Driving to a cleaner future

CHALLENGES AND OPPORTUNITIES IN DEVELOPING ELECTROMOBILITY IN EUROPE

Fortum Energy Review, October 2017

Foreword

Towards a cleaner world with electromobility

At Fortum, we believe that e-mobility can deliver a whole range of benefits, from cleaner air and less pollution to better energy usage. Electric vehicles (EVs) also support the market for renewable energy sources (RES), with car batteries offering new opportunities for grid-connected storage and bringing prosumers into the electricity market.

Improving the availability of charging infrastructure encourages consumers to uptake electric vehicles.

E-mobility is growing in the EU and its progress in Europe is expected to keep up with the global pace. A few key figures paint a clearer picture of the evolution of electric transportation:

According to BNEF, by 2040, 54% of new car sales and 33% of the global car fleet will be electric. Falling battery prices will bring price-competitive electric vehicles to all major light-duty vehicle segments before 2030, showing a dramatic shift towards electric transportation – and growth could take place at an even faster rate.[1]

Around 100,000 electric cars were sold in Europe last year, compared to 150,000 in the US, based on industry estimates. However, carmakers in Europe will be compelled to increase marketing of electric vehicles in order to meet the stricter rules with regard to emissions that will come into force in 2021. Several automakers, from Volkswagen to Aston Martin, have predicted that by 2025, a quarter of all the vehicles they produce will be electric. Volvo has gone as far as announcing that all of their new car models will feature electric motors by 2019.

The needed charging infrastructure must be in place before all these EVs hit the roads. At the moment, the limited availability of charging infrastructure – partly due to a lack of adequate business and financing models – is considered one of the biggest obstacles to the widespread adoption of EVs. Drivers still suffer from so-called range anxiety. It's a classic chicken-and-egg problem.

With this Energy Review, Fortum aims to contribute to the discussion on the development of electromobility, addressing both challenges and opportunities. In it, we share our insights, present case studies, and pinpoint key aspects that should be

[1] Bloomberg New Energy Finance, Electric Vehicle Outlook 2017.

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improved to enable the swift uptake of EVs and consequently facilitate the decarbonisation of the transport sector.

We hope readers find this review interesting and informative. Furthermore, we hope that it encourages active dialogue among our customers, car manufacturers, energy companies, service providers, and authorities, thereby helping stimulate progress for a cleaner world.

Fortum Corporation

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Fortum's views on electromobility

EV uptake is proceeding faster than expected

Fortum believes that the electrification of transport will take off rapidly. This trend, which can be viewed as disrupting the mobility sector, is developing at a much faster pace than anticipated, and is certain to impact the movement of people and goods. For example, car sharing will continue to grow in popularity, changing the paradigm of car ownership as we know it today. Autonomous driving and ride-hailing services such as Uber will fundamentally alter the way people move from one place to another. The commercial use of electric ferries, ships, and lorries will soon emerge. Fortum is playing a role in this revolution by providing customers with smart and innovative charging solutions that are facilitating the transformation of the Nordic energy system.

EVs will play a key role in the future energy system

As solar and wind energy production increases, energy storage and load balancing will begin to play a part in our everyday lives. We believe that car batteries should be allowed to contribute to these inevitable developments. Home charging, public charging, solar-to-vehicle, vehicle-to-grid (V2G), and other services related to EVs are important ways to meet the demand for smart homes, energy storage, and grid balancing. However, a number of regulatory issues still require considerable clarification. For example, matters surrounding frameworks for self-consumers of electricity, free choice and interoperability between different charging service providers, and flexible consumption enabled by electricity suppliers should be better defined. Doing this will require well-planned and effectively implemented legislation both on the EU and national levels.

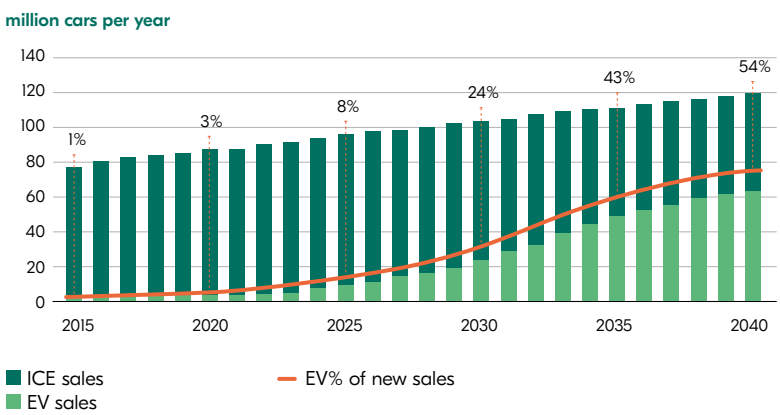
Range anxiety — the fear of running out of power before reaching one's destination or another charging station.

EVs will certainly have an impact on electricity consumption. However, it is likely to be only a moderate one, according to the New Energy Outlook by Bloomberg New Energy Finance (BNEF), which predicts that only 5% of global electricity demand will come from EVs in 2040.[2] This modest increase can be explained by the simultaneous growth in demand that is expected in the commercial, residential and industrial sectors.

In the present chicken-and-egg situation, the question generally comes to this – are there too few EVs on the roads to justify investing in charging infrastructure, or is charging infrastructure inadequate to justify investing in EVs?

One of the largest obstacles to greater EV adoption, apart from the current cost of EVs, is the lack of publicly available charging infrastructure. Subsidies may be needed to kick-start the development and deployment of broad charging networks, and

Annual global light-duty vehicle sales



Source: Bloomberg New Energy Finance, 2017.

[2] Bloomberg New Energy Finance. New Energy Outlook 2017.

incentives will likely be used to speed up EV adoption by private individuals in most countries. Nevertheless, Fortum believes that the rising number of electric cars worldwide will consequently create a demand for commercial charging services.

The current lack of sufficient infrastructure is cited as the most common reason for range anxiety, creating a purchasing barrier that is affecting potential EV sales. At the same time, it is difficult for operators to invest in charging infrastructure without an existing demand for charging services. In this situation, state intervention may be necessary to break the impasse and allow swifter development.

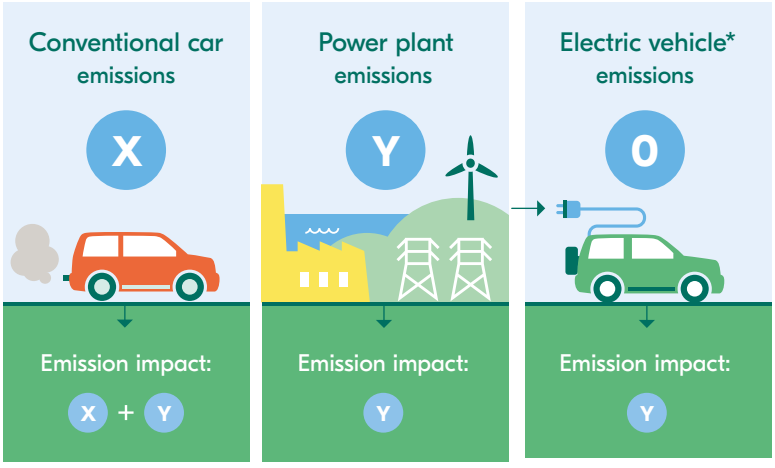
Effective regulation can support the uptake of electromobility

We believe that further intra-regional harmonisation – from the standardisation of plugs and sockets to overall system interoperability and the enabling of roaming – would support the uptake of electromobility in Europe.

The overall objective should be to make EV charging as easy as filling up the tank of a petrol or diesel-fuelled car. It is also highly important that EV charging be considered a commercial business activity, and not a part of the regulated electricity infrastructure sector.

Policy makers should ensure that post-2020 emission standards further encourage the development and uptake of low-emitting vehicles. Such policies would promote EVs, especially in the EU, where the emissions trading system (ETS) sets the cap for emissions, including those from electricity generation. Hence, moving emissions from the transport sector into the ETS would mean that EV emissions would not increase, regardless of the fuel and technology used for electricity generation.

Transferring emissions from transport to the electricity sector



*Assuming that electricity is produced in the EU under the ETS

Digital solutions for smart charging networks

SaaS solutions for EV charging

SaaS stands for Software as a Service. SaaS services for electric vehicle charging enable Charge Point Operators (CPOs) to remotely manage smart charging networks that are composed of hardware from multiple vendors. They help maintain system stability, prevent vendor lock-in, and allow additional supplementary services to be developed and integrated into the software platform.

The EV charging value chain

Grasping the role that SaaS services play in the EV charging business requires an overall understanding of the players in the value chain: Namely, who will purchase the charger? Who owns the land that the charger is located on? Who supplies the electricity to the charger? Who will operate it – or more specifically, who will make sure that it is functioning properly, handle customer service, and set pricing? Who will take care of maintenance? These roles would be fulfilled by players in the value chain of an electric vehicle charging station.

Operating a network

Running a charging network involves selecting the right hardware for the station, installing it, operating it, as well as maintaining it, and making necessary updates. Chargers are often offered with their own back-end software, which is used to operate the charging business system; as well as firmware, which steers the charger internally. The software that comes with the charger is typically not compatible with other devices, which means that the operator would need to purchase all their hardware from the same manufacturer if they wished to expand their network. This situation is referred to as vendor lock-in.

In addition, factory software rarely includes payment functionalities. So in order to operate a charging network with more than one hardware supplier, and to enable end-user payment for charging, an SaaS solution will be necessary.

SaaS services for EV charging enable remote management of smart charging networks.

Charge & Drive cloud-based SaaS solution

Fortum Charge & Drive's SaaS solution is a cloud-based business software used to administer charging networks. It is bundled with end-user software, including mobile applications, and an online portal for registered users. Fortum Charge & Drive's SaaS service was originally developed as part of Fortum's charging operations in the Nordics, and has been commercialised as a white-label service after its development and use in Norway, the world's only EV mass-market.

The features in Charge & Drive's SaaS service have been developed based on practical experience of consumers' needs and behaviour. Fortum's knowledge of grid infrastructure and management makes Charge & Drive's SaaS service unique, as it also takes grid development with regard to load peaks, balancing, and smart home consumer services into consideration.

For more information, visit: www.chargedrive.com.


Cloud-based
solution

Charging an electric vehicle

Glossary of basic EV terms

BEV = Battery Electric Vehicle
CPO = Charge Point Operator
EV = Electric Vehicle
EVSE = Electric Vehicle Supply Equipment
ICE = Internal Combustion Engine
PHEV = Plug-in Hybrid Electric Vehicle

Range anxiety is a term used to describe drivers' fear of running out of power before reaching their destination or another charging station, and is frequently cited as one of the purchase barriers working against electric vehicles' favour. Continued investments in charging network infrastructure will help ease range anxiety by reassuring drivers that they will be able to make it to their destinations and back.

Home charging

Home charging is currently the bread and butter of EV charging. Compared to destination charging, it is generally cheaper – or better for the wallet; as well as slower – or better for the battery. Home charging is the obvious alternative for private homes, garages, and housing estates with dedicated parking spaces.

Destination charging

Destination charging is the term used to describe charging stations away from home. These are typically located at shops, malls, hotels, park-and-ride parking lots, service stations, and restaurants at destinations. Destination chargers tend to be quick chargers or semi-fast ones, depending on the location.

Quick chargers (50kW) can fill a battery from zero to 80% in approximately 30 minutes, and are necessary when travelling greater distances, particularly, along highways; or for businesses such as taxis and postal delivery services. Semi-fast or flexible chargers (up to 22kW) take approximately three to four hours to charge a battery to 80%, and are frequently found around shopping centres, office parking lots, and street-side.

Urban charging

The locations of EV charging stations in urban environments are typically chosen to make charging part of another activity or service at a destination such as a shopping centre, cinema, office or park-and-ride parking lot. The speed of the charger installed is influenced by the amount of time the driver is expected to spend at the destination. The location can also offer chargers with different speeds, so that the driver can select the charging speed most appropriate for the duration of their stay.

We at Fortum believe that the challenges of urban charging as well as range anxiety will be better met as charging speeds and battery capacities increase, leading to faster charging sessions and longer distances on a single charge; as well as with the expansion of charging infrastructure to more densely populated areas and along highways. It is reasonable to assume that once drivers use EVs on a regular basis, their range anxiety would decrease to the same level as they might experience in petrol cars.

Which comes first: Charging infrastructure or EVs?

Designing the EV market

To gain a general understanding of the change that is taking place in the mobility industry as a whole, it is helpful to examine the factors that influence the availability and accessibility of electric vehicles. Three major stakeholders influence the development of EVs, and each one is dependent on the others. These are automobile manufacturers, battery manufacturers, and charging infrastructure providers.

Towards widespread charging infrastructure

The availability of charging infrastructure is integral to increasing the penetration of EVs in each market. To quote the Global EV Outlook 2017 released by the International Energy Agency (IEA), "the need to minimise deployment costs suggests that the deployment of charging infrastructure should be tailored to the evolution of electric car stock growth."

The roll-out of charge point infrastructure presents great prospects. Fortum and a number of other actors are already building networks today, and many companies are competing to win. Among them are not only utility companies with expertise in providing electricity and managing networks, but also numerous other players. Capital goods industry players and car manufacturers are also looking into developing infrastructure for charging points. A whole new segment is growing to supply EV owners with opportunities to charge.

Several players building networks

The US electric car charging company ChargePoint, Inc., entered the European market in March 2017 with an 89 MEUR investment led by Daimler. ChargePoint owns a network of more than 33,000 charging stations across the US.

Volkswagen, Daimler, BMW, and Ford had announced a consortium to build about 400 next-generation charging stations, with a longer-term ambition of having thousands of stations available to electric car drivers across Europe by the end of the decade.

Moreover, a new strategic partnership between international energy company E.ON and Denmark based e-mobility service provider CLEVER has been established with the ambition of rolling out ultra-fast charging stations for EVs along main European motorway corridors. Remarkably, while the infrastructure is developing rapidly, the perceived lack of it still remains a major barrier to widespread EV adoption.

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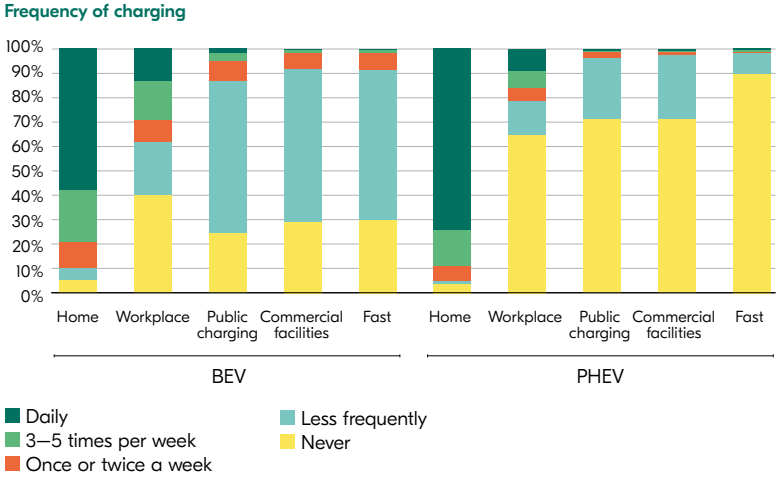
Charging habits for a sample of Norwegian electric car users, 2016



Source: IEA elaboration based on results from Figenbaum and Kolbenstvedt (2016).

Also, despite this boom in infrastructure development, there is still a vastly larger number of EVs in proportion to publicly available charging stations, which suggests that most EV drivers rely primarily on private charging points. This is consistent with the trends that Fortum has observed in consumer EV charging.

Batteries

The single most expensive part of an EV is its battery, which defines the car's driving range and charging possibilities. However, in recent years, the cost of the lithium-ion battery has been in a freefall. According to McKinsey, the cost of battery packs fell from USD 1,000/kWh in 2010 to USD 227/kWh in 2016. Furthermore, their projections estimate that prices will continue to drop below USD 190/kWh by 2020, and to less than USD 100/kWh by 2030.[3] Similarly, BNEF predicts that lithium-ion battery prices will plummet by 70% between 2020 and 2030.[4]

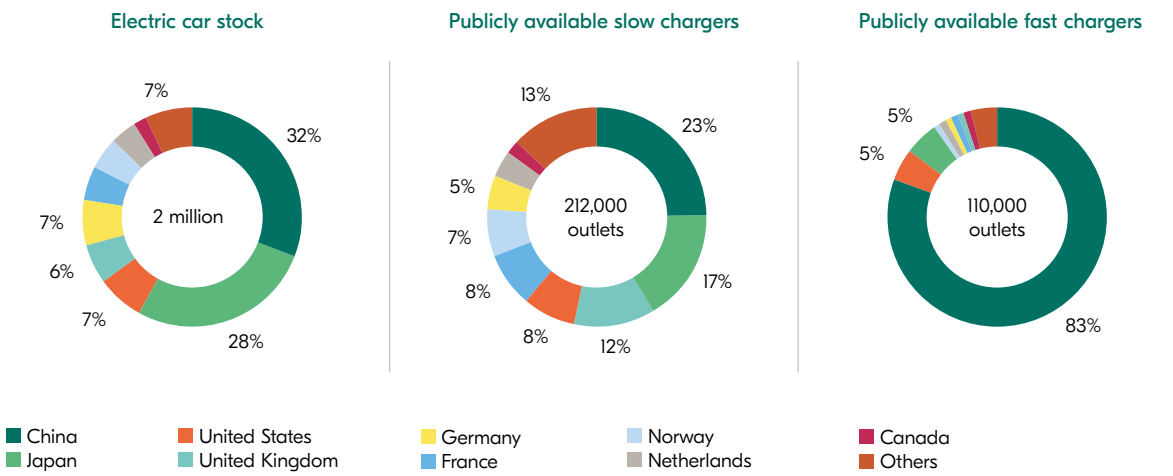
This dramatic decrease in battery costs has made producing mass-market EVs a possibility for automobile manufacturers. Consequently, there has been a deluge of announcements from automakers stating plans to release new long-range EV models within the next few years.

Automobile manufacturers

Volkswagen recently announced the target that 25% of its total sales will come from EVs by 2025, and Toyota Motor Corp. has proclaimed its intention to phase out fossil-fuelled vehicles altogether by 2050. Porsche revealed plans for 50% of its production to be electric within six years, while Volvo stepped up the game by stating that all of its new models will have electric motors beginning 2019. Every major auto manufacturer has revealed plans to produce electric vehicles, and with the EV boom particularly intense in China, due in part to the need to combat urban smog, the wide-scale adoption of EVs worldwide is an inevitability.

The previously mentioned report by BNEF states that the current purchase cost of a battery electric vehicle (BEV) without subsidies is approximately 45% greater than that of an equivalent internal combustion engine (ICE) vehicle, whereas plug-in hybrids (PHEVs) are at least 20% more expensive. Cost parity between ICE vehicles and EVs, without incentives or subsides, is forecast be achieved by 2025.[5]

Electric car stock and publicly available EVSE outlets, by country and type of charger, 2016



Source: IEA analysis based on EVI country submissions, complemented by EAFO (2017a).

[3] McKinsey&Company. Electrifying insights: How automakers can drive electrified vehicle sales and profitability.

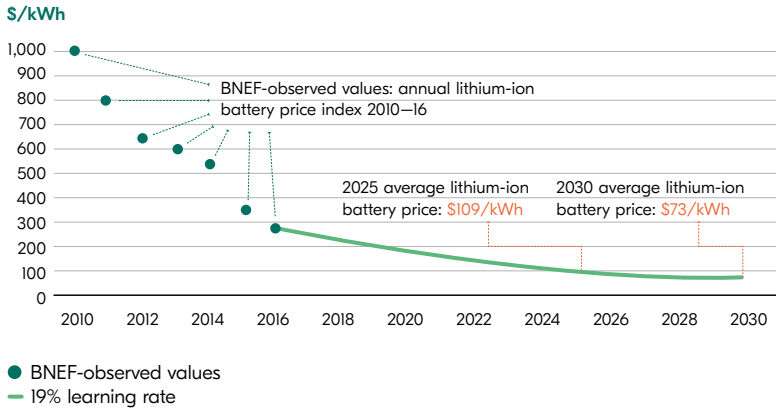
[4,5] Bloomberg New Energy Finance. Electric Vehicle Outlook 2017.

Responding to the increasing consumer demand for electric vehicles, automobile manufacturers are launching a staggering number of new models. More than 80 new EV models, both BEV and PHEV, will be brought to market between 2017 and 2020. The forecast for EV adoption is 20% by 2030, and 25% by 2040. Incentives such as the ones seen in Norway, which include the lowering or waiving of purchase tax, free parking, access to bus lanes, and exemptions from road tolls, are likely to lower the comparative cost of EVs versus ICE vehicles, and as a result, increase the overall rate of adoption.

The automobile industry is reshaping itself towards the electrification and digitalisation of transport, and these changes will have dramatic implications. With the widespread adoption of electric vehicles, automobile manufacturers will be able to take on a more significant role in offering new types of mobility services for consumers, such as car-sharing, ride-hailing, and autonomous driving. In addition, the relationships between battery, computer, and automobile manufacturers will grow much closer.

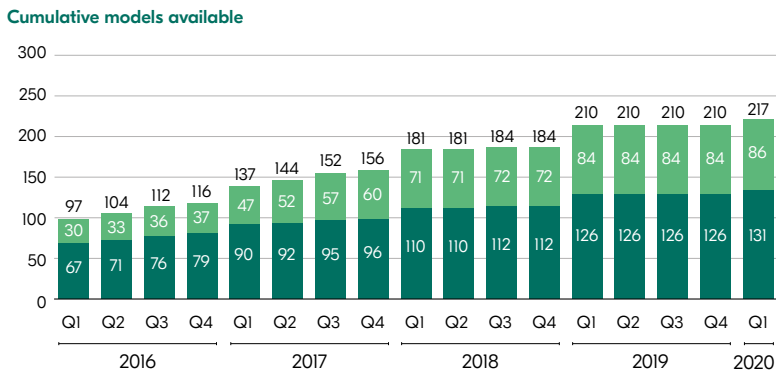
The demand for fossil fuels will decline as the number of EVs on the road increases, with BNEF forecasting that by 2040, EVs will displace 8 million barrels of transportation fuel per day.[6] Mobility and transport are experiencing a paradigm shift with far-reaching implications in manufacturing, innovation, and sustainability.

Lithium-ion battery prices, historical and forecast



Source: BNEF Electric Vehicle Outlook 2017.

Number of available BEV and PHEV models globally



Source: Bloomberg New Energy Finance.

Note: Based on stated model launch targets from automakers.

[6] Bloomberg New Energy Finance. Electric Vehicle Outlook 2017.

The era of electromobility

Contributed by Lisa Wolf, Advisor at EURELECTRIC

2017 is set to be a decisive year for electromobility. Many are asking, are we finally getting there?

The developments in automobile manufacturing match well with the latest projections published by Bloomberg New Energy Finance, which suggest that 33% of the global car fleet will have an electric motor by 2040; this against the background of an expected growth of the global car fleet between 60-100% between now and 2040[7]. The Grantham Institute at Imperial College London even thinks that up to 52% of cars and vans globally could be electric by the same date.[8]

While this does sound very promising, there are several reasons to expect that it will not be enough, at least not if Europe is serious about its commitments to the Paris Agreement. The EU's commitments imply a reduction in EU greenhouse gas emissions of around 80–95% by 2050 compared to 1990 levels.[9] The current official pledge for transport decarbonisation is a reduction of 60% by 2050 compared to 1990, which will simply not be adequate to reach the overall GHG reduction target. The pressure to reduce emissions from road transport is even higher, as the maritime sector is only projected to reduce emissions by 40% in comparison to 2005, and doubts remain whether aviation will have more success in reducing its climate impact. Currently, transport emissions in the EU are 20% higher than they were in 1990, and with the region's transportation needs expected to grow by around 50% from 2010 to 2050, a serious and concerted effort is needed to deliver profound emissions reductions in the sector.[10]

This is the backdrop against which current EU legislation must be defined. EU legislators have recognised that the electrification of transport will be a key measure to meet the EU's decarbonisation objectives. Electric motors are around four times more energy efficient than internal combustion motors, and thus will play an important role in reducing total EU energy demand, and also help in meeting EU energy efficiency targets.

When the European Commission published its "Clean Energy for All Europeans Package" at the end of 2016, it included an important measure to pre-equip buildings with infrastructure necessary for electric vehicle charging in the revision of the Energy Performance of Buildings Directive. This is aimed at minimising the cost of the later installation of charging points, and helping to combat range anxiety.

This initiative complements the 2014 Alternative Fuels Infrastructure Directive, which obliges EU Member States to offer a minimum amount of publicly available charging or refuelling infrastructure for alternative, low-carbon fuels. The Commission is currently assessing the transposition and implementation of the Directive by Member States and will publish its report in November 2017.

Another initiative under the same legislative package is a proposal to oblige fuel suppliers to include a share of renewable energy in their transport fuels. With an ever-growing share of renewable electricity in the EU electricity mix, this is intended to be an additional support for electrification.

In May 2016, as part of its "Europe on the Move" Package, the Commission put forward a proposal for a revised Eurovignette Directive, which sets out rules on how Member States can charge road vehicles for the use of infrastructure. Here, the Commission introduces a measure clearly in line with the "polluter pays" principle, where vehicles with the highest CO_2 emissions are obliged to pay more. On the other hand, zero emission vehicles, such as battery electric or fuel cell

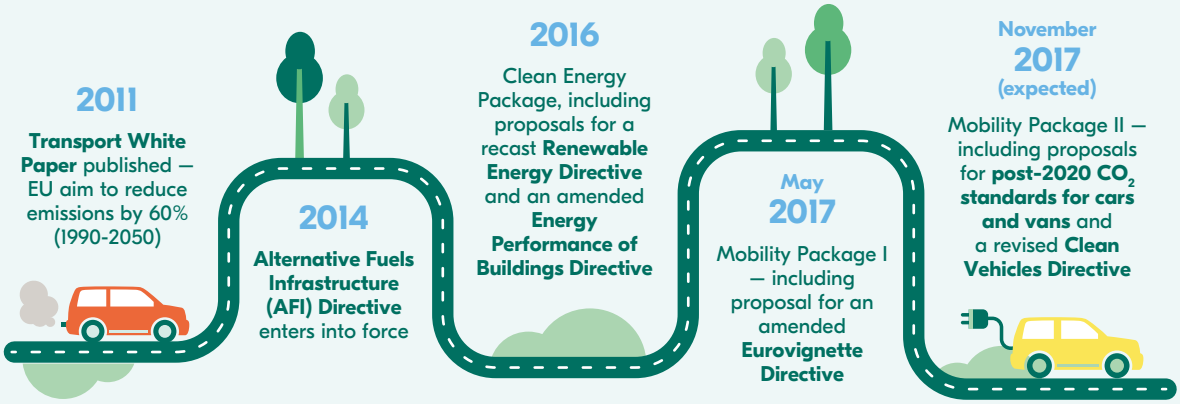
[7] BP expects the global car fleet to roughly double between 2015 and 2035, while BNEF expects the number of cars to increase by around 60% between 2015-2040.

[8] Carbon Tracker and The Grantham Institute at Imperial College London. Expect the unexpected: The disruptive power of low-carbon technology.

[9] European Commission 2050 Energy strategy. Http://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2050-energy-strategy.

[10] European Commission, Reducing emissions from transport, A European Strategy for low-emission mobility. Https://ec.europa.eu/clima/policies/transport_en.

EU transport legislation



The Commission has proposed the introduction of a measure in line with the "polluter pays" principle.

vehicles, would be granted discounts on road tolls. Such a measure would be especially important for commercial vehicles, which are utilised much more heavily than private ones, and whose owners are generally more sensitive to operational costs. The current Directive is limited to trucks only, but the Commission proposes extending its scope to passenger cars, buses, and vans.

Further legislative proposals are expected in November this year, including the revision of the Clean Vehicles Directive which sets out rules on how public authorities should consider the environmental performance of the vehicles they procure. The focus of this Directive is mainly on buses, as these are to a large extent procured by public authorities, in contrast to passenger cars, which are mostly bought by private customers. This proposal will be accompanied by revisions of current EU regulations on CO_2 emission standards for new passenger cars and vans. These are generally regarded as the most effective measure for driving decarbonisation, and ultimately, the electrification of transport, and therefore should be set with a view to achieving road transport decarbonisation by 2050.

As both the environmental and climate performance of electric vehicles are significantly superior to those of internal combustion engine vehicles, these initiatives, together with the recently adopted national air quality targets in the National Emission Ceilings Directive, are expected to support the electrification of transport.

As all these measures will now face the test of being subjected to the respective legislative processes in the Council and the European Parliament, we may expect many of them to change significantly, also in terms of their ambition levels. So while battery prices for electric vehicles continue to fall, and as some analysts assert that all new cars across the continent will be battery electric as early as 2035, the question remains: Will the clean energy transition in the transport sector happen quickly enough to meet our decarbonisation objectives?

The environmental factor — a greener green

There is intense and ongoing debate about whether electric cars are more environmentally friendly than their fossil-fuelled cousins, specifically when taking into account their entire lifespans, from cradle to grave.

One typical question is whether or not the electricity produced to power electric cars is environmentally friendly. In the EU, the ETS sets a cap for the emissions covered by the scheme, including electricity generation. When EVs are used instead of ICE vehicles, the emissions are transferred from the non-ETS transport sector into the ETS. In practice, this would mean that if all conventional cars were to be transformed into EVs, vehicle emissions in the transport sector would decrease to zero. Regardless of the technology or fuels used for electricity generation, emissions from the ETS sector would not increase, as they are capped.

In comparing EVs and ICEs, a study from 2013 shows that the total greenhouse gas emissions from the production of electric cars is somewhat higher than for conventional cars.[11] This was mainly due to battery production, and since the time the study was published, significant advances have been made in manufacturing batteries in a more environmentally sustainable and efficient manner. Although electric cars may be less environmentally friendly to produce, the overall calculation is decidedly in favour of EVs when considering total environmental impact. Moreover, EVs get greener and greener the longer one drives them.

[11] Comparative Environmental Life Cycle Assessment of Conventional and Electric Vehicles. Http://onlinelibrary.wiley.com/doi/10.1111/j.1530-9290.2012.00532.x/full

Case study: From early adoption to mass market uptake in Norway

Fortum Charge & Drive has been present in Norway since 2011, and is today a market leader with approximately 1,000 charging stations all over the country, of which about 400 are quick chargers. We had 67,000 unique users in the Fortum Charge & Drive network last year. Our pricing model in Norway is based on charging time in minutes, with a higher cost for quick charging and a lower cost for semi-fast charging.

Norway is the global flagship in terms of e-mobility and EVs. Of all passenger cars in the country, 4.4% were already fully electric by the end of July 2017, and when plug-in hybrids are included, the number is even higher. This share is only continuing to grow. According to the Norwegian interest group Opplysningsrådet for Veitrafikken (OFV), in June 2017, EV sales in the country surpassed all records when 27.7% of all new cars sold were electric. When plug-in hybrids are also taken into account, the share of chargeables exceeded 42%.

Government incentives have proven to be instrumental, as found by research done in 2016 by Enova SF, the Norwegian government body that promotes environmentally friendly energy production and consumption; and SINTEF, Scandinavia's largest independent research organisation. Their study showed that exemptions from purchasing taxes and vehicle taxes were the biggest factors influencing people's decision making when purchasing EVs. Of the 3,400 respondents, 83% claim that the absence of purchase tax was crucial in their choice.[12]

Apart from government incentives, other factors have contributed to the success of EVs in the market. First of all, Norwegian electricity prices are relatively low, ensuring a low fuel cost for EVs. Secondly, private and public investment in charging infrastructure has also been very important. Fortum is one of the companies that has invested in charging infrastructure in Norway, together with partners like Nissan, Renault, BMW, VW, McDonald's, IKEA and Shell (St1), to name a few.

Through Enova's funding programs, government has also partially funded the building of charging infrastructure along highways to connect the cities of Norway.

Norway's long-held status as the so-called EV Capital of the World, with the highest number of EVs per capita globally, is largely a result of long-term political commitment and diverse incentives, which have created consumer confidence and led to widespread EV adoption. As the market develops further, consumers expect more intuitive applications, such as maps and payment alternatives, additional services at charging stations, and more stable chargers.

Incentives for EV owners in Norway[12]

- No purchase tax or import tax, where cars are normally heavily taxed
- Exemption from 25% VAT on purchase
- Exemption from 25% VAT on leasing
- Low annual road tax (from €315 to €52)
- 50% reduction in company car tax
- No charges on toll roads or ferries**
- Free municipal parking**
- Access to bus lane.**

For more information, visit: www.chargedrive.com.

[12] Incentives for promoting Battery Electric Vehicle (BEV) adoption in Norway. Http://www.sciencedirect.com/science/article/pii/S1361920915002126.

**These are generally governed by the local municipalities, and may vary from case to case. Some municipalities charge fees while others waive them.

Sources: Incentives: https://elbil.no/english/norwegian-ev-policy/, Statistics on sales: Data from Opplysningsrådet for Veitrafikken in Norway.

Case study: High-power charging

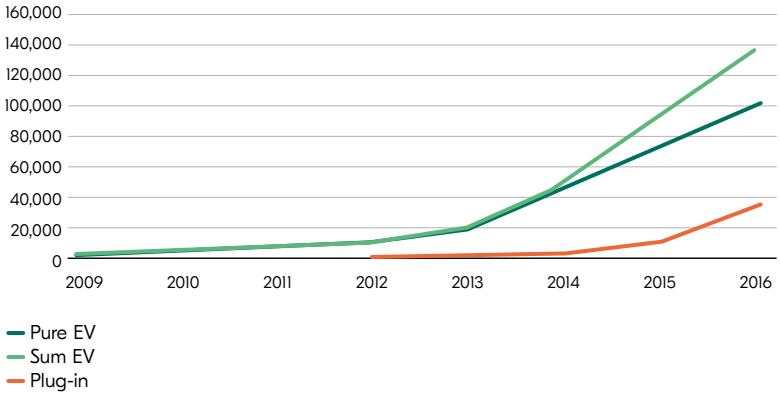
Fortum Charge & Drive will build the first High-Power Charging (HPC) corridor between Oslo, Stockholm, and Helsinki. The corridor provides charging possibilities for the upcoming long range (over 300 km) EV models with higher charging speeds. This means that EV models that are expected to be on the market by early 2018 will be able to drive from Helsinki to Oslo in the same amount of time as conventional cars. This is the first step in establishing a Nordic network that will enable drivers to take full advantage of the new generation of electric vehicles and make long-distance travel a reality.

Construction work at the site in Norway and the two sites in Sweden will be conducted during autumn 2017, and the final installation is planned for the last quarter of the year. Work on the Finnish site is planned to follow those of the sites in Norway and Sweden.

The high-power charging stations will be able to generate 150-350 kW of power and will be equipped to serve all major car models. A network of 1,500 chargers in 16 European countries are operating on Fortum's platform.

For more information, visit: www.chargedrive.com.

EV ownership in Norway



Source: Elbilforeningen, Norwegian EV Association.

Facts about EVs

Not all EVs have the same charging connectors. It is important to check which connector or adaptor is required for quick charging on longer distances.

The current manufacturing emissions of an EV are higher than a comparable internal combustion engine (ICE) car. Lifetime emissions of EV vs ICE are much smaller, with the EV becoming greener and the ICE emitting more the longer they are driven.

Electric vehicles can be BEV (pure electric), PHEV (plug-in hybrid), and hybrid cars. A prospective buyer should evaluate their actual needs before deciding whether an electric vehicle is right for them.

Roughly 40% of the current manufacturing cost of an EV is related to its battery.

For cost efficiency and improved battery life, EVs should preferably be charged at home (slow AC charging). Quick charging (DC) is ideal when it is occasionally required.

Paying for public charging is typically possible by, e.g. RFID, SMS, or mobile app. Costs are typically per minute, or per kWh.

At rapid chargers, it is better for the battery as well as more cost-effective to only charge enough to get to the next destination.

As with any emerging technology, various incentives would help stimulate a more widespread take-up of EVs.

It currently takes about 30 minutes to charge an EV from 0-80% at a quick charger.

The overall lifetime cost of an EV is influenced by possible purchase subsidies (e.g. VAT), use incentives (parking, tolls, etc.), and use costs.

The future is here today

CO_2 from fossil fuel and industrial processes represent 65% of global greenhouse gas emissions. Of these fossil-fuel based emissions, transportation and the transport sector – including burning fossil fuels for cars, trucks, ships, trains, and airplanes – make up roughly 30%. As the political commitment to cut emissions strengthens, there is sometimes a cynical attitude towards the costly subsidies and incentives in place to encourage the replacement of ageing fleets with more environmentally friendly options. Sceptics insist that electric vehicles will remain a city phenomenon, unlikely to proliferate into rural areas, and that subsidies would ultimately be insufficient.

But electric car drivers now have compelling evidence to dispute these claims. They can cite the real-world case study of Norway, which has introduced a subsidy system that works and provides clear environmental benefits, and point to research from MIT which shows that the range of existing EVs on the market is sufficient for 90% of drivers' needs in the US, and that the uptake of EVs in rural areas is similar to that of densely populated urban centres.[13]

The Norwegian example proves that incentives can be very effective in terms of environmental impact as well as consumer behavior.

We have already witnessed EVs becoming a technological status symbol, and consumers voting with their hearts and acting with their wallets. Once EV prices are on par or cheaper than combustion engine alternatives, consumers will be more likely to favour EVs because of overall savings in lifetime costs – and this decision will be reinforced by environmental and smart technology benefits.

[13] Nature Energy, Potential for widespread electrification of personal vehicle travel in the United States. Https://www.nature.com/articles/nenergy2016112.

Elements needed to support electromobility development in the EU

- The EU-wide standardisation of electromobility systems should aim to make charging an EV as easy as fuelling a conventional car's tank.
- EU-wide and national policies should incentivise and stimulate the deployment of EVs for both private and public transport, and support the construction of charging infrastructure. Public investments in charging infrastructure should target high-power charging.
- Policies and instruments that aim to accelerate EV market development should be coordinated in order to maximise their effect. At the same time, the duplication of incentives, such as purchase tax exemptions, one-off grants, increasing taxes on fossil fuel use and lowering or diminishing the registration taxes or import taxes should be avoided.
- Post-2020 fuel policies should take into account that electricity used for powering EVs is already covered by the ETS emission cap. Hence, EVs deliver a positive impact on the environment in any case, as all-electric vehicles produce zero direct emissions, helping to improve air quality especially in urban areas.
- Post-2020 vehicle emission standards should continue to set ambitious emission targets.
- Frameworks for self-consumers of electricity should be clarified, and the choice between different charging service providers enabled and promoted. Charging ought to be defined as a commercial service, and not part of traditional, regulated electricity distribution.
- The Alternative Fuels Infrastructure (AFI) Directive should be implemented in a coordinated and meaningful way in all Member States, with a focus on common standards as well as on the promotion of the uptake of high-power charging.
- Electric vehicles with smart charging solutions will play an important role in the future power system by providing balancing services. To support this, various regulatory aspects must be clarified, such as the roles and responsibilities relating to energy storage and taxation of storage.

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The energy sector is in the midst of a transition. Megatrends such as climate change, emerging technologies, changes in consumer behaviour, and questions regarding resource efficiency have a major influence on the global energy sector. Fortum intends to participate actively and offer solutions in this evolving market.

It is our wish to engage our stakeholders in a dialogue about the future. The Fortum Energy Review series highlights the challenges and opportunities we see in the energy sector and outlines our solutions to them.

Fostering electromobility – Fortum's key messages

- Electric vehicles (EVs), along with smart charging solutions, will play an important role in the power system of the future by serving as a balancing mechanism. Electromobility should therefore be treated as a bridge between the energy, building, ICT and transport sectors.
- As for any emerging technology, providing incentives for EV owners as well as for charging infrastructure would be well justified. Finding efficient means to incentivise citizens to purchase EVs has proven difficult, and thus deserves greater attention.
- Well-designed incentives are needed in both EU and national policies in order to stimulate the deployment of EVs for private and public transport. The European Commission should actively participate in efforts to finance cross-border projects.
- EVs shift emissions from non-ETS sectors into the ETS sector. This means that EV take-up does not increase overall emissions, as EVs do not produce direct emissions.
- Post-2020 vehicle emission standards should continue to set ambitious targets for all vehicles.
- EV charging ought to be defined as a commercial service, and not as electricity sales or as part of regulated electricity distribution.
- The Alternative Fuels Infrastructure (AFI) Directive should be implemented in a coordinated and meaningful way in all Member States.