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Border crossings to neighboring countries – analysis of the opportunities and challenges of catenary trucks for freight transport to neighboring regions of Baden-Wuerttemberg

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1 Introduction and objective

Significant shares of the heavy-duty freight transport found on the roads in Baden-Wuerttemberg are transborder transportations. This working paper therefore focuses on a discussion of border crossings to neighboring countries (especially France, Switzerland, and Austria) in relation to catenary trucks and other alternative powertrains in heavy-duty road freight transport. This involved a one-day workshop with experts representing energy supply, freight transport and transport infrastructure from Baden-Wuerttemberg and its neighboring countries, which took place at the beginning of 2020. The workshop's objectives were to discuss practical experiences and pass them on to countries that have not yet taken action.[1]

This paper was prepared as part of the project eWayBW.

2 Design and objective of the expert workshop

The expert workshop was held in Munich on 16 January 2020. 24 participants from Germany, France, Switzerland, Austria, Italy and Hungary took part in the one-day event. Those attending were from research, politics and industry, among others. The workshop's objectives were:

- To present and discuss experiences from the pilot projects in Germany
- To discuss a possible utilization of this technology in neighboring countries like France, Austria, and Switzerland
- To identify the drivers and barriers involved as well as open research issues.

The main findings are presented below, supplemented by figures and evaluations compiled prior to and following the workshop. As Austria, Switzerland, and France, the countries bordering Baden-Wuerttemberg, are so-called Alpine countries, specific aspects of overhead line truck corridors through the Alps were examined as well. Since the test route in Baden-Wuerttemberg displays certain characteristics at several points, for instance with regard to topography, some of which are also found in the Alps, the results of this German test route are of particular interest for the Alpine countries.

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1 To date in Europe, field trials with catenary trucks are only being funded in Sweden and Germany.

3 Results of the expert workshop

At present, competition is seen between the different alternative powertrains and fuel technologies for heavy-duty road freight transport, ranging from catenary trucks through hydrogen trucks and battery-electric trucks up to trucks running on synthetic fuels. It is largely assumed that one of the new technologies will prevail because of

- the limited number of heavy-duty trucks (the stock is currently around 200,000 in Germany)
- the limited number of truck suppliers and
- the high investments needed for R&D as well as for developing production sites and infrastructures.

A pluralism of alternative fuels and powertrains is regarded as less likely, although a mixture of electrical variants would be conceivable, such as battery-electric trucks and battery-catenary trucks. The decision in favor of one of the new technologies is pending in the next two to four years[2]. Solutions for heavy-duty road freight transport are needed in the near future in order to achieve the climate targets for road transport in Germany and Europe, and because it will take time to develop the necessary infrastructure.

3.1 Success factors and barriers for catenary trucks in Europe

There was general agreement at the workshop that a success of the overhead line technology in Europe can only be achieved through joint action by many European countries, preferably coordinated by the EU. Due to the high share of transit traffic in Switzerland and Austria[3], the success of the overhead line infrastructure is directly and to a large extent also dependent on Europe-wide activities.

If it is to be successful, it is important that standardization and harmonization take place in good time. The efficiency and performance of European rail freight transport is being hampered by too slow progress in standardizing the European train control system ETCS and the length and loading gauge of rolling stock, as

2 For this discussion, see Plötz et al. 2018, who illustrate the pressure to act.

3 E.g. this amounts to more than 73% in Alpine corridors over the Gotthard in Switzerland (see UVEK 2014) and to more than 85% in Austria over the Brenner (see Tirol 2016).

well as by heterogeneous approval requirements for locomotives and training requirements for train drivers. The efforts made by the EU Commission and the European Railway Authority (ERA) towards a harmonized European railway area face ingrained national protectionism and high safety standards in the railway system[4].

In this context, the experts discussed different voltages and cable diameters for the overhead lines, and several representatives favored increasing the voltage to approx. 1,250 or 1,500 Volt. Ultimately, standardization and regulation should lead to catenary trucks being able to drive in all EU countries without restriction. Work is being done on these issues at present; a proposal for a standardized overhead line infrastructure is currently in progress and a valid standard is expected in the next few years. At present, it is possible to operate the vehicles on all the test routes realized or being constructed in Germany and the overhead line in Sweden, because the vehicles are currently all from one manufacturer. A representative of the automotive industry also announced that both diesel-hybrid and battery-electric catenary trucks will be offered.

The disparate ownership and management models of highways in Europe could be an additional obstacle to the deployment of overhead line infrastructure.

Especially in light of the huge significance of a harmonized European solution, a proposal was developed to conduct a Europe-wide feasibility study for overhead line technology.

Platooning and the possibilities to link this with catenary trucks was regarded as a topic for further research.

The social acceptance of the technology represents another important factor for its diffusion, which has already become clear in the field trials in Germany. It is important to involve the residents near a test route at an early stage; the experiences and best practice examples from Sweden can be referred to here. In addition, it is important to convince the population as a whole of the technology's benefits and to close any knowledge gaps that could lead to a lack of acceptance. The acceptance of highway and road operators could also play an important role for the further diffusion of the technology – as far as countries are involved where road management is largely in the hands of private companies.

[4] cf. Doll et al. (2019), European Commission (2019)

The experts also commented that the feasibility assessment must distinguish between local, regional and long-distance transport. It is possible that a larger number of solutions are conceivable for local transport than for long-distance transport.

Finally, another obstacle to the technology's implementation mentioned by the experts is the currently very limited range of vehicles on offer.

3.2 Assessments of potentials in neighboring countries

Rail transport has very high relevance in some of the countries bordering Baden-Wuerttemberg, with shares of rail freight transport substantially above the shares in Germany, especially at St. Gotthard (see Figure 1).

The further development of rail infrastructure in Austria and especially in Switzerland aims at contributing to shifting freight transport off the roads and onto rail[5].

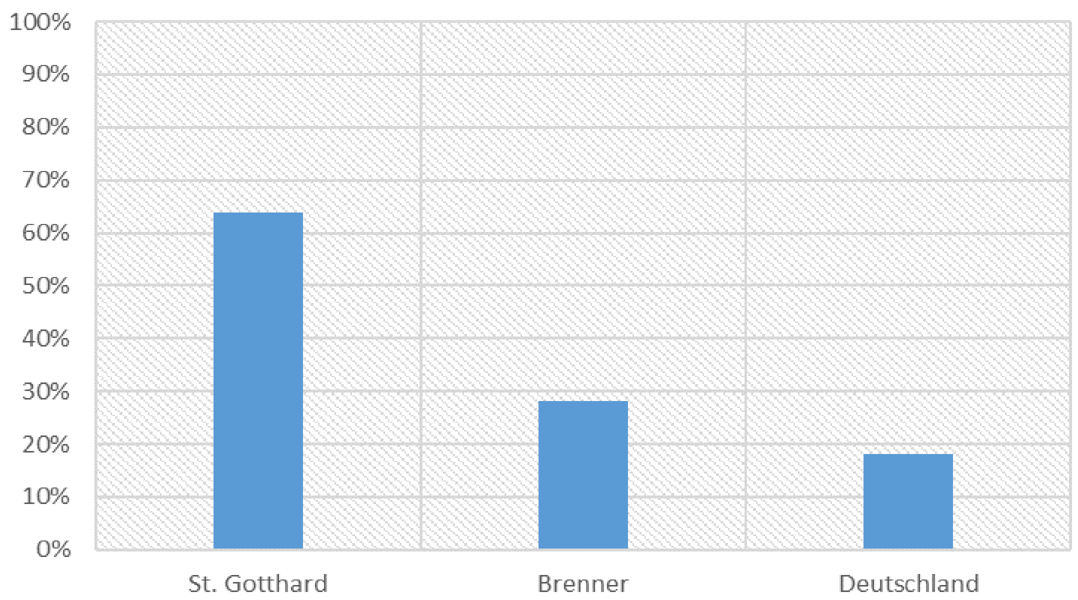

Figure 1: Share of rail freight transport in total goods transport [million tonnes] 2015 (data sources: EC 2017, Statista 2018)

5 For instance, the new Gotthard Base Tunnel opened as part of the New Railway Link through the Alps (NRLA) construction project in 2016, and a further increase in capacity is expected once the Ceneri Base Tunnel and the 4 meter corridor are completed (NRLA Gotthard axis: 252 trains in both directions) (UVEK 2017).

Swiss experts at the workshop therefore estimated that catenary trucks in Switzerland could face relevant problems with acceptance due to the competition with rail (the priority of rail freight transport is anchored in law). In general, the experts from Switzerland stated that the topic of catenary trucks is not particularly relevant in Switzerland and that this technology could only be used for local and regional transport. However, as a transit country, Switzerland is confronted with substantial volumes of transit traffic and must deal with pan-European technologies. There are no field trials currently taking place in Switzerland itself, nor are any planned.

In Austria, construction of the Brenner Base Tunnel is an important infrastructure project to improve rail transport. The tunnel is due to be completed by 2022. The intention is to triple the goods capacity of rail "from 600,000 to 1.8 million truckloads"[6]. This means that 400 trains instead of approx. 270 should be able to pass through the Brenner with significantly reduced journey times (50 minutes instead of 2 hours from Innsbruck to Bolzano)[7].

The experts from Austria assessed the situation in their country as follows: solutions for heavy road freight transport are being sought, and the discussion about catenary trucks plays a certain role here (these are mentioned in the roadmap for the next 20 years). The country is currently in the orientation phase of reorganizing heavy road freight transport and studies are required about the advantages and drawbacks of the alternatives. It is also waiting to see in which direction EU policy will go. In general, however, a certain skepticism was expressed about technologies that require the construction of new infrastructure and/or are seen as competition to rail. However, the fact that so many representatives from Austria turned up at the workshop indicates a fundamental interest in the technology.

The representatives from France also mentioned that they are currently still in an orientation phase. However, the low CO_2 emissions of French power plants are regarded as favorable for electrified solutions. The company Alstom, for instance, is working on electric road systems, which supply power via rails at road-level; however, work is also being done on inductive solutions by the company VEDECOM, among others.

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6 https://www.tagesspiegel.de/kooperationsabkommen-brenner-tunnel-wird-gebaut/982282.html (retrieved on 23.08.2018)

7 http://www.faz.net/aktuell/wirtschaft/neuer-brenner-tunnel-mit-tempo-250-durch-die-alpen-13671819.html (retrieved on 23.08.2018)

The Hungarian representatives at the workshop emphasized their country's interest in this technology and reported that preparations are underway to install Hungary's own test routes; along highways on the one hand, and for local distribution transport on the other. However, the Hungarian government, especially the Ministry for Innovation and Technology, is also testing other alternatives for decarbonizing road freight transport such as fuel cell trucks, for example.

Some interest in the technology can be observed in Italy as well, especially in Lombardy, where a field test is planned along a highway (A35 "Brebemi"). Air pollution control is regarded as the main driver in Lombardy.

3.3 Implications for test tracks in topographically demanding areas

Another important topic at the workshop was the design and construction of the overhead lines through the Alps, which is addressed below.

The restricted space, construction requirements linked to the subsoil and special requirements due to nature conservation could be challenges here that could represent an obstacle or increase construction costs. When comparing the three test routes currently implemented in Germany, it became clear that the stretch of main road through the Murgtal (a valley in the Black Forest) displays greater challenges than the two other test routes along flat stretches of highway. The partially stony ground and bridges along the test route in the Black Forest are considered of interest for possible implementation in the Alps. For example, it was pointed out that the statics of some bridges had to be recalculated based on concrete core sampling in order to guarantee the necessary stability of bridge piles when adding masts for the overhead power lines.

In addition, the energy supply infrastructure has to be designed for the gradients in the Alps. Particular attention must be paid to the increased energy demand of vehicles driving uphill that can only be partially compensated for by the recuperation of trucks traveling downhill.

When considering local pollutant emissions and noise pollution due to traffic, the so-called Alpine factor must be taken into account on the transport routes studied. The confined spatial conditions as well as the topographical and meteorological conditions in the mountains enhance the impact of noise and pollutant emission sources so that a vehicle in a high Alpine region can cause pollutant concentrations that are up to three times higher than in the Swiss plateau (UVEK 2017). However, local pollutant emissions have decreased in the last few years[8].

The potential CO_2 savings of catenary trucks are much higher in Switzerland and Austria compared to Germany and many other countries as well. This is due to the high share of hydropower in both countries and the still high shares of nuclear power plants in electricity production in Switzerland (BFE 2012, Österreichs Energie 2017). According to *wiesoeigentlich.de* (2018), the CO_2 emissions in Austria were 279 g/kWh and 169 g/kWh in Switzerland when considering domestic electricity production including electricity imports. In comparison, the CO_2 emission factor for electricity for domestic consumption in Germany was 537 g/kWh in 2017 (UBA 2018).

Due to the large number of pumped and storage power plants in Austria and Switzerland, they have high potential to react flexibly to the demand for power. This means the challenge of a lack of flexibility in managing the electricity demand of catenary trucks is less relevant in these two countries.

8 In 2016, heavy goods vehicles (HGV) caused 24% of all NO_x emissions and 20% of all PM10 emissions. CO_2 emissions have remained more or less constant over the last few years, with HGV accounting for a share of approx. 26% in 2016 (UVEK 2017)

4 References

Bundesamt für Energie (BFE) (2012): Die Energieperspektiven für die Schweiz bis 2050. Auftraggeber Bundesamt für Energie. Durchgeführt von Prognos.

Doll, C., J. Köhler, D. Horvat et al. (2019): Policy and business–how rail can contribute to meet transport climate targets in the freight sector. Summary Report 3 of the study LowCarb-RFC – European Rail Freight Corridors going Carbon Neutral, supported by Stiftung Mercator and the European Climate Foundation. Fraunhofer ISI, Fraunhofer IML, TPR / University of Antwerp, M-Five. Karlsruhe.

Europäische Kommission (2019): Sixth report on monitoring development of the rail market SWD(2019). Bericht der Kommission an das Europäische Parlament. Brüssel.

Plötz et al. (2018): Alternative Antriebe und Kraftstoffe im Straßengüterverkehr – Handlungsempfehlungen für Deutschland. Fraunhofer Institut für System- und Innovationsforschung ISI, Öko-Institut, ifeu – Institut für Energie- und Umweltforschung. Fraunhofer ISI: Karlsruhe

Statista (2018): Anteil des Schienengüterverkehrs an der gesamten Güterbeförderungsleistung in Deutschland von 2008 bis 2015. Online verfügbar unter https://de.statista.com/statistik/daten/studie/3539/umfrage/anteil-vom-schienenverkehr-am-guetertransport-in-deutschland/, zuletzt geprüft am 18.10.2018.

Tirol (2016): Verkehr in Tirol – Bericht 2016 – Alpenquerender Güterverkehr. Herausgeber: Amt der Tiroler Landesregierung, Innsbruck, Österreich.

Umweltbundesamt (UBA) (2018): Strom- und Wärmeversorgung in Zahlen. Online verfügbar unter https://www.umweltbundesamt.de/themen/klima-energie/energieversorgung/strom-waermeversorgung-in-zahlen, zuletzt geprüft am 19.10.2018.

UVEK (Eidgenössische Departement für Umwelt, Verkehr, Energie und Kommunikation) (2014): Güterverkehr auf Strasse und Schiene durch die Schweizer Alpen 2014. Schlussbericht.

UVEK (Eidgenössische Departement für Umwelt, Verkehr, Energie und Kommunikation) (2017): Bericht über die Verkehrsverlagerung vom November 2017. Verlagerungsbericht Juli 2015 – Juni 2017.

wiesoeigentlich.de (2018): Aber sind Elektroautos nicht letztlich schlechter fürs Klima? Online verfügbar unter https://wiesoeigentlich.de/co2-emissionen/, zuletzt geprüft am 19.10.2018.European Commission (EC) (2017): Statistical pocketbook 2017, EU transport in figures. doi:10.2832/041248 MI-AA-16-002-EN-N.

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