e-Mobility in Germany

Overview of examples in different areas of e-mobility in Germany:

- E-cars:

According to the German Association of the Automotive Industry (VDA), the accumulated number of newly registered e-cars was at 222,525 by the end of March 2019 of which 54% were battery electric vehicles . The decrease of new registrations from 2018 to 2017 was at 24%. Even though the market for e-cars is still considerably small in Germany, it can be seen, that this mobility segment is increasing. This is because the number of different available models increases constantly, the range that can be driven with a full charge is getting larger and the charging infrastructure expands more and more. The number of different available models encompasses 60 models at the moment, from which 26 models are coming from German manufacturers .

Yet, the development stage of the infrastructure differs largely from region to region. In Germany, in total 17,400 public and semi-public charging points are listed . Most of these charging points are located in major cities or larger urban areas. In Hamburg for example, the number of 1,000 public charging points will be reached in 2019. At these, only renewable energies are used . Another promoting factor for the increasing number of electric vehicles is a number of different local and federal funding programs. The most relevant federal funding program is the so called environmental bonus with a total budget of 1.2bn EUR. The funding for battery electric vehicles is here at 4,000 EUR. Other local funding programs also aim at the charging infrastructure.

- E-buses:

Whereas statistics for e-cars are very comprehensive in Germany, the total number of e-busses is not yet communicated in a similar way. According to media, by February 2018, test with e-busses were conducted in 45 different cities throughout the country . Due to clean air action plans and EU limit

values for emissions, more and more municipalities are forced to replace old diesel-powered busses by emission-free busses. With federal subsidies, some cities test hydrogen busses, but at the moment the larger number of cities purchase electric busses to fulfil the new regulations. In Hamburg for example, only emission-free must be purchased by 2020. By the end of 2019, the total number of e-busses in use on the streets of Hamburg should be at around 50 in total

- E-Bikes:

The sale of e-bikes is constantly increasing in Germany. Whereas in 2010 the total sale was at about 200,000 e-bikes, in 2018 it was already at 980,000. This high number corresponds roughly to 25% of all bike sales in the last year . E-bikes are commonly used by commuters, elderly people, but also by messengers who use e-cargo bikes. With the appearance of new bike models, however, other groups of buyers will follow. Even though stationary bike sharing systems became very common in the major cities in Germany within the last decade, mostly regular bikes are for rent. The bike sharing system in Hamburg for example, StadtRAD, which is operated by the Deutsche Bahn Connect on behalf of the Municipality of Hamburg, includes 220 stations with more than 2,600 bikes. In the next years, both numbers should increase. It is planned to offer 4,500 bikes at 350 stations throughout the entire city of Hamburg . These high numbers allow the assumption that there is a relevant potential for e-bikes. In 2019, 20 e-cargo bikes were added to the stock of rental bikes in Hamburg.

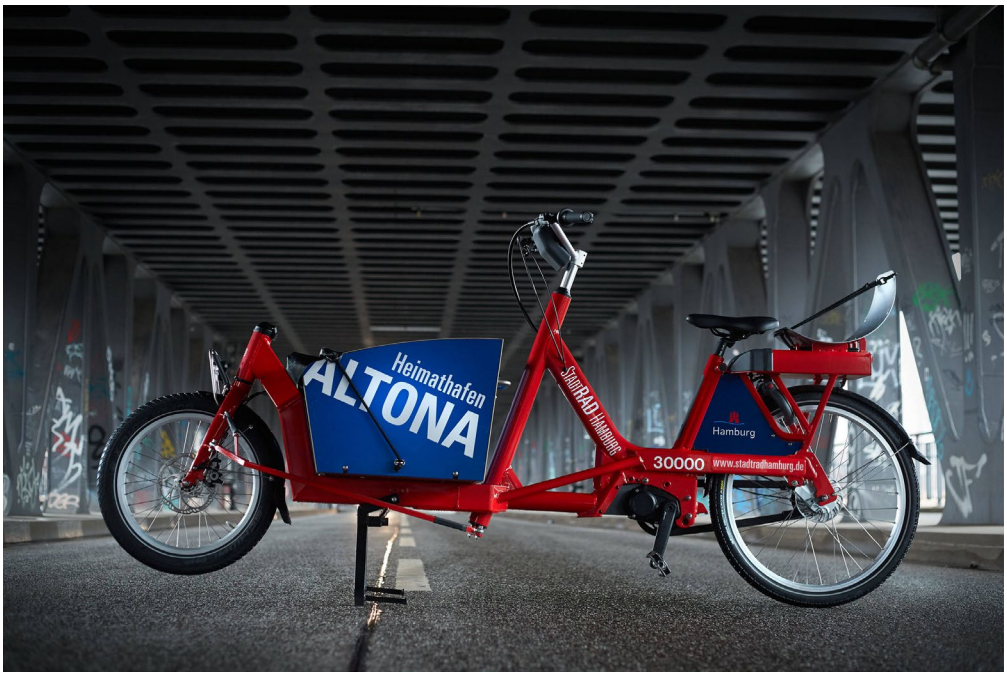

Figure 1 E-Cargo Bike in Hamburg

In Germany, no direct funding for e-bikes is available. Yet, similarly to company cars, where the employee can use a car that is bought or leased by the company and obtains tax benefits, bikes can be purchased under the same conditions.

- E-logistics:

In many major cities in Germany, different logistics service provider started experimenting with electrified vehicles. This ranges from e-bikes for last mile services to e-trucks for longer distances in the cities. One of the largest projects in this area is the StreetScooter. The StreetScooter is an

electrified light delivery truck specifically developed for logistics purposes. The manufacturing company is now a subsidiary of the Deutsche Post DHL Group. For DHL, currently around 9,000 of these vehicles are in operation in Germany .

Figure 2 StreetScooter Work

Whereas there are already several different electric vehicles available for inner city delivery services, longer distances overland need to be executed with conventional trucks, if the train is not an option. To electrify this area of the logistics sector, an, for Germany unique, experiment is going to start in 2019 in norther Germany. A 25 kilometers long section of an autobahn has been equipped with overhead lines for trucks. Later in further tests other sections should follow to find out, whether this technology can be an option for Germany.

- E-scooters:

With regards to e-scooters it is important to consider that different kinds of vehicles are commonly referred to as e-scooters. There are electrified kick scooters, mopeds with electric motors and mobility scooters that are usually equipped with electric motors. The latter system is commonly used among elder people or handicapped people. In Germany, these serve rather as a mobility aid, than as a relevant mean of transport.

The popularity of electrified kick scooters and e-mopeds, however, is growing rapidly. This has primarily to do with the fact that both systems are now certified to be used on German streets. Because the certification of electrified kick scooters was passed in May 2019, the number of these vehicles is not as large as of other electric vehicles yet. As it can be seen in other European countries or in the USA, however, it has to be expected that they will become an integral component of urban transportation. Especially because plans exist to offer these kick scooters in sharing systems. As it is already done for e-bikes and for e-mopeds in many of the major cities in Germany.

- E-ferries:

Very few pilot projects can be found in Germany. See the example of Northern Germany below.

E-Mobility in Northern Germany

Overview of activities and achievements in the field of electromobility in Northern Germany.

E-Cars

Current activities by the public sector of Mecklenburg-Vorpommern aim at efforts to build a charging infrastructure as part of nationwide measures. Areas were identified to which a certain number of charging points were assigned. Leka GmbH, an association closely cooperating with the Ministry of Energy of Mecklenburg-Pomerania, is therefore currently preparing a study.
In addition, measures to support the ramp-up of the market are undertaken. Further, there are a number of private initiatives to create charging stations, e.g. connected with economic offers (real estate, parking, car rental/car sharing etc.). The preparation of an overview of these is in work.

The purchase of electric cars will be supported with 4,000€ for battery electric vehicles and hydrogen fuel cell vehicles, while hybrid vehicles are supported with 3,000€. Municipalities get support for the construction of charging infrastructure and procurement of vehicles as well as for the development of electromobility concepts within the framework of funding instruments. The federal program runs from 2017 to 2020 and there are calls for projects. The Climate Directive promotes investment in clean and renewable technology regionally in Mecklenburg-Pomerania. Here, a pro-rata subsidy amounting to 30% to 50% of the climate-relevant additional expenditure for purchases, e.g. Charging infrastructure, vehicles (according a reference lists), energy production and investment concepts. Funding will also be provided for the expansion of a hydrogen infrastructure to relieve the burden on the electricity grids and to use surplus electricity from wind turbines.

In cities, there are different approaches to promoting electric cars through free parking, free charging or the use of bus lanes. There are initiatives and offers from the private sector and SMEs including free parking and charging as well as car-sharing/leasing in connection with the rental of apartments, service bases with solar carports and charging stations in public areas.

Hydrogen as fuel

Rostock has a hydrogen filling station up to 700 bar since 2017. However, the number of vehicles in operation is very low. See also the annotation under e-Bikes.

E-Buses

In western Mecklenburg-Pomerania, there were initiatives for the implementation of electric buses (Rostock, Schwerin and Ludwigslust/Parchim) as part of a program "Clean Air". There was no donation, as the cities did not meet the criteria for CO2 pollution compared to others. As a result, no electric buses are currently in use in Mecklenburg-Vorpommern.

Hydrogen fuel cell buses

"Fuel cell technology is not yet ready for production. At the moment, battery technology is the solution," mentioned a representative of Hamburger Hochbahn[1]. The company is considered a pioneer among municipal transport companies in terms of switching to emission-free buses. From 2020, it will only be possible to procure buses in Hamburg that emit no exhaust fumes. The

[1] https://www.handelsblatt.com/unternehmen/industrie/autokonzern-rueckschlag-fuer-daimler-hamburger-hochbahn-verkauft-wasserstoff-busse/23984282.html

Hamburger Hochbahn and the city of Hamburg are thus a driver behind the alliance of 18 cities, including the capital Berlin, which are jointly using new technologies for emission-free public transport. Thus, the elevated railway relies on battery buses. There will be 30 deliveries in 2019 and another 30 in 2020.

Hydrogen electric buses were also tested in rural areas in Mecklenburg-Vorpommern. A hydrogen bus, owned by the city of Barth, was acquired by Wind-Projekt-GmbH[2] in Börgerende (Rostock district), which deals with hydrogen technology.

The ATI Küste GmbH was involved in this hydrogen project with the city of Barth as a member of the association "Hydrogen Technology Initiative e. V.".

E-Trucks/E-Logistics

Increasingly, test tracks for the construction of so-called e-highways are to be observed. On the A1 motorway between Hamburg and Lübeck lanes are equipped with overhead lines. Comparable projects are also available on other sections, e.g. on the A7 between Frankfurt and Darmstadt.

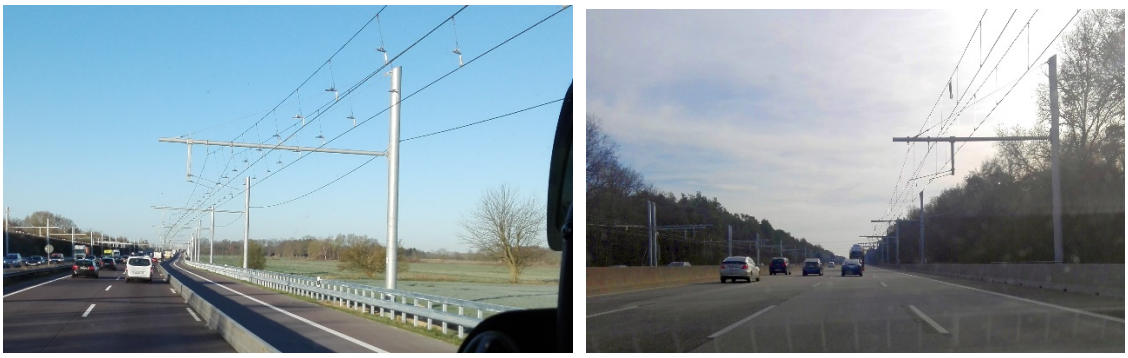

Fig. Test track "E-Higway" between Hamburg and Lübeck as well as Frankfurt and Darmstadt

E-Bikes

As part of the program Interreg South Baltic, the project ElRos[3] implemented a pedelec rental as an element of multimodal transport in the city of Rostock. The rental system offers electric bicycles, the charging infrastructure and secure parking spaces near transport hubs. There is a tariff system and a smartphone app for payment of that service.

In addition, the possibility of public use and rental of electric bicycles is possible in most cities of tourism. There are professional rental companies as well as hotels that offer both a charging infrastructure (wall-box) and e-bikes.

Annotation

The energy provider WEMAG from Schwerin integrated various energy and e-mobility solutions under the name of REVOLT: e-cars, e-bikes and battery storages for the domestic solar system. The batteries for the e-bikes can be purchased in the hire purchase. Used batteries are reused in the

[2] https://www.ostsee-zeitung.de/Vorpommern/Ribnitz-Damgarten/Wasserstoffbus-wird-verkauft
[3] http://www.rsag-online.com/elros/

battery energy stores. (In addition, WEMAG has been operating a battery storage power plant with an installed capacity of 10 MW since 2014.)

E-Scooter

It is noteworthy that the Spanish company "Torrot" offers e-bikes in the "Vespa look" which are becoming increasingly popular in larger cities such as Berlin. Discussions with company representatives went towards building systems for the lending systems for these vehicles. However, a minimum size of the market, the city or a region is required.

Recently, there are considerations to use smaller e-scooters in the city of Rostock. These electric scooters are already known in other cities such as Oslo.

E-Ferries

The plan in the project is to realize the ferry connection in the city of Rostock by an electric ferry. The electrification project will replace the current ferryboat. It is currently competing with a project to build a pedestrian bridge. Ferry pilot projects are difficult due to high investment. Therefore, we focus on the exchange of experience with ferry operators and existing ferries.

New ships are currently planned for various connections. Activities and projects for the implementation of electrically operated ferries and excursion boats were and are in Waren/Müritz, in Schwerin, in Krakow and on the Peene in Vorpommern. In addition, projects for the construction of a battery-electric ferry from Stralsund to Altefähr and a hybrid-electric ferry from Schaprode (Rügen) to Vitte (Hiddensee) are planned.

In regular service electric ferry boats are operational in Berlin on the Spree river. These ships have battery storage as well as solar panels for additional energy supply. According to the operator, this will enable up to 80% of the energy to be used to power the ships from solar energy during the summer.

For planned new buildings and conversions, electric drives are preferred for ferries. Depending on the route, the planning considers battery-systems or hybrid systems for the energy supply. Concepts for this are based on generator sets with internal combustion engines or hydrogen fuel cells. The hydrogen needed for this could come from surplus and unsortable electrical energy from wind turbines, which would alternatively be "grounded".

The use of hydrogen as a fuel for ferries is a way of storing and using energy and is the subject of a project, which is still in the concept phase. A project is being prepared to use excess electric energy from renewable sources in the form of hydrogen for ferries.

Under the name Warnow Hopper, Neptun Ship Design from Rostock presented a concept for electric water taxis and electric ferries on the Warnow[4]. As already mentioned, this project is in competition with the project of a pedestrian bridge.

[4] https://www.nnn.de/lokales/rostock/idee-vom-neptun-hopper-begeistert-id15027001.html

The same company is committed to the implementation of a ferry between Ueckermünde and the Island of Usedom[5]. From the seaside resort of Ueckermünde, the tourist center on the Szczecin Lagoon, it is 16 kilometers by boat to the island of Usedom. The project serves to relieve the island of Usedom from heavy traffic. Plans to build a tunnel in Świnoujście under the Swine river as a road to Poland will bring additional traffic to the island.

[5] https://www.nordkurier.de/ueckermuende-usedom/studie-zu-verbindung-ueckermuende-usedom-wird-vorgestellt-0333892112.html