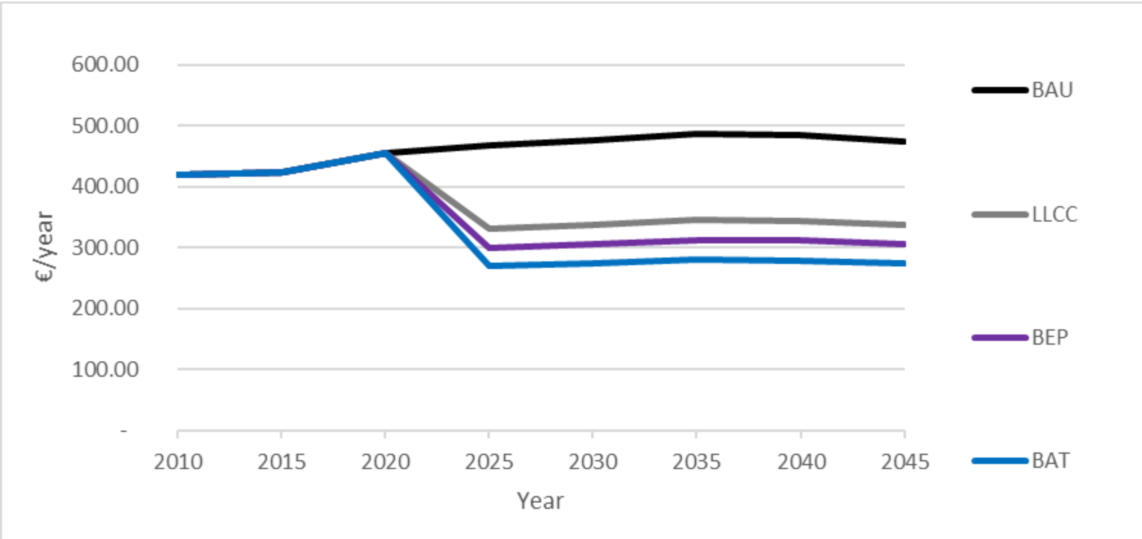

Figure 7-12: Energy costs of a new lift placed on the EU-28 market

7.3.1. Impacts on business

In this sub-section, the impact of the different policy scenarios on the business actors is presented.

In terms of turnover, it is assumed that:

- manufacturer turnover corresponds to the annual product purchase costs i.e. it corresponds solely to the turnover due to the production and sale of lifts

[39] please note that the Y-axis is truncated

- turnover of the installers corresponds to the annual installation costs; nevertheless, some manufacturers might be involved in the installation business
- the turnover of the maintenance companies corresponds to the maintenance costs; nevertheless, some manufacturers might be involved in the maintenance business
- the turnover of the electricity companies corresponds to the electricity costs.

The revenue of the lift sector is based on the turnover of the lift sector (manufacturers, the installers and the maintenances companies) multiplied by their margins. Figure 7-13 shows the estimate of the revenue of the lift sector according to the choice of scenario.

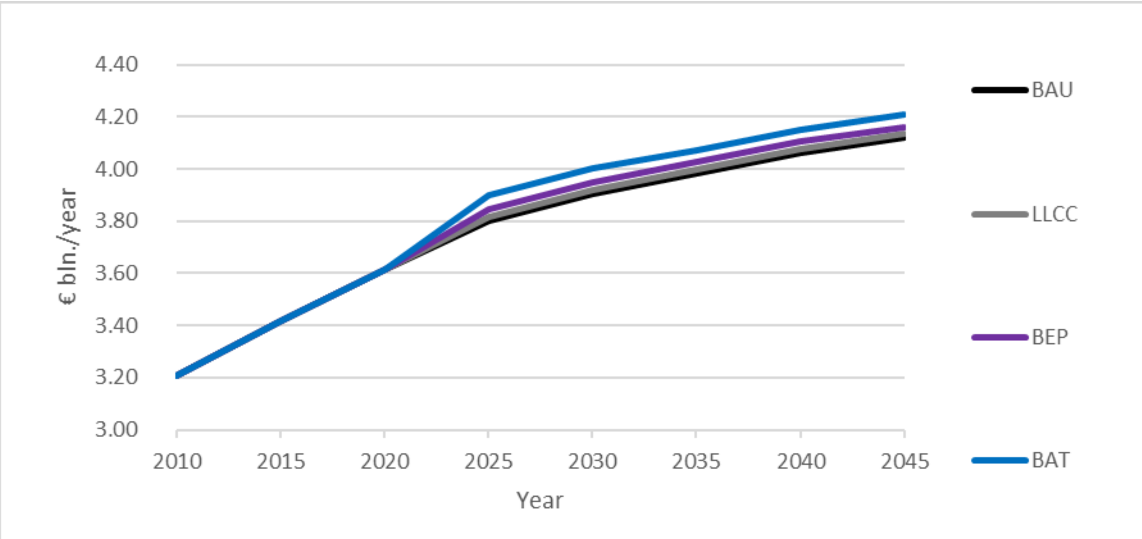

Figure 7-13: Revenue in Bln. € of the lift sector (EU-28)[40]

7.3.2. Impacts on employment

In this sub-section, the impact of the different policy scenarios on jobs is presented.

The number of jobs in the lifts sector are estimated from the turnover figures and the ratio of jobs / turnover (see Table 7-5). Figure 7-14, Figure 7-15, Figure 7-16 and Figure 7-17 show the projected number of jobs according to the scenario and the job classification (manufacturers, installers, maintenance and energy companies).

[40] Please note that the Y-axis is truncated

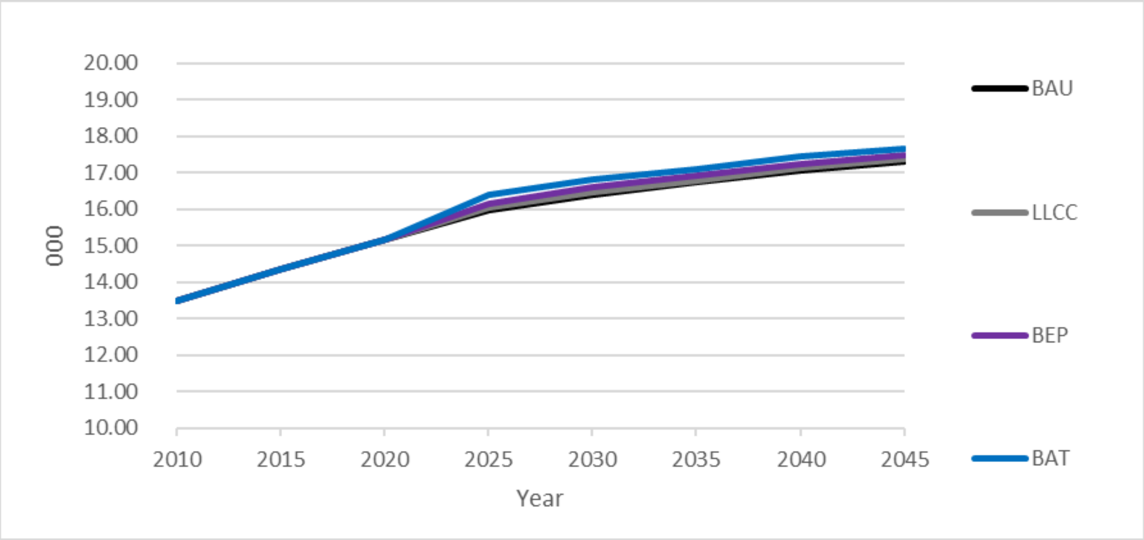

Figure 7-14: Manufacturing jobs (1000s)[41]

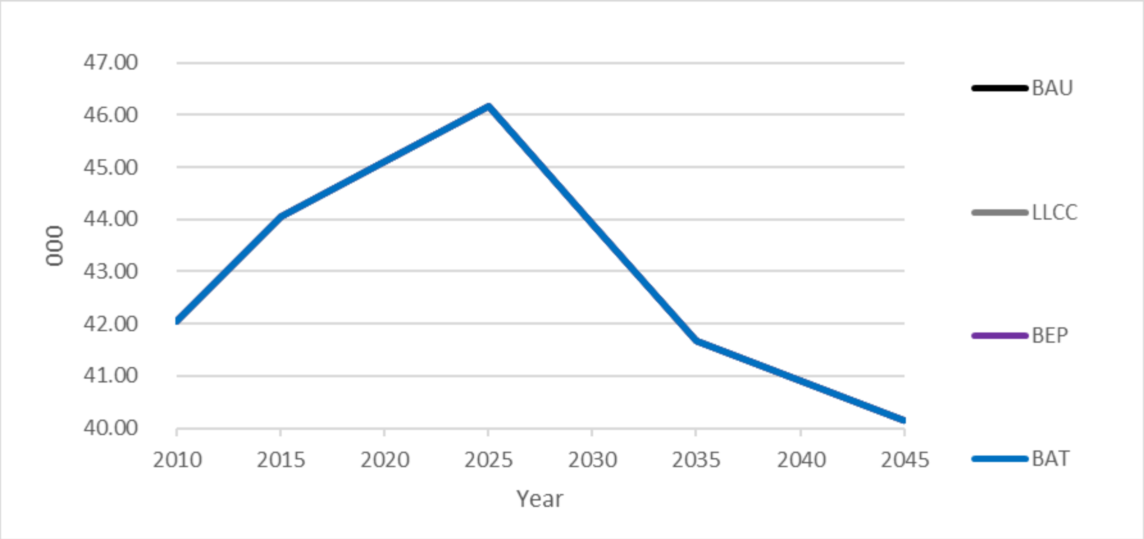

Figure 7-15: Installation jobs (1000s) [42]

[41] Please note that the Y-axis is truncated
[42] Please note that the Y-axis is truncated

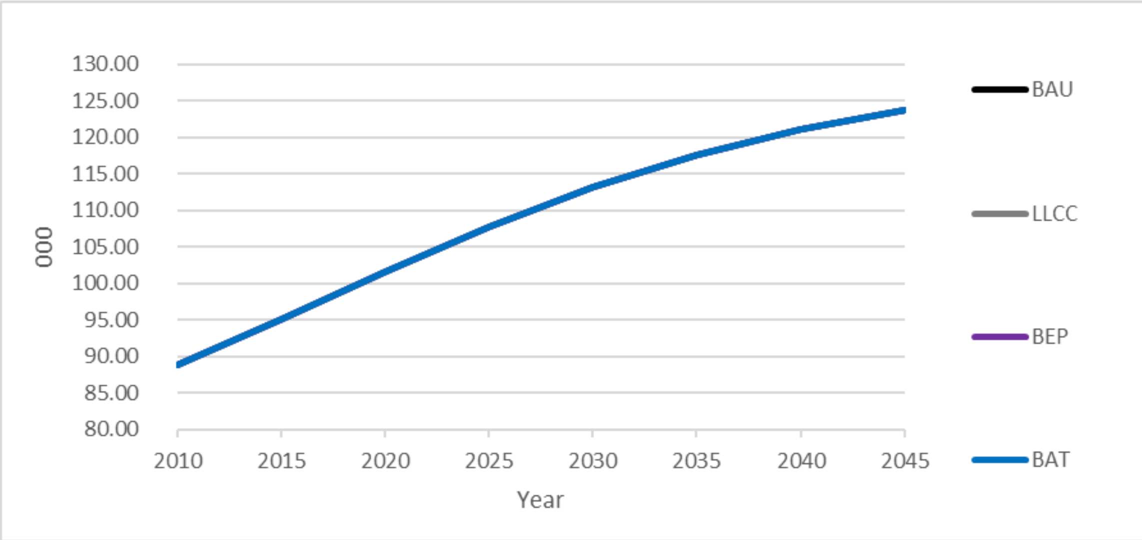

Figure 7-16: Maintenance jobs (1000s) [43]

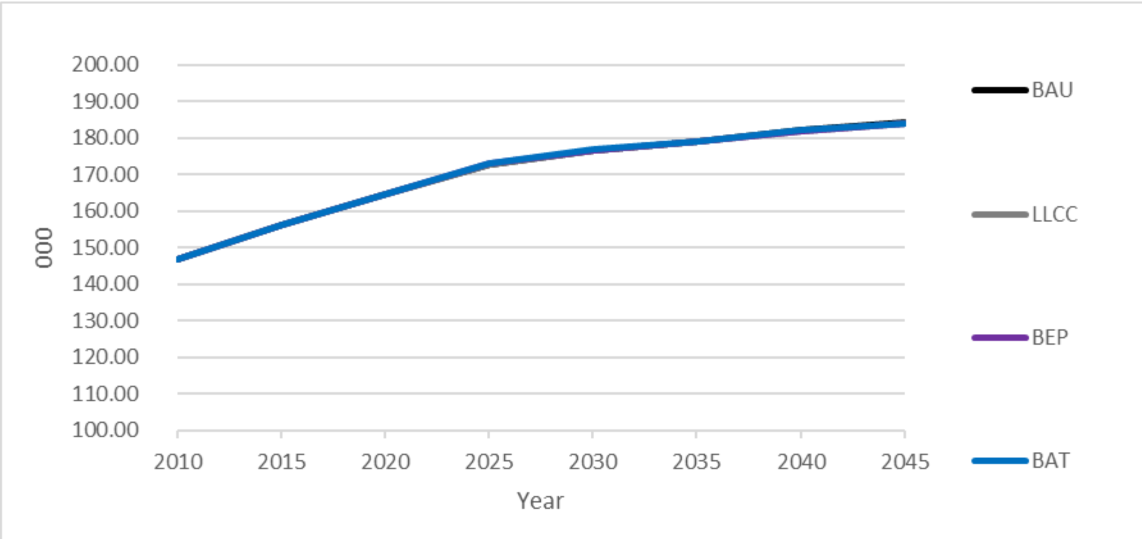

Figure 7-17: Overall number of jobs[44] (1000s)[45]

In total, the number of jobs in the lift sector is expected to increase from 164 649 in 2020 to 184 148 in 2045.

[43] Please note that the Y-axis is truncated

[44] Manufacturers, installation, maintenance as well as in the energy sector (impact due to the energy savings)

[45] Please note that the Y-axis is truncated

7.4. Sensitivity analysis on the main parameters

7.4.1. High Sales projection

The Task 2 report includes an "accelerated renovation scenario" of buildings, leading to higher lift sales projections. Based on these assumptions, higher sales and stock are assumed in the future. Figure 7-18 presents the lift stock projection for the "high sales projection" case.

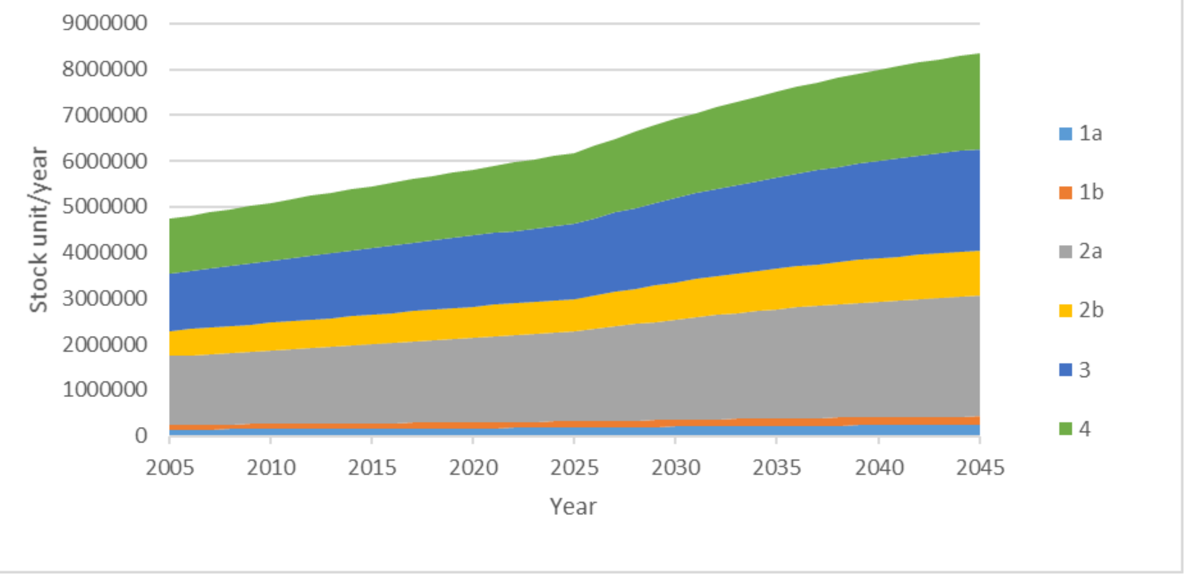

Figure 7-18: Stock evolution of lifts per Base Case in the "accelerated renovation scenario" (EU-28)

The main impacts in the case of the high sales projection for 2045 are provided in Table 7-13.

Table 7-13: Main impacts of the scenarios by 2045 (high sales projection)

Criteria			MAIN IMPACTS IN YEAR 2045			
			1	2	3	4
			BAU	LLCC	BEP	BAT
ENVIRONMENT						
	Electricity	TWh/year	21.72	18.79	18.12	17.45
	GHG	Mt CO2-eq./	6.08	5.26	5.07	4.89
CONSUMER						
EU totals	Expenditure	€ bln./year	39.62	39.15	39.27	39.56
	of that, purchase costs	€ bln./year	4.33	4.45	4.70	5.12
	of that, installation costs	€ bln./year	2.74	2.74	2.74	2.74
	of that, maintenance costs	€ bln./year	28.23	28.23	28.23	28.23
	of that, energy costs	€ bln./year	4.32	3.74	3.61	3.47
Per product sold	Sales (regulated)	000	150.91	150.91	150.91	150.91
	Product price	€	28,662.90	29,463.66	31,142.27	33,926.65
	Installation costs	€	18,144.77	18,144.77	18,144.77	18,144.77
	Energy costs	€/year	474.03	336.25	304.73	273.54
BUSINESS						
EU turnover	Manufacturers	€ bln./year	4.33	4.45	4.70	5.12
	Installers	€ bln./year	2.74	2.74	2.74	2.74
	Maintenance	€ bln./year	28.23	28.23	28.23	28.23
	Electricity Companies	€ bln./year	4.32	3.74	3.61	3.47
	Revenue	€ bln./year	4.94	4.96	4.99	5.05
EMPLOYMENT						
Employment (jobs)	Manufacturers	000	20.75	20.82	20.97	21.22
	Maintenance	000	145.66	145.66	145.66	145.66
	Installers	000	52.03	52.03	52.03	52.03
	Electricity Companies	000	3.38	2.92	2.82	2.72
	Indirect Employment	000	0.00	0.00	0.00	0.00
	TOTAL	000	221.82	221.43	221.48	221.62

7.4.2. Electricity prices

In line with the MEErP methodology, the scenarios have been recalculated with higher and lower (+/-50%) energy prices.

The overview of the scenarios in 2045 with energy prices 50% below the former assumptions (see Table 7-4) is presented in Table 7-14:[46]

[46] Same sales and stock assumption as in 7.2.2

Table 7-14: Main impact of the scenarios by 2045 (low energy price scenario)

Criteria			MAIN IMPACTS IN YEAR 2045			
			1	2	3	4
			BAU	LLCC	BEP	BAT
ENVIRONMENT						
	Electricity	TWh/year	18.73	16.67	16.19	15.73
	GHG	Mt CO2-eq./	5.25	4.67	4.53	4.40
CONSUMER						
EU totals	Expenditure	€ bln./year	31.30	31.19	31.34	31.62
	of that, purchase costs	€ bln./year	3.34	3.43	3.63	3.95
	of that, installation costs	€ bln./year	2.11	2.11	2.11	2.11
	of that, maintenance costs	€ bln./year	23.98	23.98	23.98	23.98
	of that, energy costs	€ bln./year	1.86	1.66	1.61	1.56
Per product sold	Sales (regulated)	000	116.50	116.50	116.50	116.50
	Product price	€	28,662.90	29,463.66	31,142.27	33,926.65
	Installation costs	€	18,144.77	18,144.77	18,144.77	18,144.77
	Energy costs	€/year	237.02	168.13	152.36	136.77
BUSINESS						
EU turnover	Manufacturers	€ bln./year	3.34	3.43	3.63	3.95
	Installers	€ bln./year	2.11	2.11	2.11	2.11
	Maintenance	€ bln./year	23.98	23.98	23.98	23.98
	Electricity Companies	€ bln./year	1.86	1.66	1.61	1.56
	Revenue	€ bln./year	4.12	4.13	4.16	4.21
EMPLOYMENT						
Employment (jobs)	Manufacturers	000	17.31	17.36	17.48	17.67
	Maintenance	000	123.76	123.76	123.76	123.76
	Installers	000	40.16	40.16	40.16	40.16
	Electricity Companies	000	1.46	1.30	1.26	1.22
	Indirect Employment	000	0.00	0.00	0.00	0.00
	TOTAL	000	182.69	182.58	182.66	182.82

The overview of the scenarios in 2045 with energy prices 50% above the former assumptions (see Table 7-4) is presented in Table 7-15:[47]

[47] Same sales and stock assumption as in 7.2.2

Table 7-15: Main impact of the scenarios by 2045 (high energy price scenario)

Criteria			MAIN IMPACTS IN YEAR 2045			
			1	2	3	4
			BAU	LLCC	BEP	BAT
ENVIRONMENT						
	Electricity	TWh/year	18.73	16.67	16.19	15.73
	GHG	Mt CO2-eq./	5.25	4.67	4.53	4.40
CONSUMER						
EU totals	Expenditure	€ bln./year	35.03	34.51	34.56	34.75
	of that, purchase costs	€ bln./year	3.34	3.43	3.63	3.95
	of that, installation costs	€ bln./year	2.11	2.11	2.11	2.11
	of that, maintenance costs	€ bln./year	23.98	23.98	23.98	23.98
	of that, energy costs	€ bln./year	5.59	4.98	4.83	4.69
Per product sold	Sales (regulated)	000	116.50	116.50	116.50	116.50
	Product price	€	28,662.90	29,463.66	31,142.27	33,926.65
	Installation costs	€	18,144.77	18,144.77	18,144.77	18,144.77
	Energy costs	€/year	711.05	504.38	457.09	410.30
BUSINESS						
EU turnover	Manufacturers	€ bln./year	3.34	3.43	3.63	3.95
	Installers	€ bln./year	2.11	2.11	2.11	2.11
	Maintenance	€ bln./year	23.98	23.98	23.98	23.98
	Electricity Companies	€ bln./year	5.59	4.98	4.83	4.69
	Revenue	€ bln./year	4.12	4.13	4.16	4.21
EMPLOYMENT						
Employment (jobs)	Manufacturers	000	17.31	17.36	17.48	17.67
	Maintenance	000	123.76	123.76	123.76	123.76
	Installers	000	40.16	40.16	40.16	40.16
	Electricity Companies	000	4.37	3.89	3.78	3.67
	Indirect Employment	000	0.00	0.00	0.00	0.00
	TOTAL	000	185.61	185.18	185.18	185.26

7.5. Summary

This section provides a summary of the main outcomes of the previous analyses, looking at suitable policy options to achieve improvements in the environmental performance of lifts and in the light of the life cycle costs as determined in Task 6.

7.5.1. Main policy recommendation

The analysis provided in sections 7.2 and 7.3 shows that there are substantial cost-effective energy savings. Energy efficiency requirements could indeed help to tap these potentials.

Specific advantages and disadvantages of potential policy measures within the Ecodesign Framework have been presented in 7.1.3 (in particular in Table 7-1). However, there are some challenges for the imposition of policy measures for lifts within the Ecodesign framework:

- Lifts are products integrated into buildings. They are assembled in buildings and the performance in running mode also depends on the quality of the installation, especially of the guide-rails in the shaft. Lift manufacturers do not always assemble the lifts at the customer's site. Thus, it might be a challenge to hold them responsible for the (non-)compliance with Ecodesign requirements of the installed product. Compliance, as defined in the Ecodesign context, would be rather difficult to verify in the case of lifts when considering the entire installation.

- Task 6 shows that the impact of the energy efficiency design options (DO) on the LCC was relatively limited. This is the result of three main factors: a) lifts are characterised by a long lifetime during which there are many regular inspections, b) the energy costs represent a small part of the LCC and, in addition, c) the price of some of the DO is low compared to the CAPEX of the lift. Therefore, the ranking of the DO according to the LCC and also, the analysis of the LLCC and BEP levels is sensitive to the assumptions considered in this study. An analysis based on an updated representative panel of lifts would improve the quality of the results provided in this study.
- In the methodology set out in EN ISO 25745-2:2015, the energy efficiency assessment of a lift depends on the technology and components chosen, but also on the usage category of the lift. However, it is difficult to determine the usage category for new buildings. To reduce variability of the energy efficiency performance, it might therefore be more appropriate to have energy efficiency requirements that do not depend on the usage category.
- The potential for energy savings in standby mode is substantial - especially for low usage lift categories – and some of these potentials can be tapped by changing the parameter setting of the controller (see design option 2: "switch off components"). Unfortunately, there is no guarantee, that after installation, the standby parameter setting will continue to be applied, or only changed if justified. Ecodesign measures cannot properly address such behaviour.

Though it is technically possible to establish an Ecodesign regulation for lifts there are difficulties related to their implementation. On the other hand, the EPBD might be a more promising policy instrument to set most energy performance requirements with (see Task 1):

- The EPBD is a Directive which allows for the inclusion of lifts in principle, even if it does not do so mandatorily. According to Task 1, two Member States already specify lift energy performance requirements in their building energy codes (the topic of the EPBD):
    - Denmark: In the most recent buildings regulation of 2018, §248 it is stated that lifts in new buildings, or the installation of new lifts in already existing buildings that are not solely intended for residential usage, have to comply with the energy class B performance specifications set out in EN ISO 25745-2:2015, or with VDI 4707 in cases where the former cannot be calculated. This applies to lifts with a nominal load of up to 2000kg. Higher energy consumption than energy class B may be accepted if equivalent compensatory energy savings are implemented.
    - Portugal has required lifts in non-residential buildings to attain at least the energy class B level under VDI 4707 since 2016.

  Since the Base Case Level was assumed to be class B (according to EN ISO 25745-2), this level could constitute an appropriate energy efficiency requirement for all lifts to start ensuring the energy efficiency of the lift market. The experience gathered in Denmark and Portugal in terms of implementation of minimum energy efficiency requirements for lifts will be valuable when considering the adoption of this measure at the EU level, at least for buildings that are not solely intended for residential usage.

According to the findings presented in this study, the class B requirement is already easily met by BC 1a, 1b and 2a. The market is actually more complex and, depending on options and features, many lifts are less energy efficient than in the assumed Base Case configuration. Therefore, a class B requirement is expected to improve the energy efficiency of all the base cases and to have a positive impact. It would be also achievable by BC 2b, even if the level of performance is lower than the BEP level. The additional costs that would be incurred are quite limited (see Task 6).

- While lifts undergo mandatory inspections, these are strictly focussed on safety aspects and do not include energy efficiency issues. The EPBD not only sets requirements for new buildings and their equipment, it also foresees regular inspections (e.g. for heating systems). If lifts were to be fully included in the EPBD, there would be a possibility to include inspections, which would allow to check whether the standby consumption is still low or the lift still complies with the energy efficiency requirements.
- For buildings, where the lift configurations or the usage patterns are special, energy class B might be unreachable. As the EPBD deals with the whole building, it could be possible to have some flexibility and to balance the excess energy consumption of the lift by additional energy savings in other parts of the buildings. Here also, the experience from Denmark, which has implemented such a mechanism in its regulation, would be valuable.
- The EPBD can address the energy efficiency of the lift but would also have the possibility to include the heat losses of the shaft. This subject has not yet been analysed very well and would require an integrated assessment of the lift and the building where it is installed.

Indeed, EPBD might have the potential to be a more appropriate instrument to promote the energy performance of lifts than the Ecodesign Directive. Accordingly, the study team is considering a two-step approach:

- based on the current EPBD, encourage Member States to include mandatory and specific requirements in their national implementation of the Directive, as Denmark and Portugal have done. Energy Efficiency Class B according to EN ISO 25745-2:2015 seems to be an adequate level of requirements. The experience gathered by the front runner countries during the implementation of the EPBD will be very valuable to improve the data available to public authorities on the lift market, regarding energy efficiency aspects.
- in a second step: the study team strongly supports the idea of extending the list of technical building systems to include lifts and also to include lifts in the list of systems subject to regular inspections. At that time, if more information becomes available on home lifts, this product group could also be included.
- independently: the study team encourages the Technical Committee ISO/TC 178 to update the EN ISO 25745-2, in particular with regard to the definitions of the energy efficiency classes. A rescaling of the thresholds seems to be necessary, as the performance level for most of the base cases was Class B, so the current classification does not allow sufficient differentiation among the "more energy efficient" lifts for their performance distinctions to be visible to potential investors.

During this preparatory study, some stakeholders (e.g. ELA) also supported the idea that the EPBD could be an appropriate framework to regulate lifts.

Finally, as stressed by most of the stakeholders – from the manufacturers to – LCA and circular economy are very important aspects for lifts. The study team considers that the PCR UN CPC 4354, setting down the rules for lifts that are either new or modernised, provides a good starting point as an LCA standard. However, the PCR is quite complex and small lift manufacturers or assemblers are not expected at short notice to be able to assess the environmental impact of a lift according to the PCR. These challenges will hopefully be taken into account in the coming update of the PCR.

Requirements on circular economy formulated by some stakeholders would probably go behind the scope of a future review of the EPBD, still, they could be addressed within the framework of the Lift Directive (since spare parts are relevant for safety issues) or in regulations of the relevant lift components (e.g. motors).

7.5.2. Main outcomes of the scenarios

Based on the criteria mentioned in Art. 15 of 2009 /125/EC (Ecodesign Directive), the impacts of the scenarios have been assessed in this report.

The main figures are presented in 2035 (see Table 7-16) and 2045 (see Table 7-17).

Table 7-16: Main impacts of the scenarios in 2035

Criteria			MAIN IMPACTS IN YEAR 2035			
			1	2	3	4
			BAU	LLCC	BEP	BAT
ENVIRONMENT						
	Electricity	TWh/year	19.03	17.78	17.50	17.22
	GHG	Mt CO2-eq./	6.09	5.69	5.60	5.51
CONSUMER						
EU totals	Expenditure	€ bln./year	32.33	32.17	32.32	32.60
	of that, purchase costs	€ bln./year	3.46	3.56	3.76	4.10
	of that, installation costs	€ bln./year	2.19	2.19	2.19	2.19
	of that, maintenance costs	€ bln./year	22.79	22.79	22.79	22.79
	of that, energy costs	€ bln./year	3.88	3.63	3.57	3.51
Per product sold	Sales (regulated)	000	120.88	120.88	120.88	120.88
	Product price	€	28,662.90	29,463.66	31,142.27	33,926.65
	Installation costs	€	18,144.77	18,144.77	18,144.77	18,144.77
	Energy costs	€/year	485.94	344.70	312.38	280.41
BUSINESS						
EU turnover	Manufacturers	€ bln./year	3.46	3.56	3.76	4.10
	Installers	€ bln./year	2.19	2.19	2.19	2.19
	Maintenance	€ bln./year	22.79	22.79	22.79	22.79
	Electricity Companies	€ bln./year	3.88	3.63	3.57	3.51
	Revenue	€ bln./year	3.98	4.00	4.02	4.07
EMPLOYMENT						
Employment (jobs)	Manufacturers	000	16.73	16.79	16.90	17.10
	Maintenance	000	117.61	117.61	117.61	117.61
	Installers	000	41.67	41.67	41.67	41.67
	Electricity Companies	000	3.04	2.84	2.79	2.75
	Indirect Employment	000	0.00	0.00	0.00	0.00
	TOTAL	000	179.04	178.90	178.98	179.13

Table 7-17: Main impacts of the scenarios in 2045

Criteria			MAIN IMPACTS IN YEAR 2045			
			1	2	3	4
			BAU	LLCC	BEP	BAT
ENVIRONMENT						
	Electricity	TWh/year	18.73	16.67	16.19	15.73
	GHG	Mt CO2-eq./	5.25	4.67	4.53	4.40
CONSUMER						
EU totals	Expenditure	€ bln./year	33.17	32.85	32.95	33.18
	of that, purchase costs	€ bln./year	3.34	3.43	3.63	3.95
	of that, installation costs	€ bln./year	2.11	2.11	2.11	2.11
	of that, maintenance costs	€ bln./year	23.98	23.98	23.98	23.98
	of that, energy costs	€ bln./year	3.73	3.32	3.22	3.13
Per product sold	Sales (regulated)	000	116.50	116.50	116.50	116.50
	Product price	€	28,662.90	29,463.66	31,142.27	33,926.65
	Installation costs	€	18,144.77	18,144.77	18,144.77	18,144.77
	Energy costs	€/year	474.03	336.25	304.73	273.54
BUSINESS						
EU turnover	Manufacturers	€ bln./year	3.34	3.43	3.63	3.95
	Installers	€ bln./year	2.11	2.11	2.11	2.11
	Maintenance	€ bln./year	23.98	23.98	23.98	23.98
	Electricity Companies	€ bln./year	3.73	3.32	3.22	3.13
	Revenue	€ bln./year	4.12	4.13	4.16	4.21
EMPLOYMENT						
Employment (jobs)	Manufacturers	000	17.31	17.36	17.48	17.67
	Maintenance	000	123.76	123.76	123.76	123.76
	Installers	000	40.16	40.16	40.16	40.16
	Electricity Companies	000	2.92	2.59	2.52	2.45
	Indirect Employment	000	0.00	0.00	0.00	0.00
	TOTAL	000	184.15	183.88	183.92	184.04

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Annex A: Minutes of Stakeholder Meetings

Meeting 1:

https://www.eco-lifts.eu/eco-lifts-wAssets/docs/Reports_Stakeholder_Meeting_1/Eco-design_PrepStudy_Lifts_Stakeholder_Meeting_1_20180221_Minutes_Corrected.pdf

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Date :	21/02/2018	Ref.	VITO/1710436/PVT/2018/01
From :	Paul Van Tichelen	Annex(es):	**Powerpoint presentations of the meeting (https://www.eco-lifts.eu/eco-lifts-en/content/documents.php)**
To :	Cesar Santos; Stakeholders		
Copy :	Project team		

Minutes of stakeholder Meeting for Ecodesign Preparatory Study on Lifts - First Stakeholder meeting on 21/2/2018

DG Grow: 21/2/2018, Avenue d'Auderghem 45, B-1040 Etterbeek, Brussels

Participants

European Commission

DG GROW — Cesar Santos (CS)

Project Team

ISI Fraunhofer — Antoine Durand (AD)

ISI Fraunhofer — Simon Hirzel (SIM)

ISI Fraunhofer — Clemens Rohde (CR)

ISR — Joao Fong (JF)

VITO — Paul Van Tichelen (PVT)

Registered stakeholders for the meeting

Organization	firstname	lastname	acronym
Business Energy and Industrial Strategy	Adrian	Barker	AB
ANACAM	Luca	Incoronato	ANACAM
European Commission	Katajisto	Vesa	KV
ECOS	Chloe	Fayole	ECOS_NR
European Federation for Elevator Small and Medium-sized Enterprises (EFESME) aisbl	Andrea-Eleonora	Masotto	EF_AM
EFESME	Luciono	Faletto	EF_LF
European Lift Association	Robert	Wright	ELA
ELCA	Luc	Rivet	ELCA
Hydroware AB	Kjell	Johansson	HYD
Kollmorgen Steuerungstechnik GmbH	Björn	Kollmorgen	Koll
Schindler Elevators Ltd.	Roger	Beuret	SC-RB

1

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VDMA e.V.	Dieter	Unger	VD_DU
VDMA	Sascha	Schmel	VD_SAS
Viegand Maagoe A/S	Anne	Svendsen	VIEG_AS
FINLAND Member State	Juha	Toivanen	FIN

Note: Note: this table was corrected on 22/5/2018.

Objective of the meeting

The intention of the meeting was to serve as a first stakeholder meeting for the Ecodesign preparatory study for Lifts. The purpose of this meeting was to discuss the initial findings on the Tasks 1 to 3 within the project and to the hear the views of the stakeholders on the findings so far. Stakeholders were informed that draft reports for Tasks 1 to 3 were available to the public before the meeting on the project website (https://www.eco-lifts.eu/).

Note: complementary to this minutes of the meeting the meeting powerpoint presentation can be consulted

Agenda

9:45 – 10:00	**Arrival of participants**
10:00 – 10:15	**Welcome and round of introductions** Cesar Santos, European Commission
10:15 – 10:30	**Background and objective of the study** Cesar Santos, European Commission
10:30 – 10:50	**Methodology of the study and objectives of the meeting** Clemens Rohde, Fraunhofer ISI
10:50 – 11:15	**Presentation of preliminary results of Task 1: Scope** Antoine Durand, Fraunhofer ISI
11:15 – 11:45	**Presentation of preliminary results of Task 2: Markets** Paul van Tichelen, Vito
11:45 – 12:45	**Discussions on Task 1 and 2**
12:45 – 13:45	***Lunch break***
13:45 – 14:05	**Presentation of preliminary results of Task 3: Users** Simon Hirzel, Fraunhofer ISI
14:05 – 15: 05	**Discussions on Task 3**
15: 05 – 15:45	**Further proceeding and schedule, other issues** Clemens Rohde, Fraunhofer ISI
15:45	**Closing** Cesar Santos, European Commission

Minutes

Welcome and Short presentation of participants (all)

The project officers Cesar Santos opened the meeting. He said that the study took place because it was identified as relevant in the Ecodesign working program. The study will follow a standardized process (MEErP). The final aim is to end up with Ecodesign Implementing Measures and normally industry is supportive. After this study the EC takes over and does an Impact Assessment study. Better regulation principles will have to be followed. I am aware that Germany has already labels. The role of stakeholders

2

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is important and their help is welcome. The role of harmonized standards is also crucial. We see that there are already standards, ideally they are available at the time of the regulation.

Rohde Clemens presented an introduction to the MEErP process (see powerpoint). This is the first of three stakeholder meetings during the preparatory study. The study follows a structured process, MEErP, which contains 7 Tasks. He also referred to the questions in the task documents, providing replies will make the study better.

Antoine Durand (AD) presented Task 1 (see powerpoint).
Afterwards a discussion took place:

abbr	Comment/answer
ELA	Question on slide 7: are only lifts above 0,15 m/s included?
AD	Yes, scope of the prep study will exclude lifts with less than 0,15 m/s
KV	Commented: In Ecodesign we are looking at products before they are placed on the market, this means also assessing their energy efficiency prior to be in service, which is a challenge. The Lifts Directive and especially its application, is currently in revision[1] and therefore the old document should not be used as reference. It is not clear yet which products will be covered in the revision as we are in a transitional period. It will be important to define what are new lifts. After having been entered in service, the lift directive doesn't apply anymore only Member States Regulation. Before there was the lift directive there were national standards, Lifts in service are not covered.

[1] https://ec.europa.eu/docsroom/documents/15350/attachments/1/translations/en/renditions/native

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Koll	Statement: When lifts are installed where there was already a existing lift it is not always clear when it is a new Lift.
EF	Commented: The interpretation is ongoing. The old guide is still available on the EC website but it is subjective to interpretation. It needs to be further clarified.
ELCA	Commented on slide 19: Mentioned that there are 2 LCAs available within EPD(Environmental Product Declarations) and in his opinion they are in contradiction with the E4 project results. The EPD showed that outcome depend on the amount of trips and hydraulic elevators can be a good environmental choice for low usage elevators under 300 trips/year.
EF	Commented: Within EPBD taking lifts into account is not compulsory. However in Italy a new standard is being developed for EPBD, including the energy use of lifts in non-residential buildings. Also he noted that there are in Italy Lifts which have lower usage than in the initial table ISO25745-2, which was changed to accommodate these differences. Finally, CEN is developing a new standards, that also includes home lifts. This is a growing market. Please do not forget this.
ECOS	The study could discuss what exemptions of the Lift Directive can have potential significant environmental impact and should be included in the scope of the study.
CR	We assume that home lifts consume less because they have low usage and can therefore be left out of scope
KV	Commented: The scope is important. It is also important to monitor any later legislation. It is important that consistency among different directives within the same product group is maintained. The safety first principle should not be disregarded for energy efficiency sake. Other aspects, accessibility, lighting and contrast, etc. should also not be disregarded. Regulation should be technology neutral. issues. Fair treatment of innovative technologies should also be respected. The machinery Directive also covers dismantling. The official statistics are not very useful and specific, for example PRODCOM.
EF	VDI4707 this is a document prepared in Germany. It opened the way for the ISO standard but it is not applicable to all countries and market players. The correct document is the ISO standard.
AD	We mainly based our work on ISO but for completeness, we presented also VDI. The proposed product categories in the preparatory study are based on ISO usage categories We do not want to be contrary.
SC	Confirmed that we should work with the ISO standard and said that VDI is harmonising with the ISO in the next revision.

Paul Van Tichelen(PVT) presented Task 2 (see powerpoint).
Afterwards a discussion took place:

abbr.	Comment/answer
ELA	why do we need the product price?
PVT	Replied that it is needed because in later tasks 5 and 6 we will do a life cycle cost (LCC) analysis and it will take into account the least life cycle cost (LLCC) solutions for recommendations on any later regulation.

4

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R	in the end it is rental cost and therefore we should know the overall cost.
ELA	Questioned on how to weight the environmental impact against cost?
CS	said that regulation will be should be set at the minimum LLCC. Therefore he stressed that it will be important to know the impact on the product price? Manufacturers should say this, especially what is the extra cost for improving the product.
EF	Commented: A lot of data comes from PRODCOM but according to them there might be everything in this category and it should also be noted that data for example from Denmark is not consistent. In their opinion there no reason to categorise into bottom and top supported but it can be done according to technology. Upgrading and partial renovation is a parallel market where maintenance companies play a big role.
VIEG	Suggest to consult maintenance companies to understand the structure of the market in terms of age of installation. They also suggest to check other building regulations to see if there are other aspects that require to install an elevator e.g. in Denmark every building over 3 stories has to have an elevator for each staircase entrance.
KV	Commented: Modernization can provide statistics but only when there is a big change. Prices seem low from PRODCOM The installation must be considered. The price is an important issue because it is a question about investment.
AB	PRODCOM is far too low.
Clem	we have an issue with price data and there are methods to work. We will improve it along the study. We need an achievable range.
ELCA	Commented: It comes always back to the same statistics. The same lift will cost less for example in Bulgaria vs Sweden. For the total life cycle cost one should look at the investment cost of the and the maintenance. According to him the potential energy savings are very low per year lift and hence the cost saving.
EF	Question: (4) of the Energy labelling Regulation (ELR) stress that Lift don't fall under that regulation and as a stakeholder they support that idea, can this be confirmed?
CS	Confirms that (4) of Energy labelling Regulation excludes lifts

Lunch Break

Simon Hirzel (SIM) presented Task 3: Users (see powerpoint)
Afterwards a discussion took place:

abbr.	Comment/answer
VIEG	Question: You calculated the energy consumption from the ISO standard but does it reflect the reality because there are many deviations possible.
SIM	The real challenge is to have usage category but the ISO standard seems a good

	approximation to deal with the complexity of reality.
SC-RB	Commented: It is also important to consider legal aspects. There are legal requirements that influence the energy consumption (e.g. alarm is required and consumes energy or special illumination requirements for handicapped). These requirements may differ from country to country.
SIM	Legal aspects are in principle in Task 1. Raised the question: Do stakeholders expect safety equipment to substantially affect energy demand?
KV	Commented: Safety must be there and it is not an issue of more or less safety. But accessibility requirements have an impact on the energy consumption.
SC-RB	There are still local regulation on accessibility that make a difference in energy consumption. They can differ per country. They are sometimes regardless of use, e.g. the power consumption of alarms.
ELA	Commented on slide 45: The statement on policy should be removed from the report as it seems premature.
SIM	Project team will take this into consideration.
EF_LF	Commented: You insist mentioning a label. The correct information in Italy not the label and in his opinion the label has no useful information. Rather absolute consumption estimates in kWh should be used. The ISO standard is based on a lot of calculation but apart from that also trip counter could measure traffic and can be a useful tool, and a trip counter is not part of the standard.
KV	Commented: The label calculation is useful because it can be calculated when the loft is placed on the market. Refers to the Lift directive, the building interaction can be taken into account.
SC-RB	Commented: 800 to 1000 kWh measurement value are mentioned. Lift consumption has improved by a factor 5 as compared to the values indicated in E4, thus it is not the state of the art.
SIM	Replied: The state of art will be dealt with in task 4.

Joao Fong (JF) presented on introduction to Task 4 .

abbr.	Comment/answer
HYD	Commented: You did not mention modularity, please also look at this. This means also standardisation, it is difficult but if you do not do it you will lose a lot of improvement potential. It should also be taken into account that different components have different life time and the functional unit should reflect this, it should be for the life time of the building. In his opinion modularity is the most important part in LCA for improvement.
CS	Commented: The directive mentions modularity. Raised the question: What is on you mind?
	A simple example is the door panel, this can be standardized.
CS	What do manufactures?
ELCA	There is already some modularity

HYD	Commented: Automotive is already ahead of that and it is important for products with such long life time.
KV	Commented: For the new lifts covered by CE marking. Manufacturer should take into account maintenance but it is not obliged to put is product in modular form. Inspection and maintenance is national legislation.

Antione Durand explained the next steps. The deadline for comments on Tasks 1-3 is 15th of March. The updated tasks 1-3 and first draft tasks 4 and 5 are scheduled for autumn. There will be two more stakeholder meetings, the next is scheduled for September.

Cesar Santos thanked the participants and closed the meeting.

Annex

The powerpoint presentation of the meeting are available at the project website: https://www.eco-lifts.eu/eco-lifts-en/content/documents.php

Meeting 2:

https://www.eco-lifts.eu/eco-lifts-wAssets/docs/Reports_Stakeholder_Meeting_2/Stake-holder_Meeting_2_20180917_Minutes_update.pdf

Distribution: General

Date : 17/09/2018
From : Karolien Peeters
Paul Van Tichelen

Ref. VITO/1710436/PVT/2018/02
Annex(es): **Powerpoint presentations of the meeting (https://www.eco-lifts.eu/eco-lifts-en/content/documents.php)**

To : Cesar Santos; Stakeholders
Copy : Project team

Minutes of stakeholder Meeting for Ecodesign Preparatory Study on Lifts - Second Stakeholder meeting on 17/9/2018

DG Grow: 17/9/2018, Avenue d'Auderghem 45, B-1040 Etterbeek, Brussels

Participants

European Commission

DG GROW	Cesar Santos (CS)

Project Team

ISI Fraunhofer	Antoine Durand (AD)
ISI Fraunhofer	Simon Hirzel (SH)
ISI Fraunhofer	Clemens Rohde (CR)
Waide	Paul Waide (PW)
ISR	Joao Fong (JF)
VITO	Paul Van Tichelen (PVT)
VITO	Karolien Peeters (KP)

Registered stakeholders for the meeting

Organization	firstname	lastname	acronym
ANACAM	Luca	Incoronato	ANACAM
ECOS	Gwendoline	Dandoy	ECOS_GD
ECOS	Nerea	Ruiz Fuente	ECOS_NR
European Federation for Elevator Small and Medium-sized Enterprises (EFESME) aisbl	Andrea-Eleonora	Masotto	EFESME_AM
European Federation for Elevator Small and Medium-sized Enterprises (EFESME) aisbl	Luciono	Faletto	EFESME_LF
Hydroware AB	Kjell	Johansson	KJ
Kollmorgen Steuerungstechnik GmbH	Björn	Kollmorgen	BK
Schindler Elevators Ltd.	Roger	Beuret	RB
VDMA	Sascha	Schmel	VDMA_SS

1

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FINLAND Member State	Juha	Toivanen	FIN
ELA	Markus	Wellinger	ELA
OTIS	Harald	Wilhelm	OTIS
KONE	Hanna	Uusitalo	KONE
ThyssenKrupp	Paula	Casares	ThyssenKrupp
ELCA	Luc	Rivet	ELCA
UK	Adrian	Bakker	UK

Objective of the meeting

The meeting was the second stakeholder meeting for the Ecodesign preparatory study for Lifts. The purpose of this meeting was to discuss with stakeholders the implementation of the stakeholder feedback in Tasks 1-3 and the initial findings on Tasks 4 and 5. Stakeholders can share their view on the reports and the following steps of the project. The draft reports of Task 1-5 are available at https://www.eco-lifts.eu/.

Note: complementary to this minutes of the meeting the meeting powerpoint presentation can be consulted on https://www.eco-lifts.eu/

Agenda

9:45 – 10:00	Arrival of participants
10:00 – 10:20	**Welcome and round of introductions** Cesar Santos, European Commission
10:20 – 10:50	**Updates of Task 1, 2 and 3** Antoine Durand/Simon Hirzel/Paul van Tichelen Fraunhofer ISI/VITO
10:50 – 11:20	**Presentation of preliminary results of Task 4: Technologies** Joao Fong, ISR-University of Coimbra
11:20 – 11:50	**Presentation of preliminary results of Task 5: Environments and Economics** Karolien Peeters, Vito
11:50 – 13:00	**Discussion of Task 4 and 5** Clemens Rohde, Fraunhofer ISI
13:00 – 14:00	***Lunch break***
14:00 – 14:15	**Wrap-Up on Discussion** Clemens Rohde, Fraunhofer ISI
14:15 – 14:30	**Outlook on Tasks 6 and 7** Antoine Durand, Fraunhofer ISI
14:30 – 14:45	**Further proceeding and schedule, other issues** Clemens Rohde, Fraunhofer ISI
14:45	**Closing** Cesar Santos, European Commission

2

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Minutes

Welcome and Short presentation of participants (all)

The project officers Cesar Santos opened the meeting. He welcomed the stakeholders and explained that the final part of the project now started. The Commission looks at this part with an open mind and will only regulate lifts if good arguments are found to do so. He welcomes stakeholders to benefit from the discussions today by taking the advantage to check the possibilities. He explains that a voluntary agreement is an option as well and asks the stakeholders to think about this option. It is also possible to have different requirements for different technologies. E.g. in lighting regulation the requirements for halogen lamps are not the same as the requirements for LED. Today we can have a discussion and think together what technology neutrality would mean for lift market.

Clemens Rohde welcomes the participants and presented the agenda for today's meeting.

The powerpoint presentations can be downloaded from the project website: https://www.eco-lifts.eu/eco-lifts-en/content/documents.php

Antoine Durand (AD) presented Task 1.
Paul Van Tichelen(PVT) presented Task 2
Simon Hirzel (SH) presented Task 3

Afterwards a discussion took place:

abbr.	Comment/answer
Manufacturers	There is a general agreement amongst the stakeholders that no new elevators below 320 kg are currently sold. The accessibility requirements for disabled persons in most of the EU Member States make lifts with a minimum load of 450 kg mandatory in practice.
CR	The project team will consider this issues for the base cases
KONE	The speed of the base cases is 0.7 m/s. This is not corresponding to reality. The speed that can be applied in elevators is either 1 m/s or 0.63 m/s, but never 0.7 m/s. This should be reflected in the base cases.
RB	The project team presented on ppt how it dealt with the comments. Can we get feedback before the next stakeholder meeting? Now stakeholders had to compare all the documents.
CR	This will be done for the comments provided for this phase of the project.
EFESME_LF	The assumptions used to calculate the accelerated renovation rate (task 2) are not clear. If you look at the stock, you see that lifts are not renovated before 50-60 years. Lifts are not renovated apart from when the entire building is renovated. It is not easy to replace the lift. People will never recover the investment even if there is a saving on the energy!
PVT	The figures are based on the EU renovation building strategy according to the EED and EPBD
CR	This might be a sensitivity assessment. Ecodesign will never trigger accelerated exchange. In the later task we will do potential projections on how the market will evolve.
ECOS_NR	What about the potential significant environmental impact of the exemptions? Is this not a good opportunity to look at the exemptions? Low speed lifts are not considered, because statistics are poor. But can we have at least an aggregated figure on this? This will allow to take a more informed decisions, rather than automatically exclude them.
AD	After the first stakeholder meeting, the project team had a look at this comment and tried to find statistics but almost no statistics could be found. The energy consumption is probably comparably low, both due to individual consumption and the numbers. Therefore, footnote 4 has been added in the report explaining why the scope was restricted.
ECOS_	You are comparing a slow lift with a high-speed lift, but we ask for an aggregated figure of

3

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NR	all low speed lifts in the market (all the lifts, not one single product). And would the current process not be a good moment to ask for better data/statistics?
AD/SH	If we extend the scope we have to deal with additional legislative boundaries. The major issue remains the lack of data. Therefore, we stick to the high-speed lifts.
ELCA	Usage category: the figures are not correct in several tables – table 1-4. ELCA gives several examples. There are discrepancies in all the tables.
CR	Figures/comments in written are welcome.

Joao Fong (JF) presented Task 4: Technologies

Use of more efficient Electric motor:
The team received feedback from stakeholders on this question in the task 4 report and will reformulate the question. The stakeholder feedback was that the efficiency of the electric motor is not listed in product catalogues. The question was however more in terms of efficiency class. Nevertheless, the question will be reformulated and will ask for the efficiency of the base cases.

abbr.	Comment/answer
KONE	There are many BAT in the market regarding the motor: e.g. permanent magnet with high RPMS and low RPMs. They cannot be compared and are not compatible. You cannot draw conclusions directly by stating efficiencies.
SH	As part of task 6 we have to bundle design options. We have to know what is the standard lift sold on the market and how much it can be improved. How can we deal with this if we do not have a reference value?
KONE	A proposal could be to look at the system level energy performance, not at the component. Some components match together, some do not match at all. ISO 25745 describes how running energy performance is made at its best and how the standby energy performance is made at its best and how they then based on the usage category are combined.
SH/CR /AD	We have to look at the specific design options. We define different design options, that for example say: replace the motor, lighting, improve the control system. The motor is maybe the cheapest replacement, so replace this. But control system to expensive. So no replacement. According to the MEErP methodology[1] we are supposed to follow the component approach. We look at improvement on component level and look at the BAT in terms of system. If stakeholders can deliver improvements at system level and then describe what is influenced at component level, it can be taken into account as well. We note this issue.

Joao Fong (JF) presented Task 4: Technologies (cont. 1)

Regarding the standby power consumption, comments were received that data are outdated. The available set of data from E4 monitoring campaign have been used. We see no relation between the year of installation and stand-by power consumption. Stakeholders may provide evidence for different stand-by power.

abbr.	Comment/answer
KONE	The data are outdated. In Denmark, the elevator performance is regulated: the minimum

[1] see : https://www.eco-lifts.eu/eco-lifts-wAssets/docs/MEErP_Methodology_Part_1.pdf

	requirement is energy class B of the ISO 25745. This is the bare minimum, many customers want better.
AD	This is already mentioned on page 49 in the Task 1 report. However, the B class requirement in Denmark is only for lifts not intended for residential use, therefore, only one part of the market is covered and we need data for the EU-28.
CR/SH	Minimum requirements for lifts are missing in the building code of many of the countries, e.g. Germany. So we have to find the efficiency of new sales. We noted the comment on the outdated data. But how low are they actually and why is the consumption different? Using LED-Lighting certainly made its contribution, but what other measures have been taken? We need more evidence on real consumption values. We would be happy to get better and more recent figures we receive from the participants.
EFESME_LF	The problem of patents is mentioned by EFESME. As an example the patent on belts has been given. In addition, EFESME_LF mentioned that there are commercial agreements in place as well.
AD	Ecodesign mentions in Art 15. 4) e. "in principle, the setting of an ecodesign requirement shall not have the consequence of imposing proprietary technology on manufacturers"
CS	These types of constraints are typically investigated in the impact assessment before a regulation will be proposed. They are not investigated in this preparatory study.

Joao Fong (JF) presented Task 4: Technologies (cont. 2)

Base cases

abbr.	Comment/answer
KONE	The speed for usage category 2 is automatically 1.0 m/s. This is correctly stated in task 1, but in task 4 some of the parameters are changed. Speed has an impact on the energy consumption.
CR	We will check this and correct the values.
RB	The technology described in task 4 is old technology. Also base cases are not what is currently sold on the market. Why focus on old technologies (e.g. geared technology)?
CR	Even if they some technologies hardly exist, they can be described here and quoted as being outdated. We have to rely on available information. Please provide information and give suggestions.
JF	This section will be improved.
KONE	When you look at the future market, how do you define the right number of floors and travel height, so it is in line with the new buildings sold? You have to ask the building and construction market.
RB	Are the ISO categories fixed for the number of stops? This would be a misinterpretation of the standard. The standard just contains an informative table in an annex which is not binding.
CR	We will check if the figures are fine for the next couple of years.
CS	It is not possible to have dynamic base cases over time. What is possible is to look at static base cases that factor in assumptions on how buildings will change in the future.
CR	The base cases are static, but the market share between the base cases might change, this will be analysed in task 7.
EFESME_LF	BOM: electric lifts are machine-room-less, variable speed drive... Some progress in improving energy efficiency has already been done in the lift industry. Electric lifts are not less than 450 kg and most of them not geared.
CR	We need specific information from the stakeholders to update the data in the study.

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ELA	This information is confidential info. Mutual agreements have to be signed.

Joao Fong (JF) presented Task 4: Technologies (cont. 3)

Assumptions for energy calculations

abbr.	Comment/answer
KONE	For Denmark you get to the ballpark figures when you consider ISO B as your minimum performance.
AD	What would be very helpful is to know the typical energy class for the base cases
BK	There are two problems with this: - The base cases are not defined in a way that we can easily calculate the power consumption, e.g. indicators are not in, signalisation are not defined. - Once installed in the building, lifts have to serve other needs, e.g. building automation -> an interface is needed; in public building signalisation cannot be switched off; in large office buildings you might not be able to run all the lifts on a secondary energy supply… There are a lot of functions for lifts that they have to serve and cannot be defined as a general level of stand-by energy consumption. This also explains the large differences in the table you showed. Differences are probably not due to a very inefficient gear, but due to the fact that the lift serves other functions.

Karolien Peeters (KP) presented Task 5: Environment and economics

abbr.	Comment/answer
KONE	How did you distribute travel distances (road, aircraft…) ? It is different from the PCR?
AD/KP	We used the ecoreport tool for the LCA Assessment. It is different from the PCR. In the ecoreport tool, there are default assumptions for transportation which are linked to the volume of the packaged product.
KJ	If you look at the graph comparing base case 2A and 2B. The impact from production in the impact category climate change is almost the same, while the difference in weight between the two cases is 44%. This is not logical.
PVT/KP	We have to cross check this.
KONE	Remark on slide with EU-totals. The data from E4 are not from 2012, but older. Please also mention the year of measurement, not only the year of publication of the results.
KP	OK, we used default citation style but we will deal with that.
EFESME_LF	There is a leaflet from industry available, which contains LCC information.

Clemens Rohde (CR): Discussion on Task 4 and 5

abbr.	Comment/answer
BK	Question on the accelerated sales data.
PVT	We can share the calculations.
UK	State–of-the-art changed significantly. More data need to be gathered. Do lifts meet criteria for ecodesign directive? Or should they be considered within EPBD?
CR	The second question is a political questions. Regarding the data we are using, we noted this point and welcome stakeholders to provide better data.

6

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Lunch Break

Clemens Rohde (CR): Wrap up on discussion

- The major issue is data availability. Stakeholders are welcomed to provide better data.
- In addition there is a need for more transparency on the underlying data.
- The definition of the base cases is not representing the market as it is for the moment. This will be updated. It will of course have an impact all the results. The updated base cases will be presented for consultation.
- The bill of materials will be updated.
- Maybe there are issues with the figures that went into the ecoreport tool (impact product stage for base case 2A and 2B very comparable, while difference in weight of 44%). This will be checked.

Antoine Durand (AD) presented an Outlook on Task 6 and Task 7

For task 7, the position of the industry has to be formulated, preferably as concrete policy proposals. We will have a third stakeholder meeting discussing the results of all tasks.

abbr.	Comment/answer
EFESME_LF	The performance of a lift depends on the type of application. In certain applications certain types perform better, in other applications, other types perform better.
CR / AD	There might be different policy options for different base cases. In a ecodesign regulation, the aim is usually to have a technology neutral approach. However, in the analysis we can consider different cases. If a certain application can only be achieved with a certain technology, this must be reflected.
CS	A Voluntary Agreement (VA) offers a lot of advantages to the sector, because the manufacturers set their own targets and they are in charge of the VA. The Commission oversees everything, but industry is in charge. There are currently VA in place for following products: imaging equipments, complex set-top boxes, games consoles. As soon as the VA is recognised, the Commission refrains from proposing any regulation. For the industry this can be an attractive proposal. Of course there are minimum requirements to be followed. This has to become clear in the next half year. Is the lift industry interested in a VA?
ELA	ELA cannot answer this question today.
ECOS_NR	Concerning the Energy labelling regulation: Can you clarify what you mean with 'means of transport are outside'?
AD	In the new Labelling Regulation, there is a specific sentence, which is dedicated to lifts. The text mentions (in the introduction not in the main part of the regulation) that lifts are excluded because they are already regulated, but in fact, there are only two countries having a regulation in place focusing on EE of lifts.
CS	Confirms that means of transport are excluded from Energy Labelling Regulation. Ecodesign excludes means of transport, but it is not mentioned that lifts are a means of transport. We are considering to check this with lawyers.
ECOS_NR	There are no resource efficiency requirements in your presentation. Can this be considered?
ELA	Concerning input by the manufacturers: An approach for treatment of confidential information has to be set up. ELA offers to draft a non-disclosure agreement (NDA). The consortium will check who has to sign the NDA.
AD	What is the impact of the policy on lift efficiency, which is in place in Portugal and Denmark? How was the market (in terms of EE class) before and after the policy entered into force?
BK	A law was necessary to make the lift requirements effective within the implementation of

	the EPBD, but this law never passed through the Parliament (according to 3-years old information)
RB	Also, France is considering an ecopassport for lift.
KJ	Sweden: LCA will have to be implemented as a part of the construction sector (no rule yet).

Cesar Santos thanked the participants and closed the meeting.

Next steps:

- 01/10/2018: deadline for comments on draft reports task 4 and 5: all comments on inputs are welcome, specially comments, which have an effect on the base cases. Due to the changes that will be made to the base cases, it is not useful to provide comments on the results as results will change. Please also tell us in which direction we have to improve the figures.
- 12/10/2018: New Bases Cases Online
- 31/11/2018: Deadline for Stakeholder Inputs on Task 6-7 (Policy Scenarios and Improvement Options)
- 14/02/2019: Reports Task 1-7 online
- **11/03/2019 (new date confirmed): 3rd stakeholder meeting**

Annex

The powerpoint presentations of the meeting are available at the project website: https://www.eco-lifts.eu/eco-lifts-en/content/documents.php

Meeting 3:

https://www.eco-lifts.eu/eco-lifts-wAssets/docs/Reports_Stakeholder_Meeting_3/Ecodesign_PrepStudy_Lifts_SM3_minutes_20190425_final.pdf

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Date :	11/03/2019	Ref.	VITO/1710436/KP/2019/01
From :	Karolien Peeters	Annex(es):	**Powerpoint presentations of the meeting (https://www.eco-lifts.eu/eco-lifts-en/content/documents.php)**
To :	Cesar Santos; Stakeholders		
Copy :	Project team		

Minutes of stakeholder Meeting for Ecodesign Preparatory Study on Lifts - Third Stakeholder meeting on 11/03/2019

DG Grow: 11/03/2019, Avenue d'Auderghem 45, B-1040 Etterbeek, Brussels

Participants

European Commission

DG GROW	Cesar Santos (CS)

Project Team

ISI Fraunhofer	Antoine Durand (AD)
ISI Fraunhofer	Simon Hirzel (SIM)
ISI Fraunhofer	Clemens Rohde (CR)
Waide Strategic Efficiency Ltd	Paul Waide (PW)
ISR University of Coimbra	Joao Fong (JF)
VITO	Karolien Peeters (KP)

Registered stakeholders for the meeting

Organization	firstname	lastname	acronym
ANACAM	Luca	Incoronato	ANACAM
ECOS	Rolf	Tieben	ECOS_RT
ECOS	Nerea	Ruiz Fuente	ECOS_NR
ELCA	Luc	Rivet	ELCA_LR
European Federation for Elevator Small and Medium-sized Enterprises (EFESME) aisbl	Luciano	Faletto	EFESME_LF
Hydroware AB	Kjell	Johansson	Hydroware_KJ
Kollmorgen Steuerungstechnik GmbH	Björn	Kollmorgen	Kollmoregen_BK
Schindler Elevators Ltd.	Roger	Beuret	Schindler_RB
KONE	Hanna	Uusitalo	KONE_HU
ThyssenKrupp	Paula	Casares	Thyssen_PC
UK	Adrian	Barker	UK

1

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EFESME	Elettra	Bilibio	EB
Matrix Liften	Tom	Essel	Matrix_TE
Danfoss	Michael	Müller	Danfoss_MM
ELA	Luca	Pezzini	ELA_PZ
ubeon	Hugo	Verstraeten	HV
DG Grow C1	Michael	Bennet	DG GROW_MB
DG Grow C3	Vesa	Katasisto	DG GROW_VK

Objective of the meeting

The meeting is the third stakeholder meeting for the Ecodesign preparatory study for Lifts. The purpose of this meeting was to discuss with stakeholders the implementation of the stakeholder feedback on Tasks 1-5 and the initial findings on Tasks 6 and 7. Stakeholders can provide comments on the draft reports of task 6 and 7. The draft reports of Task 6 and 7 are available at https://www.eco-lifts.eu/.

Note: complementary to this minutes of the meeting the meeting powerpoint presentation can be consulted on https://www.eco-lifts.eu/

Agenda

10:45 – 11:00	Arrival of participants
11:00 – 11:20	**Welcome and round of introductions** Cesar Santos, European Commission
11:20 – 11:50	**Updates of Task 1, 2, 3, 4 and 5** Antoine Durand/Simon Hirzel/Paul van Tichelen/João Fong Fraunhofer ISI/VITO/ISR
11:50 – 12:20	**Presentation of preliminary results of Task 6: Design Options** Simon Hirzel, Fraunhofer ISI
12:50 – 14:00	**Lunch**
14:00 – 14:20	**Presentation of preliminary results of Task 7: Scenarios** Antoine Durand, Fraunhofer ISI **Discussion of Task 7**
14:20 – 14:50	Antoine Durand, Fraunhofer ISI
14:50 – 15:30	**Wrap-Up on Discussion** Clemens Rohde, Fraunhofer ISI
15:30 – 15:45	**Further proceeding and schedule, other issues** Clemens Rohde, Fraunhofer ISI
15:45	**Closing** Cesar Santos, European Commission

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Main discussion points:

- Definition of a 'new lift' and what the stock/data represents.
- Lifetime: 25 years for the LCA should be reconsidered. The assumption of 60 years lifetime of the lift for the stock model depends on the building category. Question to differentiate between building types.
- Unclear where the assumption that the Base-Case is class C comes from. Data in task 4 and 5 have been criticized due to the outdated information.
- According to stakeholders, Base-Case (average product) is not a class C lift, but a class B lift. The study team will recalculated the results.
- Table 6.2. Sources for the energy saving potentials are not clear. Wrong underlying assumptions but no objection of the assumed energy consumption of the BAT level.
- Costs: When we try to improve the cost for the owner due to a reduced yearly energy consumption, the maintenance cost will be much higher.
- Lack of data leads to inaccurate results: stakeholders are encouraged to still deliver data.
- Resource efficiency: according to some stakeholders, focus should be rather on the production of the materials than the energy use phase. The task 5 results contested by one of the stakeholders and focus of the study should shift to material use. Modularity is an important work area.

Minutes

Welcome and Short presentation of participants (all)

The project officers Cesar Santos (CS) opened the meeting. He welcomed the stakeholders and explained that this is the last stakeholder meeting of the preparatory study. We are in the final part of the study. Stakeholders can comment on the reports. Stakeholders have at least six weeks to comment on the draft reports. Afterwards the study will be concluded between the study team and the EC. The contract of the study runs till August, but the consultants will submit their reports mid-June, after which the Commission can ask for further clarifications.

The timing after the preparatory study is unclear because there will be a new Commission taking office normally in November. After the study, the Commission Services will check if a regulatory intervention is necessary and what type of intervention. The main input for this is the report and the stakeholder comments. The Commission Services will prepare the decision at administrative level, but the next Commission will take the political decision to go ahead or not with an Ecodesign Regulation. For various reasons, the legislation cannot include an Energy Labelling Regulation. If a regulation will be put in place, it will be an Ecodesign Regulation. If the Commission decides to go ahead with the regulatory intervention, the details of this intervention will be discussed many more times with the Stakeholders.

Clemens Rohde (CR) welcomes the participants and presented the agenda for today's meeting.

The powerpoint presentations can be downloaded from the project website: https://www.eco-lifts.eu/eco-lifts-en/content/documents.php.

Updates of task 1, 2, 3, 4 and 5

The list of the comments and how we dealt with them has been provided through email.

Antoine Durand (AD) presented Task 1 (see powerpoint).

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AD asked for clarification on the forseen update of the PCR. We lack information on the status of the update and don't have any draft. If stakeholders have more information on this, please provide it to the study team.

Karolien Peeters (KP) presented Task 2 (see powerpoint).

Task 3: Users: no update

Joao Fong (JF) presented Task 4: Technologies (see powerpoint)
The new Base-Cases (average products) were presented, including the Bill-of_Materials (BOM).

Karolien Peeters (KP) presented Task 5: Environment and economics (see powerpoint)

Afterwards a discussion took place (combined discussion on update of task 1-5):

abbr.	Comment/answer
Kollmorgen _BK	What was the reason for exempting the non-lift Directive lifts from the study?
AD/SH	For several reasons: - Focus of the study (it is already challenging to cover the lifts covered by the Lift Directive); - Stock consists mainly out of lifts covered by the Lift Directive; - Energy consumption is covered in a different way for lifts not covered by the Lift Directive; - No data available about the number of lifts in this group, also no data on energy consumption.
ECOS_NR	ECOS asks for at least a figure/estimation on the energy consumption of both lift groups.
DG GROW_VK	What is the definition of a 'new lift', taking into account that lifts undertaking a modernisation can be considered as new lifts?
AD	The understanding of a new lift was based on the definition of the Lift Directive (see Task 1).
DG GROW-VK	The Lift Directive does not give a definition on when a lift in service again becomes a new lift. The decision whether a product will become a new product or not is formed case by case. If it is a new product, then the Lift Directive applies. In order to correctly understand the statistics/provided numbers, it is important to understand on which basis they are calculated, only completely new lifts or also modernisations considered as new lifts.
CS	Who decides whether a repaired or refurbished lift must be considered as a new lift in the Lift Directive Framework?
DG GROW_VK	This is decided case by case. It is not only the Lift Directive Framework, which applies. You can find guidance in the Blue Guide.
AD	It is decided case by case and also depends on the national legislation.
DG GROW_VK	This is true, but it is not for the Member states to decide whether the Lift Directive applies or not.
KONE_HU	It is easy to study a completely new building and new lift installation. Then the study considers buildings without a lift to be renovated and a shaft being built and lift being installed. That is a new lift as well. But anything that you are considering now in your renovation scenario, whatever is in that grey area, needs to be defined. The stock market of existing buildings without lift is much smaller than what you are considering today, even in your accelerated renovation scenario. It is very important to define this in an understandable manner.
EFESME_LF	It is not clear why the 25 years life cycle time of the lifts is kept, only because it is mentioned in the PCR for lifts. The PCR for lifts is not a verified document by the market.

Distribution: General

	Lifts last for more than 40 years in real life. The study should reconsider this assumption.
AD	In the EPD from many manufacturers, a lifetime of 25 years is used.
Schindler_RB	The EPD mentions the designed lifetime.
AD	For the LCA calculation, a lifetime of 25 years has been used. In task 7 (scenarios), the sales of the lifts should match the stock (= total number of lifts in operation in the EU). This is the case when a lifetime of 60 years is considered. Accordingly, 60 years as technical lifetime for a lift has been assumed in Task 7. It means also, in Task 7, after 60 years a completely new lift will be reinstalled.
EFESME_LF	It depends on the type of lifts. There are building categories for which this assumption is far from real life. The difference in the building categories should be taken into account in order not to discriminate. Some lift types would be heavily adversely affected by the implementation of such assumptions.
CS	CS explains how an eventual Ecodesign Regulation might affect repaired or refurbished lifts. The Blue Guide says that when the initial performance of the product has been significantly changed, it should be considered as a new product. It is not evident to capture this spirit in a legislation. There is a grey area and in the end it are market surveillance inspectors who decide whether the refurbished product should be considered as a new product and comply to the Ecodesign Regulation requirements. There is a good Blue print for the power transformers. The amending legislation includes a provision that says what you need to do with a transformer that has been repaired to be able to consider it as a new product that must comply to all applicable regulations. Regulations in principle are not intended to persuade economic operators not to repair products. A regulatory intervention in principle is neutral. In the case of transformers the technical committee from CENELEC provided the input. If you replace the core and the windings, it must be considered as a new product. We should find something similar for lifts and normally that knowledge comes from the standardisation authority.
GROW_VK	This knowledge should come from the coordinating crew (the Member States together with the Commission). The standardisation body is a private independent third party body. When a product is refurbished or repaired, not only the energy efficiency is important, but also the new materials/components. Therefore it is important to understand what the concept of a new product is in this framework.
EFESME_LF	When an existing lift undergoes a modification which makes it to be considered as a new lift, all the other assumptions that you have to produce a lot of new items is do not apply. It is not a new lift going through a full cycle, it is just a modification, for which only that part of production/installation applies. This is something also to be taken into account. The implementation of the circular economy should change the indications given in the PCR. The PCR is based on a certain assumed number of life cycle years, which might be suitable for comparing solutions. Taking into account the need to make products which last longer due to the possibility of replacing/recycling items should bring to the need to revise the PCR. Lifts lasted much longer in the past. It cannot be accepted that new lifts last less long than old lifts.
CS	Conclusion of the discussion: If there was an Ecodesign Regulation for lifts and there were provisions on repair/refurbishment of lifts, it should be very clear to economic operators when certain intervention results in the lift having to comply with the Ecodesign Regulation for Lifts. It should be done in coordination with all other applicable Regulations.
GROW_VK	Remark on task 5 presentation: 'distribution' of a lift is not a correct terminology. The lift is assembled at its location. Rather use the terminology 'logistics'.

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Simon Hirzel (SH) presented Task 6: Design options (see powerpoint)

Afterwards a discussion took place:

abbr.	Comment/answer
KONE_HU	Some further explanation on table 6.2 is required (slide 10). What are the sources for the mentioned saving potentials? For example traction elevator Base-Case 1A. For regeneration you need to consider that your typical difference in height is 3 to 6 meters. How much time do you have in 3 m drop for a small car (450 kg) to regenerate. Please explain in physics what is possible.
SH	There are two ways of regeneration. First thing is short term storage (condensator). If you use a regenerative drive, you have also the connection where you can install something in short term. And you have the option to feedback to the grid. The values are estimates. We welcome feedback and will take it into consideration.
KONE_HU	Asks Danfoss_MM (drives expert) what the possibility is for regeneration in a 3 m travel. Also the question is raised to comment on table 6.3, which mentions that these options come with no extra costs.
MM	No concrete numbers available here. In theory, the regenerative energy which could be available is max 50% on traction lifts. There are also additional losses to be considered when feeding the energy back to the grid. On a small elevator (450 kg) it might indeed not be attractive to apply regeneration.
KONE_HU	In BREEAM (requires certain number of design choices reducing the energy consumption) regeneration used to be mandatory, but it has now been removed from the list with mandatory design choices for the small category of lifts. In low rise, regeneration is just an extra cost. The situation is of course different for Base-Case 4.
AD/SH	Please remark that the saving potential only applies to the running consumption, not of the overall consumption.
KONE	1% of reduction would be fair, not 20%.
EFESME_LF	The problem does not occur for regenerative drive applied to hydraulic lifts of category 1 and 2. You might get some regeneration. However, it is not considered cost effective. The number of cycles is very low. We suggest not to consider some of the options for category 1 and 2 lifts as they would not give any practical benefits We insist on the fact that the PCR and ISO tend to cover the worldwide market. There are markets where the distribution of buildings is completely different. The hydraulic lifts perform much better in a specific market segment compared to traction lifts.
CS	CS asks the stakeholders for other feedback on the figures in table 6.2.
Kollmorgen _BK	The table states that 35% energy reduction is possible by using low energy equipment. What is the basis for comparison?
SH	We started with class C as a Base-Case. We have indications that A is possible on the website of some manufacturers. In addition, it was stated before that it is possible to reduce energy by 5 times compared to E4. So class A is something that can be achieved with the current technology. Then we broke down the consumption values and based on what our expertise allocated them to the different improvement options. We did not use a bottom-up

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	approach, but a top-down approach, starting with the assumption that it is possible to achieve a class A lift.
Kollmorgen _BK	In slide 20 (of task 6 presentation) you show the priority of measures. This picture is wrong. Is this based on the possible reductions mentioned in the E4 study? if you assume that 35% can be reduced and our products are already so highly efficient today that it is not possible anymore, do we have to expect a 35% reduction threshold.
SH/JF	Our starting point is a class C lift. 35% reduction applies to the class C lift. We did not use the E4 values. We got comments that some energy consumptions figures are 5 times to high.
Thyssen_P C	How do you know that A class is achievable for these Base-Cases? It might not be possible for the elevators mentioned here.
KONE_HU	Website do not always mention if it is class A according to VDI or ISO. All claims based on VDI should be neglected here because VDI is under estimating the energy consumption (compared to ISO). In addition, the way the energy consumption of lighting is calculated is different.
KONE_HU	To get proof of class A for use in this study, you need to find claims based on configurations using exactly the same number of floors, ropes…. It should be available for more than one manufacturer and should be measured at the end consumer. Please check the specifications (load, travel, speed) mentioned on the website. If they are not available, you have to start programming yourself using laws of physics.
Kollmorgen _BK	What has not been done in this exercise is looking at the available technology as it stands on itself. A measure from Ecodesign saying that you have to save 35% is impossible, because the products are already very efficient. The way the percentages are deducted is not correct and they are far from reality.
CR	An Ecodesign Regulation would not say that you have to save 35% compared to what you currently sell. If you only sell C elevators or worse, than this would be the case.
Hydroware _KJ	Seven design options are mentioned here and none of them has to do with the materials. Ecodesign should not only look at energy consumption during use phase. The most important design option is modularity. Reuse of materials following circular economy principles and adaptiveness was also mentioned.
Schindler_ RB	Discussion on saving potential. Fundamental weaknesses in the concept: - The data much reassembles E4 (although you say it is not); - 'Saving potential' is used, but this should be 'efficiency increase'. Saving potential gives the wrong impression that there is a lot to gain. An elevator is a system. There are several system aspects that come together.
CS	Do you agree that there is saving potential?
Schindler_ RB	Yes there are some, but not as large as pointed here. The options come with extra costs. This is not correctly captured in the tables. In addition you have to be careful that you do not look at the old technologies. Light boxes for examples are already regulated and removed.
SH	Even within LED you have saving options.
Schindler_ RB	There is a conceptional weakness in the MEErP. Lifts are not a standard product. You have to look at the entire system and the product is unique.
Thyssen_P C	The assumptions that class A is possible for all the Base-Cases is not true.
CS	CS asks what the study team will do with all these comments and challenges.
CR	Detailed data are not available. This is the solution applied to overcome this problem. If you can provide data on what is achievable for which classes, the proposed assumptions will be corrected.
JF	JF asks what is wrong in the applied methodology:

	• Is it the starting point, being that the we assume that a class C elevator is the current elevator or; • Is it the end point, being that class A is achievable. We know the reduction you get when going from a class C lift to an A class. These numbers are fixed, so one of the above assumptions has to be wrong.
Kollmorgen _BK	The failure is to consider C as the standard lift. Another failure is that the energy use of a lift is not based on a single measure, it is based on a whole system.
KONE_HU	You have incorrectly referred to the assumption of an A class lift. You need to point out the reference points you found on the websites that fit your Base-Cases. ISO method is a system level measurement (running, idle, 5min, 30 min are correctly defined). You have to play with all those system level figures to see where you can go. Worried about the simplification.
Schindler_ RB	Agrees that system level is important.
CS	CS explains how possible ecodesign requirements might work. Ecodesign requirements are minimum requirements that would push installations to a certain average at a reasonable cost. For those installations that are already above the minimum requirement the regulation would not have an effect. It means that minimum requirements for energy efficiency would be defined in absolute terms or relative terms (energy efficiency index). We look for requirements that push the market to a certain minimum level. We do not try to push products to the top of the market (this is the aim of Energy Labelling).
Schindler_ RB	We provided a statement in our position paper.
Kollmorgen _BK	The provided criticism is on how we get there. The analytics are misleading us and do not start from the right assumptions.
CS	CS asks if there are similar reservations for other percentages in table 6.2.
KONE_HU	An optimized machine and power unit typically goes hand in hand with regenerative drive. If you don't use regenerative drive, you do not have a machine and power unit The friction depends highly on installation quality (high variance on installation quality).
AD	The ecodesign methodology requires to look first at each design option individually. We agree that some of the options make no sense on their own. In the system approach, the savings are not simply added (see slide 22).
KONE_HU	When we sell lifts, we start with the customer value. Main value is typically transport of people in most optimal manner. Here the building type and space saving is important. Also grouping of lifts to optimize transportation as much as possible is applied. Afterwards the design options the customer wants are discussed: digitalization, look and feel. After this selection you know which class is reachable.
PW	You mention that the system currently applied to determine classes is not normalizing for all of the factors it needs to normalize for. Efficiency is energy use per service delivered and you have to normalize to the service delivered. You were mentioning screens, marble floors, which sounds like you are taken into account the commissioning situation. Are these not factored into the ISO methodology?
KONE_HU	Yes they are considered in the weight of the moving masses which greatly affects the energy consumption. ISO is not yet recognizing lift systems in the building and travel patterns in the building. Human behaviour is not captured.
EFESME_LF	Supports most of the comments.

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	Depending on the type of building, number of floors the same lift can be another performance class.

Antoine Durand (AD) presented Task 7: Policies

Currently we have one letter from ELA stating the options they want to support. Self-regulation is not an option for ELA. ELA suggests in its letter to set a MEPS which is our assumption of the average product on the market (C-level).
ELCA_LR mentioned that also ELCA sent a letter, opposing lifts to be included in the Ecodesign Directive.

Afterwards a discussion took place:

abbr.	Comment/answer
Kollmorgen _BK	In the beginning of your presentation you mentioned the letter of ELA. The letter asks for a minimum level of C. Later in your presentation you said that following this the assumption for the average lift is class C. This is the wrong assumption. The average technology is currently much better than class C.
AD	If we assume C would be the average technology, then a MEPS with C would not affect the outcome.
Kollmorgen _BK	The gap is much lower than 27%.
CR	Is the C class representing the average market wrong and too low for the average product?
Kollmorgen _BK	I'm stating that ELA has provided a minimum target and has not given information about the average product available.
AD	The assumption of class C came from task 6, not from the ELA letter. We assumed the base case is class C according to our work in task 4 and task 5. Later, we got the letter from ELA, showing that we obviously had not the same assumptions for the average energy efficiency level of new lifts on the market, but we didn't took the assumptions for the Base-Case from the letter ELA provided.
Kollmorgen _BK	But where is your assumption of class C coming from?
AD	From the work done in task 4 and 5.
Kollmorgen _BK	Indeed, but we criticized this due to the outdated information. The data background for this assumption is unclear.
AD	The definition of the Base-Case says it should represent the average product on the market.
Thyssen_P C	Some lifts are class D to meet consumer requirements.
CR	If we assume a Gauss distribution of the market, the market average is better than class C.
Kollmorgen _BK	Yes, the logic would follow this.
CS	This is how the Ecodesign Regulation works. Manufacturers will be given time to adapt. The intervention pushes manufacturers to improve at a reasonable cost.
Kollmorgen _BK	We understand and accept that. The issue is that we have an impact assessment that is showing an impact that is not there. The impact is less, by taking C as the standard for BAU you are widening the gap.
CR	We will adapt our BAU scenario, and adapt it to a B class.

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	We can have a scenario where C is the minimum scenario.
Schindler_ RB	Question on the installation cost graph. Why is the installation cost reduced so dramatically? Where is this assumption coming from?
AD	The graph is not starting at zero. It zooms in to better show the trend.
KONE_HU	Now that you revisited the Lift Directive on what is a new lift, what do you expect to be the results?
AD	In Task 7, a new lift is a lift installed due 1) to the increased stock of lifts or due 2) to the fact, that an existing lift reached 60 years and has to be replaced. It is not a lift undergoing a deep renovation after 25 years.
KONE_HU	So the information on your volumes will not change?
AD/CR	We didn't get in much detail on what is a new lift. These figures have been taken from task 2 on markets. It is not a new assumption, but it has been taken from the previous tasks.
KONE_HU	Could you work through this? If you have a change in the stock because of the definition of a new lift, could you than reconsider the calculations?
CS	But we discussed in the morning that there is not clear guidance on when a lift that is being repaired is a new lift.
KONE_HU	There are currently elevators on the market today, which do not comply with the lift directive. When it is modernized (substantially), it becomes a new lift. You will need to add several components, which are safety related. If the lift was a B class, it can becomes C when you modernize it. You add so many new safety and electrical components.
DG GROW_VK	It is not only the energy consumption during use that should be considered. It is also what is invested as production input for manufacturing of components, transportation. This has to be taken into account. Do the energy savings during the use really pay back?
CR	In Ecodesign we don't look at what the product was before. If it would be a new product and in the scope of the Ecodesign Regulation, it has to comply with the requirements. Would it be possible for this lift to reach the MEPs set down in the Directive? It is more a political question.
CS	The stock model is conservative, because it does not takes deep renovation into account. This is because there is no clear guidance on when a lift is to be considered as new. This is a limitation of the stock model, it underestimates the energy saving potential. Another discussion is the trade-off between safety and energy efficiency. Before class C is made the minimum requirement, we must take into account that there might be trade-offs with safety. This is something for the impact assessment and has little to do with the way the stock model is built.
EFESME_LF	We are talking only about energy efficiency while this should be an ecodesign project. The cost of maintenance is higher compared to the cost of energy. When we try to improve the cost for the owner due to a reduced yearly energy consumption, the maintenance cost will be much higher.
CR	We noted this and it will be considered in the process.
Schindler_ RB	Maintenance is a national regulation and it is not under our control. Some countries have weak regulations, other have strict regulations which drive up the cost
Schindler_ RB	The sections 7.5.1 to 7.5.3 are missing in the report. It may have impact on some of the following tables.
AD	This section will be written in the report, but today we wanted to discuss the scenarios and level of impact. Based on your comments we will write the missing section
Schindler_	Please reconsider the table with 'O' and '+'. For example the statement 'no excessive

Distribution: General

RB	administration burden on manufacturers'. If you look into a scenario with technical information, it might be quite a burden to proof some things for every single installation after it has been installed, this might be quite a burden.
CR/CS	In principle: no third party verification. It is a self-declaration checked by market surveillance.
Hydroware _KJ	Why do we look only at the energy in usage into consideration? In a residential building, (residential with 6 stops), ¾ of the environmental impact comes from the production of the lift.
CS	What requirements would save materials throughout the life cycle?
Hydroware _KJ	That is the modularity. A lift is a function of the building and you have to look at the lifetime of the building, not at the lifetime of the lifts. It is not possible to replace the lift 3 times in the lifetime of the building.
CR	Figures come from task 5, use phase is important in.
ECOS_NR	We are very surprised that ELA does not want a voluntary agreement. We don't think we should the legitimacy of the letter as more important than any other arguments put on the table We are disappointed that we are still struggling with fundamental questions in the third stakeholder meeting. I wonder, whether there is still room to improve the data. If stakeholders are not providing data we fully support the study doing some assumptions. We also want to move beyond energy efficiency. Our proposal is also to go to more ambitious requirements on resource efficiency. Repair/maintenance and durability measures could be very useful here. There are many products as unique as yours and they have their Ecodesign Regulation. The industry survived and we have better products in the markets. This is the third stakeholder meeting and we are wondering what we are going to do next. Are we going to provide data?
Hydroware _KJ	The LCA is wrong. Table 5.5 shows there is a difference of 1 ton in material weight in a small 450 kg lift. Producing 1 ton of steel consumes 10 000 kWh. The usage in an old hydraulic lift in a residential building is 800 kWh per year. How can the evaluation of this LCA show that these two are equal? Circular economy is important now, reuse is important. Lifts should be made modular.
DG GROW_VK	The study has a certain scope. It concerns the use of the lift. I also agree with the points highlighted by Sweden. Also the impact of dismantling and recycling should be considered.

CR: we hope to improve our data especially for the latter tasks.
Deadline for commenting is 12th of May (not 30th of April as announced during the stakeholder meeting).

Question on missing chapters: when will they be available? AD: not sure it is worth to do it before we have feedback on the previous tasks.

Cesar Santos thanked the participants and closed the meeting.

Next steps:

- **12th of May (update)**: deadline for stakeholder comments (not on 30th of April as announced during the stakeholder meeting).
- June: final report

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Afterwards the EC decides whether a Regulation is necessary or not, that would not happen before the autumn, draft regulation not before second quarter 2020.
There will be a public consultation as well. All assumptions underlying this study will be checked by impact assessment team. This will be done by another team and data will be double checked.

Annex

The powerpoint presentation of the meeting are available at the project website: https://www.eco-lifts.eu/eco-lifts-en/content/documents.php

Annex B: Hydraulic oil vs. biodegradable oil

Several LCA studies have been performed comparing the environmental impact of mineral oil with bio based alternatives. Ekman et al. (2011)[48] compared mineral oil-based and vegetable oil-based hydraulic fluids. Two different production routes of vegetable oil-based hydraulic fluids were evaluated, namely a chemical production route and an enzymatic production route. The difference in environmental performance between these two production routes is minor. The vegetable oil-based fluids score better in the impact categories of global warming and primary energy, while mineral oil performs better in the impact categories of eutrophication and acidification.

McManus et al. (2004)[49] did a life cycle assessment of mineral and rapeseed oil used in mobile hydraulic systems. They concluded that the systems running on rapeseed oil are not necessarily better for the environment. Many of the environmental issues examined in their study were affected more negatively by the use of rapeseed oil than mineral oil. The main exception to this was greenhouse gas emissions, which are consistently higher for systems using mineral oil because of the use of fossil resources. This study however dates from 2004 and might not be representative for current technology.

Cuevas (2010)[50] did a comparative life cycle assessment of bio-lubricants (rape oil and soybean oil) and mineral based lubricants. Also here the impact of bio-based lubricants was lower in the global warming potential impact category. They investigated two different types of oil, being rape oil and soybean oil, and observed large differences between the two. Soybean oil scored better on all investigated impact categories compared to rape oil except for the impact category of eutrophication. When compared to rape oil, mineral oil scores better on all investigated impact categories, except for those of global warming potential, respiratory effects and ozone depletion. When soy bean oil is compared to mineral oil, soy bean oil scores better on most of the investigated impact categories, except for eutrophication and chemical smog.

The well-known life cycle inventory database Ecoinvent[51] has life cycle inventory data available for lubricating oil (mineral based), soy bean oil and rape oil. These data records can be used to calculate their environmental impact using the characterization factors imposed by the MEErP methodology. The graph below shows the Ecoinvent results. Mineral oil scores better on most of the environmental impact categories, except for 'primary energy', 'hazardous waste', 'NMVOC' and 'heavy metals to air'. For the calculation of GWP the effects of land use transformation and CO_2 during plant growth have been considered. Soy bean oil has a high impact on GWP due to the assumed land transformations (e.g. primary forest in Brazil transformed into agricultural land for soy bean production).

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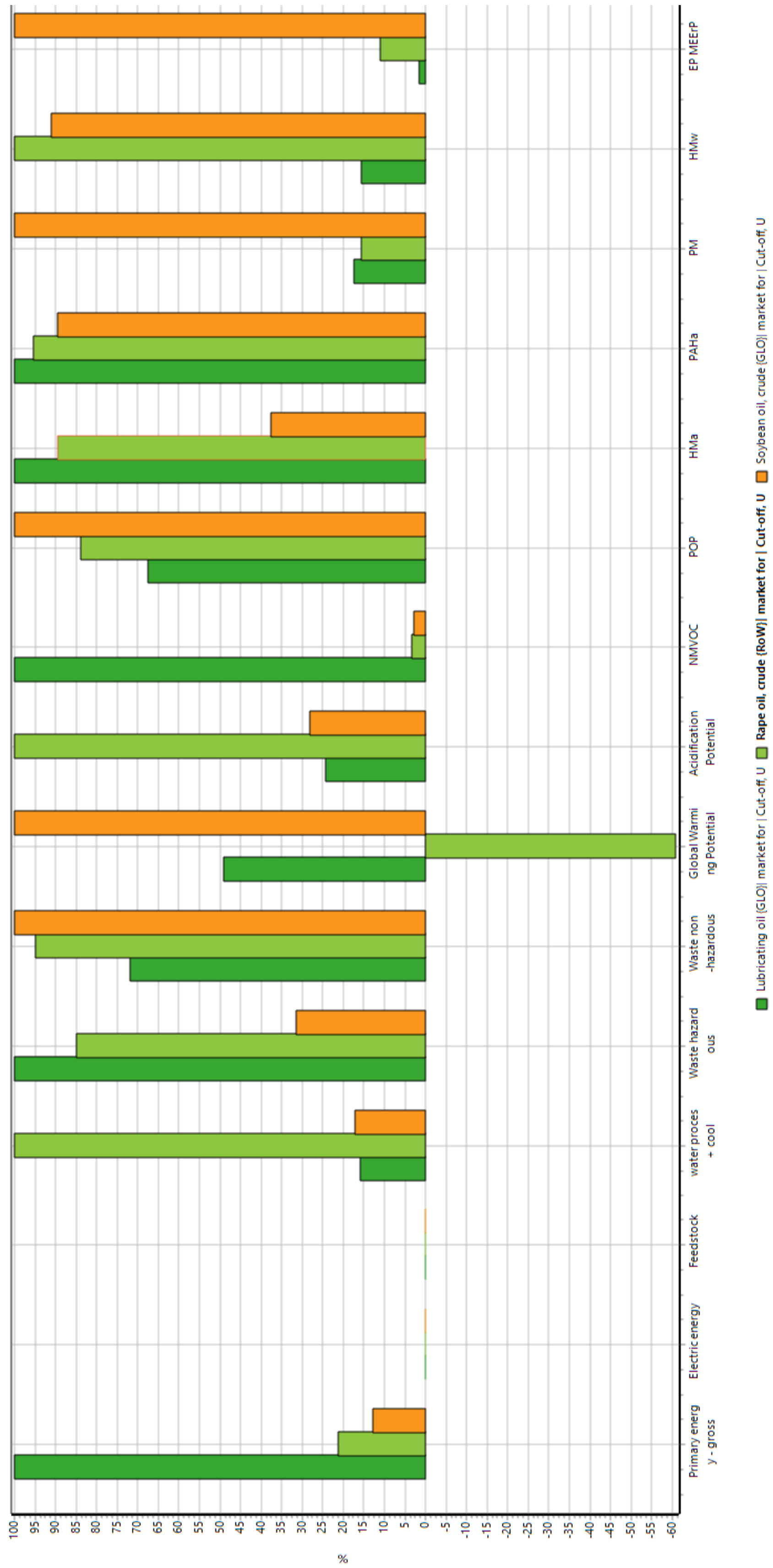
48 Ekman A., Börjesson P. 2011. Life cycle assessment of mineral oil-based and vegetable oil-based hydraulic fluids including comparison of biocatalytic and conventional production methods. Int J Life Cycle Assess (2011) 16:297–305. DOI 10.1007/s11367-011-0263-0

49 McManus M., Hammond G., Burrows C. 2004. Life-Cycle Assessment of Mineral and Rapeseed Oil in Mobile Hydraulic Systems. Journal of Industrial Ecology, volume 7 number 3-4.

50 Cuevas P. 2010. Comparative life cycle assessment of biolubricants and mineral based lubricants. Thesis dissertation. UNIVERSITY OF PITTSBURGH SWANSON SCHOOL OF ENGINEERING.

51 Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., and Weidema, B., 2016. The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, [online] 21(9), pp.1218–1230. Available at http://link.springer.com/10.1007/s11367-016-1087-8

Task 7



Supporting graphs (Ekman 2011)

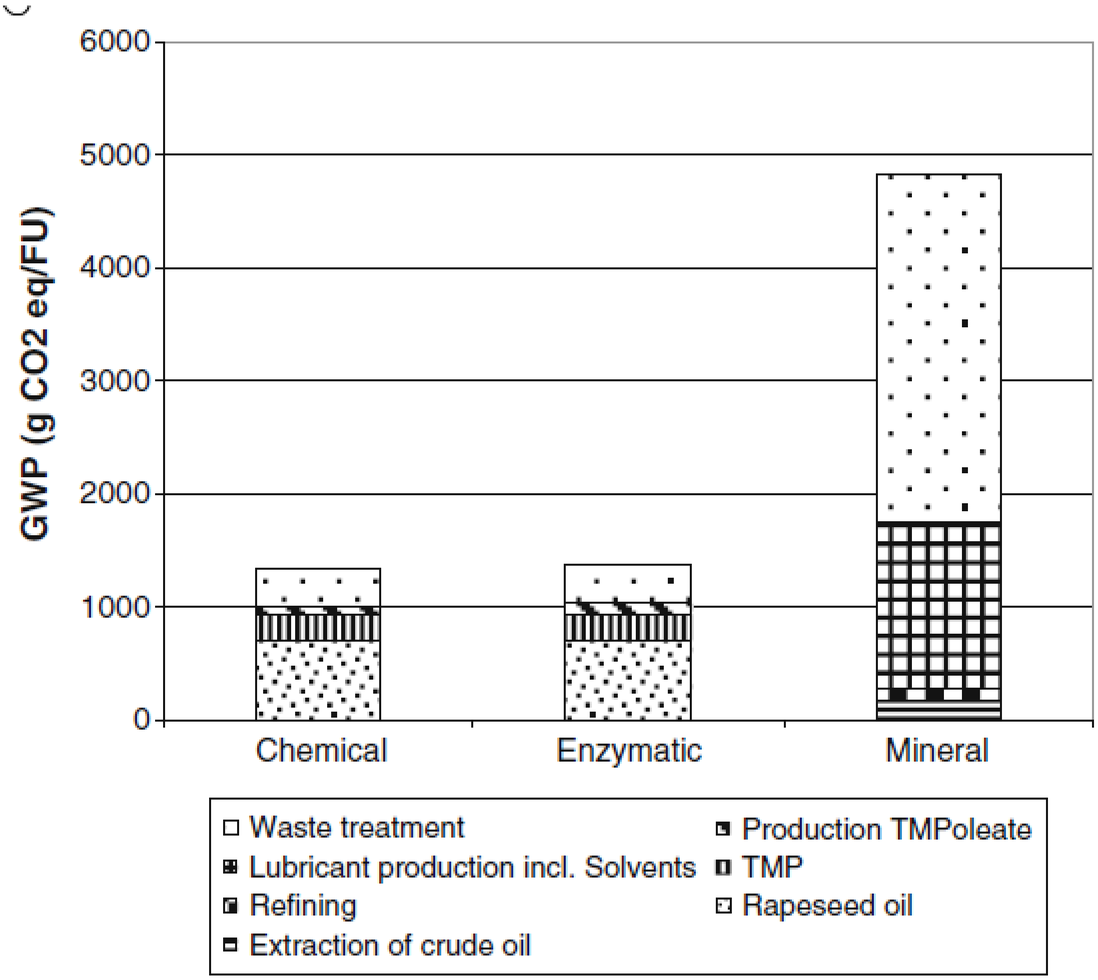


Fig. 4 Contribution to global warming

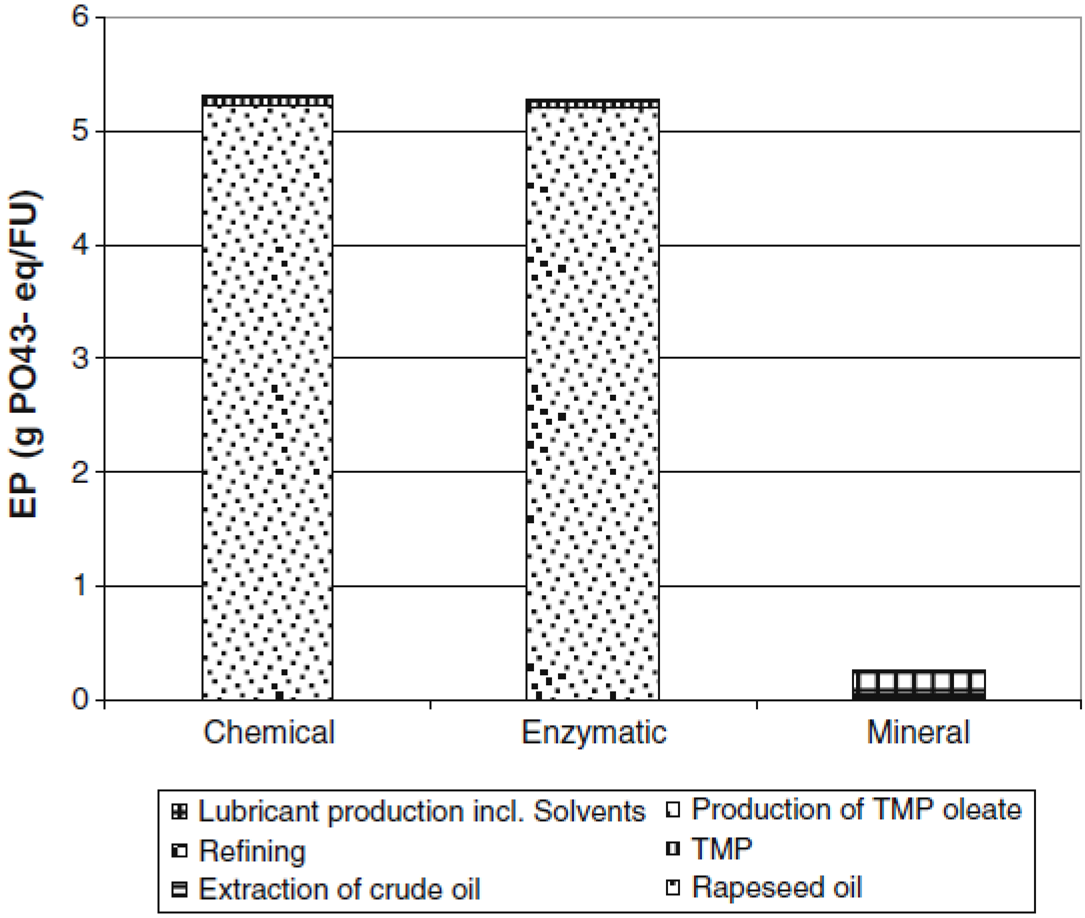


Fig. 6 Contribution to eutrophication

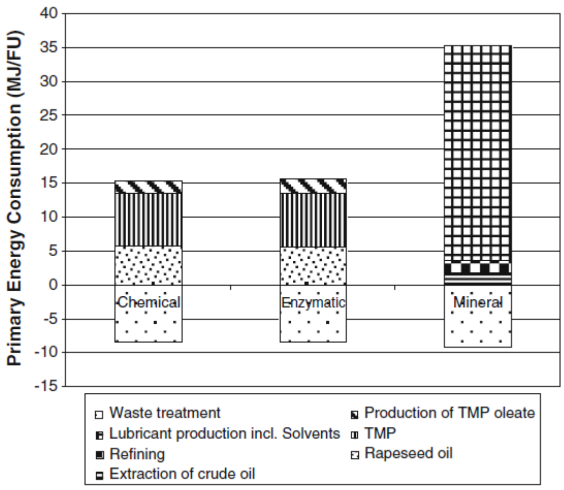


Fig. 3 Primary energy consumption for the production of hydraulic fluids

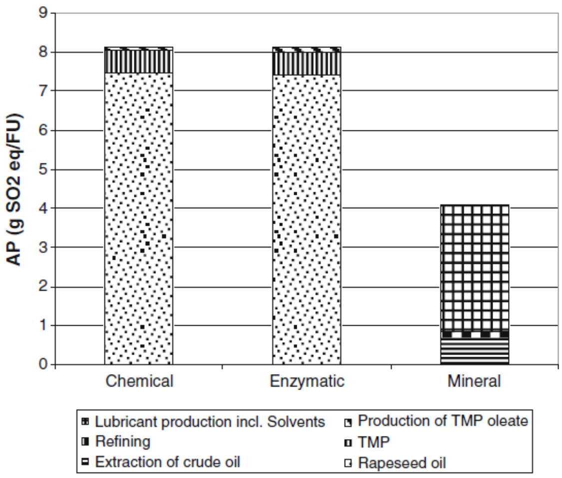


Fig. 5 Contribution to acidification

Cuevas 2010

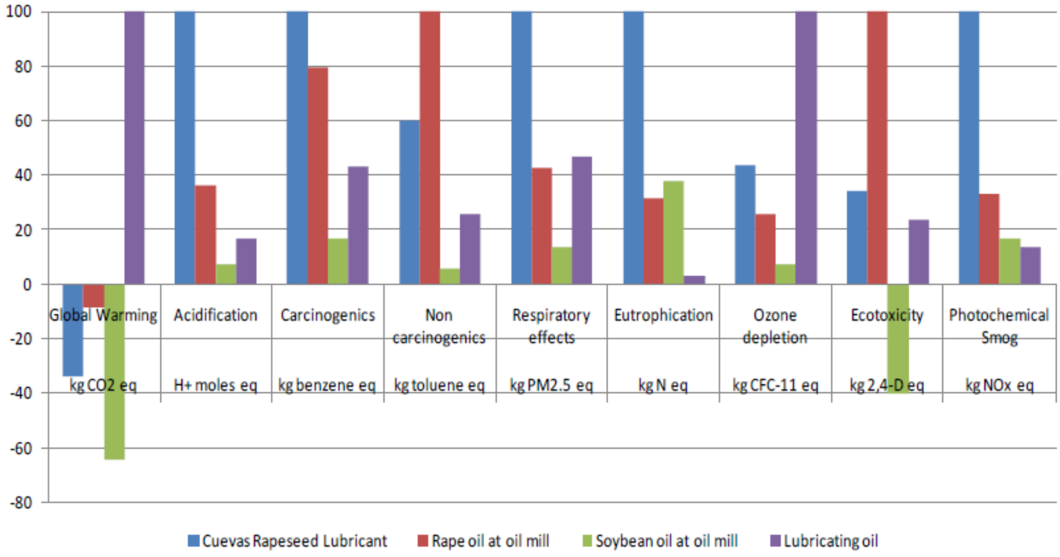


Figure 3.18. Normalized LCIA results