Transport- og Boligministeriet

Report on Denmark's deployment of alternative fuels infrastructure

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1. Introduction

The EU's Directive on the deployment of alternative fuels infrastructure (AFI) was adopted in October 2014 with the aim of facilitating the development of an internal market for alternative fuels for transport.

In a broader context, the deployment of infrastructure for alternative fuels is an element in the EU's strategy to minimise the transport sector's dependence on oil and to reduce greenhouse gases by 60% by 2050. Electricity, gas, biofuels and hydrogen are identified by the Directive as currently the most important alternative fuels capable wholly or partially of replacing fossil oil products for transport. Gas comprises natural gas and biogas, which can be used either in compressed form (CNG) or in liquid form (LNG).

Under the Directive, Member States must establish a national policy framework for the deployment of alternative fuels infrastructure, including expectations regarding developments within the switching of the transport sector to alternative energy sources. The Member State's policy frameworks must establish targets that ensure adequate infrastructure, i.e. electric recharging points, CNG refuelling points, LNG refuelling points and any hydrogen refuelling points.

Objectives for hydrogen infrastructure are voluntary.

There is no focus on infrastructure for biofuels, because such refuelling can take place via conventional refuelling points, either by directly blending biofuels with diesel and petrol, or by deploying extra refuelling points at existing refuelling points.

Denmark's national policy framework was drawn up in 2016/2017.

It also follows from the Directive that, every three years, Member States must submit a report to the European Commission which sets out the status of national developments in the field and extrapolates expectations over the coming decade. This report constitutes Denmark's first report on the policy framework.

The report must cover all parts of the transport sector, i.e. road transport, public transport, maritime transport and air transport. The report must present an account of the legal framework for the field, political measures which support the deployment of fuels for transport, support for deployment, production and research and statements of existing infrastructure and fleets of vehicles which use alternative fuels.

The report is divided into an introduction, 10 main chapters and a summary.

Chapter 2 gives an account of the legal and legislative measures of the Member States that support the deployment of alternative modes of transport and associated infrastructure. 'Legislative measures' means regulatory and administrative measures and decisions that create a framework that either permit or directly support the deployment of infrastructure.

Chapter 3 presents specific policy measures that government agencies implement with the aim of supporting the deployment of infrastructure and stimulating sales of alternative modes of transport.

The policy measures include direct financial incentives in connection with the purchase of alternative modes of transport, particularly favourable tax conditions or other financial incentives and advantageous conditions which support the deployment of alternative modes of transport, as well as non-financial benefits such as dedicated parking spaces or preferential use of special lanes to make alternative modes of transport more attractive.

Chapter 4 presents an account of Denmark's support for the deployment and production of infrastructure or production for alternative modes of transport.

Chapter 5 describes the public support that is given to development and research within alternative modes of transport and fuels. This support is presented broken down by mode of transport and fuels.

Chapter 6 gives an account of status and expectations regarding market trends concerning alternative fuels (electricity, CNG, LNG and hydrogen), and regarding the deployment of infrastructure for road transport.

Chapter 7 covers status and expectations regarding *public transport*.

Chapter 8 covers status and expectations regarding *maritime transport*.

Chapter 9 covers status and expectations regarding *air transport*.

Chapter 10 presents an assessment of expectations regarding developments in *energy consumption* in Denmark.

In connection with the preparation of Denmark's report, three thematic meetings were held with stakeholders in the transport sector concerning expectations regarding alternative fuels infrastructure of the future. The delegates attending these meetings have contributed analyses, data and general quality assurance of the report.

2. Status of legal measures

An account is presented below of the legal and legislative measures that support the deployment of alternative modes of transport and associated infrastructure. 'Legislative measures' means regulatory and administrative measures and decisions that create a framework that either permits or directly supports the deployment of infrastructure.

The relevant legal measures (the EU Directive excluded) are presented in the annex as Table 1 (Annex 2).

2.1. EU Directives

2.1.1. Sulphur Directive

Stricter sustainability requirements for fuels for maritime transport were introduced under the EU's Sulphur Directive with effect from January 2015. As a result, ships operating in sulphur emission control areas, such as the Baltic Sea, North Sea and English Channel, became subject to stricter requirements regarding the amount of sulphur that they can emit. The requirements can be met either by using fuels with a sulphur content of less than 0.1% or by installing flue gas treatment for sulphur dioxide. There will also be stricter requirements for ships outside the environmental zones, with a requirement at global level for the sulphur content not to exceed 0.5% as of 2020. The tightened requirement for sulphur emissions increase the incentive for ship operators to switch to LNG or biofuels.

2.1.2. Fuel Quality Directive

Denmark is subject to the EU's Fuel Quality Directive, which requires EU Member States to reduce cradle-to-grave emissions of greenhouse gases in transport fuel by 6% per energy unit in 2020 relative to 2010, measured in grams of CO_2/MJ. The sustainable energy requirement of 10% is clearly higher, but it may become apparent that the requirements of the Fuel Quality Directive are more restrictive than the Renewable Energy Directive, as a result of a focus on the entire life-cycle of the fuels. The Danish Energy Agency believes that the aspects of the Fuel Quality Directive that are not directly fulfilled through the sustainable energy requirement can be fulfilled most cost-effectively by purchasing Upstream Emission Reduction (UER) credits.

2.1.3. Energy Performance of Buildings Directive

In 2018, the EU revised the Energy Performance of Buildings Directive, which dated from 2010. (Directive (EU) 2018/844). The revised Directive stipulates that, from 2020, new or renovated buildings must be prepared for the installation of recharging points for electric vehicles, including:

- a requirement for one recharging point in new non-residential buildings with more than 10 parking spaces and preparation for recharging points (deployment of conduits) for one in every five parking spaces

- a requirement for preparation (deployment of conduits) for all parking spaces in new residential buildings with more than 10 parking spaces
- a requirement for the installation of a minimum number of recharging points for all non-residential buildings with more than twenty parking spaces. The requirement applies from 2025.

2.1.4. Ambient Air Quality Directive

The Ambient Air Quality Directive lays down rules regarding air quality, including limit values for concentrations of specific substances and a requirement for air pollution to be measured.

2.1.5. Environmental Noise Directive

The aim of this Directive is to define a common European approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including nuisance, due to exposure to environmental noise. As a result of the Directive, noise mapping must be carried out and action plans prepared in order to prevent and reduce environmental noise.

2.1.6. Directive on the promotion of clean and energy-efficient road transport vehicles

The aim of the Directive is to stimulate the purchase by public bodies of vehicles based on alternative fuels, including public transport based on alternative fuels.

2.2. Acts and Regulations

2.2.1. Tax relief for vehicles which use alternative fuels

Since the end of 2016, a number of forms of tax relief have been in place to promote electric vehicles, plug-in hybrid vehicles, hydrogen vehicles and gas vehicles, including a registration tax and a low electricity tax for recharging. These are based on the following Acts:

- Act amending the Registration Tax Act, Fuel Consumption Tax Act, Act on Electricity Tax and various other Acts (Act No 687 of 8 June 2017)
- Act amending the Registration Tax Act, Fuel Consumption Tax Act and Act on weight tax on motor vehicles, etc. (Act No 1730 of 27 December 2018)

2.2.2. Act on alternative fuels infrastructure

- Introduction in 2017 of an Executive Order on requirements for technical specifications for publicly available alternative fuels infrastructure.

2.2.3. Proposal for amendment of the Building Act

- Presentation of proposal (October 2009) to amend the Building Act with a view to granting authority to lay down requirements concerning recharging points (implementation of provisions in the Energy Performance of Buildings Directive).

2.2.4. Parking stand area

- Benefits for the parking of green vehicles

  Amendment of the Executive Order on parking on public roads, which gives municipal authorities more scope to grant discounts for low and zero emission vehicles

2.2.5. Taxis

- Tightening of energy requirements for taxis

  Gradual tightening of energy requirements for taxis; see the amendment of the Executive Order on energy and environmental requirements for taxis. Executive Order BEK No 715 of 9 July 2019, amending BEK No 1509 of 13 December 2018.

- Reservation of permits for zero emission taxis

  Reservation of 50 permits for zero emission taxis during the transition period; see Act No 557 of 17 June 2019 amending the Taxi Act. 50 out of 125 taxi permits are reserved every quarter for zero emission taxis.

2.2.6. Permission for low emission vehicles to use bus lanes

- Introduction in 2019 of Executive Order No 314 of 21 March 2019 amending the Executive Order on the use of road markings and Executive Order No 313 of 21 March 2019 amending the Executive Order on road markings.

3. Status of policy measures

An account is given below of policy measures which support the deployment of alternative fuels infrastructure. These measures include direct financial incentives in connection with the purchase of alternative fuels for transport, particularly favourable tax conditions or other financial incentives and advantageous conditions which support the deployment of alternative modes of transport, as well as non-financial benefits such as dedicated parking spaces or preferential use of special lanes which make alternative fuels for transport more attractive.

The financial incentives include a CO_2 tax on fossil fuels of approximately DKK 166/tonne CO_2, which indirectly supports alternative fuels, as the energy tax on petrol, diesel, biofuels and natural gas gives an incentive to use electricity and hydrogen. Particularly lenient rules have also been introduced in relation to the registration tax for electric vehicle, plug-in hybrid vehicles and hydrogen vehicles. Many special allowances have also been introduced for electric vehicles, according to which no registration tax is payable for electric vehicles up to DKK 400,000 in 2019 and 2020.

The relevant policy measures are presented in Table 2 (Annex 2).

3.1. CO_2 tax on fuels

Fossil fuels are currently subject to a CO_2 tax which corresponds to approximately DKK 175.3/tonne CO_2. This tax indirectly supports the use of biofuels, biogas, etc., as these are not subject to this tax and therefore gain a competitive advantage through the tax. In 2019, petrol is subject to a CO_2 tax of 50 øre per litre including VAT, whilst diesel is subject to a CO_2 tax of 54.1 øre per litre including VAT.

3.2. Energy tax on fuels

Petrol, diesel, biofuels and natural gas are subject to energy taxes.
DKK 5.33 per litre including VAT for petrol, while the rate applicable when blended with biofuel is 426.5 øre in 2019. For diesel, the rate is 274.2 øre and thus amounts to DKK 3.42 including VAT.
The energy taxes which are higher than the EU's minimum requirements offer a direct incentive to use electricity and hydrogen.

3.3. Tax relief on registration, owner and electricity taxes for green vehicles

Many policy measures, both direct and indirect, have been introduced which are of significance as regards the relative financial attractiveness of electric vehicles compared with petrol vehicles.

Particularly lenient rules are also in force in relation to the registration tax for electric vehicles, plug-in hybrid vehicles and hydrogen vehicles. Numerous special allowances have also been introduced for electric vehicles, which mean that in practice electric vehicles up to DKK 400,000 in 2019 and 2020 pay DKK 0 in registration tax.

Direct support has only been used to a limited extent in Denmark. During the period 2008 - 2015, it is estimated that support was given for the purchase of around 3,000 vehicles. Indirect support in the form of allowance benefits, tax reductions and exemptions and other similar incentives are of considerable importance as regards the deployment of electric vehicles in Denmark.

Until 1 January 2016, electric vehicles were exempt from both registration tax and motor vehicle tax. Through the *Agreement on future taxes for electric vehicles and fuel cell vehicles of 9 October 2015*, it was decided that the registration tax would be gradually phased in for electric vehicles commencing on 1 January 2016, and become subject to the full motor vehicle tax. The registration tax is determined according to the ordinary rules for cars, although a special battery allowance will be deducted from the basis for the registration tax during the phasing in of the registration tax, and a tax-free allowance will be deducted from the registration tax during the initial part of the introductory period. Under current rules, the registration tax will be phased in at 20% minus a tax-free allowance of DKK 40,000 in 2019, 40% minus a tax-free allowance of DKK 77,500 in 2020, 65% in 2021 and 90% in 2022. In 2023, electric vehicles will be subject to the full registration tax.

Registration tax will also be phased in for plug-in hybrid vehicles using the same profile. However, only a proportion of the registration tax will be phased in, not the full tax. The statement of fuel consumption for plug-in hybrid vehicles does not include electricity consumption. This results in substantial deductions for fuel efficiency. In 2019, 20% of the difference between the registration tax determined when electricity consumption is included in the calculation of fuel consumption supplements/allowances and when it is not included, minus a tax-free allowance, will also be added to the fully implemented tax of DKK 40,000 in 2019. The supplement rises to 40% minus a tax-free allowance in the fully implemented tax of DKK 77,500 in 2020, 65% in 2021, 90% in 2022 and 100% in 2022 onwards. Similarly for electric vehicles, a special battery allowance will be granted which is deducted from the basis for the registration tax during the phase-in period. A proportion of the registration tax on gas vehicles will also be phased in using the same profile as for electric vehicles.

Fuel cell-powered vehicles will remain exempt from registration and motor vehicle tax until 2021. From 2022 onwards, they will become subject to full motor vehicle tax, and they will gradually become subject to registration tax over a four-year period in the same way as electric vehicles, although without any tax-free allowance or battery allowance.

Under current rules for electric and plug-in hybrid vehicles which are recharged commercially (e.g. through a commercial service such as CLEVER or EON), an electricity tax of just 0.4 øre is payable for electricity used for recharging purposes, equivalent to the rate that is paid on electricity used by the process industry. This special scheme will remain in force until the end of 2019. [1]

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[1] To maintain the incentive to choose electric vehicles, in the proposed Finance Act for 2020 (FFL20), the government has decided to extend the special temporary scheme concerning the low rate of process electricity tax for the recharging of electric vehicles, etc. through to 2020 and 2021

From 2020, the ordinary electricity tax rate will apply to all recharging, i.e. the rate that also applies to household electricity consumption for lighting, heating, etc. In 2020, the ordinary electricity tax rate is 89.2 øre/kWh, falling to 86.1 øre/kWh in 2023 and to 78.9 øre/kWh (2020 prices) through to 2025, as a result of the reductions in electricity tax under the Energy Agreement from June 2018.

3.4. Incentives for biofuels

In Denmark, it is currently mandatory to blend petrol and diesel used for land transport with at least 5.75% biofuels (as a proportion of energy content). The requirement for blending is intended to promote the use of renewable energy resources in the transport sector and to reduce greenhouse gas emissions from fuels in the transport sector. The requirement was introduced through the Act on sustainable biofuels (Act No 468 of 12 June 2009), and will be increased in 2020 to 7.6% of the energy content in accordance with the EU's Renewable Energy Directive (Directive 2009/28/EC).

3.5. Public bus transport

Trials have been conducted on a number of bus routes in Copenhagen and Frederiksberg using electric buses, and 41 new electric buses will be introduced into service by the end of 2019. In Aarhus, four electric buses were introduced into service on 11 August 2019.

3.6. Electric trains

The Danish railway network is currently only partially electrified: The Copenhagen-Odense-Fredericia main line and the associated link on to Padborg and continental Europe, and the entire S-train network. In May 2017, the 57-km route between Esbjerg and Lunderskov was fully electrified, and electric trains began operating on the route in August 2017.

Electrification of the Køge-Næstved route was essentially completed in March 2019, and the new high-speed Ringsted-Køge N-Copenhagen H line has also been constructed as an electrified railway. Although the railway infrastructure permits electric trains to be used, most Fjernbane services use diesel traction.

Over the coming years, the train fleet will gradually be replaced, and electrification of the railway will be essential in order to use the electric trains of the future.

The practical electrification of the railway is managed under Banedanmark's Electrification Programme, which aims to electrify much of the Danish railway network. Work is currently under way on a number of high-profile electrification projects on the railway under the auspices of this programme, including Fredericia-Aarhus, Aarhus-Lindholm and Roskilde-Kalundborg. Once these projects have been implemented as planned, a high proportion of the Danish railway network will be electrified.

4. Status of support for deployment and production

This chapter covers direct public investment at state, regional and municipal level in infrastructure or production for alternative modes of transport. This support could for example be in the form of the deployment of recharging points for electric vehicles, public support for the production of biofuels, support for the construction of production facilities for biofuels, etc. The grants awarded to support deployment and production are specified in the annex in Table 3 (Annex 2).

The following points describe the areas which support the deployment of alternative modes of transport at state, regional or municipal level.

4.1. The 2018 Energy Agreement

In connection with the 2018 Energy Agreement, a funding pool has been established which may be of relevance to the AFI report. This pool was established with the aim of supporting green transport from 2020-2024, and amounts to DKK 500 million in total, which will be implemented over the period (DKK 70 million in 2020, DKK 130 million in 2021 and DKK 100 million every year from 2022 – 2024.) *(Ministry of Climate, Energy and Utilities)*

4.2. Hydrogen pool

In spring 2017, a pool of DKK 10 million was established to promote fuel cell vehicles, including infrastructure. The pool was established under the Executive Order concerning a pool to promote fuel cell vehicles.

4.3. Support for the deployment of light rail

Under the Finance Act, the Ring 3 Light Railway in the Capital Region will receive support totalling approximately DKK 1.4 billion during the period 2016 - 2022. Under the Finance Act, Odense Light Rail will receive support totalling approximately DKK 930 million during the period 2016 - 2020. Under the Finance Act, Aarhus Light Rail will receive support totalling approximately DKK 460 billion in 2016 and 2017.

4.4. The regions' budgets

The Capital Region's budget allocates DKK 3 million to the support of electric vehicles during the period 2016 - 2019. The Capital Region's budget for 2019 allocates a further DKK 7.3 million to trials using hydrogen buses.

In its 2019 budget, Region North Jutland has allocated DKK 5 million to support a green pool which also includes green transport. The budgets for 2018 and 2019 also set aside funding amounting to a total of DKK 2.5 million for trials with hydrogen buses.

4.5. The budgets of selected municipalities

Many of the budgets of the largest municipalities in the country have also been reviewed to identify support for infrastructure and deployment of alternative fuels in the transport sector. These municipalities are Copenhagen Municipality, Odense Municipality and Aarhus Municipality.

The 2018 budget for Copenhagen Municipality includes investments in infrastructure for green harbour buses for the period 2019 - 2019 totalling DKK 11.5 million. The budget also allocates DKK 6 million to cover increases in the cost of operating the harbour buses using green biodiesel. The 2019 budget for Copenhagen Municipality includes DKK 12.3 million for infrastructure for electric buses.

Odense Municipality's budgets for 2018/2019 include investments and operating subsidies for light rail for the period 2017 - 2022 amounting to a total of approximately DKK 350 million.

Aarhus Municipality's budget from 2016 allocates approximately DKK 126 million to investment in the new light rail system for the years 2017/2018.

5. Status of research, technological development and demonstration

An account is presented below of the status of Denmark's public support for research and development relating to alternative modes of transport and fuels.

During the period 2016 - 2019, support was allocated to research projects of relevance to the AFI Directive through a number of public subsidy programmes, including the Energy Technology Development and Demonstration Programme (EUDP), the Innovation Fund and the EU's framework schemes.

Through Energiforskning.dk, an overview has been obtained of research projects within the AFI framework which have received public support through one of these support schemes.

5.1. Projects supported in 2019

In 2019, three projects of relevance to AFI received public support from the EUDP. Two of the projects looked at various alternative fuels for maritime transport, while the third project reviewed possible new opportunities for the development of methods for the production of sustainable methanol, which can be used both in the transport sector and elsewhere as a blending agent. Together, the three projects received approximately DKK 50 million in support.

5.2. Projects supported in 2018

In 2018, eight projects of relevance to the AFI Directive received support through the EUDP and the EU's Framework Programme. These projects focused overwhelmingly on the development of hydrogen and fuel cell technology and associated infrastructure. The project received a total of DKK 118 million in support.

5.3. Projects supported in 2017

In 2017, four projects of relevance to the AFI Directive received support through the various support schemes. The projects studied batteries for electric maritime transport and hydrogen technology, and received a total of appropriately DKK 72 million in support.

5.4. Projects supported in 2016

In 2016, four projects of relevance to the AFI Directive received support through the EUDP and the Innovation Fund. The project studied hydrogen technology, bioethanol and smart chargers for electric vehicles, and received a total of appropriately DKK 29 million in support.

6. Market trends and objectives - road transport

Road transport accounts for three quarters of the total energy consumption by the transport sector and is therefore pivotal in relation to the AFI Directive.

Within road transport, conventional petrol- or diesel-powered vehicles continue to dominate, accounting for more than 99% of the total vehicle fleet.

However, technological advances will shift the competitive advantages between conventional vehicles and new technologies, including in particular electric technology, but improvements to engines for gas-powered operation may also be of significance as regards market trends.

6.1. Electricity

6.1.1. Vehicles

In the Baseline projection 2019, total electricity consumption by the transport sector was set at 1.84 PJ in 2019 and is expected to rise to a total of 7.51 PJ in 2030, of which 0.28 PJ and 3.63 PJ are used for road transport in 2019 and 2030 respective, equivalent to 15% and 48%.

The increase in the consumption of electricity for road transport primarily stems from growth in the use of electric cars and light goods vehicles.

At the end of 2018, the fleet of electric vehicles comprised around 16,000 battery-powered vehicles, of which 5,000 were plug-in hybrid vehicles and 900 electric and plug-in hybrid light goods vehicles.

According to the Baseline projection 2019, there are expected to be a total of approximately 300,000 electric cars and light goods vehicles in 2030.

Table 3 shows the 2018 fleet and the expected future fleet of electric vehicles. Future trends are shown for 2020, 2025 and 2030.

Table 3: Historical and expected number of electric and plug-in hybrid vehicles, broken down by type
Source: Baseline projection 2019, Statistics Denmark

Alternative Fuels Vehicles (AFV)	Current and past number of AFV			Number of AFV expected to be registered		
	2016	2017	2018	2020	2025	2030
ELECTRICITY						
Electric Vehicles, EV (total road including Two Wheelers)	**11 696**	**12 591**	**17 504***	**37 155**	**111 800**	**334 259**
Powered Two Wheelers (PTW)	**1 123**	**1 331**	**1 386**	**1 480**	**1 995**	**2 510**
Electric Vehicles, EV (excl. PTW)	**10 573**	**11 260**	**16 118**	**35 675**	**109 805**	**331 749**
Electric Passenger Cars (Battery Electric Vehicles (BEV)+Plug in Electric Vehicles PHEV)	9 763	10 541	15 205	32 531	98 484	294 373
• **BEV**	8 662	8 765	**10 037**	19 276	58 075	186 265
• **PHEV**	1 101	1 776	**5 168**	13 255	40 409	108 108
Electric Light Commercial Vehicles	803	713	905	2 996	10 556	35 572
• **BEV**	623	512	669	2 247	7 917	26 679
• **PHEV**	180	201	236	749	2 639	8 893
Electric Heavy Commercial Vehicles	0	0	0	2	31	208
• **BEV**	0	0	0	2	23	156
• **PHEV**	0	0	0	0	8	52
Electric Buses and Coaches	7	6	8	146	734	1 596
• **BEV**	6	5	7	97	489	1 064
• **PHEV**	1	1	1	45	245	532

**This figure includes two-wheeled electric vehicles*

6.1.2. Recharging infrastructure

No data is available concerning the exact number of recharging points in Denmark at the end of 2018. This report is therefore based on the current number of recharging points (as of September 2019).

At present, there are approximately 1,789 publicly available recharging stations with around 3,648 recharging points in Denmark (September 2019). This includes approximately 3,452 recharging points for normal charging (up to 42 kW), 174 high-power recharging points (50-100 kW) and 22 Ionity recharging points (100+ kW). This is equivalent to approximately one recharging point for every four electric and plug-in hybrid vehicles based on the number of vehicles in 2018, which is the most recent year for which figures have been reported.

In light of strong sales of electric and plug-in hybrid vehicles in 2019, the number of vehicles per recharging point is estimated at around six.

The recharging stations are provided by E.ON, Clever and Ionity, with E.ON and Clever being by far the largest providers of publicly available recharging stations. Tesla also has nine recharging stations with a total of 116 recharging points, which are only available to Tesla owners and are therefore not considered to be publicly available.

Many factors will impact on demand for and deployment of public recharging points. Public recharging is primarily of relevance to electric vehicle owners who travel long distances, and electric vehicle owners who live in high-rise housing without any private parking provision.

Demand for recharging points is rising as the number of vehicles increases, but it will decline as the range of vehicles increases, as their recharging needs will be met through private recharging at home to a greater extent.

The development of high-capacity fast chargers will similarly reduce the number of recharging stations required, as fast chargers will be capable of serving many vehicles over the course of a day, partly because they can offer a relevant alternative to kerbside charging for residents in high-rise housing. On the other hand, convenience and a greater willingness to pay in order to have access to a vehicle which is always fully charged may lead residents of high-rise housing to prefer kerbside charging.

The AFI Directive stipulates that there should be approximately one publicly available recharging point for every 10 electric vehicles. By comparison, the current level of coverage in Norway is one recharging point per 20 electric vehicles, whilst in a report on expectations concerning the deployment of electric vehicles in Denmark in 2030, Dansk Energi concludes that only around one recharging point per 60 electric vehicles will be needed. However, Dansk Energi's report is based on an assumption of there being 700,000 electric vehicles and 300,000 plug-in hybrid vehicles.

Thus, there is a wide span between the very high level of coverage in Denmark which exists at present, what the AFI Directive assumes, what is observed in practice in Norway, and finally what is expected by Dansk Energi.

Denmark's objective for the deployment of recharging infrastructure is based on the assumption that, from 2020 onwards, Denmark will have recharging point deployment which corresponds to the objective stipulated in the AFI Directive of 1:10.

Based on the anticipated phasing-in of electric vehicles, the target is therefore for the number of public recharging points to rise from around 3,700 at the end of 2019 to around 5,400 at the end of 2020, 9,800 in 2025 and around 29,400 through to 2030.

It is assumed that the ratios between the numbers of recharging points of different power outputs will remain constant through to 2030 (Table 1). No information is available concerning the number of private recharging points, and such recharging points are therefore not included in the statement.

Alternative Fuels Infrastructure (AFI)	Current and past number of recharging/refuelling			Target number of recharging/refuelling points		
	2016	2017	2018*	2020	2025	2030
Electricity						
Total recharging points (public* + private)	**1 749**	**2 699**	**3 648***	**5 519**	**9 848**	**29 437**
Recharging points (publicly accessible)	**1 749**	**2 699**	**3 648**	**5 419**	**9 848**	**29 437**
Normal power recharging points, P ≤ 22kW (public)	1 345	1 374	1 402	2 083	3 785	11 313
High power recharging points, P > 22kW (public)	404	1 325	2 246	3 337	6 063	18 124
• AC fast charging, 22kW < P ≤ 43 kW (public)	340	1 195	2 050	3 045	5 534	16 542
• DC fast charging, P < 100 kW (public)	0	87	174	258	470	1 404
• DC ultrafast charging, P ≥ 100 kW (public)	64	43	22	33	59	178
Recharging points (private)	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Normal power recharging points, P ≤ 22kW (private)	N/A	N/A	N/A	N/A	N/A	N/A
High-power recharging points, P > 22kW (private)	N/A	N/A	N/A	N/A	N/A	N/A

Alternative Fuels	Current and past number of recharging/refuelling			Target number of recharging/refuelling points		
• AC fast charging, 22kW < P ≤ 43 kW (private)	N/A	N/A	N/A	N/A	N/A	N/A
• DC fast charging, P < 100 kW (private)	N/A	N/A	N/A	N/A	N/A	N/A
• DC ultrafast charging, P ≥ 100 kW (private)	N/A	N/A	N/A	N/A	N/A	N/A

**This figure shows the current population of recharging points (September 2019).*
Table 3: Number of recharging points, broken down by power output and ownership.
Sources: Data from E.ON and Clever.

6.2. Compressed Natural Gas (CNG)

CNG is natural gas which has been compressed to 200 bar.

6.2.1. Vehicles

Gas vehicles at present account for less than one-thousandth of the total number of vehicles on the road.

The current fleet of gas vehicles in Denmark comprises 130 cars, 138 light goods vehicles, 154 buses and 156 trucks. The fleet has steadily increased in size over the period. Gas-powered heavy goods vehicles also include refuse collection vehicles, which are used in many cities.

Natural gas consumption in the transport sector is expected to rise from approximately 0.13 PJ in 2016 to approximately 0.27 PJ in 2019 and to 0.44 PJ in 2030.

The rise since 2016 is due to the switching of several bus routes in Copenhagen and Sønderborg to gas.

Table 4 shows the number of CNG vehicles and the expected future number of CNG vehicles:

Alternative Fuels Vehicles (AFV)	Current and past number of AFV			Number of AFV expected to be registered		
	2016	2017	2018	2020	2025	2030
CNG (including biomethane)						
CNG Vehicles (total road)	**363**	**544**	**578**	**862**	**1 522**	**2 153**
Powered Two Wheelers	**0**	**0**	**0**	**0**	**0**	**0**
CNG Vehicles (excl. PTW)	**363**	**544**	**578**	**862**	**1 522**	**2 153**
CNG Passenger Cars	93	127	130	300	570	792
CNG Light Commercial Vehicles	86	129	138	208	313	372
CNG Heavy Commercial Vehicles	111	134	156	125	105	89
CNG Buses and Coaches	73	154	154	229	534	900

Table 4: Historical and expected number of gas vehicles, broken down by type.
Sources: Baseline projection 2019. Statistics Denmark.

6.2.2. Recharging infrastructure

The AFI Directive requires the Member States to deploy sufficient CNG refuelling points by 2020 to enable gas-powered vehicles to be driven in urban/suburban agglomerations and other densely populated areas in a network determined by the Member States.

It must also be ensured that CNG refuelling points are put in place along the TEN-T Core Network, so that CNG vehicles can be driven throughout the European Union by 2025. As an indication, CNG refuelling points should be set up at least every 150 km along the TEN-T Core Network.

There are currently 17 natural gas refuelling points spread across the country. It is anticipated that the existing refuelling point capacity will be sufficient to meet the rising demand for CNG in the transport sector, and the objective is therefore to maintain the number of CNG refuelling points at the current level through to 2030. The deployment of gas refuelling points is shown in Figure 3 below.

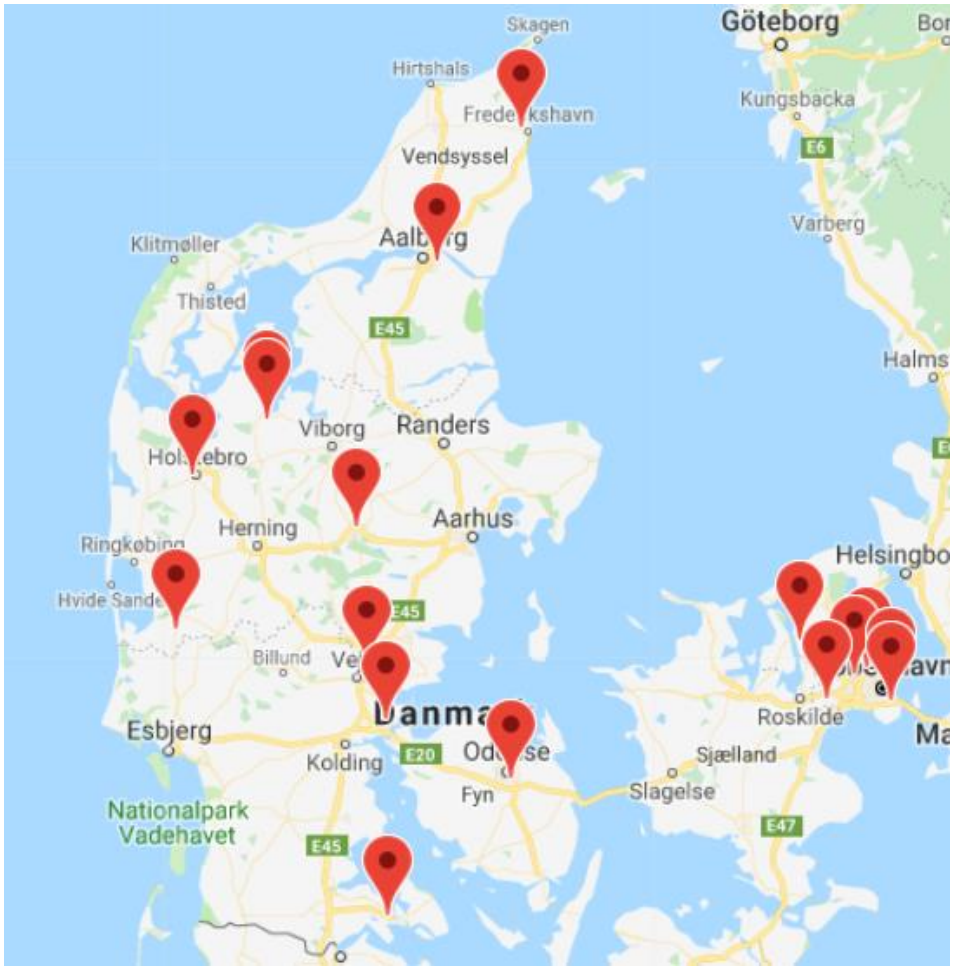

Figure 3: Map showing the location of natural gas refuelling points in Denmark, 2019.
Source: https://www.gasbiler.info/her-er-gastankstationerne

Table 5 below shows the number of CNG refuelling points and the expected future number of CNG refuelling points:

Alternative Fuels Infrastructure (AFI)	Current and past number of recharging/refuelling			Target number of recharging/refuelling points		
	2016	2017	2018	2020	2025	2030
Natural gas (including biomethane)						
CNG refuelling points (total)	**14**	**17**	**17**	**17**	**17**	**17**
CNG refuelling points (public)	14	17	17	17	17	17
CNG refuelling points (private fleet operators)	0	0	0	0	0	0

Table 5: Historical and expected number of gas refuelling points.
Source: FDM.

6.3. Liquefied Natural Gas (LNG)

Liquefied Natural Gas is the liquid form of natural gas which is formed by cooling natural gas to approximately minus 162 °C.

6.3.1. Vehicles

There are currently no vehicles registered in Denmark which use LNG as fuel.

6.3.2. Recharging infrastructure

Under the AFI Directive, in order to promote the development of LNG infrastructure for road transport purposes, Member States must deploy sufficient publicly available refuelling points on roads along the TEN-T Core Network, if this is deemed to be financially advantageous. A target should ideally be set of LNG refuelling points being put in place every 400 km by 2025.

No refuelling points have yet been established for LNG along the TEN-T road network, and it is therefore not possible to refuel vehicles with LNG.

In order to achieve such an objective, LNG refuelling facilities must at least be established around Aalborg, the Triangle Region and Copenhagen.

As the market in Denmark is not developed, the economic conditions for LNG vehicles and LNG recharging infrastructure are unknown. The economic conditions must therefore be analysed before the framework conditions for LNG can be expanded. Furthermore, it will be important to monitor developments in the countries surrounding Denmark.

Table 6 below shows the expected number of LNG refuelling facilities:

Alternative Fuels Infrastructure (AFI)	Current and past number of recharging/refuelling			Target number of recharging/refuelling points		
	2016	2017	2018	2020	2025	2030
Natural gas (including biomethane)						
LNG refuelling points (total)	**0**	**0**	**0**	**0**	**3***	**3***
LNG refuelling points (public)	0	0	0	0	3*	**3***
LNG refuelling points (private fleet operators)	0	0	0	0	0	**0**

** It is anticipated that market-driven development will contribute to the deployment of LNG refuelling facilities.*

Table 6: Historical and expected number of LNG refuelling points.

6.4. Liquefied Petroleum Gas (LPG)

LPG is a mixture of propane and butane, which can be stored under pressure in gas bottles as a clear liquid.

6.4.1. Vehicles

LPG is currently only used to a limited extent in Denmark and four refuelling facilities are currently available.

It is expected that LPG will be phased out of the transport sector completely through to 2030 and that there will be no demand for LPG refuelling stations.

The following Table 7 on the LPG vehicle fleet is reported to the European Commission:

Alternative Fuels Vehicles (AFV)	Current and past number of AFV			Number of AFV expected to be registered		
	2016	2017	2018	2020	2025	2030
Liquefied Petroleum Gas (LPG)						
LPG Vehicles (total road)	**18**	**14**	**12**	**8**	**3**	**0**
Powered Two Wheelers	**0**	**0**	**0**	**0**	**0**	**0**
LPG Passenger Cars	4	4	4	2	0	0
LPG Light Commercial Vehicles	13	9	7	5	3	0
LPG Heavy Commercial Vehicles	0	0	0	0	0	0
LPG Buses and Coaches	1	1	1	1	0	0

Table 7: Historical and expected number of LPG vehicles, broken down by type.
Sources: Baseline projection 2019 and Statistics Denmark.

6.4.2. Recharging infrastructure

The following Table 8 on the LPG refuelling facilities is reported to the European Commission:

Alternative Fuels Infrastructure (AFI)	Current and past number of recharging/refuelling			Target number of recharging/refuelling points		
	2016	**2017**	**2018**	**2020**	**2025**	**2030**
LPG						
LPG refuelling points (total)	**4**	**4**	**4**	**4**	**2**	**0**
LPG refuelling points (public)	4	4	4	4	2	0
LPG refuelling points (private fleet operators)	0	0	0	0	0	0

Table 8: Historical and expected number of LPG refuelling points.
Source: FDM.

6.5. Hydrogen

Under the AFI Directive, Member States may include hydrogen in their national policy frameworks on a voluntary basis. Denmark has not included hydrogen in its national policy framework and no objective has therefore been established for the deployment of infrastructure for the refuelling of hydrogen vehicles.

Under the Directive, Member States opting to make a commitment to hydrogen vehicles and hydrogen infrastructure should put in place a sufficient number of publicly available hydrogen refuelling points by 2025.

Hydrogen refuelling infrastructure has been established in Denmark and is therefore covered in the report to the European Commission.

6.5.1. Vehicles

According to Statistics Denmark, there are currently 85 cars in Denmark which run on hydrogen, and development is therefore still in a trial phase and the technology has not yet broken through into the market.

Table 9 shows the current fleet of hydrogen vehicles and the expected future number of hydrogen vehicles.

Alternative Fuels Vehicles (AFV)	Current and past number of AFV			Number of AFV expected to be registered		
	2016	2017	2018	2020	2025	2030
Hydrogen						
Fuel Cell Vehicles, FCEV (total road)	**0**	**0**	**85**	**516**	**889**	**954**
Powered Two Wheelers	**0**	**0**	**0**	**0**	**0**	**0**
Hydrogen Passenger Cars	0	0	85	314	680	657
Hydrogen Light Commercial Vehicles	0	0	0	0	0	0
Hydrogen Heavy Commercial Vehicles	0	0	0	0	1	21
Hydrogen Buses and Coaches	0	0	0	2	208*	276*

**According to information from H2Bus http://h2bus.eu/index.html, 200 hydrogen buses are expected to be introduced into service by 2023, which is not indicated by the Baseline projection 2019. These have been added to the table.*

Table 9: Historical and expected number of hydrogen vehicles, broken down by type.
Sources: Baseline projection 2019, Statistics Denmark.

6.5.2. Infrastructure

There are currently seven hydrogen refuelling points in Denmark. These refuelling points are located across the country close to major towns and cities and traffic intersections.

A number of state-supported projects have been carried out to establish hydrogen infrastructure and vehicles which use hydrogen. A new consortium, H2Bus Consortium, has announced that it intends to introduce 200 new hydrogen buses into service in Denmark with a total of approximately DKK 100 million in support from the EU by 2023. These buses are not included in the Baseline projection 2019, but have been added to Table 9.

The following Table 10 on refuelling infrastructure for hydrogen is reported to the European Commission:

Alternative Fuels Infrastructure (AFI)	Current and past number of recharging/refuelling			Target number of recharging/refuelling points		
	2016	**2017**	**2018**	**2020**	**2025**	**2030**
Hydrogen						
H2 refuelling points (total)	**10**	**8**	**8**	**7**	**7**	**7**
H2 refuelling points – 350 bar (total)	0	0	0	0	0	0
H2 refuelling points – 350 bar (public)	0	0	0	0	0	0
H2 refuelling points – 350 bar (private fleet operators)	0	0	0	0	0	0
H2 refuelling points – 700 bar (total)	10	8	8	7	7	7
H2 refuelling points – 700 bar (public)	10	8	8	7	7	7
H2 refuelling points – 700 bar (private fleet operators)	0	0	0	0	0	0

Table 10: Historical and expected number of hydrogen refuelling points. Source: Brintbiler.dk.

7. Market trends and objectives - public transport

Public transport primarily consists of buses and trains. For this purpose, information has been obtained from the traffic companies in Denmark regarding the current status of use and future prospects for alternative fuels within the area of bus operation.

There are six regional transport companies in Denmark which are responsible for the provision of public transport in their respective areas of Denmark. The way it works in practice is that the municipalities request bus and train routes from the transport companies, which tender for bus and rail services. In connection with tenders, an emphasis can be placed on different parameters, including environmental considerations, and this is increasingly the case.

7.1. Buses

Buses for scheduled services are typically refuelled at special bus refuelling points, and infrastructure for this purpose is therefore put in place more or less independently of infrastructure for private transport needs. Public access to gas refuelling points has, however, been established in the deployment of gas-powered buses, and these refuelling points have contributed to the general deployment of infrastructure in gas for transport.

For the existing electric bus fleet which operates in Copenhagen, one recharging station has been deployed at each terminus, i.e. there are two recharging stations. However, these stations are not publicly available.

Gas consumption in the transport sector was approximately 0.13 PJ in 2013, is approximately 0.30 PJ in 2019 and is expected to rise to 0.58 PJ in 2030. The rise since 2016 is due to the switching of several bus routes in Copenhagen and Sønderborg to gas.

All of Roskilde Municipality's 20 buses switched to running on electricity instead of diesel in April 2019. The municipality's new electric buses are expected to transport approximately 2.8 million passengers a year and reduce CO_2 emissions by buses by around 1,400 tonnes CO_2 per year. The buses are equipped with 374 kWh traction batteries, which gives them a range of 250-300 km. The batteries can be charged with a charging power of up to 150 kW, enabling them to be fully charged in around two hours[2].

The traffic companies' buses typically operate on 12-year contracts. As is apparent from the figure below, around 4,000 buses will be the subject of invitations to tender through to 2030 and could therefore be switched to alternative fuels. Many buses will be covered by invitations to tender over the coming years. In Aarhus, there are plans to introduce 18 electric buses into service in 2021, whilst there

[2] https://sn.dk/Roskilde-Avis/En-stroem-af-el-busser-Roskilde-er-foregangsby/artikel/832039.

are plans for 12 electric or hydrogen buses in Herning in 2021. In connection with the 2020 invitation to tender, traffic company NT is planning to acquire a total of 103 'green' buses, although half of these will not be replaced until the contract period has commenced. In NT's 2021 invitation to tender, 61 buses will be introduced into service, of which 32 will be green. During 2021, Sydtrafik expects 50 buses to be introduced into service, of which 29 are expected to be green. In 2022, NT will introduce 108 buses into service, of which approximately 20 will be green. Thus, many bus routes will be the subject of invitations to tender through to 2029 for which no decision has been taken as to which fuel they will use.

Figure 3 below shows the bus companies' planned invitations to tender for bus services through to 2030.

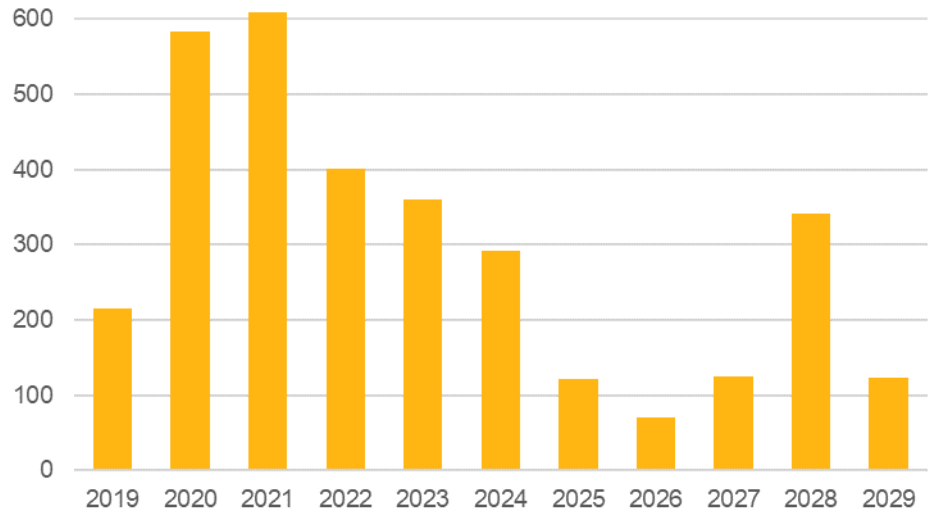

Figure 3: Expected invitations to tender for bus operation 2019-2029.
Source: The traffic companies.

7.2. Trains

Rail services in Denmark encompass long-distance and regional trains, local railways, light rail systems, suburban trains and the metro. In addition, freight trains run on the Danish state railways, which are not part of public transport, but are included here in the combined overview of train operations. As is apparent below, some train operations have already been electrified, and ambitious plans are in place to electrify the railway network going forward. Energy consumption for trains in 2013 broke down into around 60% diesel and 40% electricity. Electricity is primarily used in suburban trains (S trains) and the metro, while long-distance and regional trains, as well as local railways, mainly run on diesel.

7.2.1. Electric trains

The Danish railway network is currently only partially electrified on the Copenhagen-Odense-Fredericia main line and the associated link to Padborg and continental Europe, along with the entire S-train network. In May 2017, the 57-km route between Esbjerg and Lunderskov was fully electrified, and electric trains began operating on the route in August 2017.

The practical electrification of the railway is managed under Banedanmark's Electrification Programme, which aims to electrify much of the Danish railway network. Work is currently under way on a number

of high-profile electrification projects on the railway under the auspices of this programme, including Fredericia-Aarhus, Aarhus-Lindholm and Roskilde-Kalundborg. Once these projects have been implemented as planned, a high proportion of the Danish railway network will be electrified.

7.2.2. Suburban trains (S-trains)

The S-train network encompasses 84 stations across seven lines in Greater Copenhagen and the surrounding area. Every day, around 360,000 passengers use the 135 S-trains which are operating. All S-train services are electric. There are currently no plans to extend the S-train network.

7.2.3. Metro

Since Copenhagen's Metro opened in 2002 with two lines (M1 and M2), it has been extended on two occasions, firstly through completion of a link to the airport in 2007, and then through the addition of the M3 City Circle Line, which opened in 2019. There are currently 37 metro stations in Copenhagen, and metro services transport approximately 64 million passengers annually. Metro services are entirely electric. Further extensions to the metro - M4 - have been approved, including a line to Nordhavnen, which will open in 2020, and a line to Ny Ellebjerg, which will open in 2024.

7.3. Vehicle fleets - buses and trains

The current and expected numbers of buses and trains which use alternative fuels are presented in Table 11.

Alternative Fuels Vehicles (AFV)	Current and past number of AFV			Number of AFV expected to be registered		
	2016	2017	2018	2020	2025	2030
Hydrogen Buses and Coaches	0	0	0	2	208	276
LNG Buses and Coaches	0	0	0	0	0	0
CNG Buses and Coaches	73	154	154	229	534	900
LPG Buses and Coaches	1	1	1	1	0	0
Electric Buses and Coaches	7	6	8	146	734	1 596
• **BEV**	6	5	7	97	489	1 064
• **PHEV (hybrid)**	1	1	1	49	245	532
Rail Locomotives (electricity)	345	248	253	253	295	353

Table 11: Historical and expected number of buses and trains, broken down by fuel. Sources: Baseline projection 2019, Statistics Denmark.

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8. Market trends and objectives - maritime transport

The AFI Directive sets out a number of requirements to increase mobility options within maritime transport with alternative fuels, which involve targets for both shore-side electricity supply and LNG refuelling points at inland and maritime ports.

Denmark does not have any inland ports, so no requirement in this regard need be included in the policy framework.

8.1. Battery-powered ferries

Ferry operations predominantly use diesel-powered ferries, but electric ferries have been introduced in recent years on certain routes. This includes the ferry 'Ellen', which sails between Fynshav and Ærø, and Tycho Brahe and Aurora, which have been converted from diesel to electric, and sail between Helsingør and Helsingborg. Over the coming years, Scandlines is also planning to convert two ferries on the Rødby-Puttgarden route to electricity, while the Thyborøn-Agger ferry will be converted to electric operation later in the year. Finally, Arriva has planned seven electric harbour buses, and two of the ferries used for canal tours and Haderslev Dambåd are electrically powered.

In addition, there are a number of hybrid ferries which have a small battery installation instead of an auxiliary engine. This includes the ferries used on the Rødby-Puttgarten and Gedser Rostock crossings. There are also a number of domestic ferries which have a hybrid solution, e.g. the Venø ferry and the Thyborøn Canal. The Ministry's contracts with Molslinjen concerning the two state routes Samsø-Kalundborg and Bøjden-Fynshav also expire in 2024, and the scope to impose a requirement for ferries to be used which use either electricity or LNG will be investigated further in connection prior to the issuing of any invitation to tender.

8.2. Shore-side electricity supply

It follows from the AFI Directive that shore-side electricity supply for maritime transport will be assessed and a supply established for ports in the TEN-T Core Network and other ports by 2025 at the latest if this is deemed to be financially and environmentally beneficial.

All Danish ports have established shore-side electricity supply installations for use by ships which require a limited power supply.

However, it is difficult to make a financial case for deploying shore-side electricity supply installations, e.g. for use by cruise ships with substantial power supply needs, and shore-side electricity supply installations for use by such ships are therefore not yet widespread in Denmark.

The statement of future shore-side electricity supply installations is subject to some uncertainty, as many of the considerations regarding (major) shore-side electricity supply facilities are at an early state

of conceptual development without any binding plans. However, it is considered to be reasonable to assume that the shore-side electricity supplies that are discussed here will be deployed through to 2030.

Below, shore-side electricity supply is specified on the basis of installations rather than recharging outlets, for which it has not been possible to obtain information.

In 2019, the Port of Faaborg became the first commercial port to deploy a shore-side electricity supply. In 2019, the Port of Grenå deployed a mobile shore-side electricity capable of supplying 2 MW.

As part of the EU-supported 'Skandinavisk Elektrisk Transport System' project, the ports of Skagen, Hirtshals and Frederikshavn are to be electrified and have shore-side electricity supplies installed over the next three years.

Plans for the development of the Port of Copenhagen around Nordhavn included the possible deployment of a shore-side electricity supply, and Copenhagen Municipality, Copenhagen Malmö Port (CMP) and By & Havn have begun the planning process for a shore-side electricity supply for cruise ships at the Oceankaj Cruise Terminal in Nordhavn. The goal is for the facility to become operational during 2021.

It has also been decided that the Copenhagen to Oslo ferry will be connected to a shore-side electricity supply when docked. Funding has also been set aside to consider the possibility of deploying a shore-side electricity supply at Langelinie.

At the Port of Aarhus, a broad majority on the city council want work to begin on the rapid deployment of a shore-side electricity supply for cruise ships. No binding objectives have so far been established for the deployment.

8.3. Liquefied Natural Gas (LNG)

Under the Directive, sufficient LNG refuelling points must be put in place at maritime ports for LNG vessels for transport on inland waterways or seagoing LNG ships to be able to circulate throughout the TEN-T Core Network by 2025.

The maritime ports which will provide access to LNG refuelling points are to be determined in Member States' policy frameworks, taking account of current market needs.

In Denmark, two LNG bunkering facilities have so far been deployed in Denmark: one at the Port of Hirtshals and one at the Port of Hou. The facility at the Port of Hou is only used by the Samsø Ferry. The two Hirtshals Fjord Lines ferries also use LNG, but both refuel in Norway.

In addition, there are a number of ports that have prepared a financial sustainability analysis prior to investment in LNG installations. These include the following ports: Aarhus, Copenhagen, Esbjerg, Fredericia, Rønne and Orehoved. The ports of Aarhus and Copenhagen have received EU aid for the sustainability analysis.

As a result of the EU's Sulphur Directive, demand has arisen within the maritime transport sector for more sustainable fuels, including LNG. However, LNG can only be used on new ships, and a switch to LNG can therefore only take place as and when existing ships are replaced by new ones.

Port of Hirtshals
The LNG terminal in Hirtshals opened in 2015, and has a storage tank with a capacity of 500 cubic metres and a bunkering capacity of 200 tonnes or 500 cubic metres of LNG. The refuelling installation is primarily intended to supply the two cruise ferries of Fjord Lines, which currently refuel in Norway, but is also intended to enable other LNG-powered ships to be supplied. There are plans to develop the terminal to boost its capacity to 10,000 cubic metres for its LNG refuelling facility. The terminal has received EU aid totalling EUR 1,305,374 through TEN-T, meeting 50% of the combined costs.

Port of Hou
The gas ferry MF Samsø, which entered service in 2009, has a 'dual-fuel' engine and is able to sail on both LNG and conventional marine diesel. The municipality of Samsø has entered into an agreement with Q8 concerning the supply of gas for the first Danish domestic LNG ferry. Q8 is responsible for a complete supply chain solution, including a mobile LNG bunkering unit on the ship side in Hou, Jutland.

8.4. Use of alternative fuels in maritime transport

Within the maritime transport sector, almost 100% of all fuel which is currently being used is marine diesel oil (*Baseline projection 2019*).

Through to 2030, this proportion is expected to drop to 99%, with 1% expected to be covered by electricity.

Table 12 presents the anticipated trend in the use of alternative fuels in maritime transport, including electricity and LNG.

Alternative Fuels Vehicles (AFV)	Current and past number of AFV			Number of AFV expected to be registered		
	2016	2017	2018	2020	2025	2030
ELECTRICITY						
Seagoing Ships	0	0	3	3	5	5
LNG						
LNG Seagoing Ships	3	3	3	3	4*	4*

Table 12: Historical and expected trend in the use of LNG/electricity as a fuel in maritime transport. Source: Danish Transport, Construction and Housing Authority.

*In 2022, Molslinjen will introduce a new dual fuel high-speed ferry between Rønne and Ystad, which – unlike Molslinjen's current high-speed ferries on the route – can operate on LNG.

Table 13 presents the expected trend in recharging infrastructure for ships.

Alternative Fuels Infrastructure (AFI)	Current and past number of recharging/refuelling			Target number of recharging/refuelling points		
	2016	2017	2018	2020	2025	2030
Electricity						
Shore-side electricity supply for seagoing ships in maritime ports	0	0	2	4	11	11
Shore-side electricity supply for inland waterway vessels in inland ports	0	0	0	0	0	0
LNG						
Maritime Ports - LNG refuelling points	1	1	2	2	2	2
Inland Ports - LNG refuelling points	0	0	0	0	0	0

Table 13: Historical and expected recharging infrastructure for ships, broken down by fuel. The table is based on available media sources and is subject to uncertainty.

9. Market trends and objectives - aviation

An account is presented below of the need to deploy electricity supply facilities at airports for use by stationary aircraft, and the development and use of sustainable aviation fuels.

Electricity supply facilities for aircraft at airports can reduce fuel consumption, noise and air pollution.

The three largest airports – Copenhagen, Billund and Aalborg – which account for more than 97% of all passenger flights, have already established an electricity supply for stationary aircraft. Denmark is well advanced in this area, and possesses the necessary capacity to supply electricity to stationary aircraft.

The technology to enable aircraft to be powered entirely by electricity is not yet considered to be sufficiently mature for commercial aviation. There are therefore no electric aircraft in Denmark at present. It is still too early to consider whether aircraft which are completely or partly (hybrid) powered by electricity will be introduced into service through to 2030.

Modern aircraft engines can already be powered by a blend of up to 50% sustainable, CO2-neutral aviation fuel, which consists of fuel produced from biomass or synthetic fuel (electro-fuels). The technologies are considered to be sufficiently mature to be put into production. However, the range of sustainable aviation fuels which are currently available is relatively limited, and prices can be up to four times higher than for fossil fuels. Thus, there is currently no production of sustainable aviation fuel in Denmark, and the use of sustainable aviation fuels is very limited.

The production of sustainable aviation fuel is expected to rise towards 2030. It is, however, not possible to quantify this.

10. Trends in fuel consumption

A description is presented below of expectations regarding trends in energy consumption within the transport sector in Denmark, including trends in the consumption of alternative fuels.

10.1. Expected trends in the use of alternative fuels

In this report, the description of expectations regarding trends in total energy consumption, the composition of energy consumption and the number of vehicles using alternative fuels is based on the Danish Energy Agency's Baseline projection 2019.

According to the Baseline projection 2019, total energy consumption for transport is expected to rise very slightly towards 2030. The projection can be seen in Figure 4.

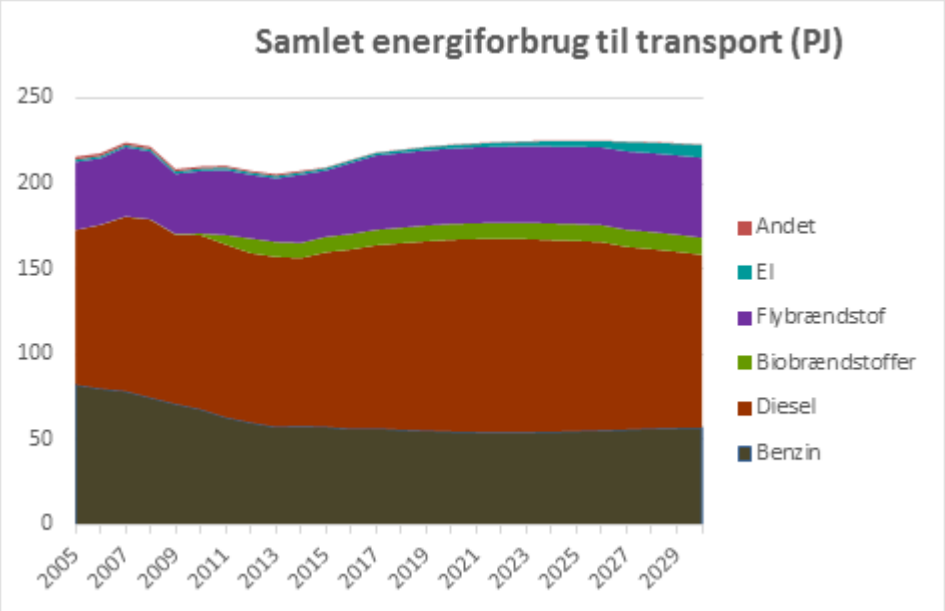

Figure 4: Projection of energy consumption for transport from the Danish Energy Agency's baseline projection from 2019.
Source: Baseline projection 2019.

Key:

Samlet energiforbrug til transport (PJ)	Total energy consumption for transport (PJ)
Andet	Other
El	Electricity
Flybrændstof	Aviation fuel
Biobrændsoffer	Biofuels
Diesel	Diesel
Benzin	Petrol

The number of kilometres travelled by cars is expected to rise by 1.97% per year through to 2030, whilst the corresponding figure for light goods vehicles is expected to increase by 0.86% per year, trucks by 1.38% per year and buses by 0.47% per year. However, the increase in the number of kilometres travelled will be almost entirely offset by the vehicles becoming more energy-efficient over the period. Total energy consumption by the transport sector is therefore expected to rise by just 0.2% annually through to 2030, by which time the total energy consumption by the transport sector is expected to have reached 223 PJ.

The proportion of fossil fuels in the transport sector's energy consumption is expected to drop from 95% in 2017 to approximately 92% in 2030. Sales of electric vehicles are expected to rise steadily and will account for around 22% of all new car sales and almost 9% of the collective fleet of cars and light goods vehicles in 2030. Electricity consumption by the transport sector is expected to rise by around 13% annually through to 2030.

Projection of fuel consumption

The projection of fuel consumption within the transport sector in Denmark is based on the Baseline projection 2019 and therefore represents a 'frozen policy' expectation regarding the trend in fuel consumption. According to the Baseline projection 2019, no major changes are anticipated in the composition of fuel consumption through to 2030. Within fuels for road transport, petrol is expected to remain reasonably stable at around 35%, whilst diesel is expected to drop slightly to the current 60% to approximately 57% in 2030. Electricity is expected to grow from less than 1% today to around 2% in 2030, whilst biofuels are expected to remain constant at around 6%.

10.2. Historical trend in energy consumption and CO_2 emissions

Energy consumption and CO_2 emissions from transport in Denmark have historically been on the rise, but peaked in 2007 and have been decreasing since. Since 2013, a modest rise has once again taken place, but both energy consumption and CO_2 emissions are still below the 2007 peak.

The decline since 2007 is due in part to a decline in goods transport as a result of the financial crisis and in part to the improved fuel economy of cars and goods vehicles. Prior to 2007, energy consumption closely followed the trend in demand for transport, i.e. a 1% rise in transport demand was reflected in a 1% rise in energy consumption for transport purposes.

As is apparent from Figure 5, energy consumption over the period 1990 - 2007 consisted almost entirely of fossil oil products (diesel, petrol and fossil aviation fuel), and CO_2 emissions therefore rose at the same rate in that period.

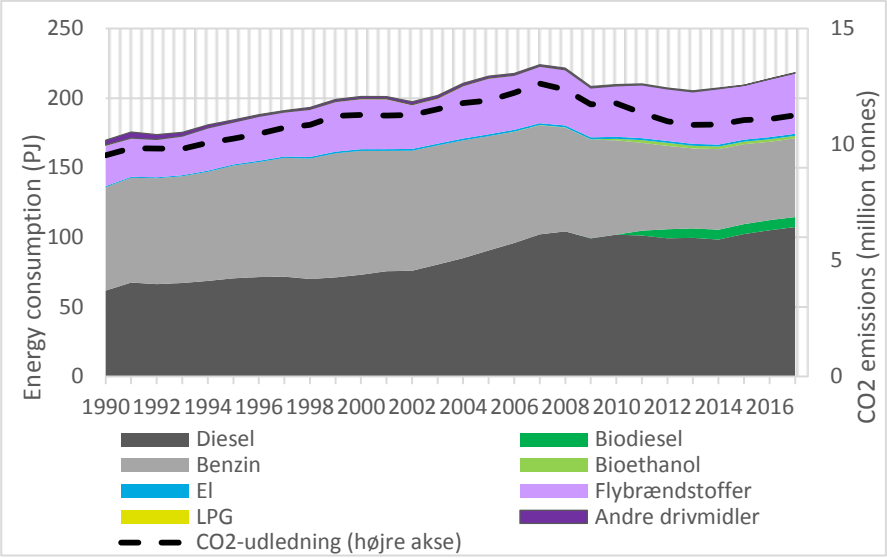

Figure 5 Energy consumption and CO_2 emissions from transport, broken down by fuel. Source: Energistatistik 2017.

Key:

Energiforbrug (PJ)	Energy consumption (PJ)
CO2-emissioner (mio. tons)	CO2 emissions (million tonnes)
Diesel	Diesel
Benzin	Petrol
El	Electricity
CO2-udledning (højre akse)	CO2 emissions (right-hand axis)
LPG	LPG
Biodiesel	Biodiesel
Bioethanol	Bioethanol
Flybrændstoffer	Aviation fuels
Andet drivmidler	Other fuels

During the period 2007 - 2013, CO_2 emissions from transport fell by more than energy consumption, because a larger share of energy consumption came from renewable energy sources. In 2017, renewable energy accounted for around 5% of energy consumption for all transport, when all biofuels and electricity are included in this category. Biodiesel accounts for around two thirds, while electricity and bioethanol account for the other third. Gas consumption today is so low that it is of no significance in relation to the other forms of energy. The blending of biofuels with conventional fuels followed from a requirement imposed on the petrol companies to ensure that at least 5.75% of sales of diesel and petrol from 2012 onwards consisted of sustainable fuels. Biofuels are currently blended with all forms of diesel and petrol sold for road transport use at refuelling points in Denmark. Diesel cars now run on the standard B7, which consists of 7% biodiesel, and petrol cars run on the standard E5, which consists of 5% bioethanol.

The improvements in the fuel economy of cars and light goods vehicles have been driven by a combination of the EU's energy efficiency requirements for new vehicles, the environmentally friendly changes to vehicle taxes introduced in 2007 and technological advances in the automotive industry. This combination of measures meant that energy consumption by cars during the period 2007 - 2014

remained virtually unchanged, despite an increase in the number of kilometres travelled. However, energy consumption rose by around 4% during the period 2014 to 2017. During the period 2000 to 2015, mean CO_2 emissions for new passenger vehicles in the EU fell from around 170 g CO_2/km to around 120 g CO_2/km in 2015. During the past two years, CO_2 emissions from new vehicles have stopped falling and have actually risen slightly instead, and are now well above the target for 2020. CO_2 emissions from light goods vehicles have dropped markedly since 2012 and are well on the way to fulfilling the target for 2020. Figure 6 below shows the proportion of energy consumption accounted for by various fuels in road transport.

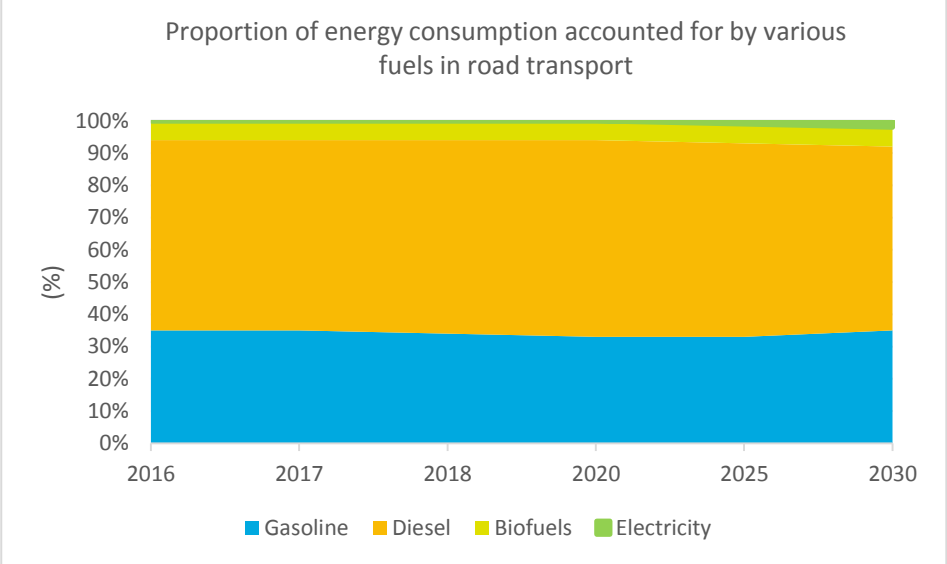

Figure 6
Source: Data from Baseline projection 2019.

10.3. Future developments

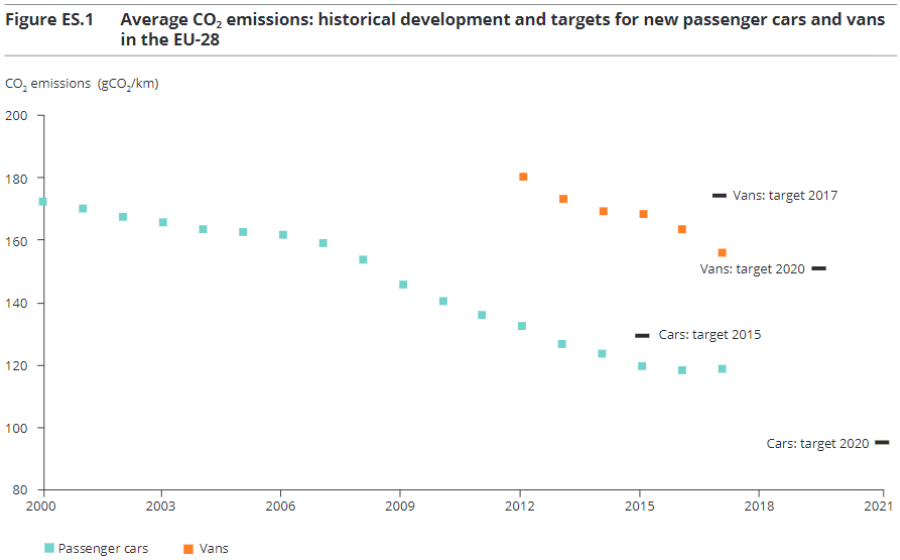

Figure 7: Overview of mean CO_2 emissions for passenger vehicles and light goods vehicles in the EU28. Source: https://www.eea.europa.eu/publications/monitoring-co2-emissions-from-new-2

The restructuring of vehicle taxes in 2007 introduced a deduction in the registration tax based on the expected energy efficiency of the vehicle, measured in km/l. This provided a substantial incentive to choose more environmentally friendly vehicles which can travel a long distance per litre of fuel. During 2015, the registration tax was reduced from 180% to 150% by the government of the time. Through to 2022, electric vehicles will be exempt from the registration tax but to a decreasing extent.

The EU's energy efficiency targets are imposed on the vehicle manufacturers and hence new cars consume less energy per kilometre travelled. In 2015, the target was for new cars on average to emit no more than 130 g CO_2/km (175 g CO_2/km for light goods vehicles), which is reduced to 95 g CO_2/km from 2021 (147 g CO_2/km for light goods vehicles). In 2017, mean CO_2 emissions for new cars in Denmark amounted to 107 g CO_2/km. The improved fuel economy of new cars will be significant for many years ahead as new cars replace old ones.

At the end of 2018, the EU28 countries agreed that CO2 emissions for new cars and light goods vehicles in 2030 would be cut by a further 37.5% compared with the level in 2021[3].

[3] https://www.euractiv.com/section/transport/news/eu-agrees-on-37-5-co2-reduction-for-cars-by-2030/.

11. Fulfilment of Denmark's national policy framework

An account is given below of how Denmark expects to fulfil its national policy framework.

11.1. Road transport - electricity

Technology	Minimum requirements in the AFI Directive
Electricity	The Directive requires the Member States to ensure, through their policy frameworks, the deployment of a sufficient number of accessible charging points by 2020 to ensure that electric vehicles as a minimum can be driven in urban/suburban agglomerations and other densely populated areas in a network determined by the Member States themselves. As an indication, a minimum target of one recharging point per 10 electric cars should be set. Recharging points installed from January 2017 onwards must fulfil the technical specification requirements of the AFI Directive.

It is estimated that at the end of 2018 there were around 3,650 publicly available recharging points for electric and hybrid vehicles, roughly equivalent to one recharging point for every four electric and plug-in hybrid vehicles. With the given national and EU policy framework and technological advances which mean that electric vehicles are expected to become financially equivalent to petrol vehicles in 2030, it is anticipated that vehicles which use alternative fuels will become widespread. At the present time, it is anticipated that around 27 000 publicly available recharging points will be deployed over the next eleven years. Denmark will therefore fulfil the objective.

11.2. Road transport - CNG

Technology	Minimum requirements in the AFI Directive
CNG	The Directive requires the Member States to ensure a sufficient number of CNG refuelling points by 2020, so that gas-powered vehicles can be driven in urban/suburban agglomerations and other densely populated areas in a network determined by the Member States. It must also be ensured that CNG refuelling points are put in place along the TEN-T Core Network so that CNG vehicles can be driven throughout the European Union by 2025. As an indication, CNG refuelling points should be set up at least every 150 km along the TEN-T Core Network.

There are currently 17 natural gas refuelling points (CNG) spread across the country. From a technical perspective, the existing infrastructure is expected to be sufficient to supply the number of compressed natural gas vehicles (CNG) anticipated by the Baseline projection 2019 through to 2030, but availability

and geographic distribution will result in a need for increased deployment. Denmark fulfils the guideline indication of the AFI Directive concerning deployment within the Member States by 2020 of CNG refuelling points for every 150 km along the TEN-T road network.

11.3. Road transport– LNG

Technology	Minimum requirements in the AFI Directive
LNG	For the development of LNG infrastructure for road transport, each Member State has to ensure a sufficient number of refuelling points accessible to the public on roads along the TEN-T Core Network, if this is deemed to be financially advantageous. A target should ideally be set of LNG refuelling points being put in place every 400 km by 2025.

No refuelling points for LNG have yet been established along the TEN-T road network, and it is therefore not possible to refuel vehicles with LNG in Denmark. There is currently a strong focus on the deployment of LNG for transport in a number of Denmark's neighbouring countries, and it can be expected that, in the years to come, there will be LNG vehicles using Denmark as a transit country, and that Danish and foreign LNG vehicles will be used for the transport of goods by road to and from Denmark. A market is therefore expected to emerge for the deployment of a number of LNG refuelling points at hubs in the Danish road infrastructure, which could for example include LNG refuelling points around Aalborg, the Triangle Region and Copenhagen. It is therefore anticipated that a market-based trend will contribute to attainment of the Directive's guideline objective in 2025 with the deployment of at least three LNG refuelling points.

11.4. Maritime transport - shore-side electricity supply

Technology	Minimum requirements in the AFI Directive
Electricity	The need for shore-side electricity supply from land for maritime transport will be assessed and a supply established for ports in the TEN-T Core Network and other ports by 2025 at the latest if this is deemed to be financially and environmentally beneficial.

As regards ships which require a limited electricity supply whilst the ship is in port, provision for electricity supply has been deployed in Danish ports. Certain Danish ports have deployed mobile shore-side electricity supply facilities for cargo ships. In general, however, electricity supply facilities have not been deployed for ships with substantial power needs, including cruise ships. Through to 2025, an increase in demand is anticipated from industry, which could provide an economic case for Danish ports in the TEN-T Core Network (Aarhus and Copenhagen) to invest in shore-side electricity supply facilities on market conditions.

11.5. Maritime transport - LNG

Technology	Minimum requirements in the AFI Directive
LNG	A sufficient number of LNG refuelling points will be put in place at maritime ports for LNG vessels for transport on inland waterways or seagoing LNG ships to be able to circulate throughout the TEN-T Core Network by 2025.

LNG facilities have so far been deployed at two ports in Denmark. These are Hirtshals and Hou, the latter only serving the Samsø ferry. The aforementioned ports are not part of the TEN-T Core Network. The TEN-T Core Network ports in Denmark are Aarhus and Copenhagen.

It is anticipated that market-based development will contribute to attainment of the Directive's guideline objective in 2025 with the deployment of a sufficient number of LNG refuelling points in maritime ports to enable LNG ships to sail on the TEN-T Core Network in 2025. If demand does not increase sufficiently quickly for these ports to recoup their investment in LNG refuelling facilities, consideration will be given during the period to how the minimum requirement can be met through regulatory initiatives.

11.6. Air transport

Under the AFI Directive, the Member States' policy frameworks must include consideration of the need to install electricity supply facilities at airports for use by stationary aircraft.

There are no electric aircraft in Denmark at present. Denmark has deployed electricity supply facilities for stationary aircraft at Copenhagen, Billund and Aalborg airports, and Denmark is therefore fulfilling the guideline objective of the AFI Directive.

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