Pathway to the future
– Scandria®2Act Clean Fuel Deployment Strategy

Interreg Baltic Sea Region
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND
FLAGSHIP

Imprint

Publisher

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Acknowledgements

This project is co-funded by Interreg Baltic Sea Region Programme 2014–2020, www.interreg-baltic.eu
We wish to acknowledge the generous assistance of all project partners and stakeholders, and the time and information that they kindly contributed to this project. In particular, we appreciate the contributions of the following fellow partners of Work Package 2 of Scandria®2Act:
• Anna Tibbelin, Desirée Grahn and Marcus Larsson, Skåne Association of Local Authorities
• Jan Carsten Gjerløw, Akershus County Council (ACC)
• Teréz Palffy, Region Skåne
• Philip Michalk, Technical University of Applied Science, Wildau
• Stig Hvoslef and Ingrid Falkflaug Misund, Akershus County Council
• Sven Friedrich, INFRASTRUKTUR & UMWELT

Disclaimer

The project Scandria®2Act is co-funded by Interreg Baltic Sea Region Programme 2014–2020, www.interreg-baltic.eu. Further information about the project and its results can be found at: https://scandria-corridor.eu/index.php/en/projects/scandria2-act.

Date of this document:
November 2018

Clean Fuel Deployment Strategy

1 Introduction

For decades, transport has been an area of EU common policy, including the harmonisation of national laws, regulations and administrative provisions. As a result, the technological, social and tax environments in which transport services are provided has also steadily gained importance. Besides changes in manufacturing and stock management systems, the abolition of internal borders and a consequent fall in transport prices have also led to an increase in goods and passenger volumes. The transport sector accounts for almost a quarter of all greenhouse gas (GHG) emissions in the EU. In contrast to other sectors, it has not seen the same gradual decline in emissions. Here road transport is the largest emitter, accounting for more than 70% of all GHG emissions from transport in 2014 (European Parliament 2017).

In order to meet its climate goals, the EU has to speed up its efforts to replace conventional fuels for road vehicles and ships with cleaner alternatives. At present, the markets for these fuels across Europe are at differing stages of development. In January 2013, the European Commission announced a package of measures to ensure the development of alternative fuel stations across Europe. In 2014, the new EU rules were officially adopted. As part of this package, Directive 2014/94/EU on the deployment of alternative fuels infrastructure (AFID) seeks to establish a common framework of measures for the deployment of alternative fuels infrastructure. The Directive aims at establishing a “common framework of measures for the deployment of alternative fuels infrastructure in the Union in order to minimise dependence on oil and to mitigate the environmental impact of transport” (European Union, 2014, p. 9). It outlines an agreed and consistent approach to alternative fuels infrastructure and technical standards across EU Member States. In this way, the Directive facilitates the physical interoperability of public infrastructure across countries. Member States were obliged to submit so-called National Policy Frameworks (NPF) to the Commission by 18 November 2016, summarising the status quo as well as targets and measures for developing infrastructure for the alternative fuels electricity, hydrogen and natural gas (cf. European Union, 2014, p. 10f.)

Aim and scope of the report

Road transport in particular has resulted in growing challenges to the climate and environment. The transport sector accounted for 23% of the EU’s greenhouse gas emissions in 2015 and is a source of environmental and health problems in urban areas. It therefore requires appropriate policy instruments that boost mobility by using energy-efficient and environmentally friendly means of transport, and promote innovative mobility solutions with alternative propulsion systems and fuels. These should lead to reductions in emissions, while simultaneously facilitating market access for innovative and energy-efficient mobility products with multiplier potential. The “Clean Fuel Deployment Strategy” (CFDS) is a white paper that includes a list of strategic measures derived from a strategic diagnosis of clean fuel deployment in the Scandria®-Corridor. Addressing fields of action of strategic relevance, it illustrates the development of the clean fuel market, clean fuel technology and clean fuel infrastructure. It identifies relevant measures needed to enable clean fuel deployment from a corridor perspective. It therefore addresses the issues of political coordination, financial incentives, standardisation and information, as well as the financing models of clean fuel infrastructure. The goal is to enable regional and national decision-makers to identify effective and efficient actions in order to support clean fuel deployment. The CFDS therefore strives to promote knowledge acquisition and improve the decision-making process. It includes a list of strategic measures, which can be efficient levers to facilitate clean fuel deployment on different levels.

The CFDS briefly discusses the EU’s climate and energy goals as well as the Union’s transport policy and the role of alternative fuels. Following this, the strategy outlines the present state of alternative fuels and vehicles in relation to targets. Since the main goal of the paper is to evaluate which policy instruments and measures have been shown to facilitate the market uptake of alternative fuels, it

outlines the supporting schemes and incentives that have been or are currently in place within the countries selected. To provide the reader with an overview, a selection of these instruments is illustrated in a table and rated according to certain criteria. In the next section an ex-post assessment is carried out, which discusses the measures taken within country-specific policy frameworks. This chapter serves as the basis for the catalogue of strategic measures, which is directed at policy-makers and reflects on the success factors of policy instruments and their transferability to other countries and regions.

The CFDS covers Germany, Denmark, Sweden, Finland and Norway. Just as in the AFID alternative infrastructure deployment is pursued for electricity, hydrogen, natural gas and biomethane. These are defined as ”alternative fuels” in this report as well. ”Electric vehicles” include both battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV), combining electricity with conventional fuels. ”Fuel cell vehicles” are those which run on hydrogen (FCEV), and ”natural gas vehicles” cover both natural gas and biomethane, either as compressed natural gas (CNG) or as liquefied natural gas (LNG). Although policies for trucks and buses are also discussed, the report focuses mainly on passenger cars.

EU’s climate & energy policy

At the Paris Climate Conference (COP21) in December 2015, the EU Member States were part of the 195 countries that adopted the global climate agreement (European Commission, 2016a). Governments agreed on a long-term goal of keeping the increase in global temperature below 2°C. Prior to this, the European Union had already long been committed to international efforts to tackle climate change, and aims to pursue robust policy-making in this area. In 2007 the European Council agreed on European climate and energy targets to be achieved by 2020: (1) cut EU greenhouse gas emissions to at least 20% below 1990 levels, (2) increase the share of EU energy consumption coming from renewable sources to 20% and (3) improve energy efficiency to reduce the amount of primary energy used by 20% compared with projected levels (European Commission, 2017a). In 2011, as a long term goal, the European Council confirmed the EU objective of reducing greenhouse gas emissions by 80–95% by 2050 compared to 1990 (European Commission, 2017a). To set clear targets beyond 2020, in October 2014 the Council agreed on the 2030 climate and energy framework. Among other things, the agreement includes continuing with three targets in the areas of reducing greenhouse gas emissions, increasing the share of renewable energies, and energy efficiency:

- (1) 40% cut in greenhouse gas emissions compared with 1990 levels;
- (2) 27% of total energy consumption from renewable energy;
- (3) 27% increase in energy efficiency (European Commission, 2017b).

In the light of the Paris Agreement, the target of a 40 percent reduction in greenhouse gas emissions is seen as a minimum, and can be increased accordingly. The renewable energy target is only legally binding at EU level, and not for the individual member states. The same applies for the indicative target to reduce energy consumption by at least 27 percent compared to the projected use of energy. It will be reviewed before 2020 with a view to increasing it to 30 percent (Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, 2017).

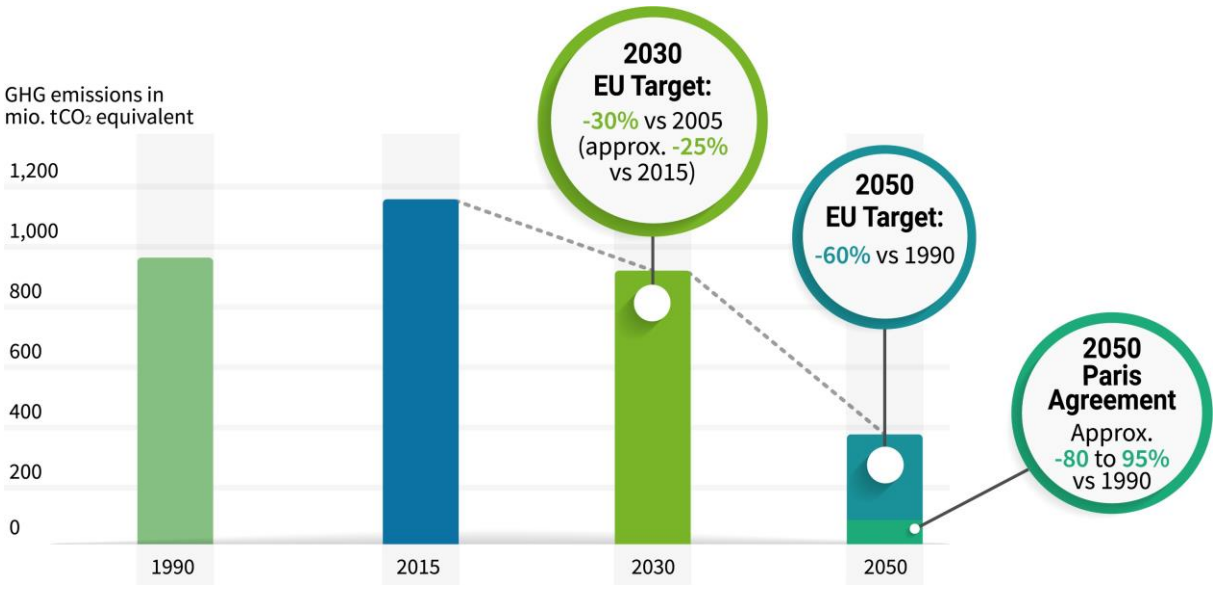

Figure 1: GHG emissions from the transport sector (EU28) and EU climate targets (authors' own representation based on European Union, 2017)

In addition to the AFID, the mandatory emission reductions targets for new cars and light commercial vehicles (LCV) can also be regarded as an instrument to promote alternative fuels in the EU. Whereas in 2015 the target to be reached by the average car fleet was 130g CO_2/km, this will be reduced to 95g CO_2/km from 2021, and after that on the basis of the New European Driving Cycle. Compared with the 2007 fleet average of 158.7g CO_2/km, the 2015 and 2021 targets represent reductions of 18% and 40% respectively. Penalties apply if the average carbon emissions of a manufacturer's fleet exceed the limits. An "excess emissions premium" has to be paid for each car registered: €5 for the first gCO_2/km above the limit, €15 for the second, €25 for the third, and €95 for each subsequent gramme of CO_2/km. From 2019 onwards, the cost will be €95 for every gramme above the limit. So-called "supercredits" have been introduced in order to encourage industry to invest in vehicles with very low emissions (below 50gCO_2/km) (European Commission, 2016b).

GHG emissions from transport sector in the EU

About 20% of the EU's total emissions of GHG can be traced back to road transport. Between 1990 and 2007, GHG emissions grew from 855 to 1,131 million tonnes. The decline subsequently observed was only due to decreasing freight transport volumes and efficiency enhancement. In 2015, emissions were more than 20% above 1990 level, and transport is the only major sector where GHG emissions are still rising.

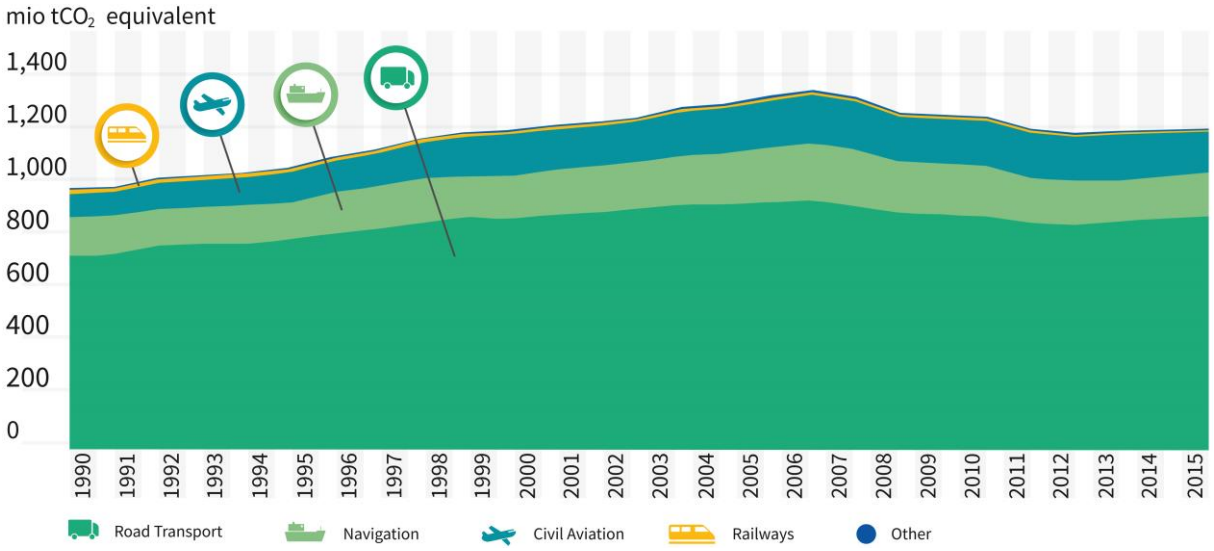

Figure 2: GHG emissions from transport sector by mode (EU28) (authors' own representation based on European Union, 2017)

The main source of emissions in Europe is Germany with a share of 17.9 %, followed by France (14.3%), the United Kingdom (13.3 %), Italy (11.2 %) and Spain (9.2 %). These five countries accounted for two-thirds of the transport sector's GHG emissions in the EU28 (plus Norway) in 2016. Given their smaller populations, the percentages for Sweden (1.8 %), Denmark and Norway (both 1.4%) and Finland (1.3%) were less significant (European Environment Agency, 2018).

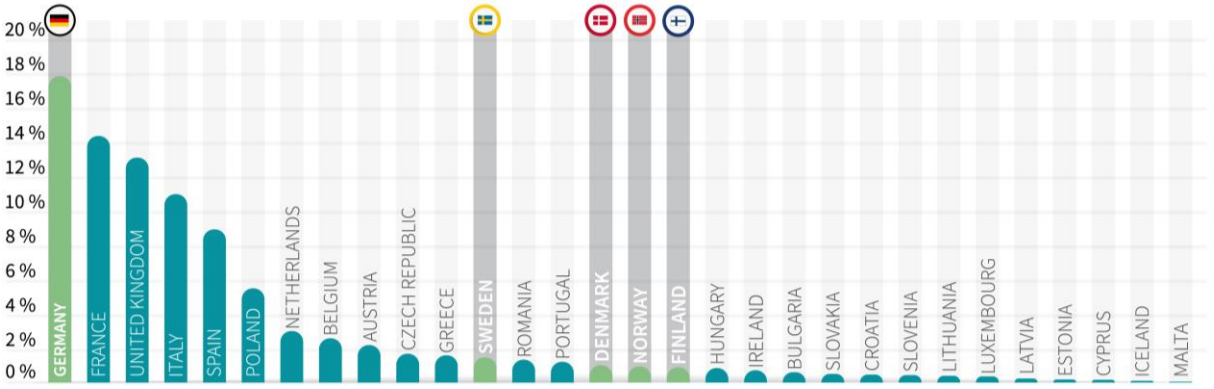

Figure 3: Share of GHG emissions from the transport sector 2016 by country (EU28 plus Norway) (authors' own representation based on European Environment Agency, 2018)

2 Alternative fuels market in the Scandria countries

This report focuses on the countries that constitute the Northern Scandria Corridor: Denmark, Finland, Germany, Norway and Sweden. As Figure 4 shows, new registrations of alternative passenger vehicles show different trends in these countries. While in Norway the market launch of BEVs and PHEVs was very successful, in all other countries it is far behind. In Germany, the market for BEVs

and PHEVs grew slowly until 2016, and then by over 100 % in 2017 and around 45 % for BEVs and 23 % for PHEVs in 2018. In Sweden, PHEV new registrations in 2018 are five times higher than 2015, while BEVs show a positive trend too, but play a smaller role. It is interesting to note that new registrations of CNG vehicles are declining until 2017, but show a positive trend since then in Germany and Finland (eafo, 2018a, 2018b, 2018c, 2018d, 2018e). In Sweden there was a strong positive trend in late 2017, albeit from a low starting point, and the bonus/malus system introduced in Sweden on 1 July 2018 is expected to fuel a further increase.

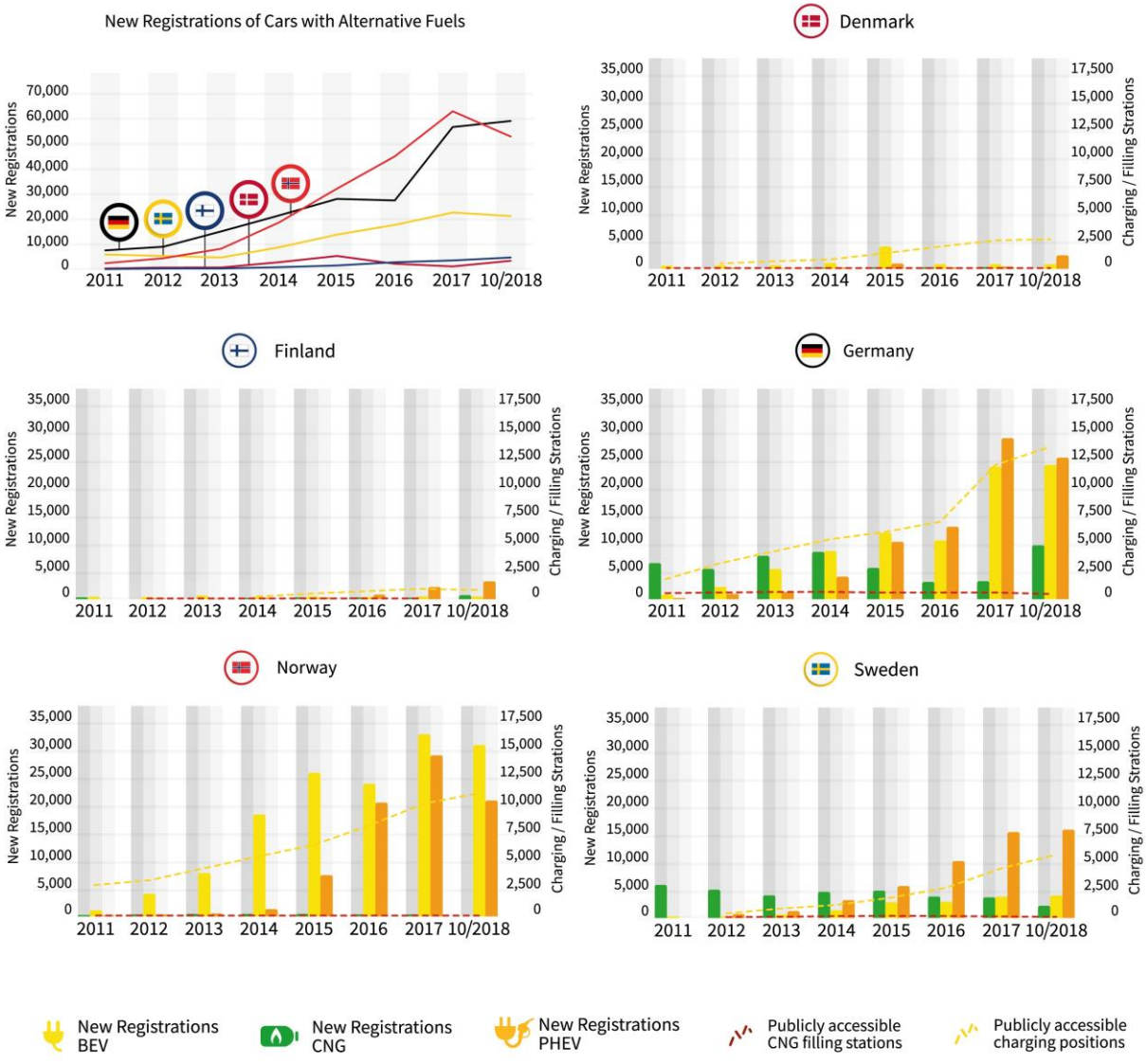

Figure 4: Growth in new registrations of alternative vehicles (passenger cars) and infrastructure (authors' own representation based on eafo, 2017a; bdew, 2017; gibgas, 2018; gas24, 2018; Statistics Denmark, 2018a)

The expansion of refuelling and charging infrastructure developed in a similar way. The greatest progress with regard to publicly accessible charging points was made in Norway and Germany[1] with about 10,000–12,000 charging points per country. Sweden comes next with 4,733 charging points, then Denmark with 2,581, while the fewest charging points are located in Finland (947). The refuelling infrastructure for CNG is declining or stagnating, except with Finland where there is a continued increase.

3 Policy instruments in the Scandria Corridor to stimulate clean fuel deployment

Typology of policy instruments

The implementation of alternative fuels in road transport is still lagging behind political expectations. Existing market structures constitute the existing vehicle and fuel market, which is common to many new technologies and can be overcome through adequate policy measures. In the early stages of market deployment for alternative fuels, policy support is indispensable to enable market growth. Policy instruments can encourage uptake by making alternative fuel vehicles more appealing for consumers, reducing risks for investors, and encouraging manufacturers to scale up production. To varying degrees, Scandria member states have started to speed up their efforts to increase the percentage of alternative fuels in their respective markets. The following chapter provides an outline overview of different instruments that are currently in place within the five selected countries. These instruments can be open to all technologies or specifically designed to support a certain kind. The instruments can take different forms. In the following, they are assigned to three different categories: (1) financial, (2) regulatory, (3) soft instruments.

(1) Financial instruments

Frequently, and particularly in the short term, innovative technologies imply higher costs. Often such a “price premium” can be traced back to low economies of scale and a lack of a critical mass. Financial supporting schemes often aim to overcome barriers for consumers such as the extra cost of vehicle purchase, extra vehicle operating costs and additional fuel costs. Direct financial support measures are often required to accelerate the uptake of alternative fuels. The instruments are often time-limited until the technologies are market-ready. Complementary policies are frequently required to phase out the financial incentives when technologies become cost-competitive. Consequently, financial instruments also include increased taxes for conventional vehicles and fuels, as well as tax exemptions, bonus/malus systems, grants or subsidies.

(2) Regulatory instruments

Through regulatory instruments, policy-makers aim to reach certain environmental quality targets and induce market participants to adjust their behaviour. This can be achieved by means of restrictions or by establishing suitable incentives. Regulatory instruments to control environmental externalities in the transport sector are often classified into different categories. In the process, the instruments often target vehicle engines (e.g. fuel economy or emission standards), fuel quality (content or blending quotas) or transport demand (traffic management through encouraging or discouraging the use of

[1] The higher numbers in 2016 and 2017 were extracted from (eafo, 2017b)for purposes of data comparability. However, the authors assume that the lower numbers from (bdew, 2017)are more realistic.

certain vehicles/technologies). Regulatory instruments aim to incentivise a shift to alternative fuels by means of a positive or negative discrimination for certain technologies.

(3) Soft instruments

Another option that policy might choose is to introduce rather soft instruments, which include better communication, coordination and research and development. Informing the consumer about the advantages of alternative fuels is regarded as a rather soft approach compared to regulating the markets by means of restrictions or incentives. Communication and information e.g. take the form of new vehicle efficiency labelling. This is regarded as an instrument that addresses market failure arising from the lack of information. Increasing consumer acceptance requires knowledge about the existence of alternative fuels and their properties (e.g. fuel quality, vehicle compatibility, availability of recharging/refuelling points, environmental impact as well as financial and safety aspects). Due to problems such as market barriers and small market shares for alternative fuels, cooperation and coordination between the different players is also seen as being beneficial. By means of better coordination, the use of alternative fuels is expected to become more efficient. The coordination can be carried out by public players, but can also take the form of private initiatives. In order to encourage the deployment of alternative fuels technologies, most countries also allocate a specific annual budget to support research into, technological development of, and demonstration of alternative fuels in the transport sector. Similarly, private investors have also formed coalitions to promote technological research and participate in financing the research, demonstration and deployment activities related to alternative fuels.

National policy and policy instruments for alternative fuels in Scandria countries

Denmark

In terms of area, Denmark constitutes the smallest country in the northern Scandria corridor. Transport in Denmark is modern and highly developed. In particular, the Great Belt Fixed Link that connects the islands of Zealand and Funen, and the New Little Belt Bridge connecting Funen and Jutland guarantee smooth traffic flow across the country on both motorways and rail. The government's ambition is that by 2050, Denmark should satisfy its total energy consumption with renewable energy.

Population: 5,781,190
Area: 42,934 km²
Population density: 131.5 people per km²
Gross domestic product: €277,489 million
Length of road network: 74,558 km Motorways: 1,255 km Main or national roads: 2,598 km Secondary or regional roads/other roads: 70,713 km
Total vehicles (2015): 2,850,025 Total commercial vehicles: 445,934 Passenger Cars: 2,404,091 Light commercial Vehicles: 395,645 Medium and heavy commercial vehicles: 41,457 Buses: 8,832

By fuel type:

	Petrol	Diesel	Electric (incl. plug-in)	Hybrids	LPG/CNG	Other
Passenger Cars	68.4%	30.5%	0.3%	0.2%	0.00%	0.6%
LCV	11.3%	88.1%	0.23%	0.2%	0.02%	0.2%
MCV & HCV	0.1%	98.2%	0.03%	0.03%	0.3%	1.3%

Targets according to the Danish national policy framework:

- Denmark has set itself the target of being independent of fossil fuels by 2050, including in the transport sector. Denmark has three official policy papers paving the way for the development of alternative fuels:
    - Agreement on a Green Transport Policy, the Energy Strategy 2050, and the Danish Policy Framework for the Implementation of the AFID.
    - One of the government's targets is that there should be 10% of renewable energy in the transport sector by 2030.
    - In addition to promoting electric cars, the government also aims to have a 10% percentage of biofuels in the transport sector by 2020.
- BEV vehicle target: introduce electric vehicles by implementing various policy measures, such as establishing a fund and a tax exemption scheme.
- Hydrogen vehicle target: Denmark is a leading EU player in this field. The Danish industry has developed a "Hydrogen Strategy 2008-2025".
- CNG/LNG vehicle target: CNG/LNG is identified as a promising fuel for freight transport to reach national 2030 targets for CO_2 emissions.
- Infrastructure targets
    - Charging points
    - Hydrogen fuel stations
    - CNG/LNG stations

Sources: (Statistics Denmark, 2018b, 2018c, 2018d; Eurostat, 2015, 2017a; ACEA, 2017a; BMVI, 2016)

	Battery electric vehicles	Hydrogen fuel cell vehicles	Natural gas/biogas
Financial instruments	• Green owner tax incentivising the use of BEVs (since 1997) • Reduced registration tax for BEVs (since 2007) • The Danish Energy Agency has provided a national funding programme for projects related to electric vehicles (EV) (2008-2015) CPH-Electric has obtained funding for several projects. One of these is purchase subsidies for municipalities and companies buying BEVs • Electricity tax reductions for businesses • The government has decided that municipalities can exempt EVs from parking fees up to €671/year.	• No registration tax for FCEVs until 2019 • Financial support is provided for build-up hydrogen infrastructure	
Regulatory instruments	• No “hard” regulatory instruments forcing market of clean vehicles		
Soft instruments	• No central coordinated soft instruments regarding clean vehicles.		

Table 1: Policy instruments for alternative fuels in Denmark

Finland

Finland has land borders with Sweden to the northwest, Norway to the north, and Russia to the east. The transport system is well-developed, and owes its character to the sparse population and long distance between towns and cities, as well as the cold climate. In 2015, the National Climate Change Act began implementing a long-term target of reducing greenhouse gas emissions by at least 80% by 2050, compared to the 1990 levels. Finland has been hit particularly hard by the financial crisis of 2008 and faced a recession for much of 2011–15. The problems can be mainly traced back to the decline of Nokia and the forestry industry as well as to sanctions against neighbouring Russia.

Population: 5,503,297
Area: 338,400 km²
Population density: 18.0 people per km²
Gross domestic product: €215,773 million
Length of road network: 78,110 km Motorways: 810 km Main or national roads: 12,522 km Secondary or regional roads/other roads: 13,565 km / 51,213 km
Total vehicles: 3,028,316 Total commercial vehicles: 415,394 Passenger Cars: 2,612,922 Light commercial vehicles: 307,706 Medium and heavy commercial vehicles: 95,233 Buses: 12,455

By fuel type:

	Petrol	Diesel	Electric (incl. plug-in)	Hybrids	LPG/CNG	Other
Passenger Cars	74.3%	23.6%	0.03%	0.4%	0.02%	1.7%
LCV	10.0%	89.6%	0.03%	0.00%	0.03%	0.3%
MCV & HCV	1.2%	94.3%	0.02%	0.02%	2.5%	1.9%

Targets according to the Finnish national policy framework:

- The entire car fleet should consist of near-zero emission vehicles by 2050. Finland's National Energy and Climate Strategy declares that Finland aims at 50,000 gas-fuelled vehicles by 2030 and 250,000 electric vehicles.
- All new cars and vans should be compatible with alternative fuels by 2030. The same applies to new trucks and buses.
- By 2025, 50% of new cars and vans should be powered by an alternative fuel, and the goal for 2020 is a 20% share.
- By 2025, 60% of new trucks and buses should be compatible with an alternative fuel, and the goal for 2020 is a 40 % share.
- With regard to infrastructure, Finland's target is
    - a minimum of 2,000 publicly accessible recharging points by 2020. The goal for 2030 is a minimum of 25,000 public recharging points.
    - around 20 hydrogen refuelling stations by 2030.
    - some 50 natural gas and biogas stations in total by 2020.

Sources: (Eurostat, 2017b; European Union, 2016; Eurostat, 2015, 2017a; ERF, 2016; ACEA, 2017a)

	Battery electric vehicles	Hydrogen fuel cell vehicles	Natural gas/biogas
Financial instruments	• Registration tax linked to vehicle-specific emissions of passenger cars (since 2008) • Annual vehicle tax beneficial for low-emission cars (since 2011) • 9 million euro subsidy programme for companies purchasing EVs, FCEVs and charging equipment (2012–2017). • €4.8 million charging infrastructure investment subsidy (30–35%) for operators installing smart public charging stations (2017–2019) • 6 million euros for purchase subsidies of €2,000 for electric and fuel cell electric vehicles. Maximum price per vehicle must not exceed €50,000 (2018–2021) • Scrapping bonus for low CO_2-emission vehicles (≤110 gCO_2/km; €1,500) and for BEV, PHEV and CNG (€2,500)	• Registration tax linked to vehicle-specific emissions of passenger cars (since 2008) • Annual vehicle tax beneficial for low-emission cars (since 2011) • 9 million euro subsidy programme for companies purchasing EVs, FCEVs and charging equipment (2012–2017). • 6 million euros for purchase subsidies of €2000 for electric and fuel cell electric vehicles. Maximum price per vehicle must not exceed €50,000 (2018–2021)	• €1,000 subsidy for converting a normal vehicle to a gas vehicle (2018–2021). • There is a low tax on natural gas and no tax for biogas. • Scrapping bonus for low CO_2-emission vehicles (≤110 gCO_2/km; €1,500) and for BEV, PHEV and CNG (€2,500)
Regulatory instruments	• No “hard” regulatory instruments. Goals set in Finland’s National Energy and Climate Strategy are intended to be met with the help of financial instruments and natural technological developments, which lead to a market where clean vehicles are the first choice.		

Soft instruments	• No central coordinated soft instruments regarding clean vehicles.

Table 2: Policy instruments for alternative fuels in Finland

Germany

Germany is Europe's most populous country and highly industrialised, with a particular focus on the automotive industry. In contrast to other sectors, emissions trends in transport have been stagnating or even increasing in the last few years. According to the Federal Government's Climate Action Plan 2050, the transport sector as a whole will be obliged to reduce its CO_2 emissions by at least 40% by 2030 (compared with 1990).

Population: 82,800,000
Area: 357,300 km²
Population density: 228.6 people per km²
Gross domestic product: €3,144,050 million
Length of road network: 591,034 km Motorways: 12,879 km Main or national roads: 39,604 km Secondary or regional roads/other roads: 178,034 km/413,000 km
Total vehicles (2015): 48,427,094 Total commercial vehicles: 3,355,885 Passenger cars: 45,071,209 Light commercial vehicles: 2,374,822 Medium and heavy commercial vehicles: 902,718 Buses: 78,345

By fuel type:

	Petrol	Diesel	Electric (incl. plug-in)	Hybrids	LPG/CNG	Other
Passenger Cars	66.2%	32.3%	0.1%	0.3%	1.1%	0.02%
LCV	5.5%	93.2%	0.2%	0.00%	1.1%	0.01%
MCV & HCV	0.5%	98.9%	0.1%	0.1%	0.4%	0.03%

Targets according to the German national policy framework:

- By 2020, Germany plans to have one million electric vehicles on the roads. This objective includes battery electric vehicles, plug-in hybrids, and fuel cell vehicles.
- The Federal Government supports the goal of achieving a natural gas share of about 4% in the energy mix of German road traffic by 2020. This would translate roughly to 1 million vehicles.
- With regard to infrastructure, Germany's target is to
    - establish 36,000 publicly accessible recharging points by 2020.
    - create a basic network of 100 hydrogen refuelling stations by 2018 and increase it to 400 stations by 2023.
    - consolidate the current network of CNG stations, which is sufficient for the AFID's requirements. Based on a maximum network distance of 400 km, there would be a need for 6 additional filling stations for LNG.

Sources: (Eurostat, 2017a; European Union, 2016; Eurostat, 2015, 2017b; ERF, 2016; Pro Mobilität, 2014; ACEA, 2017b; BMVI, 2016)

	Battery electric vehicles	Hydrogen fuel cell vehicles	Natural gas/biogas
Financial instruments	• Subsidy for the purchase of BEVs (2016–2019) • BEV owners are exempted from paying vehicle tax for ten years (since 2011) • Employees charging their BEV at work pay a reduced rate of 25% on this non-cash benefit (since 2017) • Comprehensive programme for funding charging infrastructure (since 2017) • Financial support programme for trucks with alternative fuels – BEV; H2, CNG/LNG (2018-2020)	• Subsidy for the purchase of HFCVs (2016–2019) • Programme to provide financial support for infrastructure and production of hydrogen and its application in the transport sector (1st phase: 2006–2016, 2nd phase 2016–2026) • Financial support programme for trucks with alternative fuels – BEVs; H2, CNG/LNG (2018-2020)	• Financial support by federal ministries for pilot projects in the area of LNG (since 2016) • Financial support programme for trucks with alternative fuels – BEVs; H2, CNG/LNG (2018–2020) • (Regressive) tax reduction for natural gas until 2026 (since 2006)
Regulatory instruments	• Toll charge exemption for electric and natural gas trucks until 2020 respective 2020		
Soft instruments	• “Nationale Plattform Elektromobilität” (NPE) government/industry/science dialogue (until 2018)	• Public and private initiatives supported by federal ministries (NOW, H2-Mobility)	• Private initiative supported by federal ministries (Initiative Erdgasmobilität, LNG-Taskforce)
	• “Nationale Plattform Zukunft der Mobilität” - government/industry/science dialogue (since 2018) • “Mobilitäts- und Kraftstoffstrategie” - government/industry/science dialogue (since 2011)		

Table 3: Policy instruments for alternative fuels in Germany

Norway

Norway's low population density, narrow shape and long coastline have an impact on the transport sector. The system is less developed in rural areas but well developed in and around cities. The country has the world's largest registered stock of plug-in electric vehicles per capita. In 2016, the Norwegian parliament approved the goal of achieving climate neutrality by 2030, two decades earlier than originally planned.

Population: 5,258,317

Area: 365,123 km²

Population density: 16.9 people per km²

Gross domestic product: €335,503 million

Length of road network: 94,260 km

- Motorways: 392 km
- Main or national roads: 10,581 km
- Secondary or regional roads/other roads: 44,317 km / 38,970 km

Total vehicles: 3,180,159

- Total commercial vehicles:
- Passenger cars: 2,592,390
- Light commercial vehicles: 487,674
- Medium and heavy commercial vehicles: 100,095
- Buses: n.a.

By fuel type:

	Petrol	Diesel	Electric (incl. plug-in)	Hybrids	LPG/CNG	Other
Passenger Cars	41.94%	47.62%	5.12%		0.01%	5.32%
LCV	5.69%	93.46%	0.74%		0.09%	0.02%
MCV & HCV	4.09%	95.37%	0.00%	0.00%	0.44%	0.09%

Targets according to the Norwegian national policy framework – the National Transport Plan 2018-2029

- All new passenger and light duty vehicles should be zero emission from 2025
- New buses should be zero emission or biogas from 2025
- 75% of long-distance buses and 50% of heavy duty vehicles should be zero emission from 2030
- By 2030, the distribution of goods in the largest city centres will be almost zero emission
- Infrastructure target: no specific targets

Sources: (Eurostat, 2017a; Statistics Norway, 2017; Eurostat, 2015, 2017b; ERF, 2016; ACEA, 2017)

	Battery electric vehicles	Hydrogen fuel cell vehicles	Natural gas/biogas
Financial instruments	• No purchase/import taxes on BEVs (since 1990) • 25% VAT exemption on purchases of BEVs (since 2001) • Reduced annual road tax for BEVs (since 1996) • No fees on toll roads or ferries for BEVs (1997 and 2009) * • Free municipal parking for BEVs* (since 1999) • 50% reduced company car tax (2000) • 25% VAT exemption on leasing (2015)	• No purchase/import taxes on FCEVs (since 1990) • 25% VAT exemption on purchases of FCEVs (since 2001) • Reduced annual road tax for FCEVs (since 1996) • No fees on toll roads or ferries for FCEVs * (1997 and 2009) • Free municipal parking for FCEVs* (since 1999) • 50% reduced company car tax (2000)	• Road tax exemption for biomethane • Programme for funding professional biomethane light and heavy duty vehicles (Enova, since 2017)

	• Funding of charging infrastructure (various programmes over several years) • Programme for funding professional electric light and heavy duty vehicles (Enova, 2017) • Increased scrap refund of up to ca. €1,500 (up to 13,000 NOK) when replacing an LDV using fossil fuels with a zero-emission vehicle (2018)	• 25% VAT exemption on leasing (2015) • Programme for funding professional fuel cell vehicles (Enova, since 2017) • Financial support for the expansion of hydrogen refuelling stations (2017) • Increased scrap refund of up to ca. €1,500 when replacing an LDV using fossil fuels with a zero-emission vehicle (2018)	
Regulatory instruments	• Access to bus lanes for BEVs.* (since 2005)	• Access to bus lanes for FCEVs (since 2005)	
Soft instruments	• No central coordinated soft instruments regarding clean vehicles		

Table 4: Policy instruments for alternative fuels in Norway

* Some instruments are being reduced. Municipalities can decide whether BEVs and FCEVs should pay for parking; counties can decide the same with regard to ferries. In some cities, BEVs are allowed access to bus lanes in rush hours only and with two or more persons in the vehicle.

Sweden

In terms of population, Sweden is the biggest country in Scandinavia. The population density is substantially higher in the south than in the north, and about 85% of the population live in urban areas. The government plans to achieve a 70% reduction of emissions from the transport sector by 2030 compared to 2010, and 0% net emissions of greenhouse gas by 2045.

Population: 10,128,320

Area: 438,600 km²

Population density: 23.8 people per km²

Gross domestic product: 465,186 Mio. €

Length of road network: 216,482 km

- Motorways: 2,013 km
- Main or national roads: 13,507 km
- Secondary or regional roads/other roads: 82,988 / 117,974 km

Total vehicles (2015): 5,279,391

- Total commercial vehicles: 610,328
- Passenger cars: 4,669,063
- Light commercial vehicles: 516,168
- Medium and heavy commercial vehicles: 80,046
- Buses: 14,114

By fuel type:

	Petrol	Diesel	Electric (incl. plug-in)	Hybrids	LPG/CNG	Other
Passenger Cars	68.7%	29.8%	0.1%	0.3 %	0.3%	0.8%
LCV	11.2%	86.9%	0.2%	0.00%	0.8%	0.8%
MCV & HCV	1.2%	94.3%	0.02%	0.02%	2.5%	1.9%

Targets according to the Swedish national policy framework:

- The overall target is the Climate Law adopted by the Parliament in 2017. It defines a climate reduction pathway, with no net contribution of CO_2 by 2045. The only sector target is for transport, 70% CO_2 reduction by 2030 compared to 2010.
- Two different long-term policies were put in place on 1 July 2018 that will have a strong impact on cars and on fuels on the market:
- Sweden introduced a bonus/malus system, providing a bonus for vehicles with registred emissions below 60 grammes CO_2/km (BEV, PHEV and CNG cars), and a penalty for vehicles emitting more than 120 grammes.
- A reduction mandate for all fuels was introduced on the same date, mandating fuel providers to blend in biofuels so as to lead to a predetermined CO_2 reduction. The target is set according to the CO_2 reduction, not specific blending levels. The targets start at 19.3% for diesel fuels, and 2.6%. for gasoline. By 2030, the CO_2 reduction mandate will be 40%.
- In 2018 the Swedish Government decided that by 2020 all fuel pumps must have a label detailing the origin, climate impact and raw material base for all fuels.
- Vehicle tax is calculated based on CO_2. As more electric and biofuel cars enter the market, it will have to change to a distance-based tax. This is being investigated.
- There are no specific targets for BEV, PHEV, hydrogen or methane cars.
- For heavy trucks and goods movement, a road tax is being discussed that will incentivise trucks with alternative fuels, used outside densely populated areas, and that will also target and incentivise modal shifts to rail and ship.

Sources: (Eurostat, 2017b; European Union, 2016; Eurostat, 2015, 2017a; ERF, 2016; ACEA, 2017a)

	Battery electric vehicles	Hydrogen fuel cell vehicles	Natural gas/biogas
Financial instruments	• Super-green car rebate as a subsidy for the purchase of vehicles with maximum 120g CO_2 emissions (2012–June 2018, replaced by bonus/malus system) • The vehicle tax is calculated on the basis of the amount of CO_2 emissions. Until 2018 alternative-fuelled vehicles, or BEVs or PHEVs, were exempt from vehicle tax for five years. This measure was abolished when bonus/ malus was introduced on 1 July 2018. • The taxable value of a company car is reduced by 40% compared with the nearest comparable conventional car, up to a maximum of 10,000 SEK (ca. €1,000) per year (2017–2020) • A bonus/malus system where cars with zero emissions receive SEK 60,000 in bonuses. This bonus decreases proportionately for every gram of CO_2 – down to SEK 10,000. The measure was introduced on 1 July 2018, with no end date.	• Super-green car rebate as a subsidy for the purchase of vehicles with maximum 120g CO_2 emissions (2012–June 2018, replaced by bonus/malus system) • The vehicle tax is calculated on the basis of the amount of CO_2 emissions. Until 2018 alternative-fuelled vehicles, or BEVs or PHEVs, were exempt from vehicle tax for five years. • A bonus/malus system where vehicles emitting more than 90g CO_2/km or more than 140g CO_2/km must pay a higher tax, while vehicles emitting less than 60g CO_2/km pay a lower tax. July 2018 – no end date. • Action program (Klimatklivet) that supports reduced emissions of CO_2 at a local level, for example through the rollout of alternative fuels infrastructure (from 2015 until 2020).	• Super-green car rebate as a subsidy for the purchase of vehicles with maximum 120g CO_2 emissions (2012–June 2018, replaced by bonus/malus system) • The vehicle tax is calculated on the basis of the amount of CO_2 emissions (different components of this tax have different start and end dates). Until 2018 alternative-fuelled vehicles, or BEVs or PHEVs, were exempt from vehicle tax for five years. • A bonus/malus system where vehicles emitting more than 90g CO_2/km or more than 140g CO_2/km must pay a higher tax, while vehicles emitting less than 60g CO_2/km pay a lower tax. Vehicles running on gas get a fixed bonus (€1,000). July 2018 – no end date. • Action program (Klimatklivet) that supports reduced emissions of CO_2 at a local level, for example through the rollout of alternative fuels infrastructure, or by covering part of extra cost of alternative fuels vehicles

	• Action program (Klimatklivet) that supports reduced emissions of CO_2 at a local level, for example through the roll-out of alternative fuels infrastructure (from 2015 until 2020). • Programme to support charging stations in private houses with 50% of installation and 50% of equipment costs up to a maximum of 10,000 SEK (ca. €1,000) per house. (2018 – no end date) • Purchase subsidy for electric buses >30 passengers (2016–2023).		(from 2015 until 2020). • Biofuels for vehicles are exempted from energy and carbon dioxide tax (temporary agreement with the European Commission until 2020) • The taxable value of a company car is reduced by 40%, up to a maximum of 10,000 SEK (ca. €1,000) per year (until 2019)
Regulatory instruments	• Environmental zones for heavy vehicles (no end period): The Government has set out criteria for environmental zones for cars (they have existed for heavy trucks since 1996 in the larger cities). Three zones can be implemented: Zone 1 for all cars; Zone 2 limited to Euro 5 diesel or cleaner vehicles from 2020, and to Euro 6 only after 2022; and Zone 3, for zero-emission vehicles and methane cars only (Euro 6). The implementation is voluntary.. • Refuelling stations selling more than 1,500 m³ of fuel must provide at least one type of alternative fuel (2005–no end period). Historically these have been E85 (ethanol) pumps, however with a declining market for flexifuel vehicles, this will be discussed.		
Soft instruments	• There are two notable initiatives from the private sector that support the development of clean fuel vehicles: ○ The 2030 Secretariat is a coalition of 80 industrial stakeholders, catalysing developments in the areas of biofuels, vehicle technologies and responses towards the 2030 target of 70% GHG reductions vs 2010. ○ Fossil Free Sweden is a private-sector initiative based on the decision by the Parliament to make Sweden climate-neutral by 2045. The Fossil Free Sweden initiative has encouraged business sectors to draw up their own roadmaps to show how they will become fossil-free while also increasing their competitiveness.		

	• From 1 January 2019, new Swedish legislation will be introduced stipulating that all fuels should be labelled with climate effect and country of origin. This labelling is to be displayed at the refuelling and charging stations. Sweden will thus become the first country in the world with this kind of requirement to show source information on fuels.

Table 5: Policy instruments for alternative fuels in Sweden

4 Assessment of selected policy instruments to stimulate Clean Fuels

The present analysis is intended to focus on the identification and evaluation of efficient policy instruments in the transport sector. From an academic point of view, the success of a policy instrument is measured by its cost and effectiveness. Further, it is meaningful to evaluate the extent to which the instrument is accepted and appreciated by the market participants, i.e. producers and consumers. Time plays a crucial role for both: the lead time to establish the instrument as well as the effective period.

Efficient instruments should substantially contribute towards reducing GHG emissions. Accordingly, the higher the proven or expected GHG reductions of an instrument are, the more the instrument can be assessed as being effective. In order to rate an instrument not only as effective, but also efficient, the cost of such an instrument must be considered. Thus, particularly efficient instruments have low costs in relation to the size of their impact on GHG emission reduction.

However, a correct assessment of an instrument's effectiveness turns out to be challenging. Environmental or market trends are never monocausal and it is thus hard to argue that only the application of an instrument led to a certain development. As a consequence, an assessment can only be an approximation to the instrument's actual impact. Besides internal factors such as other policies (taxes, subsidies), external factors like oil/gas prices and technological innovations can also influence GHG emission and market developments.

Definition of criteria

The following table is a preliminary qualitative assessment to provide the reader with an overview of the most powerful actions to support clean fuel deployment in the Scandria countries. The selected instruments are part of a broader policy designed to increase the uptake of alternative fuels and ultimately reduce harmful emissions. They are assessed by the means of the following criteria: cost, effect, acceptance and time to point out their advantages and disadvantages. Thus by comparing political efforts in different countries in relation to their success, it is possible to estimate their initial transferability to other regions or countries.

Cost: The cost of introducing the instrument in monetary terms. "++" implies an inexpensive solution. The instruments' cost can result from direct payments such as subsidies or reduced tax revenues.

Effect: The effect is defined as the instrument's grade of accomplishing the desired result. In other words, it is the level of measurable impact by the instrument, e.g. increasing new alternative vehicle registrations. A high effect is labelled "++".

Acceptance: The instrument's acceptance is the extent to which the measure is approved by the general public and policy makers. In this regard "++" means a high level of acceptance.

Time: This indicator describes the time from designing the policy instrument until implementation. "++" means an ideally short duration.

The assessment according to the above categories is based on a survey of existing literature, comprising existing meta-analyses such as (Hardman et al., 2017) as well as primary sources. A non-exhaustive list of references for each instrument can be found in the table below. The qualitative assessment below has been complemented by a survey of transportation experts in the respective region or country. The table includes a selection of measures in the respective countries and regions, but is not exhaustive. Some recent measures have not been included, as it is too early to evaluate their effect (e.g. LNG/BEV HDV subsidy in Germany, bonus/malus system in Sweden).

+ + = very positive, + = positive, o = medium, - = negative, - - = very negative

Assessment of selected instruments on national level

Battery electric vehicles and plug-in hybrid electric vehicles

Purchase subsidies/tax rebates

	Cost	Effect	Acceptance	Time	Literature
Reduced registration tax for BEVs	--	++	+	--	(Electrek, 2017)
Purchase subsidies for BEVs for municipalities and companies	-	+	+	o	(IEA, 2018a, p. 28)
CO_2-based vehicle registration tax	+	+	++	o	(Ministry of Transport and Communications, 2017, p. 27; INSERO, 2018, p. 24; IEA, 2018a, p. 21; ACEA, 2017b, p. 88 ff)
Subsidy for the purchase of BEVs	-	o	+	o	(BAFA, 2017, 2018; Tietge, 2016)
No registration taxes on BEVs, reduction for PHEVs	--	++	+	o	(Figenbaum et al., 2014; Fearnley et al., 2015; Haugneland et al., 2017; IEA, 2018a, p. 21; Figenbaum, Kolbenstvedt, 2015, 2016; Tietge et al., 2016;
Exemption from VAT on purchase for BEVs	--	++	+	o	

					Bjerkan et al., 2016; Norsk Elbilforening, 2017)
Purchase tax rebate for “super-green cars”	--	++	o	--	(ICCT, 2017; IEA, 2018a, p. 21)
Bonus/malus for new cars	++	++	+	-	Own assesement on the basis of partner information

Table 6: Purchase subsidies and tax rebates for BEVs & PHEVs in Scandria countries

Vehicle ownership taxes

	Cost	Effect	Acceptance	Time	References
Exemption of BEVs from annual vehicle tax (subsequent phase-out)	o	+	+	o	(Electrek, 2017; Sierzchula et al., 2014)
CO_2- and weight-based vehicle ownership tax	o	o	+	++	(Ministry of Transport and Communications, 2017, p. 27; IEA, 2018a, p. 26)
Exemption from vehicle ownership tax	o	o	+	o	(ACEA, 2017b, p. 105; Deutscher Bundestag, 2016; Harendt et al., 2017, p. 145)
Reduced vehicle ownership tax for BEVs	o	+	o	o	(Figenbaum et al., 2014; Fearnley et al., 2015; Haugneland et al., 2017; IEA, 2018a, p. 21; Figenbaum, Kolbenstvedt, 2015; Tietge et al., 2016; Bjerkan et al., 2016; Norsk Elbilforening, 2017; Figenbaum, Kolbenstvedt, 2016)
Lower tax for bonus cars and biofuel cars from year four in the bonus/malus model	++	+	+	+	Own assesement on the basis of partner information
Vehicle ownership tax exemption for five years after registration	o	+	+	o	(IEA, 2018a, p. 26; INSERO, 2018)

Table 7: Vehicle ownership taxes for BEVs & PHEVs in Scandria countries

Charging infrastructure

	Cost	Effect	Acceptance	Time	References
Income tax relief for home charger installation costs	o	+	+	+	(IEA, 2018a, p. 51)
Energy tax rebate for EV charging for businesses	+	+	+	o	(Noel et al., 2017)
Subsidy for investment in charging infrastructure	o	o	+	+	(International Energy Agency, 2018, p. 51)
Subsidy for charging Infrastructure	-	+	+	-	(BMVI, 2017, 2018; Hall, Lutsey, 2017)
Funding of charging infrastructure	-	+	o	o	(Hall, Lutsey, 2017; Lorentzen et al., 2017; Norsk Elbilforening, 2017)
Subsidy for investment in charging infrastructure	-	+	+	o	(IEA, 2018a, p. 53; Langbroek et al., 2016)

Table 8: Subsidies for charging infrastructure in Scandria countries

Tolls, parking, access and other instruments

	Cost	Effect	Acceptance	Time	References
National funding programme by the Danish Energy Agency for projects related to EVs	o	+	+	+	Own assesement on the basis of partner information
Government allows municipalities to exempt EVs from parking fees	o	o	-	o	(IEA, 2018a, p. 27)
No fees on toll roads for BEVs	-	+	+	o	(Aasness, Odeck, 2015; Mersky et al., 2016; Norsk Elbilforening, 2017)
No fees on ferries for BEVs	o	o	o	o	
Free municipal parking for BEVs	-	o	+	o	
Access to bus lanes for BEVs	+	+	+	o	

Purchase tax rebate in the bonus/malus system	++	++	+	-	Own assesement on the basis of partner information

Table 9: Tolls, parking, access and other instruments for BEVs and PHEVs in Scandria countries

Hydrogen fuel cell vehicles

	Cost	Effect	Acceptance	Time	Literature
Exemption from vehicle registration tax	o	+	+	o	(Dolman et al., 2014)
CO_2-based vehicle registration tax	+	o	+	o	(Ministry of Transport and Communications, 2017, p. 27)
CO_2- and weight-based vehicle ownership tax	+	o	+	+	(Ministry of Transport and Communications, 2017, p. 27)
Exemption from vehicle ownership tax	o	-	+	+	(ACEA, 2017b, p. 105; Deutscher Bundestag, 2016)
National Innovation Programme for applied research and market development	--	o	+	o	(McKinsey & Company, NOW, 2017)
No purchase/import taxes on FCEVs	o	o	+	o	(Norwegian Hydrogen Forum, 2017; Pütz et al., 2012)
Exemption from VAT on purchase of FCEVs	o	o	+	o	
Reduced vehicle ownership tax for FCEVs	o	o	+	o	
Purchase tax rebate in the bonus/malus system	++	++	+	-	(ACEA, 2017b, p. 233; Larsson, 2015)
Vehicle ownership tax exemption for five years after registration	o	-	o	o	(ACEA, 2017b, p. 235; Larsson, 2015)

Table 10: Funding instruments for FCEVs in Scandria countries

Natural gas/biogas

	Cost	Effect	Acceptance	Time	
CO_2-based vehicle registration tax	+	o	+	o	(Ministry of Transport and Communications, 2017, p. 27)
CO_2- and weight-based vehicle ownership tax	+	-	+	+	(Ministry of Transport and Communications, 2017, p. 27)
Energy tax reduction for natural gas	-	+	+	--	(BMWi, 2017; Deutscher Bundestag, 2017)
Road tax exemption for biomethane	o	-	o	o	(IEA BIOENERGY, 2014, p. 20)
Exemption of natural gas from energy tax	-	++	o	o	(ACEA, 2017b, p. 237; Boesgaard, 2017; Larsson et al., 2016; Strauch et al., 2012)
Reduced vehicle ownership tax from year four in the bonus/malus system	-	o	o	-	(ACEA, 2017b, p. 235; Larsson et al., 2016; Mathiasson, 2016; Strauch et al., 2012)

Table 11: Funding instruments for CNG in Scandria countries

Key messages from national instrument assessment

- All Scandria countries have purchase incentives for electric vehicles, either in the form of direct subsidies or registration tax rebates. These instruments are usually effective, proportional to the amount of the financial incentive. Further differences between countries arise from the fact that some instruments have been suspended on short notice due to depletion of funding, creating uncertainty for potential buyers.
- A similar picture arises for vehicle ownership taxes. All countries surveyed have rebates for electric vehicles. Overall they are less effective than financial incentives at the time of purchase, as they are smaller in size, and accrue only over a time horizon of several years.
- Most national governments offer matching funding for private investment in publicly accessible EV charging infrastructure. There is not always a direct link between these programmes and charging infrastructure, and public chargers do not directly link to increased adoption of electric vehicles.
- The effect of other instruments, such as parking privileges, is highly dependent on the local circumstances and the resulting financial benefit. Mostly these instruments enhance clean fuel deployment in the early market phase but are seldom a main argument for investments in clean vehicles.

- For FCEVs, the same conditions as for EVs usually apply. As the fuel cell technology is still more expensive, and thus further from the mass market, these incentives have only little effect.
- Nationally implemented measures for CNG in transportation vary widely between countries. Sweden and Germany are the only countries with a strong record of effective CNG policy. Other countries, such as Norway, have only weak measures in place.

Assessment of selected instruments on regional level

Battery electric vehicles

	Cost	Effect	Acceptance	Time	
Establishment of ”Copenhagen Electric” regional initiative in cooperation with OEM	+	+	+	o	(Van der Steen et al., 2015)
Public charging stations at all hospitals and at the central administration in the Capital Region of Denmark as well as all new parking facilities	o	+	+	++	(Hall et al., 2017, p. 10)
Reduced parking fees in Helsinki	o	o	+	+	Own assesement on the basis of partner information
Access to one selected bus lane leading to Helsinki	+	-	-	++	
New Public Procurement System (Hamburg)	o	+	+	+	(difu, NOW, 2014, p. 24; Harendt et al., 2017)
Funding of charging infrastructure and provision of free charging in Oslo and Akershus	o	++	o	o	(Hall et al., 2017, p. 16; Tietge et al., 2016, p. 56)
Free city centre parking permits (until approximately 2015)	+	+	o	o	(Hall et al., 2017, p. 18; Trosvik, Egnér, 2017)

Table 12: Assessment of selected instruments for EVs on regional level

Hydrogen fuel cell vehicles

	Cost	Effect	Acceptance	Time	
Reduced parking fees in Helsinki	o	o	+	+	Own assesement on the basis of partner information
Access to one selected bus lane leading to Helsinki	+	-	-	++	
Funds for investment in hydrogen refuelling stations, and financing of operation costs in Akershus	-	+	+	+	(Akershus County Council, 2014)
Funds for municipal vehicles and taxis in Akershus and Oslo	-	+	+	+	(Akershus County Council, 2014)

Table 13: Assessment of selected instruments for FCEVs on regional level

Natural gas/biogas

	Cost	Effect	Acceptance	Time	
Reduced parking fees in Helsinki	o	o	+	+	Own assesement on the basis of partner information
Access to one selected bus lane leading to Helsinki	+	-	-	++	
Procurement of vehicles for public transport e.g., in Augsburg	o	++	+	+	(Röder, 2017)

Table 14: Assessment of selected instruments for CNG on regional level

Key messages from regional instrument assessment

- Regional initiatives and actions can highly influence and promote clean fuels deployment today, especially when their actions affect many private and commercial users (such as commuters or logistics providers).
- Today most regional actions accompany national instruments. They usually reinforce national financial support. Because the success of regional actions also depends on the market conditions and clean fuel vehicle range, political actions in dense settled regions and communities can be a starting point for national actions.

- For EVs, there are several cases in the Northern Scandria region where local initiatives provided strong and effective incentives, e.g. in Oslo/Akershus and Copenhagen. Their implementation can be swifter than some national measures, and better targeted to the specific mobility requirements of the population. Several measures, such as designated parking areas for electric vehicles, are comparatively inexpensive to execute.
- Regional measures seem better suited for promoting hydrogen than national ones in the current market situation. This is because, besides direct financial incentives, filling infrastructure needs to be considered and vehicle availability remains limited.
- While CNG is the most competitive alternative fuel, regional public procurement and other initiatives could be an efficient instrument to quickly reduce emissions with a comparatively mature technology.

Excursus – Regional actions that reinforce clean fuel deployment

The following excursus presents examples where national and regional instruments collaborated particularly well and accelerated clean fuel deployment.

Germany: Shift to natural gas and biomethane in the city of Augsburg

The Bavarian City of Augsburg, with around 300,000 inhabitants, is a good example of how ambitious local initiative in combination with public support can bring about a long-term deployment of clean fuels. In 1995, Augsburg was chosen as a role model city of gas mobility. With federal public funding of €5,000 per new bus, the local public transport provider Stadtwerke Augsburg (swa) implemented the first CNG-buses in the new fleet and built a publicly accessible gas fuel station. Since then, the model of operating vehicles with natural gas has worked successfully. In 2006, in the city's air quality plans, the mayor of Augsburg decided to give priority to CNG vehicles when renewing or extending the vehicle fleet. Earlier that year, the German Government approved a tax break for natural gas, initially until 2018, which in 2017 was extended to 2026. First, by 2010, the swa fleet was running completely on natural gas. Then, from 2011, swa chose to operate their entire vehicle fleet of 93 buses purely using biogas. In parallel, the Augsburg waste vehicle fleet has been switched to gas, as well as parts of the municipal car fleet. Up to 2016, swa additionally incentivised the use of CNG in private and company cars with CNG vouchers. So today, there are around 50 CNG taxis and 1,600 private CNG cars registered in Augsburg, which are supplied by 5 gas fuel stations. Today, public transport in the city of Augsburg has the lowest greenhouse gas emissions in Germany. There have been no extra ticket price increases, and consumers voted swa one of the best public transport providers in the whole of Germany – and number one in terms of environmental efforts and GHG emissions.

To continue clean vehicle deployment, in 2017 the city council of Augsburg passed a resolution to support all alternative fuels in their fleet. All new council cars are supposed to have alternative propulsion systems. If not, justification must be given as to why an alternative propulsion system cannot meet the requirement in an appropriate way.

Norway: National and local incentives for BEVs

The massive development of BEVs in Norway is the result of a combination of strong national and local incentives. We have seen a particularly high development in the larger city regions, and Oslo has been at the forefront. The market share of new registrations of BEVs in Oslo has increased from 16% in 2014 to 30% in 2017. 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. Oslo has also co-funded private companies who have built fast chargers. BEVs may park for free on municipal parking spaces, and recharge for free in some places. Other cities and municipalities are providing funding for charging infrastructure as well, and some offer consultancy services and advice for housing cooperatives wanting to install chargers. Building charging stations throughout the city has been a strategy for the city of Oslo to ensure that people can use BEVs. In 2018 Oslo will be building 600 new publicly available charging stations. The City Council also provides 2 million euros to build chargers in housing cooperatives, which has proven to be a very successful scheme. Taxes on toll roads in to the city are another incentive for people to switch to zero-emission vehicles. Vehicle taxes have increased substantially in recent years, while BEVs and FCEVs currently pay no tax. From 2019 BEVs will pay a low tax, a fraction of the high taxes that diesel vehicles in particular pay. The city of Oslo is planning to introduce more actions to further increase the use of zero emission vehicles and to reduce traffic in the city. Emission-free zones and elimination of parking spaces in the city centre are amongst the planned measures.

Sweden: Biogas and EV incentives in the region of Skåne

Region Skåne has set out to have their whole administration fossil-free by 2030, in terms of both energy consumption and transport. Year after year Region Skåne has been selected as one of the top regions in Sweden when it comes to the number of alternative-fuelled cars, light goods vehicles and buses/trucks (cf. MiljöfordonSyd, 2018). There are almost 300 Type 2 public charging points and 28 CN/BG (compressed natural/biogas) filling stations, giving a high level of accessibility to clean fuel infrastructure per capita. This is complemented by one LBG (liquefied biogas) filling station. There are 47 biogas plants in Scania, producing more than 400 GWh of biogas per year, most of it used as vehicle fuels.

The strategic goal was set by Region Skåne in 2016, and developed in close contact with the municipalities in the region. Through various public-private partnerships, such as Scandria 2 and GREAT, external financing has been secured for local infrastructure. Public procurement has played an important role, as well as a commitment from the regional public transport authority to buy alternative-fuelled buses. The success of Region Skåne's commitment is due to a broad anchoring in local and regional public organisations. Involving private partnerships has proven a strong ally in reaching this target.

5 Instruments and framework conditions – Development of national markets over time

After the assessment of selected policy measures in the previous section, this part serves to further contextualise these instruments within the national markets. Analysing the development of clean fuel vehicle registrations and corresponding infrastructure over time provides clues to the interplay between different measures, and further differentiates the previous assessment. It also allows us to compare the progress in developing the clean fuel market in the Northern Scandria countries.

The measures here are considered against the backdrop of the specific national conditions.[2] Therefore, it is important to note the general determinants of clean fuel policy, as they vary between countries:

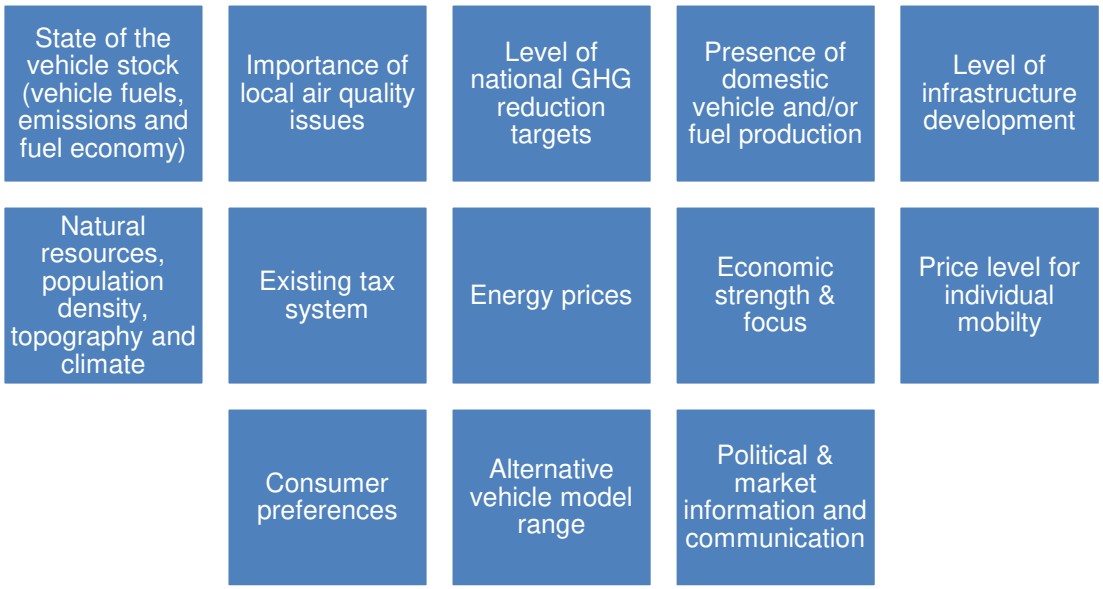

Figure 5: General determinants of clean fuel policy in Scandria countries

[2] For a more detailed overview of general country characteristics, please refer to the tables in chapter

Denmark

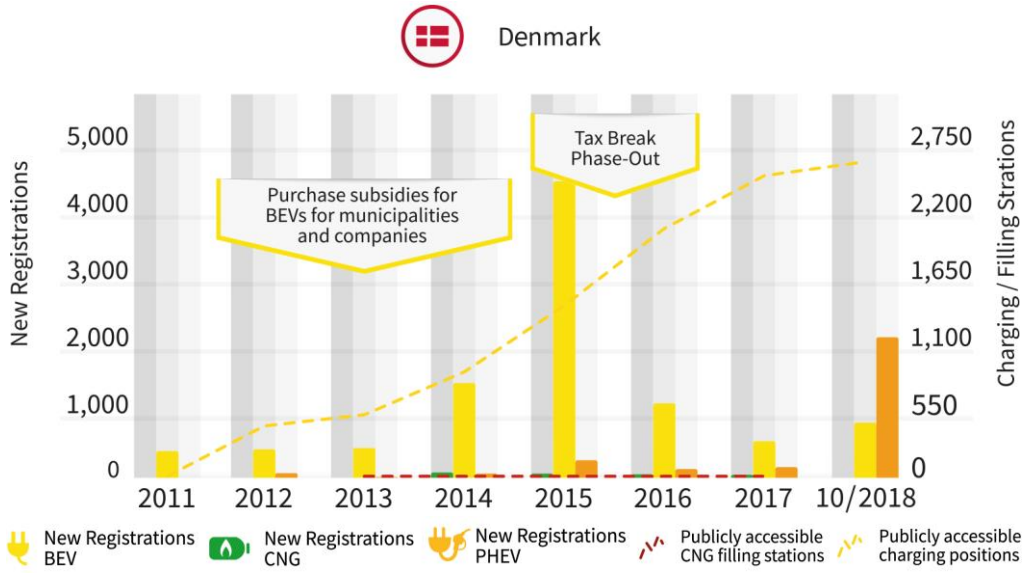

Figure 6: Introduction of funding instruments and their effect on new registrations and infrastructure in Denmark

- Similarly to Norway and Sweden, the Danish vehicle market is characterised by high registration taxes. Fossil fuels, especially diesel, are slightly cheaper than in other markets in the Northern Scandria region, except Germany.
- From 2011 until 2015, BEVs were exempt from registration tax. This large financial incentive proved an effective measure for slightly increasing the number of new registrations of BEVs. Subsequently, the government decided to gradually roll back the tax exemption, starting from 2016 until 2020. At the same time, registration tax for all vehicles had been reduced (IEA, 2018a). This drop in financial incentives led to a dramatic decrease in new registrations of BEVs from 2015 to 2016. The following year, some of the changes were revoked and a new registration tax enforced. However, markets have not rebounded since. This shows that consumers focus on cost aspects consequently do not accept high cost disadvantages. Also, market uptake requires a reliable framework and reacts sensitively to sudden changes in policy.[3]
- Compared to other markets, PHEVs didn't play a big role in the Danish market until 2018. This was due to lower (registration) tax incentives, making PHEVs more expensive than comparable ICE cars (IEA, 2018a). This also means that PHEVs were not affected by the changes in registration tax exemption that applied for BEVs. Instead, they seem to have benefited from the reduced overall registration tax in 2016.
- CNG is not a priority of national policy. Due to the absence of effective policy measures, there is no significant number of filling stations or car registrations. It should be noted that, starting from close to zero in 2014, the share of biogas in the Danish gas grid has reached more than 4% (Boesgaard, 2017), so CNG would constitute a growing low-carbon transportation technology.

[3] However, the phase-out of BEV support is already planned, as well as an increase in the electricity taxes for charging electric vehicles (Electrek, 2017).

- Charging infrastructure for electric vehicles shows a continuous upwards trend. The increase in the number of charging stations accelerated further in the years 2016 and 2017. Due to strong government support, the ratio of charging points per EV is one of the highest in the region, at 0.2 (IEA, 2018a).

Finland

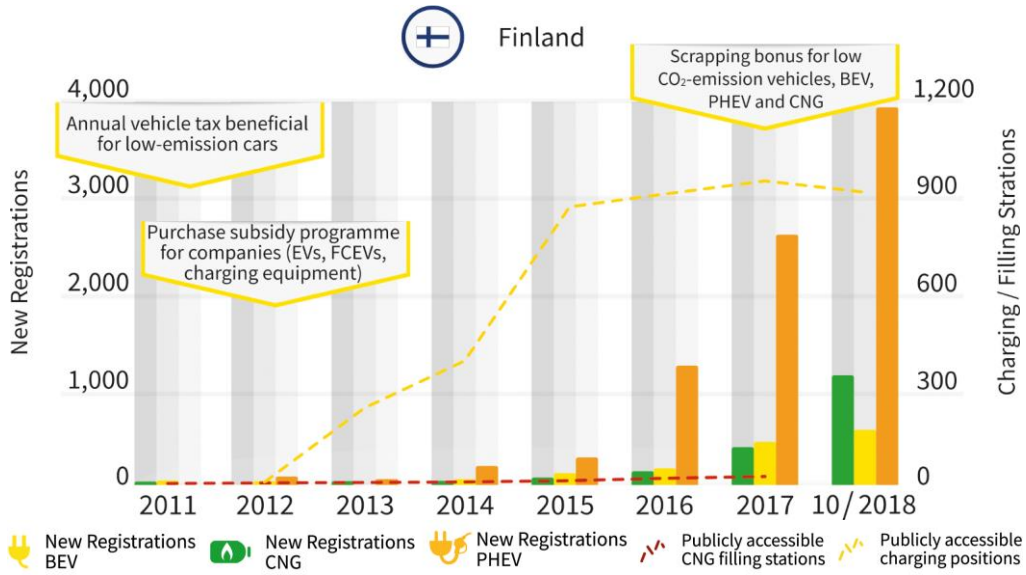

Figure 7: Introduction of funding instruments and their effect on new registrations and infrastructure in Finland

- Finland lags behind other Nordic countries in developing clean vehicle markets. This is to some degree caused by strong biofuel industry, backed by political support. Finland also suffered from the economic crisis and did not use financial support like Sweden and Norway. Fuel prices are similar to other Northern Scandria countries.
- Incentives for clean fuel vehicles are implemented in a CO_2-based taxation system. Amongst the Northern Scandria countries, it is unique in being technology-agnostic, providing a clear guiding affect towards low-emission vehicles. Depending on specific emissions, tax rates range from around 5% to 50% of vehicle value (ACEA, 2017b). The system is dependable, transparent and includes zero transaction costs. However, registration numbers for alternative vehicles remain low, suggesting these incentives are not strong enough.[4] However, PHEVs have seen an substantial increase in recent years. Previous instruments aiming to increase clean vehicle registrations have had limited effect. The energy investment subsidy programme did substantially increase the EV market.
- Electric vehicle infrastructure development subsidies have been successful, as they have helped Finnish companies to develop smart charging services and products. Nonetheless, the number of public charging points is still relatively low.

[4] However, the Finnish government is already continously steepening the tax curve over the period 2015–2019 (ACEA, 2017b).

Germany

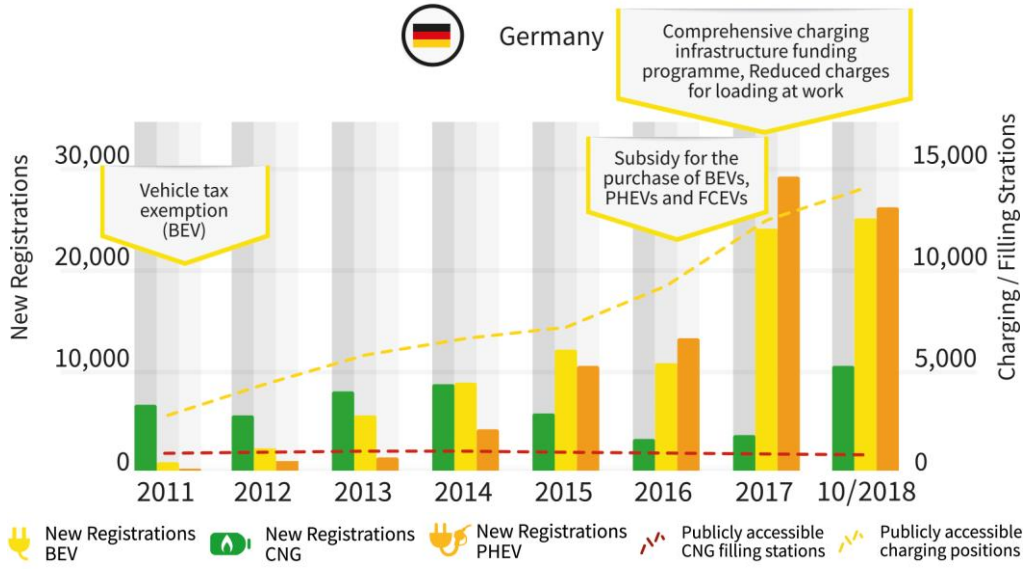

Figure 8: Introduction of funding instruments and their effect on new registrations and infrastructure in Germany

- In comparison to other Northern Scandria countries, acquiring and owning vehicles is inexpensive, due to a much lower tax rate. This provides less leverage for implicit subsidies through tax breaks. Also, many other transfers and taxes are indifferent to the type of fuel, absolute or relative fuel consumption: company car taxation[5], commercial vehicles' tax deduction or commuting allowance. Taxes on fuel are comparably low.
- Germany's strategy for alternative fuels implementation has so far been based on supporting instruments without regulatory restrictions. The soft instruments and relatively weak financial incentives have had a moderate effect on alternative propulsion system sales in the absence of other hard instruments benefiting sustainable systems. Market uncertainty resulting from claims against communities, the NO_x-scandal and the BEV/PHEV purchase subsidy (environmental bonus) have pushed sales. Since 2016, sales of both BEVs and PHEVs almost doubled.
- On the regional level, at present there are no effective instruments in force disincentivising ICE and incentivising alternative propulsion systems. Additional local support programmes for BEVs/PHEVs/FCEVs are planned, public procurement procedures are focusing more on alternative propulsion, and temporary bans on old diesel cars are discussed. Alternative propulsion systems benefit, but petrol-driven vehicles benefit especially.
- Compared to other Northern Scandria countries, there is a high number of CNG vehicles. However, from 2013 to 2017 market development was negative as a result of low energy prices and tax uncertainty. In 2017 tax reduction for CNG/LNG was extended to 2026 (BMWi, 2017) and sales went up. In 2018 sales of CNG-vehicles are three times higher than in the years before.This highlights the importance of reliable and consistent policy frameworks.

[5] However, this is due to change following a recent legislative proposal by the federal government to cut levies for BEVs by half.

- In the area of EV charging infrastructure, the recent national funding programme finds large acceptance amongst businesses investing in this area, contributing to an acceleration in the growth of charging points. The political package of supporting charging infrastructure supply and sales bonuses, in conjunction with the availability of more attractive vehicles, stimulated BEV and PHEV sales, and could lead to stronger growth in the future.
- H_2-infrastructure expansion in Germany is driven by national subsidies and business cooperation between the energy and vehicle industries. There is a political agreement to provide a base infrastructure, even if so far here has been a very low demand from the transport sector. At present, due to a limited vehicle range, high vehicle costs and the relatively high cost of H_2-fuels, no rapid market growth of FCEVs can be expected.

Norway

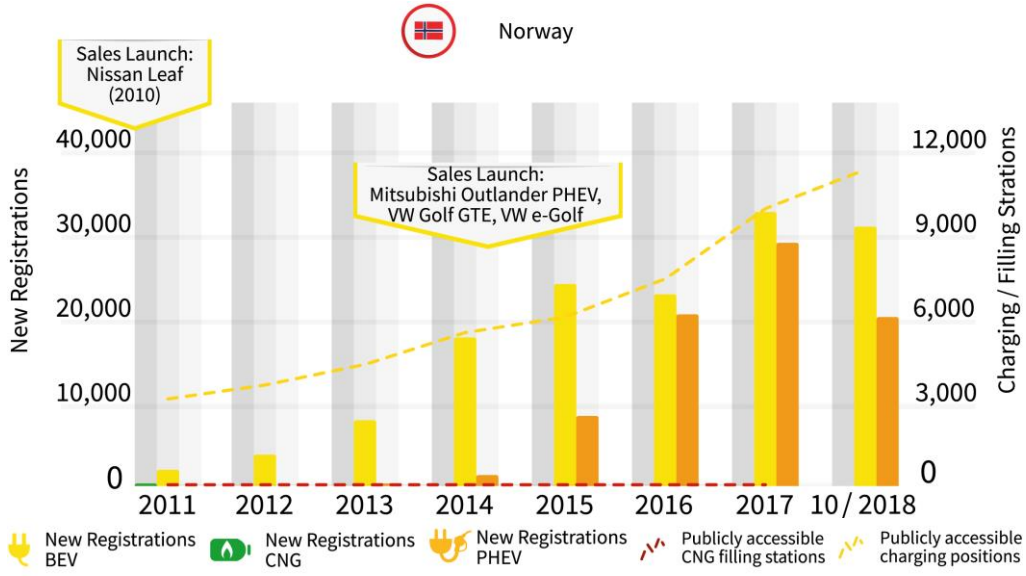

Figure 9: Effect of market introduction of BEV/PHEV models on new registrations in Norway

- In comparison to other Northern Scandria countries, private and commercial investments in vehicles and fuels cost are expensive. Fossil fuel prices are the highest of any of the countries surveyed in this paper. By contrast, electricity is relatively cheap.
- In Norway, financial instruments such as exemption from purchase/import taxes, reduced annual road tax and free parking for EVs were already implemented in the 1990s. At the beginning of the new century, the reduction of 50% of the company car tax and 25% of VAT followed. These instruments provided the basis for EV market development. In combination with the VAT exemption, the high registration tax on passenger vehicles makes the tax exemption incentive very effective, and BEV ownership inexpensive. Norway is now in a position where it is becoming more “normal” to buy a zero-emission vehicle than a fossil-fuel vehicle. In March 2018, 37% of all new registrations were BEVs. Of the total number sold, 27% were hybrids, including 19% plug-in hybrids. Light and heavy duty vehicles are not subject to the same registration tax, and companies receive VAT deduction. Other incentives are therefore needed.

- In larger cities there is a drive towards toll road taxes for vehicles using petrol and diesel. FCEVs and BEVs currently pay no toll road tax, but BEVs will in some areas from 2019. The tax will be limited to a maximum of half that for petrol cars.
- FCEVs are so far very less prevalent in the market. However, it seems that hydrogen will be more important as fuel for light or heavy duty vehicles than for passenger vehicles. Also, we can see a great interest in using hydrogen for maritime transport, with ongoing projects for passenger and car ferries. This may help deployment of FCE passenger, light duty and heavy duty vehicles as well.
- There is an increasing interest in using biogas in transportation, although this is developing slowly and is not a priority for passenger cars. Recently, it was suggested that heavy duty vehicles should be allowed tax reduction on toll roads in Oslo to stimulate development. There is political interest in increasing the use of LBG for both regional and long-distance transport.

Sweden

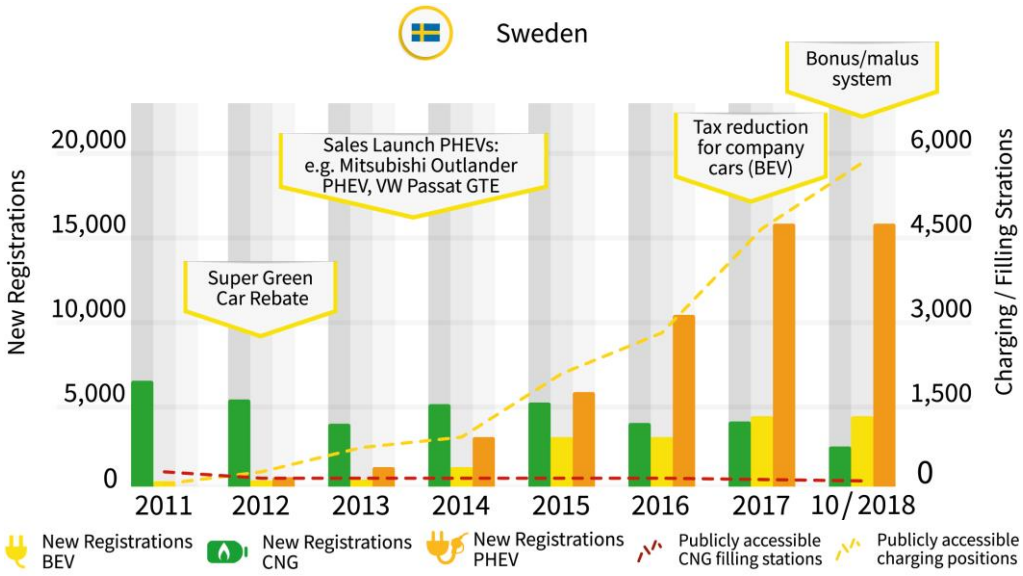

Figure 10: Introduction of funding instruments and market introduction of BEV/PHEV models and their effect on new registrations and infrastructure in Sweden

- In Sweden, the market is characterised by high fossil fuel prices comparable to Finland's (lower only than Norway's). A large proportion of all cars, around 50%, are bought by companies and public authorities.
- The clean vehicle promotion goes back to biofuel programmes around the turn of the century. At the time. flexifuel cars entered the market, soon after CNG cars. Different support mechanisms were put in place, many on a local level (free parking etc.)
- In 2010 a clean vehicle bonus was introduced, which in 2012 was developed into a more substantial clean vehicle incentive, four times higher. This incentive has since developed further, and is now the bonus component in the bonus/malus system.
- For electric vehicles, the main policy instrument on the national level is the green car premium introduced in 2012 for both BEVs and PHEVs, as well as for biofuel vehicles. The growth in electric vehicles has to a large extent depended on models available on the market. In Sweden the trend

has been roughly 75% PHEVs and 25% BEVs. The super-green car programme ran out of budget several times (ICCT, 2017); until funding was replenished, no subsidy was available to EV buyers.[6]

- There are about 60,000 CNG vehicles in the Swedish vehicle fleet. This is 1.3% of the national vehicle fleet, more than most countries in Europe. There are 172 CNG filling stations and CNG remains a large market. The coverage of CNG filling stations remains in general fair in the south part of Sweden (south of Gävle), but good in city clusters, and along major roads.
- There is a reduced carbon dioxide tax and no energy tax on natural gas for transport (ACEA, 2017b). Annual vehicle taxes depend on CO_2, so there is another advantage for CNG-vehicles versus comparable gas vehicles. Since 2008, the biogas share in "vehicle gas" has been more than half, and in 2017 it was 86% (Svensson, 2018), so CNG constitutes an option for defossilisation.
- In terms of charging infrastructure, there is an ongoing increase in public charging points. Since the introduction of the government's charging infrastructure programme in 2015, the number of charging stations has almost doubled, further stabilising this upward trend. This was complemented by the GREAT project, which cofinanced 50kW fast chargers through EU/CEF funds.

[6] A bonus/malus system was implemented in July 2018 to provide more stability and dependability of financial incentives. It replaces both the BEV exemption from annual vehicle tax and the super-green car premium (IEA, 2018b)

6 Summary – results of the policy instrument assessment and literature

The assessment of instruments to foster clean fuels in the Scandria region shows that there is not any single instrument (or magic formula) that fits all countries and every stage of market development. However there are tendencies in all countries, which can be also backed up by results from European and North American studies:

- So far, the most effective political actions to foster the use of alternative fuels by private consumers have been upfront financial incentives when buying vehicles. If there are no other strict regulations, the more they cover the price difference between conventional ICEs and alternative vehicles, the more effective they are.
- For primary consumer investments in vehicles a minimum level of refuelling infrastructure is necessary. The way to extend the infrastructure – financed fully privately or with state support – scarcely depends on the opportunities to generate business with the different fuels.
- Strategic and consistent policy with long-term perspectives and commitments is most effective. Short-term actions and quickly changing instruments do not provide the necessary investment security, neither for market players nor consumers. Unstable political decision-making leads to uncertainty, lack of trust and market slumps.
- Non-financial instruments can boost vehicle sales. The can motivate interested consumers and open up new market segments. But in the early market phase they are not appropriate as the sole instrument.
- Communities and regions are frontrunners and supporters in the drive to increase market uptake of alternative fuels. Market growth of innovative products, and hence alternative fuels, originates in densely settled, highly populous regions. Because these communities are tightly interconnected with their surrounding regions in terms of transport, and form part of transport corridors, their actions are catalysts for the whole market. So today, big communities in particular have the power to create a framework which increases the demand for alternative vehicles and supports infrastructure deployment.

The qualitive assessments of the instruments in Sections 4 and 5 show that there are multiple factors influencing alternative fuel deployment. Empirical studies from different countries complement these overviews. In terms of choosing a consistent strategy towards low emission fuels and alternative propulsion systems, in the best-case scenario effective and efficient policy instruments should contribute to all the goals described in Figure 11.

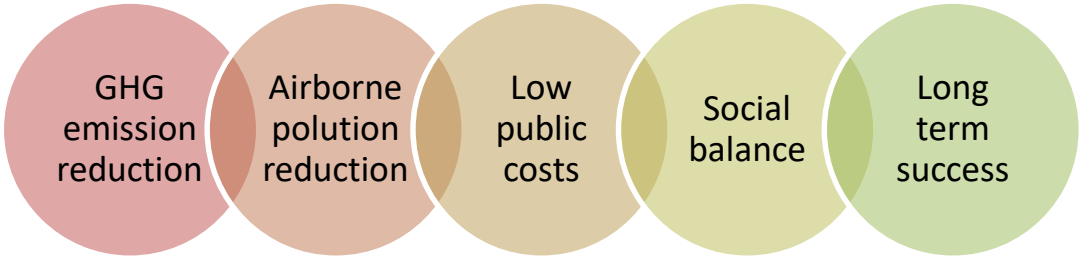

Figure 11: Goals of a consistent strategy towards low emission fuels and alternative propulsion systems

Because conflicts can occur between the goals mentioned over time, instruments will need to be adapted, depending on market success. Regional and national decision-makers along the Scandria corridor (but also elsewhere) should learn from good and bad experiences that have already occurred in the past. However the findings of other countries and regions regarding success or failure of instruments cannot be adopted on a one-to-one basis. They have to be compared with each country or region's corresponding situation regarding market and policy frameworks, and the stage of market development for alternative fuels.

Table 15 lists important factors influencing the attractiveness of investing in alternative fuels and vehicles on the regional and national level. Addressing these factors is relevant to making long-term progress regarding GHG-emission reduction in transport and alternative fuels market uptake.

Factors influencing attractiveness and market uptake of alternative fuels	
Culture & economy	Attitude to mobility
	Attitude to private transport
	Status of private transport and vehicles
	Existence or non-existence of automotive industry
	Road transport dominance – availability of public transport and railway transport
Energy	Fuel prices
	Electricity price
	Fuel dependency (import) – local energy availability (self-supply, export)
	Share of renewable energies and availability of renewables
	Renewable energy potential
Consumer	Consumer driving habits
	Attitude towards environment and climate change
	Level of education and age
	Purchasing power; private/average household income
	Information, interest and awareness regarding alternative vehicles
Charging & alternative fuel infrastructure	Public and private charging availability
	Fast charging options
	Regional and national H_2 and CNG/LNG infrastructure density
	Infrastructure development goals and plans

Policy strategies and instruments	Existence of financial or non-financial incentives
	Design of policy and market incentives
	Long-term vs. short-term political strategies and incentives
	Supply side incentives (infrastructure) and/or demand side incentives (vehicle)
Political communication & public actions	Positive vs. critical public information and discussion
	Support or lack of support for information and awareness campaigns
	Extensive or cautious public procurement as role model
	Consistent policy actions; credibility of actions
Settlement structure, climate and topography	Densely populated urban areas, suburban areas, rural areas
	Very cold areas, temperate climate, winter/summer differences etc.
	Flat landscapes, mountain areas
Transport market	Existence vs. non-existence of road tolls
	Frequency of traffic jams and availability of priority lanes
	Public parking policy, parking fees
	Private and fleet vehicle taxation
	Diversity of transport modes, state support for public transport

Table 15: Factors influencing attractiveness and market uptake of alternative fuels

Most political actions regarding alternative fuels and vehicles so far have focused on private passenger transport. But international road freight transport in particular has been growing, and is predicted to increase even faster in the future. So freight transport's share of GHG emissions will probably tend to increase more and more.

This is the reason why political efforts should focus much more on **road freight transport** than has occurred in the past and is the case today. To impose GHG emission reduction on freight transport is on the one hand easier, on the other hand more difficult because:

- Commercial users are less emotional and very much more rational. The most important factors which matter to them are total cost of ownership (TCO) and suitability of the technology.
- The total cost of a technology matters to commercial users such as road hauliers. But the difference in costs from other available technologies and the costs of their competitors matters to hauliers much more.
- Road freight transport today is a highly internationalised and competitive market. So national and regional actions are very important, but also have to affect hauliers and forwarders from other countries in order to avoid unfair competition. This particularly affects vehicle and emission standards and fuel prices. So it seems very important to at least arrive at a European solution regarding ambitious vehicle standards and minimum fuel taxation.

- The technical options and solutions in road freight transport differ very much from private transport. There are very different requirements for different transport operations regarding payload, transport distance etc. Not all alternative propulsion systems today are technologically ready for every aspect of transport.
- Commercial users – hauliers and forwarders – need long-term planning perspectives. Investments in new vehicle fleets are related to the available infrastructure. Infrastructure investments are mostly designed for 15 years and more.

To promote alternative fuel deployment in freight road transport as well, experts and political decision-makers should discuss strategies and plans for increasing the percentage of alternative vehicles, and coordinate their strategies for expanding alternative fuel infrastructure.

Local and corridor infrastructure perspective

The infrastructure development of refuelling and charging stations is a shared responsibility for market players and policy. In markets with sufficient vehicles and hence sufficient energy demand, infrastructure development is a self-sustaining, market-driven process. But today the market framework and energy demand from alternative vehicles is generally not sufficient to foster such a self-sustaining infrastructure development. In particular most EV charging stations and, to date, H_2 refuelling stations do not offer an adequate business case. However, even if these stations do not offer an adequate business case today, they should be attractive and available to as many regional and international users as possible. With a view to the international mobility and vehicle markets and with respect to an optimal utilisation of the publicly supported infrastructure, communities should not only bear in mind regional or national, but also international infrastructure standards and transport demands in order to avoid insular infrastructure solutions.

We can therefore recommend

- that communities and regions engage in close dialogue and cooperation when it comes to infrastructure development which affects mobility along transport corridors
- that communities and regions should play an active role and be part of national or EU project funding for alternative fuel infrastructure

Status quo and next steps in alternative fuel market development

Analyses of the alternative vehicle markets and instruments to develop the markets reveal large differences between the Scandria corridor countries. With regard to the availability of alternative vehicles, vehicle costs and costs of infrastructure, all countries in the Scandria corridor (and the EU) have nearly the same framework conditions today. What makes the difference are the political actions and political frameworks, which have greater or less ambition to drive the market. As a result of the political actions in the past, the Scandria corridor countries have a very different level of vehicle and infrastructure penetration today. Furthermore there are not only differences between the countries, but also between different alternative fuels in each country.

Examples in Denmark and Norway show how important it is to have a long-term policy oriented towards market success rather than short-term political or financial constraints. The effectiveness of instruments broadly depends on their ability to bridge the price gap between conventionally fuelled vehicles and those using alternative fuels. As shown by Germany, subsidies remain less effective due to their rather low contribution towards bridging the gap. Thus it is important to introduce accompanying instruments that make it more attractive to invest in clean fuel vehicles according to the "polluter pays" principle, e.g. bonus/malus systems. To this extent all clean fuel technologies should be supported, even as there is no "ideal" technology available but rather technologies that have "use-specific" advantages. This is especially important in an international context, as it is necessary to avoid a situation where a certain technology is limited to national borders. Other Scandria®2Act project results show that a lack of technical systems or different technical standards in the Scandria corridor can be major limitation to alternative fuel deployment.

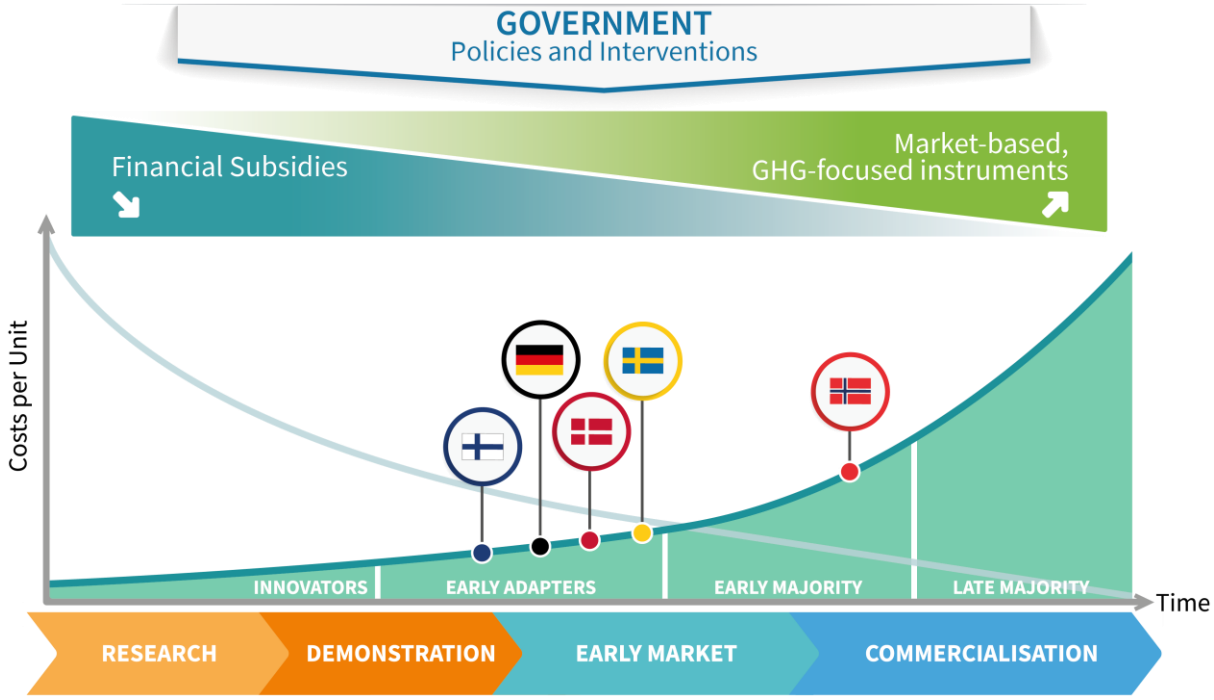

Figure 12: Current market stage of alternative vehicles in Scandria countries

Comparing the current market stage of alternative vehicles and political actions, Norway is by far the frontrunner in the Scandria corridor, while Sweden has made progress and implemented new regulations. Denmark and Germany have recently been gathering pace, followed by Finland.

With respect to the political goals named in Figure 11 and the study results regarding effective political instruments, the actions to foster alternative fuel deployment in the Scandria corridor will probably differ from country to country over the coming years.

While Norway's alternative fuel market share has reached around 50%, its success still depends heavily on financial subsidies, especially tax benefits. To stabilise market share growth but avoid windfall profits and unbalanced public funding, the coming years could be characterised by reductions in direct financial subsidies, and increased alignment of pricing towards CO_2-intensive vehicles and fuels. This assumes improved technological attractiveness of alternative vehicles and further reductions in production costs.

The experience of Denmark's rapidly declining EV market in 2016 and 2017 reveals the enormous significance of political stability for driving alternative vehicle market development. Instruments already in place, such as the registration tax, provide Denmark with a very good starting position to steer market uptake of low emission vehicles. Particularly after the Danish government announced its goal of banning new ICE car registration from 2030 on, Denmark should avoid a quick phase-out of the reduced vehicle registration tax in order to avoid consumer insecurity. Instead of totally phasing out vehicle registration tax reductions, another option could be to link the taxation more closely to each vehicle's CO_2 emissions, not just its price.

In comparison to Denmark, Sweden's market in recent years has shown stable, positive tendencies in BEVs and PHEVs, but a declining market share for CNG vehicles. The most important consumer incentive of recent years has been purchase tax rebates, which especially favoured PHEV and BEV growth. From July 2018 onwards Sweden switched from a "rebate only system" to a bonus/malus system, which from the perspective of public cost and the "polluter pays" principle seems to be a good long-term instrument. It remains to be seen if vehicles running on gas can benefit from a fixed extra bonus of €1,000 in the new system. It could support the temporary tax exemption of bio-CNG, which has a dominant share in Sweden's gas fuel mix.

Vehicle prices in Germany are low in comparison to other Scandria countries, as is vehicle taxation. So far, private users have had low incentives to buy a vehicle using alternative fuels. Public discussion and some recent court decisions about optional driving bans for diesel vehicles in some German cities brought some fresh movement to the vehicle market. The so-called "Umweltbonus" rebate for BEVs and PHEVs was implemented in 2016, but is rarely a strong consumer incentive as long as high emission vehicles have no financial disadvantage. Because two thirds of newly registered German cars belong to commercial fleets, at the beginning of 2019 the taxation for private fleet users of BEVs and PHEVs will decrease from 1% to 0.5% p.a. (countervailing benefit). This will probably increase BEV and PHEV demand. To improve the efficiency of the system and reduce tax shortfalls, low-emission vehicles should benefit from reduced taxation, while taxation for vehicles with higher emissions should be more than 1% p.a. The latest government decision to exempt EVs from road tolls until 2022, and gas trucks until the end of 2020, has given rise to high expectations. This is a high financial incentive for commercial fleets, but the planning perspective is very short. The coming years will therefore provide an opportunity for new road toll pricing legislation for all trucks, with a focus on their CO_2-emissions.

Finland's incentives for clean fuel vehicles are implemented by a CO_2-based taxation system, with lower tax e.g. for natural gas, and no tax for biogas. This could be one reason for the 2018 market increase in CNG vehicles, in addition to the 2018 subsidy for converting conventional vehicles to gas. Vehicle registration tax and ownership tax are dependent on specific CO_2 emissions. BEV vehicle owners pay the minimum, while for PHEVs the owner tax is much lower than for ICEs. New purchase

subsidy programmes for vehicles and charging infrastructure seem to have had a positive effect since the number of EVs, especially PHEVs, has nearly doubled each year since 2015. The question remains whether the market increase of the last three years can remain stable. Most purchase subsidies will end at least by 2021.

7 Recommendations – catalogue of strategic measures

As discussed in the previous chapters, there are no specific political recommendations which fit all Scandria countries. The recommendations in this clean fuel deployment strategy are based on the following **principles to support sustainable advantageous technologies**

- The aim of political instruments and actions should be to compensate higher costs for new technologies and enable price competitiveness in the early market phase
- Political instruments to promote clean fuels should be part of a country's holistic and comprehensive mobility strategy and overall GHG emission reduction strategy
- Political instruments must be introduced taking account of the specific market phase and technology-readiness of each alternative vehicle technology
- Political instruments should focus on stimulating the demand side in order to avoid bad infrastructure investments
- Political instruments should comply with GHG and other emission reduction targets
- Political instruments are important, but other factors such as technological development and energy prices also play a decisive role in fostering clean fuels and technologies. Market success cannot be traced back to one single instrument. Political instruments should therefore be an long-term enabler for clean technologies.
- Market supporting mechanisms should stimulate the market in order to allow a market-driven achievement of goals. However, especially in imperfect markets, regulatory instruments are necessary to guarantee GHG emission reduction and technology development.

Reduce the price difference	•The most important factor for consumers is the price difference between vehicles •Very low-emission vehicles will probabely remain more expensive in the future •It is not only about subsidising low-emission vehicles, but also increasing prices of high-emission vehicles
Upfront support helps consumer	•Consumers prefer upfront financial support, be it tax or rebates •Subsequent (tax) reduction is not that effective
Rebates can avoid overspending	•Rebates are better for controlling public spending and avoiding subsidies for high- income groups •Rebates are more efficient in terms of social responsibility and windfall effects
Tax reduction is effective but expensive	•In many countries tax reduction is the most effective single instrument for clean vehicles •But tax reduction also subsidies high-income groups and allows windfall profits •With advanced market maturity of clean verhicles, tax reduction should be replaced by budget-neutral instruments
Information & awareness support attractiveness	•Considered separately, information campaigns do not have a great effect, but they are important in combination with other actions •Information campaigns emotionally reward consumers of clean vehicles, inform interested consumers and create awareness
Focus on GHG emission reduction	•State support has to privilege technolgies with the lowest GHG emissions •EVs with an electric driving range <50km have only marginal advantages •Energy tax, company car tax, vehicle registration tax and vehicle ownership tax need to have a stronger connection to GHG emissions

Adapt instruments, depending on market maturity	•The more mature the market and vehicles are, the fewer state subsdies are necessary •With growing market maturity comsumers have to be more challenged, and policy instruments have to become neutral for the state budget •Policy framework has to set incentives for industry to reduce costs and prices
Long-term perspective and reliable policy enable investments	•Rapid political changes and replacement of instruments destroy trust and are not effective •Clean vehicle policy has to be transparent in a long-term perspective
Socially balanced state support	•The bigger the clean vehicle market becomes, the more important it is to avoid overspending, especially by high-income groups •In the early commercialisation phase at least, a shift to budget neutrality is recommended
Avoid windfall profits of consumer and industry	•Subsidies for expensive high-class vehicles are not effective, because many consumers would buy the clean vehicles anyway. Such ineffective support should be avoided, also with a view to the efficent allocation of limited public expenses •Overspending and subsidies that last too long create risks of reduced pressure on the industy to invest in improving products and reducing costs
"Polluter pays" principle –consumer has to be challenged, not just privileged	•At the moment clean fuels deployment is mainly driven by public support •Besides clean fuels support, there are still privileges for fossil mobility •A consistent clean fuel policy has to reduce these privileges and focus on the "polluter pays" principle

Figure 13: Political recommendations to foster clean fuel deployment

General recommendations for promoting alternative vehicles in commercial transport

The commercial transport market is characterised by international competition, relatively low margins and relatively rational (TCO-based) decision-making processes. To overcome the cost disadvantages of energy-efficient technologies and low-carbon fuels, decision-makers at all levels could support:

- Actions to promote cooperation along the whole value chain of the transport market, in order to share the companies' investment risk
- All available technologies which can already achieve advantages in terms of environmental and GHG emissions today, because so far it is not clear how fast different technologies will achieve market readiness. In the future different technologies will probably have different "job profiles" as well as regional advantages.
- Road toll differentiation in order to privilege low-carbon fuels and efficient technologies as one of the main drivers for haulier investment.
- Fuel taxation which should be much more dependent on the specific GHG emissions of fuels, at least in the medium term.
- Initial expansion of clean fuel infrastructure on important strategic (international) routes along the corridor. This can be an important incentive for infrastructure visibility. But it has to be combined with actions that stimulate vehicle and fuel demand at the same time.
- Courier, parcel and express delivery is one of the fastest growing markets, with a high impact on urban transport and emissions. Low-emission zones for urban delivery could accelerate market penetration of low-emission vehicles very quickly.

Scandria corridor recommendations

The study analysis shows that Clean Fuel Deployment in the Scandria corridor to date has not been on the same level with regard to infrastructure and vehicles. This is due to political and economic reasons as well as country specifics. In comparison to the past, the technological development of clean vehicles has made considerable progress. However, the challenges are still big. Deeper cooperation and concerted actions between communities and country representatives in the corridor are therefore highly recommended. The following actions could be game changers and catalysts to accelerate clean fuel deployment:

- Intensive discussion between the most important communities along the Scandria corridor regarding clean transport actions.
- Development of a common Scandria corridor clean fuel vision with clean fuel deployment goals. It could be complemented by a common roadmap for clean deployment with concerted actions, including awareness campaigns, in the coming years.
- Collective lobbying for ambitious goals to integrate the external costs of GHG emission into road toll charging – especially with regard to the directive on the charging of heavy goods vehicles for use of certain infrastructures.
- Cooperation on using a common road toll system in future that is also GHG emission-based
- Because road freight transport requires an international perspective, collective analyses of heavy duty vehicle transport flows in the Scandria corridor could be valuable in supporting international infrastructure deployment (at strategically important sites)

- Public support for multi-fuel stations at strategically important sites along the Scandria corridor, as well as common standards for these multi-fuel stations, could stimulate future investments by energy providers
- Closer cooperation and support of cross-border pilot projects could help raise awareness of clean transport for market players in freight movement and private transport
- Even with a rapid market uptake of electrified vehicles, there will probably be a huge demand for liquid and gasified fuels in 2030 and thereafter. So all countries and communities in the corridor should lobby for instruments and projects to increase the amount of sustainable renewable fuels, especially e-fuels, on the EU and national level. Approaches include the national implementation of RED II, extra feed-in guarantees for e-fuels or increasing CO_2 prices for fuels.

The role of different policy levels in supporting alternative vehicles

Even if most road transport movements occur at the regional level, they are not limited by national borders. International road transport, especially road freight transport, increased heavily in the last two decades. So alternative fuel development can only be designed cooperatively, in the best case through the concerted action of EU member states and communities. Actions have to address both the supply and demand side. The EU Commission has made one important step with the Alternative Fuel Infrastructure Directive (AFID), and is going one stage further with emission regulation for cars, light duty vehicles and, for the first time, heavy duty vehicles. These actions should find support at member states level and community level. Looking towards the future, there are three examples for possible cooperation.

- **Fuel taxation:** Especially with regard to international freight transport a GHG emission based taxation should not be implemented just in individual countries. So EU Commission and member states should team up to define a minimum fuel taxation for all fuels in the EU, which is at least partly based on the GHG emissions. Each member state still have the sovereignty for it´s own fuels taxation and can vary the taxation of different fuels on the base of a common EU minimum taxation. In order to reduce emissions, GHG emission based taxation can be an efficient instrument as it
  - Directly addresses private and commercial users who are responsible for the emissions
  - Gives incentives to drive energy-efficiently and to use energy-efficient vehicles
  - Gives incentives for investments in alternative propulsion systems
  - Gives incentives for using low-emission fuels in the long-term perspective

- **Road toll** charging could provide a strong incentive to promote alternative propulsion systems, if it is based on distance and CO2-emissions. So far there have been a multitude of different national toll systems. The EU and EU member states should cooperate to agree on a common toll system for cars, and opt to include CO2 as one factor in the already existing Eurovignette directive. Each member state would be responsible for the individual toll design and the use of the revenues. Additionally, local communities could be given the option of implementing congestion charges to reduce local emissions and drive the shift towards public transport. However, this should be accompanied by an improvement in public transport services.

- **Emission performance standards** for new passenger cars, light-duty vehicles and heavy-duty vehicles are the main driver for industry to invest in alternative propulsion systems. However, setting standards alone will not be successful. Member states and communities have to create a framework to boost the demand for the vehicles. On the national level, fuel and vehicle taxation as well as road toll charging is very important. Initial infrastructure expansion can be promoted by member states and communities. On the local level, long-term targets for low emission vehicles and discussions regarding driving bans strengthen awareness and the need to invest in alternative vehicles.

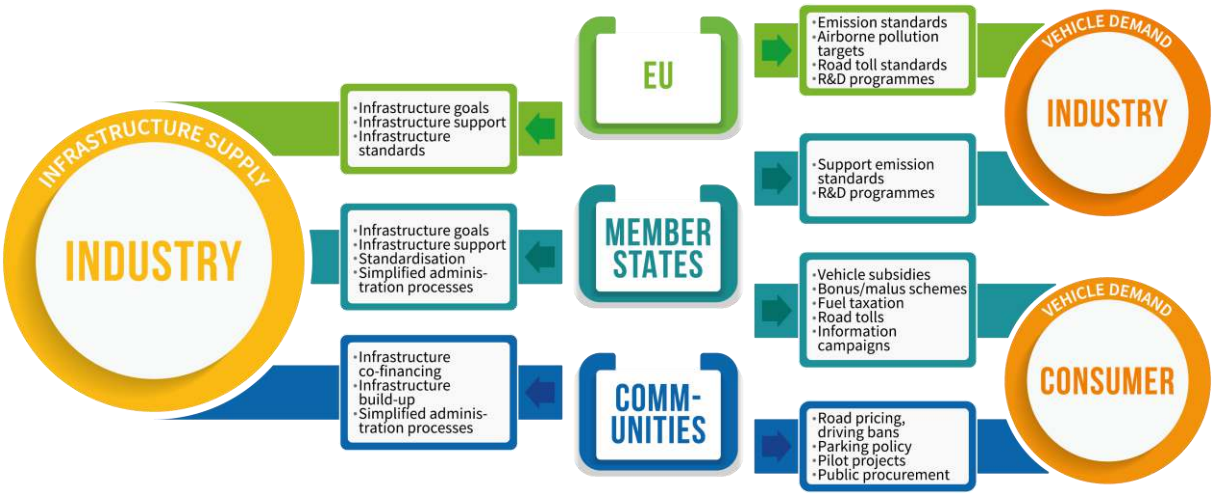

Figure 14: Different policy levels to support alternative vehicles and infrastructure

Annex

Denmark		**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**10/2018**
New registrations	BEV	415	471	497	1,533	4,524	1,223	706	892
	PHEV	0	33	11	100	444	179	207	2,390
	CNG	0	0	15	110	53	63	47	-
Infrastructure	Charging position	0	452	552	954	1,392	2,096	2,581	2,616
	CNG filling station	1	1	2	7	10	13	15	16
Finland		**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**10/2018**
New registrations	BEV	29	51	50	185	242	225	502	541
	PHEV	0	128	168	291	415	1,207	2,553	3,938
	CNG	35	63	104	123	158	168	433	1,118
Infrastructure	Charging position	0	0	267	405	888	911	947	927
	CNG filling station	18	18	19	24	24	24	31	-
Germany		**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**10/2018**
New registrations	BEV	1,828	2,555	5,464	8,39	12,097	11,243	24,437	24,056
	PHEV	266	1,232	1,656	4,401	11,111	13,383	29,124	25,378
	CNG	6,283	5,215	7,835	8,194	5,285	3,240	3,723	10,057
Infrastructure	Charging position	-	2,241	3,819	4,454	5,553	5,894	7,407	13,500
	CNG filling station	904	915	920	921	911	833	833	856
Norway		**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**10/2018**
New registrations	BEV	2,010	4,273	8,232	18,098	25,792	24,224	33,025	31,367
	PHEV	0	340	324	1,680	7,819	20,664	29,145	20,631
	CNG	38	36	87	114	129	116	169	-
Infrastructure	Charging position	3,105	3,746	4,655	5,434	5,987	8,157	10,333	11,535
	CNG filling station	23	23	24	17	-	7	14	-
Sweden		**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**10/2018**
New registrations	BEV	185	264	444	1,206	2,987	2,945	4,217	4,022
	PHEV	0	657	1,112	3,472	5,712	10,470	15,815	16,267
	CNG	6,609	5,430	3,859	5,016	5,109	3,965	3,399	2,698
Infrastructure	Charging position	131	505	1,020	1,205	2,167	2,738	4,733	5,833
	CNG filling station	179	189	195	-	-	169	172	174

Table 16: Growth in new registrations of alternative vehicles (passenger cars) and infrastructure

Acronyms and abbreviations

Abbreviation	Description
AFID	Alternative Fuels Directive (2014/94/EU)
BEV	Battery Electric Vehicle
CNG	Compressed Natural Gas
CN/BG	Compressed Natural/Biogas
E-fuels	E-Fuels are gaseous and liquid fuels such as hydrogen, methan, synthetic petrol and diesel generated from renewable electricity
E-mobility	Electric mobility using electric vehicles
EV	Electric Vehicle (BEV and PHEV)
FCEV	Fuel Cell Electric Vehicle
FCS	Fast Charge Station
HDV	Heavy-Duty Vehicle
ICE	Internal Combustion Engine
LBG	Liquefied Biogas
LCV	Light Commercial Vehicles
MCV	Medium Commercial Vehicles
HCV	Heavy Commercial Vehicles
LDV	Light-Duty Vehicle
LNG	Liquified Natural Gas
NFP	National Policy Framework
PHEV	Plug-in Hybrid Electric Vehicle
WLTP	Worldwide Harmonised Light Vehicles Test Procedures

Figures

Tables

Literature

Aasness, Marie Aarestrup; Odeck, James (2015): The increase of electric vehicle usage in Norway—incentives and adverse effects. In: *European Transport Research Review*. 7 (4), DOI: 10.1007/s12544-015-0182-4.

ACEA (2017a): Vehicles in use - Europe 2017.

ACEA (2017b): ACEA Tax Guide.

Akershus County Council (2014): Summary of Hydrogen Strategy 2014 - 2025 Akershus and Oslo.

BAFA (2017): Elektromobilität (Umweltbonus) - Förderung elektrisch betriebener Fahrzeuge.

BAFA (2018): Elektromobilität (Umweltbonus) - Zwischenbilanz zum Antragstand vom 30. Juni 2018.

bdew (2017): Ausbau der öffentlich zugänglichen Ladepunkte.

Bjerkan, Kristin Ystmark; Nørbech, Tom E.; Nordtømme, Marianne Elvsaas (2016): Incentives for promoting Battery Electric Vehicle (BEV) adoption in Norway. In: *Transportation Research Part D: Transport and Environment*. 43 , pp. 169–180, DOI: 10.1016/j.trd.2015.12.002.

BMVI (2016): Nationaler Strategierahmen über den Aufbau der Infrastruktur für alternative Kraftstoffe.

BMVI (2017): Förderrichtlinie Ladeinfrastruktur für Elektrofahrzeuge - Bilanz zum 1. Förderaufruf.

BMVI (2018): Förderrichtlinie Ladeinfrastruktur für Elektrofahrzeuge - Zwischenbilanz zum 2. Förderaufruf.

BMWi (2017): Monatsbericht 04-2017.

Boesgaard, Knud (2017): Biogas in Scandinavia. Skandinavisk Biogaskonference 7.11.2017.

Deutscher Bundestag (2016): Entwurf eines Gesetzes zur steuerlichen Förderung von Elektromobilität im Straßenverkehr.

Deutscher Bundestag (2017): Entwurf eines Zweiten Gesetzes zur Änderung des Energiesteuer- und des Stromsteuergesetzes.

difu; NOW (2014): Elektromobilität in der Stadt- und Verkehrsplanung - Praxiserfahrungen aus den Modellregionen und weitere Wissensbedarfe.

Dolman, Michael; Madden, Ben; Butt, Saleem (2014): The role of cities and regions in the early rollout of hydrogen transport.

eafo (2018a): Denmark. Accessed 02.08.2018 from http://www.eafo.eu/content/denmark.

eafo (2018b): Finland. Accessed 02.08.2018 from http://www.eafo.eu/content/finland.

eafo (2018c): Germany. Accessed 02.08.2018 from http://www.eafo.eu/content/germany.

eafo (2018d): Norway. Accessed 02.08.2018 from http://www.eafo.eu/content/norway.

eafo (2018e): Sweden. Accessed 02.08.2018 from http://www.eafo.eu/content/sweden.

EAFO (2017a): European Alternative Fuels Observatory. Accessed 12.12.2017 from http://www.eafo.eu/.

EAFO (2017b): Country incentives Germany. Accessed 09.01.2018 from http://www.eafo.eu/content/germany.

Electrek (2017): Denmark to relaunch its electric vehicle market with incentives after a year with almost no sales. Accessed 09.01.2018 from https://electrek.co/2017/04/19/denmark-electric-vehicle-incentive/.

ERF (2016): Road Statistics - Yearbook 2016.

European Commission (2016a): Paris Agreement. Accessed from https://ec.europa.eu/clima/policies/international/negotiations/paris_en.

European Commission (2017a): *2020 climate & energy package*.

European Commission (2017b): 2030 Energy Strategy. Accessed from https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2030-energy-strategy.

European Commission (2016b): Reducing CO2 emissions from passenger cars. *Climate Action - European Commission*. Accessed 02.08.2018 from https://ec.europa.eu/clima/policies/transport/vehicles/cars_en.

European Environment Agency (2018): EEA greenhouse gas - data viewer. *European Environment Agency*. Accessed 02.08.2018 from http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer.

European Union (2014): Directive on the deployment of alternative fuels infrastructure.

European Union (2017): Statistical Pocketbook 2017 - EU Transport in figures.

European Union (2016): Living in the EU. *European Union*. Accessed 08.02.2018 from https://europa.eu/european-union/about-eu/figures/living_en.

Eurostat (2015): Population density. Accessed 08.02.2018 from http://ec.europa.eu/eurostat/tgm/table.do?tab=table&plugin=1&language=en&pcode=tps00003.

Eurostat (2017a): GDP and main components (output, expenditure and income). Accessed 08.02.2018 from http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_gdp&lang=en.

Eurostat (2017b): Population on 1 January. Accessed 08.02.2018 from http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tps00001&plugin=1.

Fearnley, Nils; Pfaffenbichler, Paul; Figenbaum, Erik; Jellinek, Reinhard; Institute of Transport Economics (TØI) (ed.) **(2015):** E-vehicle policies and incentives - assessment and recommendations.

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2017): *EU Climate Policy*.

Figenbaum, Erik; Kolbenstvedt, Marika (2015): *Pathways to electromobility - perspectives based on Norwegian experiences*.

Figenbaum, Erik; Kolbenstvedt, Marika (2016): Learning from Norwegian Battery Electric and Plug-in Hybrid Vehicle users Results from a survey of vehicle owners.

Figenbaum, Erik; Kolbenstvedt, Marika; Elvebakk, Beate (2014): Electric vehicles - environmental, economic and practical aspects.

gas24 (2018): Erdgastankstellen in Deutschland. Accessed 09.11.2018 from https://www.gas24.de/cms/index.php?article_id=155&clang=0.

gibgas (2018): Anzahl CNG-Stationen mit Erdgas und Biomethan in Deutschland. Accessed 09.11.2018 from https://www.gibgas.de/Tankstellen/Service/Statistik.

Hall, Dale; Lutsey, Nic (2017): Emerging best Practices for Electric Vehicle Charging Infrastructure.

Hall, Dale; Moultak, Marissa; Lutsey, Nic (2017): Electric Vehicle Capitals of the World - Demonstrating the Path to Electric Drive.

Hardman, Scott; Chandan, Amrit; Tal, Gil; Turrentine, Tom (2017): The effectiveness of financial purchase incentives for battery electric vehicles – A review of the evidence. In: *Renewable and Sustainable Energy Reviews*. 80 , pp. 1100–1111.

Harendt, Bertram; Schumann, Detlef; Wirth, Matthias (2017): Schaufenster-Programm Elektromobilität, Abschlussbericht der Begleit- und Wirkungsforschung 2017.

Haugneland, Petter; Lorentzen, Erik; Bu, Christina; Hauge, Espen (2017): Put a price on carbon to fund EV incentives – Norwegian EV policy success.

ICCT (2017): Lessons learned from Sweden's electric vehicle rollercoaster. Accessed 16.01.2018 from https://www.theicct.org/blog/staff/lessons-learned-sweden-EV-rollercoaster.

IEA (2018a): Nordic EV Outlook 2018 - Insights from leaders in electric mobility.

IEA (2018b): "Bonus-malus" for new passenger vehicles. Accessed 09.08.2018 from https://www.iea.org/policiesandmeasures/pams/sweden/name-167633-en.php.

IEA BIOENERGY (2014): Task 37 – Biogas Country Overview - Energy from Biogas.

INSERO (2018): Insero Quarterly, Q4 2017.

Langbroek, Joram H. M.; Franklin, Joel P.; Susilo, Yusak O. (2016): The effect of policy incentives on electric vehicle adoption. In: *Energy Policy*. 94 , pp. 94–103, DOI: https://doi.org/10.1016/j.enpol.2016.03.050.

Larsson, Marten (2015): The role of methane and hydrogen in a fossil-free Swedish transport sector.

Larsson, Marten; Grönkvist, Stefan; Alvfors, Per (2016): Upgraded biogas for transport in Sweden – effects of policy instruments on production, infrastructure deployment and vehicle sales. In: *Journal of Cleaner Production*. 112 (5), pp. 3774–3784.

Lorentzen, Erik; Haugneland, Petter; Bu, Christina; Hauge, Espen (2017): Charging infrastructure experiences in Norway - the worlds most advanced EV market.

Mathiasson, Anders (2016): Present status and future projects of biomethane in Sweden. 12.5.2016.

McKinsey & Company; NOW (2017): Evaluation of the National Innovation Program Hydrogen and Fuel Cell Technology Phase 1.

Mersky, Avi Chiam; Sprei, Frances; Samaras, Constantine; Qian, Zhen (Sean) (2016): Effectiveness of incentives on electric vehicle adoption in Norway. In: *Transportation Research Part D: Transport and Environment*. 46 , pp. 56–68.

MiljöfordonSyd (2018): Årets Miljöfordonsdag hölls i Kungsbacka. *Miljöfordon Syd*.

Ministry of Transport and Communications (2017): Alternative transport fuels infrastructure - Finland's National Plan.

Noel, Lance; Zarazura de Rubens, Gerardo; Kester, Johannes; Sovacool, Benjamin K. (2017): Policy Brief - The Status and Challenges of Electric Vehicles In Denmark 2017.

Norsk Elbilforening (2017): Norwegian EV owners survey 2017.

Norwegian Hydrogen Forum (2017): The Norwegian Hydrogen Guide.

Pro Mobilität (2014): Länge des Straßennetzes in Deutschland 2012. Accessed 08.02.2018 from http://www.promobilitaet.de/zahlen-fakten-statistik/strasseninfrastruktur-finanzierung/laenge-des-strassennetzes-in-deutschland.

Pütz, Konrad; Nørbech, Tom; Transnova (2012): The way ahead for hydrogen in transport in Norway . Which lessons can be learned from the successful implementation of battery electric vehicles? OECD.

Röder, K (2017): 20 Jahre Erdgasbusse/ Erfahrungsbericht eines Flottenbetreibers der ersten Stunde.

Sierzchula, William; Bakker, Sjoerd; Mat, Kees; van Wee, Bert (2014): The influence of financial incentives and other socio-economic factors on electric vehicle adoption. In: *Energy Policy*. 68 , pp. 183–194.

Statistics Denmark (2018a): Registration figures for private cars by fuel (E-Mail).

Statistics Denmark (2018b): Population at the first day of the quarter by marital status, age, sex, region and time. Accessed 19.04.2018 from http://www.statbank.dk/statbank5a/default.asp?w=1440.

Statistics Denmark (2018c): Area. Accessed 19.04.2018 from https://www.dst.dk/en/Statistik/emner/geografi-miljoe-og-energi/areal/areal.

Statistics Denmark (2018d): Road network 1st January by part of the country and type of roadStatBank Denmark. Accessed 19.04.2018 from http://www.statbank.dk/statbank5a/default.asp?w=1680.

Strauch, Sabine; Krassowski, Joachim; Fraunhofer UMSICHT (2012): *Green Gas Grids - Overview of biomethane markets and regulations in partner countries*.

Svensson, Frederik (2018): Statistik om fordonsgas. Energigas Sverige.

Tietge, Uwe (2016): Diesels dip, electric vehicles rise in Germany. *International Council on Clean Transportation*. Accessed 03.08.2018 from https://www.theicct.org/blogs/staff/diesels-dip-electric-vehicles-rise-in-germany.

Tietge, Uwe; Mock, Peter; Lutsey, Nic; Campestrini, Alex (2016): Comparison of Leading Electric Vehicle Policy and Deployment in Europe.

Trosvik, Lina; Egnér, Filippa (2017): Electric Vehicle Adoption in Sweden and the Impact of Local Policy Instruments.

Van der Steen, Martijn; Van Schelven, R.M.; Kotter, R.; M.J.W., van Twist; P., van Deventer(2015): EV Policy Compared: An International Comparison of Governments' Policy Strategy Towards E-Mobility. In: Leal Filho, Walter; Kotter, Richard (eds.) *E-Mobility in Europe: Trends and Good Practice*. Springer, pp. 27–53. — ISBN: 978-3-319-13194-8


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