Decarbonizing the freight sector in Switzerland

SCCER Mobility Academia-Industry Dialogues

Synopsis of the event from 29 November 2018

Following air freight, transporting goods on the road is the most energy intensive freight mode per ton km and it is fueled almost exclusively by fossil energy carriers. Electrification and renewable electricity are expected to change the energy intensity in the case of cars on the mid- to long-term. But for heavy-duty vehicles, achieving useful autonomy ranges using battery electric propulsion is challenging due to the lower energy density of batteries. One possible workaround is to (re)charge vehicles during operation, e.g. using electric road systems (such as overhead lines or dynamic wireless charging systems), opportunity charging or swapping the entire battery. Alternatively, electricity can be converted to synthetic fuels such as hydrogen, thus allowing more energy to be carried on board. All of these solutions promise decarbonization yet they require new, expensive energy infrastructure, interfere with operations and only work if the decarbonization of the electricity supply chain can indeed be guaranteed.

Decarbonization may thus be complicated and expensive, but it could also provide opportunities for new business models. To address exactly such questions, SCCER Mobility hosted this Academia-Industry Dialogue to bring together experts from research and practice to discuss possible paths towards decarbonizing the freight sector in Switzerland.

New powertrain technologies in freight transport

During the short input presentations, industry representatives from the freight sector gave insights about what decarbonization means for their business and how they are investigating and implementing low-carbon propulsion technologies. While diesel engines will likely remain central for quite some time, efficiency improvements through hybridization and better energy management will promote greenhouse gas (GHG) emission reduction. For example, Peter Krähenbühl points out that FPT Motorenforschung AG is implementing predictive synchronization of subsystems, thus optimizing kinetic, thermal, chemical and electrical energy to reduce vehicle energy consumption. Furthermore, he highlighted that the portfolio of the future will be more complex as new technologies emerge. Therefore one of the great technical challenges will be to increase modularity in the design.

Along with improvements of conventional technologies, increased electrification will also be vital. However, electric trucks have a larger potential to be employed in urban settings, as their range restriction will be less of a disadvantage there. Additionally, employing more electric vehicles reduces local noise and pollutant emissions and will thus have a positive impact on urban quality. In this context, Coop has several e-trucks (manufactured by E-Force) in operation that deliver goods to grocery stores in Switzerland. Georg Weinhofer (Coop) explains that e-trucks are a suitable replacement for conventional ones, but do pose some problems in mountainous areas, which underlines the fact that they are more appropriate in urban conditions. However, a major problem for companies wishing to add more e-trucks to their fleets is that at the moment there is no OEM that can produce large numbers of these trucks at a reasonable price. In turn customers are often not willing to pay the higher price.

For covering longer distances, alternative fuels like natural gas or hydrogen and propulsion systems like fuel cells or electrified highways may be more important. Electric road systems where trucks are powered directly by overhead lines instead of by an on-board battery could overcome the range issue

of e-trucks while taking advantage of the high energy conversion efficiency of electric propulsion. Newest innovations in the field like the Primove truck highway using dynamic wireless charging could even overcome the need for overhead lines. Christian Köbel (Bombardier Primove) presented the successful demonstration of this technology that took place on a test track in Germany. Testing under real driving conditions and analysis of the cost effectiveness are underway.

Hydrogen and fuel cell powered trucks may also be a more viable option for covering longer distances. This is mainly because hydrogen has a higher energy density than batteries, thus offering longer ranges. Additionally, it can be stored more easily, so that refueling is also easier and faster compared to batteries. However, costs for both fuel cells and hydrogen production are still high and the purity of hydrogen can also be problematic for fuel cell operation. Markus Zeifang (SCCER BIOSWEET) also mentioned that it is still difficult to obtain maintenance contracts for hydrogen stations, as was the case for a demonstration project at PSI.

Potentials and environmental assessment

Small-scale implementation of these new technologies are under way in Switzerland. However, as Gil Georges from the Energy Systems Group (ETH Zurich) elucidated in his presentation, their potential for reducing GHG emissions is somewhat limited when extrapolated to the entire Swiss truck fleet. For example, a recent study from the group showed that a massive electrification of the truck market and near full decarbonization would require significantly improved battery energy density (factor 5-6 compared to the current state of the art), higher charging power (200 kW or more), swapping batteries multiple times (4-6 times per day) or combinations thereof. No matter the approach, battery electric trucks are generally significantly heavier than their diesel counterparts, and thus require exemptions on their maximum permissible weight. Efforts to investigate other options like hydrogen, natural gas and plug-in hybrid electric trucks are ongoing.

Along these lines, the CO_2 reduction potential is not only dependent on new powertrains, but also on a low-emission fuel supply. From a lifecycle assessment (LCA) perspective, Christian Bauer (Laboratory for Energy Systems Analysis, PSI) illustrated that electric or fuel cell trucks only offer GHG emission advantages compared to conventional diesel trucks if the supplied electricity (to charge batteries or to produce hydrogen) comes from renewable sources. Therefore, it is paramount that the electricity sector is decarbonized in parallel to the transport sector. Furthermore, lifecycle emissions of e-trucks increase with increasing battery size, so that the full benefit of freight electrification will only be reached if implemented over short distances, which requires smaller batteries. Again, this stresses the importance of tuning technology application according to the purpose.

Infrastructure requirements

Implementing new powertrain and fuel options into the freight fleet will also require modified or new infrastructure for refueling the vehicles. While for some companies this may not pose a problem if trucks return to distribution centers for refueling, it does for vehicles that travel across the country or the continent. In the former case, companies have control and can set up their own refueling facilities. However, in the latter case, national and international infrastructure networks have to be funded and coordinated so that refueling needs are met beyond distribution centers and beyond national borders. As this usually falls into the public/governmental realm, the lacking business component can slow down the process substantially. Along with missing infrastructure, suitable servicing for vehicles with alternative powertrains is also not in place yet, which can pose a major challenge for fleet operators. Operating time is valuable in the freight business, so new technologies only have a chance if they do not interfere with or slow down operation substantially.

Integrative energy and freight system towards decarbonization

In order to decarbonize the freight sector, there was a consensus in the discussion that new technologies should not be in competition, but seen as be part of an integrative solution covering different freight transport purposes. For example, electric vehicles are appropriate for the last-mile of shipments and urban freight, but less suitable for trans-European freight. In the latter case, trucks powered by natural gas, hydrogen or other synthetic fuels may be more appropriate. Likewise, power-to-gas technologies should not compete with the direct use of renewable electricity. Rather they should be part of the energy system as a means of providing energy storage, different energy carriers for different applications and year-round fuel supply. Integration and the appropriate combination of powertrain options will also vary regionally, as geographic aspects will constrain renewable power production and already established infrastructure will be different.

An integrative platform or agent (e.g. a company) is clearly needed both on the vehicle and infrastructure level. However, from the discussion it did not become clear how this can be achieved easily in a liberal market. One possible solution could be the internalization of external costs and let the market regulate how different technologies will fare. The other option would involve policy intervention to drive this integration.

The role of policy

In line with current trends in the EU to lower emission standards for trucks, the Swiss Federal Council is also discussing the possible extension of these new regulations to Switzerland, as Men Wirz from BFE highlighted in this presentation. Indeed regulations, taxes and incentives can be important for pushing new technologies and solutions. These are often available, but need to be triggered by policies beyond taxes and regulations as was the case for car e-mobility.

In Switzerland alternative-fueled trucks are currently exempt from the LSVA (distance-related heavy vehicle fee) so that there is a break-even for investing in these technologies. This is a good starting point to promote businesses to switch to low-carbon trucks, but it is uncertain if this LSVA exemption will still be upheld in future, as e.g. noise emissions could also fall under regulation to reduce freight traffic flow.

Even so, it appears that there are not enough drivers to support substantial efforts towards the decarbonization of freight. Perhaps this could be solved by further economic incentives or an instrument that supports the creation of new business models that promote new technologies. Once a critical mass is reached, technologies can become established in the market more easily.

The Swiss Competence Center for Energy Research - Efficient Technologies and Systems for Mobility (SCCER Mobility) aims at developing the knowledge and technologies essential for the transition from the current fossil fuel based transportation system to a sustainable one with minimal CO_2 output, primary energy demand as well as virtually zero-pollutant emissions. 25 experts from industry, public offices and academia participated in this dialogue event on 29 November 2018.

Drawing from the presentations and the discussion of this event, SCCER Mobility will identify new research fields and develop its competency towards investigating relevant questions for businesses active in the freight sector. Additionally, SCCER Mobility plans to uphold the exchange and discussion with interested stakeholders for specific research questions and projects as well as a planned white paper dealing with this topic.