3. SCALABILITY & RESOURCE EFFICIENCY

Facts about climate-friendly road freight transportation

What's the best strategy for realizing climate-friendly road freight transportation? Let's take a look at the facts.

To achieve the necessary CO2 reductions in time, it's not enough for a technology to be available now. It also needs to be possible to scale it up quickly so that intermediate goals can be met: for example, 70 percent of new semi-truck sales in 2030.

This challenge is one of "scalability", which depends on factors like the capabilities of the supply chains (including available expertise and staff) and the degree to which these capabilities can be quickly channeled into a rapid transformation of the road freight sector (for example by having open and common standards and fast approval processes).

Closely related to the issue of scaling is the availability of natural resources. Especially during a rapid growth in material demand, there's a risk of supply bottlenecks that could hinder a timely, large-scale implementation.[1]

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In the case of **Overhead Contact Lines (OCL),** two factors that are sometimes mentioned as negatives – that it's an old, almost ancient, technology and that it's strongly associated with the railway sector – actually turn out to be strong positives. Thanks to more than a century of use across six continents and all climatic zones, there are plenty of relevant standards and regulations that can be utilized. And thanks to the roughly €10 billion annual market for rail electrification,[2] there are strong supply chains that can be leveraged in road applications.

Installing OCL on roads has this advantage over today's railway applications: All OCL trucks have onboard batteries, which means the OCL doesn't need to cover the entire distance from A to B, which makes implementation faster. Studies already show how commercial OCL could work on shuttle routes of about 100 km in length.
As already demonstrated these initial routes can be used by both Battery-Electric Vehicles (BEVs) without large batteries and by hybrid trucks. Both and other truck configurations utilizing batteries can use the OCL for **dynamic charging**, which means only segments of a route would need to be equipped with OCL in order for the whole journey to be covered electrically.

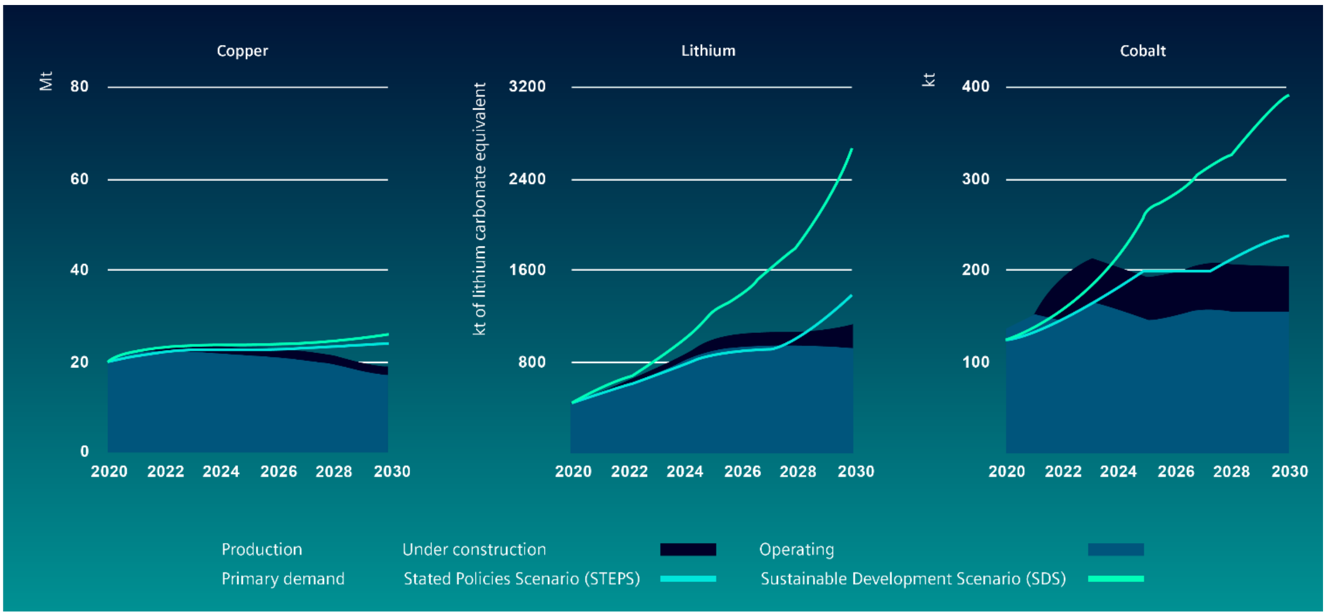
The latter vehicles will be able to operate across Europe right from the start: in other words, without having a comprehensive infrastructure network in place. This helps OCL overcome the so-called "chicken and egg" problem.

From the early shuttle routes, the OCL infrastructure can be expanded stepwise and power levels increased as the number of users grow, into a national and continental network.[3]
The latter will be facilitated by recent work within CENELEC on Europe-wide standards for both OCL infrastructure and the interface between the OCL infrastructure and OCL trucks. Scaling up OCL vehicle production is mainly dependent on the speed of OCL infrastructure deployment.

It helps to know that in times past, Germany was able to electrify 5,000 km of railway in 10 years.[4]

A large installation company estimates that in today's Germany it would be possible to electrify 500 km of highways (for example 500 km times two directions) per year.[5]

One reason it would move quickly is that OCL can be built as an upgrade of existing motorways: It wouldn't require land to be claimed or changes to sensitive landscapes. One critical necessity for OCL is copper. If almost four ton of copper are needed per km of motorway, then 4,000 km of German roads would consume 16,000 tons. This is less than 0.1 percent of the annual global production (around 20 million tons), and that's before considering that OCL infrastructure doesn't need to be replaced every year.[6]



Committed mine production and primary demand for selected minerals[8]

So even with interest in OCL increasing[7], there seems to be little reason to fear a shortage of copper.There's of course the risk that other developments will affect the price of copper, but the forecasted supply-demand mismatch up to 2030 is a relatively minor 25 percent.

Battery-Electric Vehicle (BEV) has the advantage of a strong ecosystem of actors working on producing batteries, chargers, and trucks. Of these three elements, the focus for scaling up is on battery production and the deployment of chargers. The BEV industrial ecosystem around is pushing for market consensus on industry standards (via the organization CharIN). A standard for megawatt charging systems (MCS) was expected by now, but it's been postponed until 2024. Even without a large European network of MCS,
long-haul BEVs would be able to use slow-charge using less powerful chargers – however, a complete network of MCS is essential for making long-haul BEV operations run smoothly across Europe.

Finding space at truck parking areas is already a challenge today,[9] and it won't get any easier if equipment is added that makes already tight side-by-side parking more difficult, or if only certain types of trucks can park in certain spaces. Taking new land and converting it into parking spaces will therefore be necessary in order to scale up BEV. The parking spaces will also need substantial grid connections. Because queuing at chargers means truckers losing valuable time, an international booking system is also required: without it, preventing queues would require the construction of so many MCS that their utilization – and therefore their economic return – would suffer. Ensuring that the booking system is robust against manipulation and enforceable against those who would abuse it will be crucial.

At the time of this writing, it's not known if this type of system is already being developed or on what legislative basis it would operate. In addition to the afore-mentioned issues for MCS, another possible bottleneck in scaling up involves the batteries. Battery cost and performance has improved dramatically in the past decade, and more economies of scale in their production as more factories come online is likely. However, this results in battery technology becoming cost-competitive with fossil fuels in segments like LCV and cars much earlier than with semi-trucks (which one BEV manufacturer thinks isn't possible before 2040).[10]

If the demand from other segments triggers a greater demand than can be supplied due to scarce raw materials, this will feedback into battery prices, which at large-scale production are primarily dictated by material costs.
IEA estimates that the mismatch between supply and demand by 2030 could be 1to 2: for example, for every kg demanded, only 0.5 would be produced. Over the longer run, new production sites could be developed (recycling won't play a significant role this century[11]); but the issue is how the rapid ramping up of battery production and use could be navigated with minimal disruption in the coming one or two decades that are critical for climate protection.

To scale up **Fuel-Cell Electric Vehicle (FCEV)**, three components need to fall in place: vehicle production, fueling infrastructure and fuel supply. Ramping up vehicle production and their supply chains is of course possible, but the scale of ramping that's needed isn't well understood.
Bringing down the cost of expensive vehicle components like fuel cells and hydrogen storage tanks will be highly dependent on the success of FCEV in the car market (Hyundai, IEA)[12]. A recent Hydrogen Council report said that 900,000 units sold per year would help make fuel-cell vehicles cost-competitive. The current vehicle market is far from achieving that number, and realizing it will probably require substantial policy support.

When it comes to hydrogen refueling stations (HRS), scaling up is currently limited by a lack of standards, and the three different ways to store and refuel hydrogen (in liquid form or gaseous at 350 bar or 700 bar) are at very different levels of maturity (see "time to market" article). Crucially the HRS network needs to be very large (at least Europe-wide) in order to serve long-haul trucking, because the trucks' batteries are too small to use stationary chargers for journeys beyond the HRS network. Nor are the trucks likely to be hybrids with an additional combustion engine.

Lastly, because Europe is viewed as unlikely to have enough renewable electricity to make all the green hydrogen it needs, most FCEV truck scenarios focus on importing green hydrogen. Scaling up imports requires both large-scale production abroad and a means to import it.

There are plenty of places with strong winds and lots of sunshine, which are needed for making renewable electricity. However, not all of those places are easy to do business or make large investments: for example, if they're too remote or are in ungovernable regions. Some locations do offer stable conditions (Australia): but even there, we need to ask if it wouldn't be better for the climate to decarbonize local energy consumption first before exporting green molecules. As to the international transportation of hydrogen, there's currently only one ship that can transport (liquid) hydrogen.[13]

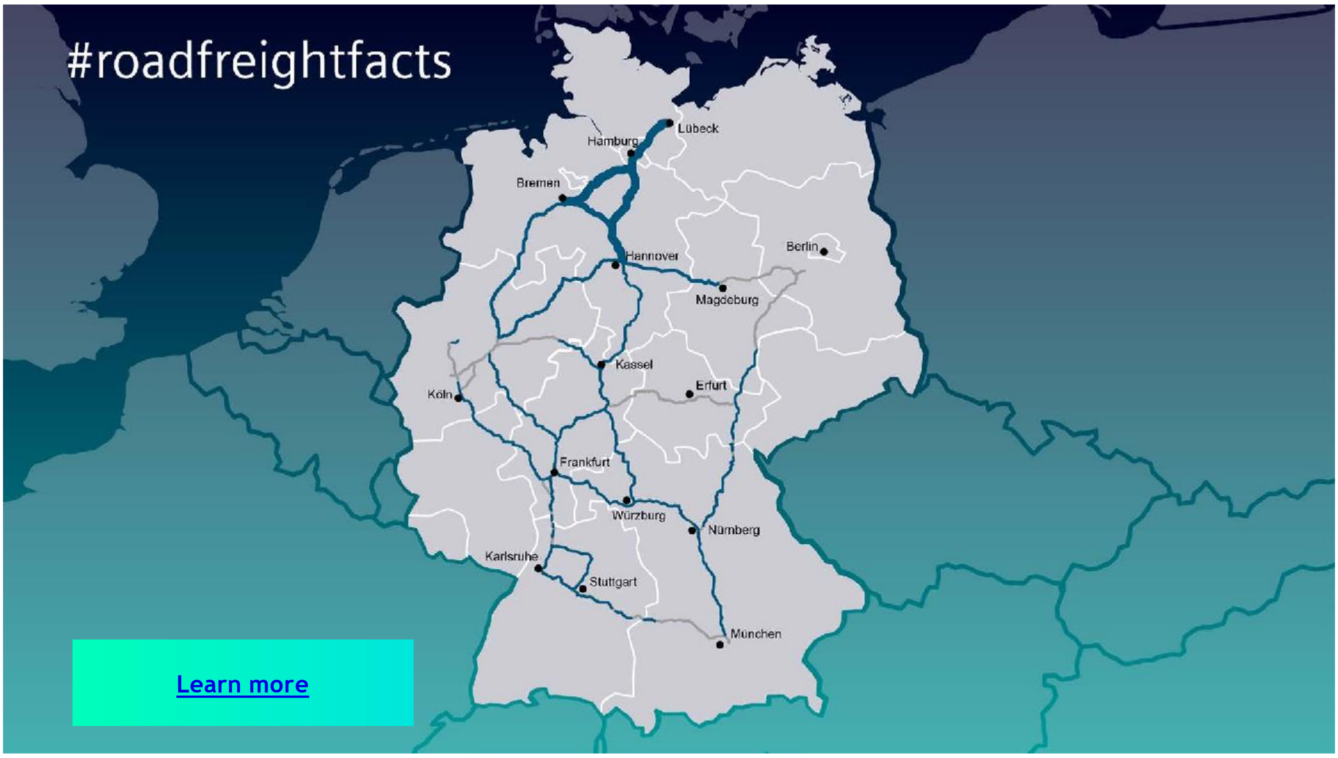
Although a bigger one has been announced for 2025, there are few indications that much transportation capacity will be available in this decade or even the next.

Only from experience with the first trials will we know if many shipyards will be able to add to the production capacity of such vessels.

Renewable Fuel (RF) "only" require the scaling up of fuel availability, which nevertheless remains a major challenge to solve. Synthetic fuels are hydrogen-based and would – due to the additional energy losses in their production – require even larger investments in renewable energy production and additional processing facilities than for the FCEV case.

Biofuels are restricted from scaling up because of indirect land use changes, and many studies advocate deploying them only where no other alternative is feasible.

Illustration of a possible national eHighway network and how it could be gradually expanded[14]



[1] IEA https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

[2] https://www.railwaypro.com/wp/worldwide-rail-electrification-remains-at-high-volume/

[3] https://vbn.aau.dk/ws/files/411666417/846463_sEEnergies_D2.3_EE_potentials_transport_scenarios.pdf

[4] https://www.linkedin.com/posts/patrik-%C3%A5kerman-b572bb_wecandothis-ehighway-klimaschutzprogramm-activity- 6580833014073356288-zyhJ

[5] ENGIE SPL https://on24static.akamaized.net/event/23/34/93/3/rt/1/documents/resourceList1591710970699/ehighwaywebinar20052020159171096164 8.pdf

[6] We can provide a simplified sample calculation: Assume that 20 percent of the copper initially installed would be worn off after 10 years. This means that it'd take 50 years to consume the total amount of copper installed.

[7] NDTV https://www.ndtv.com/india-news/centre-trying-to-construct-e-highway-on-delhi-mumbai-expressway-minister-nitin-gadkari-2399233

[8] Source: https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions page 9

[9] ADAC https://www.adac.de/news/mangel-lkw-parkplaetze-autobahn/

[10] Daimler: https://www.daimler.com/sustainability/co2-neutral-commercial-vehicle-fleet-until-2039.html

[11] UC Davis, Alissa Kendall https://ncst.ucdavis.edu/events/webinar-importance-life-cycle-assessment-evaluating-environmental-performance- future

[12] Source: https://www.bloomberg.com/news/articles/2020-06-09/hyundai-s-hydrogen-chief-on-why-the-auto-giant-bet-on-fuel- cells?srnd=hyperdrive

[13] https://global.kawasaki.com/en/corp/newsroom/news/detail/?f=20191211_3487

[14] Source: https://www.ifeu.de/fileadmin/uploads/Roadmap-OH-Lkw-Bericht-Einfuehrungsszenarien-web.pdf

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