



24.1 Major Developments in 2017

- In 2017 EV taxation was reduced to revitalize the EV market by extending the 20 % registration tax break until the end of 2018 or until 5,000 additional sales.
- However, EV sales in 2017 is still at the low level since the introduction of the EV vehicle registration tax in 2016 and the ending of the EV support programmes. Sales in early 2018 show an upward trend.
- 2017 was a new record year with 43.4 % of Denmark's electricity consumption supplied by wind power. Renewable energy production from wind power has more than doubled since 2008. At least 50 % will be covered by renewable energy by 2030 as new offshore wind farms are developed. Thus electric transport also becomes more sustainable.
- Research and demonstration, new green and autonomous mobility solutions, novel business models and integration between smarter and greener transport and energy sector has developed more focus, including in V2G and V2X projects (Vehicle to Grid/Everything).
- New modes of electric transport are gaining momentum in Denmark. Large electric ferries are introduced, more electric buses in public transport, several electric car-sharing services including DriveNow, GreenMobility and LetsGo.
- Denmark has a strong EV charging infrastructure thanks to the major private e-mobility providers: CLEVER, E.ON, CleanCharge Solutions, Tesla and Nerve Smart Systems.
- Many EV projects have been launched to familiarize companies, public authorities, and private consumers with EVs and strengthen Denmark's position as an important green transport corridor in Northern Europe.

24.1.1 Framework for the Electrification of Transport in Denmark

Denmark is supporting the Paris Agreement including a very ambitious national target of being fully independent of fossil fuels by 2050, and a 2030 milestone of 50 % of energy consumption supplied by renewable energy.

According to EU targets, EU greenhouse gas emissions must be reduced 20 % in 2020 (10 % of energy in transport must be renewable in 2020), 40 % in 2030 and 80-95 % in 2050 (all these EU targets are compared to 1990). Within the EU, Denmark is expected to have a 39 % reduction target in non ETS sectors (which include transport) in 2030 (compared to 2005).

Globally, as well as in Denmark, transport is recognized as a challenging sector for greenhouse gas emission reductions. Transport demand, energy consumption and greenhouse gas emissions are all increasing. And transition to low carbon and renewable solutions is depending on a range of new technologies to be matured, industrially scaled and price-competitive before becoming a mass market mover.

For more than a decade, the transformation of Danish transport sector has been seen in relation to the very ambitious transformation of the Danish energy sector. Denmark holds several years of world records of fluctuating wind power in the electricity mix. In 2017, the wind power generation in Denmark corresponded to 43.4 % of the electricity consumption.

In 2017, 2016, and 2015, World Energy Council ranked Denmark as number one among 125 countries energy systems on three core dimensions: energy security, energy equity, and environmental sustainability.

The combination of a prize-winning, strong and flexible energy system with record-breaking shares of fluctuating renewable energy positions Denmark as an interesting test laboratory for exploring the interplay between the energy system, renewable energy and e-mobility in terms of smart grid, smart energy and storage. Well-developed public transport, focus on new and electric mobility, new business models and e-mobility as a service, e-car-sharing, e-buses and autonomy will also be at the front in the coming years. Electric maritime propulsion is upcoming, with several ongoing e-ferries projects in Denmark. Biking is very important in Denmark and e-biking continues to grow.

With policy strategies and grant schemes since 2008, Denmark was one of the first mover countries in introducing battery electric cars and hydrogen and fuel cell based transport, since 2008 in a testing and demonstration context, and since 2012 also in deployment mode.

Incentive programmes focused broadly on electric application in passenger cars, buses, vans, garbage trucks, including charging infrastructure. Private and public fleets together with city car sharing systems have been a main priority. In the private segment, commuters and families with more than one car has been another important focus area. Denmark is actively represented and participating in a broad palette of regional, international and EU programmes, ranging from charging and roaming standards, cross bordering and highway charging corridors and smart grid

projects to e-mobility as service and as an energy efficient and environmental friendly form of transport. Hydrogen programmes have especially focused on R&D in fuel cells and deployment of a Danish network of hydrogen filling stations.

Broad political agreements governed the development. The 2008 energy agreement continued the decarbonising of the energy system and initiated the first programmes for electric mobility and charging infrastructure. The broad political energy agreements from 2012 set out the ambitious targets for the energy system in 2020 and 2050 and also initiated new e-mobility and charging infrastructure programmes with focus on deployment vehicles and infrastructure for alternative fuels, mainly electrically, but also hydrogen and biogas.

In the transport sector two political agreements in 2009 and 2014 focused on a Green Transport Policy and financial support for green solutions in the public transport sector (2009), for research in alternative fuel technologies, and for small-scale tests of electricity and CNG vehicles (2013). These funds and programmes largely ended in 2015, with projects running until their projects periods end, typically within 3-5 years. A small scheme of 1,6 million USD (1.35 million EUR) funds new fuel cell vehicles and infrastructure in 2018.

The support for green transport provided by the government has helped regional and municipal authorities to develop initiatives promoting e-mobility like Copenhagen Electric and the Municipality of Copenhagen.

In 2016, Copenhagen City published a new climate plan aiming at making the city the first CO₂-neutral capital by 2025, including in the public transport sector. The plan contains objectives, main activities and initiatives adopted by the City Council to be implemented to achieve this goal.

24.1.2 Taxation

Until January 1, 2016, battery electric vehicles (BEV) were exempted from the relatively high registration tax on passenger cars (VAT was applied). The exemption was a very strong incentive, which together with the national and regional activities brought Denmark in the e-mobility forefront. The taxation systems lead to some disproportionate incentive towards expensive BEVs which resulted in rather high shares of sales.

A progressive reduction of the tax exemption was decided in 2015, starting from 2016 and with full taxation phased in by 2020. The detailed phase-in steps were initially 20 % in 2016, 40 % in 2017, 65 % in 2018, 90 % in 2019, and 100 % in 2020. This led to a drop in sales of BEVs in 2016, where taxation was phased in with a 20 % first step. Due to low EV sales, the taxation was changed again with two political agreements in 2017.

New Political Agreement as per April 18, 2017:

- EV taxes stay 20 % for the next 5,000 EVs or latest to the end of 2018.
- EV purchase tax is 40 % in 2019, 65 % in 2021, 90 % in 2021, 100 % from 2022 on.
- New (2017-2021) BEV and PHEV purchase tax rebate of 225 USD/kWh (190 EUR/kWh) battery, max 45 kWh (10,000 USD; 8,458 EUR).
- Energy tax exemption (0.124 USD/kWh) (0.105 EUR/kWh) for commercial charging to 2019, from 2020 full tax.
- Energy tax exemption for charging e-buses extended to 2023 or longer according to the EU.
- Grant scheme for Hydrogen filling stations: 5 million DKK (0.7 million USD) (0.59 million EUR) in 2017-2018
- New Car Taxation Political Agreement as per October 3, 2017:
- Vehicle low purchase tax is reduced from 105 to 85 % high tax is maintained 150 %.
- Cut between low and high tax is moved from (16,900 USD; 14,294 EUR) to (29,300 USD; 24,783 EUR).
- Bonus/Malus from 16 to 20 km/l gasoline and 18 to 22 km/l diesel.
- Malus rose from 1,000 DKK/l (134.27 EUR/l) to 6,000 DKK/l (805.63 EUR/l); Bonus is still 4.000 DKK/l (537.08 EUR/l).

Effects generally:

- Cheap ICE cars getting a bit more expensive, expensive cars getting cheaper, also HEV
- Lower cost EVs not much more expensive first years, high cost EVs more expensive
- Consumer reaction on tax exemption removed at the end of 2015 has been dramatic
- Taxation changes in 2017 did not change this, but slightly upward trend

24.2 HEVs, PHEVs and EVs on the Road

The Danish EV and PHEV stock increased in 2016 to approx. 9,300 EV units and 1,300 PHEV units. The number of new EV registrations in 2016 was reduced to approx. 1,400 EV units and 650 PHEV units due to the new taxation system for EV and PHEV.

Table 1: Distribution and sales of EVs, PHEVs and HEVs in Denmark in 2017 (Data source: Dansk Elbil Alliance/De Danske Bilimportører DBI (Danish car importers association); Bus numbers are from Movia; E-bikes numbers are from Danish Bicycle Retailers, but usually not available before April 2018)

Fleet Totals on 31 December 2017					
Vehicle Type	EVs	PHEVs	HEVs	FCVs	Total ^f
2- and 3-Wheelers ^a	217	0	0	0	217
Passenger Vehicles ^b	8,513	1,648	16,500	81	26,742
Buses and Minibuses ^c	5	0	20	0	25
Light commercial vehicles ^d	512	173	1,200	1	1,886
Medium and Heavy Weight Trucks ^e	5	0	2	4	11
Totals without bicycles	9,252	1,821	17,722	86	28,881

Total Sales during 2017					
Vehicle Type	EVs	PHEVs	HEVs	FCVs	Total ^f
2- and 3-Wheelers ^a	n.a.	n.a.	n.a.	n.a.	n.a.
Passenger Vehicles ^b	698	614	7,101	15	8,428
Buses and Minibuses ^c	0	0	0	0	0
Light commercial vehicles ^d	61	23	493	0	577
Medium and Heavy Weight Trucks ^e	2	0	0	0	2
Totals without bicycles	761	637	7,594	15	9,007

n.a. = not available

^a UNECE categories L1-L5

^b UNECE categories M1

^c UNECE categories M2-M3

^d UNECE categories N1

^e UNECE categories N2-N3

24.3 Charging Infrastructure or EVSE

Denmark has a very well developed public charging infrastructure, thanks to the four major private e-mobility providers: CLEVER, E.ON, CleanCharge Solutions, and Tesla. Combined, the four companies provide publicly accessible recharging networks countrywide. The Danish Road Directorate has conducted tenders to establish public charging infrastructures at rest stops on national Danish highway

system. E.ON and CLEVER have deployed combined fast chargers on these sites, while Tesla has deployed chargers close to the highway system.

E.ON, CLEVER and CleanCharge provide data to a map that gives an overview of publicly available charging infrastructure in Denmark. The project is supported by the Danish Transport and Construction Agency. The map is hosted by the Danish Electric Vehicles Alliance here: <https://www.ladekortet.dk>.

In terms of interoperability, all quick chargers in Denmark today are multi-standard types (CHAdeMO, CCS and Mennekes type 2) and are connected to backend systems which allow billing of customers based on actual consumption of kWh.

E.ON and CLEVER’s business models are primarily based on customer subscriptions of the company’s recharging infrastructure (with a monthly subscription fee) and charges for energy consumption. Both e-mobility providers also offer non-subscription based recharging services. CleanCharge Solutions is a Danish e-mobility provider. The company installing equipment and providing value-added services (billing services, charging data processing, etc.) to charging point operators and parking operators that provides open access with direct payment for the use of the recharging stations. Tesla has installed a network of Supercharger stations in Denmark where drivers can fully charge their Tesla vehicles for free.

Table 2: Information on charging infrastructure in 2017 (Data source: Dansk Elbil Alliance)

Charging Infrastructure on 31 December 2017	
Chargers	Quantity
AC Level 1 Chargers	0
AC Level 2 Chargers	948
Fast Chargers	146
Superchargers	85
Inductive Charging	0
Totals	1,179

24.4 EV Demonstration Projects

Since 2008, the Danish Energy Agency (DEA), the Danish Road Safety Agency and the Danish Road Directorate administrated several programmes to support deployment of electric, plug in hybrid and hydrogen transport and infrastructure in the Danish transport sector. Funds have been used to support projects that allow companies, public bodies, and private consumers to familiarize themselves with EVs and other vehicles, develop synergies between relevant stakeholders and support the deployment of alternative fuel infrastructure. These funds and

programmes largely ended in 2015, but will be running until their projects periods end, typically within 3-5 years.

Electric Car-Sharing Schemes in Denmark

Denmark hosts several electric car-sharing services, including DriveNow, GreenMobility and Let's Go.

- DriveNow operates in several European countries, but in Copenhagen its fleet is 100 % electric. It includes some 400 BMW i3s to be booked via an app. The pricing models include rates per minute, daily rates or monthly subscriptions.
- GreenMobility operates in Copenhagen and surrounding regions. It includes more than 400 Renault ZOE's to be booked and accessed via an app. The pricing models include rates per minute, daily rates or monthly subscriptions.
- Let's Go is a non-profit organisation operating in several Danish cities, currently with 30 electric cars, representing 15 % of the total fleet. Let's Go is a membership-based organisation, with dedicated parking. Members pay based on time and distance travelled.

Partnerships with the public sector, and funding from the Danish Energy Agency and the Capital Region of Denmark for the deployment of public charging infrastructure, has helped to expand the operational zone of these schemes, for example to serve hospitals.

Electric Buses in Danish Public Transport

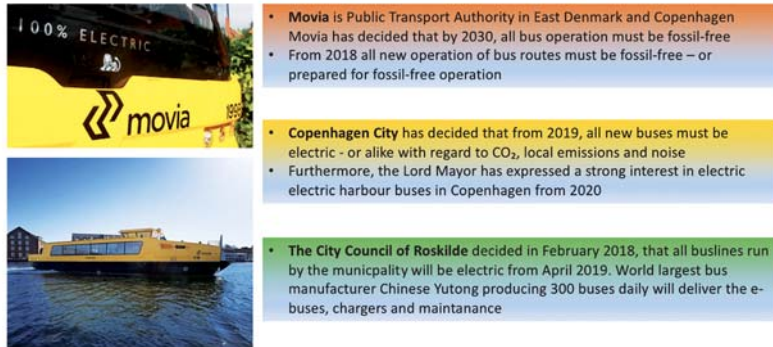
Movia is the Public Transport Authority (PTA) in East Denmark including the capital area of Copenhagen. Movia started using electric buses in 2009-2014, with 11 all-electric 8 m buses in Copenhagen. In 2014-2015, Movia tested two 12 m depot-charged electric BYD buses. In 2016-2019, Movia and Copenhagen are testing opportunity-charged electric Finnish Linkker buses. Out of Movia's 1,241 in-service buses today three are electric buses. Movia has decided that by 2030, all bus operation must be fossil-free. Furthermore, local NO_x must be reduced by 97 %, particles by 92 % and external bus noise by 15 %. This is on top of former targets, of a 29 % reduction of the CO₂-emission and a 75 % reduction of the NO_x and particles in 2020 compared with the baseline year 2008. To meet the goal of fossil-free bus fleet by 2030, all new bus operation starting from 2018 and forward must be fossil-free – or prepared for fossil-free operation.

In 2016, Copenhagen published a new climate plan aiming at making the city the first CO₂-neutral capital by 2025, including the public transport sector. It contains

objectives, activities and initiatives adopted by the City Council. For public buses, the goal is to shift the bus fleet to all-electric buses. The City Council has decided that from 2019 and forward, all new city buses must be electric - or perform alike on CO₂-emission, local emissions and noise. Furthermore, the Lord Mayor has expressed a strong interest in electric harbour buses in Copenhagen from 2020.

The City Council of Roskilde decided in February 2018, that all bus-lines run by the municipality to be electric from April 2019 on. The world’s largest bus manufacturer Chinese Yutong will deliver e-buses, chargers and maintenance.

PROJECT EXAMPLES – EV BUSES IN CPH AND ROSKILDE
[HTTPS://WWW.MOVIATRAFIK.DK/PRESSE/PRESSE-OG-NYHEDER/FREMTIDENS-ELBUSSE-KOERER-NU-I-KOEBENHAVN](https://www.moviatrafik.dk/presse/presse-og-nyheder/fremtidens-elbusser-koerer-nu-i-kobenhavn)



- **Movia** is Public Transport Authority in East Denmark and Copenhagen. Movia has decided that by 2030, all bus operation must be fossil-free
- From 2018 all new operation of bus routes must be fossil-free – or prepared for fossil-free operation
- **Copenhagen City** has decided that from 2019, all new buses must be electric - or alike with regard to CO₂, local emissions and noise
- Furthermore, the Lord Mayor has expressed a strong interest in electric electric harbour buses in Copenhagen from 2020
- **The City Council of Roskilde** decided in February 2018, that all buslines run by the municipality will be electric from April 2019. World largest bus manufacturer Chinese Yutong producing 300 buses daily will deliver the e-buses, chargers and maintenance

Figure 1: Project examples, e-buses in CPH and Roskilde

Parker Project - V2G Cars Providing Energy System Services

The Parker project builds on two previous Danish projects, the EDISON and Nikola projects, which have founded the understanding the electric vehicle’s potential for balancing the Danish power system. Parker represents the next technology readiness level by allowing balancing services to be applied to a fleet of electric vehicles.

PROJECT EXAMPLES – PARKER PROJECT

[HTTP://PARKER-PROJECT.COM](http://parker-project.com)

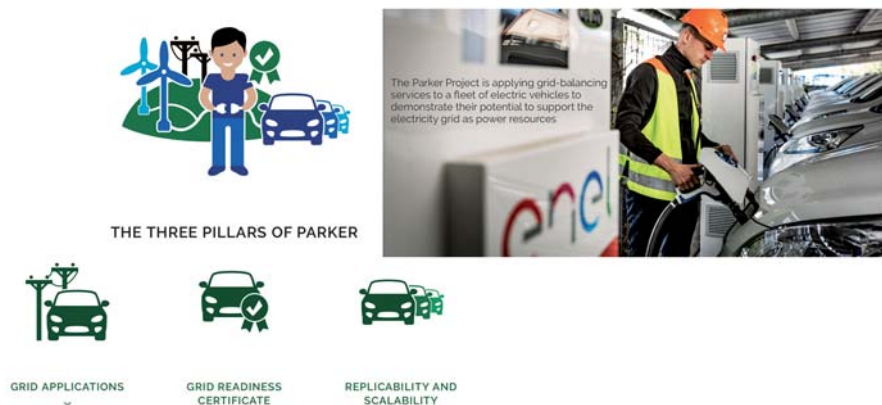


Figure 2: Project examples, “Parker” project

Research and development in the project is carried out as a multidisciplinary collaboration between commercial OEMs, technology providers, fleet owner and customers as well as academic institutions.

Parker works together with the world’s first commercial pilot of series produced V2G cars providing system services, the Frederiksberg Pilot, to ensure market adoption, applicability and re-usability to power systems in Denmark and elsewhere. One of three goals is to produce a Grid Integrated Vehicle (GIV) certificate which demonstrates whether vehicles and chargers are able to support the power grid.

350 kW High Power Battery Assisted Charging

Nerve Smart Systems is a new Danish company developing a charging solution based on a battery system making charging significantly faster without overloading the power grid. The solution allows an electric car to be charged in less than 10 minutes via a 350 kW high power charging station connected to the energy grid with a regular connection.

The GREAT Project

The Green Region for Electrification and Alternatives fuels for Transport project (GREAT) aims to development a green transport corridor connecting Norway, Sweden, Denmark, and Germany.

Project partners include E.ON, Nissan, Renault, and the Technical University of Denmark (DTU). The latter is partially responsible for conducting studies on learning experiences from the new corridor.

The MECOR Project

The Multimodal e-mobility connectivity for the Oresund Region project (MECOR) aims to promote multimodal e-mobility by installing 30 semi-fast charging sites in Denmark and Sweden. The charging sites will be located in transport “hotspots” such as bus and train stations to underpin multimodal e-mobility. The project is in line with the Oresund Regional development strategy, which calls for the development of “green corridors”. CLEVER is a key project partner.

Platform for E-mobility in ÖKS Region

The project aims to increase environmentally friendly transport in the Öresund-Kattegat-Skagerrak region by helping the municipalities adapt to e-mobility. A common platform delivers expertise to help increase deployment of EVs in public fleets and among private citizens. The platform is established by The Danish EV Alliance (DK), Power Circle (SWE), and Elbilforening (NOR). It is funded by 50 % by the EU Interreg programme.

The Danish Ærø e-Ferry Project

“Ellen” is a highly energy efficient medium sized and a long 22 nautical mile range e-ferry for passengers, cars, trucks and cargo in island communities, coastal zones and inland waterways. It is supported by the European H2020 initiative, demonstrating design, building and operation of a fully electric powered ‘green’ ferry. Electricity from wind power of the Danish island Ærø will allow “Ellen” to run without any emissions. The e-ferry is expected to be in operation in 2018/2019.



Figure 3: Project examples, image by the “e-Ferry” project

World's Largest Battery Ferries HH-ferries/Scandlines

Tycho Brahe and Aurora cross 4 km Helsingborg in Sweden and Helsingør in Denmark carrying + 7.3 million passengers and 1.8 million vehicles annually. The combined 8,320 kWh battery is equivalent to 10,700 car batteries.

With 15 minutes schedule, charging is fast and automated in both ports using robots, 3D laser and wireless communication to maximize charging time. Co-financed by the European Union Connecting Europe Facility, Tycho Brahe is expected to be in full electric operation in summer 2018.



Figure 4: World's largest battery ferries (Source: Scandlines)

24.5 Outlook

- DK world leader in greening energy systems, gCO₂/kWh 550 g in 2006 to below 200 g in 2017.
- Record breaking strong energy system, RE shares and ambitious targets.
- DK first mover with EV policy strategies and grant schemes since 2008.
- Very strong charging infrastructure with several operators.
- New EV taxation is very challenging, but with increasing sales in the beginning of 2018.
- Applications in fleets, buses, ships, bicycle etc. increases.
- A lot of exciting projects show that DK is an ideal technical and commercial test bed for interplay between e-mobility, smart energy system, renewable energy and energy storage.
- Cities and regions as Capital Region of Copenhagen/CPH Electric City and commercial players are very active in many projects.
- For electric buses in DK the charging tax exemption could mean a positive commercial business case due to lower energy cost (EV bus basically twice as expensive, but three times more energy efficient).
- E-Trucks are not taxed.