



## Assessment of Clean Fuel Deployment and Market Access of Clean Fuels in the Northern Scandria® Corridor



## Authors

Jan Carsten Gjerløw, Akershus County Council (ACC)  
Anna Cornander, Research Institutes of Sweden (RISE)

Contact information for this document: [jan.carsten.gjerlow@afk.no](mailto:jan.carsten.gjerlow@afk.no)

Illustrations by Karina Knihinicka

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## Glossary and abbreviations

Abbreviation	Description
BEV	Battery electric vehicle
BMVI	The Electromobility Model Regions programme of the Federal Ministry of Transport and Digital Infrastructure in Germany.
CBG	Compressed biogas
CBG100 filling stations	Refuelling stations of compressed biogas with 100 % renewable biogas content.
CEF	Connecting Europe Facility. A programme under the Innovation and Networks Executive Agency (INEA).
CEP	Clean Energy Partnership
CNG	Compressed Natural Gas
DAFI	Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure.
EAFO	European Alternative Fuels Observatory
ESA	EFTA Surveillance Authority
EV	Electric Vehicle
FCEV	Fuel cell electric vehicle
FCH JU	The Fuel Cells and Hydrogen Joint Undertaking (FCH JU) is a public/private partnership supporting research, technological development and demonstration (RTD) activities in fuel cell and hydrogen energy technologies in Europe. Its aim is to accelerate the market introduction of these technologies, realising their potential as an instrument in achieving a carbon-lean energy system.
GREAT	GREAT - Great Regions with Alternative Fuels for Transport, an EU funded project.
H2DK	H2DK - Hydrogen for Transportation in Denmark, is a project that aims to establish new hydrogen refueling stations (HRS) in Denmark.
H2ME	Hydrogen Mobility Europe – consisting of the projects H2ME1 and H2ME2 – is a flagship project giving fuel cell electric vehicle (FCEV) drivers access to the first truly pan-European network of hydrogen refuelling stations.
HRS	Hydrogen refuelling station
HyFIVE	Hydrogen For Innovative Vehicles (HyFIVE) is a European project including 15 partners who will deploy 185 fuel cell electric vehicles (FCEVs) from the five global automotive companies who are leading in their commercialisation (BMW, Daimler, Honda, Hyundai and Toyota).
LBG	Liquefied Biogas
LBST	Ludwig-Bölkow-Systemtechnik
LNG	Liquefied Natural Gas
M1 Vehicle category	Cars used for the carriage of passengers, with no more than eight seats in addition to the driver's seat; also known as passenger cars.
NGV	Natural gas vehicle
NIP	National Innovation Programme for Hydrogen and Fuel Cell Technology in Germany
NOW	NOW GmbH (National Organisation Hydrogen and Fuel Cell Technology) is responsible for the coordination and management of the National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP) and the Electromobility Model Regions programme of the Federal Ministry of Transport and Digital Infrastructure (BMVI) in Germany.
OEM	Original Equipment Manufacturer
PEV	Plug-in electric vehicle
PHEV	Plug-in hybrid electric vehicle
Super-Green Car	The Swedish Transport Agency has defined the super-green car as a passenger car that complies with the EU's latest exhaust emissions limits and which emits no more than 50 grams of carbon dioxide per kilometre. The super-green Car Premium is a subsidy in Sweden that should cover possible additional costs of such cars.
The TEN-T Core Network	The Trans-European Transport Networks (TEN-T) is a project of the European Union to co-fund the establishment of a transport infrastructure connecting all EU Member States.
TOC	Total Cost of Ownership
ZEV	Zero emission vehicle



# 1 Executive Summary

The aim of this report is to provide a comprehensive overview of the status of Clean Fuel deployment in the Northern Scandria@Corridor and to describe experiences of market access of Clean Fuels.

The report benchmarks Clean Fuel performance in the Northern Scandria@Corridor in the European context, provides results related to obstacles and success factors, exemplifies relevant best practice in the Corridor regions and provides relevant contacts. It will enable the partners to identify crucial barriers and best practice examples.

The geographic scope comprises the regions located along the Baltic Sea Region stretch of the Scandinavian-Mediterranean Core Network Corridor (in this report referred to as the “Northern Scandria@Corridor”), including regions in Eastern Germany, the German states of Schleswig-Holstein and Hamburg, Denmark, South Sweden, Southeast Norway and Southwest Finland. See Figure 3 and detailed description of included regions in Chapter 2. In some sections of this report, statistics from The European Alternative Fuels Observatory (EAFO) are used. Numbers from EAFO are provided at national level only. However, in many cases, development at national level can also provide a picture on development in the Northern Scandria@Corridor.

The major objective of the Scandria@2Act project is to foster clean, multimodal transport throughout the Corridor regions, and to increase connectivity and competitiveness of the Corridor regions while at the same time minimising negative environmental impact created by transport activities. The joint approach addresses the deployment of Clean Fuels and multimodal transport services and the establishment of a multilevel governance mechanism. This report is an output of the work package of Clean Fuel Deployment, which aims to enable the deployment of Clean Fuels with regard to freight and passenger transport along the Northern Scandria@Corridor.

In preparing this report, an assessment of Clean Fuel market access experiences has been carried out in parallel with an assessment of Clean Fuel deployment in the Northern Scandria@Corridor. Information was collected through a questionnaire answered by partners and national experts and through telephone interviews with national experts from each region. Information and statistics have also been gathered from reports, literature, EAFO and national reports from the partner countries regarding the EU Alternative Fuels Infrastructure Directive (DAFI).

The assessment has followed the Scandria@2Act multi-fuel approach, including electricity, hydrogen, biomethane and natural gas.

## 1.1 Main conclusions

Deployment of Clean Fuels in the Northern Scandria@Corridor develops slowly. There were actually fewer alternative fuel vehicles registered in 2016 than in 2015. The countries in the region vary quite strongly when it comes to the use of incentives for developing the infrastructure and use of alternative fuels. In this early phase of development, the use of incentives is crucial for the prevalence of alternative fuels. Alternative fuel vehicles are generally more expensive than diesel and gasoline vehicles. The infrastructure is more expensive to develop as well, and the availability is limited.

Figure 1 may serve as an illustration of the development of the market. The bar chart shows the number of new registrations of BEVs, FCEVs and CBG/CNG vehicles in the five countries in the Northern Scandria@Corridor. Numbers are at a national level. From 2013 to 2014 the numbers increased by 62%, and from 2014 to 2015 by 31%. In 2016, the total number is down from about 56,000 vehicles to 47,000, or by -15%. The number of FCEVs is the only one increasing, but is still at a negligible level. At the same time, the total number of vehicles sold in each country is increasing, as shown in Table 4 in chapter 4.

Figure 2 shows the market share of BEVs, PHEVs and CBG/CNG passenger vehicles. Market share in the Northern Scandria@Corridor is compared with the rest of Europe.

Figure 1 and Figure 2 show that there is still a long way to go before we have a large number of alternative fuel passenger vehicles on the roads in the Northern Scandria@Corridor. The development rate is discouraging. There seem to be no major forthcoming changes in politics or the use of incentives promising a significant change in the deployment of Clean Fuels.

Despite the disappointing development rate, the benchmark of Clean Fuel performance in the Northern Scandria@Corridor shows that the countries are ahead regarding both BEVs and PHEVs when compared to the rest of Europe. Hence, even if the Northern Scandria@Corridor countries need to improve in order to reach the goals set for the reduction of CO<sub>2</sub> from transport, there are many good

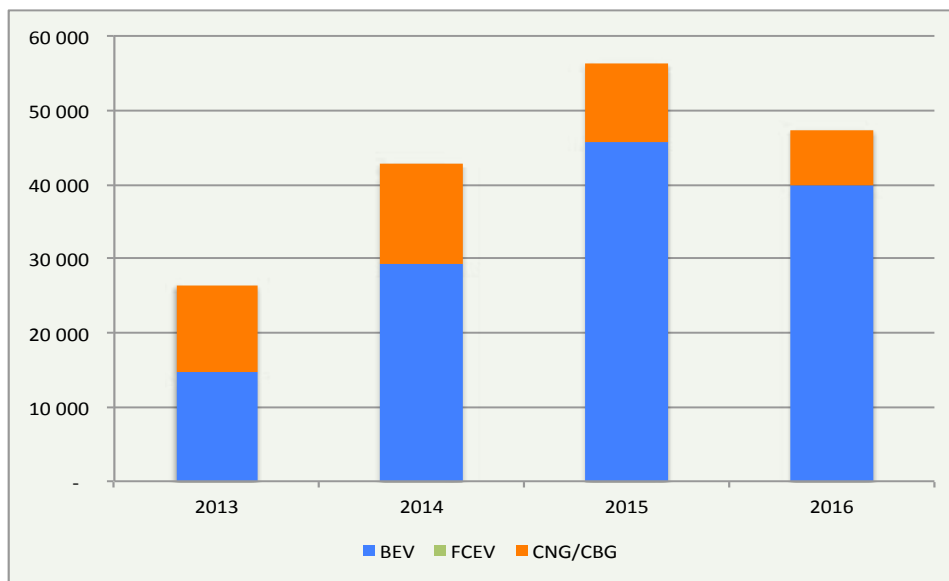


Figure 1. Total number of alternative fuel passenger vehicles sold in Germany, Denmark, Sweden, Norway and Finland in 2015 and 2016. Numbers are given at a national level. Source: [EAFO].

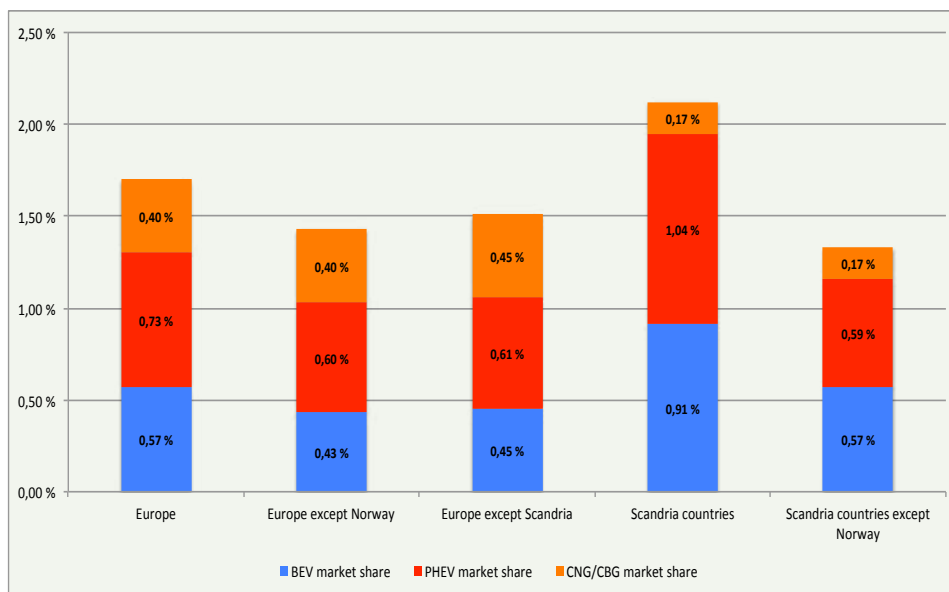


Figure 2. Market share of BEVs, PHEVs and CBG/CNG passenger vehicles in 2016. Numbers are given at a national level. Source: [EAFO].

examples and experiences from the Corridor that it would be desirable to spread to the rest of Europe, as shown in chapter 9.

## 1.2 Key findings

We hereby present our key findings at the national and Corridor level, regional level and in terms of fuel specific issues.

### National and Corridor level:

1. The deployment of Clean Fuels in the Northern Scandria®Corridor is developing too slowly to reach the desired national and EU/EEA targets for reduction of CO<sub>2</sub> emissions from transport.
2. Stronger national incentives are important to foster infrastructure development and the use of Clean Fuels. Aims are different in different countries. Some of the Scandria®Corridor countries don't seem to use strong enough incentives to ensure the required development.
3. Availability of Clean Fuel infrastructure is in general too limited to ensure clean transport throughout the Northern Scandria®Corridor. Lack of Clean Fuel infrastructure in some countries may actually hinder the use of Clean Fuels for long-distance transport of goods and persons in the Northern Scandria®Corridor.

4. There is a need for standardised payment systems for Clean Fuels across the national borders.

5. A limited model selection of Clean Fuel vehicles and especially the limited consumer perception of these cars are obstacles to market development. BEVs with a longer range are expected in 2017, but they will still be in the small and medium sized market. FCEVs are slowly entering the market and in limited numbers. A range of CBG/CNG cars are available in all segments, except luxury class, which will change at the end of 2017. Light and heavy CBG/CNG and LBG/LNG vehicles are also available for each weight category. In contrast, BEV trucks from 7.5 tons upwards are still not standard production vehicles. The same applies for FCEV heavy duty vehicles. At a market level, OEMs sales and marketing activities still focus on conventional combustion engines, mainly the segment of powerful larger vehicles such as SUVs.

#### **Regional level:**

6. Public transport plays an important role in increasing the use of Clean Fuels. Municipalities, counties and regions should demand that public transport is run on Clean Fuels. Regulatory measures may be used to foster this, where possible.

7. Regional and local decision makers will become more important as the main driver for shifting to alternative fuels in the near future. The EU infringement procedure against many Member States and Communities regarding air pollution (particle matters, NOx), increases the pressure to implement measures significantly reducing pollutants. There are several examples in the Northern Scandria@Corridor demonstrating how political decisions have fostered market development.

8. The regional perspective is important in ensuring the development of Clean Fuel infrastructure in such a way that it permits, and stimulates, transport with Clean Fuels. Municipalities and regions have the chance to be the main driver for clean vehicles while demonstrating their concern for air pollution control. They can implement their own Clean Fuel strategies and strengthen regional cooperation on the deployment of Clean Fuels. In the best case, municipalities match each other in implementing measures and should be aware of (EU) financing instruments allowing the co-financing of strategic planning and investments. Collaboration between regions may give OEMs

a larger market to address with a specific vehicle as well.

#### **Fuel specific issues:**

9. The cost of producing renewable fuels is in generally much higher than that of fossil alternatives. This may be because of low production volumes and the technology being immature. Furthermore, the infrastructure build up and maintenance costs of CBG/CNG, LBG/LNG and hydrogen are above those of petrol stations. Also no successful business case has been made thus far for the construction of charging stations. This is especially challenging in the market ramp-up phase when there is relatively low fuel demand. Tax incentives or other supporting incentives as well as regulatory instruments are needed to make the clean alternatives more competitive.
10. There are several best practice examples of setting frameworks, using incentives and carrying out concrete measures within the Northern Scandria@Corridor. Information about these should be more widely spread so that they can serve as inspiration for other regions.

The conclusions from this report show that there is an absolute need for the continuing activities in the Scandria@2Act work package of Clean Fuel Deployment:

- *A2.2 Increasing regional capacity to implement Clean Fuels in a Corridor perspective*, where the output report will contain a concept for a Clean Fuel Multi-fuel station, an analysis of best practice for public/private partnership finance models for investments in Clean Fuel infrastructure, and lessons learnt from e-mobility in city logistics. Moreover the report will contain an evaluation of the transferability to other Corridor regions, and a recommendation concerning the strategic action at decision-making level.
- *A2.3 Fostering Clean Fuel Deployment in the Northern Scandria@Corridor*, where the output is a Clean Fuel Deployment Strategy that addresses action fields of strategic relevance and identifies relevant measures needed to enable Clean Fuel deployment.
- *A2.5 Fostering Market Access of Clean Fuels*, where three Clean Fuel Corridor Road Show events will be realised in Oslo/Akershus, Skåne/Öresund and Berlin-Brandenburg to communicate the broad experiences in the partner regions directly to potential customers.



# 2

## Introduction



## 2 Introduction

The Scandria@2Act project addresses major regional development challenges associated with future transport development along the Baltic Sea Region stretch of the Scandinavian-Mediterranean Core Network Corridor. In this report, the geographic scope of the Scandria@2Act project is referred to as “the Northern Scandria@Corridor”.

This Corridor includes the following regions and counties:

- Germany: Hamburg, Schleswig-Holstein, Lower Saxony, Mecklenburg-Vorpommern, Brandenburg and Berlin.
- Denmark: the whole country.
- Sweden: The regions of Halland, Jönköping, Kronoberg, Skåne, Stockholm, Södermanland, Uppsala, Västmanland, Västra Götaland, Örebro and Östergötland.
- Norway: Oslo, Akershus, Østfold and parts of Hedmark, along the E-16.
- Finland: Uusimaa, Pirkanmaa, Southwest Finland, Tavastia Proper and Satakunta.

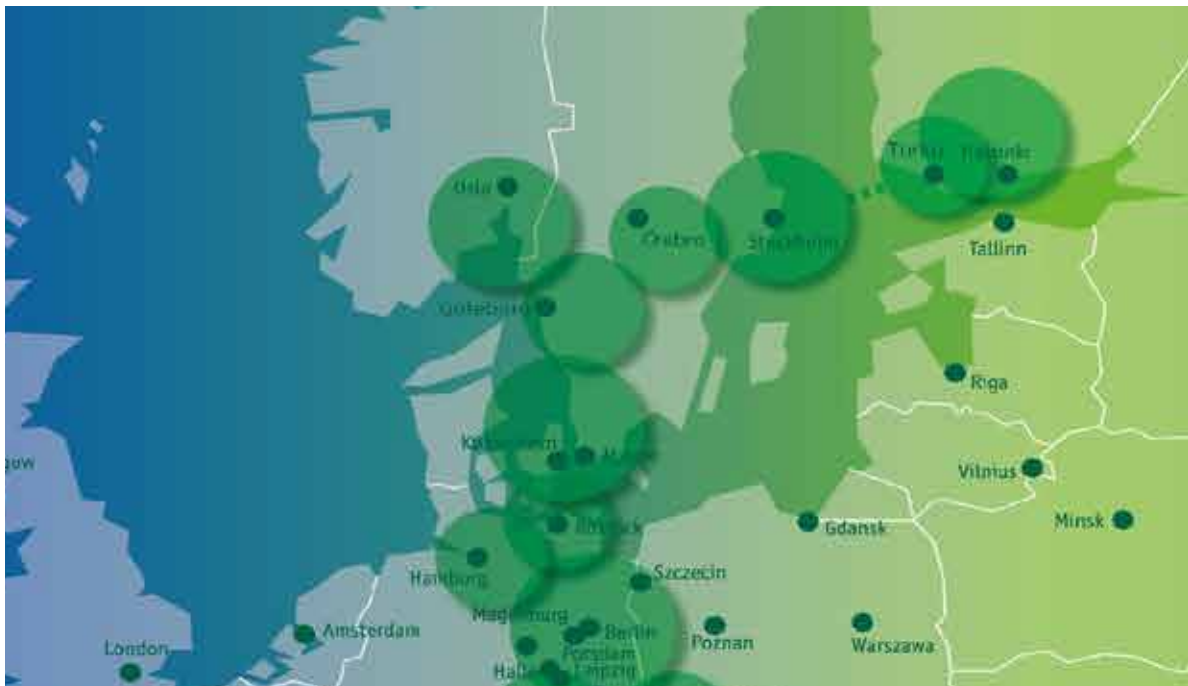
The partnership is composed of local and regional authorities, national authorities, expert and business support organisations, private transport operators and academic institutions from the five countries.

The major objective of Scandria@2Act is to foster clean, multimodal transport throughout the Corridor regions to increase the connectivity and competitiveness of these Corridor regions, while at the same time minimizing negative environmental impact created by transport activities. To achieve this objective, the project partners have developed a joint approach that addresses:

- The deployment of Clean Fuels (WP 2);
- The deployment of multimodal transport services (WP 3);
- The establishment of a multilevel governance mechanism based on mutual dialogue between decision makers at regional, national and European level (WP 4).

### 2.1 Directive on the Deployment of Alternative Fuels Infrastructure

The Directive on the Deployment of Alternative Fuels Infrastructure [DAFI] establishes a common framework of measures for the deployment of alternative fuels infrastructure in the European Union in order to minimise dependence on oil and to mitigate the environmental impact of transport. The Directive sets out



*Figure 3. Geographic Scope of the Scandria@2Act project. The Northern Scandria@Corridor consists of regions in Germany, Denmark, Sweden, Norway and Finland.*

minimum requirements for the development of alternative fuels infrastructure, including charging points for electric vehicles and refuelling points for natural gas (CBG/CNG and LBG/LNG) and hydrogen, to be implemented by means of the Member States' national policy frameworks, as well as common technical specifications for such charging and refuelling points, and user information requirements.

Each Member State shall adopt a national policy framework for the development of the market as regards alternative fuels in the transport sector and the deployment of the relevant infrastructure. An assessment of the current state and future development of the market regarding alternative fuels in the transport sector, national targets and objectives for the deployment of alternative fuels infrastructure etc should be included in the policy framework. Member States were to notify the Commission of their national policy frameworks by 18 November 2016. As of March 16th, 16 of 28 states have submitted their policy documents, and they are being analysed by DG Move before they are published [MORSI].

## 2.2 Clean Fuels and Clean Fuel Vehicles

In this report, the terms Clean Fuels and alternative fuels are used interchangeably. The following fuels are included in the assessment, according to [DAFI]:

- Electricity
- Hydrogen
- Natural gas, compressed and liquefied
- Biomethane (upgraded biogas), compressed and liquefied

Biogas is produced by the anaerobic digestion of organic matter such as dead animal and plant material, manure, sewage, organic waste, etc. Biogas contains methane (CH<sub>4</sub>), carbon dioxide (CO<sub>2</sub>) and small amounts of other gases. After the removal of contaminants, biomethane is the same as natural gas, and can be used as a transport fuel in the form of Liquid Biomethane (LBG) or Compressed Biomethane (CBG).

Clean Fuel Vehicles are specified as follows in this report:

- BEVs, Battery Electric Vehicles, are vehicles that only use batteries as energy storage. Plug-in Hybrid Electric Vehicles (PHEVs) are not considered Clean Fuel vehicles. However, some of the figures in the report also show numbers for PHEVs.
- FCEVs, Fuel Cell Electric Vehicles, sometimes called Hydrogen Vehicles, are vehicles using

hydrogen as the fuel for a fuel cell, generating electricity to drive the vehicle. Electric Vehicles with a hydrogen and fuel cell system as a range extender are also denoted FCEVs.

- CBG/CNG vehicles use compressed natural gas or compressed biomethane as fuel.
- LBG/LNG vehicles use liquefied natural gas or liquefied biomethane as fuel.

## 2.3 Clean Fuel Vehicle numbers

Our study focuses on the five countries constituting the Northern Scandria@Corridor. The numbers of Clean Fuel Vehicles referred to is sometimes at national level, and sometimes at the Corridor level. EAFO is the European Commission's initiative to provide alternative fuels statistics and information regarding electricity, hydrogen and natural gas [EAFO]. We have used EAFO numbers in some parts of the report, especially in chapter 6, describing the market access of Clean Fuels. EAFO numbers are at national level only. Numbers in chapter 4 are at the Corridor level, including regions that are part of the Northern Scandria@Corridor only. It is clearly stated in each case if numbers are at the national or Corridor level.

Even though the numbers from EAFO are provided at a national level only, we find that they have a high relevance for our purpose. For Norway, Sweden and Finland the most densely populated areas are included in the Northern Scandria@Corridor. All of Denmark is included. For Germany, the Scandria part constitutes a minor part of the country with respect to the number of inhabitants. EAFO emphasize that the website is in the making and that the accuracy of the data is not guaranteed. Considering this, and the fact that the numbers are given at a national level, our conclusions based on the numbers from EAFO should be seen as normative. However, lacking up to date statistics for the Northern Scandria@Corridor, we consider the numbers from EAFO to give a representative picture for development in the Northern Scandria@Corridor.

We sometimes refer to the number of new registrations per year, and sometimes the total number of vehicles in a certain year. The latter includes all vehicles registered, including new registrations in the year in question. This is also clearly stated in the text whenever it is relevant.

## 2.4 Clean Fuel Deployment

The overall aim of work package 2 is to enable the deployment of Clean Fuels with regard to freight and passenger transport along the Northern Scandria@Corridor, addressing the deployment of Clean

Fuel infrastructure and the penetration of Clean Fuel technology into the market.

The utilisation of Clean Fuels will be optimized according to their specific advantages through an inclusive multi-fuel approach i.e. LBG/ LNG, CBG/ CNG, BEV (Battery Electric Vehicle) and FCEV (Fuel Cell Electric Vehicle).

A Clean Fuel infrastructure deployment strategy will be developed in project activity 2.3, to empower regions with the knowledge to deploy Clean Fuel solutions that work in a transnational Corridor environment. The strengths and weaknesses of regional approaches will be assessed and recommendations for legislative, financial and technological measures at the various decision making levels will be given to shape European and national policies dedicated to alternative fuels.

The market share of Clean Fuels is supposed to be increased by a Clean Fuel Corridor Road Show in project activity 2.5, aimed at potential customers. The Road Show will present technological, organizational or financing solutions at work within the participating regions. In this way, other regional markets and regional stakeholders will get a better understanding of which solutions are available to meet their future needs.

## 2.5 This report

This report provides a comprehensive overview of the status of Clean Fuel deployment in the Northern Scandria@Corridor and describes experiences of the market access of Clean Fuels. It will enable the partners to identify crucial barriers and best practice examples. The results will later be promoted in the Clean Fuel Corridor Road Shows.

The Assessment of Clean Fuel Market Access Experiences (A2.1) was carried out in parallel with the Assessment of Clean Fuel Deployment in the Northern Scandria@Corridor (A2.4). To collect information, a joint questionnaire was distributed to partners from all Corridor regions and filled out by those partners or national experts external to the project. The assessment followed the Scandria@2Act multi-fuel approach and included biomethane and natural gas, hydrogen and electricity. Biodiesel of different sorts was not included. These fuels can, however, be part of the solution for reducing CO<sub>2</sub> emissions in some countries.

Information regarding policy incentives was also collected through telephone interviews with three national experts from each region, one for each of the fuel technologies: biomethane /natural gas, hydrogen and electricity. The experts and the interview questions are listed in Appendix 3.

The assessment of Clean Fuel Deployment (A2.1) covered the entire Scandinavian-Mediterranean Corridor in the Baltic Sea Region and included the size of vehicle fleets operated on Clean Fuels, the number, location and specifications of Clean Fuel filling stations, legal and political incentives, major obstacles and success factors to Clean Fuel deployment, the identification of Clean Fuel best practice in the Corridor, the set-up of a Clean Fuel expert database, and experiences from the access of Clean Fuel to the market. Passenger vehicles and light and heavy transport vehicles are included in the assessment, as per the project application. Buses and maritime transport are not included.

The output O2.1 from this assessment, the Assessment of Clean Fuel Deployment in the Northern Scandria@Corridor, provides an overview of the status of Clean Fuel deployment in the individual Corridor regions; it also benchmarks Clean Fuel performance in the Northern Scandria@Corridor in the European context, provides results related to obstacles and success factors, exemplifies relevant best practice in the Corridor regions and provides relevant contacts.

As Clean Fuels are entering a fossil fuel-based market, their market penetration is relatively low and has to be fostered by policy incentives. The aim of the Assessment of Clean Fuel Deployment in the Northern Scandria@Corridor (A2.4) was to assess the variety of policy incentives provided in the participating regions at national, regional and local level, while also describing the experiences of deployment of all the relevant types of Clean Fuels throughout the region. The analysis took into account the fact that there are variations in experiences gained regarding the deployment of different types of fuels in different regions. Hence, the assessment of regional successes and failures regarding specific fuels has been carried out, and the experiences described, in such a way that the result is the most relevant possible for stakeholders throughout the regions. The output O2.4, the Clean Fuel Access Experience Report, describes the Clean Fuel market in the respective regions and benchmarks these regions.



Clean Fuel Infrastructure

### 3 Clean Fuel Infrastructure

In the figures given in this chapter, the number and specifications of Clean Fuel refuelling stations available in each country are shown and specified by fuel. The numbers are as per December 2016, unless otherwise noted, and they are given at a Corridor level. In Appendix 2, maps are shown for the infrastructure in the Corridor.

#### 3.1 Electricity

DAFI states the following regarding electricity:

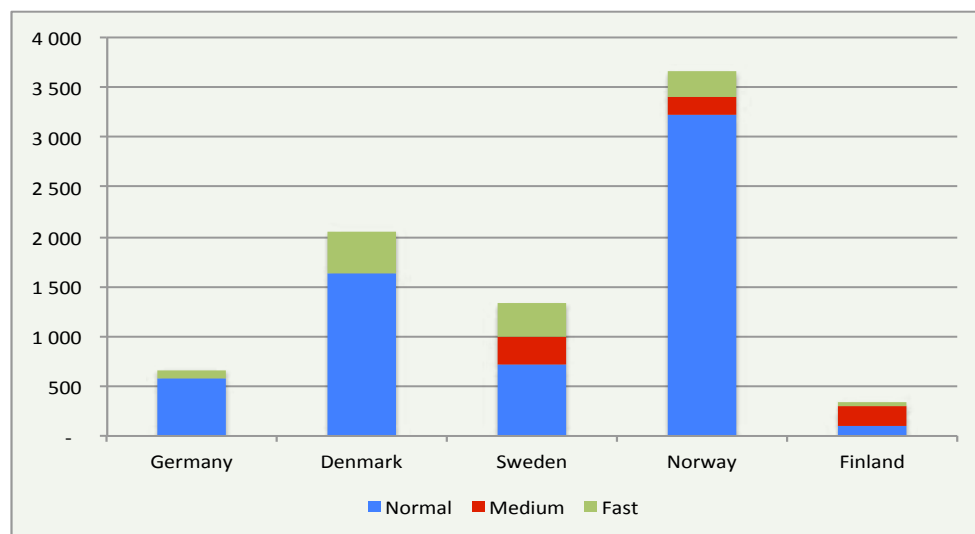
- *Member States should ensure that recharging points accessible to the public are constructed with adequate coverage, in order to enable electric vehicles to circulate at least in urban/suburban agglomerations and other densely populated areas, and, where appropriate, within*

*networks determined by the Member States. The number of such recharging points should be established taking into account the number of electric vehicles estimated to be registered by the end of 2020 in each Member State. As an indication, the appropriate average number of recharging points should be equivalent to at least one recharging point per 10 cars, also taking into consideration the type of cars, the charging technology and the available private recharging points.*

Table 1 and Figure 4 show the numbers of publicly available charging points in the Northern Scandria@Corridor in 2016. Figure 5 shows the number of charging stations in the largest cities and along the main roads in the Corridor.

Charging points	Normal	Medium	Fast	Total
Germany*	579		88	667
Denmark *	1 630		421	2 051
Sweden	715	280	342	1 337
Norway	3 227	167	265	3 659
Finland	98	196	43	337
<b>Total</b>	<b>6 249</b>	<b>643</b>	<b>1 159</b>	<b>8 051</b>

**Table 1.** Publicly available charging points in the Northern Scandria@Corridor in 2016. The numbers for Germany are estimates by T.H. Wildau, and only include the East German states and the states of Schleswig Holstein and Hamburg. \*) The numbers of fast chargers for Germany and Denmark include medium chargers. Source: Project questionnaires and [EAFO].



**Figure 4.** Publicly available charging points in the Northern Scandria@Corridor in 2016. The numbers for Germany are estimates. The numbers of fast chargers for Germany and Denmark include medium chargers. Source: Project questionnaires and [EAFO].



Figure 5. Charging stations in the largest cities and along the main roads in the Northern Scandria®Corridor. The source for the numbers is [www.chargemap.com](http://www.chargemap.com). Normal, medium and fast chargers are included in the numbers.

## 3.2 Hydrogen

DAFI states the following regarding hydrogen:

- *Member States who decide to include hydrogen refuelling points in their national policy frameworks should ensure that a publicly accessible infrastructure for the supply of hydrogen to motor vehicles is created, ensuring the circulation of hydrogen-powered motor vehicles within the networks determined by the Member States. Where appropriate, cross-border links should be taken into account with a view to enabling hydrogen-powered motor vehicles to circulate throughout the European Union.*

Table 2 and Figure 6 show the number of publicly available hydrogen refuelling stations in the North-

ern Scandria@Corridor. We split these into 350 bar and 700 bar stations. Stations delivering 350 bar are used by buses and some light duty vehicles using hydrogen and fuel cells as a range extender. For passenger FCEVs, the standard is 700 bar. For Norway, three of the four 700 bar stations are demonstration type stations with a limited capacity. The other stations in the Corridor have a larger capacity, typically 150-200 kg per day, and are able to serve about 50 vehicles a day.

Figure 7 shows the location of hydrogen refuelling stations in the Northern Scandria@Corridor. 350 bar, 700 bar and combined stations are marked in different colours.

Hydrogen stations	350 bar	700 bar	Total
<b>Germany</b>	2	7	<b>9</b>
<b>Denmark</b>		10	<b>10</b>
<b>Sweden</b>	1	2	<b>3</b>
<b>Norway</b>	1	4	<b>5</b>
<b>Finland</b>	1	1	<b>2</b>
<b>Total</b>	<b>5</b>	<b>24</b>	<b>29</b>

Table 2. Publicly available hydrogen refuelling stations in the Northern Scandria@Corridor in 2016.

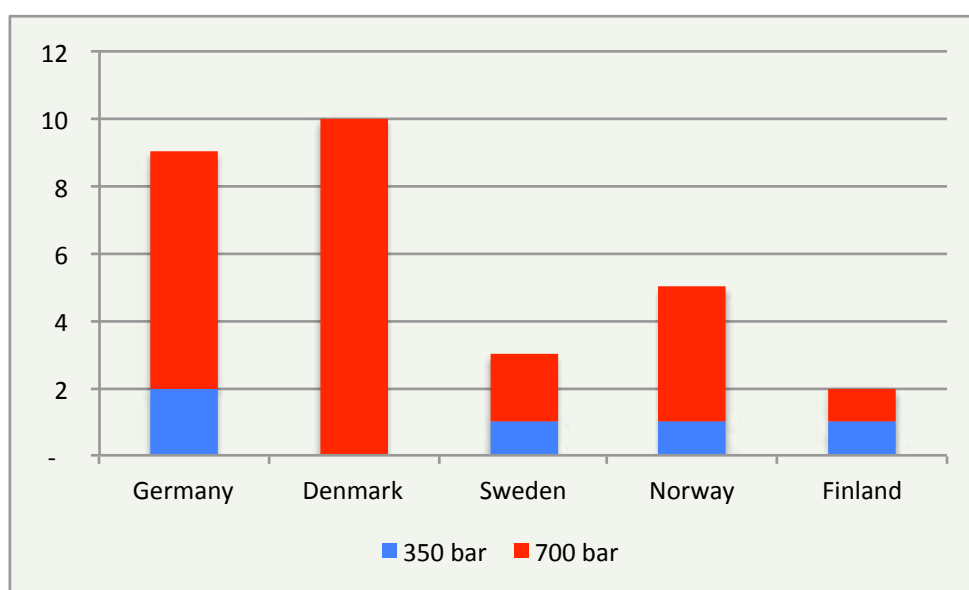


Figure 6. Publicly available hydrogen refuelling stations in the Northern Scandria@Corridor in 2016

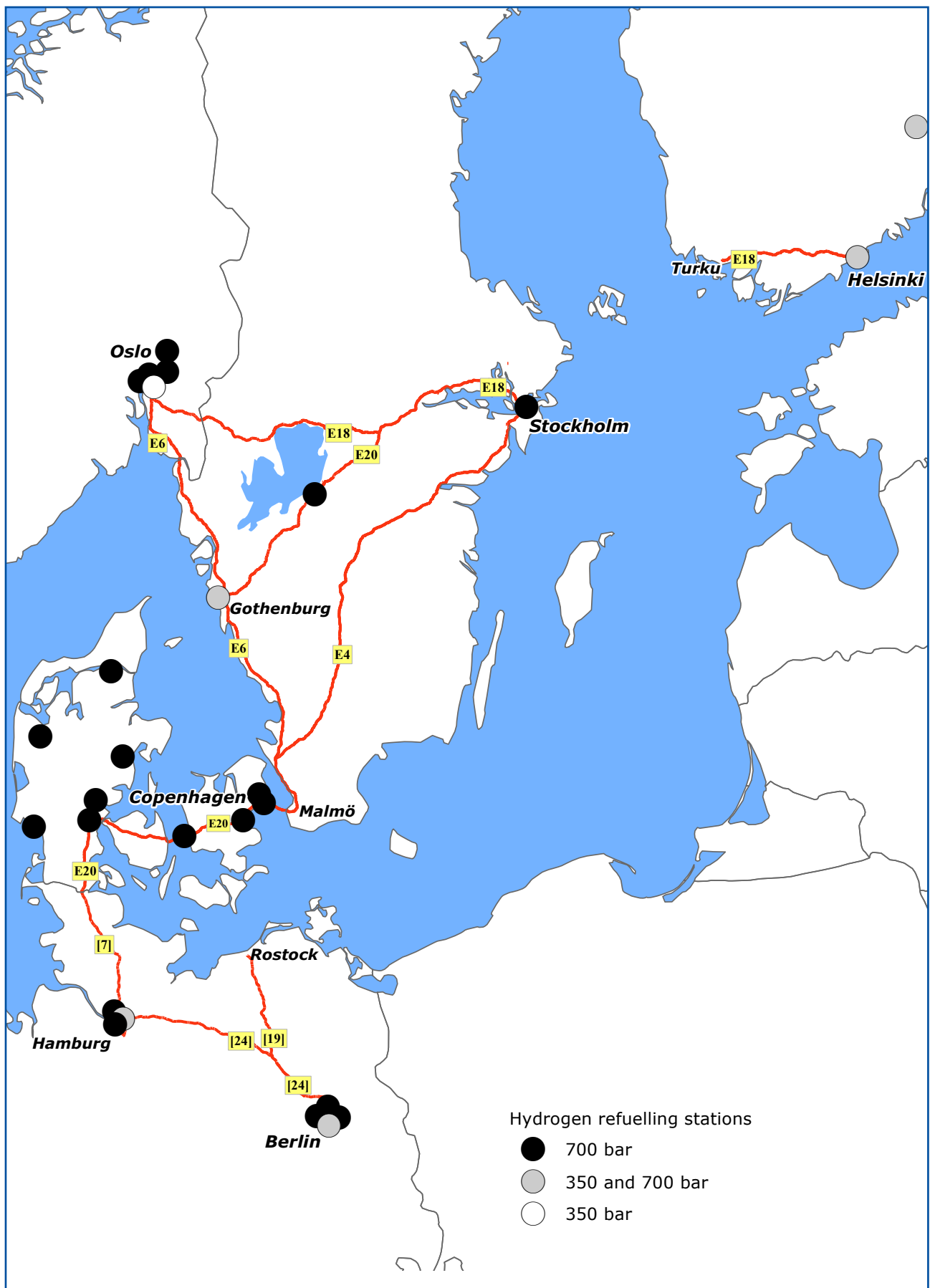


Figure 7. Hydrogen refuelling stations in the Northern Scandia@Corridor.

### 3.3 Biomethane and natural gas

DAFI states the following regarding CBG/CNG:

- *Member States should ensure, by means of their national policy frameworks, that an appropriate number of publicly accessible refuelling points is constructed for the supply of CNG or compressed biomethane to motor vehicles, in order to ensure that CNG motor vehicles can circulate in urban/suburban agglomerations and other densely populated areas as well as throughout the European Union, at least along the existing TEN-T Core Network.*
- *When establishing their networks for the supply of CNG to motor vehicles, Member States should ensure that refuelling points accessible to the public are put in place, taking into account the minimum range of CNG motor vehicles. As an indication, the necessary average distance between refuelling points should be approximately 150 km. To ensure market functioning and interoperability, all CNG refuelling points for motor vehicles should provide gas of the quality required for use in current and advanced technology CNG vehicles.*

And for LBG/LNG:

- *Member States should ensure an appropriate distribution system between storage stations and refuelling points for LNG. As regards road transport, the availability and geographical location of loading points for LNG tank vehicles are essential to developing an economically sustainable LNG mobility.*

- *The TEN-T Core Network should be the basis for the deployment of the LNG infrastructure as it covers the main traffic flows and allows for network benefits. When establishing their networks for the supply of LNG to heavy duty motor vehicles, Member States should ensure that refuelling points accessible to the public are put in place, at least along the existing TEN-T Core Network, within adequate distances taking into account the minimum range of LNG heavy duty motor vehicles. As an indication, the necessary average distance between refuelling points should be approximately 400 km.*

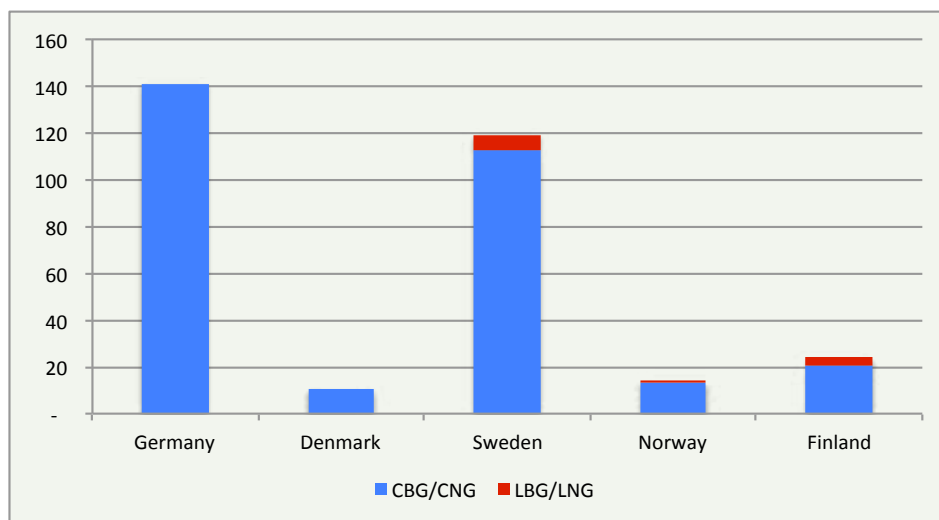
The number of refuelling stations for compressed and liquefied gas in the Northern Scandria@Corridor is shown in Table 3 and Figure 8. About 16% of the total amount of gas at German CBG/CNG stations is biomethane, while in the German part of the Corridor the number is only about 1.5%. Some stations provide 100% biomethane; some have a minor proportion of bio blended with natural gas. The average biomethane proportion being used was 23% in 2014.

In Denmark, 100 % of the gas in the refuelling stations is biomethane. In Sweden, the percentage was 61% in 2013 and 74% in 2015. In Norway, the share of biomethane in compressed gas refuelling stations is 95%. In Finland it is 40% for public refuelling stations and 52% when buses are included.

Figure 9 shows the number of CBG/CNG refuelling stations in the largest cities and along the main roads in the Corridor.

BG/NG stations	CBG/CNG	LBG/LNG	Total	Share of biomethane
Germany	141	1	41	1.5 %
Denmark	11		11	100 %
Sweden	113	6	119	74 %
Norway	13	1	14	95 %
Finland	21	2	15	52 %
<b>Total</b>	<b>299</b>	<b>10</b>	<b>209</b>	

*Table 3. Publicly available refuelling stations for CBG/CNG and LBG/LNG in the Northern Scandria@Corridor in 2016, and the total share of biomethane.*



*Figure 8. Publicly available refuelling stations for CBG/CNG and LBG/LNG in the Northern Scandria®Corridor in 2016.*



Figure 9. CBG/CNG refuelling stations in the largest cities and along the main roads in the Northern Scandria@Corridor.

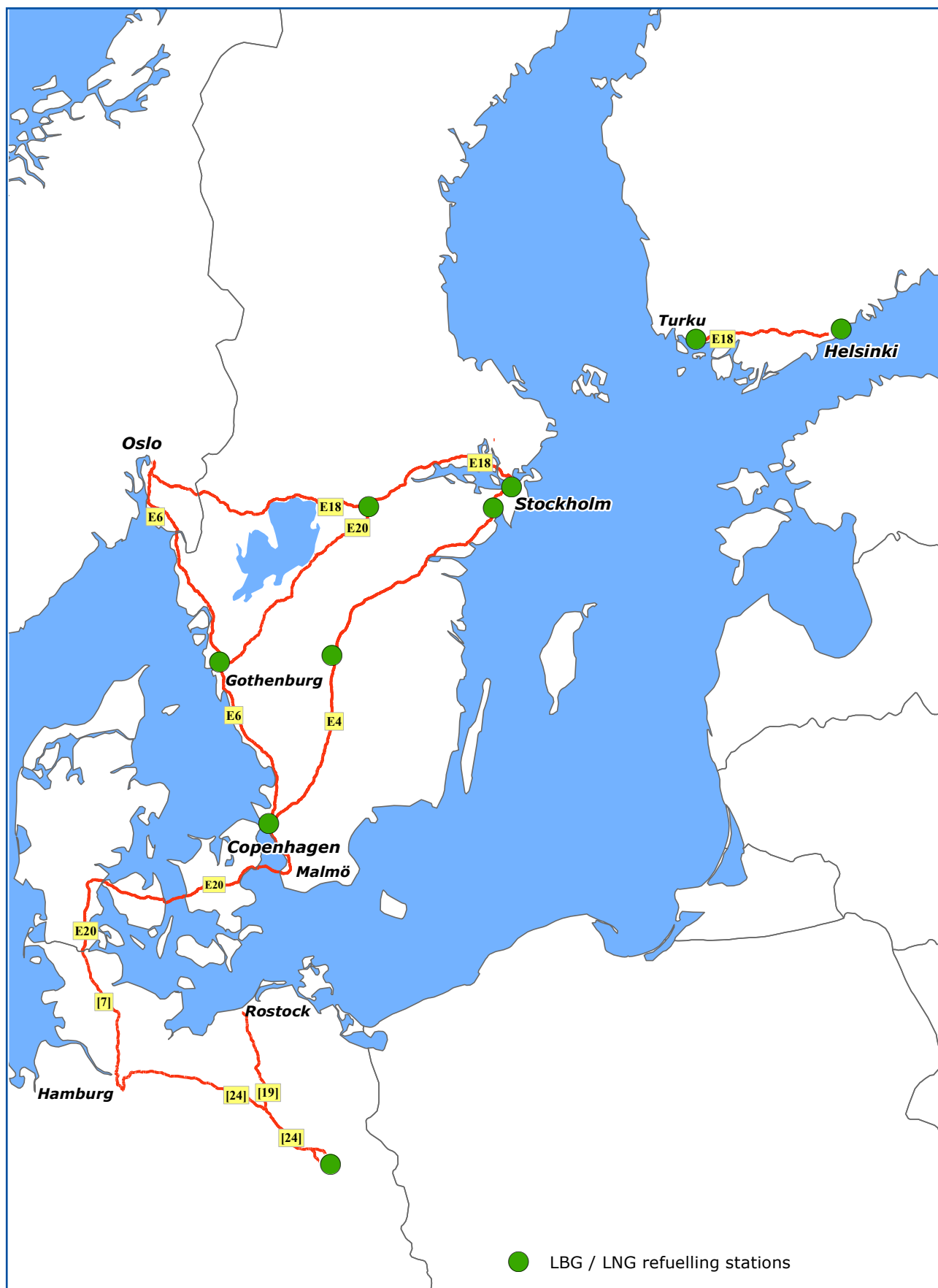


Figure 10. LBG/LNG refuelling stations in the Northern Scandria@Corridor.





# Clean Fuel Vehicles



4



## 4 Clean Fuel Vehicles

In the following table and diagrams, the number of Clean Fuel vehicles in each country in 2013 and 2015 is shown. The sources are project partners and <http://www.statistikbanken.dk>. All numbers in this section are given at a Corridor level.

Table 4 shows the number of vehicles, while the numbers for each Clean Fuel are shown in the figures later in the section. Table 4 includes the total number of vehicles for all fuels in the Scandria part of each country, as well as the total number at a national level, making it easier to consider the number of Clean Fuels related to the total vehicle stock.

Buses are not included in the numbers. It should be noted that there are quite a few buses running on alternative fuels in each country. In Sweden and Germany, CBG/CNG buses are quite common and often used as a solution to reduce CO<sub>2</sub> and local emissions from the public transport sector. The number of CBG/CNG buses within the Swedish part of the Northern Scandria@Corridor was more than 1,700 in 2015; in Germany around 1,450 have been registered. Some Swedish cities within the region are using electric buses as well. Hydrogen buses are used in Oslo and Hamburg, while Finland, Denmark and Norway also have a number of CBG/CNG buses.

	Passenger vehicles		Light Duty Vehicles		Heavy Duty Vehicles	
	2013	2015	2013	2015	2013	2015
<b>Germany</b>						
BEV	1,365	3,014	381	836	20	27
Hydrogen	70	70				
CBG/CNG/LBG/LNG	26,717	27,53	5,995	5,839	184	148
Total all fuels	5,405,504	5,487,987	440,531	465,605	14,494	15,170
Total all fuels, national	43,851,230	45,071,209	2,099,835	2,275,762	529,374	525,018
<b>Denmark</b>						
BEV	1,4	7,45	136	463		
Hydrogen	10	55				
CBG/CNG/LBG/LNG	81	84		79		91
Total all fuels, national	2,237,122	2,329,578	417,016	398,066	42,541	41,495
<b>Sweden</b>						
BEV	862	4,042	414	967		
Hydrogen	2	4				
CBG/CNG/LBG/LNG	34,734	38,697	6,003	6,775	708	747
Total all fuels	3,348,406	3,485,466	357,285	377,985	57,080	57,906
Total all fuels, national	4,496,473	4,669,063	486,052	516,168	79,130	80,046
<b>Norway</b>						
BEV	8,102	27,383	272	1,006		
Hydrogen	10	14				
CBG/CNG/LBG/LNG	32	85	43	50	35	59
Total all fuels	700,752	734,449	132,642	139,029	19,648	20,218
Total all fuels, national	2,500,265	2,610,352	434,636	450,385	79,437	77,120
<b>Finland</b>						
BEV	139	504	84	106		
Hydrogen	1	1				
CBG/CNG/LBG/LNG	1,5	2	100	200	65	100
Total all fuels	352,86	357,039	43,718	43,877	16,532	15,890
Total all fuels, national	3,127,399	3,257,581	391,952	418,87	134,146	142,02

**Table 4.** The number of Clean Fuel vehicles in the Northern Scandria@Corridor in 2013 and 2015. The total number of vehicles for all fuels is included as well, and so is the total number of vehicles at the national level.

## 4.1 Battery Electric Vehicles

Figure 11 shows the total number of BEVs in 2013 and 2015 in the Northern Scandria®Corridor. Although Norway has the largest increase in numbers, Denmark had a comparatively larger increase of passenger vehicles at +432%. For light duty vehicles, Norway had the largest relative increase at +270%.

## 4.2 Fuel Cell Electric Vehicles

Figure 12 shows the total number of FCEVs in 2013 and 2015 in the Northern Scandria®Corridor. The numbers are still at a very low level, but increasing. Denmark had the highest relative increase, at +450%. This is not surprising considering the comprehensive development of infrastructure in the

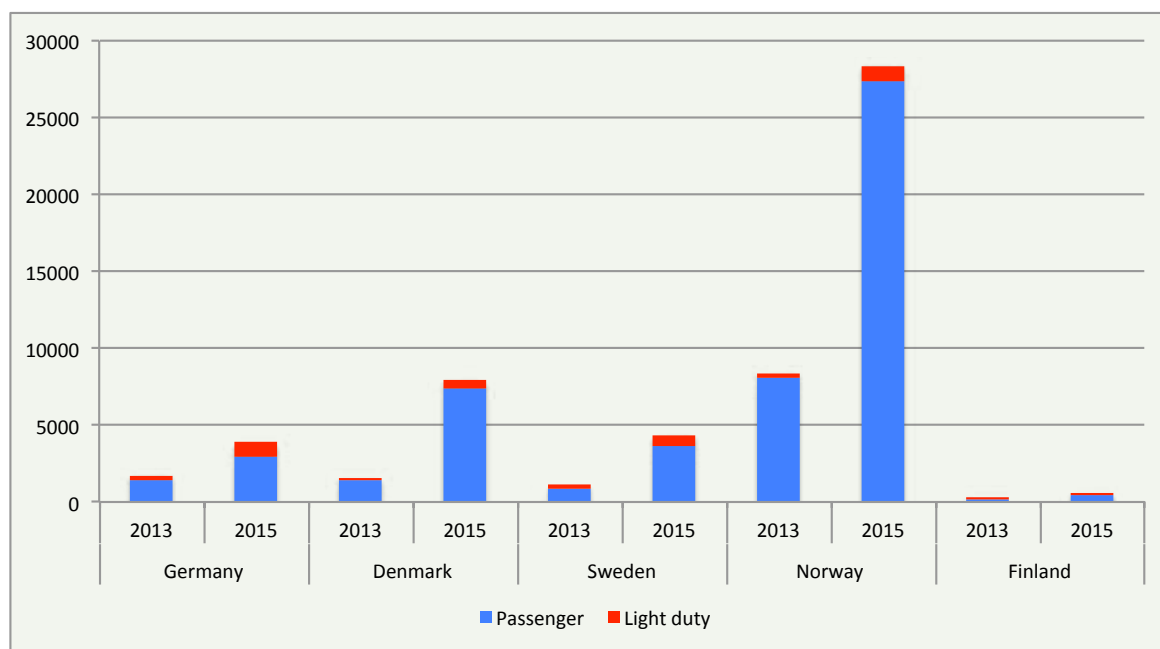


Figure 11. BEV passenger and light duty vehicles in the Northern Scandria®Corridor by country in 2013 and 2015.

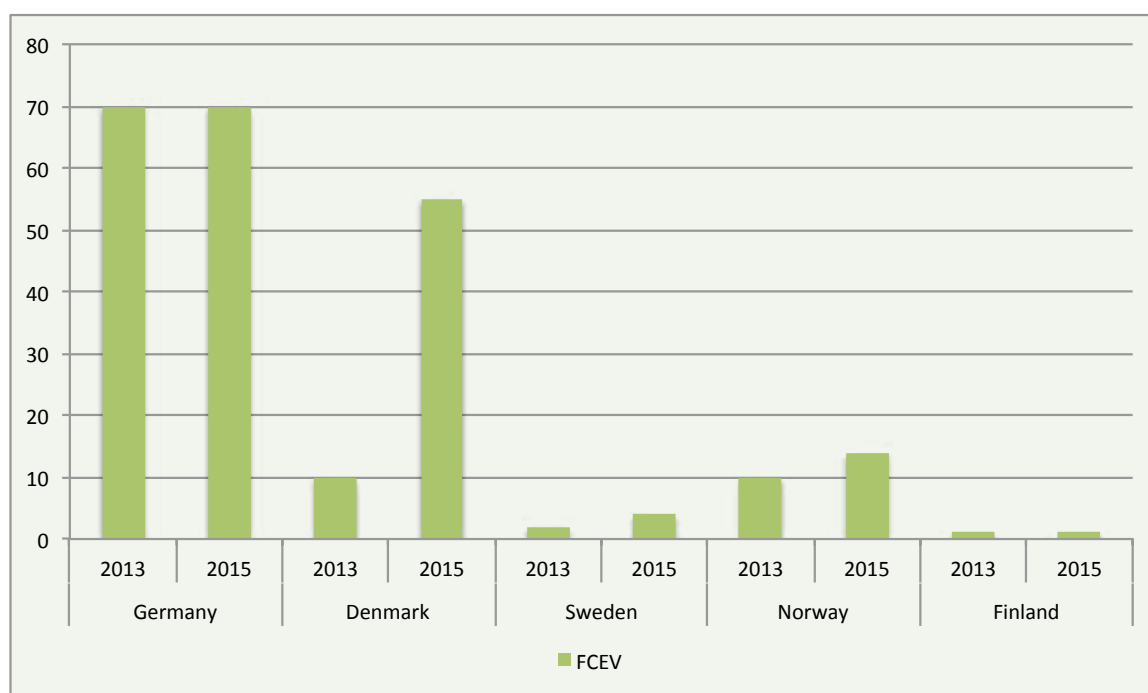


Figure 12. FCEVs in the Northern Scandria®Corridor by country in 2013 and 2015.

same period. The number in Germany is about the same in 2015 as in 2013. The reason is that some fleets used for test and demonstration was withdrawn after the test period between 2013 and 2015.

### 4.3 CBG, CNG, LBG and LNG Vehicles

Figure 13 shows the total number of CBG/CNG/LBG/LNG vehicles in 2013 and 2015 in the Northern Scandria@Corridor. The numbers clearly show the varying prevalence of these fuels in the Corridor, with

Norway and Denmark at a very low level. Although Norway had the highest relative increase for passenger vehicles, the numbers are negligible. Development in Finland is quite good, with an increase in passenger, light duty and heavy duty vehicles of 33%, 100% and 54% respectively. Sweden shows slightly positive development in all categories, while in the German part of the Northern Scandria@Corridor the number of heavy duty vehicles is decreasing by 20%, the number of passenger and light duty vehicles remaining static.

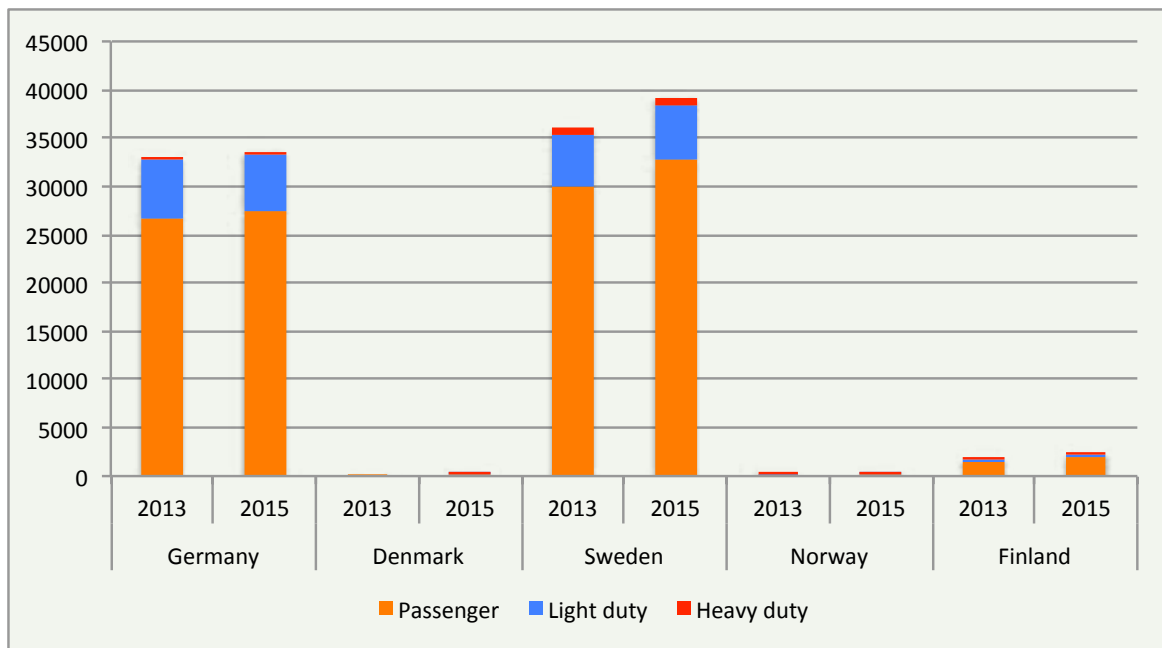


Figure 13. CBG/CNG/LBG/LNG vehicles in the Northern Scandria@Corridor by country in 2013 and 2015.

# Incentives and legislations



## 5 Incentives and legislations

In this chapter we describe the different political and economical incentives available in the five countries, mainly at a national level but also including some important examples of regional initiatives within the Northern Scandria@Corridor. The importance of the incentives is discussed in the next chapter, which focuses on Clean Fuels market access. Information about the incentives was collected through a questionnaire which was filled out by partners or national experts, and through complementary telephone interviews with national experts from each region, as described in chapter 2.5.

National and regional authorities may use incentives and regulatory efforts to foster the deployment of Clean Fuels. Incentives are in general considered to be positive, and to stimulate private persons and companies to choose Clean Fuel vehicles. Tax exemptions and free parking are examples. Regulatory efforts are in general considered more negative, limiting possibilities and enforcing a certain choice. Zero emission zones and demanding zero emission taxis are examples. Output 2.3 of Scandria@2Act, Clean Fuel Deployment Strategy, will analyse the cost and effectiveness of incentives and regulatory efforts.

Table 5 lists relevant incentives for the development of alternative fuels in Europe. Information taken from EAFO has been supplemented with incentives for biomethane studied in Scandria@2Act.

### 5.1 Germany

#### Vehicle incentives

##### *Purchase subsidies*

In general, electric mobility incentives in Germany are financial based. These incentives have two main aims: fostering the acquisition of electric vehicles, in order to establish Germany as a market, and supporting the German industry in becoming a lead provider of electric mobility technology.

A number of financial aid programs exist on a federal level, in order to finance research projects and/or the installation of systems (e.g. IT-systems, accounting, charging and others) or the market entry of new technologies.

The market stimulus package for electric mobility from 18.05.2016 supports the market launch of electric vehicles through further measures. A directive on the promotion of the sale of EVs of up to 3.5 tonnes is implemented by BMVI (The Federal Ministry of Transport and Digital Infrastructure in Germany). An environmental bonus of 2,000 € for BEVs and FEVs and 1,500 € for PHEVs is awarded. This grant is linked to a subsidy of the OEMs of the same amount. So car buyers get an advantage of 4,000 or 3,000 € respectively. The subsidy will be paid up to the total disbursement of the federal funds envisaged for this purpose, amounting to 600 million €, until 2019. In Germany, there are also a number of financial aid programmes at different geographical levels for purchasing electric vehicles and for infrastructure. In some cities, for example, there is a financial award of 500 – 1,000 € per electric vehicle purchased.

CBG/CNG cars do not get special public federal support. But there are some (local) energy suppliers supporting car purchases or fuel consumption. Some federal states also have supporting schemes for CBG/CNG buses. For LBG/LNG, there has been financial support for a pilot project by the BMVI. An amount of 360,000 € has been invested in 20 LBG/LNG trucks. For spring 2017, a general support programme for “Clean trucks” is expected, limited to an amount of 10 million €. LBG/LNG, and CBG/CNG, have an energy tax reduction until 2018. But the German government has approved the extension of this tax reduction until 2026, with a degressive reduction from 2024. Next to broad funding programmes for refuelling infrastructure for hydrogen and electricity, a new programme has been announced to support the

Country	Purchase Subsidy	Registration Tax Benefit	Ownership Tax Benefit	Company Tax Benefit	VAT Benefit	Other Financial Benefit	Local Incentives	Infrastructure Incentives
Germany	✓		✓	✓			✓	
Denmark	✓	✓					✓	✓
Sweden	✓		✓	✓				✓
Norway		✓	✓	✓	✓	✓	✓	✓
Finland		✓	✓					

Table 5. Incentives available by country. Source: EAFO and project questionnaires.

procurement of low CO<sub>2</sub>-emission heavy duty trucks >7.5 tons. CBG/CNG and LBG/LNG could benefit from this programme, as electric or fuel cell drives are not yet commercially available for these kinds of vehicles.

#### **Tax incentives**

BEVs will also be exempt from paying vehicle tax for ten years with retroactive effect from January 2016. From 2017-2020 employees who charge their electric vehicles at work will also be able to pay a reduced tax rate of 25 % on this non-cash benefit.

#### **Infrastructure incentives**

The 10 year programme NIP (National Innovation Program for Fuel Cells and Hydrogen) is ending in 2017. To further support hydrogen technology, a new programme, NIP II, will run for another 10 years from 2017. The aim of NIP II is to provide financial support for hydrogen infrastructure, hydrogen production from renewable energy, and its application in the transport sector.

For charging stations, the transport ministry launched in February 2017 the first phase of a support programme of around 300 million €. For electric vehicles, the support scheme promotes the installation of new standard and high-speed charging stations and the extension of the existing infrastructure. It also stipulates that the electricity for the charging infrastructure comes from renewable energy sources.<sup>1</sup>

Several actions to support investment in charging infrastructure are also being carried out at a regional level. Examples of these are as follows:

- Since October 2014, Mecklenburg-Vorpommern has been providing investment support for normal and fast-charging infrastructure, as well as for hydrogen infrastructure, on the basis of separate funding guidelines for economically active and non-economic organisations.
- In Schleswig-Holstein, various plans exist for the expansion of charging infrastructure, and these are already supported by concrete funding options.
- In the “Hanse” project, 50 charging stations in the metropolitan area of Hamburg are to be launched in order to stimulate the expansion of the charging infrastructure.
- In Leipzig there is financial support of 200 € per wall-box charging station.

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1. [http://europa.eu/rapid/press-release\\_IP-17-266\\_en.htm](http://europa.eu/rapid/press-release_IP-17-266_en.htm)

## **5.2 Denmark**

### **Vehicle incentives**

Until 2015 there was no registration tax for EVs in Denmark. This was changed from 2016. The calculation of Danish registration tax is very complicated. The car's value is a major factor, but the way it is equipped and the engine's energy consumption also play a role. In the phase-in period, BEVs are subject to a registration tax of 20 % of full tax in 2016, 40 % in 2017, 65 % in 2018, 90 % in 2019 and 100 % from 2020. This means that in 2020, the buyer of a BEV must pay a registration tax that corresponds to 150 % of the value of the BEV [FLADER]. In 2016 and 2017, BEVs are granted the basic allowance for the registration tax of up to about 1,356 € (10,000 DKK). There is for the moment no registration tax for FCEV's.

Incentives for biomethane are directed to the production of the gas, not the use. There are no tax reductions. There is a 0.4 € (3 DKK) tax per m<sup>3</sup> for using both natural gas and biomethane. The reason for the equalized tax is that it is not possible to guarantee what type is distributed from the dispenser, and therefore as long as there is a blend it is taxed as natural gas.

### **Purchase subsidies**

The Danish Energy Agency provides subsidies up to a maximum of about 2,700 € (20,000 DKK) to municipalities and companies buying BEVs, until a certain amount of subsidies has been spent.

### **Infrastructure incentives**

There are electricity tax reductions for those who hire or subscribe to a recharging point in Denmark. This is decided on a year-to-year basis. There are also some indirect incentives such as free parking in some municipalities. The difference in parking costs for EVs and fossil fuel vehicles is restricted by the Danish government.

Hydrogen refuelling infrastructure is built partly by public funding, via EU and/or national programs. The only national incentive for encouraging the use of natural gas and biomethane for transport is a project of about 5.4 million € (40 million DKK), whereby about 1.3 million € (10 million DKK) is used to support a refuelling station in Skive municipality which opened in October 2016. As part of the project, 40% of the additional cost of a truck that will be used by a private transport company is subsidised. There are no regional incentives for using natural gas as a fuel.

## 5.3 Sweden

Sweden has purchase subsidies, ownership tax benefits and company tax benefits.

In Sweden, most of the relevant legal and political incentives are of a general nature and mainly technology neutral. Most of them are economic incentives, but policy instruments also exist. The Swedish Energy Agency is focusing their research programmes mainly on vehicles, biofuels, energy efficiency, and a demonstration programme for electric vehicles, including cost-effective recharging systems.

### Vehicle and fuel incentives

#### *Tax benefits*

Fossil fuels are charged carbon and energy tax in Sweden while all biofuels that meet the EU sustainability criteria in accordance with Directive 2009/28 / EC are exempted.

Sustainable CBG is exempted from carbon and energy tax, and CNG is exempted from energy tax. The European Commission has approved tax exemptions for liquid and gaseous biofuels. This decision applies until the end of 2018 for liquid biofuels and until the end of 2020 for biomethane, and has a corresponding value of around 75 € (708 SEK/MWh) compared to petrol and around 60 € (570 SEK/MWh) compared to diesel.

Passenger vehicles, light duty vehicles and light buses with improved environmental properties, so-called green cars, are exempted from vehicle tax for the first five years. To be exempted from vehicle tax, these vehicles must meet the emission requirements of Euro 5 or Euro 6.

The Government intends to introduce a bonus-malus system, at the latest by July 2018, which will significantly increase the target level for the environmental impact of the vehicle tax compared to the current system. In the bonus-malus system, vehicles with relatively low emissions will be rewarded at purchase, while vehicles with relatively high emissions will be burdened with an elevated vehicle tax.

In Sweden, there is also a reduced taxable benefit for certain green vehicles. A taxable benefit occurs when an employee uses a vehicle for private purposes that was allocated to them for employment or assignments. The taxable benefit for green cars is reduced to a level equivalent to the benefit of the closest comparable conventional car, in order to facilitate the introduction of green cars to the market.

For some green cars (electric cars, plug-in hybrids

and CBG/CNG vehicles) a reduction equivalent to 60 % of the taxable benefit for the nearest comparable conventional car, with a maximum of about 1,690 € (SEK 16,000) per year, was temporarily introduced until the end of 2016. In the Budget Bill for 2017, the Government proposes that this temporary reduction is extended until 2020, and that the maximum reduction is limited to about 1,055 € (SEK 10,000) per year.

#### *Purchase subsidies*

The Swedish "Miljöbilspremie" and "Supermiljöbilspremie" - green car rebate and super green car rebate - are important incentives. The green car rebate of about 2,110 € (SEK 20,000) is paid to newly registered vehicles with CO<sub>2</sub> emissions up to a maximum of 50 g/km, while the super green car rebate, about 4,220 € (SEK 40,000), is paid to vehicles with zero CO<sub>2</sub> emissions.

### Other financial benefits

Sweden has introduced environmental zones in the three largest cities for heavier vehicles. This trend has continued and been supplemented by crowding charges in Stockholm and Gothenburg. The legal right for municipalities to establish environmental zones for light vehicles is however lacking in Sweden today.

### Infrastructure incentives

"Klimatklivet", a state programme for investing in local and regional climate impact reducing measures, was introduced in 2015 with an initial total budget of about 203 million € (SEK 1,9 billion), to be distributed from 2015 to 2018. Most of the supported investments include building charging stations for electric vehicles, converting from fossil fuel to renewable, or expanding production of biogas. The aid covers on average about 40% of the total investment cost. So far, approximately 33 % of applications have been approved. The program is prolonged so that 1.6 billion SEK are added in total until 2020.

## 5.4 Norway

Norway has all types of incentives, except purchase subsidies. The zero emissions incentives include the following (year introduced in parentheses):

- No purchase/import taxes (1990)
- Exemption from 25% VAT on purchase (2001)
- Low annual road tax (1996)
- No charges on toll roads or ferries (1997 and (2009)
- Free municipal parking (1999)

- Access to bus lanes (2005)
- 50 % reduced company car tax (2000)
- Exemption from 25% VAT on leasing (2015)
- Exemption from electricity tax for hydrogen production

### **Incentives for reducing purchase price and yearly cost**

The Norwegian transportation sector is heavily taxed, and an exemption can be of great economic value. The first-time registration or import tax is based on emission and weight. For the Volkswagen Golf, for example, one of the most popular cars in Norway, the tax is between 6,000 € and 9,000 € (52,000-78,000 NOK). VAT is calculated as 25% of sales price minus registration tax. The exemption from the two taxes makes the BEV and FCEV price comparable to that of fossil fuel cars. For CBG/CNG cars there are no purchasing incentives.

The annual road tax applies for private cars, at three different rates. For 2017 the rates are about 362 € for diesel cars, 310 € for gasoline cars and 50 € for zero emission cars. The tax on using a zero emission company car is 50% of that applied to a conventional car.

Enova, a public enterprise owned by the Ministry of Petroleum and Energy, has introduced a programme for the funding of professional fuel cell vehicles in March 2017. The programme provides funding of up to 50% of additional costs for fleets of passenger and light duty vehicles, and also for projects demonstrating heavy duty vehicles and buses.

### **Incentives for reducing usage costs and time saving**

Zero emission cars do not pay fees on toll roads, or on ferries. Toll roads may be expensive, especially in the Oslo area and other larger city areas. The cost saving may be up to 1,000 € per year for commuters, and in some areas much more. For ferries, this is relevant in more rural areas, and the value for this incentive may also be high. Free parking is another benefit that may reduce costs by quite large amounts, especially in urban areas. The exemption is only for municipal parking, however, and car parks are for the most part operated by private companies. Access to bus lanes is a benefit that allows EV users save time driving to work during rush hour. This is of high value to users in regions with heavy rush-hour congestion.

Biomethane has an exemption from road tax, while a blend of biomethane and natural gas will be taxed. The tax exemption is currently being notified at ESA. At present the tax level is unknown. No other incentives for the use of biomethane are currently offered.

### *Incentives being adjusted*

The BEV incentives were originally meant to last until 2017 or until a target of 50,000 BEVs was reached, whichever occurred first. BEV number 50,000 was registered in April 2015. The Norwegian government has extended the incentives, recognising that BEV diffusion in the rest of the world is developing more slowly than expected, and that the vehicles still are more expensive than gasoline and diesel cars. The government has stated that the incentives will be kept in place until 2020, however indicating that some of them might be adjusted. This has already been done in some cases. BEVs are, for instance, not allowed in bus lanes on the main roads in Oslo during rush hours unless there are two or more persons in the car. Municipalities are now free to charge BEVs for municipal parking, but the fee should not be more than 50% of the standard rate. On toll roads in and out of Oslo the plan is to charge BEVs from 2017. The fee will however be much lower than for fossil fuel cars, still making BEVs a much cheaper alternative. For FCEVs, the incentives are expected to last until 2025 or until there are 50,000 FCEVs registered.

### **Infrastructure incentives**

Incentives for developing the charging infrastructure have also been comprehensive. Enova has funded infrastructure in cities as well as on the main roads between the larger cities. In 2015 and in 2016, there have been four initiatives for support for the development of a basic charging infrastructure. Funding has been provided as tenders, based on transport corridors prioritized in the National Transport Plan. The funding has usually been up to 50% of the building cost.

There are several infrastructure measures at the regional and local level. Counties and municipalities have supported the building of normal and fast-charging stations, especially those located at public buildings, sports arenas and other public places.

Enova has funded investments in the hydrogen refuelling stations available today, as part of a New Technology Program. From 2017, Parliament has asked Enova to launch a support regime for deployment of hydrogen refuelling stations. The Government's aim is to use the incentives to establish an infrastructure sufficient for a number of cars, until the market is commercially viable. Details of the support scheme are not yet known.

Enova provides funding for manufacturing plants wanting to upgrade biogas to fuel quality. There is also some limited funding for investments in smaller biogas plants in agriculture.

## 5.5 Finland

### Vehicle and fuel incentives

#### *Tax benefits*

Car taxation was reformed in Finland in 2007 and in 2011. The registration tax on passenger vehicles was differentiated according to vehicle-specific emissions (g CO<sub>2</sub>/km). The lowest tax rate (5 %) on the retail price applies to cars with zero carbon dioxide emissions, while the highest tax rate (50 %) applies to cars with carbon dioxide emissions exceeding 360 g/km.

The Vehicle Tax Act was also reformed in 2007, 2011, and 2015. In these reforms, the basic part of the tax was differentiated according to the carbon dioxide emissions of each vehicle, as in the car taxation reform. The first two taxation reforms were beneficial to all low-emission cars, irrespective of the technology used. But the 2015 tax reform specif-

ically raised the taxes of lower CO<sub>2</sub> emission passenger cars. The basic part of the emission-based vehicle tax now varies between 69 € and 617 € per year, depending on the car's specific carbon dioxide emissions.

#### *Purchase subsidies*

During the period 2012 to 2017 a total of 9,000,000 € of energy investment subsidy has been allocated to companies purchasing BEVs, FCEVs and charging equipment. The subsidy programme is implemented at a national level. Cars received a maximum 30 % subsidy (max. 500 €/month) and charging points 35 % subsidy. On average, cars received 330 € worth of subsidy / month over the leasing period of 36 months. No other kind of incentives and beneficial regulations exist for BEVs.

# 6

## Market access of Clean Fuels



## 6 Market access of Clean Fuels

In this chapter we describe the market access of alternative fuels in each country. This is related to incentives to support the use of the fuels and for the development of infrastructure. The findings are mainly based on interviews with experts in each country. We also look into what can be expected of development regarding market access. This part is mainly based on the countries' policy frameworks in accordance with [DAFI].

We use the most recent statistics from EAFO to visualize future development for Clean Fuel passenger vehicles. The numbers are provided at national level only. EAFOs numbers for EVs also include PHEVs, which are given here as well.

### 6.1 Germany

In terms of transport, passenger transport accounts for 55.3% of the share of CO<sub>2</sub> emissions in Germany, followed by public and freight road transport (23.3%), air transport (15%), rail transport (4.5%), public road transport (1.5 %) and shipping (0.4 %) [DAFI-GE]. At the present time, fossil fuels dominate with 94 % share of fuel used in 2015, of which diesel represented 62.6 % share and petrol 31.4 % share. Biogenic fuels amounted to 4.8 % based on the energy content. The energy share of renewable energy sources in the road transport sector amounted to 5.3 % in 2015, which represents a drop of -0.3 % compared to 2014. By 2015, the share of biomethane of total methane used for transport was 20%; in 2016 it declined to around 16 %.

The German car market has been growing since 2014. In 2016, new registrations increased by 4.5%. Generally, a high share of premium cars characterizes the German car market. Due to the recent price decline in conventional fuels as well as strategic marketing activities, new registration of cars like SUVs has increased significantly in the past years. Every fifth new registered car in Germany is today a SUV. Average emissions of new passenger cars are around 128 g CO<sub>2</sub>/km. These circumstances make it harder for alternative fuels and for attempts to increase its market share. At a national level, the proportion of alternative fuel vehicles among new registrations amounted to only 2% in 2016, and these were mainly hybrids.

#### 6.1.1 Electricity

##### Incentives

Generally, electric mobility incentives in Germany have been weak in the past. The responsibility laid partly by communities, as cities could decide if they want to allow BEVs driving on bus lands or have parking priority. Since 2016 there are now some stronger financially based incentives having two main aims:

- Fostering the acquisition of electric vehicles, in order to establish Germany as a market;
- Supporting the German industry in becoming a lead provider of electric mobility technology.

The actual effect of the incentives is difficult to assess at the moment, as most of these programmes started in 2012 at the earliest, and a large number of these programmes started in 2016. The funding aid offering a grant of 2,000 € plus 2,000 from the OEMs for BEVs is important. No new financial incentives that will have a major impact on market development are expected. However, it will be interesting to see to what extent the current discussion about car entry bans on older diesel cars will affect the demand for alternative vehicles.

There are some local BEV benefits such as free parking, reserved parking spots and the use of bus lanes. These incentives seem to be used more in rural areas, whereas the larger cities use the federal incentives. However, in some cases cities support car-sharing and other initiatives aimed at increasing the number of EVs and reducing CO<sub>2</sub> emissions. In Brandenburg there are state-owned organisations helping to find funding for start-up companies who will develop services and technology for EVs.

##### Infrastructure

The infrastructure for electric vehicles seems to be adequate for the number of existing electric vehicles. 73% of the population lives in cities, and this is where the main efforts have been made so far. Commercial users normally purchase their own charging stations. Recently, a joint venture of BMW, Daimler and Ford announced that they intend to create the highest-powered charging network in Europe in order to enable long-range travel for battery electric vehicle drivers.

Recharging for people living in the city may become an important obstacle to development. Most people live in apartments and don't have the possibility of recharging at home. However, a number of energy

providers, prominently RWE and Vattenfall, are starting to install public charging stations in larger cities. There are also some initiatives by larger car sharing companies (e.g. Car2Go, DriveNow, Flinkster), to increase the number of electric vehicles in their fleets, and these initiatives are accompanied by the installation of charging infrastructure.

### Vehicles

Purchase prices for vehicles seem to be a major obstacle to development. In the commercial market, this is coupled with a very thinly spread maintenance network. Trucks of all sizes are estimated to be at least 2 or 3 times more costly. For private cars the purchase prices are still very high; they are estimated to be 1.5 – 2 times more expensive than for gasoline cars. The fact that costs of fuel and maintenance are cheaper than conventional cars, seem to be less important, whilst the fuel price difference is moderate. The purchase price still has a much larger effect on the total cost of ownership because of the high price difference, and it is therefore the most important issue for commercial customers.

Figure 14 shows the number of new registrations of plug-in electric vehicles of category M1 in Germany in recent years. Category M1 is used for the carriage of passengers, with no more than eight seats in addition to the driver's seat; these vehicles are also known as passenger cars. The number was about the same in 2016 as in 2015. This was a change from the trend up to that point, which had an approximately doubling in number for each year. It might be the result of low diesel pricing, weak incentives or the fact that people were waiting for new models of vehicles, which would have a longer driving range and other properties. Furthermore financial subsidies have been expected in 2016, resulting in consumer reluctance to buy BEVs and PHEVs without a benefit.

## 6.1.2 Hydrogen

### Incentives

Germany has taken a leading role in the deployment of infrastructure for hydrogen. Under NIP (the National Hydrogen and Fuel Cell Technology Inno-

vation Programme), a total of more than 1.4 billion € have been invested in infrastructure and R&D over a ten year period. This includes investments in HRSs of up to 50% of the costs, and to a certain degree also the funding of operating costs until the end of the programme in mid 2017. The Clean Energy Partnership (CEP) is a joint initiative of the government and industry, including 20 industry partners. Refuelling stations to be built in the coming years will be financed by projects within FCH JU and other international and national programmes.

NOW, the National Organisation of Hydrogen and Fuel Cell Technology, is responsible for the coordination and management of NIP. When NIP enters its second phase from 2017 to 2026, the focus will be on two main activities. Firstly, R&D will continue for hydrogen production, infrastructure and vehicles. Secondly, there will be a focus on market activation, putting more FCEVs fleets on the road. For the latter, the programme will provide funding for fleets of three vehicles or more. Public and private companies and municipalities may receive funding of 40% of the additional cost of a FCEV. Fund for a HRS may also be granted in some cases.

For private persons, the premium reward of 2,000 + 2,000 € also applies to FCEVs. This is an important incentive, reducing the price difference between FCEVs and gasoline/diesel versions, which is quite high.

### Infrastructure

There are 31 HRSs in operation in Germany, nine within the Northern Scandria@Corridor. So far, the focus has been on establishing a basic infrastructure in the larger cities, such as Munich, Hannover and Berlin. The 50 stations programme, aiming to build the first 50 stations in Germany has been extended to mid 2017 and will almost reach its goal. The refuelling stations are operated by industrial companies and by H2MOBILITY. The latter is a joint venture of six industrial companies (Air Liquide, Daimler, Linde, OMV, Shell and TOTAL) and five associated partners from the automobile, gas and oil sectors. During 2017, the ownership of most of the stations will be transferred to H2MOBILITY, which is the main pro-

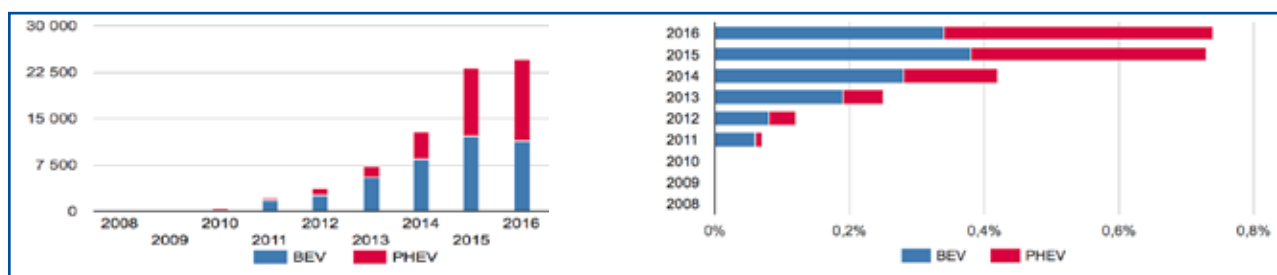


Figure 14. Sales of passenger BEVs and PHEVs in Germany. To the left is the number of new registrations, to the right is the market share of new registrations. Numbers are given at a national level. Source: [EAF0].

vider of hydrogen fuel in Germany. H2MOBILITY's roadmap provides for the creation of the first 100 hydrogen stations by 2018/2019. This is to be done unconditionally and irrespective of the number of fuel cell vehicles on the road. The goal is to set up ten stations in each of six German metropolitan areas (Hamburg, Berlin, Rhine-Ruhr, Frankfurt, Stuttgart and Munich) as well as ensuring hydrogen corridors along motorways.

CEP is setting the standard for HRSs in Germany, and every station needs approval from CEP to be operational. To refuel, you need to have the CEP H2-card, giving access to all stations. CEP also is working to ensure that green hydrogen, produced from renewable energy, is provided at the stations. The target has been 50% green hydrogen, with an aim of increasing this to 100%. H2Mobility, however, has no such target. The first priority is to get the stations built and in operation, and the focus on the source of production of the hydrogen will have to come later.

### Vehicles

According to NOW, there are about 260 FCEVs in Germany. It is estimated that about 90 vehicles (35%) are registered in the Northern Scandria@Corridor. This means that there are on average about 10 vehicles per station. One reason for the small number is an insufficient infrastructure. Another explanation is the limited number of cars and models available. In 2015, Hyundai and Toyota launched their first FCEV into the German market. Honda has so far not prioritized the European market for their FCEV model, Clarity. It is also fair to argue that the interest for FCEVs will increase when German cars become available. The Mercedes GLC F-Cell, expected to be available for sale in early 2018, will be important in this respect. A third reason for the small number of registered vehicles is the purchase price. The Hyundai ix35 Fuel Cell costs ca. 65,000 € in Germany. This is about double the price of a comparable gasoline version.

Increasing the number of vehicles is the main priority for future incentives. The BeeZero car-sharing concept of Linde serves as a template for this, having a fleet of 50 Hyundai's in Munich. This is also under consideration in other larger German cities. By funding fleets via NIP, the aim is to have a substantial number of FCEVs in operation over the next years.

NOW also consider the use of hydrogen for other kinds of transport to be interesting. Some buses are in operation today, and more will come as part of upcoming FCH JU projects. Hydrogen trains have also received considerable interest in Germany. The first trains are to be trialled by the end of 2017 in the North-West of Germany. Trains will be very good for

demonstrating the possibilities of the use of hydrogen for transport, and thus will also have a positive effect on other sectors.

### 6.1.3 Biomethane and natural gas

#### Incentives

The reduced tax on natural gas, biomethane and synthetic natural gas is likely to be extended until 2026. That gives OEMs, energy suppliers and consumers a new perspective and allows for investment towards achieving a market share, whereby the recently extended subsidies are no longer needed. There is currently only a very small incentive for the use of biofuels, including biomethane. Everyone selling fuels has to meet the CO<sub>2</sub> reduction target that is set by Fuel Quality Directive (FQD) at 6% by 2020 – biomethane is an option to fulfil this requirement. An alternative use of upgraded biomethane is in the natural gas grid for heat and electricity production. A controversial topic being discussed is the national implementation of RED II. The national draft of so-called BimschV would allow natural gas to acquire GHG-reduction obligations. This is positive for CNG and LNG in general, but reduces the price-competitiveness of biomethane.

Commercial transport in particular is a low-margin business. Price is the main factor in competition. Private persons and companies tend to choose a lower price before a lower environmental impact. As long as the diesel price is low, alternative fuels have tough competition. In December 2016, the diesel price in Germany was about 93 Eurocents per litre excluding VAT for bulk consumers. The CNG price at the same time was about 106 Eurocents per kg. The difference is making it difficult for users to choose anything other than diesel both for private cars and for transport companies.

The expert from Zukunft ERDGAS GmbH is of the opinion that the tax on diesel fuel has to increase, at least for passenger vehicles. However, there seems so far to be no political will for this. One reason is that the car manufacturing industry is of great national importance. German car manufacturers are working to develop more efficient diesel and gasoline engines with lower CO<sub>2</sub> emissions. It is unlikely that politicians will implement measures which have negative consequences for the industry.

#### Infrastructure

During 2016 the total number of CBG/CNG stations in Germany declined from 911 to 883. At the end of 2015, about 140 of these were located in the Northern Scandria@Corridor. Most stations are publicly available under the roof of fossil fuel stations, and are situated next to diesel and gasoline dispensers. Most of the stations provide gas for passenger

vehicles, while stations providing fuel for fleets are not normally publicly available. About 15-16 % of the total amount of gas in Germany is biomethane. For the German part of the Northern Scandria@Corridor, the figure is only about 1.5%. Some stations provide 100% biomethane, some a minor proportion of biomethane blended with natural gas.

The capacity of the infrastructure in Germany is currently too high for the demand. About 80% of the stations are not profitable. Refuelling stations serving municipal garbage trucks or buses are the only ones that are currently profitable.

#### *LBG/LNG infrastructure is lacking*

While there are several refuelling stations for compressed natural gas in Germany, there are two mobile LBG/LNG stations. One was opened in early 2017, at Ludwig Meyer GmbH & Co. on the south side of the Berliner Ring orbital motorway. The company will acquire 20 LBG/LNG trucks for the purposes of fresh food logistics and distribution in the Berlin area. The project receives funding from the Federal Ministry of Transport and Digital Infrastructure (BMVI). Last year, Iveco and Uniper opened another fueling station for trucks in Ulm. Furthermore, there is a test station in operation near Bremen. The public funding appears to be crucial. Distributors don't invest until they have a known demand for such a station. A minimum turnover is needed, and for LBG/LNG stations it seems that 20 trucks is a relevant number in this respect.

As part of the LNG Blue Corridors project, several LBG/LNG stations were planned in Germany. The project started in May 2013 when the diesel price was quite high. Iveco, the only provider of LBG/LNG trucks available on the German market with 400 horse power, launched the first truck in September 2014. The diesel price has since decreased, making the competitive environment hard for gas and delaying the realisation of more stations.

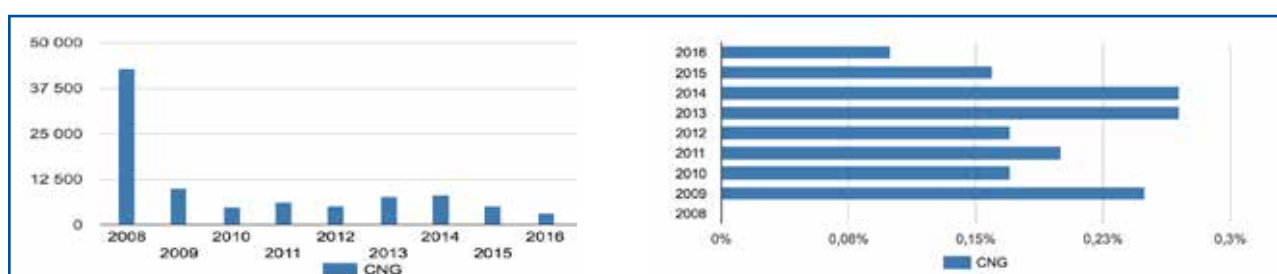
## Vehicles

The number of new registrations of NGVs declined by 36% in 2016. In consequence, the gas turnover at the CBG/CNG stations has become smaller, which intensifies the critical economic situation for most operators. The absence of political decisions e.g. about the continuation of the reduced excise duty for natural gas as a fuel until March 2017, caused further loss of confidence among the OEMs, potential customers, and station operators. The car manufacturers are not launching as many new models as before, and have decreased the number of cars being produced. At the same time, more old CBG/CNG cars are now leaving the market. This is true for passenger cars, for light vehicles and for buses. This negative trend is challenging the profitability of CNG and CBG stations. The trend is visualized in Figure 15, showing recent developments in new registrations and the market share of passenger cars. In some areas, operators of CBG/CNG stations support users with an amount of money, approximately 500 €, for using the station, or they might even in some cases provide free gas.

LBG/LNG trucks are about 35,000 € more expensive at purchase than the diesel alternative. It is hard to justify such an investment for transport companies. For the moment it seems that only fleet owners wanting to build a reputation based on clean transport are able or willing to lead the way.

### 6.1.4 Expected development - DAFI

Germany has prepared the National Strategic Framework (NSR) as part of the implementation of Directive 2014/94 / EU on the development of alternative fuels infrastructure [DAFI-DE]. The NSR provides a comprehensive overview of the state of development of the market, the central objectives for the publicly available refuelling and charging infrastructure, and the measures taken by the Federal Government to achieve the objectives.



**Figure 15.** Sales of passenger CBG/CNG vehicles in Germany. To the left is the number of new registrations, to the right is the market share of new registrations. Numbers are given at a national level. The number of new registrations in 2008 was about 12,000<sup>1</sup>, and not as high as indicated here. Source: [EAFO].

<sup>1</sup> According to German Expert on biomethane and natural gas, Michael Schaarschmidt, Zukunft ERDGAS GmbH.

In order to be able to electrify all traffic, battery and fuel cell technology must be further developed. The aim of the Federal Government is to provide all alternative fuels and vehicles with an opportunity to compete in the market. Ultimately, the user will decide which technology will prevail. To this end, several new “refuelling station networks” are needed for electricity, hydrogen, compressed and liquefied natural gas. In order to stimulate the required investment for market expansion, financial resources for infrastructure construction can be provided in the initial phase until economic business models have been developed. Public investment is thus a lever for the overall investments required for the construction of an infrastructure for alternative fuels.

Electromobility is a key technology for changing the energy base in transport. The Federal Government has set ambitious targets for the expansion of electric mobility. By 2020, one million electric vehicles will be on German roads. This objective includes battery electric vehicles, plug-in hybrids and fuel cell vehicles. As a common goal, it was agreed that by 2020 Germany should be both the lead provider and the lead market for electromobility. Another objective is that natural gas should have a share of about 4 % in the energy mix of German road traffic by 2020. In order to support the achievement of this target, the German automotive industry has said that it will launch further competitive vehicle models powered with natural gas.

#### Charging infrastructure

By 2020, the Federal Government assumes that a total of around 7,000 publicly accessible fast-charging points will be required, taking into account wide-

spread usage by BEV users, according to current plans, around 1,400 fast-charging points are to be created by 2017.

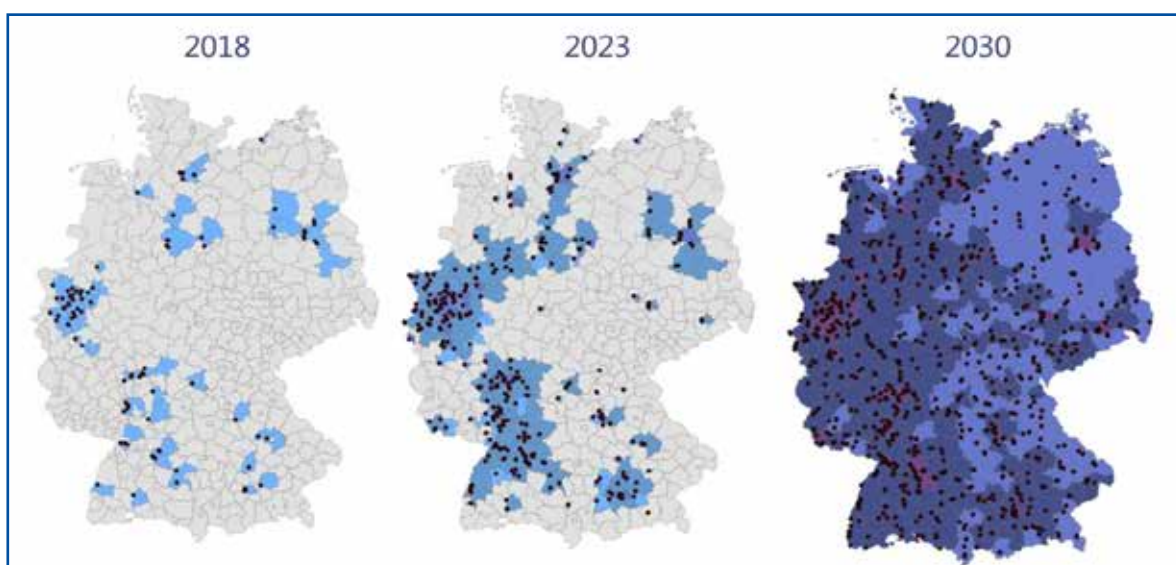
In addition, according to scientific analyses, it is estimated that a total of 36,000 publicly available re-charging points will be required by 2020 for standard charging. Based on the current position, the creation of an additional 30,000 recharging points will be necessary by 2020.

#### Hydrogen

The federal government sees a nationwide filling station network for hydrogen as a key factor in the successful market introduction of fuel cell vehicles. The future demand for hydrogen will remain limited to some selected regions around the German cities and the Ruhr area until 2018. In most of these regions, only one refuelling station per region will have been built, in order to ensure coverage of the area. By 2023, further regions with slightly lower population density and vehicle density will have been developed. By 2030, hydrogen demand in all regions will be ensured by a total of 1,000 refuelling stations. The density of hydrogen stations in the German part of the Northern Scandria@Corridor is not expected to be very high, as shown in Figure 16.

#### Natural gas and biomethane

Regarding the supply of compressed natural gas (CNG), Germany already has the minimum coverage required by the Directive for CBG/CNG service stations. Measures for further infrastructure development are therefore not required, according to the NSR. Instead, measures are being taken to improve



*Figure 16. Map showing the expected regional distribution of H2 demand and refuelling stations, in 2018, 2023 and 2030, with a total number of 1,000 stations by 2030. Source: [DAFI-DE].*

the economic situation of existing CBG/CNG filling stations. Because of low national and international demand, a considerable proportion of the CBG/CNG refuelling stations are in financial deficit.

For heavy goods vehicles, which are mainly used in long-distance transport, the objective is to establish a LBG/LNG service station network by 2025. Based on a maximum range of 400 km within Germany, a further seven LBG/LNG stations in addition to the one in Berlin are required to meet the policy requirements. With a maximum network distance of 150 km, there would be a need for 25 additional filling stations. A final assessment of the proportionality of costs and benefits, including environmental benefits, is still being carried out. The final objectives for an infrastructure for the LBG/LNG supply of road transport beyond the initial basic network have not therefore been confirmed as yet.

## 6.2 Denmark

In the long term, Denmark has a vision of becoming independent of fossil fuels by 2050. This includes all sectors, and also transport. There are about 2.8 million vehicles in Denmark. Only about 10,000 of these can be considered as CO<sub>2</sub> neutral today, using electricity, hydrogen or gas as fuel. Renewable energy accounts for about 5% of the energy used for all transport when all biofuels and electricity are included. Of this amount, approximately 2/3 is biodiesel, while electricity and bioethanol together represent 1/3.

Improved fuel economy for passenger cars and trucks has been driven by EU energy efficiency requirements for new vehicles and the environmental restructuring of Danish car taxes in 2007. The combination of these two measures meant that the energy consumption of passenger vehicles in the period 2007-2014 was almost unchanged despite a growing number of vehicles.

### 6.2.1 Electricity

#### Incentives

The number of new registrations of BEVs in Denmark decreased dramatically in 2016. The main reason was the introduction of registration tax for EVs. Until 2015 there was no registration tax for EVs. BEVs had a 2.2% market share of new registrations in 2015. From January 2016, EVs were taxed at 20%, resulting in sales reductions and a reduced market share of 0.56% in 2016. From January 2017 the tax is 40%. Changing the registration tax regime has dramatically changed Denmark's position within overall usage of electric vehicles. It may seem that this change has come too fast. The purpose of the tax exemption was to support the introduction of these cars into the market. EVs are still more expen-

sive than fossil fuel cars, and it seems that the market is not prepared to embrace these cars at extra cost to a great enough extent. At the same time, the tax on fossil fuel cars has been reduced since 2016, making these cars cheaper.

The Danish expert, representing the Danish Electric Vehicle Alliance, an independent trade association under the Danish Energy Association, indicates that both the tax situation and uncertainty about government policies are making people more reluctant to invest in these cars. There are currently debates regarding the registration tax and whether there should be a slower escalation than the planned 20% yearly increase.

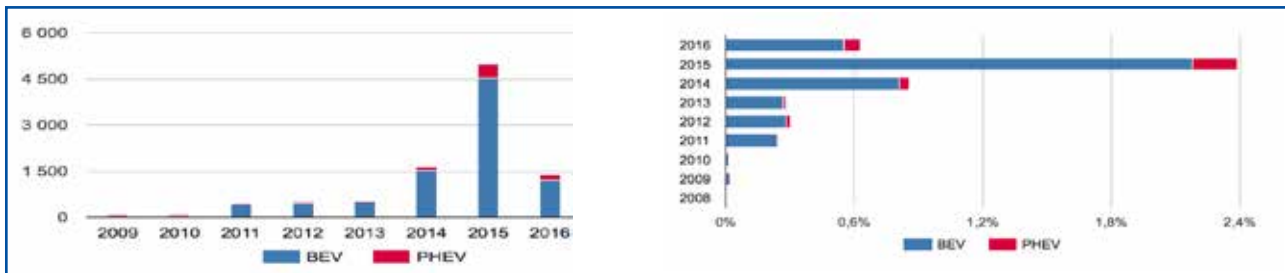
The Danish Energy Agency provides subsidies up to a maximum of 2,700 € (20,000 DKK) to municipalities and companies buying BEVs. However, Danish municipalities have reduced their acquisitions as a result of the increased tax, according to a survey performed by E.ON Denmark [E.ON].

There are electricity tax reductions for those who hire or subscribe to a recharging point in Denmark. This is decided on a year-to-year basis, giving no long-term assurances for people who invest in EVs. There are also some indirect incentives such as free parking in some municipalities. There are limitations to the extent of these incentives, making these measures of limited value.

For electric buses there is also a disadvantageous tax regime. The energy tax on electricity for buses is about 2.5 times higher than it is for diesel, and more than 200 times the electricity tax on trains and light rail vehicles. If electric buses were subject to the same electricity tax rate as trains and light rail vehicles, this would contribute substantially to the number of electric buses in cities and thus help accelerate the transition to zero emission transport, according to the expert.

#### Infrastructure

Despite the decrease in the sales numbers, there has been an increase in the number of recharging points in Denmark. The country has a good infrastructure for the recharging of EVs. The electricity supply infrastructure throughout the country is very good, so there are no problems in increasing the number of charging stations to handle a large number of vehicles. There are commercial vehicle-to-grid start-up operations, looking at how BEVs can play a role in the regional and national energy system. Denmark has a lot of renewable energy from wind and solar power, making BEVs a truly clean alternative for transport.



**Figure 17.** Sales of passenger BEVs and PHEVs in Denmark. To the left is the number of new registrations, to the right is the market share of new registrations. Numbers are given at a national level. Source: [EAFO].

Private companies build and operate charging stations. When sales of BEVs are low, it is to be expected that the infrastructure will develop slowly as well. Without public incentives providing funds, the deployment of recharging points is dependent on private companies taking the financial risk of investing in them.

### Vehicles

The number of EVs sold in Denmark decreased in 2016, as shown in Figure 17. Even though some of the BEVs are still only slightly more expensive than fossil fuel cars, the mix of increasing tax, uncertainty about the political aspect and anxiety about vehicle range have reduced sales. For battery electric light duty trucks too, there was a reduction in sales in 2016. The fact that total cost of ownership may have been marginally lower for a few select BEVs in 2016 doesn't seem to have been a decisive factor for overall BEV car sales. The Danish Electric Vehicle Alliance is presenting a report in 2017, showing the possible reductions of TCO, hoping that this will help increase sales in Denmark. The tax increases expected in 2017 may however make all BEVs a more expensive choice in terms of TCO, which may further reduce EV penetration in the Danish car market.

## 6.2.2 Hydrogen

### Incentives

FCEVs are exempted from registration tax and from annual vehicle owner tax. Other public support schemes such as free public parking, road toll exemption, driving in bus lanes and tax exemption on private use of company cars have not yet been implemented. Infrastructure has been established as a result of a partnership between industrial companies with funding support from national and EU programmes. Several projects have contributed to the construction of stations and/or deployment of

vehicles. The most important are HyFIVE and H2ME, both funded by FCH JU, and H2DK, supported with funds from the Danish Transport and Construction Agency.

### Infrastructure

Denmark is the first country in the world to have a nationwide network of hydrogen refuelling stations. These are either located at existing service stations or at major centrally located parking areas. Currently, more than 50% of the Danish population have less than 15 km to travel to the nearest HRS.

The Danish Partnership for Hydrogen and Fuel Cells is a member organisation promoting hydrogen and fuel cells in Denmark. At <http://brintbiler.dk>, the partnership releases quarterly updates on vehicles and infrastructure operation in Denmark. This gives a very good overview of the development trends for numbers of vehicles and stations, and the performance of the stations. The Danish hydrogen refuelling stations have achieved an average availability of 98% since 2011, which is on a par with that of conventional refuelling stations.

### Vehicles

There were 74 FCEVs in Denmark in 2016. The number must be considered small compared to the large number of stations available. This is most likely related to the availability of vehicles, and the fact that only two models were available during 2016. Alongside the opening of most of these stations, fleets of FCEVs have been acquired by municipalities or companies. 33 of these vehicles are partly funded by the Bridge2H project, supported by the Danish Transport and Construction Agency. The overall objective of the Hydrogen and Fuel Cell Partnership is to reach a total of 500 FCEVs in Denmark by the end of 2018. Figure 18 shows the amount of hydrogen being refuelled in Denmark during recent years.

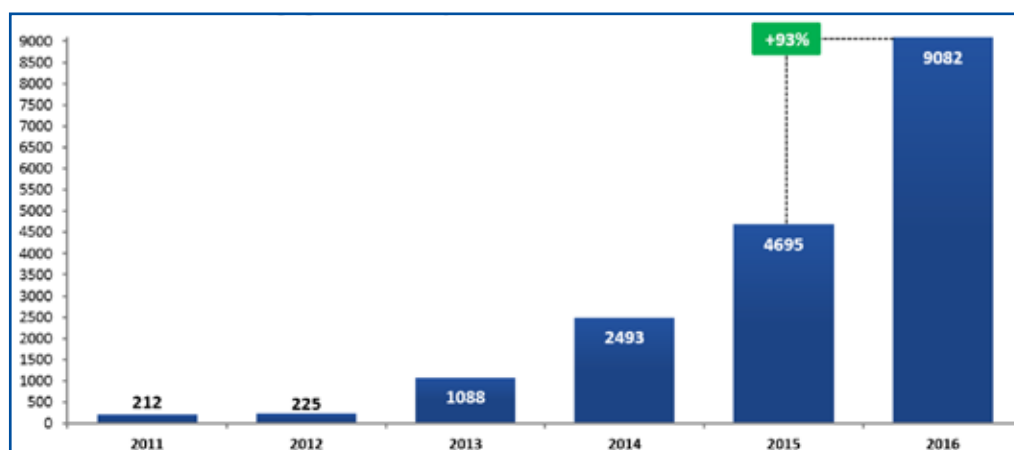


Figure 18. Yearly amount of hydrogen in kg refuelled in Denmark. Source: [www.brintbiler.dk](http://www.brintbiler.dk), Operations report on FCEVs and hydrogen stations in Denmark, 4th quarter 2016.

### 6.2.3 Biomethane and natural gas

#### Incentives

Denmark has substantial annual production of bio-gas. For 2017, production of 2 TW is expected. The gas is mainly used for heat and electricity generation. Only about 1% is upgraded to biomethane for transport. There are no incentives likely to encourage a change of priority for the use of the gas, and in general, there is a lack of incentives for the use of biomethane for transport purposes.

Tax of about 0.4 € (3 DKK) per m3 makes biomethane and natural gas slightly more expensive than diesel. The limited funding support for refuelling stations and vehicles is not helping the development of this fuel for use within heavy duty transport. There are no local or regional incentives supporting biomethane production either.

#### Infrastructure

There are currently 11 refuelling stations providing CNG and CBG in Denmark. All these stations are providing biomethane, either 100% or as a blend with natural gas. Danish production of natural gas is decreasing, and biomethane is the preferred product for transport. At the moment there are no LBG/LNG stations available, nor are any under construction.

#### Vehicles

The number of registered gas vehicles in Denmark is surprisingly low, considering the widespread availability of both natural gas and biomethane. By September 2016, 163 passenger cars and light duty trucks had been registered, plus 73 buses and 91 heavy duty trucks. The market share for new registrations of CBG/CNG passenger cars is shown in Figure 19.

The cost of ownership of a gas-fuelled heavy duty vehicle is estimated to be about 14% more expensive than that of a diesel vehicle over its lifetime. This includes the vehicle price, maintenance, fuel costs etc. At the moment, there don't seem to be any upcoming incentives that will speed up the development.

### 6.2.4 Expected development - DAFI

The Ministry of Transport, Building and Housing has submitted the Danish policy document for the implementation of the Directive on Alternative Fuel infrastructure [DAFI-DK]. The document describes the current situation in terms of infrastructure and the market for clean fuels. It also describes the Govern-

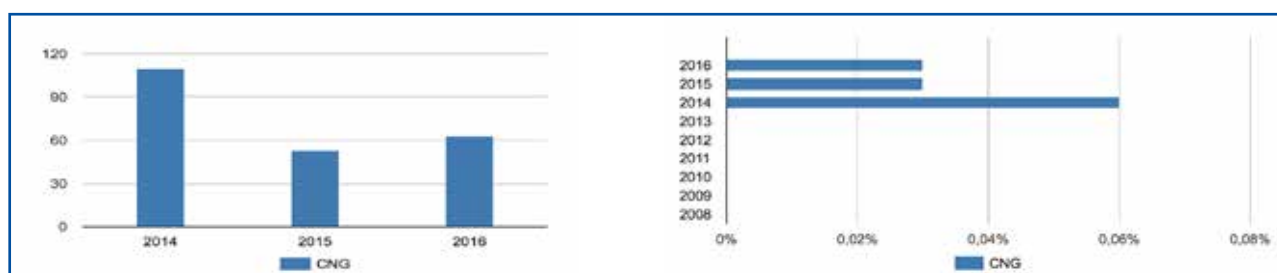


Figure 19. Sales of passenger CBG/CNG vehicles in Denmark. To the left is the number of new registrations, to the right is the market share of new registrations. Numbers are given at a national level. Source: [EAFO].

ment's plans for supporting market development, and current and future policy options.

The Danish Energy Agency's (DEA) baseline scenario expects that energy consumption for transport will be more or less unchanged until 2025, with a marginal increase. The projection is shown in Figure 20. Vehicles running on electricity, CBG/CNG and hydrogen are not expected to experience a major breakthrough before 2025 according to this projection.

The availability of alternative fuels for transportation will primarily be market driven. This means that in general public funds will not be provided for the development of infrastructure. Such funds will only be an option in exceptional cases.

### Electricity

The Government states that the market for electric cars is immature. This is partly based on the fact that favourable incentives are necessary. The DEA baseline scenario expects a population of about 30,000 BEVs in Denmark by 2020. The number is expected to reach about 65,000 in 2025. The Government state that:

- *If the ratio of the number of electric cars to expansion of the charging infrastructure in 2019 results in a number of cars per charging point above the benchmark of 10, the Government will examine whether there is a need for measures that can further support market development.*

### Hydrogen

There is a small fleet of hydrogen vehicles in Denmark. These cars are primarily acquired through public procurement. The cost of hydrogen cars and the infrastructure for refuelling is higher than the cost of other alternative fuels. It is not anticipated that price reductions will bring the costs down to a reasonable level by 2025. The Government state that:

- *Hydrogen is currently not included in government policies on the accessibility of alternative fuels.*

### CBG and CNG

The government do not expect any significant commercial sales of CBG/CNG vehicles to individuals by 2020 or 2025. There is however an expected increase in gas vehicles in the public fleet through procurement, for instance of buses and garbage collection trucks. The Government state that:

- *It will be further analysed whether it will be cost effective to create an increased demand for compressed gas for transport and to support the establishment of a network of gas filling stations within the TEN-T core network in Denmark.*

### LBG and LNG

Until 2025, the government does not expect that there will be market-based development leading to refuelling stations for LBG/LNG along the TEN-T core network in Denmark. The Government state that:

- *Once there is experience with similar building of infrastructure in other EU countries, the Government will assess whether to take the initiative to support such development, and if so, how.*

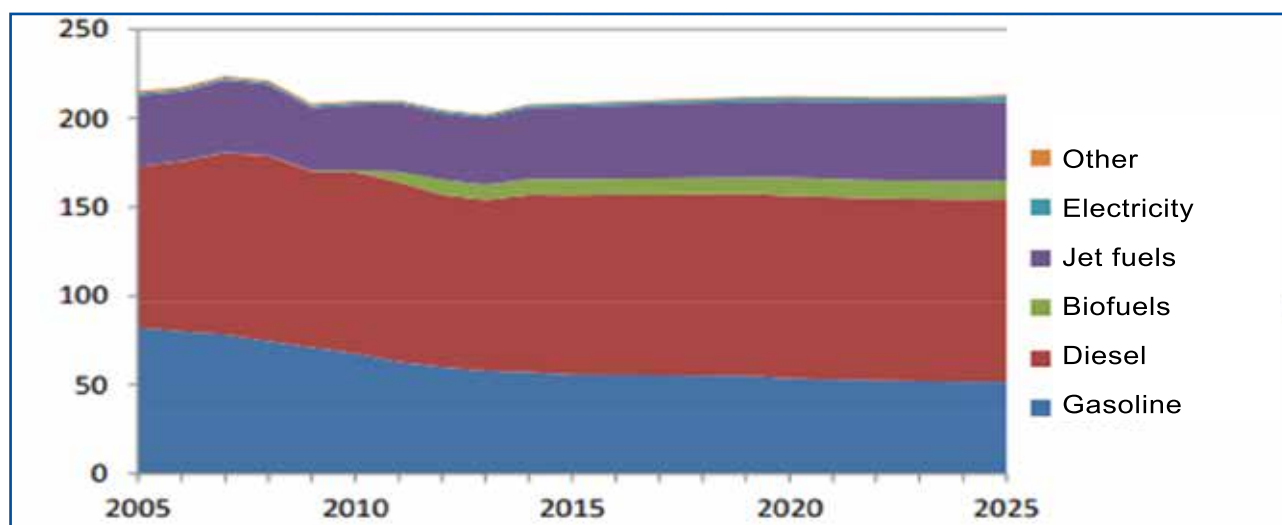


Figure 20. Projection of energy consumption for transport from the Energy Agency's baseline projection 2015. Source: [DAFI-DK].

## 6.3 Sweden

The long-term vision for Swedish climate policy is zero net emissions of greenhouse gases by 2050, and as a stepping-stone, a fossil fuel-independent vehicle fleet by 2030. Most of the legal and political incentives in Sweden are general in nature, and are not directed towards any specific fuel or technical solution. Most are in the form of economic instruments, but there are also some different policy instruments.

An important incentive is the “super green car premium” of about 2,110 € (SEK 20,000) for PHEVs and about 4,220 € (SEK 40,000) for BEVs, which is available for the purchase of new cars with CO<sub>2</sub> emissions up to a maximum of 50 g/km. This is likely to be replaced with a bonus-malus system from 2018, giving a reward to those vehicles that emit zero or small amounts of CO<sub>2</sub>, and punishing high emissions. This change will probably make the incentive more effective, accelerating the sales of zero emission vehicles.

Sweden is different from the other countries in the Northern Scandria@Corridor when it comes to the use of biomethane and natural gas. The infrastructure for gas refuelling is dense, with several stations for CBG/CNG and LBG/LNG. About 90% of the stations for compressed gas and all LBG/LNG stations are located in the Swedish part of the Northern Scandria@Corridor. The number of CBG/CNG vehicles is also quite high in all vehicle categories, even though the market share of new registrations of passenger vehicles has been decreasing over the last few years.

Sweden was among the first countries to introduce environmental zones in the three largest cities, restricting the use of heavy duty trucks. This trend has continued and has been supplemented with congestion charges in Stockholm and Gothenburg.

In recent years there has been a growing export trade in clean vehicles less than five years old, including an over-representation of company vehicles. The second-hand value is better in other countries than in Sweden. The consequence for Sweden is that the total fleet of clean vehicles is increasing more slowly than it ought to in order to reach the objective of being fossil fuel-free by the year 2030.

### 6.3.1 Electricity

#### Incentives

The super green car premium incentive is important. If this is turned into a bonus- malus system, it may

increase the reward for choosing BEVs to a maximum of about 6,330 € (60,000 SEK). This will probably accelerate the deployment of BEVs in Sweden.

The five-year exemption from paying annual road tax is also a valuable incentive for private individuals. For companies, the incentive of reduced taxable benefit (-40%) has proved important. The same goes for both BEVs and PHEVs. Company cars accounted for about 50% of new car sales in 2016.

There have been some changes in the definitions of clean vehicles and incentives over time. At the same time, uncertainty about the size of the incentives and their duration over time, the limited public budget for the premium rewards, etc. discourages people from buying BEVs. The clearer and more predictable the incentives in the company market, the higher the resulting sales, showing that long-term and predictable incentives are important.

There have been some incentives for building charging stations, funded by the Government programme Klimatklivet. Anyone apart from private individuals may apply for grant of up to 50% of the cost of a charging station. Almost 2 billion SEK are allocated to this initiative. The incentive is expected to last until 2018. So far the number of charging stations has been doubled by the use of this funding mechanism, and funding has been provided for a total of 6,000 charging points.

#### Infrastructure

Development of the infrastructure has been quite good over the last few years. Several fast and normal charging stations have been built. The majority of these are in the Northern Scandria@Corridor. The larger cities have been prioritized, but currently re-charging points are also being built along the major roads between the cities. The infrastructure is for the most part built by energy companies, however, the business case is still quite poor because of the limited number of PEVs.

New business models and payment systems for charging customers should be developed. User-friendly and easily accessible solutions are still at an early stage. Amendments may be necessary in order to terminate the grid concession requirement given certain conditions, and thus accelerate the building of charging stations. For large charging stations, the grid might need to be reinforced when a greater charging capacity is required at busy periods.

About half of the Swedish population lives in flats. Thus, Sweden faces the same challenge as the other countries in the Northern Scandria@Corridor regarding charging points for persons without their own garage or parking. There is still no good solution for this.

As part of the EU funded (CEF) GREAT project (Great Regions with Alternative Fuels for Transport), 70 fast chargers will be installed in the Northern Scandria@Corridor, 50 of these in Sweden. The project, initiated by the political network STRING, is meant to meet the urgent need to lower harmful emission levels from European road transportation, both light and heavy. GREAT highlights the business models for alternative fuels infrastructure in order to speed up the decarbonisation of road transport. Scandria@2Act cooperates with the GREAT project on these issues.

### Vehicles

According to the expert from Power Circle, an association for companies working with electricity, the three main reasons why Swedes do not buy BEVs in larger numbers are driving range, high purchase price and lack of charging stations. When it comes to the size of the car, Sweden faces the same challenges as Norway and Finland. Large cars, such as a station wagon or SUV, usually with towbar, are popular. Such cars are not yet part of the BEV model selection, thus hampering sales. The fact that, for instance, towbars are not that popular in most other parts of the world raises the question of when or if this feature will be prioritized by manufacturers. As in many countries, there is a need in Sweden for a faster increase in the awareness of user needs, acceptance of and confidence in new technologies and new fuels.

80% of all BEVs and PHEVs in Sweden are owned by companies. 73% of all rechargeable cars in Sweden are PHEV. The number of light commercial BEVs is still quite low. The main reason is probably the limited driving range, which lags behind the development of passenger BEVs, and is of great importance for the professional market. Figure 21

shows the sales of BEVs and PHEVs in Sweden at a national level.

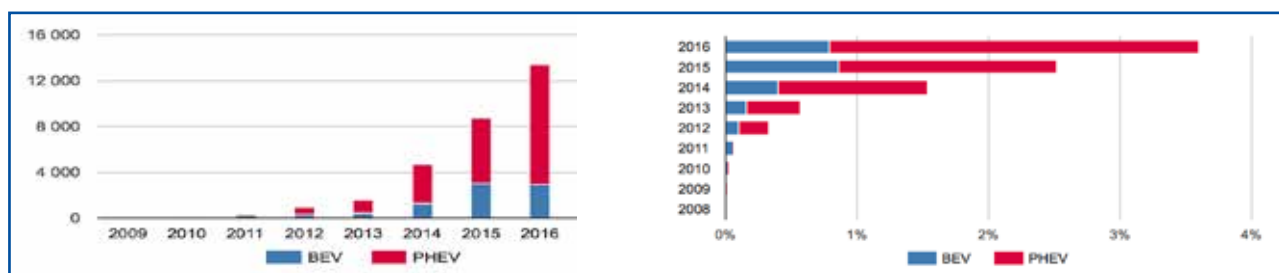
### 6.3.2 Hydrogen

#### Incentives

The same incentives apply for FCEVs as for BEVs. There is no national programme for the funding of hydrogen infrastructure. While national support for hydrogen is limited, regions and municipalities have been more eager to foster this development. The two Regions of Skåne and Västra Götaland (VGR) have supported research, innovation and testing for more than 10 years. The Regions support development projects as well as testing and demonstrations that contribute to sustainable development. Power Cell AB, a fuel cell manufacturer located in Gothenburg, is an important reason for VGR's support. The Regions also participate in and provide funding for interregional cooperation with Denmark and Norway.

Municipalities such as Malmö, Gothenburg, Mariestad, Falkenberg, Stockholm and Sigtuna (housing Stockholm Arlanda airport) have all made their own efforts to establish refuelling stations and / or purchasing of FCEVs as part of their own vehicle fleet. These initiatives are often part of EU projects including funds for infrastructure development. This is the main reason why Sweden, after lagging behind Norway and Denmark, has recently adopted several hydrogen refuelling stations.

Hydrogen Sweden is a Public/Private Partnership with members and financiers from industry, NGOs, and local, regional and national government. The organization is working to raise public awareness of and the competence of hydrogen technology, and to improve national and regional incentives for the deployment of infrastructure and vehicles. According to them, one incentive that is missing is support for acquiring vehicle fleets coupled with hydrogen refuelling stations. This would encourage more resellers to sell FCEVs, and make the business for hydrogen distributors more profitable, paving the way to a commercially viable market.



*Figure 21. Sales of passenger BEVs and PHEVs in Sweden. To the left is the number of new registrations, to the right is the market share of new registrations. Numbers are given at a national level. Source: [EAFO].*

## Infrastructure

The slow development of refuelling stations is the most limiting aspect in the deployment of fuel cell vehicles. There is an obvious 'chicken and egg' problem regarding whether to build refuelling stations first or to buy cars first. The early refuelling stations were built on local initiatives in order to demonstrate the technology and stimulate the market. Because of the lack of national incentives, future refuelling stations need to be built where it has been agreed in advance that there will be fleets of vehicles (i.e. taxi fleets, logistics companies etc). Stations can also be built because of strong incentives, decided by local or regional politicians. Refuelling stations can be found in Gothenburg, Mariestad and at Arlanda airport. Another station in Stockholm will be opened in 2017. Outside the Northern Scandria@Corridor there is one station in Sandviken, and one in Arjeplog, which is used only in wintertime by car manufacturers testing vehicles in colder conditions.

Due to high investment costs it is still hard, yet possible, to identify business opportunities where hydrogen refuelling stations are profitable. It is necessary to find stakeholders who are ready to bear the extra costs of investing in fuel cell car fleets which can, for example, profit from the fact that they offer zero emission transport to customers.

## Vehicles

In general Scandinavia is considered, from the car manufacturer's point of view, a very small market. The small number of cars means the manufacturers incur proportionally higher costs for recruiting and training service personnel, specialists etc. Yet a handful of FCEVs have been sold to Sweden.

The price of FCEVs is almost the double that of a comparable gasoline or diesel vehicle. As a result, only municipalities, regions and some companies own FCEVs; there are no privately owned vehicles. In Stockholm, the company Taxi 020 owns three FCEVs which are used for transporting passengers to and from Arlanda airport. Region Skåne and the municipality of Malmö have bought fuel cell vehicles as part of the Interreg EU ÖKS project Next Move. Gatubolaget, a company owned by the city of Gothenburg, bought 1 fuel cell car in 2016 within the Interreg EU ÖKS-project "The Blue Move for a Green Economy". At year end 2016 there were 22 FCEVs in Sweden, eight being registered in the Northern Scandria@Corridor.

### 6.3.3 Biomethane and natural gas

#### Incentives

The previous national programme KLIMP (climate investment programs), and the new programme Klimatklivet have supported investments in climate

impact reducing measures. When it comes to biogas, it is mainly investment in production facilities that has been supported.

Biomethane and natural gas benefit from no carbon dioxide or energy tax, and biomethane benefits also from no carbon dioxide tax until the end of 2020. The tax exemption cannot be continued beyond 2020. There is an argument that the lack of long-term commitment to tax incentives creates uncertainty in the market, both for production and consumption. The market needs more visible and effective incentives for CBG/CNG vehicles and LBG/LNG vehicles.

Sweden is in a unique position in Europe when it comes to biomethane. From a Swedish point of view, the EU has little knowledge about the Swedish use of biomethane as a fuel from waste.

## Infrastructure

The gas grid for natural gas in Southwest Sweden transports gas from the continent to Stenungsund, 50 km north of Gothenburg. There is also a local gas grid in Stockholm. Along the ScanMed Corridor there is good coverage of filling stations, making it possible for instance to travel the distances between Malmö and Gothenburg and further to the Norwegian border, and between Malmö and Stockholm without any difficulty. In the more rural areas however it can be more challenging, even though the infrastructure is well established in most parts of the region. The distribution of biomethane is expensive and therefore requires efficient distribution channels, such as the gas grid, which is sparse in Sweden. The price for biomethane is slightly lower than for the fossil fuel alternatives. However the price is set with low margins, making the situation challenging for producers of biomethane. The CBG/CNG market in more populated areas is already extant and could grow. The location of refuelling stations is important. Stations located in industrial areas and waste water treatment plants are not suitable for expansion since it is not considered easy to access these sites and indeed it can sometimes be perceived as unsafe.

There are six refuelling stations for LBG/LNG in Sweden. All of them are located along the ScanMed Corridor, in Helsingborg (LBG), Gothenburg, Jönköping, Järna, Älvsjö and Örebro. The northern two-thirds of Sweden lacks infrastructure for LBG/LNG. Three more refuelling stations for compressed and liquid gas for heavy trucks will be built in the Northern Scandria@Corridor in Sweden by 2018, as part of the GREAT project.

LBG/LNG is mainly a fuel for heavy duty transport. The development of infrastructure in other regions is vital to facilitate cross-boarder transport, and we



**Figure 22.** Sales of passenger CBG/CNG vehicles in Sweden. To the left is the number of new registrations, to the right is the market share of new registrations. Numbers are given at a national level. Source: [EAFO].

see a growing interest for LBG/LNG in Spain, the Netherlands, Belgium, the UK and France. Transport throughout the Northern Scandria@Corridor is going to increase. By building a comprehensive infrastructure, Sweden has made it possible to refuel long-distance LBG/LNG trucks in the region. The lack of LBG/LNG infrastructure in Germany, Denmark and Norway is an obstacle to the use of the fuel for this purpose.

### Vehicles

There are 24 different CBG/CNG passenger vehicle models available in Sweden. The market share is decreasing. The question is whether the selection is large enough, and whether the requested models are actually available. The purchase price and the cost of maintenance are a little higher than for conventional cars. The second-hand value is also quite low. These two factors, as well as the lack of acceptance of and trust in new technologies, are limiting sales.

For light duty vehicles, 7 CBG/CNG models are available. LBG/LNG vehicles have been available for a few years in the United States, and are now starting to be introduced in Sweden. Heavy duty trucks are available from Scania, Mercedes, Volvo and Iveco in a variety of models. Iveco has a smaller model, but it has not yet been requested in Sweden. Volvo aims to release a heavy duty LBG/LNG truck in 2017, and Scania a new model by 2018.

The Swedish regions have invested in biomethane buses in order to reduce emissions, especially in the cities. For instance, the majority of city buses in Region Skåne are running on biomethane and a smaller amount on electricity.

### 6.3.4 Expected development - DAFI

The Ministry of Enterprise and Innovation has submitted the Swedish policy document for the implementation of the Directive on Alternative Fuel Infrastructure [DAFI-SE]. The document describes the current situation regarding infrastructure and the market for Clean Fuels. It also describes the national

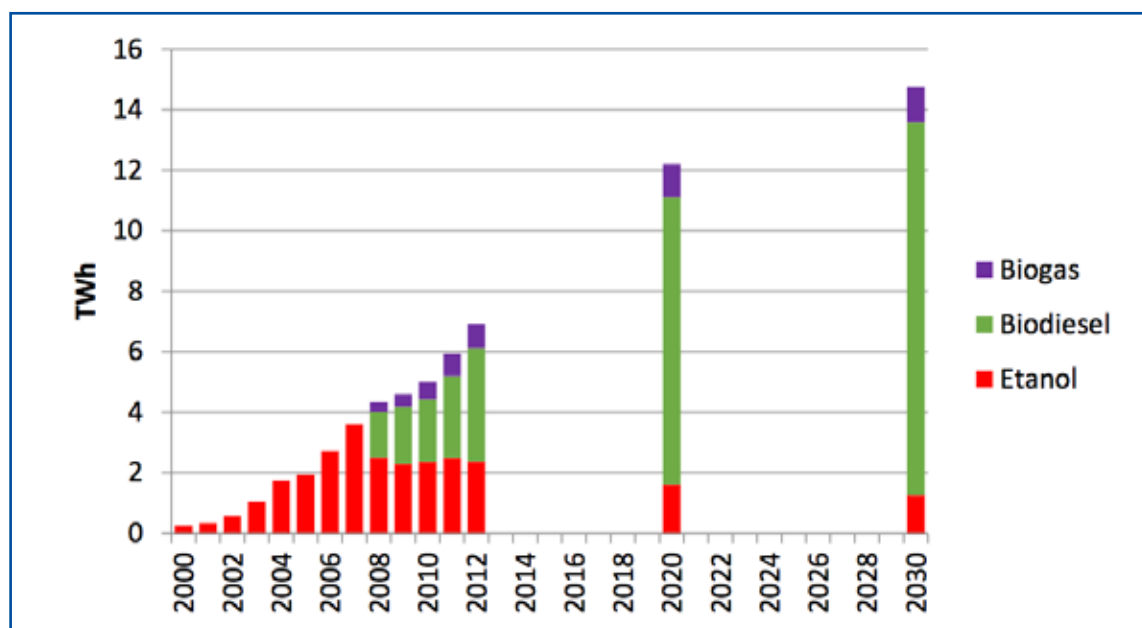
aims and targets for fostering market development, and current and future policy options and measures.

The Swedish Energy Agency's baseline scenario anticipates that total energy consumption in the transport sector will gradually decrease during the whole period up to 2030, by which time energy consumption is expected to have fallen by 12 % compared with the base year of 2011. The main reason for this is increased efficiency, primarily of passenger cars and light trucks. Foreign shipments will increase, but at a relatively weak pace. Gasoline use will decrease sharply, by 56 %, while the use of diesel will remain unchanged.

The future share of renewable fuels depends primarily on fuel prices, production costs, public incentives, expansion of the distribution system, access to vehicles and the development of refuelling and service sites. The Agency estimates that the use of biofuels will have almost doubled by 2030 - see Figure 23. In particular, the use of biodiesel is expected to increase. The use of biomethane is also expected to increase. The number of PEVs is expected to increase gradually.

Reducing emissions from the transport sector is crucial in enabling Sweden to reach its long-term climate goal and become one of the world's first fossil fuel-free welfare countries. To reach this goal, Sweden must have a fossil free vehicle fleet. Sweden has introduced a large number of national initiatives in order to reach this goal, with the intention of increasing the demand for renewable fuels.

The Government believes that widely applied initiatives that put a price on greenhouse gas emissions should be the basis for the transition to a fossil fuel-free vehicle fleet. Such initiatives create incentives for all the above changes. The Swedish carbon tax is often cited internationally as a highly effective tool in reducing greenhouse gas emissions. In Sweden, there is also a reduced taxable benefit for certain green vehicles.



*Figure 23. Use of renewable energy for domestic transport in Sweden 2000-2012, 2020 and 2030. Source: Swedish Energy Agency, report ER 2014:19.*

These wide ranging initiatives sometimes need to be complemented by more targeted measures. The Swedish super green car rebate supports the purchase of cars with the lowest emissions and contributes to increasing electrification of the vehicle fleet. The government will introduce a bonus-malus system by July 2018. Sweden also has “Klimatklivet”, a state programme for investing in local and regional climate impact reducing measures. Most of the supported investments include building charging stations for electric vehicles, converting from fossil fuel to renewables, or expanding production of biomethane.

When it comes to future ambitions for infrastructure and the number of vehicles, the policy document includes no goals or specific aims. It focuses on what incentives may be used, but do not specify in numbers what should be achieved by using them.

## 6.4 Norway

Norway has for some years been leading the way in the transition to zero emission cars. This is first and foremost due to a substantial package of incentives, probably the world’s best, starting back in the 1990s. In the early phase, these incentives were put in place to allow testing and experimenting with EVs. Norway developed an EV industry, manufacturing cars like the Pivco / Think City and Buddy. From about the year 2000, the focus shifted to supporting this EV industry, creating easier access to the market. From 2010 onwards, incentives have been linked to policies for reducing climate gas emissions in Norway. A long-term stable political framework built up piece by

piece seems to be key to the success of EVs in Norway. Politicians have agreed long-term measures, which provide predictability for buyers.

The generally high taxes on vehicles in Norway have given room for tax relief incentives rather than direct subsidies. Incentives like access to bus lanes, free parking and no tax on toll roads have given the owners of BEVs a relative advantage which seems to have been the key to EV success in Norway, according to a report from the Institute of Transport Economics [FIGENBAUM]. The availability of clean electricity may also be part of the reason for this success. Norwegian energy production is essentially renewable, with a share of 98% of electricity consumed in 2015, 96% being from hydropower. Electricity is abundantly available, pollution free, cheap and non-controversial compared with the situation in other countries. This is also a reason for the popularity of BEVs.

While the evolution of BEVs in Norway has been a success story, the use of biomethane and natural gas is much more limited. We don’t see the same kind of incentives for these fuels. Some buses and waste collection trucks are using CBG/CNG with success, while the market share for passenger cars is zero. The high focus on zero emission vehicles has to a large extent overshadowed the interest in biomethane.

There is an agreement in the majority of the Norwegian Parliament that all new cars sold by 2025 should be zero or low emission. Even though it has

not been adopted as a law, this is a very ambitious goal, considered feasible with the right policy measures. It seems that Parliament will reach this goal through a strengthened green tax system based on the principle that the polluter pays, rather than a ban on diesel and gasoline vehicles. This may also stimulate the development of the CBG market.

Another effort that can increase the sales of zero emission cars is the introduction of zero emission zones in the larger cities in Norway. This is currently being assessed in Oslo, with the aim of reducing emissions of CO<sub>2</sub> and NO<sub>x</sub> in the city. Last year, Oslo introduced the option of banning diesel cars from city roads on days with poor air quality. This option was exercised for the first time on January 17th 2017. Oslo justifies the ban by saying that exhaust emissions are sometimes so high that children with respiratory problems such as asthma or adults with cardiac illnesses are advised to stay indoors. Zero emission zones and the diesel ban may accelerate sales in the private and professional market, increasing the market share of vehicles using alternative fuels.

### 6.4.1 Electricity

#### Incentives

The incentives are a mix of purchase incentives and incentives for use. The exemption from registration tax as well as from VAT reduces the purchase cost of EVs to about the same as that of comparable gasoline and diesel vehicles in Norway. Larger EVs are even cheaper than comparable fossil fuel cars, resulting in a large number of Teslas on Norwegian roads. The economic incentives are the most important – 67% choose the BEV because of the lower costs, according to a survey by the Norwegian EV Association [ELBILISTEN]. Environmental reasons are the second most important reason for buying an EV according to 21 % of the respondents in the same survey.

It now seems that the industry itself is able to further finance the development of infrastructure. Several companies are now building charging stations at office buildings, at refuelling stations and along the main roads, especially in the south of Norway.

Oslo has been at the forefront. More than 1,000 recharging points are providing electricity for BEVs free of charge from the municipality. A total of about 1,900 charging points are publicly available in the city. The most recently created charging points are technologically equipped so that the city can introduce payment for charging. Oslo has also co-funded private companies who have built fast chargers. Other Counties and municipalities are providing funding for charging infrastructure as well, and some offer

consultancy services and advice for housing cooperatives wanting to install chargers.

The Norwegian EV owner survey of 2016 [ELBILISTEN] shows that economic benefits are the most important incentives for EV owners. This survey only considers BEV advantages, not environmental or other issues. The ranking of the importance of different incentives was as follows:

1. Zero VAT
2. Zero registration tax
3. Free toll roads
4. Low annual road tax
5. Low fuel (electricity) cost
6. Available charging infrastructure
7. Free parking
8. Access to bus lanes
9. Free recharging
10. Zero cost on ferries

#### Infrastructure

The European Clean Power for Transport directive recommends that there should be one publicly available charging point for every 10 electric cars by 2020. In 2015 there were only approximately 1,350 charging points complying with EU standards in Norway. It is hard to see how the recommendation can be achieved. If the number of BEVs should reach 400,000 by 2020, this means that there should be around 40,000 public charging points available. However, the recent improvement in the range of BEVs may lead to the need for less recharging points than the directive recommends.

While there has been improvement, there is still a backlog in the construction of charging infrastructure. For normal and semi-fast charging, most public buildings and installations in Norway lack the proper charging infrastructure. There are way too few fast-charging stations in the rural areas around the big cities. This limits market penetration, especially for the professional market, which has higher demands and less tolerance of recharging queues.

The challenge of infrastructure for large-scale use of BEVs has not yet been solved. Norwegians like to go to their cottages in the mountains in wintertime, and to the seaside in summertime. Will it be possible to build a charging infrastructure that can provide sufficient electricity without waiting in line with thousands of cars on a Friday afternoon? The world's largest charging facility, located 60 km north of Oslo opened in late 2016. It includes 20 Tesla recharging points and 8 Fortum Charge and Drive points. However, infrastructure providers have stated that it will not be possible to provide an infrastructure serving this kind of demand based on current standards and expect-

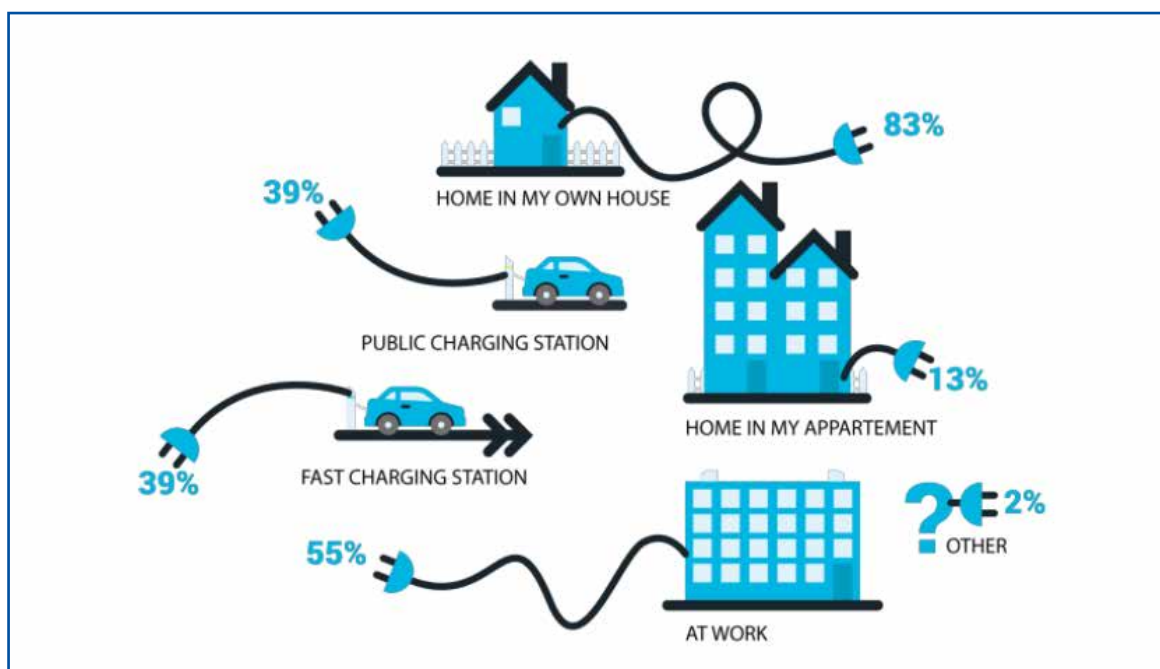


Figure 24. In Norway, most electric car owners recharge at home and start every day with a full battery. Source: The Norwegian EV owner survey, 2015. The Norwegian EV Association.

ed demand. A longer driving range and charging stations of up to 350 kW may be part of the solution to this problem.

The Norwegian EV owner survey of 2015 showed that about 96 % of EV owners have access to recharging in their own house or apartment - see Figure 24. The biggest obstacle is for those who live in shared apartment buildings and therefore are not able to install a home charger for themselves. Oslo and some other cities have a grant system to support charging stations in shared apartment buildings to lower this barrier. The survey also showed that only 7 % of EV owners used slow-charging public stations on a daily basis, and only 17 % used them weekly. When asked the same question about fast charging, less than 1 % of EV owners claimed they used it on a daily basis and 8 % weekly.

### Vehicles

The number of BEVs in Norway reached 100,000 in December 2016. This is about 4% of the total number of passenger cars. About 42% of the registered

BEVs are located in the part of Norway belonging to the Northern Scandria@Corridor. However, even though the milestone of 100,000 BEVs was reached, sales are slightly down from 2015. This was not unexpected by the Norwegian EV Association. The reason, in their opinion, is that there have been few new models entering the market and that customers are waiting for new models with a longer range which will be available from 2017. Another reason may be that some of the incentives are being adjusted, for instance, municipalities may charge BEVs for municipal parking from 2017. It should be mentioned that a relatively large number of used BEVs are imported to Norway. They are not part of the statistics for new registrations. The number of PHEVs saw a large increase in 2016. This is mainly because of reduced purchasing tax, and the introduction of more PHEV models on the market.

The Norwegian EV Association's ambition is that the population of BEVs in Norway will have grown to 400,000 by 2020. There are several challenges regarding this. Around half of Norwegian car sales

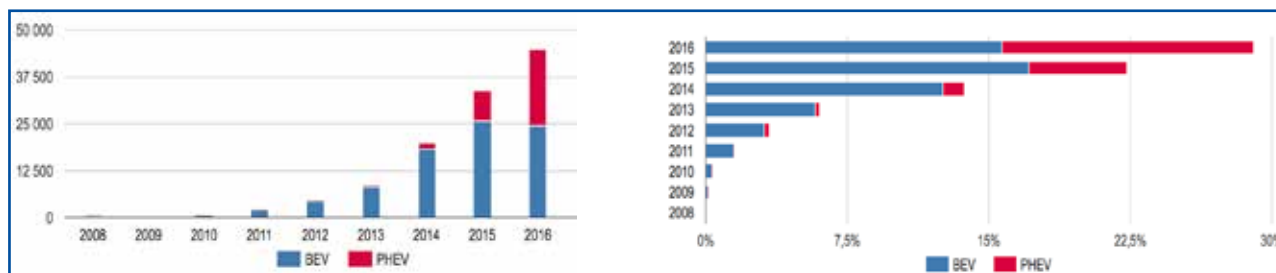


Figure 25. Sales of passenger BEVs and PHEVs in Norway. To the left is the number of new registrations, to the right is the market share of new registrations. Numbers are given at a national level. Source: [EAFO].

consist of large cars. The offering of BEVs in this segment is still poor, with only Tesla available. Even though Audi and Jaguar recently have scheduled BEVs in this segment, the actual number of models available in this segment may represent a challenge. Another challenge is the number of BEVs available for the Norwegian market. When the market in other countries develops, there is an uncertainty of how many cars will actually be available for sale in Norway. Figure 26 shows the evolution of BEVs in Norway, the green line representing the total number.

Following a small decrease in 2016, sales have to increase significantly in the coming years to reach 400,000 units by 2020. The Norwegian EV association has suggested some actions in order to reach this goal:

1. Increase the price difference between zero emission vehicles and fossil fuel vehicles at purchase;
2. Maintain advantages for using and owning BEVs;
3. Make a plan for large scale charging infrastructure;
4. Build blitz-charging stations (350 kW);
5. Facilitate recharging in parking areas;
6. Prioritize zero emission vehicles in the cities;
7. Demand zero and low emissions for taxis and distribution vehicles;
8. Focus on business development and in creased competence.

## 6.4.2 Hydrogen

### Incentives

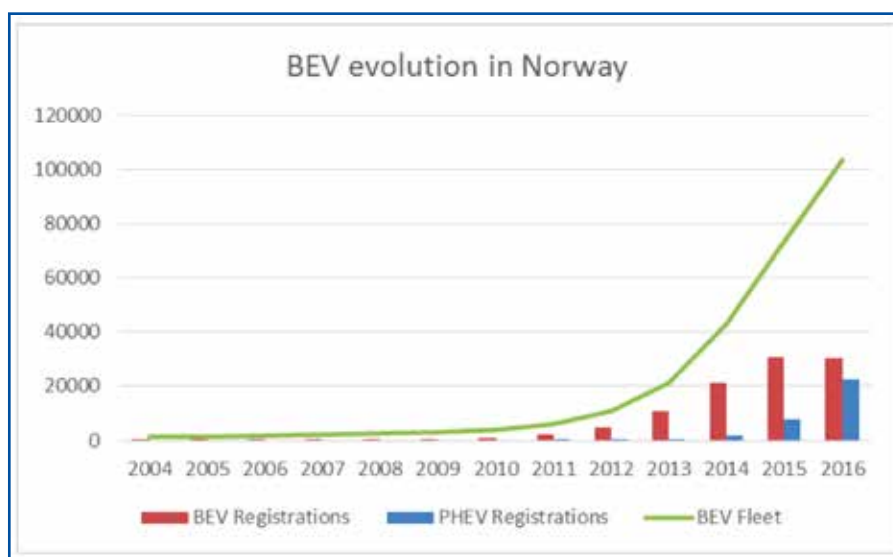
The incentives for electric vehicles also apply to fuel cell vehicles. The Government has decided that these incentives should continue until 2025, or until

a number of 50,000 FCEVs is reached. When BEVs begin to be charged on toll roads in 2017, FCEVs will still be exempted. It seems that both national and regional authorities will continue the current incentives for FCEVs during the build-up phase, as they did for BEVs.

Akershus County Council (ACC) has been at the forefront, giving funds to both investment in and operation of stations. ACC and the city of Oslo have adopted a common hydrogen strategy aiming for 10,000 FCEVs and 100 Fuel Cell Buses by 2025. ACC has been funding infrastructure and vehicle acquisition. Currently, the County Council have a new funding regime for notification by ESA. The aim is to continue the funding of both building and operation of stations. The County Council is also supporting municipalities and taxi owners buying FCEVs, with a grant of about €11,000 (100,000 NOK) per vehicle. This makes the purchase price for a vehicle comparable with that of the gasoline and diesel alternatives. The city of Oslo is expected to offer the same kind of support for up to 50 taxis from 2017. Enova recently launched a programme for purchasing support of electric and fuel cell vehicles for professional use. Fund is provided of up to 50 % of the additional costs for vehicles. Enova's programme for funding of hydrogen refuelling stations is expected before summer 2017.

### Infrastructure

Norway has been acknowledged for its infrastructure for FCEVs. The first hydrogen refuelling station was opened in 2006, and between then and 2012 five more stations opened. By the end of 2016, there were four stations for cars and one station for buses available in the Oslo region. With one exception, the stations for cars are demonstration stations, aiming



**Figure 26.** The evolution of BEVs in Norway. From 1% market share in 2011 to 15.5% in 2016, reaching a total of 100,000 vehicles in November 2016. Source: [EAFO]

to show that FCEVs are a suitable zero emission alternative for passenger transport. The first real commercial HRS was opened in November 2016 in Sandvika, Akershus, with hydrogen production on-site and the capacity to refuel up to 200 cars a day. This station is operated by Uno-X Hydrogen, a Norwegian company that aims to build 20 HRS in and between the largest cities in Norway by 2020. Partly owned by the Norwegian company Nel, a world-leading supplier of electrolyzers and HRSs, this may also pave the way for developing Norwegian technology in the global market.

### Vehicles

At year-end 2016 there were 45 FCEVs registered in Norway, all in the Northern Scandria@Corridor. The majority were of the Hyundai ix35 type, the rest were Toyota Mirai. More cars are available for sale, but a lack of refuelling stations seems to be an obstacle to further development. Oslo's and Akershus' incentives for taxi owners are expected to increase sales. It is also expected to raise the awareness of FCEVs and accelerate sales to companies and private individuals. The FCEVs models that are to come are generally larger cars than the BEVs, and this should meet the demand in Norway.

## 6.4.3 Biomethane and natural gas

### Incentives

Biomethane and natural gas infrastructure and vehicles in Norway don't benefit from substantial incentives as do BEVs and FCEVs. Natural gas has been important in preparing the ground for biomethane. Natural gas is not considered a clean fuel in Norway, and is only accepted as a backup for biomethane for road transport. The primary driver for adopting biomethane is the reduction of CO<sub>2</sub> emissions. Natural gas enjoyed an exemption from road tax up until 2016. Biomethane still is exempt from the tax, but a mix of CBG and CNG will be taxed if the amount of CNG is more than 50%. This tax is currently for notification at ESA.

Biomethane may have several advantages. The counties in the Oslofjord Region, which is to a large extent included in the Norwegian part of the Northern Scandria@Corridor, are cooperating to increase the production and use of biomethane. They recognize that biomethane is an important fuel for reducing emissions from road transport, and at the same time increases regional value creation and employment. Public transport companies are currently the main users of biomethane, especially bus fleet operators in the city of Oslo and the counties of Akershus and Østfold. Several regional waste management companies are using biomethane for their waste collection trucks. Both public transport and waste management companies are to a large extent pub-

licly owned. Thus, public transport providers are very important for the deployment of biomethane in Norway, and are paving the way for professional users.

The Norwegian government adopted a national biogas strategy in 2014. This is not very concrete when it comes to aims and execution. Enova provides funding for manufacturing plants wanting to upgrade biogas to fuel quality. There are some limited investment incentives for smaller biogas plants in agriculture.

### Infrastructure

Biogas is a limited resource, but the potential for the Norwegian part of the Northern Scandria@Corridor is not being exploited. It is expected that demand will increase up until 2020. In general, refuelling stations are not built without secure demand from a fleet of buses or trucks. Public tenders for transport services seem to be the most important driver for the use of biomethane in Norway in the years to come. By requesting low emission transport services, the counties and municipalities can encourage the use of alternative fuels. In some areas biomethane is the only alternative, until zero emission buses and trucks are past the demonstration phase. Possible restrictions on emissions from transport within city centres are also expected to increase the use of biomethane.

### Vehicles

The market for passenger CBG/CNG vehicles in Norway is almost non-existent. Only four CBG/CNG passenger cars were registered in 2016. The substantial incentives for zero emission vehicles will most probably make CBG/CNG vehicles less attractive in the future too, because of both the purchase price and the total cost of ownership.

The purchase price for biomethane trucks is about 33,000 € (300,000 NOK) more expensive than that of the diesel alternative. The users have to commit to long-term agreements with the biomethane distributor, and the potential economic gain is minimal. Some companies lease trucks. The second hand value of the trucks is uncertain, depreciation is high and it becomes a very expensive solution. This limits market development.

## 6.4.4 Expected development - DAFI

The Norwegian strategy paper for the Directive for Alternative Fuel Infrastructure will not be adopted until spring 2017.

## 6.5 Finland

Finland's government announced its most recent climate goals in the new National Energy and Climate Strategy, launched in November 2016. Transport accounts for 40 % of non-ETS emissions. With only a very limited number of electric and CBG/CNG vehicles today, Finland has a lot of catching up to do. The government's aim is to have 250,000 electric and 50,000 natural gas vehicles on its roads by 2030, of a total of about 3 million cars (2016).

A prominent feature of Finland's policy is letting the market largely control development. The incentives are in general weak. All alternative technologies will be considered equally and have the same incentives. The lowest tax rate (5 %) applies to cars with zero CO<sub>2</sub> emissions, while the highest tax rate (50 %) applies to cars with CO<sub>2</sub> emissions exceeding 360 g/km.

Finland has dispersed settlements. About 50% of the population lives in the cities. There are not many cities, and the distance between them is typically 150-200 km. Like people in the other Nordic countries, the Finns also seem to prefer larger cars, often with a towbar. The Finns are said to be quite conservative regarding their choice of vehicle, according to the BEV expert from Eera. Price is the most important criterion. All these factors are important for the deployment of clean fuels.

Thus, it seems that the deployment of alternative fuels in Finland will lag behind that of other countries in the Northern Scandria@Corridor having more attractive incentives. Liquid biofuels have a strong position in Finland, mainly because of a strong industry promoting these fuels and the importance of business development coming from the production of fuels from wood waste etc.

### 6.5.1 Electricity

#### Incentives

For companies leasing electric vehicles, there has been a support scheme with a value of about 500 €/

month, offered by the Ministry of Employment and Economy / Innovation department. This has been popular. For the time being, the only incentives are the reduced tax on purchase, and the minimum tax rate for the CO<sub>2</sub> based registration tax. There are no toll roads in Finland, so a reduced fee on toll roads is not an option. There are some regional incentives like reduced prices for parking, but there are only a few examples of these.

A framework decision as part of the Government Energy Strategy is expected but not yet decided. Possible elements may be a consumer subsidy of 4,000 € per car and a company car allowance subsidy [PÖYRY]. There are discussions about introducing a financial reward of a certain amount for those who buy an alternative fuel car, similar to what we see in for instance Sweden and Germany. This has however not yet been decided.

#### Infrastructure

Finland has one of the highest numbers of recharging points per EV. However, this is because of the small number of EVs and not because of an extensive charging infrastructure. More high power recharging points are needed on the larger roads. This is market driven, and when enough cars are entering the market the expert from Eera is certain that the infrastructure will be developed. There have been some supporting schemes for funding infrastructure, and from the beginning of 2017 the construction of public smart charging points will be subsidized by 30 – 35 % depending on the charging point.

#### Vehicles

The number of electric vehicles in Finland is still very low. As shown in Figure 27, the number of PHEVs has grown substantially in 2016, while the number of BEVs is decreasing. PHEVs are quite expensive, but the reduced tax makes the price competitive. The limited range of BEVs, together with a typically €8,000-10,000 higher purchase price, currently makes BEVs less attractive. Even though market penetration so far has been very slow for BEVs, the

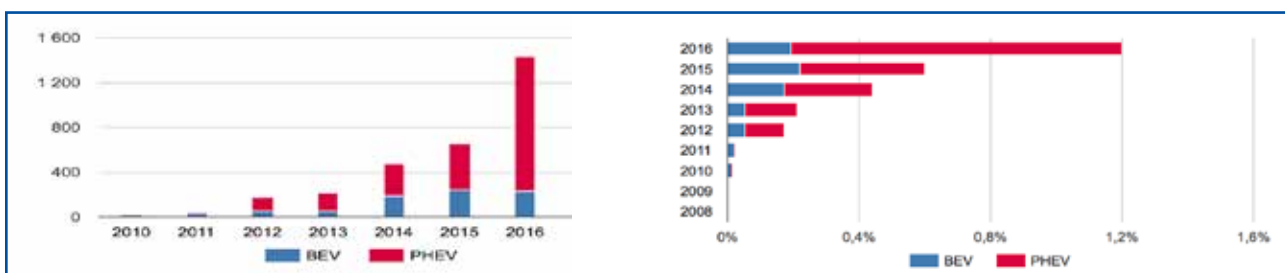


Figure 27. Sales of passenger BEVs and PHEVs in Finland. To the left is the number of new registrations, to the right is the market share of new registrations. Numbers are given at a national level. Source: [EAFO].

expert from Eera is of the opinion that BEVs will also be a success in Finland. With a more competitive driving range and purchase price, cheaper maintenance and Clean Fuel, people will prefer BEVs to diesel and gasoline cars. However, with weak public incentives, this will take time, and a breakthrough of 20% market share is expected between 2022 and 2026.

Municipalities seem to be taking a leading role and some cities have made implementation plans for electric transport. However, because of the high purchase price, development is limited.

## 6.5.2 Hydrogen

### Incentives

FCEVs are considered as electric vehicles, so the same incentives as for BEVs are valid for these. When it comes to infrastructure, there are no incentives for building or operating refuelling stations. It is totally market driven. The plan is to get more cars on the road so that the market for HRSs will develop.

All other countries in the Northern Scandria@Corridor have hydrogen associations working to foster the use of hydrogen, lobbying for incentives and facilitating collaborations between industry and public actors. There is no such association in Finland.

### Infrastructure

The infrastructure for hydrogen is very limited, with only two stations available. One is located in Voikoski, 200 km northeast of Helsinki. This has both a 700 bar and a 350 bar option. It is located at a site belonging to Oy Voikoski Ab, a company distributing gas and manufacturing refuelling stations. The plan is to move the station to a more suitable location when the number of FCEVs increases. The second one is located at the port of Helsinki, with a 350 bar option only. The station was built as part of a national showcase project, and the plan was to have hydrogen fuelled forklifts and working machines at the port using the station. However, plans were changed, and the machines were never acquired. The station is currently only used by Voikoski's FCEV.

### Vehicles

The market for passenger FCEVs is not yet viable because of the high price. The expert from A.Ojapalo Consulting expects the market to expand from 2025 onwards, but does not believe that a market share of 20% for passenger cars ever will be reached. At the moment fuel cell vehicles are very expensive, the current price including tax being about 70,000 €. Only one or two suppliers are selling FCEVs in Finland. More incentives would help, but FCEVs would still be expensive. Some Finns have bought Teslas, at a comparable price, so the expert expects

that it should be possible to sell FCEVs as well. This would however require more refuelling stations to be available. VTT (State Technology Research Institute) has forecast the FCEV volumes to be 2,000-4,000 fuel cell cars in 2025–2030 [OJAPALO].

Finland has domestic production of range extenders and working machines. Electric vehicles with hydrogen and fuel cell range extenders may be a good option for introducing hydrogen into the market. They are also cheaper and may create opportunities for building a flexible HRS network with small stations. FC buses and range extenders (FC+battery hybrid) will already be paving the way to market from 2020-2025 onwards. Some Finnish cities are considering participating in the next call for the FCH JU bus project, launched in January 2017.

## 6.5.3 Biomethane and natural gas

### Incentives

Finland's new National Energy and Climate Strategy envisions that versatile gas will be part of the implementation of ambitious energy and climate objectives. According to the strategy, there will be a significant increase in the production and use of biomethane in the next few years, and a stronger role will be played in the future by biomethane as a transport fuel. According to the strategy, the aim is for Finland to have at least 50,000 gas-fuelled vehicles by 2030.

As for hydrogen and electricity, the aim is that the deployment of biomethane and natural gas for transport purposes should be market driven. Investment subsidies for production and the supply chain are considered important in the early stages of building up the market. There is low tax on natural gas and no tax for biomethane, both for production and use.

### Infrastructure

The development of infrastructure for biomethane and natural gas in Finland has been quite good. Energy consumption of biomethane in transportation was 23 GWh in 2015 [CBG100]. All biomethane consumed in vehicles was produced from bio waste. Utilization of biogas as a vehicle fuel grew by 35 % compared to the previous year. There were 24 public CBG100 filling stations (operated by 7 companies) and many different kinds of private stations in operation. The share of biomethane was 52% overall, and 40% in public stations. Biomethane is the aim for the final product, but natural gas is considered important for building up the infrastructure.

Natural gas (CNG) is the cheapest road transport fuel and biomethane (CBG) is the cheapest renewable fuel. This is a very different situation from that in other countries, where low gasoline and diesel prices

represent a barrier to the deployment of alternative fuels.

Recently, two LBG/LNG stations for heavy duty vehicles were opened in Finland by Gasum Ltd, located in Helsinki and Turku. The next LBG/LNG stations will be opened in Vantaa (close to the main airport) and in Jyväskylä during 2017.

Unlike most of the other countries in the Northern Scandria@Corridor, in Finland there is normally no fixed fleet of vehicles when a new station is built. The expert from Gasum, the leading Finnish producer and distributor of biomethane and natural gas, is very confident that there is and will be market demand for natural gas and biomethane as a road transport fuel, and the company is developing refuelling station infrastructure accordingly. For Finland, it seems that production of biofuels is important both for environmental and business purposes. This, and the fact that the fuel can be made of local raw materials, makes biofuels including biomethane the preferred fuels.

## Vehicles

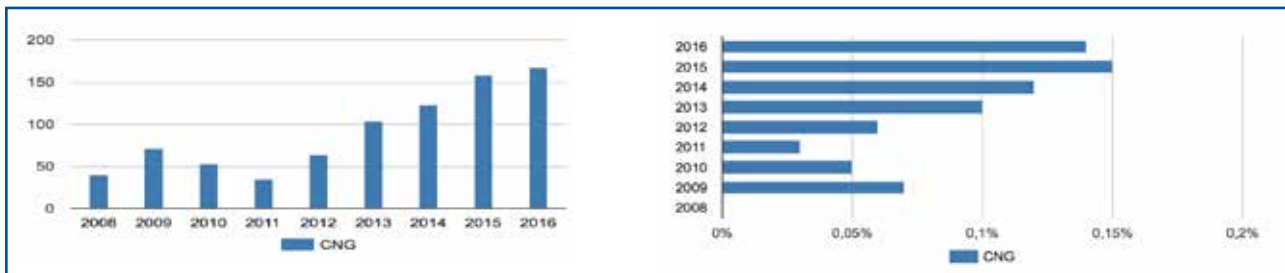
Finland has no official vehicle registration categorizing natural gas vehicles in a consistent manner. Thus, it has been difficult to find statistics for the number of CBG/CNG vehicles in the Finnish part of Northern Scandria@Corridor. The total number of CBG/CNG passenger vehicles was about 1,500 in 2013 and 2,000 in 2015, based on an estimate by the expert from Gasum Ltd.

Figure 28 shows the development of the number and market share of new registrations of CBG/CNG passenger vehicles in Finland.

Although the number of gas vehicles is limited today, the expert from Gasum expects the number to increase quickly. It is also expected that new, attractive vehicle models being available on the market from 2017 will help this development. The national target of 50,000 vehicles by 2030 is considered achievable. The heavy duty segment looks especially promising and is expected to develop.

### 6.5.4 Expected development - DAFI

The Finnish strategy paper for the Directive for Alternative Fuel Infrastructure is not available yet.



**Figure 28.** Sales of passenger CBG/CNG vehicles in Finland. To the left is the number of new registrations, to the right is the market share of new registrations. Numbers are given at a national level. Source: [EAFO].



Benchmark in the European context

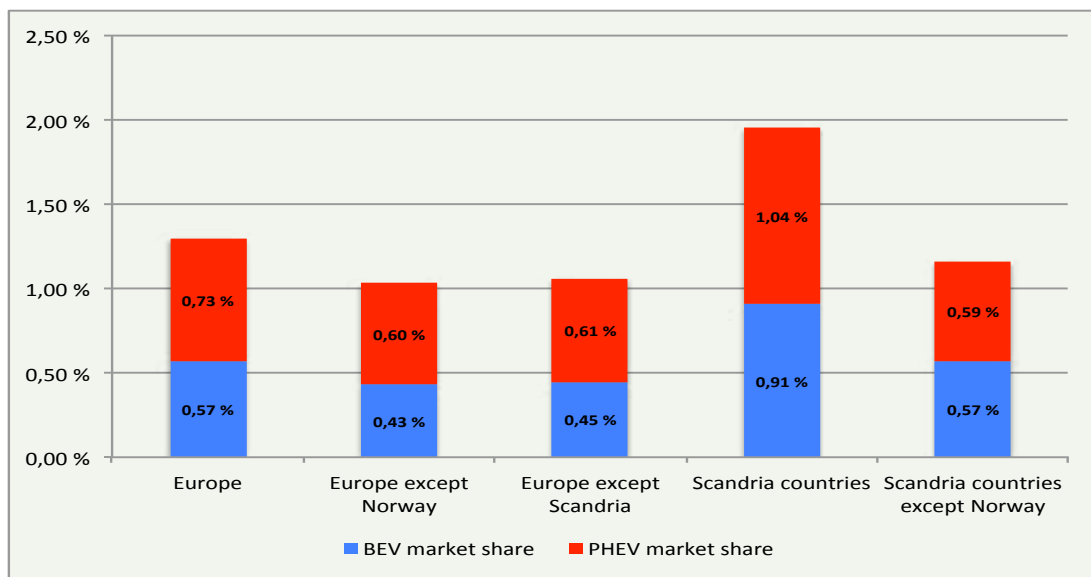
## 7 Benchmark in the European context

To create a benchmark for Clean Fuel performance in the Northern Scandria@Corridor in the European context, we have compared the status and development of Clean Fuel infrastructure and use in the region with the overall situation in Europe. Numbers from EAFO for 2016 have been used. Europe includes the EU Member States, Norway, Iceland, Switzerland and Liechtenstein (EFTA) and Turkey, 33 countries in total. It is important to note EAFO's disclaimer, that the website is under construction and the European Commission does not guarantee the accuracy of the data. Thus, we do not have the figures to make an exact benchmark and the results should be considered normative. The Northern Scandria@Corridor countries of the Scandria@2Act project include Germany, Denmark, Sweden, Norway and Finland. The figures from EAFO are at the national level, thus not limited to the regions in the Northern Scandria@Corridor. However, we consider the num-

bers from EAFO to be representative for the Corridor part of all the countries and that development at a national level can serve as an illustration of development in the Northern Scandria@Corridor as well.

### 7.1 Battery Electric Vehicles

Figure 29 shows the market share of PEVs in Europe and the Northern Scandria@Corridor countries. Norway has a unique position, way ahead of other European countries regarding the market share of both PHEVs and BEVs. We thus present the statistics with and without Norway. The Norwegian numbers are significant compared to the rest of Europe. Comparing the countries in the Northern Scandria@Corridor with the rest of Europe, we see that they are ahead both on BEVs and PHEVs. Excluding Norway, we see that the countries in the Northern Scandria@Corridor are slightly ahead for BEVs and almost at the same level for PHEVs.



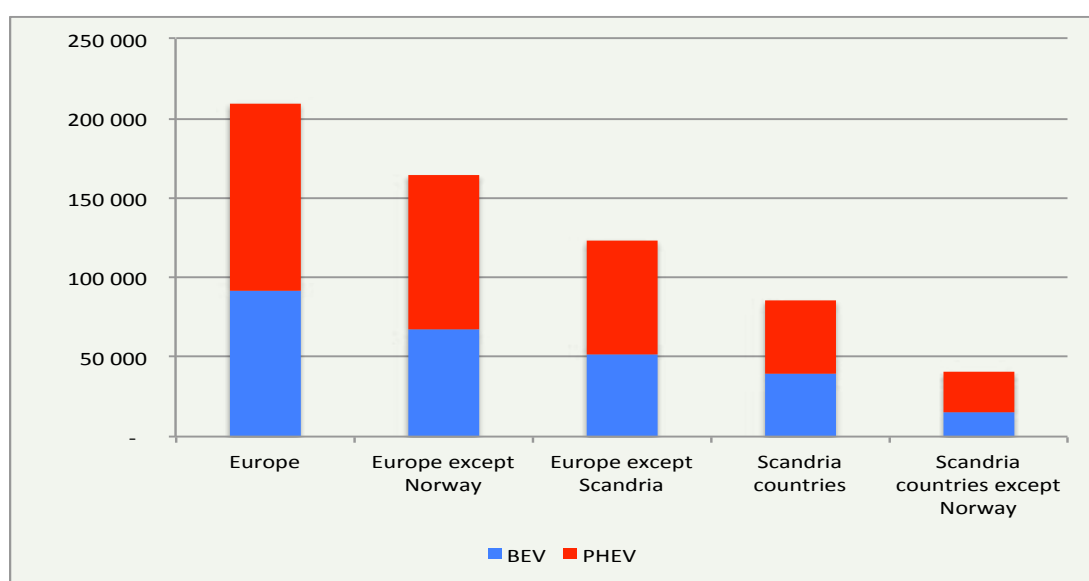
*Figure 29. Market share for passenger BEVs and PHEVs in Europe and the Northern Scandria@Corridor countries, 2016. Numbers are for new registrations, and are given at a national level. Statistics based on numbers from [EAFO].*

The corresponding numbers of new registration of PEVs in 2016 are given in Figure 30. Again, the unique position of Norway is visible. Also the five countries of the Scandria@2Act project together have a significant share of all new registrations of PEVs in the 33 countries, adding up to 41%.

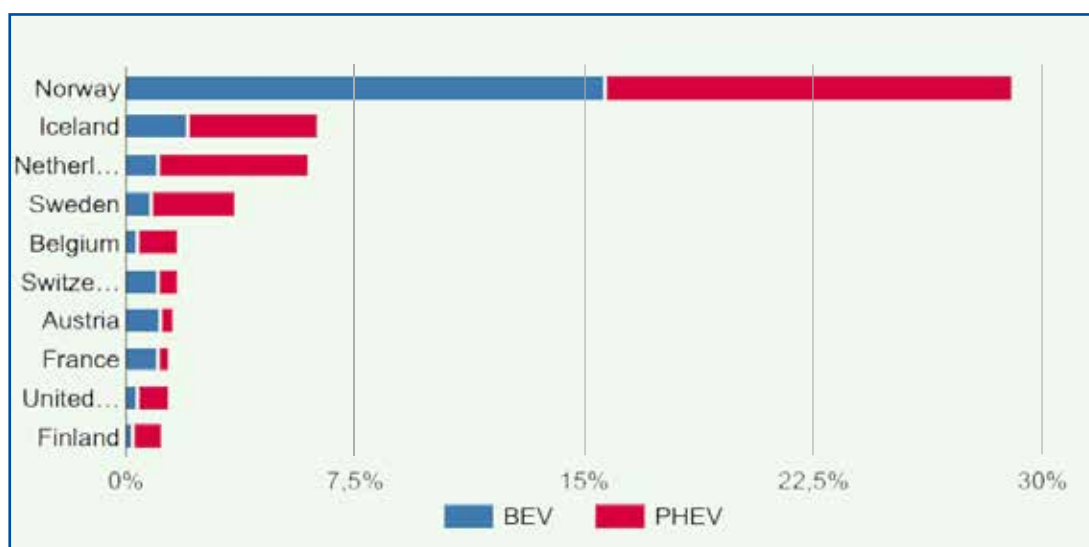
Looking into which countries have the highest share of PEVs in Europe 2016, EAFO has concluded that Norway is in the lead with 29%, Iceland is second with just over 6%, the Netherlands is third with just under 6%, Sweden 4th with 3.6% and Belgium 5th with 1.82 %. See Figure 31.

The reason for the higher share in these countries seems to be the extensive national incentives, in most cases based on reductions of taxes.

Norway's incentives were described earlier. In Iceland, there is no purchase or annual tax for BEVs, there is VAT exemption and also free parking for up to 2 hours in Reykjavik City Centre and Akureyri plus certain charging station incentives. In the Netherlands, zero emission cars are exempt from paying registration tax and road taxes, and they have low company car tax. Clean technology is also partially deductible from corporate and income taxes. In Sweden, there are purchase subsidies, ownership tax benefits and company tax benefits. In Switzerland there are tax reductions depending on each canton's policy, and there is no import tax for BEVs.



**Figure 30.** Numbers of passenger BEVs and PHEVs in Europe and the Northern Scandria@Corridor countries, 2016. Numbers are for new registrations and are given at a national level. Statistics based on numbers from [EAFO].

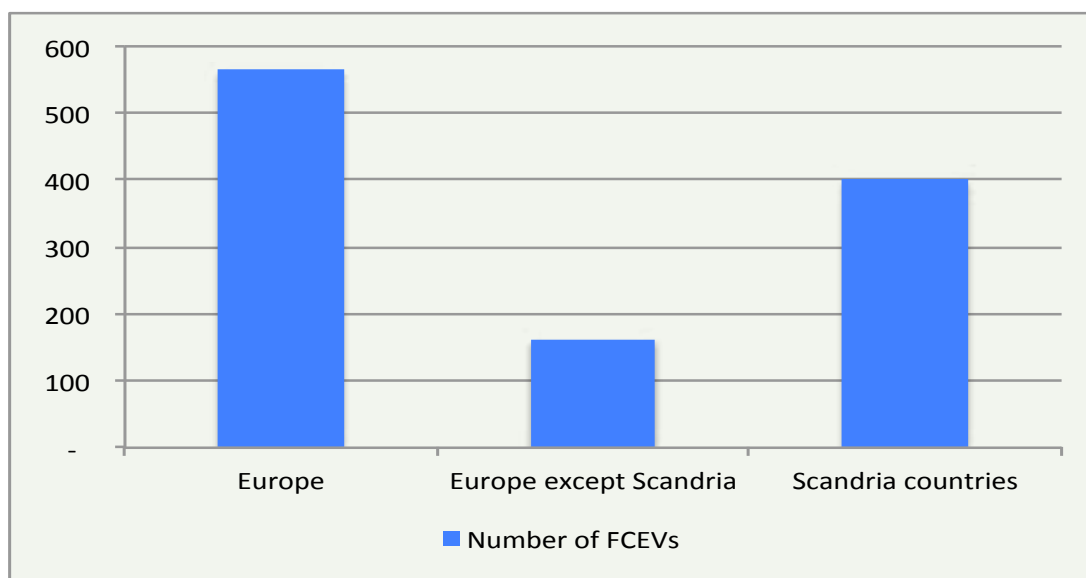


**Figure 31.** The ten leading countries for market share of PEVs in Europe 2016. Source: [EAFO].

## 7.2 Fuel Cell Electric Vehicles

Figure 32 and Table 6 shows the total number of FCEVs registered in 2016. The countries in the Northern Scandria®Corridor have the majority of the vehicles. The numbers are still very low because of the limited numbers of models and vehicles available, and a limited number of refuelling stations. Germany has a leading position, with about 46% of

all FCEVs in Europe. Denmark is in second and Norway in third place when it comes to the number of vehicles per country. It is estimated that about half of the 401 vehicles in the Northern Scandria®Corridor countries are located in the Northern Scandria®Corridor, with about 75% of the German FCEVs being located elsewhere in Germany.



*Figure 32. The total number of passenger FCEVs in Europe and the Northern Scandria®Corridor countries in 2016. Numbers are given at a national level.*

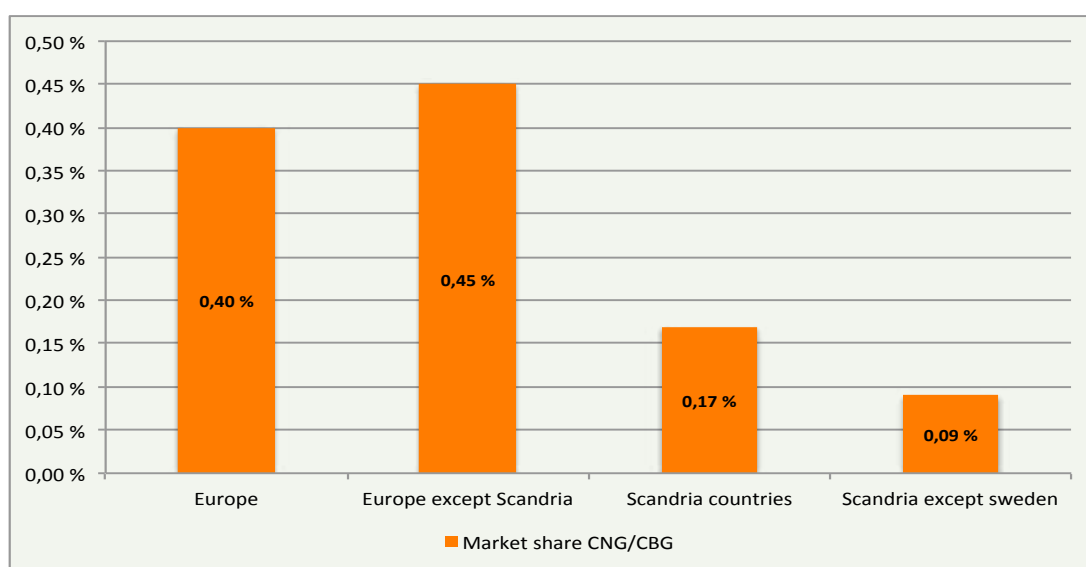
FCEV	Passenger vehicles	Buses
Europe	564	73
Northern Scandria®Corridor countries	401	21
Northern Scandria®Corridor countries %	71 %	29 %

*Table 6. The number of Fuel Cell Electric passenger vehicles and buses in Europe and Northern Scandria®Corridor countries in 2016. Numbers are given at a national level. The share of the total located in the Corridor is shown as well.*

### 7.3 CBG/ CNG vehicles

The market share for CBG/CNG vehicles is shown in Figure 33, and in Table 7 together with the number of cars. The numbers are for new registrations in 2016. As seen, the market share in the Northern Scandria@Corridor countries is substantially lower than in the rest of Europe. The total number of CBG/CNG vehicles in 2015 in the Northern Scandria@Corridor countries was 10,606, dropping by 30% to 7,445 in 2016. For Europe as a total, the numbers were 82,679 and 60,119 respectively, dropping by 27%.

The market share for CBG/CNG vehicles in Sweden is considerable compared to that of the other four Northern Scandria@Corridor countries. A market share of 1.1% in 2016 ranks Sweden as number four in Europe, behind Italy, Iceland and the Czech Republic. Excluding Sweden from the figures, we see that the market share in the Northern Scandria@Corridor countries is halved, being only 0,09%.



**Figure 33.** Market share for CBG/CNG passenger vehicles in Europe and the Northern Scandria@Corridor countries in 2016. Numbers are for new registrations, and are given at a national level. Statistics based on numbers from [EAFO]

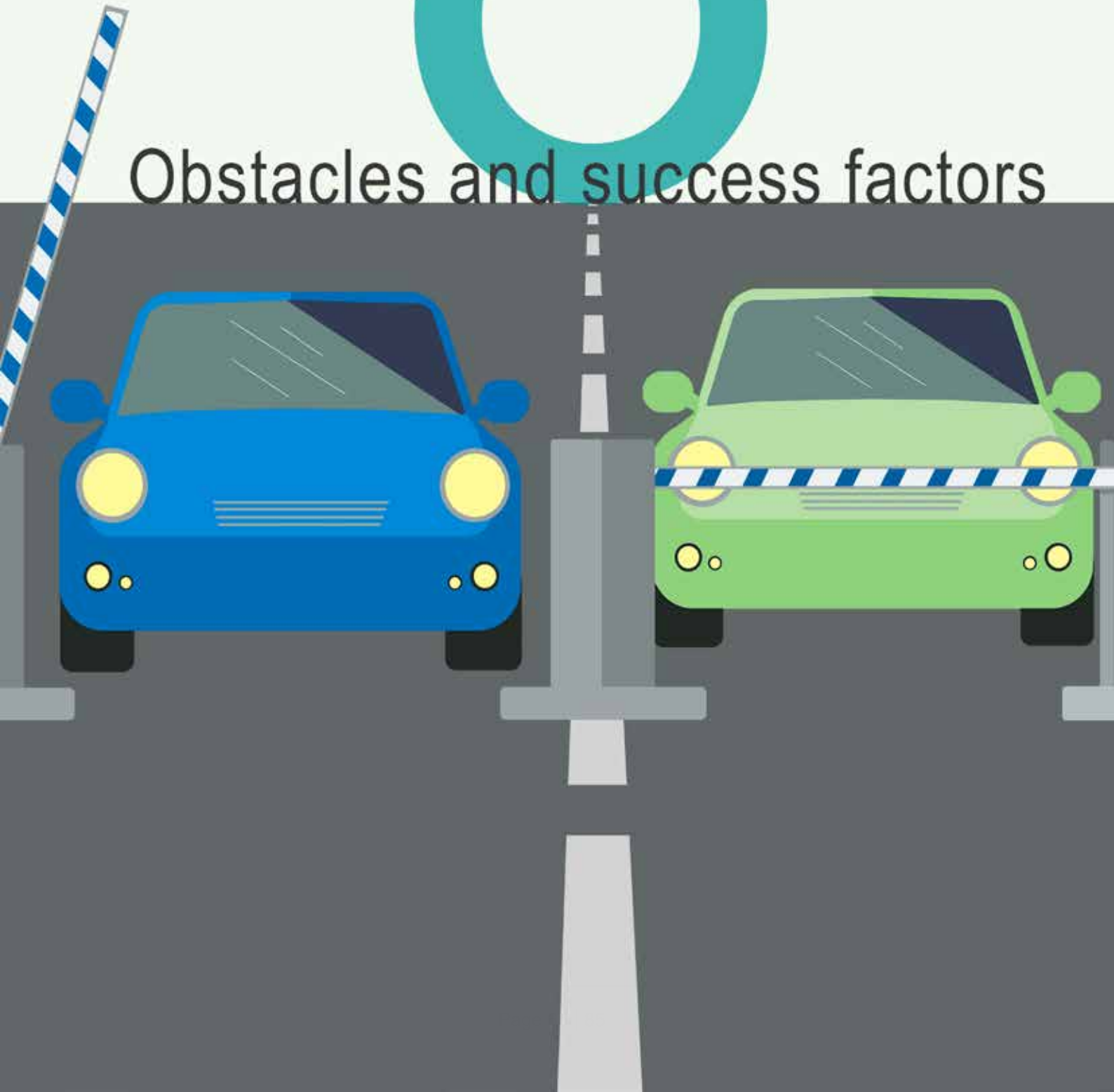
CBG/CNG vehicles, 2016	Market share	No of vehicles
Europe	0.40 %	60,119
Europe except Northern Scandria@Corridor countries	0.45 %	52,674
Northern Scandria@Corridor countries	0.17 %	7,445
Northern Scandria@Corridor countries except Sweden	0.09 %	3,48

**Table 7.** Numbers of new registrations of CBG/CNG passenger vehicles in Europe and the Northern Scandria@Corridor countries in 2016. Numbers are given at a national level. Statistics based on numbers from [EAFO].



# 8

Obstacles and success factors



## 8 Obstacles and success factors

In this chapter we will describe what we consider to be the most important obstacles and success factors for the deployment of clean fuels in each country, and in a Corridor perspective.

### 8.1 The main problem

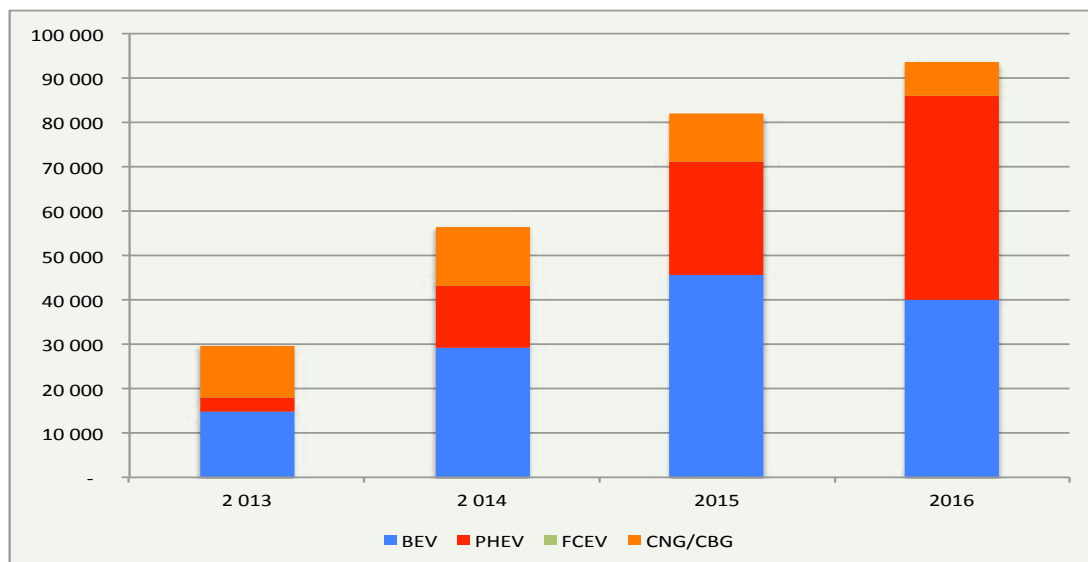
The national and regional authorities have set some ambitious goals for the reduction of CO<sub>2</sub> from transport. The status at the end of 2016 is discouraging. The numbers from EAFO show that development is far from sufficient to reach the goals. Sales of BEVs and CBG/CNG vehicles in Europe in 2016 were down from 2015. Sales of PEVs in Europe are for the first time surpassing 200,000 vehicles, leading to a market share for new registrations of over 1%. About 55% of the PEVs are plug-in hybrids, not reducing CO<sub>2</sub> emissions to a large extent. About 25% of BEVs, that is about 20,000 vehicles, are sold in Norway alone.

Figure 34 shows the development from 2013 to 2016 of sales of Clean Fuel vehicles in the five countries in this study. The numbers are for new registrations per year, and are given at a national level. The number of new registrations of PHEVs is increasing, while the number of BEVs and CBG/CNG vehicles is decreasing. The number of FCEVs is still negligible.

It is a huge challenge to speed up development so that targets can be reached.

Taking a closer look at Norway, 15.5% of new registrations of passenger cars were BEVs in 2016. The overall market share for BEVs is about 4%, representing 100.000 cars out of a total of about 2.5 million. In 2011 the market share of new registrations was 1%. It has taken five years with the world's best incentives to reach today's level of 4% overall market share. No other country is even close to having as extensive range of incentives as Norway. The market share of new registrations of PEVs in the second best of the Northern Scandria@Corridor countries, Sweden, is 3.5%, of which 2.8% are PHEVs and only 0.7% BEVs.

So, the question remains: are we moving fast enough? The development of the deployment of Clean Fuel infrastructure and vehicles is not encouraging. There seem to be no major changes in the use of national incentives in the Northern Scandria@Corridor countries. DAFI policy documents, possibly with an exemption for Germany, don't express high ambitions or actions that seem to accelerate development. It is questionable whether these efforts are sufficient to attain the national and EU goals for the reduction of CO<sub>2</sub>.



**Figure 34.** Total number of Clean Fuel passenger vehicles sold in Germany, Denmark, Sweden, Norway and Finland from 2013 to 2016. The numbers are new registrations and are given at a national level. Source: EAFO.

## 8.2 Obstacles and success factors from a Corridor perspective

### 8.2.1 Information and standardisation

For Clean Fuels to be available throughout the Corridor, it is important that the charging and refuelling technology is standardised. Today, there are several standards for charging technology. The issue is solved for hydrogen, which has one standard for 350 bars and one for 700 bars. For CBG/CNG and LBG/LNG, there is only one standard for each. Thus, for hydrogen and natural gas / biomethane, the question of standardisation is solved. For the recharging of PEVs however, there are several options.

From a Corridor perspective, fast chargers are the most important. Several standards are available, and this could be an obstacle to further development. It seems to take time to converge towards a single standard. A fast recharging standard is needed to give manufacturers and consumers confidence in EVs in the future. Several international projects are working on this issue. Organizations and authorities have to work together to try to encourage standardization.

Identifying the locations of charging stations may also be a challenge. In general, information about charging stations is available via country-specific web-pages and apps, including for larger regions. In Denmark, the Danish EV Association provides updated information via <https://www.ladekort.danskelbilalliance.dk>. The infrastructure for Norway, Sweden and Finland may be found on <http://info.nobil.no> and <http://www.uppladdning.nu>. ChargeMap, <https://chargemap.com>, provides information about the infrastructure in several countries, however it seems to be less up to date than the above-mentioned sources.

In Sweden, there are four operators of charging infrastructure, who have their own payment solutions without any connection to each other. A roaming solution making it easier for BEV users to recharge through different operators, without needing a subscription or agreement up front, is necessary. This is of particular importance across borders. However, roaming may be expensive and the solution should ideally incur no or minimal extra costs.

It is the same with the refuelling of FCEVs. In Germany, you need the CEP H2Card to refuel. You also need to undergo refilling training at one of the stations before the card can be handed over. The H2Card gives access to all German HRSs. In Den-

mark, you need a refuelling card from the operator, and the same card can be used at all Danish refuelling stations. In Norway, stations operated by HYOP are currently moving to payment by VISA or credit card, while Uno-X stations require Internet registration.

GPS services, easy access to information about the availability and location of recharging points, options for pre-booking via an app, standards for charging infrastructure, and easily available and standardised payment solutions are all important factors for EV travellers. Services may be improved in future, creating opportunities for innovations and new business in the region.

### 8.2.2 Availability of infrastructure for electricity

From a Corridor perspective, BEVs are currently most relevant when it comes to passenger vehicles. Even though battery electric light duty vehicles and recently some trucks have become available, their main use would be for local distribution and city logistics. As BEVs become more common, it is more appropriate to use these for longer trips and for holidays. The charging infrastructure will be important in ensuring that this is possible with BEVs. For instance, in Denmark the much slower deployment of BEVs and charging infrastructure compared to neighbouring countries may be an obstacle for long-distance travelling. Even though the infrastructure currently seems to be adequate, future development will be dependent on the deployment of cars. While most recharging points are built in urban areas in the early phases, fast recharging points along motorways are important to facilitate long-range driving.

In November 2016, BMW Group, Daimler AG, Ford Motor Company and Volkswagen Group signed a Memorandum of Understanding to create the highest-powered charging network in Europe. The goal is the rapid build-up of a sizable number of stations in order to enable long-range travel for BEVs. The projected ultra-fast high-powered charging network with power levels up to 350 kW will be significantly faster than the most powerful charging system deployed today. About 400 sites in Europe are planned, and by 2020 there should be thousands of charging points of this kind. This is an important step towards facilitating mass-market BEV adoption. It will be a driver both for the deployment of BEVs in Germany, and also for the transnational use of BEVs for holiday and long-range driving in general.

### 8.2.3 Availability of infrastructure for hydrogen

Hydrogen infrastructure is for the moment sparse in the Northern Scandria@Corridor. With the current network of refuelling stations, it is possible to travel within the Corridor with a FCEV. However, in this early phase, most of the development is focussed on the larger cities. Denmark has the highest density of refuelling stations, with a nationwide network of 10 stations. As with LBG/LNG, and to a certain extent also CBG/CNG, the coupling of refuelling stations and a fleet of vehicles seems to be important in encouraging private companies to build stations. When FCEVs are more common, the possibility of long-range travelling throughout the Corridor will be important.

### 8.2.4 Availability of infrastructure for LBG/LNG and CBG/CNG

LBG and LNG are currently only available in the Northern Scandria@Corridor in Sweden and Finland and in Berlin. The lack of infrastructure in Denmark, Norway and the rest of Germany is an obstacle to the use of LBG/LNG in the Corridor. The same problem applies to transnational transport between Germany and other neighbouring countries such as Poland, Belgium and the Netherlands.

Even though the range of a LBG/LNG vehicle is considerable, there have to be several additional stations available in the region. The Directive for Alternative Fuels Infrastructure sets a maximum distance of 400 km between refuelling stations. To ensure availability and to make it possible to drive on LBG/LNG outside the main roads in the Corridor too, the number should be increased from the minimum level. The aim has to be an increasing number of transport purchasers who require transportation using LBG/LNG. This will increase the number of LBG/LNG trucks, requiring more stations to be available to ensure security of supply.

It seems to be a prerequisite for building LBG/LNG stations that there is a known, regional fleet of trucks, thus ensuring demand for the fuel. This is also an obstacle for development from a Corridor perspective. Somehow, hauliers operating in the Corridor should be encouraged to buy LBG/LNG trucks, thus stimulating infrastructure development within the Corridor.

For long-distance transport, LBG/LNG and renewable diesel seem to be the relevant fuels. For distribution trucks and passenger vehicles, CBG and CNG may be used locally and in the Corridor. Within the

Northern Scandria@Corridor, the infrastructure for CBG/CNG is well developed in Sweden and Germany. It is quite good in Denmark and Finland, and poor in Norway. Further development in the latter three countries is necessary in order to develop a network of refuelling stations, rather than separate stations in limited geographic areas. This is important in enabling travel by CBG/CNG throughout the Corridor.

### 8.2.5 Cross-border cooperation

Regional cooperation is important in order to harmonize aims and learn from shared experience. Infrastructure development should be done from a regional perspective, ensuring the possibility of cross-regional transport. Regions in this sense may be national or cross-border.

Several international and interregional projects aim to foster the use of clean fuels within the Northern Scandria@Corridor, working at a policy level, on infrastructure development, knowledge building and more. Interreg, Horizon 2020 and infrastructure programs like TEN-T are important. The regions can play an important role by using their influence at the national level.

Output 2.3 of Scandria@2Act, Clean Fuel Deployment Strategy, will analyse how regions can collaborate across borders when it comes to the use of incentives and regulatory measures to foster the development of infrastructure and the deployment of Clean Fuel vehicles.

## 8.3 Obstacles and success factors from a national perspective

### 8.3.1 Model selection, costs and availability

Model selection, costs and availability are key factors in the development of Clean Fuel vehicles. We have shown that the majority of available models of BEVs don't suit a large audience in the northern countries. Currently, only two FCEVs are available on the market, while quite a large number of CBG/CNG vehicles are available. Let's have a closer look at these issues.

#### **Model selection and availability of BEVs**

According to EAFO, the market share of new registrations of BEVs in all EU Member States, EFTA and Turkey decreased from 0.59% in 2015 to 0.57% in

2016. One reason, according to the Norwegian EV Association, may be that customers are waiting for new and improved models to be available in 2017. Another significant obstacle is the size of the car, as mentioned. There need to be more models available than the Tesla in this segment. Even though the battery technology is improving rapidly, it remains to see which market segments can be covered by electric cars. Audi and Jaguar are among those car manufacturers who have indicated that they will have battery electric models available. Still, affordable large BEVs seem to represent a challenge.

On the global market, the number of BEVs manufactured is limited and will be so over the coming years. However, taking Norway as an example, the availability of models so far has been good. Several manufacturers have launched their new models for the first time in the country with the world's best EV incentives. The last in line is Opel, who launched the new Ampera-e in Oslo in November 2016. However, Norway is a very small country within the global vehicle market. When the market develops, too few cars might be manufactured to meet the demand. Other countries will be more important for the manufacturers to serve. For instance, under California's zero-emission vehicle mandate, a certain percentage of an automaker's sales must be ZEVs. Thus, the mandate forces the promotion of PEVs and FCEVs, and this is one of the reasons for California being an important market for FCEV manufacturers. There is some uncertainty in Norway as to whether the access to these cars will continue to be as good in the years to come.

The selection of light duty EVs is even more limited. The market share is still low, with Norway as the leading country in Europe having a 1.9% market share of new registrations in 2016. For heavy duty vehicles, there are demonstration projects and development going on. It is an important challenge to get more models on the market, with a longer driving range so that the commercial market can use BEVs to a larger extent.

The cost of BEVs is expected to decrease with decreasing costs for batteries and increased production numbers. Choosing a market driven approach it is to be expected that the sales numbers will remain low until the cost of the vehicle is at parity with the cost of conventional vehicles. Analysts are of different opinions regarding when this will happen. Bloomberg New Energy Finance has predicted that the total cost of ownership of electric cars will dip below that of those with internal combustion engines in 2022 [GUARDIAN]. Others say 2025. Somewhere in between is perhaps the best prediction for the time being.

### **Model selection and availability of FCEVs**

Most of the main car manufacturers have FCEVs on their model programme for the coming years. For the moment, only two models are available for sale in the Northern Scandria@Corridor, the Toyota Mirai and the Hyundai ix35 Fuel Cell. The Honda Clarity is entering the market but is still not available for regular sale. Model selection is an obstacle to market development. However, the FCEVs models available and being announced seem to be generally larger than BEVs, making them a good alternative for those who can't find a BEV suitable for their needs.

Another potential obstacle is the availability of manufactured cars. SINTEF, a leading Norwegian research institute, has estimated the number of FCEVs on the Norwegian market until 2030 [SINTEF]. The calculation took into account the barriers to introducing new technology (high initial cost, limited access to fuel, limited model selection, uncertainty of second hand value), the availability of hydrogen refuelling stations and the number of different hydrogen vehicles available. Limitations based on the estimated production volume of the cars were considered as well. SINTEF expects that it will take several years before a substantial number of FCEVs will be on the Norwegian market, as shown in Figure 35. It is worthwhile mentioning that this is the projected development for the country which also has the world's best incentives for FCEVs. It shows that the deployment of Clean Fuel vehicles takes more time than we like to think it does.

The challenge of getting manufacturers to deploy their FCEVs in Scandinavia has been an issue for several years. Through the Scandinavian Hydrogen Highway Partnership (SHHP), the Nordic countries have collaborated towards this important goal. Toyota, Hyundai and Honda consider Scandinavia as a common market and have noticed the strong political intentions towards using hydrogen as a fuel, especially in Norway and Denmark. This is an important reason for the relatively large number of FCEVs already present on Scandinavian roads. This serves as a good example of how interregional cooperation may foster the deployment of Clean Fuels.

Several development and test projects are now being implemented internationally to demonstrate the use of hydrogen in light and heavy duty vehicles. Scania will deliver the first FC heavy duty trucks, of 27 tonnes, to the Norwegian company ASKO for the distribution of groceries in 2018. Hydrogen seems to have great potential for making the distribution of goods possible with zero emission. However, this project is in a test and demonstration phase, and until vehicles are available, it will be important to foster other Clean Fuel solutions, preferably using biometh-

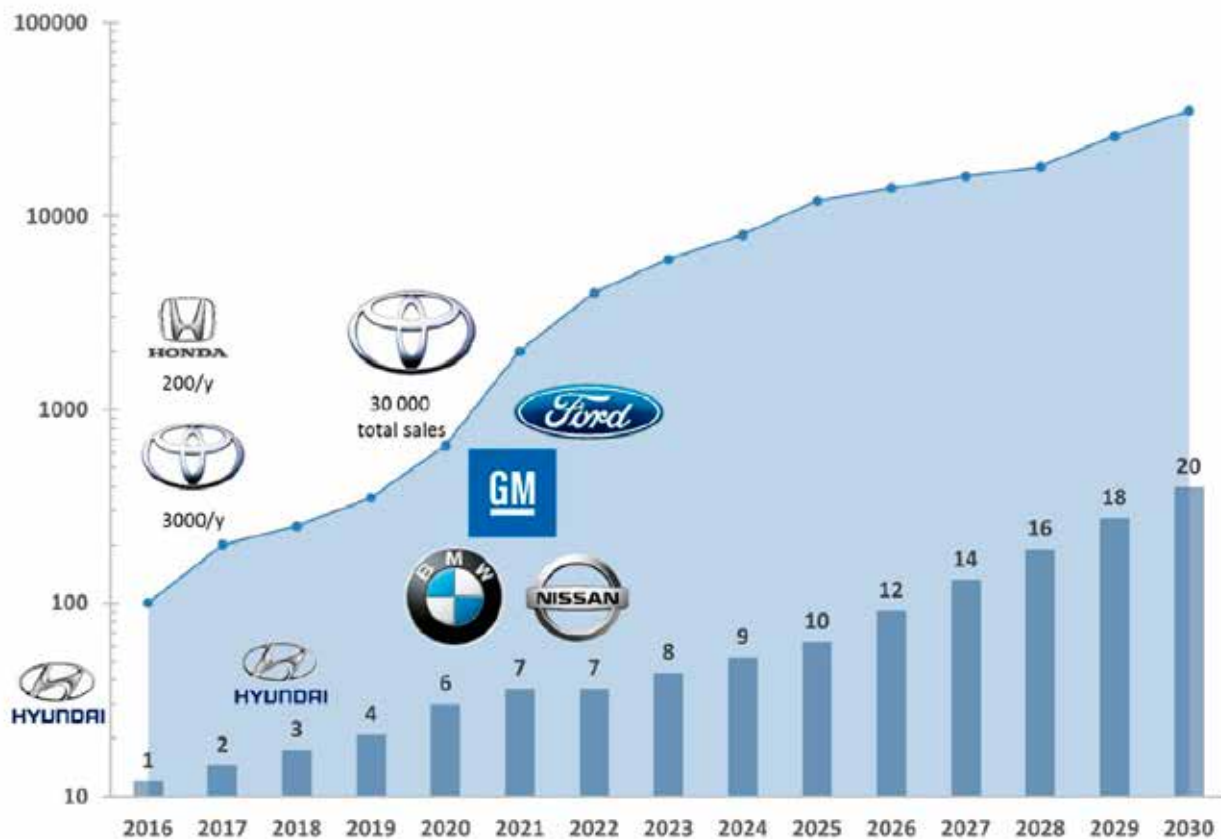


Figure 35. Estimated number of FCEV models available (bar) and total number of FCEVs on the Norwegian market (point) until 2030. Source: SINTEF.

ane or natural gas.

#### Model selection and availability of CBG/CNG and LBG/LNG vehicles

The Natural & Bio Gas Vehicle Organisation (NGVA) has provided a catalogue with a comprehensive overview of the current gas vehicles available, including passenger cars, light and heavy duty vehicles [NGVA]. Within the different categories the following numbers of models are available:

- 23 passenger cars
- 8 combined passenger cars / light commercial vehicles
- 6 light commercial vehicles
- 6 CBG/CNG trucks
- 2 LBG/LNG trucks
- 10 CBG/CNG buses
- 2 LBG/LNG buses

According to NGVA, smaller and lighter natural gas vehicles are similar in price to an equivalent diesel version, while bigger and heavier vehicles have a slightly higher price. All vehicles are not available in all countries in the Northern Scandria@Corridor, depending on demand, market conditions, and the

policy of the vehicle importers. All passenger cars are hybrid, most of them having a larger range with gasoline than by gas. It is hard to find statistics showing to what extent gas cars in general are run on gas versus gasoline, and thus how much they actually contribute to the reduction of CO<sub>2</sub> emissions.

The range of models of CBG/CNG (and LBG/LNG) vehicles includes small, medium sized and larger passenger cars. However, there is a limited number of car manufacturers who have gas vehicles in their model range. It is thus fair to assume that a limited selection of models is also an obstacle for gas vehicles.

When it comes to light and heavy duty vehicles, the selection of models is much more comprehensive than for EVs and FCEVs. The GREAT project is in dialogue with truck manufacturers in order to encourage them to provide more models to the market. Heavy duty vehicles using a combination of biomethane (or natural gas) and biofuels seems to be the most promising in the short run for reducing CO<sub>2</sub> emissions from distribution and long-distance transport.

### 8.3.2 Facilitating local production of fuels

The use of alternative fuels may reduce dependence on imported fuel. This is important for most countries, as gasoline and diesel to a large degree come from politically unstable regions. Electricity from renewable hydro, solar or wind power, biogas from food waste and hydrogen produced with renewable electricity or from biogas reforming are sustainable fuels and make it possible for countries to be more self-sufficient.

Local fuel production also represents a good opportunity for local value creation and new businesses. This is an important effect of the transformation of the transport sector as well, and something that is highlighted by several municipalities and regions. Different regions have different capabilities and strengths in terms of raw materials for the production of fuel. This may also result in differences in the infrastructure development for Clean Fuels in different regions.

### 8.3.3 Local and regional strategies for Clean Fuel

The expression “thinking global, acting local” is also valid within transport. There is a clear link from international policies at EU level, down to Member State, regional and local level. In order to achieve the international goals for the reduction of CO<sub>2</sub> emissions, measures have to be taken at local level. More municipalities, counties and regions are developing their own strategies for the infrastructure and use of Clean Fuels. Municipalities have an important role by transforming their own vehicle fleets to Clean Fuels, and facilitating opportunities for residents to use such fuels. They can do this by stimulating infrastructure development and by using their regulatory power to ensure this happens, for instance by making land available for refuelling stations and requiring

that new refuelling stations within the municipality shall provide Clean Fuels. Implementing Clean Fuel strategies and action plans are important tools for development in municipalities and regions.

### 8.3.4 Demanding transport run on Clean Fuels

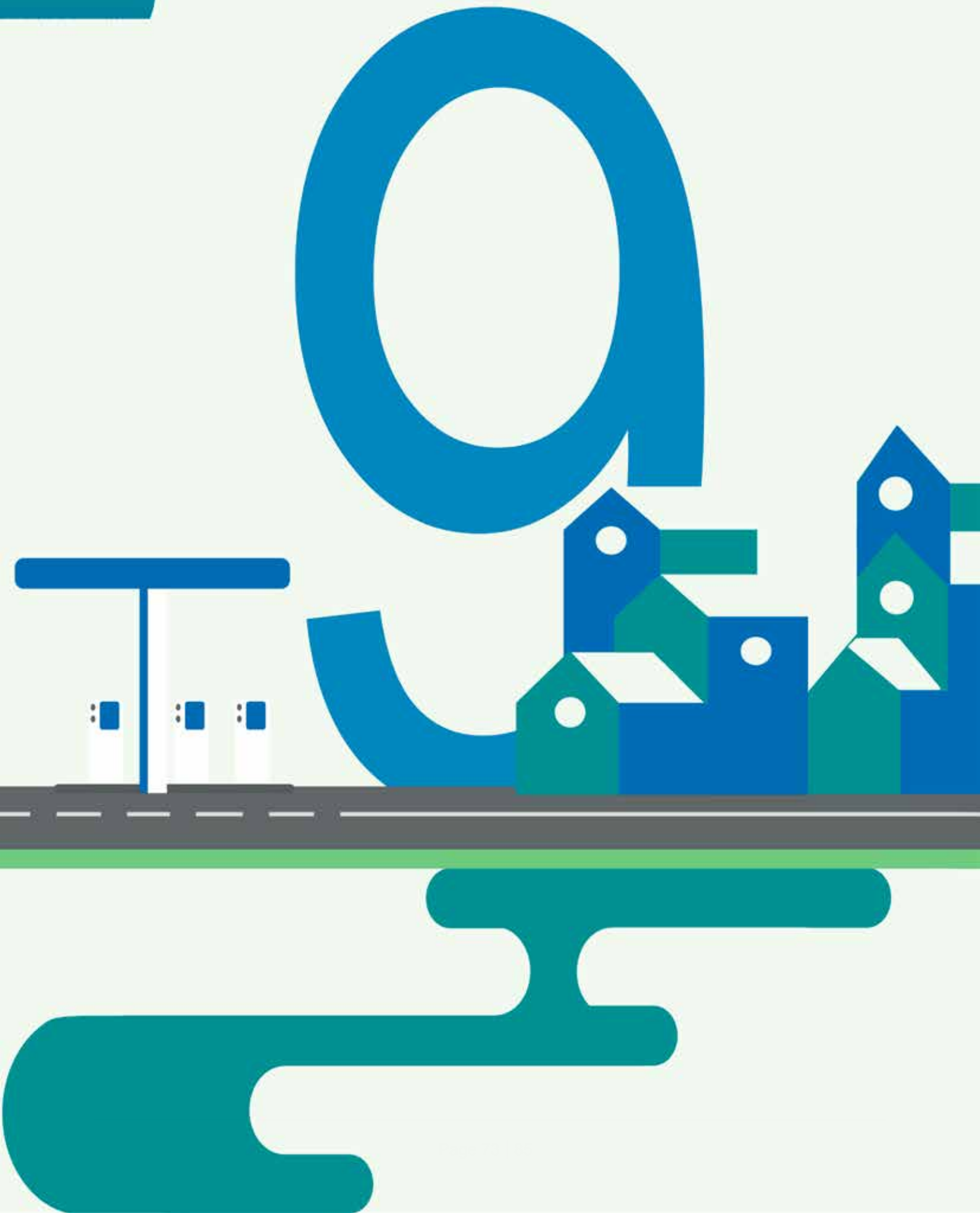
The public has an important role in paving the way for Clean Fuels. There are ways to do this without using incentives. Market stimulation is important, and may be the best way to speed up the commercial viability of Clean Fuels businesses. Public tenders should demand the use of Clean Fuels whenever it is possible. This has had a great effect in areas like public transport and urban waste collection. This may also be applied to transportation of goods and to taxis.

### 8.3.5 Charging infrastructure in the cities

Most people in the Northern Scandria@Corridor live in cities, and for the most part in apartments. Charging infrastructure is in general not available to these people. This is an important obstacle to the deployment of BEVs. There are several trends that may reduce this problem. In general, it is becoming more and more expensive and difficult to own a car in the larger cities. In several cities, ground level parking places are being removed to release the area for other purposes. In Oslo for instance, it is the intention of the city government that all individual parking spaces at surface level will be removed from the inner city centre. Car-sharing initiatives will be more common in the future, making it easier to live in the city without owning a car. However, the problem of providing citizens living in flats with a charging infrastructure without occupying large amounts of space, needs to find a solution. This will be important for all countries within the Corridor.



# Best practice examples



## 9 Best practice examples

We have identified some examples from the Northern Scandria@Corridor that may serve as best practice. We hereby present three examples of each fuel. Each country is represented. The best practice examples are described very briefly, and we provide links for more information.

### 9.1 Electricity

#### 9.1.1 Next generation charging station in Norway

At Vulkan in the centre of Oslo, Fortum has established Norway's most advanced charging station. There are charging points for 100 electric cars, and two fast charging points. The charging points are being developed in two phases, and will have a new technical solution, which includes a choice of charging power. At the same time the potentially large power output is regulated out using batteries.

The electrical system is designed to provide 22 kilowatts at any of the 100 charging points. Once the car is connected, you are able to choose the charging power you want. The basic charge is 3.6 kilowatts, which is free, but one may select 7.2, 11 and 22 kilowatts, at different price levels. The city of Oslo offers recharging at the lowest wattage for free to residents living near the facility.

The charging power is, however, a shared resource, so it will only be possible to recharge at higher power as long as there is availability. As soon as it becomes available, one can get higher charging power. To help out, a plant for power control incorporating a battery plays an important role. The battery, having a capacity of 50 kWh, will help smooth out power peaks and balance phase distortions.

The facility is also prepared for "vehicle to grid" (V2G), which means that power from batteries in the cars can be shipped out of the mains if necessary. In time, this will help to give a reduced rate for recharging. V2G is still in a test phase. No vehicles are so far officially supporting V2G. However, once they are, Fortum's plant on Vulkan in Oslo is prepared for it.

More information: <http://www.fortum.no/privat/charge-and-drive/vulkan/>.

#### 9.1.2 Promoting zero emission taxis in Sweden

The Zero Emission Campaign, Nollzon, is a non-profit organization founded by Vattenfall, IBM, the Swedish Association of Green Motorists and ABB. Nollzon aims to make cities cleaner and quieter. To achieve this, they mobilize stakeholders who are able to actively contribute to the rapid expansion of electric vehicles on Swedish roads. As a starting point, the focus is on taxi companies in large cities.

Nollzon creates a greater demand for electric vehicles and superchargers by allowing employees to prioritize EVs when they order a taxi. When a company registers its address, every cab ordered to or from the office will automatically prioritize an electric vehicle.

So far, more than 725 companies have joined Nollzon. There are about 15,000 taxis in Sweden. Taxi companies who are part of Nollzon only have a total of 33 BEVs as taxis. There is still a long way to go, but the Nollzon initiative serves as a good example of how zero emission alternatives may be promoted in daily use.

More information: <https://www.nollzon.se/in-english>

#### 9.1.3 EVs: the key factor for carbon neutral Copenhagen

Copenhagen Municipality has the ambition of becoming the world's first carbon neutral capital by 2025. The transport sector is the main challenge. In 2016, the city of Copenhagen reached a target it had been aiming for since 2009, that 85% of the city's passenger vehicles would be zero emission. From spring 2017, the fleet will consist of a total of 308 vehicles of which 242 are BEVs, 19 FCEVs, 1 CBG/CNG vehicle, 30 petrol and 16 diesel vehicles.

As an important part of the transition, the municipality has focused on digitizing its fleet. All of its passenger cars and some vans are equipped with GPS trackers and thus obtain data on the use and driving patterns of approximately 450 vehicles. By 2017, GPS tracking systems will have been installed in around 1,460 vehicles. Later on, trailers, containers, and bicycles will also be equipped with transmitters. Using these data has helped to identify the fossil fuel cars that could be replaced, and to plan effective solutions for recharging and hydrogen refuelling.

In recent years Copenhagen has led the way in a nationwide municipal cooperation on the procurement and leasing of electric vehicles, anchored in the Capital Region's EV Secretariat, Copenhagen Electric. It now comprises 20 public institutions, including municipalities, regions and NGOs.

Copenhagen Electric runs an electric vehicle network for municipalities and enterprises, the purpose of which is to gather and communicate knowledge and experience regarding electric vehicles. Copenhagen Electric is the initiator of three electric vehicle partnerships across 37 public enterprises and 38 private businesses. The partners have received financial support to procure electric vehicles. This has resulted in more than 700 additional electric vehicles, primarily in the capital region.

According to the city's climate plan, between 20 % and 30 % of all its citizens' light vehicles should run on electricity or hydrogen by 2025. The city of Copenhagen has several initiatives to pave the way for electromobility, by ensuring the presence of charging stations and parking spaces dedicated to EVs.

More information: <http://www.danskelbilalliance.dk> and <https://www.regionh.dk>.

## 9.2 Hydrogen

### 9.2.1 Fostering hydrogen and electromobility in Hamburg

The growing amount of traffic is a problem in Hamburg. In light of this, Hamburg is implementing an ambitious programme for the rapid development of electromobility. hySOLUTIONS is a subsidiary of HOCHBAHN AG, the public transport service provider in Hamburg. The company was founded in 2005, with the aim of promoting hydrogen and fuel cell technology in Hamburg. Since 2009, hySOLUTIONS as regional project coordinator has been responsible for electromobility. The company now coordinates about 20 regional projects with different partners active in hydrogen and fuel cell technologies, as well as seven projects dealing with electromobility.

Along with an increasing number of electric vehicles and charging stations, there is also a conversion to innovative charging systems for the rapid charging of electric vehicles. For fuel cell cars, there are currently four refuelling stations for public use, and another one is under construction.

Hamburg has for some years been internationally acknowledged for its ambitions and work on hydrogen as a fuel. For instance, fuel cell-powered hybrid buses have been in use in Hamburg since 2003.

hySOLUTIONS has led and participated in a large number of national and international projects, fostering the use of hydrogen for passenger cars, buses, aviation and more. Toyota chose Hamburg when they launched the FCEV Mirai in Europe, because of the city's commitment to an ambitious environmental agenda and the fact that it had the publicly available hydrogen infrastructure.

Fostering zero emission transport requires long-term effort and commitment. The way Hamburg has organized this may serve as a good example of how to give the necessary impetus to the development of Clean Fuel infrastructure and use.

More information: <http://www.hysolutions-hamburg.de/home/>.

### 9.2.2 Hydrogen distribution trucks

ASKO, Norway's largest grocery wholesaler, is a driving force in introducing alternative fuels for distribution trucks in Norway. The company has an ambition to be climate-neutral through zero emission transportation. It already has several trucks running on biofuels and some on biomethane. The first electric truck was acquired in 2016. ASKO has ordered three three-axle, 23 tonnes fuel cell electric trucks, with an option for a fourth. The trucks are electric powered from fuel cells that use hydrogen as fuel, and are to be delivered by Scania in 2018.

ASKO has storage facilities in several places in Norway, some on them with PV panels on the roof providing electricity for the buildings. The company is currently working on a large hydrogen project in the city of Trondheim, in the middle of Norway. ASKO will build a hydrogen refuelling station with local hydrogen production based on electrolysis, using electricity from solar and hydropower. The locally produced hydrogen will be used by ASKO's fork-lifts, some FCEVs and the trucks. Enova contributes financially to the project by supporting ASKO's investments in vehicles and the hydrogen production facility with more than 2.25M € (19.6 million NOK).

The experience from the Trondheim plant will form the basis for further initiatives on hydrogen within ASKO. For the moment, ASKO is assessing the use of hydrogen at their plant in Vestby, just outside Oslo, in cooperation with Vestby municipality.

More information: <https://asko.no/nyhetsarkiv/asko-skal-samarbeide-med-scania-om-hydrogen-drevne-lastebiler/>.

### 9.2.3 Nationwide hydrogen infrastructure

Denmark is the first country in the world to have a nationwide network of hydrogen refuelling stations. The stations are built through a private/public partnership with a high level of public funding from national and international programmes. Half of the stations are operated by Danish Hydrogen Fuel A/S, a joint venture between the oil company OK, the industrial gas company Strandmøllen and the hydrogen station provider Nel Hydrogen Fueling. The rest of the stations are operated by Copenhagen Hydrogen Network, which comprises Air Liquide and Nel.

The development of refuelling stations and FCEVs follows a dedicated Danish R&D and commercialization effort since 1997, when a national hydrogen programme was established. In 2005, the first national hydrogen strategy was published by the Danish Energy Agency. The public/private partnership for hydrogen and fuel cells was established in 2007. The

partnership has since been responsible for developing strategies for, and analyses of, hydrogen and fuel cell technologies, including transport. One of the first aims was to ensure there would be a nationwide network, which now is in place.

All stations are located near major cities and major highway corridors as illustrated in Figure 36. More than 50% of the Danish population have less than 15 km to travel to the nearest HRS. The network of stations allows transportation by hydrogen throughout the whole country.

The achievement of a nationwide hydrogen infrastructure in Denmark is the result of long-term ambitions and a good public/private partnership, and may serve as an example for other regions and countries.

More information: <http://brintbiler.dk>



**Figure 36.** Hydrogen refuelling stations in Denmark, numbers showing the distance to the nearest motorway exit. Source: [www.brintbiler.dk](http://www.brintbiler.dk).

## 9.3 Biomethane and natural gas

### 9.3.1 Waste collection trucks in Berlin

Throughout the Northern Scandria@Corridor, several waste management companies are using biomethane as a fuel for their waste collection trucks. Organic waste is transformed to biomethane, fuelling the trucks that collect the waste.

The municipal waste management company Berliner Stadtreinigung (BSR) serves as a good example. In summer 2013 BSR opened its first biogas plant in Spandau-Ruhleben, as part of a project undertaken to increase renewable fuel usage within the fleet. The treatment facility is expected to process about 60,000 tons of organic waste annually.

The biogas is processed into biomethane and distributed to three BSR stations in Marzahn, Prenzlauer Berg and Wilmersdorf, where the fleet of waste collection trucks refuels. BSR now operates about 150 Mercedes-Benz Econic CBG/CNG refuse trucks on its own renewable biomethane, rather than natural gas made from fossil fuels. By substituting biomethane for diesel fuel in the waste collection vehicles, BSR will save about 2.5 million litres of diesel each year.

The use of biomethane for waste collection trucks is a very good example of a circular economy in practice. Waste management companies all over the Northern Scandria@Corridor are forerunners. We find several similar examples in other parts of the Corridor as well. Management of waste from private housing is a public task, and this is an area where municipalities can be a driving force in introducing clean fuels. This serves as a good example for other municipalities, and for other kinds of municipal and regional transportation.

More information: <https://www.bsr.de>.

### 9.3.2 Public transport in Skåne

Public transport is another area where the use of biomethane has increased substantially in the Northern Scandria@Corridor. There are several examples, and the Skåne Region stands out as a good one.

Region Skåne has set a target of being completely free of fossil fuels by 2020. To achieve this goal, a number of intermediate targets have been set. Skånetrafiken is an administrative function within Region Skåne that is responsible for public transport in the region. Public transport services are provided by several companies throughout the region. Skåne-

trafiken has the overall responsibility for city buses, regional buses, commuter trains, Öresund and service trips in Skåne.

All trains operated by Skånetrafiken have long since been running on green electricity, and since the end of 2015, all city buses in Skåne have been running on fossil-free fuel. Work on sustainability is on-going and the next target is to be reached in 2018, by which time all the yellow regional buses will run on fossil-free fuel. All traffic, including Service Travels, will become fossil fuel free by 2020.

82 percent of the public transport for buses and trains in Skåne is fossil free. All trains run on green electricity and the buses in Skåne are 62% biogas (CBG), 24% natural gas (CNG), 1 % electricity and the rest is bio- or fossil diesel. Since 2015 all public transport in the cities are fossil free and from 2018 all fossil fuel will be replaced with renewable. This means that the remaining CNG will be replaced with CBG.

The regional supply of CBG is possible thanks to a system of collecting food waste from households, restaurants and large-scale kitchens for the production of biogas, with the cooperation of 32 out of the 33 municipalities in Skåne. The biogas in Skåne is also produced from sewage plants, co-digestion biogas plants, farm-based biogas plants, one industrial residues biogas plant, and landfill. In total there are 47 biogas plants in Skåne.

Region Skåne has taken on the role of coordinating Skåne's Roadmap for Biogas, which is a joint mobilization of municipalities, energy farms, the automotive industry, researchers and other organisations in Skåne to drive the development of biogas. The purpose of Skåne's Roadmap for Biogas is to join forces to achieve the main actions for the increased production and use of biogas in Skåne, but also to develop biogas as a smart fuel in Europe. The strategic goal is for Skåne to become Europe's leading biogas region by 2030.

More information: <http://utveckling.skane.se/utvecklingsomraden/miljo-och-klimat/skanes-fard-plan-for-biogas/>

### 9.3.3 Building biomethane infrastructure in Finland

We have mentioned that refuelling stations for biomethane are rarely built without there being a certain level of demand for the fuel. From a commercial

point of view this is understandable, but it is a limiting factor for the development of infrastructure and use. Gasum Ltd, the leading Finnish gas company, seems to be an exception. Gasum imports natural gas to Finland, produces and upgrades biogas in Finland and Sweden and transports and delivers these for energy production, industry, homes, and land and maritime transport.

Gasum operates 28 refuelling stations in Finland. Five more are planned to open during 2017, and the aim is to increase the number of stations by 35 over the next ten years. In addition to natural gas and biomethane stations, Gasum are developing the LBG/LNG filling station network for heavy duty road vehicles. Finland's first LBG/LNG station was

opened in Helsinki in August 2016, and the second one in Turku in November 2016. The foundations for the filling station network are provided by the current gas infrastructure, the developing LBG/LNG market and regional biomethane production.

There are a limited number of CBG/CNG vehicles in Finland today. As mentioned, development is to a large degree market driven. Gasum is driving the market by building refuelling stations, aiming to get more companies and persons to drive CBG/CNG vehicles. By developing a network of refuelling stations in the Nordic countries they are also fostering the use of biomethane and natural gas within the Corridor.

More information: <https://www.gasum.com/en/for-businesses/>

## 10 Annexes

### A1. References

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[SINTEF]	National framework and potential for hydrogen activities in Norway. SINTEF report A27350, January 2016.

## A2. Clean Fuel Experts interviewed

In this annex, the national experts interviewed regarding Clean Fuel market access are listed. The topics discussed with each expert were:

- What are your comments on infrastructure development?
- What are your comments on the development of the number of vehicles?
- What are the main obstacles and success factors for increased market access?
- Are the incentives good enough?
- What incentives are missing?
- How do you think the development of alternative fuels will be in your country?
- Are there any regional best practice examples?
- What do you see as the main challenges for increasing the use of alternative fuels from a Corridor perspective?

In addition to the experts, the members of the Clean Fuel Deployment work package in the project have contributed with facts and inputs to the report. We sincerely thank all the experts who have willingly shared their knowledge with the project.

## Electricity

Name	Country	Organisation	Description
Philip Michalk	Germany	T.H. Wildau	The University of Applied Sciences Wildau is one of five universities of applied sciences in the federal state of Brandenburg. Dipl.-Ing. Philip Michalk is working on market analysis and decision theory within transport and logistics.
Henrik H. Madsen	Denmark	Danish EV Alliance	The Danish Electric Vehicle Alliance is an independent trade association under the Danish Energy Association. The mission of the Alliance is to ensure Denmark as a pioneering country when it comes to implementation of electric vehicles.
Mazdak Haghanipour	Sweden	Power Circle	Power Circle is an electricity industry association. Various activities are run to raise awareness of e-mobility of municipalities and regions.
Erik Lorentzen	Norway	Norwegian EV association	The Norwegian EV Association has for more than 20 years been working for the successful introduction of electric vehicles. The main goal is to promote electric vehicles that run fully or partially on renewable energy.
Eemil Rauma	Finland	Eera	Eera is a strategy consultant in the field of smart and electric traffic.

## Hydrogen

Name	Country	Organisation	Description
Philipp Braunsdorf	Germany	NOW	NOW GmbH (National Organisation Hydrogen and Fuel Cell Technology) is responsible for the coordination and management of the National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP) and the Electromobility Model Regions programme of the Federal Ministry of Transport and Digital Infrastructure (BMVI).
Tejs Laustsen Jensen	Denmark	Danish Partnership for Hydrogen and Fuel Cells	The Partnership for Hydrogen and Fuel Cells is engaged in supporting the development of hydrogen and fuel cell technologies. Mr. Jensen has not been interviewed but has given valuable comments and input to the report.
Erik Wiberg	Sweden	Hydrogen Sweden	Hydrogen Sweden is a Public Private Partnership with members and financiers from industry, NGO's and local, regional and national government. The mission is to facilitate the introduction of hydrogen as an energy carrier in Sweden.
Jan Carsten Gjerløw	Norway	JC Gjerløw Consult	Jan Carsten Gjerløw has for several years been working with hydrogen and zero emission transport in Norway, as managing director of Hynor Lillestrøm, OREEC and as a consultant. He has headed national and international projects for private companies and public authorities.
Anneli Ojapalo	Finland	A.Ojapalo Consulting	A.Ojapalo Consulting Oy supplies consulting and adviser services for public and private organizations. The CEO, Anneli Ojapalo, has been the coordinator of several national hydrogen and fuel cell projects and programmes.

## Biomethane and natural gas

Name	Country	Organisation	Description
Michael Schaarschmidt	Germany	Zukunft ERDGAS GmbH	Zukunft ERDGAS is the initiative of the German natural gas industry. The organisation represents the brand and the product ERDGAS (natural gas) and are contact persons for consumers, politics and market partners. Together with the members, Zukunft ERDGAS are committed to exploiting the potential of the energy carrier, and provide information on the opportunities that ERDGAS offers to energy consumers.
Michael Stie Laugesen	Denmark	NTU International A/S	NTU International A/S is a Danish private consultancy company working internationally with consulting & development projects. NTU provides services in engineering, economics, planning, architecture, technical assistance and management in several areas, including transportation.
Britt Karlsson-Green	Sweden	Region Skåne	Region Skåne is responsible for healthcare and public transport, business development, culture, infrastructure, social planning and environmental and climate-related issues in Skåne. Region Skåne has taken on the role of coordinating Skåne roadmap for biogas. More than 60 companies and organizations are part of the work towards a sustainable region.
John Melby	Norway	AGA AS	AGA has a comprehensive range of industrial and specialty gas products and services. AGA is also a supplier of LBG and LNG. AGA is a member of The Linde Group, operating in more than 100 countries worldwide.
Jussi Vainikka	Finland	Gasum Ltd.	Gasum is a Finnish gas sector (natural gas and biogas) company. Gasum imports natural gas to Finland, produces and upgrades biogas in Finland and Sweden and transmits and delivers these for energy production, industry, homes, and land and maritime transport.

### A3. Clean Fuel Expert Database

These persons are experts on Clean Fuels in the Northern Scandria®Corridor identified during the project.

#### Electricity

Name (Country)	Position	Organisation	Contact info
Philip Michalk (D)	Dipl.-Ing.	TH Wildau	<a href="mailto:philip.michalk@th-wildau.de">philip.michalk@th-wildau.de</a>
Stefan Siegemund (D)	Manager, Renewable Energy and Energy-Efficient Mobility	German Energy Agency	<a href="mailto:siegemund@dena.de">siegemund@dena.de</a>
Ole Kolb (D)	Senior Professional, Renewable Energy and Energy-Efficient Mobility	German Energy Agency	<a href="mailto:kolb@dena.de">kolb@dena.de</a>
Henrik H. Madsen (DK)	Project Manager	Danish EV Alliance	<a href="mailto:HHM@danskenergi.dk">HHM@danskenergi.dk</a>
Mette Hoe (DK)	Special Consultant	Copenhagen Electric	<a href="mailto:mette.hoe@regionh.dk">mette.hoe@regionh.dk</a>
Britt Karlsson-Green (S)	Strategist, sustainable Transports	Region Skåne	<a href="mailto:britt.karlsson-green@skane.se">britt.karlsson-green@skane.se</a>
Mazdak Haghani-pour (S)	Expert, EVs and Charging Infrastructure	Power Circle	<a href="mailto:mazdak.haghani-pour@powercircle.org">mazdak.haghani-pour@powercircle.org</a>
Susanna Hurtig (S)	Director of E-Mobility Nordic	Vattenfall	<a href="mailto:Susanna.hurtig@vattenfall.se">Susanna.hurtig@vattenfall.se</a>
Erik Lorentzen (N)	Senior Advisor	Norwegian EV Association	<a href="mailto:erik@elbil.no">erik@elbil.no</a>
Odd-Olaf Schei (N)	Senior Advisor	Bellona Foundation	<a href="mailto:odd@bellona.no">odd@bellona.no</a>
Joakim Sveli (N)	Business Development Manager	Fortum Charge & Drive	<a href="mailto:Joakim.sveli@fortum.com">Joakim.sveli@fortum.com</a>
Elias Pöyry (F)	Executive Director	Electrictraffic.fi	<a href="mailto:elias.poyry@virta.fi">elias.poyry@virta.fi</a>
Eemil Rauma (F)	Analyst	Eera Oy	<a href="mailto:Eemil.rauma@eera.fi">Eemil.rauma@eera.fi</a>

## Hydrogen

Name (Country)	Position	Organisation	Contact info
Philipp Braunsdorf (D)	Programme Manager, Hydrogen Infrastructure	NOW GmbH	<a href="mailto:philipp.braunsdorf@now-gmbh.de">philipp.braunsdorf@now-gmbh.de</a>
Henning Niemeyer (D)	Managing Director	Spilett New Technologies GmbH	<a href="mailto:niemeyer@spilett.de">niemeyer@spilett.de</a>
Tejs Laustsen Jensen (DK)	CEO	Danish Partnership for Hydrogen and Fuel Cells	<a href="mailto:tij@hydrogennet.dk">tij@hydrogennet.dk</a>
Jacob Krogsgaard (DK)	CEO	Nel Hydrogen Fueling	<a href="mailto:jakro@nelhydrogen.com">jakro@nelhydrogen.com</a>
Björn Aronsson (S)	CEO	Hydrogen Sweden	<a href="mailto:bjorn.aronsson@vatgas.se">bjorn.aronsson@vatgas.se</a>
Erik Wiberg (S)	Intelligence Analyst	Hydrogen Sweden	<a href="mailto:erik.wiberg@vatgas.se">erik.wiberg@vatgas.se</a>
Anna Alexandersson (S)	Manager, Hydrogen Technology	RISE	<a href="mailto:anna.alexandersson@ri.se">anna.alexandersson@ri.se</a>
Ulf Hafselid (N)	CEO	HYOP	<a href="mailto:Ulf.hafselid@hyop.no">Ulf.hafselid@hyop.no</a>
Bjørn Gregert Halvorsen (N)	Technology Specialist	Nel Hydrogen	<a href="mailto:bjhal@nelhydrogen.com">bjhal@nelhydrogen.com</a>
Kristian Vik (N)	General Secretary	Norwegian Hydrogen Association	<a href="mailto:kristian@oreec.no">kristian@oreec.no</a>
Anneli Ojapalo (F)	CEO, Senior Consultant	A.Ojapalo Consulting Oy	<a href="mailto:anneli.ojapalo@ojapalo.com">anneli.ojapalo@ojapalo.com</a>
Taneli Naukkarinen (F)	Director, export sales	Oy Woikoski Ab	<a href="mailto:taneli.naukkarinen@woikoski.fi">taneli.naukkarinen@woikoski.fi</a>

## Biomethane and natural gas

Name (Country)	Position	Organisation	Contact info
Michael Schaarschmidt (D)	Head of Product Management / CNG, LNG services	Zukunft ERDGAS GmbH	<a href="mailto:Michael.schaarschmidt@erdgas.info">Michael.schaarschmidt@erdgas.info</a>
Stefan Siegemund (D)	Manager, Renewable Energy and Energy-Efficient Mobility	German Energy Agency	<a href="mailto:siegemund@dena.de">siegemund@dena.de</a>
Ole Kolb (D)	Senior Professional, Renewable Energy and Energy-Efficient Mobility	German Energy Agency	<a href="mailto:kolb@dena.de">kolb@dena.de</a>
Bruno Sander Nielsen (DK)	Head of Secretariat	Danish Biogas Association	<a href="mailto:bsn@lf.dk">bsn@lf.dk</a>
Poul Erik Pedersen (DK)	Business Developer	Gas2move IVS	<a href="mailto:pop@biogasglobal.com">pop@biogasglobal.com</a>
Michael Stie Laugesen (DK)	Head of Planning, Energy and Transportation Department	NTU International A/S	<a href="mailto:msl@ntu.eu">msl@ntu.eu</a>
Desirée Grahn (S)	Project Manager	Skåne Association of Local Authorities	<a href="mailto:desiree.grahn@kfsk.se">desiree.grahn@kfsk.se</a>
Teréz Palffy (S)	Project Manager	Region Skåne	<a href="mailto:Terez.palffy@skane.se">Terez.palffy@skane.se</a>
Britt Karlsson-Green (S)	Strategist, Sustainable Transports	Region Skåne	<a href="mailto:britt.karlsson-green@skane.se">britt.karlsson-green@skane.se</a>
John Melby (N)	Manager, Clean Energy	AGA	<a href="mailto:john.melby@no.aga.com">john.melby@no.aga.com</a>
Per Wenneberg (N)	Project Manager	Biogass Oslofjord	<a href="mailto:perw@ostfoldfk.no">perw@ostfoldfk.no</a>
Marianne Reime (N)	Project Manager	OREEC	<a href="mailto:marianne@oreec.no">marianne@oreec.no</a>
Jussi Vainikka (F)	Senior Manager, markets and investments	Gasum Oy	<a href="mailto:jussi.vainikka@gasum.fi">jussi.vainikka@gasum.fi</a>



