

# National Policy Framework to Support the Deployment of Alternative Fuels Infrastructure

as part of the transposition of Directive  
2014/94/EU

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## 1. Executive Summary

The National Policy Framework (NPF) is part of the transposition of Directive 2014/94/EU on the deployment of alternative fuels infrastructure and covers the electric vehicle charging infrastructure, the infrastructure for the supply of natural gas (compressed and liquefied natural gas) and the infrastructure for the supply of hydrogen to fuel cell powered vehicles. The NPF provides, for the aforementioned infrastructures, a comprehensive overview of the status of development, the key objectives for the publicly accessible refuelling and charging infrastructure and the measures to be taken by the Federal Government to achieve these objectives. In addition to the measures and objectives for the accelerated market penetration of the alternative fuels of electricity, natural gas and hydrogen, the NPF also addresses schemes to promote private charging infrastructure and alternative fuels in public transport, the shore-side supply of electricity to ships and the supply of ground power at airports.

### Current Status

The road transport sector is currently still dominated by oil-based fossil fuels. Biofuels and liquefied petroleum gas are established alternatives. In 2015, the share of alternative fuels based on renewable energy sources was 5.3 percent, a drop of 0.3 percentage points compared with 2014. So far, all electric vehicles have been charged predominantly at home. At the end of 2015, 5,836 recharging points were publicly accessible in Germany. Most of these recharging points are located in the regions in which demonstration projects were conducted. The Charging Post Regulations, which entered into force on 17 March 2016, contain minimum requirements regarding the deployment and operation of publicly accessible electric vehicle recharging points plus clear and binding rules governing charging plug standards. As far as compressed natural gas (CNG) is concerned, the existing infrastructure already provides coverage that complies with the Directive. The infrastructure for hydrogen is currently being deployed. In June 2016, 21 refuelling points had been completed and were in operation. An initial network of around 50 refuelling points will have been established in Germany by the end of 2016. Ships are supplied with liquefied natural gas (LNG) in seaports and inland ports by means of "truck-to-ship" bunkering. There are currently no LNG terminals in German ports. The first LNG refuelling points for heavy road haulage vehicles will have commenced operation by the end of 2016.

## Objectives

The Federal Government's key objective with regard to the charging infrastructure for electrically powered vehicles is the deployment of a network of publicly accessible recharging points that meets present and future requirements and provides universal coverage. On the basis of various studies, the Federal Government assumes that 36,000 normal power recharging points and 7,000 high power recharging points will be required by 2020. For the supply of hydrogen to fuel cell powered vehicles, the objective is to create a network of 100 filling stations by 2020 and 400 filling stations by 2025. For the supply of heavy goods vehicles, a basic network of filling station is to be launched along the Core Trans-European Transport Network (TEN-T) by 2025 to enable LNG-powered HGVs to operate throughout Europe. Analyses show that an appropriate basic network needs only a few (<10) sites along the Core TEN-T. The Federal Government's 2015 National Ports Strategy already states that the objective is to support an infrastructure ramp-up that meets the demand for the supply of LNG at seaports and inland ports.

## Measures

The Federal Government is supporting the deployment of alternative fuels infrastructure on both the demand side (vehicles) and the infrastructure side (capital grants for refuelling and charging infrastructure).

In the sphere of electricity, a market incentive package for electric mobility was adopted in May 2016 comprising additional funds for the development of the charging infrastructure, short-term incentives to purchase electric vehicles, additional endeavours in the public procurement of electric vehicles and fiscal measures. The market incentive package will make it possible to deploy 15,000 publicly accessible recharging stations nationwide (5,000 high power recharging and 10,000 normal power recharging). To fund these recharging stations, 300 million euros will be available over the period from 2017 to 2020. A short-term incentive to purchase electric vehicles ("environmental bonus") is designed to provide an additional boost to the demand for electrically powered vehicles.

Other measures will improve the regulatory framework governing electric mobility (Electric Mobility Act, Electricity Market Act, et al.). This will create the incentives for the deployment of charging infrastructure that provides universal coverage and achievement of the objectives by 2020.

To speed up the market penetration of natural gas as a fuel, the Federal Government is pursuing a demand enhancement approach, which involves creating incentives to invest for the establishment of the infrastructure by relevant service providers. The funding of vehicle procurement as part of

collaborative projects will create the foundation for the commissioning of the first LNG refuelling points for heavy road haulage vehicles. By monitoring and evaluating the projects, it will be possible to assess whether the costs of the deployment of an appropriate LNG infrastructure are proportionate in comparison with the benefit, including the environmental benefit in terms of reduced emissions of pollutants and CO<sub>2</sub>. In the shipping sector, initial demonstrators are already underway. The Federal Government has launched a short-term financial assistance programme to support the retrofitting and equipping of ships with LNG propulsion systems. In addition, the public sector will play a pioneering role by equipping its own ships and ensure that there is appropriate demand in German ports. An exchange of ideas and experience and a dialogue, coordinated by the Federal Government, between the port cities, federal state ministries, the authorizing authorities involved and the port authorities will ensure uniform application of the law with regard to the authorization procedures for the use of LNG in German ports.

In the sphere of hydrogen, the Federal Government is supporting the deployment of a network of hydrogen refuelling points that provides universal coverage in Germany. The continuation of the National Hydrogen and Fuel Cell Technology Innovation Programme (NIP) to the end of 2025 is designed to make mobility using fuel cell powered vehicles competitive. To this end, funding will continue to be provided for research and development and activation of the market for the technology, including with regard to the production of hydrogen from renewable energy sources.

The National Policy Framework sees itself a learning strategy that will be regularly reviewed and, if necessary, adapted in the ongoing process of transposing the EU Directive. To this end, the Federal Government will install a continuous monitoring procedure.





## 2. Introduction

Without the swift deployment of high-capacity refuelling and charging infrastructure for alternative fuels, the transformation of the energy system in the transport sector will not succeed. Transposition of Directive 2014/94/EU on the deployment of alternative fuels infrastructure (Alternative Fuels Infrastructure Directive – AFID) will provide a boost to the necessary infrastructure ramp-up. The evolution of the Federal Government’s Mobility and Fuel Strategy also pursues this objective in a similar manner. This Strategy, which was adopted by the Federal Cabinet in June 2013, is to be continued as a major tool for implementing the transformation of the energy system in the transport sector in line with the National Sustainable Development Strategy. So far, it has provided an overview of technologies plus energy and fuel options in the different modes of transport.

With its 2010 Energy Strategy, the Federal Government set ambitious climate change and energy conservation targets for Germany. This also concerns the transport sector. In the transport sector, the Energy Strategy establishes as a target a reduction in final energy consumption of 10 percent by 2020 and 40 percent by 2050 (related to 2005). In addition, greenhouse gas emissions are to be reduced by 80 to 95 percent by 2050 across all sectors (including the transport sector) in order to implement the 2015 Paris Climate Change Agreement. In autumn 2015, the Member States of the European Union agreed to reduce greenhouse gas emissions in the non-ETS sectors by 30 percent against 2005 levels by 2030.

In addition to the deployment of refuelling and charging infrastructure, these objectives are to be achieved by diversifying the sources of energy supply in combination with innovative drivetrain technologies, by optimizing the flows of traffic and by further enhancing energy efficiency. The Federal Government thus supports the technologically neutral development of new drivetrains and fuels/sources of energy, thereby incentivizing the establishment of innovative solutions on the market.

The objective of Directive 2014/94/EU and its national transposition is to progress the increase in the share of alternative transport fuels through the deployment of alternative fuels infrastructure.

Alongside the infrastructure for natural gas (LNG, CNG) the Directive also covers charging and refuelling infrastructure for battery electric and hydrogen-powered vehicles. Under the Electric Mobility Act, the term "electric mobility" covers both battery-electric mobility and the use of



hydrogen in fuel cell powered vehicles. However, the challenges confronting the deployment of the infrastructure necessary for the two technologies are different.

The present NPF describes the current status of alternative fuels and drivetrains in Germany, as required by the Directive. It formulates the objectives for the further establishment of the alternative fuels of electricity, hydrogen and natural gas on the market, including the necessary refuelling and charging infrastructure, and provides information on measures that will be taken to achieve the formulated objectives. The structure of the document is based on the non-binding template<sup>1</sup> published by the European Commission.

Implementation of the measures envisaged in the NPF will be subject to the availability of public funds.

### 3. Current status of alternative fuels in the transport sector

#### 3.1. Market share of alternative fuels

The transport sector is responsible for around 25 percent of CO<sub>2</sub> emissions in the EU. To achieve the overarching climate change goals and fulfil the agreements reached at the COP-21 Conference in Paris, it is thus necessary to make additional efforts to reduce emissions, especially against the background of the continuously growing number of passenger and freight kilometres and the need to permanently ensure mobility.

In terms of the individual modes of transport, private motorized transport contributes the largest share of CO<sub>2</sub> emissions from transport (55.3 percent), followed by road haulage (23.3 percent), air transport (15 percent), rail transport (4.5 percent), local public transport by road (1.5 percent) and shipping (0.4 percent).<sup>2</sup>

Against this background, alternative fuels and their related infrastructures are of crucial importance for achieving the agreed targets. This is all the more true in view of the fact the share of renewable energy sources, in terms of energy content, is lower in the transport sector than in the other energy

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<sup>1</sup> <http://ec.europa.eu/transport/themes/urban/studies/doc/2016-01-alternative-fuels-implementation-good-practices-appendix-a.pdf>

<sup>2</sup> <https://www.pwc.de/de/energiewende/assets/pwc-kurzstudie-verkehr-2015.pdf>

sectors. In 2015, it totalled 5.3 percent (including the consumption of electricity from renewable energy sources in the rail and road transport sectors), which was in fact a drop of 0.3 percentage points compared with 2014.<sup>3</sup>

Currently, fossil energy sources dominate the transport sector in Germany, with a 94 percent share of all fuels in 2015. Of the total of 56 million tonnes of fuel consumed in the transport sector, diesel fuel accounted for 62 percent and petrol for 31.4 %, whereas the share of biogenic fuels was 4.8 percent (in terms of energy content) or 3.4 million tonnes.<sup>4</sup> In the rail transport sector, around 60 percent (20,000 km) of the approximately 33,400 km long rail network is electrified.<sup>5</sup>

Established alternatives to oil-based fossil fuels in the road transport sector are currently biofuels (biodiesel and bioethanol) and liquefied petroleum gas (LPG). The vast majority of biofuels are sold by blending them with fossil fuels. Here, therefore, there are no additional requirements whatsoever with regard to infrastructure deployment.

In the field of natural gas, biomethane's share of the total amount of methane sold (20 percent) was already high in 2015.<sup>6</sup> By further increasing the share of bio-based or synthetic methane, it will be possible to further improve the climate footprint of transport fuel.

At the end of 2015, 489,095 LPG-powered motor vehicles were registered in Germany. With around 7,000 filling stations, the liquefied petroleum gas infrastructure already provides universal coverage. Thus, there is no further need for the Federal Government to take additional measures for the deployment of LPG infrastructure in Germany.

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<sup>3</sup> <http://www.umweltbundesamt.de/themen/klima-energie/erneuerbare-energien/erneuerbare-energien-in-zahlen>

<sup>4</sup> <http://fnr.de/basisdaten/bioenergie/biokraftstoffe.html>

<sup>5</sup> [https://www.bmvi.de/SharedDocs/DE/Publikationen/G/verkehr-und-mobilitaet-in-deutschland-2016.pdf?\\_\\_blob=publicationFile](https://www.bmvi.de/SharedDocs/DE/Publikationen/G/verkehr-und-mobilitaet-in-deutschland-2016.pdf?__blob=publicationFile)

<sup>6</sup>

[http://www.erdgasmobilitaet.info/fileadmin/downloads/Vierter\\_Fortschrittsbericht\\_der\\_Initiative\\_Erdgasmobilitaet.pdf](http://www.erdgasmobilitaet.info/fileadmin/downloads/Vierter_Fortschrittsbericht_der_Initiative_Erdgasmobilitaet.pdf)

### 3.2. Alternative fuel vehicles

In all segments, alternatively fuelled vehicles have hitherto only accounted for a small share. Table 1 shows the population of registered vehicles of all vehicle categories as at 1 January 2016, according to information provided by the Federal Motor Transport Authority.

Type of fuel	Vehicles	Percentage share
Petrol	34,271,456	62.8 percent
Diesel	19,564,159	35.8 percent
Liquefied petroleum gas (incl. bivalent)	489,095	0.9 percent
Natural gas (incl. bivalent)	97,804	0.2 percent
Battery electric	37,951	0.1 percent
Hybrid	131,186	0.2 percent
Of which plug-in hybrid	10,803 <sup>7</sup>	
Hydrogen	215	/
Other fuels	10,575	
<b>Total</b>	<b>54,602,441</b>	<b>100 percent</b>

**Table 1: Vehicle population (as at January 2016)**

The use of LNG as a fuel for sea-going ships and inland waterway vessels requires suitable engines and fuel storage systems, which increase the price of new builds. At the same time, LNG propulsion reduces operating costs, as LNG is less expensive than low-sulphur fuels and LNG engines do not require costly exhaust purification systems. As a result, the additional costs involved in installing LNG engines are likely to be recouped – depending on the fuel price.

In the case of sea-going ships, cargo shipping companies, because of their weak order books and the rise in the short-term charter business, are currently planning on a short-term rather than a medium-term or even long-term basis and frequently decide not to convert or equip their vessels for LNG propulsion.

<sup>7</sup> Estimate – the separate registration of plug-in hybrid vehicles did not start until 2013.

Nevertheless, there are some positive market signals. Thus, for instance, a leading cruise line operator on the German market has placed an order for the construction of two LNG-powered cruise liners. German-flagged ferries have likewise started to use LNG as a fuel. With the construction of a new multi-purpose vessel, the "Atair", to be operated by the Federal Maritime and Hydrographic Agency, the Federal Government also intends to commission its first LNG-powered ship.

In the case of inland waterway vessels, too, the initial investment involved in converting them to LNG often presents a hurdle that is too high for many of the Rhine shipping companies that are small and medium-sized enterprises. Nevertheless, LNG-powered inland waterway vessels have now started to operate along the Rhine. This trend should intensify as a result of the more stringent emission limit values for inland waterway vessel engines adopted in 2016<sup>8</sup>, because it will shift the costing of diesel and LNG propulsion and make LNG more favourable.

### 3.2.1. Electric vehicles

With regard to the need for publicly accessible charging infrastructure, simple hybrid vehicles that cannot be directly recharged from the grid are not to be taken into account. Accordingly, the present NPF covers exclusively battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).

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<sup>8</sup> Regulation of the European Parliament and of the Council on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for non-road mobile machinery, amending Regulations (EU) No 1024/2012 and (EU) No 167/2013, and amending and repealing Directive 97/68/EC (<http://data.consilium.europa.eu/doc/document/ST-10850-2016-INIT/en/pdf>; <http://data.consilium.europa.eu/doc/document/PE-21-2016-INIT/en/pdf>)

Vehicle category	Registered vehicles
Passenger cars	25,502
Motorcycles	7,300
Goods vehicles	4,367
Buses and coaches	137
Tractor units	329
Other motor vehicles	316
<b>Total</b>	<b>37,951</b>

**Table 2: Electric vehicle population (as at January 2016)**

According to information provided by the Federal Motor Transport Authority, 25,502 BEVs were registered in the passenger car segment. In addition, there are 4,367 battery electric commercial vehicles, 137 electric buses/coaches and around 7,300 electric motorcycles. At the same time, 10,803 plug-in hybrids (PHEVs) were registered. According to information provided by the Association of the German Two-Wheeled Vehicle Industry, there are just under 2,500,000 electrically assisted pedal cycles (pedelecs, high-speed pedelecs) in Germany. It is apparent that the number of electric vehicles being registered for the first time has significantly gathered pace in recent years.

	New BEV registrations	Increase over previous year	New PHEV registrations	Increase over previous year
2011	3,094	-	n/a	-
2012	6,973	+ 125 percent	n/a	-
2013	8,009	+ 15 percent	1,387	-
2014	10,632	+ 33 percent	4,529	+ 227 percent
2015	14,590	+ 37 percent	11,106	+ 145 percent

**Table 3: New BEV/PHEV registrations<sup>9</sup>**

### 3.2.2. Natural gas vehicles and ships

In Germany, a total of 80,300 natural gas powered passenger cars (including bivalent vehicles) were registered as at 1 January 2016. In addition, there are commercial vehicles (incl. semi-trailer towing vehicles), buses/coaches and other motor vehicles<sup>10</sup>, making a total of 97,774 natural gas powered vehicles registered in Germany. In the commercial vehicle segment, the vehicles can sub-divided on the basis of the Federal Motor Transport Authority's data into light duty vehicles (LDVs) with a payload up to 1,000 kilogrammes and heavy duty vehicles (HDVs) with a payload of 1,000 kilogrammes or more.

<sup>9</sup> Federal Motor Transport Authority

<sup>10</sup> "If an EC type approval has been issued, the EC classification (M or N) forms the basis for the vehicle's classification. If a general operating permit or individual approval under section 13 of the EC Vehicle Approval Regulations or an operating permit under section 21 of the German Road Vehicles Registration and Licensing Regulations has been issued, the national type of vehicle and body, according to the Index for Sytematization of Motor Vehicles and their Trailers, may be used for vehicle classification. This also applies to other types of vehicle provided that a national type approval may be issued." KBA FZ 13 "Definitions"

	Passenger cars	Buses and coaches	LDVs	HDVs	Other motor vehicles	Total	Change over previous year
<b>2009</b>	68,515	1,532	11,908	3,676	416	86,047	
<b>2010</b>	71,519	1,527	12,562	3,862	467	89,937	+ 4.5 percent
<b>2011</b>	74,853	1,501	12,907	4,038	498	93,797	+ 4.3 percent
<b>2012</b>	76,284	1,481	13,042	3,988	471	95,266	+ 1.6 percent
<b>2013</b>	79,065	1,732	13,825	2,829	486	97,937	+ 2.8 percent
<b>2014</b>	81,423	1,613	13,619	2,460	477	99,592	+ 1.7 percent
<b>2015</b>	80,300	1,422	13,391	2,180	481	97,774	+ 1.8 percent

**Table 4: Natural gas powered vehicle population by category at the end of the respective year<sup>11</sup>**

There is a rising trend in the total number of LNG-powered ships in the maritime shipping sector over the period to the end of 2016. According to information provided by the industry, a total of 77 sea-going ships (excluding LNG tankers) are in operation worldwide in 2016 (cf. Table 5). A further 44 sea-going ships have already been ordered for 2016. In addition, 35 ships have been ordered that are already prepared for LNG operation.

<sup>11</sup>

[http://www.kba.de/SharedDocs/Publikationen/DE/Statistik/Fahrzeuge/FZ/2016/fz13\\_2016\\_pdf.pdf;jsessionid=B1CFD4CDBB295C1DEE0F3D9E930C462C.live21302?\\_\\_blob=publicationFile&v=2](http://www.kba.de/SharedDocs/Publikationen/DE/Statistik/Fahrzeuge/FZ/2016/fz13_2016_pdf.pdf;jsessionid=B1CFD4CDBB295C1DEE0F3D9E930C462C.live21302?__blob=publicationFile&v=2)



	LNG-powered ships in operation	Ships ordered	LNG technically usable	Total	Change over previous year
2010	21	-	-	21	
2011	25	-	-	25	+ 19 percent
2012	35	-	-	35	+ 40 percent
2013	45	-	-	45	+ 29 percent
2014	56	-	2	58	+ 29 percent
2015	75	-	14	89	+ 53 percent
2016	77	44	35	156	+ 75 percent
2017	77	63	47	187	+ 20 percent
2018	77	79	52	208	+ 11 percent

**Table 5: Worldwide trends in maritime shipping<sup>12</sup>**

On the inland waterways and the Wadden Sea, five LNG ships (excluding passenger shipping and ferries) are currently in operation in Germany, although recent plans (June 2016) assume there are a total of 19 ships.<sup>13</sup> In addition, there are four planned LNG tankers Europe-wide. The German flagged-MS Helgoland and MS Ostfriesland are the first two ferries to be powered by LNG in Germany.

### 3.2.3. Fuel cell powered vehicles

According to information provided by the Federal Motor Transport Authority, 196 passenger cars, 15 buses/coaches and 4 commercial vehicles powered by fuel cell were registered in Germany as at 1 January 2016. 89 of the passenger cars are being operated as prototype and small-series vehicles within the National Hydrogen and Fuel Cell Technology Innovation Programme (NIP). The first

<sup>12</sup> Source: DNV GL *Die Nutzung von LNG in der Seeschifffahrt*, 26 April 2016

<sup>13</sup> <http://www.inland-navigation.org/observatory/innovation-technologies/lng>, last accessed on 7 June 2016

production models in the passenger car segment have been on the German market since 2013. Further production models have been announced for the years ahead.

### 3.3. Electric vehicle charging infrastructure

So far, most of the present-day users of electric vehicles have recharged their vehicles at a fixed parking space. In the case of private users, this is usually at home, ideally supplemented by a recharging point<sup>14</sup> at their place of work. Vehicles in company fleets frequently have a charging facility on the company premises. This is especially true of commercial and special purpose vehicles which, because of their special requirements, do not use publicly accessible charging infrastructure.

The early adopters also made their decision to purchase an electric vehicle dependent on there being appropriate recharging facilities in their garage at home or on their company's premises. The long standing times overnight or while they are at work enable convenient recharging. With a rising share of electric vehicles and the widening to additional user groups, the importance of publicly accessible charging infrastructure will continue to increase.<sup>15</sup> Commercial transport can also benefit from the network of publicly accessible charging infrastructure that provides universal coverage if the patterns of use permit, for instance, recharging during standing times in the urban environment.

The Regulations on Minimum Technical Requirements for the Safe and Interoperable Deployment and Operation of Publicly Accessible Electric Vehicle Recharging Points (Charging Post Regulations), which entered into force on 17 March 2016, transpose the technical requirements set out in Annex II to Directive 2014/94/EU. The Regulations contain minimum requirements regarding the deployment and operation of publicly accessible electric vehicle recharging points plus clear and binding rules governing charging plug standards. This will ensure that all manufacturers use the same charging plug standards and that users find one of the charging plug standards from the uniform European Combined Charging Standards at all publicly accessible recharging points. Since June 2016, the

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<sup>14</sup> Section 2(9) of the Charging Post Regulations of 9 March 2016 defines a recharging point as "a device suitable and intended for recharging electric vehicles and at which only one vehicle can be recharged at any given time." A charging station may have more than one recharging point.

<sup>15</sup> The Charging Post Regulations state that "a recharging point is accessible to the public if it is located either in the public road environment or on private property provided that the parking area belonging to the recharging point can actually be accessed by an undetermined category of persons or by a category of persons that can be determined only on the basis of general features."

deployment of charging infrastructure in Germany has had to comply with the standards required by the Charging Post Regulations.

The Charging Post Regulations stipulate that, in the future, operators of publicly accessible recharging points must notify the Federal Network Agency of their deployment and decommissioning. If they operate high power recharging points, they must also prove to the Federal Network Agency that the technical requirements are being complied with.

Based on surveys conducted by the energy supply industry, 5,386 recharging points at 2,567 charging stations were publicly accessible in Germany at the end of 2015.

	Publicly accessible recharging points	Of which high power charging (Combo 2 type as defined in Directive 2014/94/EU)
<b>December 2012</b>	3,819	n/a
<b>December 2013</b>	4,454	n/a
<b>December 2014</b>	5,553	102
<b>December 2015</b>	5,836	153

**Table 6: Trends in publicly accessible recharging points<sup>16</sup>**

In the sphere of high power charging infrastructure, there were around 350 high power recharging points in Germany at the end of 2015 (of which, according to the survey conducted by the German Association of Electricity and Water Industries, 153 with the minimum standard for high power recharging points established in the Directive). Alongside this, high power charging infrastructure with other plug systems (Japanese CHAdEMO standard, supercharger) has been installed via private sector initiatives.

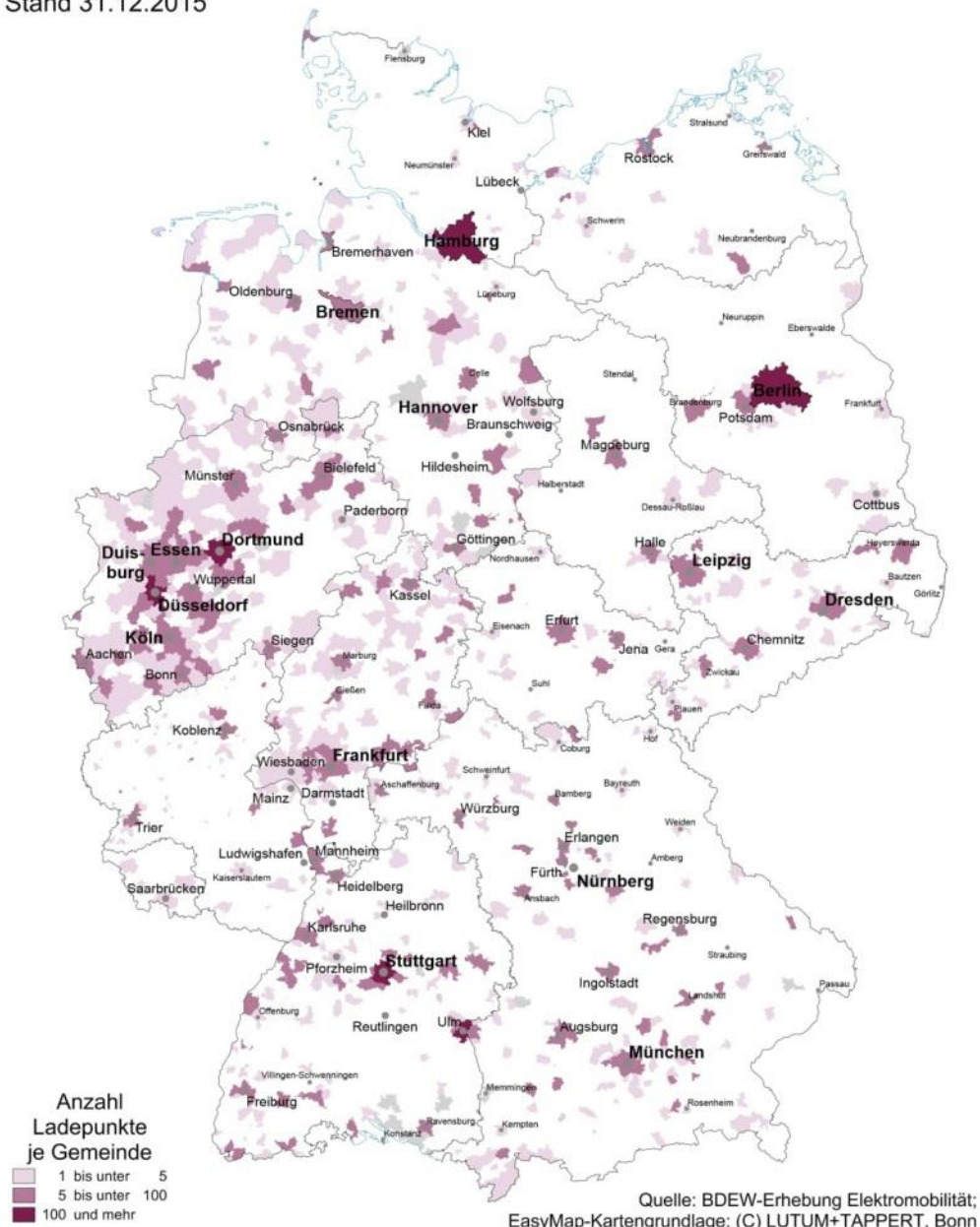
The recharging points that exist in Germany are the outcome of various private and industry initiatives and of a wide range of funding projects. Deployment so far has focused primarily on research purposes and not on deployment that will meet future requirements. The Federal Government funded charging infrastructure within the demonstration projects in the pilot regions and the electric mobility showcases (cf. Chapter 5.2.1). For this reason, the charging facilities in the

<sup>16</sup> German Association of Electricity and Water Industries, *Erhebung Elektromobilität*: <https://www.bdew.de/internet.nsf/id/bdew-erhebung-elektromobilitaet-de>

project regions are especially numerous compared with other regions. In terms of the population, the highest density of recharging points is to be found in Stuttgart. Per square kilometre of urban space, the city states of Berlin, Bremen and Hamburg have the densest network of charging infrastructure. North Rhine-Westphalia is the federal state with the highest number of recharging points, followed by Baden-Württemberg.

## Öffentlich zugängliche Ladepunkte für Elektroautos

je Gemeinde  
Stand 31.12.2015



**Figure 1: Publicly accessible recharging points per municipality (as at January 2016)<sup>17</sup>**

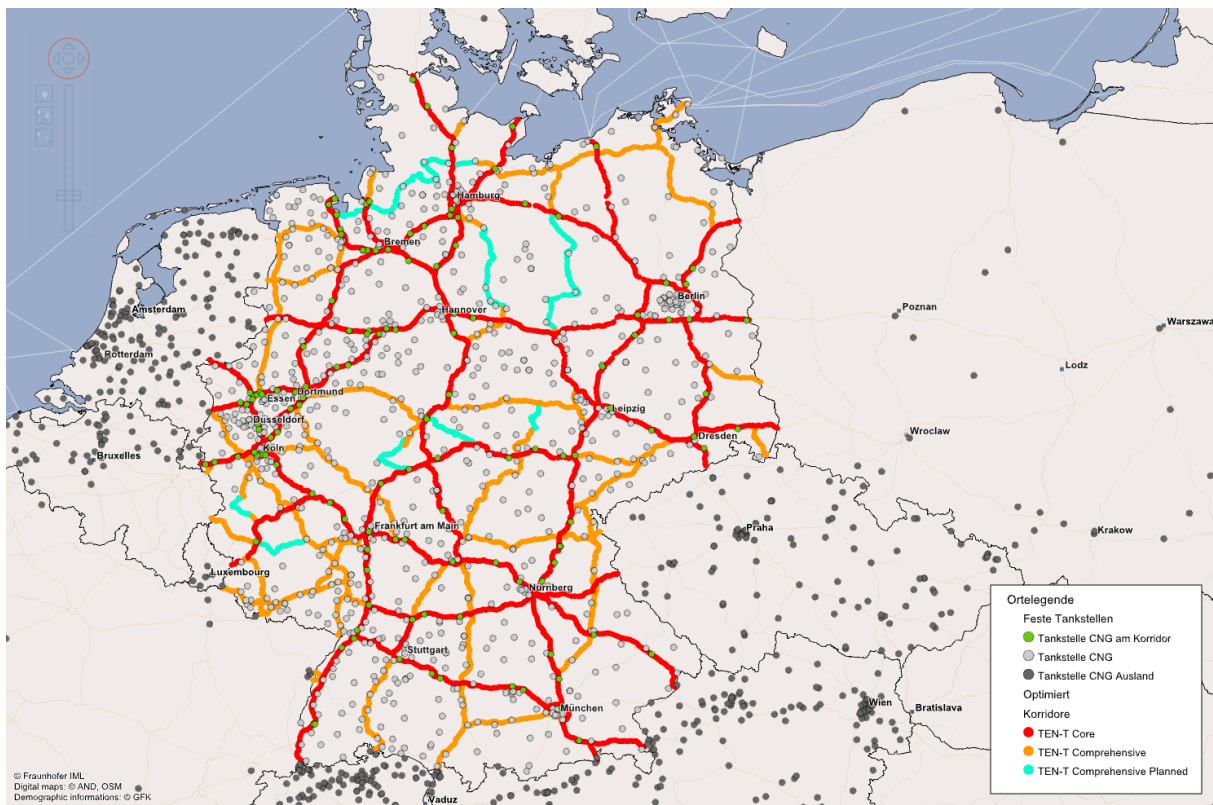
Federal state	Publicly accessible recharging points	Private households (1,000s)
Baden-Württemberg	1,097	5,073
Bavaria	794	6,219
Berlin	433	1,966
Brandenburg	49	1,235
Bremen	65	360
Hamburg	203	977
Hesse	590	2,943
Lower Saxony	467	3,829
Mecklenburg-Western Pomerania	71	829
North Rhine-Westphalia	1,255	8,555
Rhineland-Palatinate	266	1,901
Saarland	23	492
Saxony	310	2,157
Saxony-Anhalt	69	1,160
Schleswig-Holstein	55	1,419
Thuringia	89	1,109

**Table 7: Publicly accessible recharging points per federal state (as at January 2016)<sup>18</sup>**

<sup>17</sup> German Association of Electricity and Water Industries, *Erhebung Elektromobilität*: <https://www.bdew.de/internet.nsf/id/bdew-erhebung-elektromobilitaet-de>. In the future, it will be possible for the Federal Government to provide its own account on the basis of the registration of charging infrastructure with the Federal Network Agency.

### 3.4. Infrastructure for the supply of natural gas to transport

At the beginning of 2016, the network of CNG refuelling points comprised over 900 natural gas stations, most of which had been integrated into existing filling stations.<sup>19</sup> With around 90 passenger cars per refuelling point, the ratio of vehicles to refuelling points is very low compared with conventional fuels. In 2014, there were around 2,100 petrol and 980 diesel cars per filling station. The CNG refuelling points are distributed across the whole of Germany (cf. Figure2) with concentrations in conurbations such as the Ruhr or large cities such as Berlin and Munich.



**Figure2: Locations of natural gas refuelling points and motorways in Germany (as at June 2016)<sup>20</sup>**

<sup>18</sup> German Association of Electricity and Water Industries, *Erhebung Elektromobilität*

<sup>19</sup> [https://www.erdgas-mobil.de/fileadmin/downloads/Tankstellen/ERDGAS\\_MOBIL-15-004\\_Tankstellenkarte\\_online\\_17082015.pdf](https://www.erdgas-mobil.de/fileadmin/downloads/Tankstellen/ERDGAS_MOBIL-15-004_Tankstellenkarte_online_17082015.pdf)

<sup>20</sup> Fraunhofer IML: *Entwicklung von Maßnahmenbündeln zur Förderung von CNG/LNG zur Unterstützung der CPT-Initiative*

CNG refuelling point coverage along the federal motorways varies depending on the region and population density. Expressed as an average for the country as a whole, there are around two CNG refuelling points within a radius of 2 km per 100 km, often located at truckstops that are accessible from both sides. On the A 20 however, there is only one single refuelling point over a length of 322 km that sells natural gas (see the following Table 8).

Motorway	Number of CNG refuelling points	Length of motorway in kilometres	Number per 100 kilometres
A1	20	732	2.7
A2	14	486	2.9
A3	15	778	1.9
A4	10	585	1.7
A5	13	440	3
A6	9	477	1.9
A7	19	962	2
A8	9	497	1.8
A9	13	529	2.5
A20	1	322	0.3

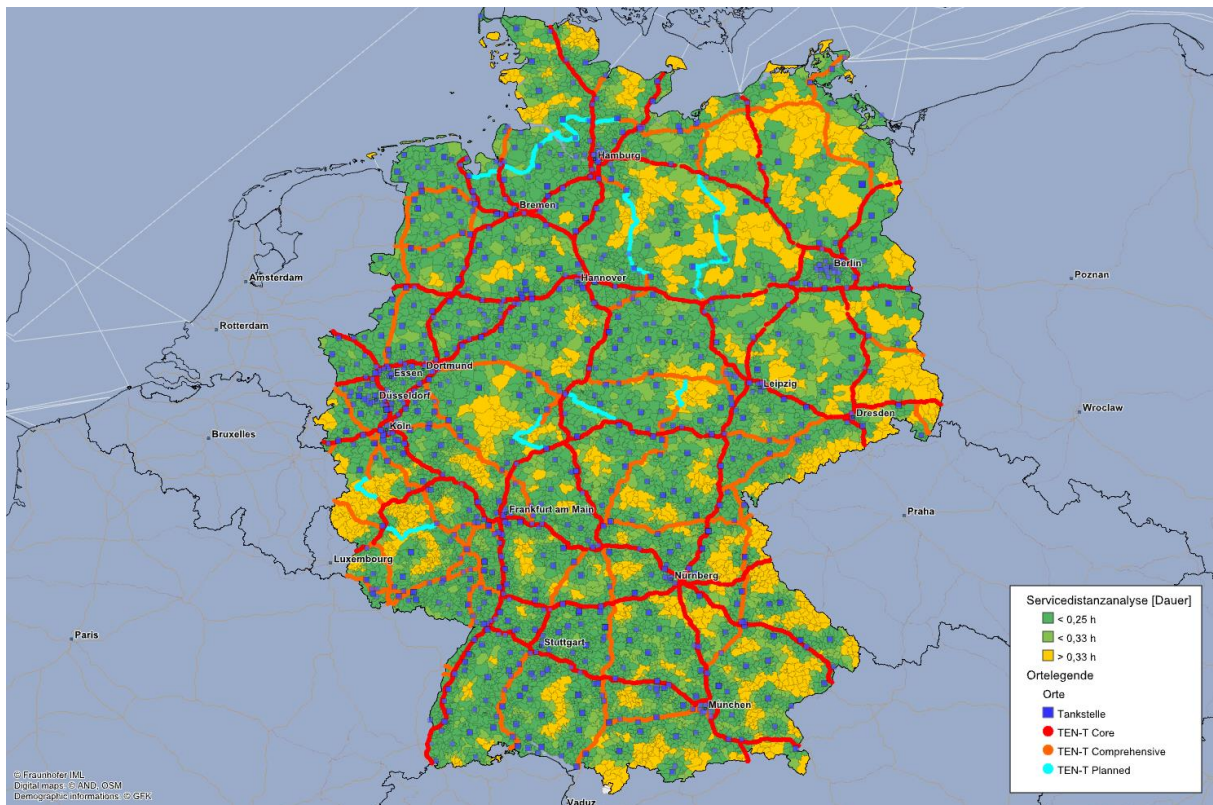
**Table 8: Number of CNG refuelling points along the 10 busiest federal motorways (within a radius of 2 km) in Germany<sup>21</sup>**

This means that, on average, Germany has 2.4 publicly accessible natural gas refuelling points per 1,000 km<sup>2</sup>. The result of the service distance analysis illustrates the good accessibility of the existing network of CNG refuelling points. The analysis shows that journey times of more than 20 minutes to the nearest CNG refuelling point are only necessary in a few regions (cf. Figure3)

In addition, as far as the conurbations in Germany are concerned, it can be stated that drivers can reach the nearest CNG refuelling point with a maximum driving time of 15 minutes.<sup>22</sup> The German conurbations are thus deemed to have adequate coverage within the meaning of the Directive.

<sup>21</sup> [www.gas24.de/cms/151-0-autobahntankstellen.html](http://www.gas24.de/cms/151-0-autobahntankstellen.html), own calculations





**Figure3: Accessibility of the network of CNG refuelling points<sup>23</sup>**

A network of LNG refuelling points for heavy duty vehicles is not yet available in Germany. However, the first LNG goods vehicles are already operating on German roads and are supplied with fuel at LNG refuelling points in the Netherlands. As part of the EU's Blue Corridors project<sup>24</sup>, 14 LNG refuelling points and 100 LNG heavy duty vehicles in 11 EU countries are to be funded in order to advance the development of the market for LNG infrastructure and LNG drivetrains for commercial vehicles and establish them on the main transport routes in Europe. Referring to the lack of demand, the German project partner has stated that, even in the fourth and final year, the deployment of the refuelling points envisaged in Germany is no longer likely. The reasons given for the lack of demand for the fuel are the non-availability of production vehicles and the fact that the price of diesel is low and will continue to fall once they are available. The lessons learned from the LNG Blue Corridors

<sup>22</sup> Section 47b of the Federal Immission Control Act defines all cities with a population of 100,000 or more and a population density of at least 1,000 inhabitants/km<sup>2</sup> as conurbations.

<sup>23</sup> Fraunhofer IML: *Entwicklung von Maßnahmenbündeln zur Förderung von CNG/LNG zur Unterstützung der CPT-Initiative*

<sup>24</sup> <http://lngbc.eu/>



project thus show that ensuring demand is of crucial importance if potential refuelling point operators are to take a decision to invest.

More stringent environmental legislation, especially in the SECAs, means that LNG is of importance as an alternative fuel in the maritime sector. The picture is different in the road transport sector. Diesel goods vehicles can meet the current EURO standards. In addition, the incentive to use alternative drivetrains is still low, because of the existing cost disadvantage.

In the inland waterway and maritime shipping sector, there is currently no stationary (or fixed within the meaning of directive 2014/94/EU) LNG infrastructure in Germany. However, it is apparent that activities are underway for the introduction of LNG at some ports.<sup>25</sup> In expectation of a demand for LNG, the ports of Wilhelmshaven, Lübeck, Rostock and Brunsbüttel have publicly called for expressions of interest and declarations of intent for the creation of LNG bunkering facilities. Truck-to-ship bunkering currently takes place in Bremerhaven, Mannheim and Rostock. At the port of Hamburg, the cruise liner "AIDAprima" is supplied with LNG during layovers. On the other hand, fixed LNG infrastructure does already exist in other European countries, such as the Netherlands, Norway and Finland.<sup>26</sup>

Europe-wide, there are seven bunkering stations for inland waterway transport, with a further nine planned.<sup>27</sup> In Germany, the first inland waterway vessel was bunkered from a truck at the port of Mannheim in 2013.<sup>28</sup> Bunkering currently takes place around every three weeks.<sup>29</sup>

Inland waterway vessels on the Rhine can be regularly refuelled in Rotterdam and Mannheim. The demand for LNG is still low, which is why bunkering from a truck is current practice. For this form of refuelling, no special authorizations are required with regard to further safety services, such as the fire brigade.

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<sup>25</sup> Federal Ministry of Transport, Building and Urban Development (2012): *Machbarkeitsstudie zum Bunkern von Flüssiggasen in deutschen Häfen*, p.29

<sup>26</sup> Federal Ministry of Transport, Building and Urban Development (2012): *Machbarkeitsstudie zum Bunkern von Flüssiggasen in deutschen Häfen*, p.56

<sup>27</sup> [www.inland-navigation.org/observatory/innovation-technologies/lng](http://www.inland-navigation.org/observatory/innovation-technologies/lng), last accessed on 7 June 2016

<sup>28</sup> [www.hafen-mannheim.de/de/presse/aktuelle-pressemitteilungen/erste-lng-betankung](http://www.hafen-mannheim.de/de/presse/aktuelle-pressemitteilungen/erste-lng-betankung), last accessed on 7 June 2016

<sup>29</sup> Interview with Mr Dietrich, port of Mannheim, 7 June 2016

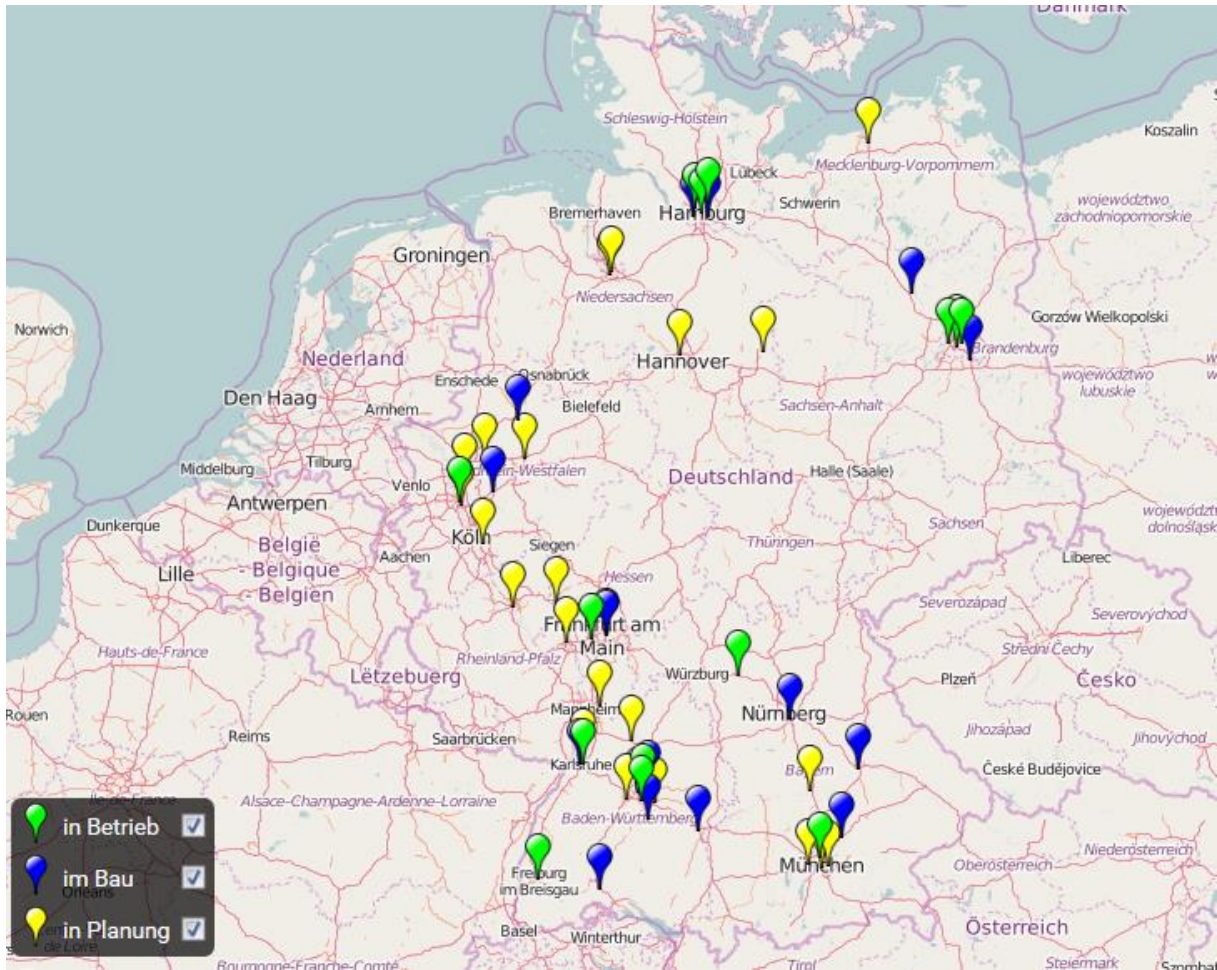
The TEN-T LNG Masterplan project ("Waterway axis Rhine/Meuse/Danube") aims to create a comprehensive project platform for the interlinking of and cooperation between authorities and industry stakeholders. The 34 project partners from 13 countries are seeking to establish a harmonized regulatory framework for the introduction of LNG as a fuel and a cargo. Another aim was to develop prototype engines, ships, bunkering stations and terminals and to prepare scoping studies for the adaptation of existing rules and regulations governing shipping and land transport. Within the scope of this study, a study was conducted in Germany into the creation of a combined LNG terminal for inland waterway vessels and goods vehicles in Mannheim.

German seaports and inland ports do not currently have an LNG import terminal, which means that LNG is imported via Belgium (Zeebrugge), the Netherlands (Rotterdam) and Poland (Świnoujście). An LNG bunkering station for maritime shipping is due to be commissioned in Rostock in 2016. The port of Brunsbüttel is engaged in planning activities for the construction of an import terminal.

### **3.5. Infrastructure for the supply of hydrogen to fuel cell powered vehicles**

21 hydrogen refuelling points are currently in operation or have been completed in Germany (as at June 2016). Around 50 refuelling points will be available by the end of 2016. The refuelling technology used by these hydrogen refuelling points, which have been established as part of the NIP's lighthouse Clean Energy Partnership (CEP) project, meets the 700 bar standard for passenger cars. The 350 bar technology is used at sites for the refuelling of buses and coaches. Within the scope of the Mobility and Fuel Strategy, the use of fuel cell technology in the goods vehicle sector is being studied. Future requirements and refuelling standards are still the subject of research.





**Figure 4: Planning map for the 50 hydrogen refuelling points programme (as at June 2016)<sup>30</sup>**

The refuelling points of the 50 refuelling points programme are part of an initial network of refuelling points, the establishment of which is being funded under the NIP. The refuelling points will ensure basic supply in conurbations (Berlin, Hamburg, Stuttgart, Munich, Rhine-Main and Rhine-Ruhr), augmented by initial sites on the key transport arteries linking them.

As the next step, the H2 Mobility Deutschland GmbH & Co. KG industry joint venture<sup>31</sup> plans to provide Germany with around 100 hydrogen refuelling points offering basic coverage by 2019/2020.

<sup>30</sup> <https://www.now-gmbh.de/de/nationales-innovationsprogramm/aufbau-wasserstoff-tankstellennetz>, as at June 2016

<sup>31</sup> The cross sectoral H2 Mobility Deutschland GmbH & Co. KG joint venture was created by the six industrial corporations: Air Liquide, Daimler, Linde, OMV, Shell and Total. Its objective is to set the stage for the phased development of the nationwide network of hydrogen refuelling points.

This means that the TEN-T Core Network will also be covered and fuel cell powered passenger cars will enjoy trans-European mobility.



## 4. National objectives and plans

### 4.1. Objectives for alternative fuel vehicles

As early as 2010, the Federal Government joined forces with the National Platform for Electric Mobility (NPE) – an association comprising industry and government representatives for the promotion of electric mobility – and set itself ambitious objectives for the development of electric mobility. The aim is for there to be one million electrically powered vehicles operating on German roads by 2020. This aim includes battery electric vehicles, plug-in hybrids and fuel cell powered vehicles.<sup>32</sup> As a joint objective, it was agreed that Germany should be both a lead provider of and a lead market for electric mobility by 2020.

The Federal Government supports the objective, formulated in a dialogue between the Federal Ministry for Economic Affairs and Energy and the automotive industry on 1 December 2015, of aspiring to have a natural gas share of around 4 percent in the energy mix of German road transport by 2020.<sup>33</sup> In the commercial vehicle and bus/coach segment, in particular, natural gas can offer advantages in terms of fuel consumption, CO<sub>2</sub> and NO<sub>x</sub> emissions, noise generation and particulate emissions. To support the achievement of the 4 percent objective, the German automotive industry pledged to roll out further competitive natural gas powered vehicle models.

### 4.2. Electric vehicle charging infrastructure

Article 4 of Directive 2014/94/EU sets out specific requirements to be met by the deployment of charging infrastructure. In particular, the Policy Framework is to establish the appropriate number of recharging points that will be required by 31 December 2020. A number is deemed to be adequate if battery electric vehicles can operate at least in urban agglomerations and densely populated areas

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<sup>32</sup> Fuel cell powered vehicles are electric vehicles within the meaning of the Electric Mobility Act.

<sup>33</sup> <http://www.bmwi.de/BMWi/Redaktion/PDF/B/branchendialog-mit-der-fahrzeugindustrie-gemeinsame-erklaerung,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf>

(Article 4(1)). An appropriate number of recharging points is to be in place, at least on the TEN-T Core Network, by 31 December 2025.

On the basis of their current habits when refuelling vehicles with liquid fuels, users – both private and commercial – expect to be able to charge electric vehicles without any major loss in convenience or time. From a user perspective, "charging like refuelling" is an objective to be aspired to in order to advance acceptance of and satisfaction with electric mobility. In addition, there are user requirements to be met regarding the easy accessibility and availability of the charging infrastructure. For this reason, the Federal Government considers the development of a high power charging network providing universal coverage, both on the mobility arteries and in rural areas, to supplement normal power charging to be a crucial factor in enhancing the uptake of electric mobility in Germany.<sup>34</sup>

As the share of battery electric vehicles rises and is widened to include additional user groups, the importance of publicly accessible charging infrastructure will increase. Both the Federal Government and the National Platform for Electric Mobility (NPE) commissioned various studies<sup>35</sup> to determine the need for publicly accessible charging infrastructure. Corresponding activities undertaken by the federal states were included and taken into account in the process. On the basis of various scientific approaches and comprehensive assumptions, such as the likely number of vehicles in 2020 and the spatial distribution of vehicles and traffic flows, the studies estimate the need for charging infrastructure. The identification of needs distinguishes between high power charging facilities on the transport arteries and in rural areas and publicly accessible normal power charging infrastructure, for instance at places where vehicles have lengthy standing times (shopping, leisure activities) or overnight. Since freight transport operations usually need private infrastructure, they were not included separately in the studies. However, depending on the operational context and usage

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<sup>34</sup> From a strategic perspective, it has so far been mainly projects to cover the transport arteries (trunk road network) with high power charging infrastructure that have been implemented or launched. The development of further high power charging facilities off the federal motorways will be necessary in order to provide universal charging infrastructure coverage for everyday transport.

<sup>35</sup> RWTH Aachen, *Flächendeckendes Schnellladenetz*, commissioned by the Federal Ministry of Transport and Digital Infrastructure; DLR, *LADEN2020: Konzept zum Aufbau einer bedarfsgerechten Ladeinfrastruktur in Deutschland von heute bis 2020*, funded by the Federal Ministry for Economic Affairs and Energy; Fraunhofer ISI, *Markthochlaufszszenarien für Elektrofahrzeuge*, commissioned by the National Platform for Electric Mobility; based on this BDEW/A.T. Kearney, *Die zukünftige Elektromobilitätsinfrastruktur gestalten*

context, some elements of commercial transport by car and (light) commercial vehicle can also benefit from publicly accessible charging infrastructure.

The study entitled "A high power charging network providing universal coverage" by RWTH Aachen University identifies a quantity structure for the deployment of high power charging infrastructure with the aim of providing nationwide recharging point coverage. The development of charging infrastructure that provides universal coverage will make it possible for the users of electric vehicles to find stations for their charging operations throughout the county and in this way to be able to simply recharge range at any time and everywhere. The STELLA simulation tool, a location-finding model developed by RWTH Aachen University, was used for the calculations. In addition to around 400 recharging points to provide basic coverage on the arteries, the needs in rural areas were identified on the basis of settlement patterns. This involved prioritizing the transport network and subdividing demand into the municipality and district levels. Established input parameters draw on mobility characteristics, settlement patterns and vehicle characteristics. The principal factor determining the number of high power recharging points required is all-battery electric vehicles' share of the total target of one million electric vehicles in 2020. Accordingly, if there are 250,000 battery electric vehicles, there is a need for around 3,000 recharging points. In the ramp-up scenario, which assumes 500,000 battery electric vehicles, there is a need for around 7,300 high power recharging points.

The LADEN2020 project developed a new methodology for analysing a charging infrastructure in Germany that will meet future requirements. Accordingly, 36,000 public and semi-public normal power recharging points and 5,000 high power recharging points will be needed. The scientific approach of the research project is the analysis of driving profiles from a survey of households, subdivide into five different types of vehicle usage. On the basis of the vehicle characteristics (type of usage, PHEV/BEV, availability of a parking space) and location (journey purpose, type of parking space), charging curves were formed for the whole week and the amount of charging infrastructure was identified. To estimate the charging infrastructure required in the long-distance transport sector, a model with three components was developed that describes the usage patterns of conventional vehicles, reproduces the nationwide demand for transport and spatially allocates the need for charging. This scientific analysis illustrates that the vast majority of recharging points will be needed at people's homes, followed by privately accessible charging points at their place of work.

For 2020, the Federal Government assumes, on this basis and taking account of the range anxiety of BEV users, that a total of around 7,000 publicly accessible high power recharging points will be required. This confirms the expectation already communicated by the NPE in the past. On the basis



of existing plans, it is likely that around 1,400<sup>36</sup> high power recharging points of this requirement will have been delivered by 2017.

In addition, the scientific analyses estimate that there will be a total need for 36,000 publicly accessible normal power recharging points by 2020. This means that, from a present-day perspective, the additional deployment of just over 30,000 recharging points will be necessary by 2020.

	Need for publicly accessible charging points in 2020
Normal power charging	36,000
High power charging	7,000

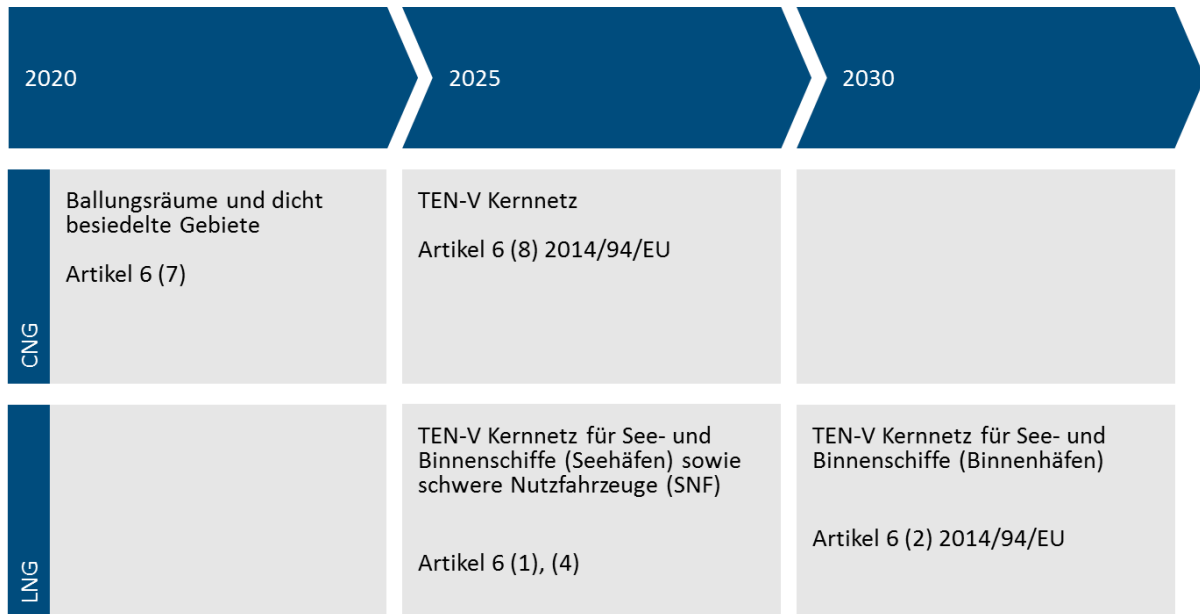
**Table 9: Need for publicly accessible recharging points in 2020**

### 4.3. Infrastructure for the supply of natural gas to transport

Directive 2014/94/EU sets out specific requirements to be met by the deployment of refuelling infrastructure for natural gas for road transport and shipping. These requirements are set out for the supply of both CNG and LNG to road transport. The supply of LNG to waterborne transport and heavy duty vehicles is called for on the TEN-T Core Network in particular. According to the Directive, LNG infrastructure is to be taken to mean both stationary and mobile infrastructure. Figure 5 summarizes the requirements set out in the Directive.

<sup>36</sup> Cf. NPE status report entitled *Ladeinfrastruktur für Elektrofahrzeuge in Deutschland*; based on planning by Tank & Rast; SLAM; TEN-T projects





**Figure 5: Target periods for CNG and LNG supply infrastructure**

As far as the supply of compressed natural gas (CNG) is concerned, the Directive formulates the objective that appropriate vehicles should be able to operate in all agglomerations and densely populated areas by 2020 (Article 6(7)) and throughout the TEN-T Core Network by 2025 (Article 6(8)). According to industry information, appropriateness is deemed to exist in the road transport and road haulage sectors if the distance between CNG refuelling points in agglomerations does not exceed a maximum of 5 km or a journey time of 15 minutes and a distance of 150 km between refuelling points along the TEN-T Network is not exceeded.<sup>37</sup>

As it was possible to show in Chapter 3.4, the German conurbations are adequately supplied, having a maximum journey time of 15 minutes to the nearest CNG refuelling point. Analyses by the Fraunhofer IML also confirm that there is adequate supply of CNG to transport along the TEN-T (cf. Table 10, analysis based on a maximum distance of 150 km).

<sup>37</sup> Interview with Peter Meyer from Zukunft Erdgas (ZE) on 30 March 2016. ZE is the Federal Ministry of Transport and Digital Infrastructure's point of contact for supporting the preparations for the roll-out of CNG and LNG for road transport as part of the transposition of Directive 2014/94 and brings together the positions of the industry stakeholders with regard to LNG/CNG in the road transport, road haulage and bus/coach sectors.

<b>Network</b>	<b>Maximum distance between refuelling points</b>	<b>Number of CNG refuelling points available</b>	<b>Still required to cover the TEN-T Network</b>
<b>Ten-T Core Network</b>	150 km	135	None
<b>Ten-T Comprehensive Network</b>	150 km	217	None

**Table 10: Outcome of a comparison between existing CNG refuelling points and future needs**

On the TEN-T Core Network, the refuelling points are even located significantly closer to one another than the 150 km distance recommended in the recitals. No further development targets will be determined for the time being. Rather, measures must be taken that make it possible in the long run to operate an appropriate network in a profitable manner.

For sea-going ships and inland waterway vessels plus heavy commercial vehicles engaged primarily in long-distance transport operations, the objective is to establish, by 2025, a network of LNG refuelling points that will make it possible for these means of transport to operate along the routes of the TEN-T Core Network, although initially only seaports will be the focus for the infrastructure (Article 6(1), (4)). Looking ahead to 2030, this target will be extended to cover inland ports. The ports are to be equipped taking the requirements of the market into account. In addition, when deploying LNG infrastructure for heavy road haulage, the cost-benefit ratio, including the environmental benefit, is to be incorporated into the planning activities.

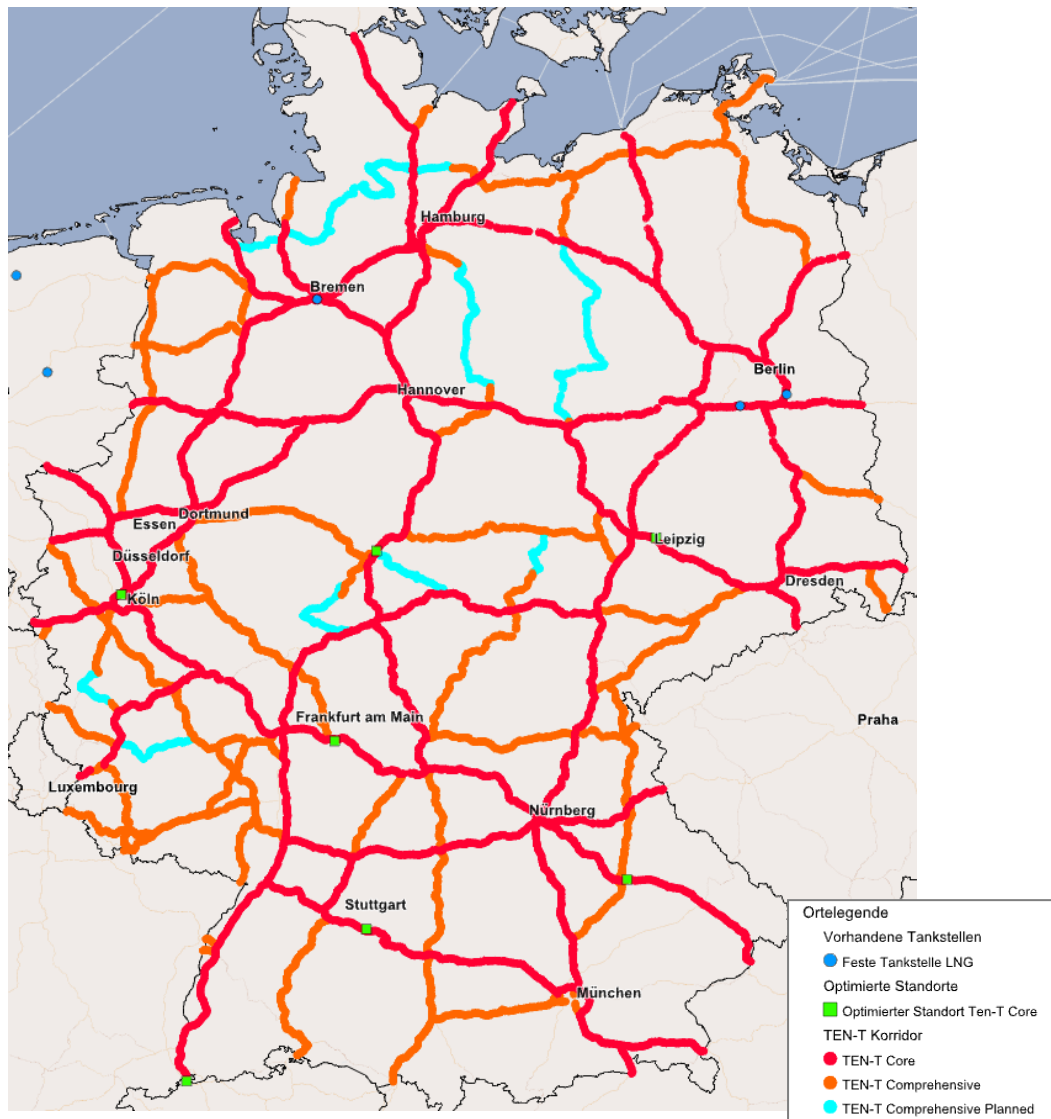
To identify the necessary sites for the provision of basic coverage in keeping with the Directive requirement for the deployment of adequate LNG supply infrastructure for heavy road haulage, the number of trips in the passenger and freight transport sectors was identified on the basis of various statistics, including the FTIP 2030 and "Motor Vehicle Traffic in Germany". Table 11 summarises the results of the analysis. Proceeding on the assumption that LNG refuelling points will commence operation in the Berlin and Bremen areas in 2016, and based on a maximum distance of 400 km, a further six LNG refuelling points will be necessary along the TEN-T Core Network in Germany to meet the requirements set out in the Directive. Assuming a maximum network distance of 150 km, there would be a need for a further 25 refuelling points.

<b>Network</b>	<b>Maximum distance between refuelling points</b>	<b>Number of LNG refuelling points available</b>	<b>Still required to cover the TEN-T Network</b>
<b>TEN-T Core Network</b>	400 km	3	6
<b>TEN-T Comprehensive Network</b>	150 km	3	25

**Table 11: Outcome of a comparison between existing LNG refuelling points and future needs<sup>38</sup>**

Figure 6 shows the optimum regions for locating the six further LNG refuelling points required for basic coverage.

<sup>38</sup> Fraunhofer IML, own analyses



**Figure 6: Example of an optimized location structure taking account of existing LNG refuelling points and for the TEN-T Core Network, maximum distance between refuelling points 400 km<sup>39</sup>**

Currently, road haulage is almost entirely dependent on fossil energy sources. For the foreseeable future, however, neither battery nor fuel cell technology will have evolved so far and be so competitive that they can also electrify demanding long-distance and heavy goods vehicle operations. Nor is the deployment of a wire-based solution (overhead wire) clearly conceivable at present. Whereas electric mobility cannot provide the power needed in these spheres, LNG can already be used as an alternative to diesel today. In the short term, mobile LNG refuelling systems can act as a surrogate for the non-existent network of refuelling points. If account is taken of the

<sup>39</sup> Fraunhofer IML, own analyses

possibility of also blending sustainably produced methane with the natural gas, the environmental and climate change benefit of gas technology is increased significantly. A final review of the proportionality of costs and benefits, including the environmental benefit, will be conducted with the help of the monitoring of demonstration projects within the scope of the Mobility and Fuel Strategy. It is currently not yet possible to derive deployment targets of an infrastructure for the supply of LNG road haulage beyond the initial basic network.

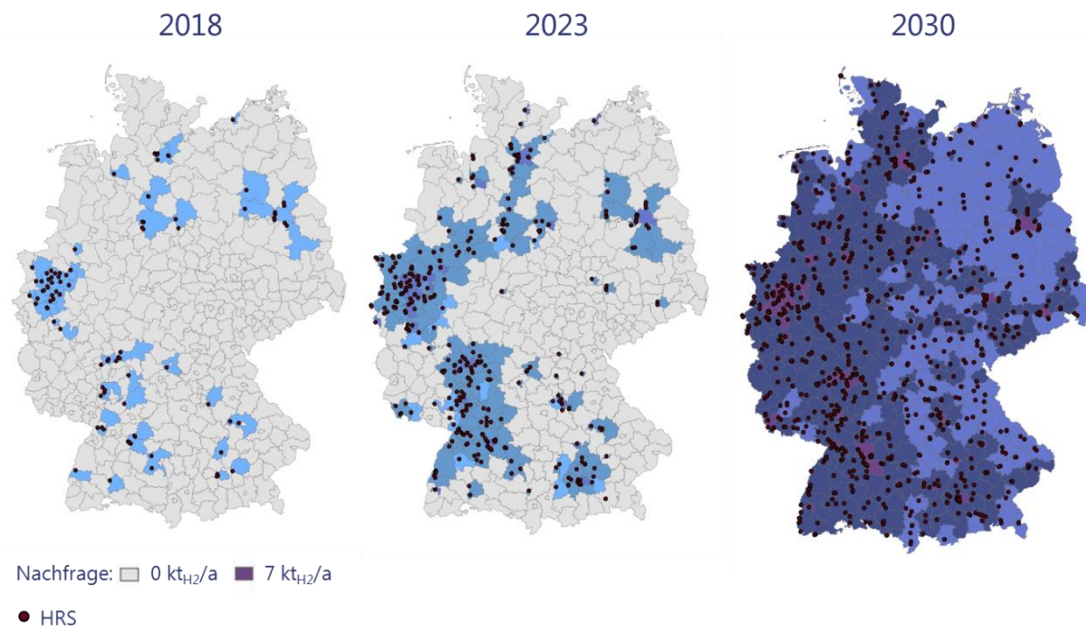
As far as the supply of LNG as a fuel in seaports and inland ports is concerned, the objective is to deploy an infrastructure that meets demand. This is already enshrined in the National Ports Strategy. Chapters 5.3.4 and 9 describe how the ramp-up of infrastructure that meets demand is to be fleshed out.

#### **4.4. Infrastructure for the supply of hydrogen to fuel cell powered vehicles**

With regard to the supply of hydrogen to transport, Article 5 of Directive 2014/94/EU calls for data to be provided on an appropriate number of hydrogen refuelling points by 31 December 2025. An appropriate number is deemed to have been reached when the operation of hydrogen powered motor vehicles (including fuel cell powered vehicles) is ensured within the determined networks, including, where appropriate, cross-border links (Article 5(1)).

The Federal Government believes that a network of hydrogen refuelling points providing universal coverage and derived from future requirements is a key factor for the successful roll-out of fuel cell powered vehicles.





**Figure 7: Regional distribution of H<sub>2</sub> demand and refuelling points<sup>40</sup>**

The future demand for hydrogen and its spatial distribution were modelled as part of scientific research supporting the 50 refuelling points programme<sup>41</sup>. Over the period to 2018, demand will remain confined to selected regions around large German cities and the Ruhr. In most of these regions, only one refuelling point will be deployed, so as to be able to ensure that rural areas are covered. Subsequently, over the period to 2023, further regions with a somewhat lower population and vehicle density will be provided with coverage. Finally, it is assumed that, by the end of the observation period in 2030, there will be a local demand for H<sub>2</sub>, which will be met by the appropriate number of refuelling points. The focus continues to be on the agglomerations around the major German cities and in the Ruhr. In addition, it is apparent that the demand for H<sub>2</sub> and the corresponding infrastructure is basically greater and denser respectively in the old federal states than in the new federal states.

Against this background, the Federal Government supports the objectives of the industry joint venture, as shown in Figure 8. In Germany, basic coverage is to be achieved by as early as 2020 through the deployment (irrespective of the number of vehicles) of at least 100 hydrogen refuelling

<sup>40</sup> LBST et al., 2016, *Begleitforschung 50-Tankstellen-Programm im Rahmen des Nationalen Innovationsprogramm Wasserstoff- und Brennstoffzellentechnologie, Teil B – Inhaltliche Ergebnisse*, 3rd interim report, May 2016

<sup>41</sup> LBST et al., 2016

points using 700 bar technology. Subsequently, there will be further development depending on trends in the actual vehicle population, so that by the time horizon of 2025 stipulated in the Directive, a total of up to 400 refuelling points will be available throughout Germany.



**Figure 8: Ramp-up of hydrogen refuelling points**

## 5. Measures to ensure targets and objectives are reached

With the 2013 Mobility and Fuel Strategy, the Federal Government presented, for the first time, a comprehensive overview of technologies and alternative fuel options for the different modes of transport. In the form of a "learning strategy", the Mobility and Fuel Strategy identifies ways of implementing Germany's new energy strategy in the transport sector in the long term. Electric mobility represents a key technology for transforming the transport energy supply mix. It provides problem-solving approaches for two major challenges confronting the transport energy supply. First, efficient electric motors make it possible to significantly reduce the amount of energy required. Second, integration with the electricity sector makes it possible to use the growing share of renewable energy sources.

If all forms of transport are to be electrified, battery and fuel cell technology must be evolved. The Federal Government's objective is to give all alternative fuels and drivetrains a chance on the market. Ultimately, it will be the users who decide which technology prevails. What is needed here is, to start with, new "networks of refuelling points" for the aforementioned energy sources – electricity, hydrogen and natural gas.

The Federal Government believes that it is basically up to the private sector to deploy alternative fuels infrastructure. Public sector supply networks are not to be created. To incentivize appropriate investment for the market ramp-up, funding may be provided for the infrastructure deployment in the initial phase until commercially viable business models have emerged. This public sector investment will thus leverage the overall investment to be made in the deployment of alternative fuels infrastructure.

### 5.1. General measures for the market penetration of alternative fuels

The Federal Government recognized at an early stage the need for a coordinated strategy and defined electric mobility as an important building block for achieving the climate change targets in its Integrated Energy and Climate Programme, which was published back in 2007. The Federal Government's National Development Plan for Electric Mobility, which was presented in 2009, set itself the objective of progressing research and development in the field of battery electric mobility and the commercialization and roll-out of this technology. In May 2011, the Federal Government's





Electric Mobility Programme fleshed out the decisions of the National Development Plan and backed them up with specific measures.

The objectives of the approach, which have been coordinated with the NPE, are the development of charging infrastructure, the evolution of vehicles and technical components and the creation of the necessary regulatory framework. Since 2010, the NPE has been supporting the Federal Government's activities with regard to the commercialization and market ramp-up of electric mobility and the establishment of a properly functioning market, which is planned for 2020.

In the field of hydrogen, the Federal Government has been implementing the National Hydrogen and Fuel Cell Technology Innovation Programme (NIP) as a cross-departmental programme in collaboration with the industry and academia. So far, the objective of the NIP has been the commercialization of appropriate technologies. By creating a stable regulatory framework and funding possibilities, the programme, which has a lifetime of ten years, has contributed to the emergence of an internationally leading branch of industry in Germany.

On the infrastructure side, the 50 refuelling points programme, with its initial network and comprehensive scientific research support, has provided a sound basis for the technology. As part of the continuation of the NIP, the Federal Ministry of Transport and Digital Infrastructure will, in the future, implement measures that aim to establish competitive mobility using hydrogen and fuel cell technology on the market in the next ten years. This includes in-vehicle technologies and systems as well as ensuring the necessary refuelling infrastructure.

The "Natural Gas Mobility – CNG and biomethane as fuels" initiative has set itself the objective of supporting the Federal Government's endeavours to increase the share of natural gas powered vehicles. This cross-sectoral initiative was launched in 2011 under the patronage of the Federal Ministry of Transport and Digital Infrastructure. It is supported by the Federal Ministry for Economic Affairs and Energy and coordinated by the German Energy Agency. The initiative brings together all the relevant players from the value chain of natural gas mobility: from the (renewable) production of fuel to its distribution and from the manufacture of vehicles to their sale to customers. In collaboration with the "erdgas mobil" trade association, the Natural Gas Mobility Initiative consolidates the positions of the industry stakeholders with regard to LNG/CNG in road transport, road haulage and bus/coach sectors and supports the transposition of Directive 2014/94/EU. In addition, in November 2015, following an initiative by the Federal Ministry of Transport and Digital Infrastructure, an "LNG for heavy duty vehicles" task force was created. Its principal role is to speed up the roll-out of LNG in the heavy road haulage sector. In the shipping sector, the Federal Ministry of Transport and Digital Infrastructure has, since 2015, been collaborating with the "Maritime LNG

Platform", which represents a comprehensive cross-section of companies, association and ports. The introduction of LNG as a marine fuel and the related infrastructure issues are discussed in a dialogue with the industry.

In working towards its objective of increasing the decarbonization of transport, the Federal Government is pursuing a technology neutral approach. Directive 2014/94/EU call for a fuel-specific account of objectives and measures in the NPF. Nevertheless, the Federal Government has developed tools that do not favour a specific technology in promoting alternative fuels and drivetrains. One example in this context is the fuel economy label for new cars, which is designed to encourage consumers to decide to purchase a particularly efficient and low-carbon car. The [www.pkw-label](http://www.pkw-label) platform, which is operated by the Federal Ministry for Economic Affairs and Energy, provides an overview of the most important data for every single new car, including information on carbon efficiency. In July 2011, the German Bundesrat gave its consent to the necessary amendment to the Fuel Efficiency Labelling of Passenger Cars Regulations, which were then able to enter into force on 1 December 2011.

## 5.2. Measures in the electricity sector

### 5.2.1. Measures for the deployment of electric vehicle charging infrastructure

If the national targets and objectives listed on Chapter 4.2 are to be achieved, it will be necessary to take comprehensive measures for the further deployment of charging infrastructure. This relates not only to the deployment of the infrastructure itself but also to the accompanying statutory framework plus activities in the field of research and development.

The financial assistance programmes launched by the Federal Government in the electric mobility pilot regions<sup>42</sup> and showcases<sup>43</sup> have produced comprehensive intelligence for commercialization and market ramp-up. Based on the findings of the scientific research support, toolkits and brochures<sup>44</sup> for

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<sup>42</sup> <http://www.bmvi.de/SharedDocs/DE/Artikel/G/modellregionen-elektromobilitaet.html?nn=36210>, <https://www.now-gmbh.de/de/modellregionen-elektromobilitaet>

<sup>43</sup> <http://schaufenster-elektromobilitaet.org>

<sup>44</sup> <https://www.now-gmbh.de/de/service/publikationen>

local authorities and users have been published and an online module<sup>45</sup> for local authority decision-makers has been developed. In addition, the findings are informing the revision and drafting of statutory instruments and funding measures for the further market ramp-up.

The Federal Ministry of Economic Affairs and Energy is funding a research project entitled "high power charging along arteries and in metropolitan regions (SLAM)". With this project, the Federal Government is already supporting the deployment of high power charging infrastructure on the motorways and in conurbations. In addition, charging infrastructure is being deployed across national borders as part of the following transnational TEN-T projects:

- Central European Green Corridors<sup>46</sup>
- Electric<sup>47</sup>
- Fast-E<sup>48</sup>
- Greening Near<sup>49</sup>

On the basis of projects already launched for the development of high power charging infrastructure, it is to be assumed that around 1,400 high power recharging points will be available by 2017.

Because the charging infrastructure is deployed as part of various projects and responsibilities, it is becoming increasingly important that the market ramp-up activities be coordinated in a uniform manner throughout Germany. The Federal Ministry of Transport and Digital Infrastructure is engaged in preparations for fleshing out this task. The foundation for this has been laid with the Charging Post Regulations (adopted on 9 March 2016, entered into force on 17 March 2016), which established review and reporting obligations for operators of publicly accessible charging infrastructure and far-reaching powers for the Federal Network Agency.

On 18 May 2016, the Federal Cabinet adopted a comprehensive market incentive package for electric mobility. As part of the market incentive package, the Federal Ministry of Transport and Digital Infrastructure will implement a support measure to provide further support to the deployment of

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<sup>45</sup> <http://starterset-elektromobilität.de/>

<sup>46</sup> [https://ec.europa.eu/inea/sites/inea/files/fichenew\\_2013-eu-92069-s\\_final\\_2016.pdf](https://ec.europa.eu/inea/sites/inea/files/fichenew_2013-eu-92069-s_final_2016.pdf)

<sup>47</sup> [https://ec.europa.eu/inea/sites/inea/files/fichenew\\_2013-eu-92043-s\\_final.pdf](https://ec.europa.eu/inea/sites/inea/files/fichenew_2013-eu-92043-s_final.pdf)

<sup>48</sup> [https://ec.europa.eu/inea/sites/inea/files/fiche\\_2014-eu-tm-0196-s\\_final.pdf](https://ec.europa.eu/inea/sites/inea/files/fiche_2014-eu-tm-0196-s_final.pdf)

<sup>49</sup> [https://ec.europa.eu/inea/sites/inea/files/fichenew\\_2013-dk-92032-s\\_final.pdf](https://ec.europa.eu/inea/sites/inea/files/fichenew_2013-dk-92032-s_final.pdf)

infrastructure. The aim is to incentivize the deployment of charging infrastructure that provides universal coverage in line with the objectives by constructing 15,000 recharging stations throughout Germany (5,000 for high power charging, 10,000 for normal power charging). A total of 300 million euros will be provided for the financial assistance programme, which will run from 2017 to 2020.

The programme is designed primarily to fund the deployment of a high power charging infrastructure network providing universal coverage to enable users of electric vehicles to recharge quickly and easily anywhere in Germany. In addition, the further deployment of normal power charging infrastructure will be funded in order to cover customer requirements depending on their driving and parking patterns (e.g. overnight charging of electric vehicles by residents of houses in multiple occupation without a garage in towns and cities, car sharing, recharging while shopping in a department store, eating in a restaurant or watching a film in a cinema).

Another measure (already underway) for the deployment of high power charging infrastructure is the installation of high power charging posts at the rest areas with services on the federal motorways. On the initiative of the Federal Ministry of Transport and Digital Infrastructure, Autobahn Tank & Rast GmbH will equip 400 sites with high power charging posts, each with two recharging points as required by the Charging Post Regulations (i.e. a total of 800 recharging points), by 2017 to the greatest extent possible. This will be implemented in the form of joint construction schemes by the federal state highway authorities and the concessionaires under the existing concession agreements, which receive pro rata funding from the Federal Government. If all approximately 430 rest areas with services are equipped, there will be high power charging infrastructure on federal motorways with 860 high power recharging points.

The Federal Government's planning activities are complemented at federal state and local authority level. The activities of the federal states and local authorities are of great importance for achieving the targets and objectives, especially in the field of normal power charging, but also for high power charging facilities in public areas. An integral component of the transposition of the EU Directive is the dialogue between the Federal Government and the federal states. Because this ensures that the former is informed about the most recent objectives and plans of the federal states and local authorities. It has been ascertained that there are also plans for the deployment of charging infrastructure and the provision of financial assistance to such projects at federal state and local authority level. This applies to both regions with extensive experience of electric mobility, such as the city states of Berlin and Hamburg, and less densely populated states, such as Mecklenburg-Western Pomerania, Schleswig-Holstein, Saxony-Anhalt and Thuringia, which have developed their own

federal state strategies with objectives in the field of alternative fuels infrastructure and the funding thereof.

The following list of examples of regional activities makes no claim to be exhaustive.

The plans of the State of Berlin contain 400 normal power recharging points and 20 high power recharging point by 2016. In addition, the state is to create its own information and authentication platform that is independent of operators and enable RFID authentication.

The Hamburg Masterplan assumed that there will be around 5,000 electric vehicles by the end of 2016. A need for 592 recharging points has been derived, comprising 70 high power recharging points and 522 normal power recharging points.

Since October 2014, Mecklenburg-Western Pomerania has provided financial support for investment in normal and high power charging infrastructure and hydrogen infrastructure on the basis of separate funding guidelines for commercially operating and non-commercially operating organizations.

In Saarland, the objective is the establishment of high power charging stations on major transport arteries and in the capital, Saarbrücken. 140 recharging points are planned in the public realm, of which 78 have already been installed.

Saxony and Bavaria are actively involved in the SLAM, TEN-T and electric mobility showcase (A9) projects. Current plans in Saxony predict a need for around 800 recharging points. Bavaria assumes that there will be a need for 7,000 publicly accessible recharging points<sup>50</sup> by 2020.

In Schleswig-Holstein, there are various plans for the development of charging infrastructure, which are already backed up by specific funding possibilities. In the "HansE" project, the first step is to be the creation of 50 charging stations in the Hamburg metropolitan region to stimulate the development of the charging infrastructure. The second step will involve reviewing whether the operator model is compatible with the strategy of the city of Hamburg. On 1 June 2016, funding guidelines for the deployment of charging infrastructure in municipalities entered into force.

In Thuringia, there are financial assistance schemes for local authorities and local authority companies in the form of individual grants with a low budget level (vehicles and charging

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<sup>50</sup> No distinction between high power and normal power charging infrastructure



infrastructure). A corresponding federal state strategy will be developed within the scope of the "Charging Infrastructure Strategy of the Free State of Thuringia for the Period from 2016 to 2020" research project.

### 5.2.2. Other measures in the electricity sector

The Federal Government's 2011 Electric Mobility Programme formulated the objective of progressing research and development in the field of battery electric mobility and the commercialization and roll-out of this technology. As the key point of contact for the various financial assistance programmes, the Electric Mobility Advice and Information Centre was created as part of the Federal Government's Research and Innovation Advice Service. A complete list of all Federal Government financial assistance programmes in the field of electric mobility can be found at <http://www.foerderinfo.bund.de/elektromobilitaet>.

The financial assistance programmes pursue different objectives and establish different priorities. In addition to the direct development of charging infrastructure, infrastructure issues are directly addressed in the following fields: user acceptance, systems research into electric mobility, coupling with renewable energy sources and network integration.

Company car fleets, in particular, constitute an important potential market segment for electric vehicles. The purchase price of an electric or hybrid electric vehicle is still higher than that of a conventional motor vehicle. To remove this obstacle, the arrangements governing the taxation of the private use of electric vehicles have been improved.<sup>51</sup>

The market incentive package for electric mobility of 18 May 2016 supports the market ramp-up of electric vehicles through further measures. Thus, for instance, guidelines to promote the sale of electrically powered vehicles up to 3.5 tonnes (environmental bonus) are being implemented by the Federal Ministry for Economic Affairs and Energy. An environmental bonus amounting to 4,000 euros is granted for all-electric vehicles and amounting to 3,000 euros for plug-in hybrids, with the Federal Government and the industry each providing one half of the funding. Funding will be provided until the federal funds earmarked for this purpose and totalling 600 million euros have been completely

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<sup>51</sup> In accordance with the second half of the second sentence of section 6(1)(4) of the Income Tax Act, the higher catalogue price of electric and hybrid electric vehicles compared with conventional motor vehicles is reduced by the price of the battery – as a lump sum – in the taxation of the withdrawal/benefit-in-kind for the private use of company cars.

disbursed or until 2019, whichever is sooner. To complement this, a bill for the provision of fiscal incentives to electric mobility in road transport has been adopted. This bill provides for amendments in the field of motor vehicle tax and income tax:

- In the case of all-electric vehicles registered for the first time between 2016 and 2020, exemption from motor vehicle tax has been lengthened from previously five years to ten years.
- For employees, the charging of an electric or hybrid electric vehicle at their employer's premises and the private use of a company-owned charging device made available temporarily are exempt from income tax. Employers will be able to apply a flat rate of income tax of 25 percent to benefits-in-kind accruing from the making available of the charging device free of charge or at a reduced rate and to grants provided for the purchase and operation of a private charging device (arrangements limited to the period from 1 January 2017 to 31 December 2020).

The deployment of charging infrastructure is accompanied by statutory measures that enhance the uptake of electric mobility and support the market ramp-up. The following statutory amendments and provisions have been able to create more legal certainty and thus a more favourable climate for investment.

For vehicles marked accordingly ("E" at the end of the registration number or sticker for vehicles registered abroad), the Electric Mobility Act has created not only the possibility of reserving parking spaces for electric vehicles but also further privileges when these vehicles use the road. This concerns concessions in the charging of parking fees, exemptions from access restrictions and the possibility of using bus lanes. This creates soft factors that can contribute to the uptake of electric mobility.

The Act on the Evolution of the Electricity Market (Electricity Market Act) of 26 July 2016 clarifies the status of charging infrastructure within the context of the Energy Industry Act. On 4 May 2016, the Electricity Tax Implementing Regulations were amended to include a procedural simplification in connection with the supply of electricity to electric vehicles. Under this amendment, anyone who supplies electricity exclusively to electric vehicles is not deemed to be a supplier within the meaning of the Electricity Tax Act and thus does not have to comply with the obligations associated with the status of supplier.

The technical requirements set out in Annex II to Directive 2014/94/EU have already been implemented by the Charging Post Regulations, which entered into force on 17 March 2016. Their re-enactment regulates not only the establishment of minimum standards for charging plugs but also the minimum requirements to be met by access and authentication such as direct payment options,

which will enable all users of electric vehicles to recharge on an ad hoc basis. This ensures that all users can recharge spontaneously, i.e. without entering into a contract with the electricity supplier or operator concerned, in the publicly accessible realm on a non-discriminatory basis.

### **5.3. Measures in the field of natural gas**

German LNG requirements for the transport sector can currently be met by imports via Belgium (Zeebrugge), the Netherlands (Rotterdam) and Poland (Świnoujście). Planning activities and authorization procedures for the construction of LNG bunkering stations are underway at various ports. Actual implementation is likely if the demand for LNG rises in sectors other than transport. A general stimulation of the demand for LNG from other sectors of industry (for instance through on-site power generation, for air conditioning or the generation of refrigeration for production processes) is possible. In the LNG sector, in particular, this can improve the prospect of guaranteed sales for LNG producers and, in the medium term, deliver economies of scales in the production and provision of LNG. The likely potential for rationalization will also benefit natural gas mobility in the form of falling LNG prices.

In order to ensure the supply of natural gas to the transport sector in the medium and long term, it must be ensured that there is a positive business case for refuelling operators/lessees to get involved in the natural gas sector. High initial investment and uncertain income potential resulting from the fact that it has so far been difficult to calculate the sales of natural gas are thus starting points for support measures.

#### **5.3.1. Measures for the deployment of CNG refuelling infrastructure**

Germany already has the minimum CNG refuelling point coverage required by the Directive (cf. Chapters 3.4 and 4.3). Measures for the deployment of further infrastructure are thus not necessary. Rather, measures will be considered that improve the commercial situation of the existing CNG refuelling points. According to information provided by the industry, a sizeable proportion of the CNG refuelling points are running at a loss.

#### **5.3.2. Measures for the deployment of LNG refuelling infrastructure for road vehicles**

A network of LNG refuelling points will have to be developed progressively. Lessons learned in the Netherlands have shown that the deployment of an initial network of LNG refuelling points in the





market entry phase in the goods vehicle sector should be geared to the needs of the early adopters. Accordingly, deployment in Germany is also to be in line with requirements, i.e. it is to be geared to the demand for natural gas. The main reason why this focusing is necessary is that LNG refuelling points represent a significant commercial risk for lessees/owners in comparison with conventional filling stations. Compared with filling stations for petrol/diesel fuel, initial investment is required that is many times higher. At the same time, however, potential sales are initially significantly lower.

The initial network of LNG refuelling points to be deployed is to make it possible for early adopters to seamlessly integrate LNG goods vehicles into diesel fleets without having to change routes or other logistical parameters. At the same time, it is to be possible to supply international traffic operating along the TEN-T Core Network.

In the first deployment phase, therefore, the infrastructure will be deployed by promoting the demand for LNG, i.e. the haulage operators. It has been possible to identify early adopters and provide financial assistance to them to convert part of their fleet. Beneficiaries of funding are obliged to guarantee the supply of LNG at the site by means of a publicly accessible LNG refuelling point. Thus, the first refuelling points will be able to commence operation in 2016. They will initially be mobile solutions. The preparation of planning application documents for stationary LNG refuelling points will probably start before the end of 2016. Within this context, the extent to which an acceleration of administrative processes for the construction/conversion of refuelling points, for example by means of generic approval procedures, is possible is being examined.

By monitoring and evaluating the projects, it will be possible to assess whether the costs of the deployment of appropriate LNG infrastructure are proportionate in comparison with the benefit, including the environmental benefit. These findings will inform the evolution of the deployment strategy for heavy road haulage.

In the EU-funded Connect2LNG project, two German LNG refuelling points for heavy road haulage are planned. With logistics service providers and shippers as project partners, the basic demand for the envisaged LNG refuelling points is already secured. Implementation is thus likely by the end of 2017.

### **5.3.3. Further measures to increase the demand for natural gas in the road transport sector**

Within the scope of its "2020 Climate Action Programme" (2014), the Federal Government decided to implement additional measures to tackle climate change in the transport sector. This programme

especially singles out LNG as a fuel for inland waterway vessels and sea-going ships and for heavy duty vehicles. It states as an objective the continuation of the reduced energy tax rate for natural gas beyond 2018. In Germany, CNG, LNG and LPG are already subject to a lower rate of energy tax, but only for a limited period of time. To continue this preferential rate of tax, the German Bundestag, in its decision of 2 July 2015, called on the Federal Government to table a bill for the extension of the reduced rate of energy taxation on natural and liquefied gas fuels, including a valid scheme for funding this measure from savings in other areas (Bundestag document 18/5378). A corresponding bill is currently at the interdepartmental coordination stage. The objective is to ensure the necessary investment certainty for securing the network of CNG refuelling points and for the planned deployment of the network of LNG refuelling points.

As a further measure of the "2020 Climate Action Programme", a short-term financial assistance programme for energy-efficient and/or low-carbon commercial vehicles is being implemented. As things stand at the moment, LNG-fuelled goods vehicles are to benefit from funding as of 2017. Another measure is the evolution of the HGV tolling scheme with regard to graduation in terms of energy efficiency and/or GHG mitigation. This can also help to speed up the market penetration of LNG and other alternative drivetrain systems in the heavy road haulage sector. In the recast of the EU Infrastructure Charging Directive, the Federal Government will lobby for CO<sub>2</sub> emissions to be a criterion of a wider range of tolls.

The Federal Government is lobbying for European Directive 98/6/EC of the European Parliament and of the Council of 16 February 1998 on consumer protection in the indication of the prices of products offered to consumers (unofficial short title: Price Indication Directive) to be amended in such a way that the price advantage in terms of energy content is displayed on the price boards at the refuelling points. The Federal Government has already included the uniform price labelling of mass-based fuels, for instance by litre equivalent, as a proposal for action in its Mobility and Fuel Strategy. Once the Price Indication Directive has been updated, Germany will speedily implement the corresponding labelling on the price boards of refuelling points.

The Federal Government will continue to cooperate closely with the platform for LNG in heavy road haulage and support it in its work. One of the objectives is to reduce the shortage of information about natural gas as a fuel and to interlink the players. In addition, within the scope of the dialogue with the automotive industry, the Federal Government supports the development of further measures that can help to achieve the industry objective of reaching a natural gas share of around 4 percent in the energy mix of German road transport by 2020. In September 2016, the Federal Ministry for Economic Affairs and Energy will host a "Round Table on Natural Gas Mobility". This

event is to identify, in a dialogue between the relevant stakeholders, ways for achieving the natural gas target from the dialogue with the automotive industry.

As the Mobility and Fuel Strategy is evolved, the following measures will be considered, among others:

- promote the deployment of further LNG refuelling points as a function of the supply of biomethane or synthetic methane ("power to gas");
- promote the conversion of CNG refuelling points so that it is possible to supply not only passenger cars but also commercial vehicles with CNG;
- introduce a flat rate for the grid charges for natural gas;
- promote semi-public refuelling points at company premises for fleet operators;
- give special rights to CNG/LNG-powered commercial vehicles, for instance longer delivery time windows of rights to enter sensitive areas.

#### **5.3.4. Further measures to increase the use of LNG in the shipping sector**

Facilities for refuelling with LNG are currently in place in the waterborne transport sector, including at the ports of Mannheim, Brunsbüttel, Bremerhaven, Hamburg and Rostock, although the ships are still bunkered from a truck.

The development of the ports is a federal state responsibility. The Federal Government's objective is to support their activities. In Germany, the legal conditions differ from one federal state to the next. In consultation with the federal states, the Federal Ministry of Transport and Digital Infrastructure coordinates appropriate events with the objective of developing common application of the law, which will make a common approval management system possible. The "Maritime LNG Platform" will be closely integrated into this process.

The ports will have to join forces with the industry to deploy appropriate supply infrastructure. On the basis of what is known today (cf. Chapter 9), this will be done predominantly in the form of mobile units (LNG containers or bunker barges). The funding provided by the Federal Government is designed, in particular, to increase demand for this fuel to such a level that investment in the corresponding supply infrastructure (bunker terminals, bunkering vessels, distribution stations, etc.) becomes commercially interesting.

To leverage the potential inherent in gas propulsion systems for achieving the energy and climate change goals, especially in the transport sector, considerable research and development efforts in



the fields of engines and drivetrains are still required. The Federal Government is promoting shipbuilding innovations within the scope of the Federal Ministry for Economic Affairs and Energy's financial assistance programme entitled "Innovative Shipbuilding Safeguards Competitive Jobs". Research and development projects conducted by marine engineering companies and by institutions of higher education and research establishments are promoted by means of grants provided under the Federal Ministry for Economic Affairs and Energy's research programme entitled "Next Generation Maritime Technologies". By establishing a new priority in energy research, the Federal Government will promote innovative gas propulsion systems and accompany the LNG funding strategy. To this end, the Federal Ministry for Economic Affairs and Energy has launched a consultation process in order to identify the actual need for research and join up the players.

The NIP lighthouse project entitles "e4ships", which is funded by the Federal Ministry of Transport and Digital Infrastructure, is studying the potential use of LNG in highly efficient fuel cell systems. By funding various other pilots, the Federal Ministry of Transport and Digital Infrastructure, for its part, is already furnishing proof of the commercial maturity of LNG propulsion systems in the maritime sector. The following pilot demonstration projects are being funded:

- the conversion of a container feeder;
- the construction of an LNG-powered ferry; and
- LNG power packs for on-board supply in ports.

This approach is being further pursued by the Federal Ministry of Transport and Digital Infrastructure with the short-term provision of financial assistance to further projects in the field of converting and equipping ships for LNG propulsion. Corresponding funding guidelines are to be published before the end of 2016 and will provide grants for the extra investment costs involved in the equipping and conversion of sea-going ships and inland waterway vessels. The budgetary conditions for this have already been created. In addition, the Federal Ministry of Transport and Digital Infrastructure is already supporting alternative propulsion systems in this field with the technologically neutral financial assistance programme for the modernization of inland waterway transport.

Some of the state-owned ships operate permanently in sea areas in which stringent environmental rules already apply today or will be introduced in the years ahead, for instance the SECAs in the North Sea and Baltic Sea. This would appear to make the use of LNG advantageous, especially since the usage profile of the state-owned ships is likely to lend itself to the use of LNG. Most of the ships owned by the Federal Government operate in a limited area in the long term and regularly return to a specific home port to pick up material, bunker provisions or change their crew. It would thus be



possible to ensure the supply of LNG by deploying and developing both stationary and mobile infrastructure for the supply of LNG.

By equipping its own ships, the Federal Government will set an example of good practice in this field. The possibility of equipping the state-owned fleet with LNG will be regularly examined in ongoing and future projects for the renewal and upgrading of this fleet. For this, too, the Federal Government has already created the budgetary conditions. The first project will be the equipping of the BSH's<sup>52</sup> new multi-purpose vessel, the "Atair", with an LNG propulsion system.<sup>53</sup>

The Federal Government welcomes the financial assistance provided to projects under the Connecting Europe Facility (CEF) to deliver shore-side electricity supply and LNG bunkering facilities.

In some federal states, funding regimes have been developed whose purpose is to support the deployment of LNG infrastructure in ports. Thus, for instance, the State of Lower Saxony issued "funding principles governing the provision of grants to improve the supply of alternative fuels and energy in seaports" in 2016. The main items eligible for funding are storage facilities, fuel depots, distribution networks and the necessary safety equipment. In Mecklenburg-Western Pomerania, necessary adaptations of the infrastructure to make the use of LNG in ports possible can be subsidized as part of the financial assistance to port infrastructure. In addition, Mecklenburg-Western Pomerania has already created the regulatory framework for the bunkering process in its Harbour Regulations.

By funding, inter alia, LNG propulsion systems for ferries, barges and tugboats, the Hamburg Senate is seeking to reduce emissions from vessels in the inland port. LNG-powered sea-going ships already receive a discount on the port dues they have to pay. This is to be extended to also include LNG-powered inland waterway vessels.

To be able to better support less favoured regions in the future in the deployment of LNG facilities, the Federal Government and federal states will make energy infrastructures eligible for funding under the joint programme for the improvement of regional economic structures. A change to this programme's coordination framework, which will make it possible to start funding initial pilot projects by 2020, is in preparation.

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<sup>52</sup> Federal Maritime and Hydrographic Agency

<sup>53</sup> It is planned to award the contract for the new build in Q4 2016.

## 5.4. Measures in the field of hydrogen

### 5.4.1. Measures for the deployment of infrastructure for the supply of hydrogen to fuel cell powered vehicles

In Germany, infrastructure for the supply of hydrogen to road transport will be deployed by the industry. By founding H2 Mobility Deutschland GmbH, the companies involved have laid the organizational basis for the deployment of a network of hydrogen refuelling points providing universal coverage, thereby creating a nationwide hydrogen supply system.

As the National Hydrogen and Fuel Cell Technology Innovation Programme (NIP) is continued with a lifetime from 2016 to 2025, assistance can be provided to the development of infrastructure for the supply of hydrogen to fuel cell powered vehicles. The future measures of the Federal Government aim to establish competitive mobility using hydrogen and fuel cells in the next ten years. The objective of funding research and development in the field of hydrogen and fuel cell technology is to further reduce the costs of components and systems. To complement this, the Federal Government is accompanying the market ramp-up in the transport sector by taking specific market activation measures in the form of initial market launch programmes.

As far as the infrastructure for the supply of hydrogen to the transport sector is concerned, the Federal Government is proactively involved in the preparations for and implementation of the development of a commercial network of refuelling points. The funding provided by the NIP is complemented by European Commission financial assistance programmes (such TEN-T, Fuel Cell and Hydrogen Joint Undertaking (FCH JU)),

Combined transport terminals (CT terminals) and inland freight ports are a point of call for vehicles from various transport sectors (goods vehicles, locomotives, inland waterway vessels). By siting refuelling points at CT terminals and inland ports, it will be possible to supply various modes of transport and ensure sufficient capacity utilization of the refuelling systems. It is true that different refuelling devices will have to be provided for the individual categories of transport. However, it will be possible to make common use of certain system components (hydrogen tanks, delivery of the tanks). Depending on where the facility is sited at the terminal, it may also be possible to use it locally for refuelling passenger cars. In this context, the Federal Government plans to prioritize CT terminals and inland ports as sites for hydrogen refuelling points.

Following an initiative by the Federal Government, the "Service of Station of the Future" is being constructed at Fürholzen West on the A 9 motorway, thereby putting into practice a filling station

strategy that not only provides refuelling facilities for conventional fuels but also completely integrates refuelling and charging infrastructure for alternative fuels. This includes the installation of high power recharging points plus a hydrogen refuelling point. Completion is scheduled for the end of 2017.

#### **5.4.2. Further measures in the field of hydrogen**

The Federal Government is considering measures to improve the regulatory framework for the production of electricity-based hydrogen. A minimum rate of hydrogen generated without producing CO<sub>2</sub> of 50 percent is already in place at the refuelling points that have been deployed. The target is a 100 percent rate.

Other topics that the Federal Government will fund as the NIP continues are: reducing upstream CO<sub>2</sub> emissions in the provision of hydrogen (production and distribution, i.e. a rising share of the production of hydrogen from renewable energy sources in the portfolio of the total amount of hydrogen put on the market as a fuel); taking account of national basic coverage, synchronized with the vehicle ramp-up, in the network planning; harmonization with relevant EU initiatives such as the Trans-European Transport Network (TEN-T); achieving technical objectives, some of which still have to be defined in detail (for instance availability) and complying with technical standards; achieving defined cost targets; non-discriminatory access; and a uniform accounting process.

The disadvantage in company car taxation has already been offset by taking the battery into account. The Federal Government is now considering whether, and if so to what extent, fuel cell powered vehicles can also benefit from this arrangement.

As part of the transposition of EU Directive 2015/652, the Federal Government plans to count the use of renewable hydrogen from non-biological sources against the greenhouse gas rate regulated by the Federal Immission Control Act. The higher efficiency of fuel cell powered vehicles will be taken into account here. This arrangement will create possibilities for fulfilling the greenhouse gas rate, which has hitherto been geared towards biofuels, by means of other measures.

The use of hydrogen in inland waterway transport and maritime shipping is also being studied as part of the NIP lighthouse project entitled e4ships. Once the feasibility and cost efficiency have been demonstrated, the fuel cell systems are to be developed until they are commercially mature.



## 5.5. Cooperation with EU Member States

Article 3(4) of Directive 2014/94/EU calls for the national policy frameworks to be coordinated and for their coherence to be ensured at Union level by means of cooperation between the Member States. In keeping with the Directive, the Federal Government coordinates its plans for the deployment of alternative fuels infrastructure not only in bilateral cooperation but also with the EU Member States in the following bodies.

### 5.5.1. Government Support Group (GSG)

Following an initiative by Germany and other Member States, the Government Support Group (GSG) was founded in 2013. The objective of the GSG is to harmonize the national policy frameworks for the uniform transposition of the Directive in the Member States. The exchange of ideas and experience in the GSG is also of great importance to ensure harmonized standards and requirements in international transport. As at June 2016, the Group comprised Germany, the Netherlands, the United Kingdom, France, Denmark, Sweden, Austria, the Czech Republic, Poland, Belgium and Luxembourg. Issues relating to specific fuels are addressed by sub-working groups of the GSG.

### 5.5.2. Sustainable Transport Forum (STF)

In addition, Germany is actively involved in the exchange of ideas and experience between Member States and the industry on the topic of alternative fuels as a whole, which is supported within the STF.

### 5.5.3. European Forum for Sustainable Shipping (ESSF)

At EU level, a forum for the discussion and exchange of information on practical issues relating to transposition of the EU Sulphur Directive has been created. This is the Commission Expert Group on Maritime Sustainability – The European Sustainable Shipping Forum (ESSF). It comprises Member States and industry representatives. Various sub-groups have been created within the ESSF, including one for LNG in the shipping sector. This sub-group addresses, among other things, issues relating to guidelines, standards as well as the delivery, bunkering and use of LNG, plus the associated market launch, safety, operational, technical and, if appropriate, training aspects. There is cooperation with other activities and initiatives in the field of LNG.





#### **5.5.4. Bilateral cooperation**

As at June 2016, institutionalized collaborative schemes on the topic of electric mobility are being established with France, Italy and the United Kingdom.

#### **5.5.5. Workshop on European Cooperation**

The aim of this meeting is to achieve closer linkage between projects for the deployment of hydrogen infrastructure, especially to ensure interoperability within Europe, thereby creating a major practical condition for cross-border mobility.



## 6. Measures to promote private charging infrastructure

Article 4(3) of Directive 2014/94 calls for Member States to take measures within their NPF to encourage and facilitate the deployment of recharging points not accessible to the public.

The purpose of private charging infrastructure on the user's own parking space (for instance at home, in an underground car park, on a rented parking space or at the workplace) is to ensure a basic supply of electricity for electric vehicles. Accordingly, it will be easier for electric mobility to establish itself in places where users have access to private charging infrastructure.

For the use of electric mobility in freight and commercial transport, in particular, private charging infrastructure is usually necessary, for instance at the depot or on the company premises. In many cases, it must be ensured that vehicles have access to the charging infrastructure at all times, in order to cover the usage profiles of the vehicles and ensure that they are ready for operation. The Federal Ministry of Transport and Digital Infrastructure's Electric Mobility Funding Guidelines of 9 June 2016 make it possible to provide financial assistance to vehicles and the requisite charging infrastructure. Special charging infrastructure for Category N2, N3, M2 and M3 vehicles and for special purpose vehicles can, after a case-by-case review, be recognized as eligible for funding in full and does not have to meet the general public accessibility requirement.

The installation, modification and change in use of electric vehicle charging infrastructure as a physical structure normally requires planning permission. In many cases, however, federal state building regulations already state that construction projects do not require planning permission.

The deployment of private charging infrastructure is primarily the responsibility of the user. Individual owners of properties can decide themselves whether they wish to install charging infrastructure (both private and publicly accessible). Persons renting parking spaces and homeowners with separate ownership or a special right to use a parking space usually require the consent of the lessor or the other homeowners.

The Federal Government is pursuing the objective of dismantling potential obstacles to the deployment of private infrastructure. It is therefore examining whether measures to support the market ramp-up of electric mobility are necessary and possible and, if so, what measures. One element of this examination is also house ownership and rent law.



The federal states of Bavaria, Saxony and Hesse have tabled an initiative in the German Bundesrat to facilitate physical measures for the installation of charging stations at private vehicle parking spaces.<sup>54</sup> The objective of the initiative is to reduce the legal obstacles for both homeowners and tenants. The aforementioned federal states are also seeking corresponding amendments to legislation at the federal level.

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<sup>54</sup> <http://www.bayern.de/bericht-aus-der-kabinettsitzung-vom-21-juni-2016;>  
[http://www.bundesrat.de/SharedDocs/beratungsvorgaenge/2016/0301-0400/0340-16.html;](http://www.bundesrat.de/SharedDocs/beratungsvorgaenge/2016/0301-0400/0340-16.html)  
[http://www.bundesrat.de/SharedDocs/drucksachen/2016/0301-0400/340-16.pdf?\\_\\_blob=publicationFile&v=1](http://www.bundesrat.de/SharedDocs/drucksachen/2016/0301-0400/340-16.pdf?__blob=publicationFile&v=1)

## 7. Measures to promote alternative fuels in public transport

Article 3(1) of Directive 2014/94/EU calls for measures that can promote the deployment of alternative fuels infrastructure in public transport services.

The Federal Government believes that there is considerable potential for the use of electric mobility solutions in public transport. In the case of buses and coaches in particular, (partial) electrification will make it possible to save fossil fuels. To make the entire spectrum of electric mobility visible to the public and to enable them to experience it at first hand, the Federal Government – in consultation with the NPE – established two funding instruments: the pilot regions and the regional showcases.

Transport operators, in particular, are becoming increasingly keen to use electrically powered buses. Electric drivetrains are quiet and produce zero emissions at the point of use, thereby making a contribution towards improving the quality of the air in towns and cities. Recently, the City of Cologne included eight electric articulated buses in its fleet for the first time. The focus of measures to electrify public transport and the associated infrastructure is on applied research and development. In diverse projects, experience is being gathered in practical tests in order to develop appropriate products to commercial maturity. Alongside the use of hybrid buses in various R&D and pilot projects, alternative charging technologies such as inductive charging for buses are being researched and trialled.

As the NIP is continued, the Federal Ministry of Transport and Digital Infrastructure will continue to fund research and development and the trialling of fuel cell powered buses with the primary objective of cutting costs. The operation of fuel cell powered buses is currently being tested in Hamburg, Karlsruhe, Stuttgart and Cologne (2016). Complementing this, projects are being funded by the EU within the scope of the FCH JU. In 2016 and 2017, one call per year will be launched for the funding of buses and hydrogen infrastructure at bus garages. By means of joint procurement clusters in Europe and at national level, nine partners in Germany (including Bolzano) are set to procure and operate more than 100 buses. Twelve partners from several European projects are involved in a European funding project for hydrogen infrastructure at bus depots.

The Federal Government will step up its efforts to promote low-emission mobility in towns and cities by launching additional funding schemes in the field of alternative fuels and drivetrains in local public



transport. This funding is intended as a subsidy for the extra investment costs involved in the new technology. The measures will focus on funding for buses with alternative drivetrains. Battery electric vehicles, fuel cell powered vehicles, natural gas powered buses and hybrid trolley buses will be eligible for funding.

More specifically, the funding of procurement within the scope of the National Climate Initiative, which has hitherto been provided for hybrid and plug-in hybrid buses, will be widened to cover electric buses, since electric buses are now ready for mass production.

Within the scope of the Electric Mobility Funding Guidelines of 9 June 2015, the Federal Ministry of Transport and Digital Infrastructure is supporting the development of local authority electric mobility strategies, including the procurement of vehicles and the deployment of charging infrastructure. This comprises first the procurement of electric vehicles and the installation of appropriate infrastructure, and second the development of electric mobility strategies, for instance for increasing the share of electric vehicles in public transport or on innovative electrically powered (heavy) goods vehicles. The market ramp-up of electric vehicles is also being supported by the provision of financial assistance to research and development in the field of the electrification of public transport, goods and special-purpose vehicles, ships and other applications relevant to transport.

On the railways, the Federal Ministry of Transport and Digital Infrastructure is supporting, within the scope of the NIP, the trialling of the operation of fuel cell powered rolling stock. Only around 60 percent of the German rail network is electrified. For this reason, many trains, especially those running on secondary lines, consist of diesel railcars. Fuel cell powered electric mobility can be a zero-emission alternative for railway undertakings. The first prototypes are due to commence test operation at the end of 2016. By 2021, a total of 50 vehicles are due to be in operation on regular passenger services in four federal states (Lower Saxony, North Rhine-Westphalia, Baden-Württemberg and Hesse). Within the scope of scientific research support for railway infrastructure, the technical, legal and economic parameters for the deployment of hydrogen infrastructure on the railways were studied from November 2015 to June 2016 and strategies for implementation were delivered.

The market launch of fuel cell powered rolling stock is contingent on its being ordered by railway undertakings. They respond to, among other things, the terms of the tenders issued by the integrated transport authorities, so that one approach is to encourage the latter to include an obligation to use alternative fuels in their invitations to tender. Currently, an invitation to tender of this nature would fail because of the lack of hydrogen infrastructure on the respective network, which means that the integrated transport authorities have to be supported here. It is on secondary

lines with regional services, in particular, that the Federal Government sees considerable potential for the introduction of fuel cell technology. It is currently seeking to clarify the extent to which a certain fuel or zero emissions can be stipulated in an invitation to tender for local transport services. If necessary, it will address the creation of appropriate legal bases.

In Germany, marshalling yards are operated predominantly using diesel traction. This is especially problematical, because there is a high level of emissions in a small area and the marshalling yards are mostly in inner city locations. These installations thus feature as emission hot spots in pollutant measurements conducted by some federal state environment agencies. For this reason, converting shunting operations to alternative fuels would directly contribute to a tangible improvement in the quality of air in conurbations. At the same time, this conversion is possible with a relatively low level of investment in refuelling points, because here there is a high level of mileage on a relatively low area. The Federal Government is thus considering the launch of a financial assistance programme for the installation of hydrogen refuelling infrastructure at marshalling yards.

In addition, within the scope of the planned amendment of the Energy Tax Act and the Electricity Tax Act, consideration is being given to the inclusion of privileges for electric buses and hybrid buses in the Electricity Tax Act.

The federal states are also promoting alternative fuels in public transport, for instance through the procurement of electric buses via their own funding guidelines. Thus, for instance, Thuringia is supporting the purchases of alternatively fuelled local public transport vehicles and the appropriate infrastructure (funding provided for two electric buses to replace diesel buses in Bad Langensalza). In Lower Saxony, grants are provided for the procurement of local public transport buses and appropriate charging facilities. Mecklenburg-Western Pomerania provides financial assistance for alternatively fuelled local public transport buses totalling up to 85 percent of the eligible expenditure (but not more than 130,000 euros per vehicle.) Within the scope of the financial assistance provided to buses in Bavaria (funding under the Bavarian Local Authority Transport Infrastructure Financing Act by the Bavarian State Ministry of the Interior, Building and Transport), electric buses have, since 2013, benefited from a higher rate of funding, which incentivizes more stringent emissions standards.



## **8. Infrastructure deployment in urban/suburban conurbations or densely populated regions and along extra-urban networks**

### **8.1. Electricity**

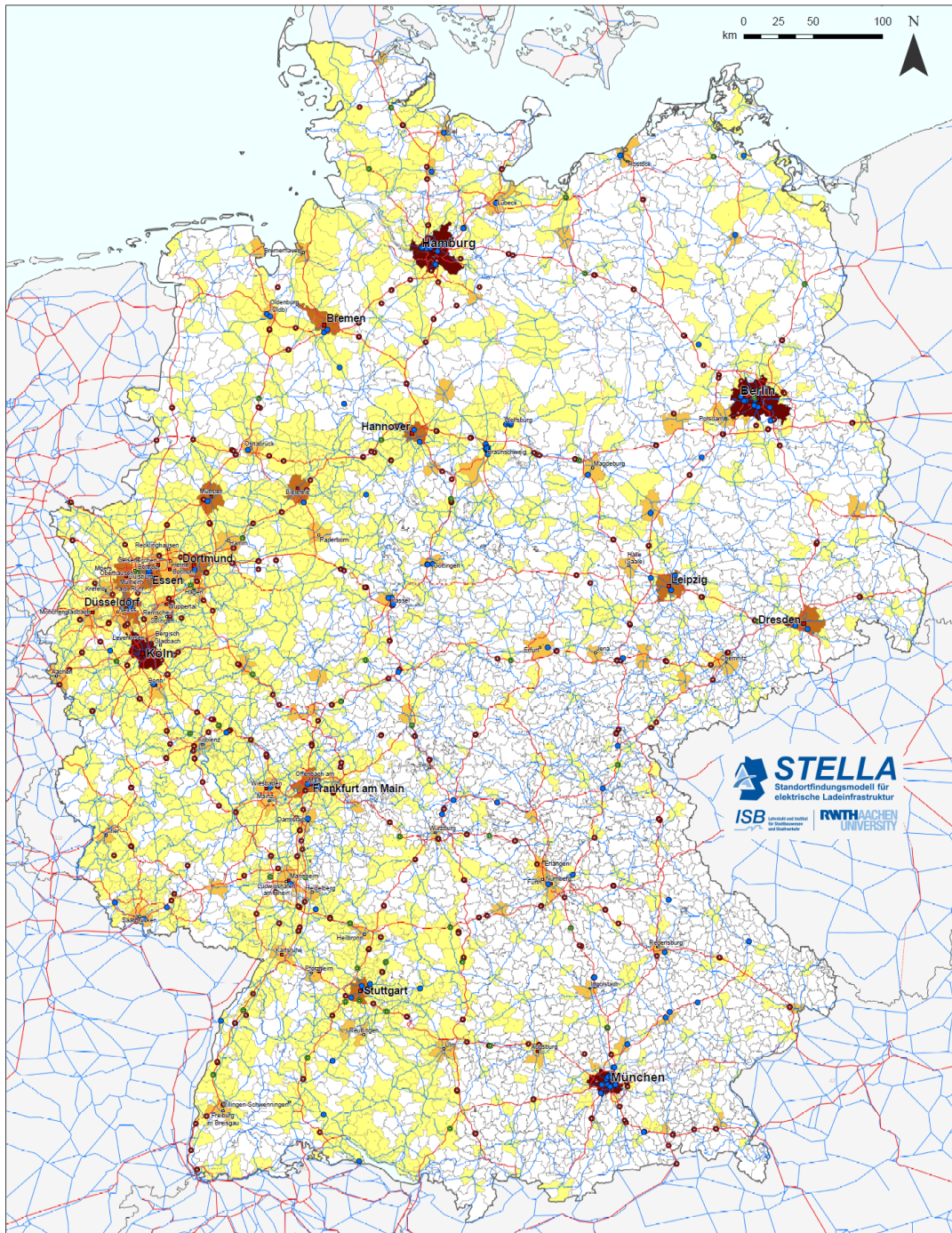
The Federal Government believes that electric mobility will not be successful unless a high power charging network that ensures nationwide coverage is available from the outset. This is the only way that customers will be able to seriously consider electric mobility as a possible option in comparison with the other types of fuel. Accordingly, the infrastructure ramp-up will lay the foundations for the vehicle ramp-up.

The objective of the Federal Ministry of Transport and Digital Infrastructure's financial assistance programme for charging infrastructure (see Chapter 5.2.1) is to launch a network that provides universal coverage. An overarching planning and monitoring tool is to ensure that the deployment is regionally balanced. The deployment of charging infrastructure must be in line with demand to the greatest extent possible but must also provide universal coverage. To ensure this, it is necessary to continuously monitor all charging infrastructure deployment activities and their integration into future planning. Within the scope of the financial assistance programme, the development of high power charging infrastructure is to be controlled regionally.

In the field of normal charging, in particular, the Federal Government's measures will be supplemented by regional and municipal activities. Thus, for instance, various federal states will implement their own support measures to boost the development of charging infrastructure. The aim is to ensure a joint course of action in the funding of charging infrastructure and the coordination of all measures by the Federal Government.

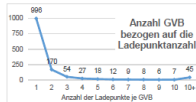






**Verkehrsnetz**  
 - Hauptfernverbindungen  
 - weitere wichtige Elemente  
 - Hauptfernverbindungen (Netz 2030)  
 - weitere wichtige Elemente (Netz 2030)

**Ladepunkte je GVB**  
 - bis zu 4  
 - bis zu 20  
 - bis zu 40  
 - mehr als 40



Bearbeiter: Waldemar Brost (ISB)  
 Methode: STELLA-Brost-v3g  
 Bearbeitungsstand: 14. Jan 2016  
 Stand Ladestationen: 8. Jan 2016  
 Kartengrundlage:  
 BKG, BWP+Verflechtung; HERE Maps;  
 SLAM; GoingElectric; EC Europe;  
 RWTH Aachen University



**Figure 9: Example of the distribution of high power recharging point on arteries and in rural areas<sup>55</sup>**

## 8.2. Natural gas

Article 6(7) of the Directive formulates the objective that CNG powered vehicles must be able to operate in all agglomerations and densely populated areas by 2020. Analyses conducted by the Fraunhofer IML research institute as part of the evolution of the Mobility and Fuel Strategy show that this requirement of the Directive is already met with the existing CNG supply infrastructure in Germany. These analyses also took the refuelling facilities in neighbouring countries into account in order to enable European cooperation through holistic optimization of the network of refuelling points.

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<sup>55</sup> RWTH Aachen: *Flächendeckendes Schnellladenetz. Studie zur Ermittlung des Ladepunktbedarfs in Deutschland*



## 9. LNG refuelling points at seaports and inland ports on the TEN-T Core Network

The six seaports are Bremen, Bremerhaven, Hamburg, Lübeck, Rostock and Wilhelmshaven, with four of these ports (Bremen, Bremerhaven, Hamburg and Lübeck) also numbering among the 21 inland ports of the TEN-T Core Network. The other inland ports of this network are primarily along the Rhine (seven ports) and within the German canal network (six ports). Of the remaining four ports, one is on the Elbe, one on the Danube, one on the Main and one on the Neckar.

	Seaports	Inland ports
<b>North Sea</b>	Bremen, Bremerhaven, Hamburg, Wilhelmshaven	Bremen, Bremerhaven, Hamburg
<b>Baltic Sea</b>	Lübeck, Rostock	Lübeck
<b>Rhine</b>		Cologne, Duisburg, Düsseldorf, Karlsruhe, Koblenz, Mainz, Mannheim/Ludwigshafen
<b>Elbe</b>		Magdeburg
<b>Danube</b>		Regensburg
<b>Main</b>		Frankfurt/Main
<b>Neckar</b>		Stuttgart
<b>Canal network</b>		Berlin, Braunschweig, Dortmund, Hamm, Hannover, Nuremberg

**Table 12: Geographical location of the seaports and inland ports of the TEN-T Core Network<sup>56</sup>**

<sup>56</sup> <http://ec.europa.eu/transport/infrastructure/tentec/tentec-portal/site/en/maps.html>, Annex II – List of nodes of the core and comprehensive network

## 9.1. Possible bunkering methods

Deployment of the refuelling infrastructure distinguishes between three different main bunkering methods for sea-going ships and inland waterway vessels: "truck-to-ship", "ship-to-ship" and "shore-to-ship".<sup>57</sup>

Truck-to-ship involves the sea-going ship or inland waterway vessel to be bunkered being supplied with LNG by truck. This method is used when there is no other infrastructure for bunkering the ships/vessels and is thus a kind of low-level option or temporary makeshift solution.<sup>58</sup> This is currently the most widespread form. According to information provided by the Ministry of Energy, Infrastructure and Regional Development of the State of Mecklenburg-Western Pomerania, a cement carrier was bunkered with LNG from a truck at the port of Rostock at the end of February 2016. In May 2016, the cruise liner "AIDAprima" was bunkered with LNG from a truck during a layover in Hamburg. This form of bunkering is also practised at Brunsbüttel and Bremerhaven. In Bremerhaven, the Borkum ferry MS Ostfriesland was bunkered from a truck for the first time after its conversion from diesel to LNG propulsion.<sup>59</sup> In the inland waterway transport sector, the first inland waterway vessel in Germany was bunkered from a truck at the port of Mannheim in 2013.<sup>60</sup>

Ship-to-ship involves bunkering a sea-going ship or inland waterway vessel via an LNG bunkering vessel. There is at yet no such bunkering vessel in Germany. However, since 2013, at the port of Stockholm, the cruise liner "Viking Grace" has been refuelled ship-to-ship via the first European bunkering vessel.<sup>61</sup> In Europe, LNG bunkering vessels are currently under construction for the ports of Rotterdam and Zeebrugge, among others, and are due to be commissioned in 2016/2017 (see also Chapter 9.2). This principle offers a certain flexibility of the bunkering location. Thus, for instance, a bunkering vessel based in Rotterdam could also serve German seaports.

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<sup>57</sup> Fraunhofer CML: *Bedarfsanalyse LNG in Brunsbüttel* (2015), p. 42

<sup>58</sup> Fraunhofer CML: *Bedarfsanalyse LNG in Brunsbüttel* (2015), p. 42

<sup>59</sup> <http://www.ag-ems.de/die-ag-ems/presse/pressemitteilungen/article/bomin-linde-lng-fuehrt-die-betankung-des-ersten-deutschen-schiffs-mit-fluessigerdgas-durch.html>

<sup>60</sup> [www.hafen-mannheim.de/de/presse/aktuelle-pressemitteilungen/erste-lng-betankung](http://www.hafen-mannheim.de/de/presse/aktuelle-pressemitteilungen/erste-lng-betankung)

<sup>61</sup>

[http://www.portsofstockholm.com/siteassets/trycksaker/ports\\_of\\_stockholm\\_meets\\_new\\_environmental\\_requirements\\_with\\_lng.pdf](http://www.portsofstockholm.com/siteassets/trycksaker/ports_of_stockholm_meets_new_environmental_requirements_with_lng.pdf)

The third bunkering method, shore-to-ship, involves a sea-going ship or inland waterway vessel being refuelled by means of direct access to an LNG tank or pipeline.<sup>62</sup> As yet, there is no such bunkering facility for sea-going ships and inland waterway vessels in Germany, although time and again there are plans for the construction of such a facility at various seaports. In Europe, there are already a few such stationary bunkering stations. In Risavika/Stavanger (Norway), for instance, a bunkering station for the refuelling of LNG ferries was opened in March 2015. Here, the ships are refuelled with the help of a loading arm rather than a hose connection, and a refuelling rate of 300 m<sup>3</sup> per hour is possible.<sup>63</sup> At Antwerp, a bunkering station with an annual volume of 45,000 m<sup>3</sup> and a refuelling rate of 100 m<sup>3</sup> per hour is planned.<sup>64</sup> Table 13 shows a comparison of the advantages and disadvantages of the bunkering methods.

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<sup>62</sup> Fraunhofer CML: *Bedarfsanalyse LNG in Brunsbüttel* (2015), p. 42

<sup>63</sup> Fraunhofer CML: *Bedarfsanalyse LNG in Brunsbüttel* (2015), p. 43

<sup>64</sup> Fraunhofer CML: *Bedarfsanalyse LNG in Brunsbüttel* (2015), p. 43

Method	Advantages	Disadvantages
<b>Truck-to-ship</b>	<ul style="list-style-type: none"> <li>- Bunkering directly at the berth, for instance during loading and unloading</li> <li>- Low investment costs</li> </ul>	<ul style="list-style-type: none"> <li>- Low tank capacity</li> <li>- High transport costs</li> </ul>
<b>Ship-to-ship</b>	<ul style="list-style-type: none"> <li>- Bunkering directly at the berth, for instance during loading and unloading</li> <li>- Can be combined with the supply of fresh water, disposal of ballast water and change of crew</li> </ul>	<ul style="list-style-type: none"> <li>- Investment in LNG bunkering barge required</li> <li>- Management of LNG bunkering barge necessary</li> </ul>
<b>Shore-to-ship</b>	<ul style="list-style-type: none"> <li>- Rapid bunkering</li> <li>- Large tank capacity</li> </ul>	<ul style="list-style-type: none"> <li>- Bunkering only possible at a fixed berth, i.e. separate from cargo handling</li> <li>- Additional time required because of extra stop</li> <li>- High investment costs</li> </ul>

**Table 13: Advantages and disadvantages of the three bunkering methods<sup>65</sup>**

## 9.2. LNG infrastructure meeting current and future requirements

To achieve an economically efficient use of LNG, ships must be able to bunker the fuel without any great additional effort or special voyages, i.e. at their planned port of call. Here, the following distinction has to be made between the different types of ship suitable for LNG:

- Ferries, which call at fixed berths, offer the theoretical option of shore-to-ship bunkering from intermediate fuel depots. However, experience has shown that the space available at ports in the vicinity of the berths is limited. It should thus first be examined, on a case by case basis, whether the creation of LNG storage sites in the vicinity of the berths is feasible, which would make shore-to-ship bunkering possible. In such cases, the use of LNG lighters for intermediate storage can make this bunkering method more flexible (ship-to-ship). In the

<sup>65</sup> Own representation based on the study by Fraunhofer CML: *Bedarfsanalyse LNG in Brunsbüttel* (2015), p. 44

case of smaller ferries, the supply of LNG by truck is the most economical form (truck-to-ship).

- Cruise ships likewise regularly set sail from certain ports and usually operate a similar route. Here, there is also the possibility of ship-to-ship bunkering.
- Container ships operate on multi-port itineraries and have to be bunkered on the quayside at these ports using the "truck-to-ship" or "ship-to-ship" method, depending on the size of the ship.

From this, it follows that there is not necessarily a need for stationary LNG bunkering facilities. The industry agrees with this assessment. It assumes that LNG bunkering facilities can be constructed at short notice if there is great demand. Ship-to-ship is an option for larger ships. Contracts for such bunkering vessels have already been awarded. One has been ordered to be based at Rotterdam. In addition to Rotterdam, an LNG bunkering vessel is also under construction for the port of Zeebrugge, which is due to be commissioned before the end of 2016.<sup>66</sup> These bunkering vessels will be able to cover the low demand for LNG at the North Sea ports in the years ahead.

In the inland waterway transport sector, the focus is on inland traffic to and from seaports, which means that a possible supply of LNG at the seaports would create synergies through refuelling options for inland waterway vessels and sea-going ships. The range of an LNG-powered inland waterway vessel is around 2,500 km. This range covers the regular round voyages in both Rhine and Elbe shipping. This applies to both multi-port itineraries in containerized transport and direct traffic in conventional transport. Truck-to-ship bunkering does not require any time-consuming authorization procedure on the part of the safety authorities and can thus be implemented relatively quickly. Currently, inland waterway vessels are refuelled regularly in Rotterdam and Mannheim.

Thus, as far as the market ramp-up is concerned, truck-to-ship or ship-to-ship bunkering is the most economically efficient option. According to information provided by the players and experts, the construction of stationary facilities (shore-to-ship) in Germany does not currently represent value for money.

For the market ramp-up, priority should be given to supporting and funding the more flexible measures, because this can create simple market access. On the whole, it is apparent that developing

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<sup>66</sup> <http://www.thb.info/rubriken/schiffbau/single-view/news/lng-bunkerschiffe-sind-unverzichtbar.html>



the truck-to-ship method as the next step, primarily along the inland waterways, is more likely to make the market ramp-up possible. Both the lower investment costs and the flexibility of the refuelling location will facilitate the introduction of LNG even if demand is low. The port of Mannheim is a positive example of this approach.

It will be possible to build on this experience in the further introduction of LNG in Germany. As demand rises, both the ship-to-ship and shore-to-ship methods will be possible options. Introduction of the ship-to-ship method has the advantage that it provides sizeable tank capacity while preserving the flexibility of the refuelling location. In this way, for instance, ports located in close proximity to one another can avail themselves of one LNG bunkering vessel. The major seaports, which have various bunkering locations, also lend themselves to the stationing of a bunkering vessel. Because of the high investment costs, the construction of a stationary terminal in the inland waterway transport sector is not currently an option. Nevertheless, depending on how the sales of LNG evolve, this approach should be reviewed again for the seaports in the years ahead and also for the inland ports at a later date. Assuming that there is a basic demand (for instance as the result of a ferry service) and that appropriate space is available at the port, a modular shore-to-ship bunkering facility could be constructed in the vicinity of the corresponding berth. Starting from a low capacity, the modular construction would make it possible to enlarge the bunkering station in line with demand. The bunkering station would be supplied either by connection to a pipeline or from the sea.

At both inland ports and seaports, shore-to-ship bunkering facilities could be delivered with other means of transport and consumers in mind, in order to exploit the synergies. Possible consumers here include local public transport, waste management, major industrial consumers or large logistics establishments. It would also be possible to exploit synergies with LNG import terminals in order to reduce the investment costs.<sup>67</sup> The use of mobile solutions would also make it possible to respond quickly to demand and requirements from outside the TEN-T Core Network, both in the Comprehensive Network and outside the TEN-T Network. Brunsbüttel is located geographically between the German North Sea ports of the TEN-T Core Network and could thus ensure the mobile supply to all TEN-T Core Network ports in the North Sea region. Wilhelmshaven would be a suitable deep-sea port for the construction of an LNG import terminal.

As already mentioned, the Rhine is the most important waterway on the TEN-T Network and has the most Core Network ports in Germany. Refuelling facilities covering the Rhine are currently in place at

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<sup>67</sup> [www.brunsbuettel-ports.de/artikel/fraunhofer-cml-studie-bestaetigt.html](http://www.brunsbuettel-ports.de/artikel/fraunhofer-cml-studie-bestaetigt.html)

Rotterdam and Mannheim. Further activities are planned at Weil am Rhein and Basle.<sup>68</sup> As a result, the most important waterway is covered for a market ramp-up. As far as Elbe shipping is concerned, demand can be covered by truck-to-ship in the first phase and ship-to-ship in the second phase.

Demand on the Danube can also be covered by truck-to-ship.

The initial lessons learned from truck-to-ship have shown, taking the Emden-Borkum ferry service or Mannheim as an example, that this method works and the bunkering of such units is possible. In addition, the lessons learned in Stockholm, for instance, have shown that the ship-to-ship method is suitable for larger tank capacities. Greater support should be given to this development for the market ramp-up and the existing mobile bunkering facilities. A bunkering vessel takes between 12 and 18 months to build.<sup>69</sup> In this way, it is possible to respond sufficiently quickly and flexibly to orders placed for LNG sea-going ships – in the case of larger ships this is known up to five years in advance – and thus to demand.

### 9.3. Funding strategy

Because of the situation regarding the demand for LNG, stationary LNG bunkering facilities will not be required in the near future. For the time being, the demand for LNG can be met using the truck-to-ship and ship-to-ship methods. The objective of a funding policy for LNG in maritime shipping is to be to support the economic viability of LNG in such a way that LNG is accepted as a fuel alternative by the German maritime shipping sector and plays an increasingly important role. Appropriate measures are described in Chapter 5.3.4.

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<sup>68</sup> Interview with Boris Kluge, Managing Director, Federal Association of Public Inland Ports

<sup>69</sup> Assessment based on talks with the "Maritime LNG Platform"



## **10. Assessment of the need for LNG refuelling points at seaports and inland ports outside the TEN-T Core Network**

Using mobile infrastructure for bunkering – truck-to-ship in the first phase and ship-to-ship in the second phase – also makes it possible to respond flexibly at ports outside the TEN-T Core Network. Ports and the waterway system enable synergies between core and non-core ports. The ranges of inland waterway vessels and the characteristics of inland waterway transport, with its focus on inland traffic to and from seaports, make it possible – primarily on the Rhine and its tributaries as well as on the Elbe and the canal system – to use the facilities at Mannheim and at the seaports of Bremerhaven and Rotterdam. The creation of separate terminals at other ports is not necessary, either now or in the immediate future.



## 11. Shore-side electricity supply at seaports and inland ports

Article 4(5) of Directive 2014/94/EU calls for the installation of shore-side electricity supply at seaports and inland ports by 31 December 2025 provided that there is demand and a positive cost-benefit ratio, including possible environmental benefits, is demonstrated.

The use of shore-side electricity can replace the use of fossil fuels for ships during layovers, thereby reducing emissions at ports. This is especially true if electricity from renewable sources is used. Shore-side electricity supply projects have already been implemented at the ports of Lübeck and Hamburg. Likewise, some berths on inland waterways have also been equipped with electric filling stations. As an optional extra to shore-side electricity generation, the use of fuel cells, for instance, to generate on-board electricity also makes it possible to replace fossil fuels and reduce emissions.

### 11.1. Regulatory framework

Section 9(3) of the Electricity Tax Act stipulates a reduced rate of taxation for shore-side electricity of 0.50 euros per megawatt hour.

It is currently difficult to describe, from a business management perspective, an appropriate provision of shore-side electricity supply at seaports because of the high investment costs involved in the establishment of the necessary connections at the ports and on board ships. A ship's electricity demand can easily be as high as several megawatt hours, which means that in some cases it may even be necessary to install new electricity generation capacity to supply the ships. In addition, there is significant investment at the level of the distribution networks and on board ships for the transmission of these quantities of electricity. TEN-T funding can help to enhance the attractiveness of shore-side electricity compared with the on-board generation of electricity.

In the inland waterway transport sector, emission and, in particular, noise mitigation requirements may produce a more positive framework for the provision of shore-side electricity supply at the berths. Because the demand for electricity is usually lower here, the requirements to be met by the connection to the grid and by the distribution network are also lower.



## 11.2. Existing and planned measures

In the Federal Government's opinion, the shore-side generation of electricity is to be considered as beneficial in principle. However, from an operational perspective and in the current environment, it can only be actually implemented in a few individual cases. The principal factors to be considered are the availability of correspondingly large amounts of electricity at the site plus the fact that it may be necessary to upgrade the grid to provide the power required.

Infrastructure projects at inland ports and seaports are the responsibility of the federal states and the port operators. Incentive programmes can thus only be established by the federal states.

Nevertheless, the Federal Government believes that it is a good idea to support the development of shore-side electricity supply in the medium to long term.

Within the scope of projects it is funding, the Federal Government is already supporting pilot projects for the provision of shore-side electricity equipment. Thus, for instance, a shore-side electricity supply facility for cruise liners was opened in Hamburg in June 2016 that was funded from the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety's Environmental Innovation Programme. As an alternative to shore-side electricity supply, various NIP projects are studying the possibility of supplying the power needed for on-board services (electricity, heating, air conditioning, steam) on cruise liners docked in port with the help of on-board fuel cells. This would obviate the need for expensive infrastructure projects at ports.

In addition, electricity supply at the port of Hamburg is provided by a "power barge". The electricity generated on board the barge is provided to cruise liners on a mobile basis.

On 20 January 2016, the Federal Cabinet adopted the National Ports Strategy, in which the objectives for its ports policy in the years ahead are defined. The major objectives include boosting climate change mitigation and environmental protection at ports, for instance through the use of alternative fuels and the supply of shore-side electricity to vessels. One of the Federal Government's objectives, as set out in the National Ports Strategy, is the adaptation of the EU Energy Products Directive to the effect that there is mandatory tax exemption for shore-side electricity supplied to commercial shipping. To this end, the Federal Government, acting on a proposal by the Commission, has had the Council extend to 2020 the arrangement – authorized as an exemption under Article 19 of the EU Energy Products Directive (2003/96/EC) – on the taxation of shore-side electricity at the minimum rate of 0.50 euros per megawatt hour from section 9(3) of the Electricity Tax Act.



Another objective must be to draw down the funds available in TEN by the federal states and ports submitting high-quality projects in order to progress the development of shore-side electricity supply.

The Federal Government is discussing further options for supporting shore-side electricity supply, for instance by exempting the generation of shore-side electricity from the renewable energy and CHP surcharges.



## 12. Ground power supply at airports

Article 3(1) of Directive 2014/94/EU requires Member States to consider the need to install electricity supply at airports for use by stationary airplanes. The development of the airports is a federal state responsibility.

Aircraft have auxiliary power units (APUs) to supply them with electricity and conditioned air on the ground. When the main engine is shut down, these units are turned on to provide a supply and run on kerosene. APUs tend to exhibit a low degree of efficiency and, as a result, consume an above-average amount of fuel. This produces significant noise and exhaust emissions on the airport grounds.

Airports are thus increasingly being equipped with ground power supply equipment, in some cases complemented by systems for the provision of preconditioned air. As part of measures to reduce noise at airports and achieve the operators' climate change and environmental targets, ground power supply has already been significantly developed in recent years. Two different versions are usually used here. At the gate stands, ground power is supplied by the airport grid. At the remote stands, on the other hand, ground power units (GPUs) tend to be used, which use diesel generators to produce the electricity.

According to information provided by the Association of German Airports, 95 percent of the existing gate stands at eleven German airports are equipped with ground power supply equipment. For the supply of ground power at remote stands, however, ground power units are available for only around 25 percent of the stands in 2016. It should, however, always be borne in mind that not every parked aircraft has a need for energy supply, but usually only those that are being prepared for their next flight. Aircraft are often parked at remote stands for lengthy periods of time and do not require any energy supply whatsoever.

Providing all remote stands with stationary ground power supply systems requires elaborate technology and is thus cost-intensive, which means that ground power units will probably continue to be the supply system of choice. In the medium to long term, there is the possibility here of also using alternative fuels (for instance hydrogen) for the mobile supply of ground power, thereby further reducing emissions. Initial pilot projects are already underway.



## 12.1. Regulatory framework

Unlike the supply of shore-side electricity to ships, the Electricity Tax Act does not contain any explicit tax reduction for the supply of ground power to aircraft. On the other hand, electricity generated on board aircraft and watercraft is totally exempt (section 9(1)(5) of the Electricity Tax Act).

It is the airport operator that incurs ground power supply costs, whereas it is the airline that benefits from fuel savings. Accordingly, operators have to consider whether investment makes sound business sense against the background of other advantages in the sphere of emissions abatement and noise mitigation.

## 12.2. Existing and planned measures

Because of their obligations to reduce pollutant and noise emissions, the German airports are already taking measures for the possible use of alternative fuels and the ground supply of power and conditioned air to aircraft. However, the provision of more equipment will impose significant costs on airports, which means that the mandatory supply of ground power may result in locational disadvantages.

