TDA Training Program on Transport Decarbonisation

Module 8

Renewable Energy for Transport

Deployment: Online / blended
Workload: 3 hrs
Extra learning: 2 hrs

Module working group:

- Pedro Faria Gomes - EDP (Leader)
- Pedro Filipe - Portugal
- Hans Verdonk - Rotterdam

Learning outcome

In this module, students should become aware that the electrification of mobility while decarbonizing electricity generation is the right way to go. Three main ideas should prevail:

1. Electrifying mobility is a more energy efficient solution, since electric vehicles (EV), particularly battery electric vehicles (BEV), are more efficient than internal combustion engine (ICE) ones;
2. Mature renewable energy sources for electricity generation are already competitive with fossil fuel ones; and
3. The total cost of ownership of EV is already close to parity with the one of ICE.

Therefore, it is expected that sales of BEV grow significantly in the coming years and that BEV charging companies strive to find renewable energy solutions in its procurement, as may be shown with cases studies. This module also addresses the main challenges to the promotion of electric mobility and the decarbonization of electricity generation.

Syllabus

Introduction

In order to become carbon neutral, the transport sector has to significantly decrease its CO_2 emissions by 2050. The Transport Decarbonisation Alliance's manifesto on Decarbonising Transport by 2050 presents an aspirational trajectory for well-to-wheel emissions (Figure 1).

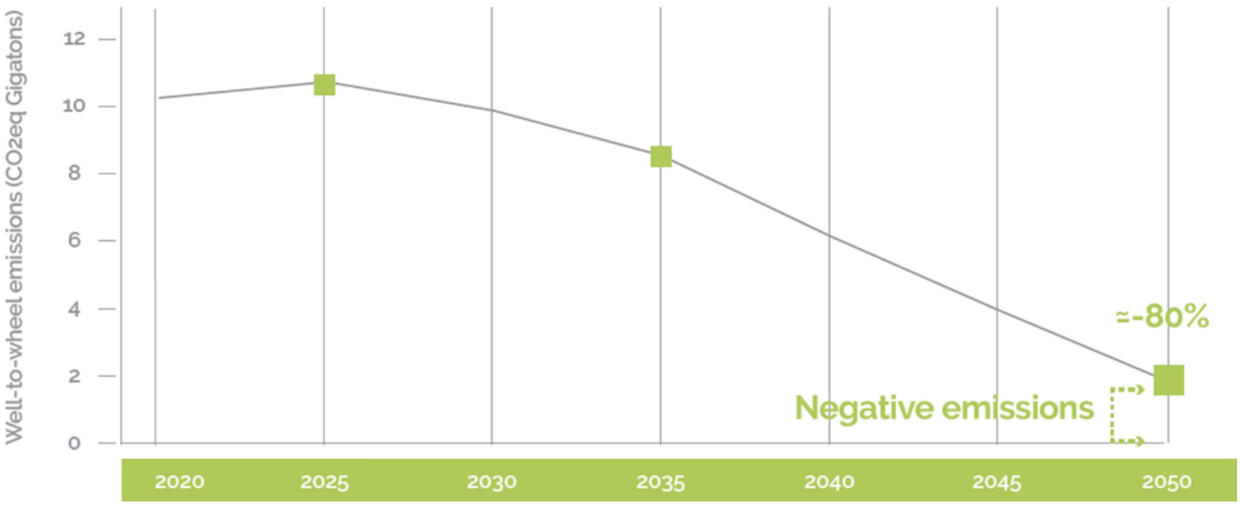

Figure 1. Aspirational track to reach net zero emission mobility by 2050 (TDA 2018)

The European Union has set ambitions targets emissions reduction. Total emissions must decrease by 40% in 2030 relative to 1990, which implies a reduction of more than 20% relative to 2016. In the transport sector, car manufacturers must keep decreasing the average emissions of their yearly sold new vehicles. These reductions range from 30% to 37.5%, depending on the type of vehicle, in 2030 relative to 2021. This ambition is also found in other geographies. As an example, California has set an emissions reduction target of 40% by 2030 vs. 1990 and China's emissions per GDP unit are to be reduced by 60%-65% by 2030 vs. 2005.

Electrifying consumption and decarbonizing electricity generation is the right way

Electrifying mobility allows for a more efficient use of energy. BEV convert 59%-62% of the energy charged into power at the wheels, while Internal Combustion Engine Vehicles (ICE) only convert 17%-21%[1]. Therefore, electrifying mobility reduces the use of energy by 3 to 4 times, and then, even if the production of electricity had the same amount of emissions per energy unit than the extraction, refinery and combustion of fuels, electrifying mobility would already be a means to decarbonize it. Moreover, since electricity production has a great decarbonizing potential, the electrification of mobility associated with the investment in Renewable Energy Sources for electricity production (RES-E) is a more efficient solution in terms of energy use and emissions than the use of ICE.

This association (BEV with RES-E), in addition, is the most cost-effective way to decarbonize mobility. On the electricity generation side, mature RES-E are already competitive with conventional energy production technologies. Figure 2 presents the Levelized Cost of Energy (LCOE) for different technologies (estimated by Lazard for the USA in 2018). This indicator provides the sum of all the costs in present value for each technology, divided by the expected generation during the project's lifetime. It could be interpreted as the fixed required revenue per energy unit produced for the project to be viable.

[1] US Department of Energy - https://www.fueleconomy.gov/feg/evtech.shtml

Figure 2 evidences many RES-E projects, especially solar PV and wind, have lower LCOE than conventional technologies ones, which means electricity can be produced at a lower cost using renewable energies.

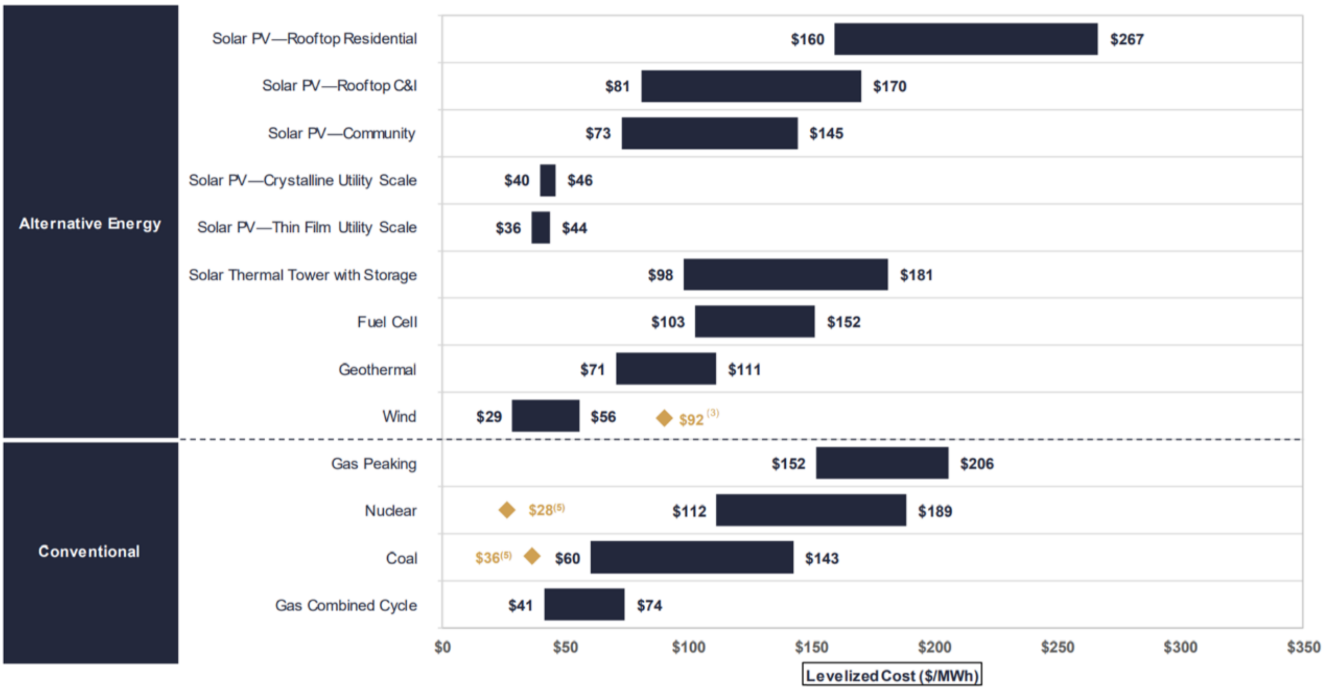

Figure 2. Levelized Cost of Energy comparison (Lazard 2018)

Provided RES-E is more cost effective than conventional generation, electrifying consumption is a good cost-effective way to decarbonize the economy if electric consumer appliances/equipment have a Total Cost of Ownership (TCO) equal or lower than non-electric ones. This is already true for most demand equipment, and BEV's TCO is in the right track to be in parity with the TCO of ICE, as shown in Figure 3.

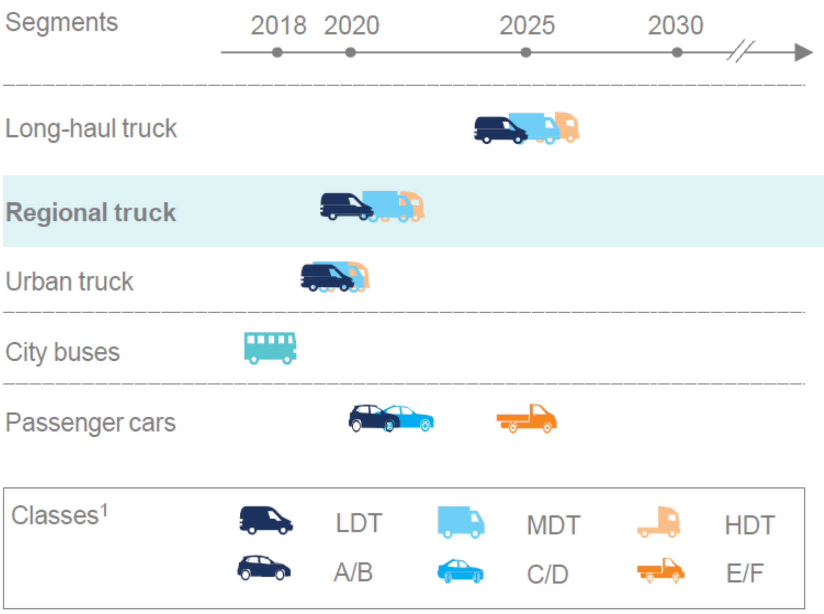

Figure 3. Timing of cost-parity of BEV with ICE based on TCO in the EU (McKinsey 2019)

Challenges to the electrification of mobility

With car manufacturers pressured to increase BEV sales and comply with CO_2 regulation standards, consumers will need assurance they can access charging seamlessly. For this to happen, the public BEV charging infrastructure needs to grow significantly. Most of the charging may be done at home nowadays, but a mass electrification of road transport implies the consumer has a chance to charge in a number of another places: offices, malls and many other venues and also the street. The current infrastructure is still not meeting these needs, as shown in Figure 4.

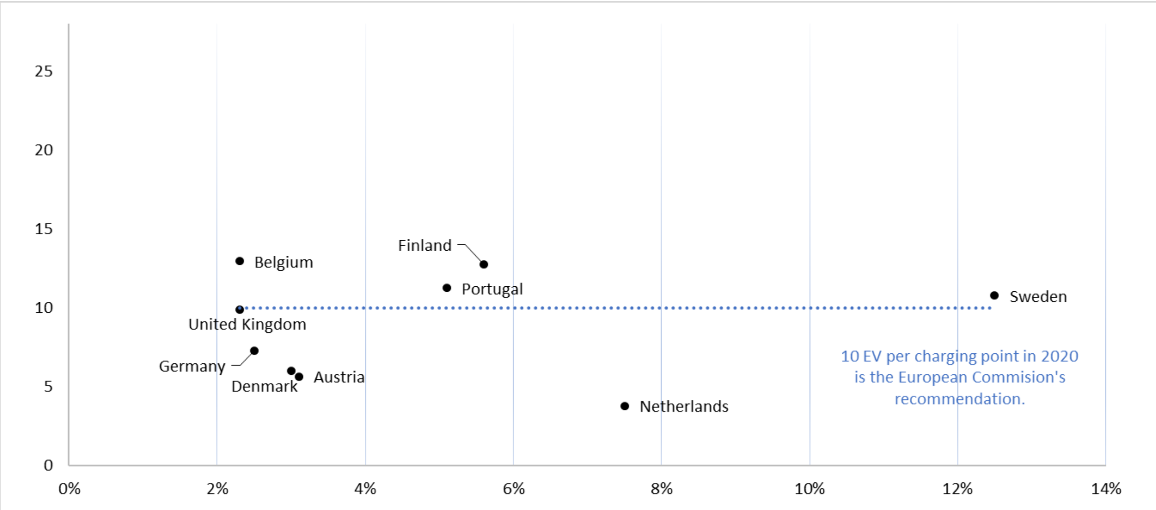

Figure 4. Number of BEV per publicly accessible charging point vs. BEV market share in new sales – 1Q2019 (EAFO)

A growing charging infrastructure will naturally pose challenges to the electric grid. If all the charging were to be done at the same time, the current grid would not have enough capacity to fulfil it. As this is a capacity problem, not an energy generation one, this challenge should be manageable with smart charging solutions.

Besides the lack of charging infrastructure, another challenge to the electrification of mobility is related with the electricity bill. In many places, as it is the case for European countries, the electricity bill is heavily taxed and charged with political costs (e.g., renewables over costs, security of supply, social policy related costs, among others). This gives the wrong price signal to consumers, since they will see electrification as more expensive than it should be, which detracts them from the most cost-effective path to decarbonize the economy.

For some transport modes, the use of batteries might imply challenges that make a fully decarbonization of mobility with BEV more difficult. The option for fuel cell electric vehicles (FCEV) and Plug in Hybrid Electric Vehicles (PHEV) might be economically sensible for cases like long haul road transport, in which batteries pose a problem due to autonomy, weight / energy ratio and reduction of transport capacity. One should still pay attention to the decarbonization of the production of hydrogen and look for solutions with RES that are cost effective.

Finally, the promotion of electric mobility also brings fiscal challenges, since there is a significant tax revenue attached to fossil fuels that governments will lose with electrification. Once more, it is important to discuss the right solutions for this problem. Transferring this tax burden to EV sales and charging would lead to the same distortion as the political costs on the electricity bill described above. Alternatively, one may think about switching from a fuel-based tax system to a mileage-based one.

Challenges to the promotion of renewables in the electricity mix

As shown above, mature RES-E are already more cost competitive than conventional technologies. However, this does not mean investors feel compelled to invest in RES-E, since there is sometimes an absence of confidence, they will recover their costs. RES-E such as solar or wind farms are capital-intensive technologies with very little or virtually no variable costs. If a RES-E project is to sell its energy in an energy-only market (a market that pays a price per unit of energy, set by the marginal cost of the most expensive unit producing at each time – marginalist market), two main problems arise: i) the investor is subject to the volatility and the evolution of price in a market in which he is usually a price taker, which increases risk hence its cost of capital and may eventually prevent him to recover all the costs and ii) RES-E projects tend to bring the price down in marginalist markets, which cannibalizes their revenues if these are based on a marginal price per energy unit.

To overcome these issues often referred to as the cannibalization effect of renewables, governments should promote mechanisms that stabilize revenues for RES-E investors (which could be market-based, like ex-ante auctions of long-term contracts), which also benefit consumers: with long-term visibility and stability of cash-flows, investors have access to capital at a lower cost, which ultimately benefits consumers through lower prices.

Case studies

Any case study that goes in the direction of electrifying mobility while decarbonizing electricity production may suitable for this module. For example, EVgo, the largest EV public fast charging network in the US, has announced it will procure Renewable Energy Certificates for the energy delivered at its growing network, therefore incentivizing the growth of RES and the electrification of mobility (https://electrek.co/2019/05/07/evgo-100-renewable-energy/).

Major references

TDA (2018) "Decarbonising Transport by 2050 - A TDA manifesto on how to reach net zero emission mobility through uniting Countries, Cities / Regions and Companies", http://tda-mobility.org/wp-content/uploads/2018/12/EY_TDA-Manifesto.pdf

European Commission (2019) Clean Energy Package

European Commission (2019) Clean Mobility Package

Lazard (2018) Levelized Cost of Energy Analysis – version 12.0

McKinsey (2019) Global Energy Perspective – Reference Case