



### 33.1 Major Developments in 2017

In 2017, Sweden adopted a progressive climate law and the domestic road transport system has two overarching environmental goals – to reduce its GHG emissions with 70 % by 2030 and become completely fossil-free by 2045<sup>62</sup>. Electrification, biofuels and a more transport-efficient society has been pointed out as key enablers to reach these goals by a report dispatched by six governmental agencies<sup>63</sup>.

Sweden has the largest plug-in electric vehicle (PEV) market share in the EU (EAFO, 2018), third globally (IEA, 2017) and in 2017, PEVs constituted 5.1 % of the new-car sales (Bil Sweden, 2017). The number of PEVs reached over 45,000 vehicles in Sweden during 2017.

The public charging infrastructure in Sweden has developed significantly during 2017, from approximately 2,200 charging points to over 4,600. Many of these have been granted support through the investment scheme Klimatklivet, the Climate leap, which by the end of 2017 in total had granted investment support to over 12,000 charging points, both public and non-public. In 2017, several efforts to further promote the development of the charging infrastructure ecosystem in Sweden were made: first, a home-charging support scheme and secondly, a project to enable charging infrastructure along larger roads in Sweden, i.e. where Klimatklivet is enough to ensure market expansion.

In 2017, the Swedish government also decided that the PEV purchase rebate system will be replaced by a cost-neutral bonus-malus system. In addition to incentives towards passenger cars and van, a purchase rebate to e-bikes and light electric vehicles (LEVs) was introduced in 2017.

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<sup>62</sup> <http://www.government.se/articles/2017/06/the-climate-policy-framework/>

<sup>63</sup> <http://www.energimyndigheten.se/nyhetsarkiv/2017/strategisk-plan-for-hur-transportsektorn-ska-bli-fossilfri/>

### **The Swedish Climate Law**

In June 2017, Sweden adopted a new progressive climate law and the new law requires all policy areas, not only environment, climate, transport and energy, to contribute to achieve the targets. The two overarching goals for the Swedish road transport system are to reduce its GHG emissions with 70 % by 2030 and to become completely fossil-free by 2045. By formalising the goals in a law means that to make changes, it must be passed through the parliament first.

### **Demand-Side Measures**

The EU emission standard regulations highly influence Swedish policy and ultimately the PEV uptake. The EU regulations today don't push for PEVs specifically, hence the need for national incentives to promote the PEV uptake.

### **The Green and the Super Green Car Definition**

In 2006, the first Green car definition was introduced in Sweden. The aim is to specify certain criteria, which vehicles in compliance with these get benefits, like tax reliefs and priority in public procurements. Over the years, the criteria have been altered, but the basic principal has focused on renewable fuels and/or energy-efficiency. Between 2006 and 2009, green cars were granted a purchase rebate. The Super Green Car definition was introduced in 2012 comprise vehicles tail-pipe emissions lower than 50 g CO<sub>2</sub>/km, i.e. plug-in electric vehicles, and was the first demand-side measure to specifically promote PEVs.

### **Super Green Car Rebate “Supermiljöbilspremie”**

The Super Green Car rebate is granted for new-sales passenger vehicles that comply with the super-green car definition, i.e. tail-pipe emissions lower than 50 g CO<sub>2</sub>/km. The subsidy was introduced in 2012 and became differentiated between BEVs and PHEVs in 2016. Both private cars and company cars are granted the super green car rebate. For BEVs, the rebate corresponds to 40,000 SEK (4,000 EUR), and from 2016 PHEVs have been granted 20,000 SEK (2,000 EUR). For a company car, the rebate covers approximately 35 percent of the price difference between a super green car and the nearest comparable car. The budget for 2016 was initially 32 million EUR, but the big interest motivated additional 19 million EUR. For 2017, 74 million EUR is allocated the scheme. The Super Green Car Rebate will be replaced by a cost neutral bonus-malus support scheme in 2018 and the rebate to PEVs (< 60 g. CO<sub>2</sub>/km) will be 6,500 EUR.

In July 2018, the Super Green Car rebate system will be replaced by a cost neutral bonus-malus system. The implementation of the bonus-malus system aims to

ensure subsidies to the most environmentally friendly vehicles without burdening the national finances.

### **Reduced Value of Fringe Benefits**

As mentioned, in addition to the Super Green Car rebate, company cars may reduce the value of fringe benefits for PEVs compared to the equivalent, conventional fossil-fueled car. After adjustment, the value of fringe benefits is reduced by 40 %, maximum 1,700 EUR in 2012-2016 and 950 EUR in 2017.

Given the PEV deployment among company cars, it constitutes for over 70 % of the PEV ownerships; this has probably been the most important incentive to promote the use of PEVs in Sweden.

### **Vehicle Tax**

Today, light-duty vehicles in compliance with the Green car definition are exempted from the annual vehicle tax for the first five years it operates. The subsidy aims to generally encourage the acquisition of energy efficient or powered by renewable fuels. The annual vehicle tax comprises a static basic sum of 360 SEK/year (35 EUR/year) and a variable part that is 22 SEK/g (2.15 EUR/g); CO<sub>2</sub> for each gram of CO<sub>2</sub> over 111 g CO<sub>2</sub>/km. Subsequently the exemption implies at least 180 EUR in tax relief the first 5 years, but for the average Swedish car in 2016 (123.1 g CO<sub>2</sub>/km) it would mean over 210 EUR. The coming bonus-malus system will limit the vehicle tax exemption to 3 years, but differentiate the vehicle tax further.

### **Support to E-Bikes and LEVs**

In 2017, the Swedish government launched a purchase rebate to e-bikes and light electric vehicles (LEVs). In September, after the new support became official, the market of e-bikes increased with 230 % compared to August. The budget for 2018 is 35 million EUR and each rebate comprises 25 % of the cost up to 1,000 EUR.

## **33.1.1 Charging Infrastructure Policies**

### **Klimatklivet – The Climate Leap**

In September 2015, the Swedish government launched the investment support scheme Klimatklivet, the *Climate Leap*, which is a general investment support scheme<sup>64</sup>. The allocation principal of Klimatklivet is competitiveness. Each call

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<sup>64</sup> [https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-2015517-om-stod-till-lokala\\_sfs-2015-517](https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-2015517-om-stod-till-lokala_sfs-2015-517)

generates applications that are ranked according to the climate-effectiveness of the proposed investments. Even though the scheme is general and welcome applications from all sectors, charging infrastructure is specifically mentioned in the directive and the directive also commissions the Swedish Energy Agency as the national coordinator for the EVSE deployment. Applicants are primarily companies, private households can't apply, however tenant-owned cooperatives can apply. The programme period is 2015-2023 and since 2015, 320 million EUR have been allocated to this purpose. For 2018-2020, the yearly budget will increase from 150 million EUR in 2018, 200 million EUR in 2019 and 300 million EUR in 2020.

So far, Klimatklivet has granted over 14,000 charging points investment support. Most are normal charging points, both non-public and public, and the scheme has also successfully received and granted support to DC fast chargers along motorways (see Figure 2).

### **Home-Charging Support Scheme**

In 2017, the Swedish government decided on a home-charging support scheme. From February 1, 2018, private households are subsidized up to 1,000 EUR, or by 50 %, when installing an EVSE at their home<sup>65</sup>.

### **Additional Charging Infrastructure along Bigger Roads**

Klimatklivet has contributed to the expansion of the fast charging corridors along several roads, but Sweden is a widespread country and there are roads where the market drivers currently are not enough. Therefore, the Swedish Government has commissioned the Swedish Transport Agency to investigate possible public measures to improve the market conditions in these areas<sup>66</sup>.

## **33.1.2 Public Transport Incentives**

### **EV Bus Rebate**

In 2016, the Government introduced a purchase subsidy specifically targeting electric buses. In the beginning, battery electric and plug-in hybrid buses could be granted rebate. Since 2017, fuel cell buses using renewable hydrogen are also included in the scheme. Several other changes in the directive were also made last year, mainly to include more public transport providers and smaller buses. Now the

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<sup>65</sup> [https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-20171318-om-bidrag-till\\_sfs-2017-1318](https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-20171318-om-bidrag-till_sfs-2017-1318)

<sup>66</sup> <http://www.regeringen.se/regeringsuppdrag/2018/01/uppdrag-om-laddinfrastruktur-langs-storre-vagar/>

minimum capacity is 15 passengers. For 2017-2023, the annual budget is 100 million SEK (approx. 9.8 million EUR).

### 33.1.3 National Activities

#### Fossil-Free Sweden

Another public initiative is Fossilfritt Sverige, Fossil-free Sweden, launched by the Swedish government in 2015<sup>67</sup>. The initiative aims to gather all different types of public and private actors, associations and other, which all support the vision of a fossil-free society. Today, the initiative comprises over 250 companies, municipalities, regions, universities, and other organizations, which all have adopted ambitious targets for their own businesses. To create a market push, the initiative launches different challenges, or campaigns. One example is Transportutmaningen, The Transport Challenge, a campaign where the participating actors have more ambitious targets for their own fleet than stated in the Climate Law and then used as showcasing forerunners. Another example for the transport sector is the campaign Tjänstebilutmaningen, the Company Car challenge. Actors that sign up for this challenge, thereby oblige to only acquire plug-in vehicles and biogas vehicles as company cars. These kind of voluntary and market-driven commitments are an interesting complement to national policies and a showcase for positive sustainable business models.

#### Research and Demonstration

Electric mobility R&D and the Swedish industrial policy interact to put fossil-free vehicles and vessels to the market. Regarding the market for heavy-duty vehicles, Swedish companies represent 20 % of the global market. Between 2013 and Q1 2017, over 1,450 million SEK (approx. 141.5 million EUR) of public means were invested in electric mobility projects as R&D support. On top of that, the automotive industry has matched that investment. Sweden is an automotive country, with a broad portfolio of passenger cars, heavy-duty vehicles, construction machinery, vessels and marine engines, and the scope of the electric mobility in Sweden includes all segments. The Swedish government has granted 1 billion SEK (approx. 96.2 million EUR) to facilitate a new electromobility lab in Gothenburg, a test bed for electrified power train, but also charging systems<sup>68</sup>.

A so called gigafactory for producing lithium ion batteries is to be built in the city of Skellefteå, accompanied by an R&D production line in Västerås with the

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<sup>67</sup> <http://fossilfritt-sverige.se/in-english/>

<sup>68</sup> <http://www.regeringen.se/pressmeddelanden/2017/05/nationell-satsning-pa-elektriska-fordon/>

support from the Swedish government<sup>69</sup>. The production capacity of the plant will be 32 GWh/year and the plant is planned to operate in 2023. The size of the factory and the Swedish electricity mix constitute good conditions to produce lithium ion batteries to a low cost with a low environmental impact.

### 33.2 HEVs, PHEVs and EVs on the Road

Sweden has the largest global market share in the EU (EAFO, 2018), third globally (IEA, 2017) and in 2017, PEVs constituted 5.1 % of the new-car sales (Bil Sweden, 2017). The total stock of PEVs in Sweden is almost 40,000, see Figure 1. There are no separate regional or local policies, only variable levels of engagement. Common for the cities and regions in Sweden where the PEV uptake is high and the deployment of charging infrastructure is advanced, is that it's the results of consistent work for many years, and in most cases were initiated by an early PEV activity such as a demonstration project and/or the PEV technology procurement. Today, ten Swedish cities have introduced a total of 51 electric buses, many as a part of a broader EV strategy.

Even though the conditions for PEVs in Sweden are more favorable outside the dense cities, the three largest metropolitan areas – Stockholm, Gothenburg and Malmö – comprise 75 % of the PEVs in Sweden. The highest uptake of PEVs in Sweden is found in Stockholm. Approximately half of the PEV stock is registered here. There are two main explanations for this: The inspirational explanation, where the city of Stockholm has been actively promoting the use of PEVs for almost 10 years and have been involved in several demonstration projects and managed the PEV technology procurement. During 2017, Stockholm adopted an ambitious political programme to promote PEVs. There is also the practical explanation, where the new-car sales in Stockholm is high and it has the highest number of company cars throughout Sweden. The PEV market share in Stockholm is approximately 6.5 %. In Gothenburg, the automotive capital of Sweden, electric vehicles operate among all vehicle segments: passenger vehicles, electric garbage trucks and distribution vehicles. Electric buses operate central bus lines and elaborate on different concepts to enhance usage of public transport. Indoor bus stops, even one in a library, and decorative Christmas lighting are only two examples demonstrated. To promote PEVs, several public entities are involved and one of the most extensive EVSE deployment project is currently carried out by the parking company, with investment support from Klimatklivet.

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<sup>69</sup> <http://www.energimyndigheten.se/forskning-och-innovation/projektdatabas/sokresultat/?projectid=24015>

Two Swedish municipalities, Sölvesborg and Varberg, have more than 20 % PEVs in their fleets<sup>70</sup>. Both Sölvesborg and Varberg have consistently worked to deploy PEVs for several years and started off with different demonstration projects. Sölvesborg has been involved in the demonstration project Green Charge Sydost, which started in 2013. Varberg was a part of the PEV Technology Procurement Scheme initiated in 2010. The Swedish public fleet comprises approximately 32,000 vehicles (passenger cars and vans) and public fleets represent a significant purchaser group, thus a great potential contribute to the climate goals.

### 33.3 Charging Infrastructure or EVSE

The cold climate in Sweden implies an extensive deployment of block heaters and other power outlets (foremost standard household outlets, Schuko) to precondition the vehicles during the winter. This infrastructure amounts of more than 600,000 outlets and even though it is rudimentary, hence not adapted to power loads over several hours, it constitutes an excellent foundation for cost-effective EVSE upgrades, both at private houses but also in public parking lots.

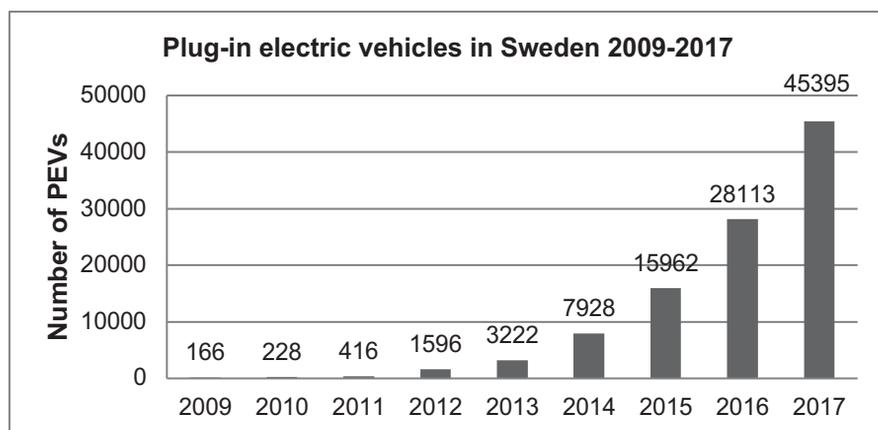


Figure 1: The number of plug-in electric vehicles in Sweden between 2009 and 2017

The public charging infrastructure in Sweden today is the result of public and private actions, sometimes in joint forces, and constitute of over 4,600 charging outlets at almost 1,300 charging stations<sup>71</sup>, see Figure 2. The Swedish market for charging infrastructure is completely deregulated, which enables almost anyone to become a charge point operator (CPO). For example, a housing cooperative could make a charging point publicly available at their ground and charge users for this

<sup>70</sup> [http://www.miljofordonsdiagnos.se/PDF/Miljofordonsdiagnos%202017\\_rapport.pdf](http://www.miljofordonsdiagnos.se/PDF/Miljofordonsdiagnos%202017_rapport.pdf)

<sup>71</sup> [www.nobil.no](http://www.nobil.no)

service. This makes it possible for a variety of different electricity suppliers and numerous charge point operators (CPOs) to create customer value in their service to PEV users.

Table 1: Information on charging infrastructure in 2017 in Sweden

Charging Infrastructure on 31 December 2017	
Chargers	Quantity
AC Level 1 Chargers	469
AC Level 2 Chargers	2,987
Fast Chargers	427
Superchargers	188
Inductive Charging	0
<b>Totals</b>	<b>4,071 outlets (EU standard)</b>

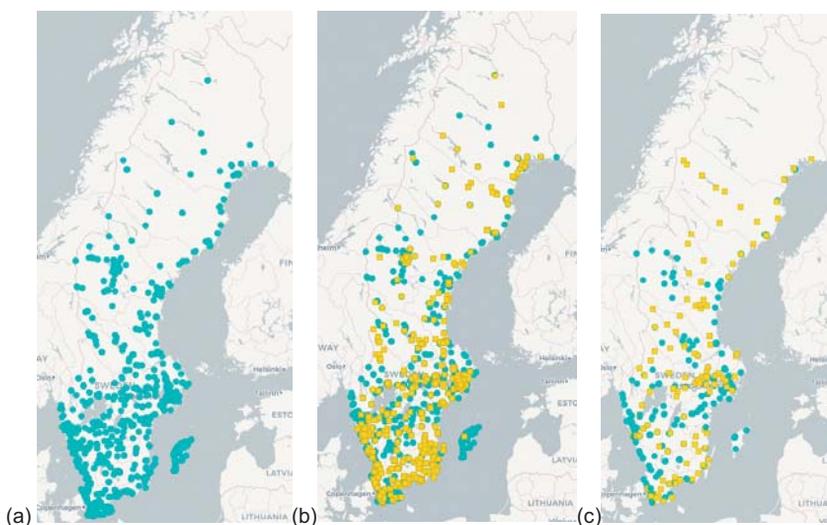


Figure 2: Public charging EVSE infrastructure in compliance with the EU standard, blue=existing yellow=granted support through Klimatklivet (a) existing EVSE (b) EVSE < 23kW (c) 50 kW DC

### 33.4 EV Demonstration Projects

A couple of years ago, the demonstration projects mainly focused on the vehicles itself and often on different types of road vehicles. Now the focus has shifted to study modal shifts in a transport-efficient society, a broader portfolio of vehicles

(such as sea vessels and construction and mining trucks) and charging infrastructure concepts.

In June 2016, the world's first electric road system (ERS) on a public road was inaugurated at E16 and the technology has now been tested with good results on a two kilometer stretch through airborne electrical wiring. An extension of the route is now discussed. Another ERS project from the intergovernmental innovation procurement scheme, eRoadArlanda, connects Rosersberg logistics area with Arlanda airport. Instead of using a pantograph, eRoadArlanda feed electricity from a rail that is immersed in the roadway. It will be inaugurated in spring of 2018 and has been granted about 12 million EUR support. The innovation procurement scheme is collaboration between the Swedish Energy Agency, the Swedish Transport Administration and Vinnova.

The company Boliden, with financial support from the Swedish Energy Agency, has initiated a demonstration project for the electrification of in-pit truck transports in Aitik – Sweden's largest open pit copper mine – together with key partners in industry and academia. The project will develop, install and operate an electric transport route with electric trolley lines and four electric mine trucks. Up to 80 % reductions of greenhouse gas emissions are expected. There is also potential identified in transport electrification related to increased productivity.



Figure 3: Illustrated, an electrified mine truck in the Aitik mine

Life cycle analysis, LCA, has been used to study biofuels for several years. However, to compare different vehicle technologies overall impact, tail-pipe emissions or fuel-LCA data is not enough. During 2017, the topic of vehicle LCA, i.e. the carbon foot print of production, operation and scrapping of the vehicle, has been raised on the agenda. In 2017, the Swedish Energy Agency and the Swedish Transport Administration initiated a study on PEV battery production. The report “The Life Cycle Energy Consumption and Greenhouse Gas Emissions from

Lithium-Ion Batteries” highlighted the difficulties to obtain this data (there are not many primary sources of data and a lot of data is relatively old), but found a clear relationship between battery size and emissions. The study got a lot of attention in the media, which constitute the topic in the public awareness.

### **33.5 Outlook**

In 2018, several new policies to promote PEVs will be in place but the most influential is the new bonus-malus system. This will come into action in July and it will be interesting to observe the market reactions to that.

During 2018, Sweden will be chair of the Nordic Council of Ministers. During the presidency, Sweden will initiate several PEV projects with the aim to address common Nordic challenges, exchange best practice and to enable a shared Nordic platform for charging point location data based on the Norwegian database Nobil.

## CHAPTER 33 - SWEDEN

Table 2: Distribution and sales of EVs, PHEVs and HEVs in 2017

Fleet Totals on 31 December 2017					
Vehicle Type	EVs	PHEVs	HEVs	FCVs	Total <sup>6</sup>
2- and 3-Wheelers <sup>1</sup>	219	0	0	0	n.a.
Passenger Vehicles <sup>2</sup>	11,005	32,211	70,237	21	5,092,238
Buses and Minibuses <sup>3</sup>	51	4	94	0	14,999
Light commercial vehicles <sup>4</sup>	196	0	62	0	600,047
Medium and Heavy Weight Trucks <sup>5</sup>	0	0	56	0	77,718
<b>Totals without bicycles</b>	<b>13,237</b>	<b>32,215</b>	<b>70,449</b>	<b>21</b>	<b>5,460,824</b>

Total Sales during 2017					
Vehicle Type	EVs	PHEVs	HEVs	FCVs	Total <sup>6</sup>
2- and 3-Wheelers <sup>1</sup>	4,359	15,986	14,467	14	324,178
Passenger Vehicles <sup>2</sup>	12	0	50	0	1,310
Buses and Minibuses <sup>3</sup>	80	0	12	0	55,390
Light commercial vehicles <sup>4</sup>	0	0	35	0	6,198
Medium and Heavy Weight Trucks <sup>5</sup>	4,359	15,986	14,467	14	324,178
<b>Totals without bicycles</b>	<b>4,451</b>	<b>15,986</b>	<b>14,564</b>	<b>14</b>	<b>387,076</b>

n.a. = not available

<sup>1</sup> UNECE categories L1-L5

<sup>2</sup> UNECE categories M1

<sup>3</sup> UNECE categories M2-M3

<sup>4</sup> UNECE categories N1

<sup>5</sup> UNECE categories N2-N3

<sup>6</sup> Including non-electric vehicles

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Table 3: Available vehicles and prices (Data source: public site [www.miljofordon.se](http://www.miljofordon.se), Renault)

Market-Price Comparison of Selected EVs and PHEVs in Sweden	
Available Passenger Vehicles	Untaxed, Unsubsidized Sales Price (in EUR)
Audi A3 E-tron	40,100
BMW 330E	49,000
BMW I3 REX	37,000
Hyundai Ioniq Electric	38,000
Kia Optima PHEV	40,000
Kia Soul EV	38,000
Kia Niro PHEV	32,000
Mitsubishi Outlander PHEV	40,000
Nissan E-NV200	35,700
Nissan Leaf	37,500
Renault ZOE	34,000
Renault Twizy 45	9,900
Tesla Model S 75	87,500
Tesla Model X 75D	103,000
Toyota Prius Plug-in hybrid	38,000
Volvo V60 PHEV	50,000
Volvo XC60 T8 Twin engine	63,700
VW e-up!	28,600
VW Passat GTE	42,600