HyLAW

National Policy Paper - Germany

December 2018

Main Author(s): [Gerd Harms, Dennitsa Nozharova, German Hydrogen and Fuel Cells Association e.V.]

Contributor(s): [Alexandru Floristain, Hydrogen Europe]

Acknowledgments:

The HyLAW project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 737977. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme, Hydrogen Europe and Hydrogen Europe Research.

Table of contents

1. Introduction and summary

1.1 HyLAW Summary and Methodology

HyLaw stands for Hydrogen Law and removal of legal barriers to the deployment of fuel cells and hydrogen applications. HyLaw aims at boosting the market uptake of hydrogen and fuel cell technologies providing market developers with a clear view of the applicable regulations whilst calling the attention of policy makers on legal barriers to be removed.

The project brings together 23 partners from Austria, Belgium, Bulgaria, Denmark, Finland, France, Germany, Hungary, Italy, Latvia, Norway, Poland, Romania, Spain, Sweden, Portugal, the Netherlands and United Kingdom and is coordinated by Hydrogen Europe.

Through extensive research, interviews and legal analysis, the HyLaw partners have identified the legislation and regulations relevant to fuel cell and hydrogen applications and legal barriers to their commercialization.

The German Hydrogen and Fuel Cell Association (DWV) has identified and analysed the applicable legislation and administrative requirements and procedures for the German market, and has developed recommendations for actions to eliminate the identified legal barriers.

This National Policy Paper provides public authorities with country specific benchmarks and recommendations on how to remove these barriers. The National Policy Paper is based on the current legislation as of 1. December 2018.

1.2 Findings and Recommendations

In the framework of the project has been analysed a broad spectrum of legal and administrative regulations for the following hydrogen and fuel cell applications:

- H2 production
- H2 storage
- H2 transport and distribution
- H2 as a fuel
- Hydrogen refueling stations
- Hydrogen powered vehicles – Cars, busses, trucks
- Hydrogen powered vehicles – Motorcycles, Quadricycles, Bicycles
- Ships (Maritime)
- Electricity grid issues – electrolysis plants
- Gas grid issues
- Stationary fuel cells

Due to the relatively short duration of the project some hydrogen and fuel cell applications have not been investigated which should be made in a future project. Such applications are H2 trains, inland ships, material handling, aircraft, underground storage, transport through hydrogen pipelines, usage in industry, co-processing of renewable hydrogen in refineries for production of conventional fuels.

Hydrogen and fuel cell applications fall under the scope of various international, EU- and national legal acts and standards in the areas of energy and environment, transport, equipment construction and safety, tax treatment etc. Therefore, some of the identified legal barriers are at international or European level and the recommendations made concern German organisations and authorities involved in the relevant legislative or regulatory process.

Current legal and regulatory framework in Germany dealing with the different hydrogen and fuel cell applications is good and detailed developed in comparison with many other EU countries. A number of legal acts, ordinances, standards and worksheets contain comprehensive provisions directly or indirectly related to the construction and operation of hydrogen production plants, hydrogen refueling stations, hydrogen storage, injection of hydrogen in the gas grid, type approval of hydrogen vehicles, tax treatment, incentives etc.

Nevertheless, some legal barriers with varying degrees of severity have been identified, hampering the widespread deployment of certain hydrogen and fuel cells applications. The recommendations for actions for removal of most important of them are listed below. An overview and analysis of the legal framework and a justification for each recommendation are provided separately.

1.2.1 Hydrogen as a fuel

Improvement of the legal framework as to allow the economically viable production of renewable hydrogen as a fuel with renewable electricity taken from the public supply grid and certified by means of guarantees of origin

Creation of an EU-wide certification system of guarantees of origin of renewable and low-carbon hydrogen allowing to transfer the guarantees of origin independently of the quantities to which they relate from one holder to another as well as of an efficient EU methodology for ensuring that the renewable fuels of non-biological origin contribute to greenhouse gas reduction when the renewable electricity used for the production of these fuels is taken from the public grid

Monitoring of research activities for verification of the quality requirements of ISO standard 14687-2 for hydrogen as a fuel in order to ensure that the standard reflects the state-of-the-art technologies

The recognition of hydrogen and synthetic methane as transport fuels (as alternative fuels irrespective of the feedstock and the production process used and as renewable fuels when produced with renewable electricity) in European and in German legislation and the ambitious climate targets of the EU level for 14% renewable energies in transport by 2030 and 70% greenhouse gas emission savings from the use of renewable fuels as of 2021 require further development of the existing legislation for the market deployment of renewable fuels.

In Germany, hydrogen and synthetic methane generated with renewable electricity can be counted towards the GHG reduction quota for all fuels on the market from the beginning of 2018. However, the accounting rules are very restrictive and, in principle, quota-capable hydrogen and synthetic methane can hardly be economically generated with renewable electricity taken from the public grid.

Neither at European nor at national level is established a binding certification system for guarantees of origin for renewable and low carbon hydrogen as a fuel. It is crucial to create at EU level a unified certification system for guarantees of origin as to accelerate the development of the green hydrogen market and to ensure the free movement of renewable and low carbon hydrogen across borders.

The very stringent requirements for hydrogen purity in ISO 14687-2 can only be verified by a few independent laboratories and are considered by a number of market players to be unreasonably high. If different requirements should apply in different countries, segregated markets could be created and the commercial use of hydrogen in transport could be hindered. Therefore, it is important to reach an agreement between the relevant stakeholders on the quality requirements for hydrogen as a fuel according to the latest technology developments. Within the EIGA and ISO / TC 197 has already begun pre-standardization work on the revision of the impurities currently included in the standard.

1.2.2 Transport and distribution of hydrogen/Quantity and pressure limitations

Building a broad consensus between the key stakeholders for increasement of the current capacities of hydrogen receptacles in view of the revisions of the existing ISO standards for gas cylinders and composite tubes

Revision of the most important ISO standards (developed in ISO/TC58/SC3) as to increase the cylinder and tube volumes and the permitted working pressures, as well as to optimise the safety factors specified in the ADR

The quantities of compressed hydrogen which can be transported by today usual trailers are suitable only for relatively small demands (up to 540kg depending on the number of cylinders and tubes). The high-pressure trailer developed by Linde Group, which uses lightweight compound cylinders at 500 bar operating pressure, can carry over 1,100 kg or 13,100 Nm3 of compressed hydrogen in a single trailer load. However, this technology is not widely available.

The high safety factors stipulated by the European Agreement concerning the International Carriage of Dangerous Goods by Road and Transportable Pressure Equipment Directive restrict the volume of hydrogen receptacles to 450 l/3,000 l. Lightweight composite gas cylinders at 700 bar and higher volume tubes (up to 10,000 l) have been

already developed, making possible to increase the overall payload. In order to facilitate the transportation of big quantities of hydrogen by road the current standards have to be revised and changed as to allow higher vessels capacities (working pressure and volume). In addition, the ADR shall be changed as to allow and define new volume categories of gas pressure receptacles and new calculation approach for the safety factor and to refer to the revised standards. The adoption of changes in ISO standards as well as in ADR is a complicate and time-consuming process involving various stakeholders from industry, research institutions, standardisation organisations and policy makers and can be only achieved if a broad consensus between the countries and within interest organisations will be reached.

1.2.3 Production of hydrogen/On-site electrolysis at hydrogen refuelling stations

Definition of the term "production on an industrial scale" for hydrogen production on-site at hydrogen refuelling stations through electrolysis

Clear exception of electrolysis plants up to a certain capacity from the permit requirements of the Federal Immission Control Act and from the requirements of the Environmental Impact Assessment Act for a general preliminary examination in each individual case to assess the need for an environmental impact assessment. The installations concerned should only be approved in accordance with the general building law

At present, in relation to permitting requirements and procedures, the hydrogen production plants are considered as chemical production plants producing inorganic gases on an industrial scale, regardless of the method of hydrogen production or the presence or absence of hazardous substances involved in the process. There is no legal differentiation between hydrogen production on an industrial scale and on a non-industrial scale and therefore for determination of the applicable permitting procedure an assessment on a case by case basis is required. As a result, is possible, that electrolysis plants with relatively small capacities should undergo a very long permit procedure with public participation provided by Federal Immission Control Act and an environmental impact assessment procedure set out in Environmental Impact Assessment Act, which may hinder investments and thus economies of scale for small units.

In principle, there are no relevant hazards to the environment arising from small-scale hydrogen production by electrolysis, so that up to a certain size of the plants, a general environmental pre-assessment in each individual case can be omitted. Moreover, since the lower environmental authorities are involved in the environmental impact assessment as a part of the building permit procedure, an independent evaluation of the local impact is always carried out.

In the interests of potential investors, but also of permitting authorities, the time-consuming assessments for determination of the applicable permitting procedure for each individual case should be avoided by clarifying the term "production on an industrial scale" in relation of hydrogen production by electrolysis at refuelling stations. This could be achieved through a determination of a reasonable electrolysers' capacity in Annex I of the 4. Federal Immission Control Ordinance above which the permitting requirements of Federal Immission Control Act shall apply.

1.2.4 Vehicles – Cars, Busses, Trucks/ Restrictions and incentives

Monitoring of legal and administrative regulations for fuel cell electric vehicles using specific structures such as bridges and tunnels, combined transport modes such as ferries and trains or parking facilities with regard to inappropriate restrictions, provided that the safety requirements of ADR are met, and taking appropriate measures to prevent or eliminate such restrictions

Development of new supportive technology-neutral policies and regulations for zero - and low-emission vehicles ensuring a level playing field between FCEVs and BEVs

Determination of higher minimum procurement targets for zero - and low-emission light-duty and heavy-duty vehicles for public bodies

Extension of the funding for acquisition of electric powered vehicles after 2020 and inclusion in the list of electric vehicles eligible for subsidy more models of FCEVs

Initiation of legislative changes abolishing the toll-charges for zero-and low- emission heavy- duty vehicles and increasing the toll charges for high-emission heavy-duty vehicles

Favouring the circulation of zero-emission vehicles in city centres (by general prohibition of entry for high-emission vehicles or introduction of a city toll)

Restrictions for hydrogen powered vehicles when using public road infrastructure may be imposed in relation to the on-board storage of compressed or liquid hydrogen and their classification as dangerous goods according to ADR. Due to the limited number of hydrogen powered vehicles in use, there is no experience and sufficient information about such restrictions. The risk of unreasonable restrictions on FCEVs when using the facilities of transport infrastructure may create an uncertainty for the users and negatively affect their choice to purchase hydrogen powered vehicles.

Considering the EU binding target for achieving at least 40% reduction in greenhouse gas emissions by 2030, the legislative proposal of the EU Commission setting new CO2 emission standards for passenger cars and vans after 2020 and a new EU fleet targets for 35%/30% emissions reduction in 2030 compared to the 2021 targets, the legislative proposal to set CO2 emission standards for heavy-duty vehicles and the minimum procurement targets for clean vehicles procurement by 2030, a new national policy framework reflecting the EU climate objectives and promoting the use of zero/ and low emission vehicles is required for the period after 2020.

1.2.5 Ships/Use of hydrogen as a fuel and fuel cells on sea-faring vessels

Initiation of a procedure for development of requirements and regulations for storage and use of hydrogen as a fuel and hydrogen fuel cells in ships

At international level (within the competence of the International Maritime Organisation (IMO)), the International code for ships using gases or other low flashpoint fuels (IGF code) contains mandatory provisions for design, construction and operation of ships using low flashpoint fuels. As hydrogen has a flashpoint below 60° C, the IGF code generally applies, but hydrogen as a fuel and fuel cells are not specifically addressed in the IGF Code.

The IGF Code Working group is currently developing provisions for installations of fuel cells (natural gas fuel cells), but not for hydrogen powered fuel cells and hydrogen use and storage.

In the absence of specific provisions, the use of hydrogen as a fuel and hydrogen fuel cells in vessels can be approved based on alternative design method with regard on ship and system design. The alternative design approval process implies much higher costs and longer approval time as compared with other, more established technologies and create regulatory uncertainty.

Considering extremely lengthy procedures at IMO level, it is crucial for the commercial deployment of technologies to initiate a procedure for preparation of provisions covering the use of hydrogen and hydrogen fuel cells in ships in a relatively short time span.

1.2.6 Legal Status of Power to gas

Creation of a clear and unified legal definition for power to gas and clarification of the ownership unbundling rules for power to gas under the EU gas and electricity legislation

Initiation of a regulatory change of the Guidelines on State aid for environmental protection and energy of the European Commission after 2020 as to include the hydrogen production by electrolysis as a fuel for mobility and as a raw material for industry in the list of electro intensive sectors, eligible for aid in form of reduction in support of renewable energies, and introduction of a subsequent corresponding amendment to the Annex 4 of the EEG and a multi-year permit for reduction in the EEG-apportionment for the electricity purchased from the grid

Establishment of a legal framework allowing and promoting PtG plants to use renewable electricity from the public supply grid, certified by means of guarantees of origin

At present, there is no legal definition for power to gas at EU and national level. The cross-sectoral nature of PtG technology links it to both electricity and gas networks and markets, and thus to the correlated EU legislation. The unbundling rules on separation of energy supply and generation from the operation of transmission networks apply for PtG plants. As PtG is not only an energy conversion activity, which produces a gaseous energy carrier, but also an energy storage technology, it should be cleared if it will fall under the scope of the newly proposed Recast Electricity Market Directive setting down new rules for unbundling of energy storage from the operation of transmission and distribution networks.

In Germany, the PtG plants are treated as end users in electricity system, as long as the produced hydrogen is not used for power recovery. The price of electricity for end users includes various energy charges and allocations (for

example network charges, EEG -, cogeneration -, offshore apportionments, electricity tax etc.). This results in a such high price for emission-free hydrogen that excludes its competitive economic use.

Considering the potential of hydrogen as renewable gas for mobility and industry to contribute to achieving the EU and national energy objectives, its production by electrolysis as a fuel or raw material, similar to the production of industrial gases, has to be included in the list of electro-and trade intensive sectors as to reduce the EEG-apportionment for the electricity used.

In general, the possibilities for PtG plants to take renewable electricity from the public supply grid, evidenced by means of guarantees of origin are legally limited for the most applications of PtG due to the lack of legal incentives (renewables in heating sector and in industry) or due to legal constraints (production of renewable fuels).

The restrictive regulations and the high electricity prices represent the main obstacles to the widespread market deployment of the PtG technology. In the context of the possible contribution of PtG to the sector integration, the current regulatory framework is not in line with the energy transition and the targeted overall climate goals, especially not in the light of recent findings that a sector coupling through hydrogen is required to achieve the climate goals for 2050.

1.2.7 Hydrogen injection into the public gas grid

Creation of a clear definition for renewable gases, including and differentiating biogases and renewable gases of non-biological origin at European and national level

Development of a harmonised system for guarantees of origin for renewable gases of non-biological origin

Continuous efforts to agree on admissible concentration of hydrogen in the gas grid and develop relevant gas quality standards

Inclusion of renewable hydrogen and synthetic methane in the definition of renewable energies or in the list of alternative measures in Renewable Energy Heating Act so they can be counted towards the renewable energy share in the heating sector and the obligations for proportionate use of renewable energies to cover the heating and cooling demand of new or substantially renovated public buildings can be met by their use

At present, there is no legal definition for renewable gases. The EU Commission proposal for a recast of the Renewable Energy Directive (RED II) does not provide such definition, but contains provisions for development of a guarantees of origin system for renewable gases including hydrogen. In Germany, the hydrogen and synthetic methane are included in the definition of biogases in Energy Industry Act, but the Renewable Energy Act and Renewable Energy Heating Act define biogases only as gases obtained by anaerobic digestion of biomass.

Considering the capabilities of PtG and hydrogen to store energy and provide ancillary grid services, which are not associated with biogas and biogas plants, as well as the current and future development of policies, legal regulations and supportive mechanisms for sectors coupling technologies, a unified definition of renewable gases, differentiating biogases from renewable gases of non-biological origin is required.

The permitted concentration of hydrogen in the gas grid varies significantly between the Member States and in large number of countries the hydrogen injection into the gas network is generally not allowed. Neither international nor European standards define rules for the admissible concentration of hydrogen admixtures, which may hamper the injection of hydrogen and the cross-border trade. In the long term, the achievement of climate goals also requires the decarbonisation of gases. From this background, a strategy program for the continuous increasement of the hydrogen content in the gas networks across Europe is needed.

In Germany, the hydrogen and synthetic methane are not recognised as eligible means for achieving the renewable energy targets in heating sector and thus their use as sector coupling solutions is restricted. The use of hydrogen can quickly and efficiently contribute to the reduction of greenhouse gases in the heating sector, especially in buildings. Therefore, a legal consideration of hydrogen is in the interests of climate protection.

2. Hydrogen as a fuel

2.1. Overview and analysis of the framework

Fuels used for road transport in the EU have to meet strict quality requirements to protect human health and the environment and make sure that vehicles can safely travel from one country to another.

Current Renewable Energy Directive 2009/28/EC[1] requires each Member State to ensure that the share of energy from renewable sources in all forms of transport in 2020 is at least 10 % of the final consumption of energy in transport. The blending of biofuels is one of the methods available for Member States to meet this target, and is expected to be the main contributor.

Fuel Quality Directive 98/70/EC[2], amended by Directive 2009/30/EC[3] requires a reduction of the greenhouse gas intensity of transport fuels by a minimum of 6% by 2020 from a 2010 baseline. The greenhouse gas intensity of fuels is calculated on a life-cycle basis, covering emissions from extraction, processing and distribution.

The 6% reduction target is likely to be mainly achieved through

- the use of biofuels, electricity, less carbon intense (often gaseous) fossil fuels, and renewable fuels of non-biological origin (such as e-fuels)
- a reduction of flaring and venting at the extraction stage of fossil fuel feedstocks.

Council Directive (EU) 2015/652[4] defines the method to be applied and the details for the reporting of the greenhouse gas intensity of fuels. Member States have been required to apply these rules since 21 April 2017.

There are currently no plans to extend the greenhouse gas reduction target beyond the year 2020. Instead, the Commission has proposed to address the decarbonisation of transport fuels after 2020 in the framework of the revised Renewable Energy Directive (RED II)[5].

On 14 June 2018, the Commission, the Parliament and the Council reached a political agreement which includes an EU-wide legally binding target for renewable energy share of at least 32% of the Union's gross final consumption in 2030, with a clause for an upwards revision by 2023. One key aspect of the agreement is the 14% target for renewable energy in transport by 2030. However, with regard to the coalition agreement of the parties supporting the Federal Government, it is to be expected that Germany will continue to impose a greenhouse gas reduction obligation on the market players.

Hydrogen is defined as an alternative fuel with a potential for long-term oil substitution, irrespective of the primary energy source by Alternative Fuels Infrastructure Directive 2014/94/EU(AFID)[6]. The renewable produced hydrogen is recognised as a renewable transport fuel of non- biological origin by Directive (EU) 2015/1513[7] amending the current legislation for biofuels (Renewable Energy Directive and Fuel Quality Directive).

In Germany, the binding target of the Fuel Quality Directive for 6% reduction of the GHG intensity of transport fuels is transposed into §37a of Federal Immission Control Act (BimSchG)[8]. The Council Directive (EU) 2015/652 is implemented with the Ordinance on counting electricity-based fuels and processed biogenic oils against the greenhouse gas quota – 37th Federal Immission Control Ordinance (BimSchV)[9].

The electricity-based, renewable transport fuels of non-biological origin are determined in Annex I of the Ordinance as follows:

---

[1] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

[2] Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC,

[3] Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC

[4] Council Directive (EU) 2015/652 of 20 April 2015 laying down calculation methods and reporting requirements pursuant to Directive 98/70/EC of the European Parliament and of the Council relating to the quality of petrol and diesel fuels

[5] Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources COM (2016) 767

[6] Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure

[7] Directive (EU) 2015/1513 of the European Parliament and of the Council of 9 September 2015 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources

[8] Gesetz zum Schutz vor schädlichen Umwelteinwirkungen durch Luftverunreinigungen, Geräusche, Erschütterungen und ähnliche Vorgänge (Bundes-Immissionsschutzgesetz - BImSchG)

[9] Siebenunddreißigste Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Verordnung zur Anrechnung von strombasierten Kraftstoffen und mitverarbeiteten biogenen Ölen auf die Treibhausgasquote - 37. BImSchV)

a) compressed synthetic methane, generated through Sabatier process with hydrogen from electrolysis fed by non-biogenic renewable energies, and

b) compressed hydrogen in a fuel cell, generated through electrolysis fed by non-biogenic renewable energies.

The compressed hydrogen in a fuel cell generated through electrolysis fed by electricity from coal (with or without carbon capture and storage) is an electricity-based transport fuel which could also be counted against the greenhouse gas quota.

According to §3 (2) of 37. Federal Immission Control Ordinance the renewable produced hydrogen or synthetic methane could be counted against the greenhouse gas quota in three cases:

1. The electricity used in the production plant is directly supplied from a renewable energy plant which is not connected to the electricity supply grid,

2. The electricity used is taken from the public supply grid when the production plant is:

a) built in a network extension area according to §36c (1) of Renewable Energy Act (EEG)[10] where the transmission grids have to be expanded due to expansion of electricity produced from renewable energy sources (Netzausbaugebiete) and

b) operated exclusively on the basis of a contract for switchable loads with the respective transmission operator in accordance with § 13 (6) of the German Energy Industry Act[11]. (Zuschaltbare Lasten)

3. By derogation from P. 2, the electricity used may be taken from the public supply network if the renewable hydrogen and/or synthetic methane are placed on the market before 1 January 2021 and produced in plants that produced such fuels for the first time before 25 April 2015 provided that the origin of electricity from renewable sources of non-biogenic origin has been proven.

The operator of the electricity-based fuel production plant must provide the Biofuel quota office (Biokraftstoffquotenstelle) with guarantees of origin for the fuels.

The renewable fuels of non-biogenic origin as defined in Annex 1 (a) and (b) of 37. BimSchV and the fuels produced with CO2 capture and utilization, provided that the energy used for their production comes from renewable energy sources, are defined, inter alia, as advanced fuels according to the 38. Federal Immission Control Ordinance[12]. The Ordinance provides for the possibility to fulfil the obligation for greenhouse gas emission reductions by certain fossil fuels inter alia hydrogen produced by steam reforming of natural gas or from coal. The use of conventional biofuels, which may be counted against the greenhouse gas quota, is limited to a maximum of 6.5 percent. In addition, from 2020, companies that place yearly more than 20 petajoules of petrol or diesel on the market will be required to place a minimum share of 0.05% of advanced fuels on the market. This quota will be gradually increased to 0.5% by 2025 and will be binding for all obligated companies.

Certification of origin

At present, there is no unified system for certification of origin of renewable and low carbon hydrogen at national and EU level. The existing standard CMS 70 for certifying green hydrogen, issued by TÜV SÜD is voluntary. The CertifHy[13] Project is currently developing the first EU-wide guarantee of origin scheme for renewable and low-carbon hydrogen. The objectives of the project are to define a widely acceptable definition of green – and low-carbon hydrogen and design a robust scheme for certification of origin for green hydrogen.

The proposal for amendments to the Renewable Energy Directive contains provisions for establishment of Guarantee of origin schemes that will include hydrogen. Article 25 of this proposal requires that the greenhouse gas emission savings from the use of renewable liquid and gaseous transport fuels of non-biological origin, excluding recycled carbon fuels, shall be at least 70% as of January 2021.

Quality requirements and measurement

The purity requirements for hydrogen as a transport fuel are defined by the international standards SAE J2719_201511 and ISO 14687-2. The ISO standard is referenced as mandatory for EU Member States in the Alternative Fuels Infrastructure Directive 2014/94/EU.

[10] Gesetz für den Ausbau erneuerbarer Energien (Erneuerbare-Energien-Gesetz - EEG 2017)

[11] Gesetz über die Elektrizitäts- und Gasversorgung (Energiewirtschaftsgesetz - EnWG)

[12] Achtunddreißigste Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Verordnung zur Festlegung weiterer Bestimmungen zur Treibhausgasminderung bei Kraftstoffen - 38. BImSchV)

[13] CertifHy-Designing the first EU-wide Green Hydrogen Guarantee of origin for a new hydrogen market, http://www.certifhy.eu/

The very high purity requirements set out in ISO 14687-2 should be verifiable, which is not the case in many EU Member States. There are just a few independent laboratories (in the world) who can verify the purity required by the ISO standard. Currently, there is still no independent laboratory in Germany that can determine the hydrogen quality on the basis of the permissible limits of impurities. Nevertheless, the quality of hydrogen supplied at the existing and planned or under construction refuelling stations must be monitored to ensure optimal vehicles (fuel cells) performance. The project Hy-Lab[14] launched in 2017 aims at development and construction of two independent laboratories for hydrogen quality measurement according to international standards within two and a half years. The project partners will evaluate and develop appropriate analytical methods and identify determining conductive impurities. In addition, pre-standartisation work within ISO/TC 197 and EIGA has started to update the impurity levels currently included in the standard.

2.2. Conclusions

The 37. BimSchV provides for the legal possibility that hydrogen and synthetic methane, which are generated with electricity from renewable energy sources, can be counted against the GHG emissions quota for all fuels placed on the market. However, the accounting rules are very restrictive and, in principle, quota-capable hydrogen and synthetic methane can hardly be generated economically with renewable electricity taken from the public supply grid.

Production of renewable hydrogen and synthetic methane by electrolysis, provided that the electrolysis plant is directly connected to a renewable energy production plant, which is not connected to the public electricity grid, is also not economically feasible. Sustainable production of renewable hydrogen and related revenues cannot be guaranteed if the power to gas (PtG) plant operates with fluctuating electricity produced from only one renewable production plant i.e. wind farm and only one type of renewable sources i.e. wind. The construction of direct electricity connection lines to more than one renewable energy plant is very expensive and economically unreasonable. Moreover, there are currently no many cases in which renewable energy plants can be operated efficiently without feeding the electricity produced into the grid. As a whole, the current regulations prevent an economically workable sector integration.

Production of renewable hydrogen by electrolysis plants, built only in network expansion areas and using excess electricity from wind generators on the ground of switchable loads contracts, is currently quite feasible. The possibility to use production plants as switchable loads is hardly regulated. There is no legal Ordinance laying down the rules for contracting and remunerating switchable loads. In addition, transmission operators are not legally obliged to conclude contracts for switchable loads and have a number of other grid stabilisation measures available and a prescribed sequence to implement them before making use of switchable loads. The contracts can be concluded only after a tender procedure and because of lack of clear regulations for switchable loads the PtG plants could be disadvantaged in comparison to other technologies. In addition, the period of classification of the respective location as being situated in a grid development area is unclear. As the term "network development area" suggests, the public target of the region concerned is the erection of new power lines so that the generated renewable electricity can be dissipated without restrictions.

The last option allowing the use of renewable electricity taken from the public grid is relevant for very limited number of PtG plants.

RED II considers that renewable fuels of non-biological origin are important to increase the share of renewable energy in sectors that are expected to rely on liquid fuels on long term and reduce the greenhouse gas emissions providing that the electricity used for the fuel production should be of renewable origin. If the electricity is taken from the grid, this requires a reliable European methodology to be developed by the European Commission.

In addition, especially given that large amounts of renewable energy needed to meet the climate targets will be imported from regions with very good solar and wind power conditions, it is necessary to create at European level a unified certification system for the origin of renewable hydrogen enabling its free movement across borders. A guarantee of origin scheme will accelerate the market development of renewable hydrogen and contribute to energy savings, and climate protection.

It is essential to reach a consensus on the quality requirements for hydrogen as a transport fuel. Should other/stricter requirements be used in different countries, segregated markets would be created and the commercial use of hydrogen for mobility would be hampered. International standards evolve in line with the technological

[14] https://www.zsw-bw.de/en/newsroom/news/news-detail/news/detail/News/hydrogen-fuel-assuring-quality-to-international-standards.html

developments and industrial needs and therefore, if the recent research activities result in new findings for verifying the quality of hydrogen, ISO 14687-2 should be appropriately changed or amended.[15]

2.3. Recommendations

Improvement of the legal framework as to allow an economically viable production of renewable hydrogen as a fuel with renewable electricity taken from the public supply grid and certified by means of guarantees of origin

Creation of an EU-wide certification system of guarantees of origin of renewable and low-carbon hydrogen allowing to transfer the guarantees of origin independently of the quantities to which they relate from one holder to another as well as of an efficient EU methodology for ensuring that the renewable fuels of non- biological origin contribute to greenhouse gas reduction when the renewable electricity used for the production of these fuels is taken from the public grid

Monitoring of research activities for verification of the quality requirements of ISO standard 14687-2 for hydrogen as a fuel in order to ensure that the standard reflects the state-of-the-art technologies

3. Transport and distribution of hydrogen/ Quantity and pressure limitations

3.1. Overview and analysis of the legal framework

Hydrogen is a gas with very low volumetric energy density at standard temperatures and pressures (over 3 orders of magnitude less than gasoline). As a result, the practical use and transport of hydrogen as an energy carrier requires that it be stored with higher volumetric energy density. For improvement of volumetric energy density hydrogen is transported as a compressed gas, a cryogenic liquid, or as a chemical compound, such as metal hydride.

Currently, for transport of compressed gaseous hydrogen for short distances (200-300km) and small users are used single cylinders, multi-cylinder bundles or long cylindrical tubes, installed on trailers. Storage pressures range between 200 and 300 bar and today usual trailers can carry up to 6, 200 Nm3 of H2 per truck subject to weight limitation of 40 tons. The quantity of hydrogen carried is relatively small (up to 540 kg depending on the number of cylinders or tubes)[16], which represents ~ 1 to 1,4 % of the total mass of the truck. The high-pressure trailer developed by Linde Group, which uses lightweight compound cylinders at 500 bar operating pressure, can carry over 1,100 kg or 13,100 Nm3 of compressed hydrogen in a single trailer load. However, this technology is not widely available.

There are no general requirements or limitations in the pressure or quantities of hydrogen transported by road. Nevertheless, the quantities per transport unit are restricted from one side to the accepted volumes of the receptacles used and from other side – to the truck weight limitations. The high safety factors stipulated in European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)[17] and Transportable Pressure Equipment Directive 2010/35/EU (TPED) [18] restrict the increase of payload of hydrogen trailers (the safety factor is the ratio between the burst pressure and the nominal fill pressure) and the cylinder/tube volumes (450l/3,000l). The ADR and TPED are transposed into German legislation through the ADR Act[19], the Ordinance on the international and cross-border carriage of dangerous goods by road, railways and inland waterways[20], the Ordinances amending

[15] The HyCoRa - Hydrogen Contaminant Risk Assessment project reached the conclusion, that the HCHO and HCOOH limits in hydrogen fuel standard ISO 14687 are currently too tight (0.01 and 0.2 ppm, respectively), and could be relaxed, (2014-2018), http://hycora.eu/

[16] DeliverHy - Optimisation of Transport Solutions for Compressed Hydrogen (2012-2013), http://www.deliverhy.eu/publics/LegalNotice.html

[17] European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR 2017)

[18] Directive 2010/35/EU of the European Parliament and of the Council of 16 June 2010 on transportable pressure equipment and repealing Council Directives 76/767/EEC, 84/525/EEC, 84/526/EEC, 84/527/EEC and 1999/36/EC

[19] Gesetz zu dem Europäischen Übereinkommen vom 30. September 1957 über die internationale Beförderung gefährlicher Güter auf der Straße (ADR)

[20] Verordnung über die innerstaatliche und grenzüberschreitende Beförderung gefährlicher Güter auf der Straße, mit Eisenbahnen und auf Binnengewässern (Gefahrgutverordnung Straße, Eisenbahn und Binnenschifffahrt - GGVSEB)

Annexes A and B to the ADR Agreement (26th ADR Amending Ordinance - 26th ADR)[21] and the Ordinance for Transportable Pressure Equipment[22].

Lightweight composite gas cylinders at 700 bar and higher volume tubes (up to 10,000l) have been already developed, making possible to increase the overall payload. In order to optimise the safety factors calculation and to adopt higher volumes of the pressure vessels, a number of measures have to be undertaken. As a first step, the most relevant standards for gas cylinders (ISO 11119-X standards) and composite tubes (ISO-11515) referenced in ADR have to be amended as to adopt a new approach to calculate safety factors for composite pressure vessels using probabilistic methods.[23] Further, the proposed revisions in standard ISO/DIS 17519:2018-4 Gas cylinders — Refillable permanently mounted composite tubes for transportation, allowing the use of 3,000 l tubes at 1,000 bar and of 10,000 l tubes at 300 bar, currently under development, have to be adopted.

After the standards adoption, the ADR shall be updated as to allow and define new volume category of pressure receptacles (tubes from 3,000l to 10,000l) and refer to the revised standards. The ADR Directive and Transportable Pressure Equipment Directive shall be amended in accordance to the changes in the ADR. Finally, the national legislation shall be adjusted accordingly.

3.2. Conclusions

Current limitations on volume and working pressure of high-pressure receptacles used for hydrogen transport by road hamper the economic delivery of big quantities of hydrogen to large refuelling stations or other (industrial) users. These limitations represent a structural barrier and therefore the current standards have to be revised and changed as to allow higher vessels capacities. Having these changes adopted is a very long process involving research institutes, industry, standardisation organisations and policy makers and can only happen if a broad consensus between countries and within interest organisations will be achieved.

3.3. Recommendations

Building a broad consensus between the key stakeholders for increasement of the current capacities of hydrogen receptacles in view of the revisions of the existing ISO standards for gas cylinders and composite tubes

Revision of the most important ISO standards (developed in ISO/TC58/SC3) as to increase the cylinder and tube volumes and the permitted working pressures, as well as to optimise the safety factors specified in the ADR

4. Production of hydrogen/On-site electrolysis at hydrogen refuelling stations

4.1. Overview and analysis of the legal framework

There are currently more than 50 publicly accessible hydrogen refuelling stations (HRS) in operation in Germany. This makes Germany, ahead of the USA, the country with the second largest hydrogen refuelling infrastructure, only surpassed by Japan.

The German legal framework has the highest degree of maturity within the HyLaw countries when it comes to the HRS permitting process. However, the permitting requirements and process are not yet fully unified, especially for HRS with hydrogen production on-site. The production of hydrogen is subject to a significant number of requirements. Although enshrined in national legislation following transposition, the source of most of these requirements can be traced to EU Directives in various fields.

One of the important directives for permitting hydrogen production is the Industrial Emissions Directive 2010/75/EU[24]. It defines the obligations of large industrial plants to avoid or minimize polluting emissions in the

[21] Sechsundzwanzigste Verordnung zur Änderung der Anlagen A und B zum ADR-Übereinkommen (26. ADR-Änderungsverordnung – 26. ADR)

[22] Ortsbewegliche-Druckgeräte-Verordnung (ODV)

[23] CEN- CENELEC/ Sector Forum Energy Management/Working Group Hydrogen Final Report; EUR 27641 EN, 2016

[24] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions

atmosphere, water and soil and to prevent the generation of waste. To this purpose, the operators of industrial installations are required to obtain an integrated permit. Presently hydrogen production falls under the Directive and is subject to a permitting process as production of inorganic chemical (Annex I, 4. Chemical industry, 4.2 Production of inorganic chemicals). The Industrial Emissions Directive stipulates that production should be understood as "production on an industrial scale by chemical processing of substances or groups of substances listed in sections 4.1 to 4.6 " leaving space for interpretation at national level. Another EU legal act laying down permitting requirements for hydrogen production is the Environmental Impact Assessment Directive 2011/92/EU [25]. In case, an electrolysis plant will be built (without methanation plant), production and storage of hydrogen falls within the projects listed in Annex II (6a and 6c - production of chemicals; and storage facilities for chemical product), for which Member States shall determine whether the project shall be made subject to an Environmental Impact Assessment (EIA) or not.

In Germany, the Industrial Emissions Directive is transposed by the Federal Imission Control Act, which regulates the permit requirements for plants and the 4. Federal Imission Control Ordinance[26], which lists the plants requiring permit. According to Annex I of the 4. Federal Imission Control Ordinance the hydrogen production plants are classified under 4. Chemicals, pharmaceuticals, mineral oil refining and further processing, 4.1.12 Equipment for production of substances or groups of substances by chemical, biochemical or biological conversion on an industrial scale for production of gases such as hydrogen.

If the hydrogen production is on an industrial scale a formal permit procedure with public participation according to § 10 of Federal Immission Control Act is required. (includes environmental impact assessment, if required). There is no regulation specifying the plant capacity for production of hydrogen on an industrial scale and therefore an assessment on a case by case basis is necessary, which may result in different permit requirements and procedures in the individual federal states.

The Environmental Impact Assessment Directive is transposed through the Environmental Impact Assessment Act (EIA Act)[27], which mirrors the provisions of EIA Directive for production on chemicals on an industrial scale. According to §7 (1) and Annex I, 4.2 of the EIA Act, for the construction and operation of a plant for the production of substances or groups of substances by chemical conversion on an industrial scale is required a general preliminary examination for each individual case.

At EU as well as at national level the hydrogen production plants are considered as traditional chemical production plants, without regard to the method of hydrogen production (steam reforming, chloralkaline electrolysis, water electrolysis…) or the presence (or absence) of hazardous substances involved in the production process. This could place a disproportionate burden on environmentally friendly production technologies, as it subjects them to the same requirements as industrial, emission emitting processes.

4.2. Conclusions

At present, the hydrogen production plants are considered as any other inorganic gas production plants. The legislation does not differ between steam methane reforming and water electrolysis. Therefore, if the hydrogen production on-site at HRS is considered to be on an industrial scale, for the construction of the electrolysis plant may be required a formal permit procedure with public participation according to § 10 of Federal Immission Control Act. This can cause high costs and significant delays in obtaining a permit.

However, some of the existing electrolysers were built without permit under Federal Immission Control Act as installations used for research, development or testing of new feedstocks, fuels or processes in pilot plants as stipulated in §1 (6) of 4. Federal Imissions Control Ordinance. Due to the sufficient technology maturity and the rapidly growing hydrogen refuelling stations network, this exemption can hardly apply to the construction of electrolysers at hydrogen refuelling stations in the future.

The absence of clear rules for relatively small production quantities may lead to a restrictive permit procedure which may discourage development of environmentally friendly production methods and further hinder economies of scale for smaller units. In principle, there are no relevant hazards to the environment arising from small-scale hydrogen production by electrolysis, so that up to a certain size of the plants, a general environmental pre-assessment in each individual case can be omitted. Moreover, since the lower environmental authorities are involved in the

[25] Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment

[26] Vierte Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Verordnung über genehmigungsbedürftige Anlagen - 4. BImSchV)

[27] Gesetz über die Umweltverträglichkeitsprüfung (UVPG)

environmental impact assessment as a part of the building permit procedure, an independent evaluation of the local impact is always carried out.

Electrolysers for production of hydrogen on-site at HRS should not be treated as plants producing chemicals on an industrial scale and therefore no formal permit procedure with public participation has to be implemented. This could be achieved through a determination of a reasonable capacity of the electrolysis plants in Annex I of the 4. Federal Immission Control Ordinance above which the permitting requirements of Federal Immission Control Act shall apply[28].

Further, the need for carrying out an environmental impact assessment is defined on the basis of a general preliminary assessment for each individual case when the plant is considered to be for production of substances by chemical conversion on an industrial scale. Due to the fact that EIA Act also uses the same indeterminate legal term, a corresponding capacity determination and exemption from the general preliminary assessment of electrolysis plants up to a certain capacity should be made in Annex I of the EIA Act.

4.3. Recommendations

Definition of the term "production on an industrial scale" for hydrogen production on-site at hydrogen refuelling stations through electrolysis

Clear exception of electrolysis plants up to a certain capacity from the permit requirements of the Federal Immission Control Act and from the requirements of the Environmental Impact Assessment Act for a general preliminary examination of the individual case to assess the need for an environmental impact assessment. The installations concerned should only be approved in accordance with the general building law

5. Vehicles – Cars, Busses, Trucks/Restrictions and incentives

5.1. Overview and analysis of the legal framework

Restrictions for hydrogen powered vehicles when using public road infrastructure may be imposed in relation to the on-board storage of high pressure or liquid hydrogen and their classification as dangerous goods according to Annex A of ADR. The fuel cell electric and hydrogen combustion vehicles are assigned to UN No. 3166. According to the special provision 666 of Chapter 3.3 vehicles assigned to this number, as well as any dangerous goods they contain necessary for their operation or the operation of their equipment, when carried as a load, are not subject to any other provisions of ADR, given that certain equipment safety conditions are met.

For hydrogen combustion vehicles and fuel cell electric vehicles (FCEVs) has not been assigned a tunnel restriction code. In addition, no parking restrictions or special requirements have been referenced in Column (19) of Table A of Chapter 3.2 of ADR.

The Member States may on ground of transport safety apply to vehicles engaged in the international carriage of dangerous goods by road certain stricter additional provisions not included in ADR, provided that those provisions do not conflict with the provisions of ADR and are contained in their domestic legislation applying equally to vehicles engaged in domestic carriage of dangerous goods by road. Such additional provisions are, inter alia, additional safety requirements or restrictions concerning vehicles using certain structures such as bridges and tunnels, vehicles using combined transport modes such as ferries and trains, or vehicles entering or leaving ports or other transport terminals.

The uniform rules of ADR are extended to the road transport within and between EU Member States with Directive 2008/68/EC on the inland transport of dangerous goods[29]. The Directive is transposed into German legislation by the ADR Act and the Ordinance on the international and cross-border carriage of dangerous goods by road, railways and inland waterways.

[28] Electrolysis plant with capacity of 1 to 1.5 MW. The limit value was set on the basis of hydrogen storage quantities for which no BimSchG permit procedure is required (up to 3t).

[29] Directive 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods

At present, no substantial restrictions or barriers for hydrogen powered vehicles using the elements of the public transport network are identified. As a whole, there is no enough experience and sufficient information about the restrictions which may be imposed on hydrogen busses and trucks.

Nevertheless, the passing through some categories of tunnels could be forbidden for some types of hydrogen powered vehicles, especially busses and trucks, the parking in underground garages may be restricted by the parking facilities owners. Due to the limited number of hydrogen powered vehicles in use, the potential restrictions on their transportation with ferry or train are rather unknown. It is possible that the ferry/train operator may require information about the type of the vehicle to be transported or restrict the number of hydrogen powered vehicles on board. The only known restriction is the prohibition for carriage of FCEVs as vehicles powered by flammable gas by Eurotunnel Le Shuttle. This is an operational barrier for the free movement of FCEVs in Europe and should be removed.

The EU has set itself targets for reducing its greenhouse gas emissions progressively up to 80%-95% by 2050. In order to achieve the goals for 20% cut in greenhouse gas emissions (from 1990 levels) and 20% renewables in total energy consumption in the EU by 2020, European Union has adopted a number of legal acts in the energy and transport sectors. The most important of them aimed at creating framework for granting various financial- and non-financial incentives for clean vehicles are the Alternative Fuel Infrastructure Directive 2014/94/EU (AFID)[30] and the Clean Vehicle Directive 2009/33/EC[31].

AFID aims at developing a market for alternative vehicle powertrains, fuel technologies and infrastructure and mandates the Member States to grant direct or tax incentives for the purchase of private and public alternative fuel vehicles (AFVs) and for the building-up of the relevant infrastructure. Each Member State shall submit to the Commission a report on the implementation of its national policy framework by 18 November 2019, and every three years thereafter. Those reports shall include inter alia information about the undertaken policy measures, such as:

- direct incentives for the purchase of AFVs or for building the infrastructure,
- availability of tax incentives to promote AFVs and the relevant infrastructure,
- use of public procurement in support of alternative fuels, including joint procurement,
- demand-side non-financial incentives, for example preferential access to restricted areas, parking policy and dedicated lanes.

AFID does not oblige Member States to build refuelling infrastructure for hydrogen vehicles, it is up to national policy makers to include hydrogen refuelling points in their national policy frameworks and promote hydrogen powered vehicles.

The Directive is transposed into national law through the National Strategic Framework for the Development of Infrastructure for Alternative Fuels[32], the Charging Stations Ordinance[33], the Law for the Further Development of the Electricity Market (Electricity Market Act)[34] and the Law on Measuring Point Operation and Data Communication in Intelligent Energy Networks (Measuring Point Act)[35]

Clean Vehicles Directive requires contracting authorities to invest in environmentally friendly vehicles and thus to promote and stimulate the market for clean and energy efficient vehicles. An evaluation carried out in 2015 showed that the results have been limited. Public bodies are on average not using public procurement well enough to boost the market uptake of clean vehicles. Furthermore, its scope is insufficient and a definition of clean vehicles is lacking. Provisions for vehicle purchase are either vague (technical specifications) or overly complex (monetisation of external effects).

[30] Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure

[31] Directive 2009/33/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of clean and energy-efficient road transport vehicles

[32] Nationaler Strategierahmen über den Aufbau der Infrastruktur für alternative Kraftstoffe, https://www.bmvi.de/DE/Themen/Mobilitaet/Mobilitaets-Kraftstoffstrategie/Nationaler-Strategierahmen-AFID/nationaler-strategierahmen-afid.html

[33] Verordnung über technische Mindestanforderungen an den sicheren und interoperablen Aufbau und Betrieb von öffentlich zugänglichen Ladepunkten für Elektromobile (Ladesäulenverordnung – LSV)

[34] Gesetz zur Weiterentwicklung des Strommarktes (Strommarktgesetz)

[35] Gesetz über den Messstellenbetrieb und die Datenkommunikation in intelligenten Energienetzen (Messstellengesetz)

Clean Vehicle Directive is transposed in Germany by the Ordinance on the Award of Public Contracts (Public Procurement Ordinance).[36]

In November 2017, as a part of its Clean mobility package, the EU Commission proposed a revision of the Clean Vehicle Directive[37]. The proposal provides a definition for clean light-duty vehicles, based on a combined CO2 and air-pollutant emissions threshold and a definition for heavy-duty vehicles, based on alternative fuels.

The proposed revision should ensure that all relevant procurement practices are covered, clear, long-term market signals are provided, and provisions are simplified and effective. It sets out minimum targets for clean vehicle procurement by 2025 and by 2030 differentiated by Member State and by vehicle segment categories.

According to the proposal the minimum target for the share of clean light-duty vehicles in the total public procurement of light-duty vehicles in Germany is 35% by 2025 as well as by 2030. The minimum targets for the share of clean heavy-duty vehicles are as follows:

- Trucks – 10% by 2025, 15% by 2030,
- Buses – 50% by 2025, 75% by 2030.

On 8 November 2017, the European Commission presented a legislative proposal setting new CO2 emission standards for passenger cars and light commercial vehicles (vans) in the European Union for the period after 2020[38] . The proposed targets are set for the EU-wide average emissions of new cars and vans in a given calendar year from 2025 on, with stricter targets applying from 2030. Average emissions of the EU fleet of new cars in 2030 will have to be 30% lower than in 2021. The proposed framework builds on the current EU Regulation[39] setting CO2 emission targets of 95 g CO2/km for passenger cars and 147 g CO2/km for light commercial vehicles for 2020/2021.

On 17 May 2018, the European Commission presented a legislative proposal setting the first ever CO2 emission standards for heavy-duty vehicles in the EU[40]. The average CO2 emissions from new heavy-duty vehicles shall be in 2025, 15% lower and in 2030, at least 30 % lower than in 2019 (indicative target, subject to review in 2022).

The both proposals, for passenger cars and for heavy duty vehicles also include mechanisms to incentivise the uptake of zero- and low-emission vehicles, in a technology-neutral way.

On 18 May 2016, on the basis of the Government Programme for Electric Mobility[41], the German government adopted a package of measures to press ahead with electric mobility. The package includes various financial and non-financial incentives for electric powered vehicles which are listed below.

Besides the battery electric vehicles (BEV) and plug-in hybrids (PHEV), the FCEVs are included in the definition of electric powered vehicles, given in §2 (1) of the Electric Mobility Act[42]. The purpose of the law is to grant special privileges to electric powered vehicles categories L, M1, N1, N2 (when driven with class B driving license) on the roads such as, for example, allocating them special parking spaces near charging stations in public areas, lowering or waving parking fees, and exempting electric vehicles from certain access restrictions.

The Electric Mobility Act's provisions are implemented by the Road Traffic Ordinance[43]. Decisions about the privileges granted to electric vehicles are to be made by the competent local authorities. A number of cities have already implemented special rights for electric vehicles on the basis of the Electric Mobility Act.

---

[36] Verordnung über die Vergabe öffentlicher Aufträge (Vergabeverordnung)

[37] Proposal for a Directive of the European Parliament and of the Council amending Directive 2009/33/EU on the promotion of clean and energy-efficient road transport vehicles COM (2017) 653

[38] Proposal for a Regulation of the European Parliament and of the Council setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast) COM (2017) 676

[39] Regulation (EC) No 715/2007 of the European Parliament and of the Council of 20 June 2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information

[40] Proposal for a Regulation of the European Parliament and of the Council setting CO2 emission performance standards for new heavy-duty vehicles COM/2018/284 final

[41] Regierungsprogramm Elektromobilität, https://www.bmvi.de/SharedDocs/DE/Anlage/VerkehrUndMobilitaet/regierungsprogramm-elektromobilitaet.html

[42] Gesetz zur Bevorrechtigung der Verwendung elektrisch betriebener Fahrzeuge (Elektromobilitätsgesetz, EmoG)

[43] Straßenverkehrs-Ordnung (StVO)

Non-hybrid electric vehicles registered for the first time in the period from 18 May 2011 to 31 December 2020 are exempt from the annual circulation tax for a period of ten years from the date of their first registration according to §3d of Motor Vehicle Act[44].

Company car fleets are an important potential market segment for electric vehicles. Companies possessing fleets normally have the capacity to develop purchasing policies for clean vehicles and can easier solve the technical and logistical problems of supplying vehicles with hydrogen. To ensure that the continuing high level of prices for electric and hybrid vehicles compared with conventional vehicles are not a deterrent to procurement, the Federal Government took on 1 August 2018 a decision to improve the rules on the private use of these cars. At present, an employee who uses privately his company electric or hybrid vehicle must pay monthly tax on 1% of the list price as a so-called non-cash benefit. This provision is not applicable for FCEVs. According to the bill which has to be adopted by the German Bundestag, the monthly tax for private use of companies electric and hybrid vehicles, purchased or leased between 1 January 2019 and 31 December 2021, shall be calculated on the half of the list price and this rule will apply for FCEVs too.

At least 20% of the German Federal Government vehicle fleet should consist of electric vehicles till 2020. 100 million EUR have been earmarked for this.

Since July 2016, an environmental bonus of 4,000 EUR for purchase of BEVs and FCEVs and 3,000 EUR for PHEVs are available. The subsidy is to be paid towards purchases of vehicles categories M1, N1 and N2 (cars and small trucks) with a list price of up to 60,000 EUR. The subsidies are part of a 1.2-billion-euro package to bring 1 million electric cars to German roads, and those who purchase vehicles first will benefit from it. The subsidies are granted to electric car buyers until 2019 and the German Federal Government and the automotive industry each cover half of the costs.

As of 8 August 2018, 166 vehicles models are eligible for the purchase bonus, from them only two are fuel cell electric vehicles.

According to the interim report of the application status of the Federal Office of Economics and Export Control (BAFA) an environmental bonus was paid for the purchase of 41,531 battery electric vehicles, 28,791 plug-in hybrid vehicles and 17 fuel cell electric vehicles by 30. July 2018.

5.2. Conclusions

The risk of unreasonable restrictions on FCEVs when using the facilities of transport infrastructure may create an uncertainty for the users and negatively affect their choice to purchase hydrogen powered vehicles.

Hydrogen powered vehicles, especially cars and busses, are key for achieving the EU climate goals for limiting the global warming to well below 2° C and decarbonization of the transport sector. In this context, it is important that current policies affecting the market deployment of FCEVs vehicles and the corresponding refueling infrastructure ensure and promote a level playing field for all types of clean vehicles.

Germany has set itself the ambitious goal to became a leading market and provider for electromobility and put onto German roads one million electric vehicles by 2020 as part of its "National Electromobility Development Plan"[45]. The Federal Government has therefore decided on a package of measures to promote electromobility, which includes, among others, a purchase bonus for electric cars (environmental bonus), tax incentives, comprehensive subsidies to improve the charging infrastructure and a procurement program for the public sector.

These measures are quite insufficient to stimulate the market for FCEVs so far. The registered FCEVs in Germany are only 314 till the beginning of 2017.

Considering the EU binding target for achieving at least 40% reduction in greenhouse gas emissions (from 1990 levels) by 2030; the legislative proposal of the EU Commission from November 2017, setting new CO2 emission standards for passenger cars and light commercial vehicles (vans) in the European Union for the period after 2020 and a new EU fleet target for 35%/30% emissions reduction in 2030 compared to the 2021 targets; the legislative proposal to set CO2 emissions standards for heavy-duty vehicles and the minimum targets for clean vehicles procurements by 2030, a new national long-term policy framework is required for the period after 2020

This framework should incentivise the uptake of zero- and low-emission vehicles, in a technology-neutral way and provide a clear signal and predictability for industry to invest, stimulate employment, foster innovations and

[44] Kraftfahrzeugsteuergesetz (KraftStG)

[45] National Electromobility Development Plan, https://www.bmvi.de/SharedDocs/DE/Anlage/VerkehrUndMobilitaet/national-electromobility-development-plan.html

competitiveness. In addition, it would accelerate the deployment of zero- and low-emission vehicles and the development of fuel-efficient technologies and thus provide the basis for maintaining the German automotive industry's success in global markets.

5.3. Recommendations

Monitoring of legal and administrative regulations for fuel cell electric vehicles using specific structures such as bridges and tunnels, combined transport modes such as ferries and trains or parking facilities with regard to inappropriate restrictions, provided that the safety requirements of ADR are met and taking appropriate measures to prevent or eliminate such restrictions

Development of new supportive technology-neutral policies and regulations for zero - and low-emission vehicles ensuring a level playing field between FCEVs and BEVs

Determination of higher minimum procurement targets for zero - and low-emission light-duty and heavy-duty vehicles for public bodies

Extension of the funding for acquisition of electric powered vehicles after 2020 and inclusion in the list of electric vehicles eligible for subsidy more models of FCEVs

Initiation of legislative changes abolishing the toll-charges for zero-and low- emission heavy- duty vehicles and increasing the toll charges for high-emission heavy-duty vehicles

Favouring the circulation of zero-emission vehicles in city centres (by general prohibition of entry for high-emission vehicles or introduction of a city toll)

6. Ships/Use of hydrogen and fuel cells on sea-faring vessels

6.1. Overview and analysis of the legal framework

Maritime transport emits around 1000 million tonnes of CO2 annually and is responsible for about 2.5% of global greenhouse gas emissions[46]. Shipping emissions are predicted to increase between 50% and 250% by 2050 – depending on future economic and energy developments. This is not compatible with the internationally agreed goal of keeping global temperature increase to below 2°C compared to pre-industrial levels, which requires worldwide emissions to be at least halved from 1990 levels by 2050.

Ships' energy consumption and CO2 emissions could be reduced by up to 75% by applying operational measures and implementing existing and new innovative technologies[47].

In April 2018, IMO's Marine Environment Protection Committee (MEPC) adopted an initial strategy on the reduction of greenhouse gas emissions from ships, setting out a vision to reduce GHG emissions from international shipping by at least 50% by 2050 compared to 2008. Unfortunately, hydrogen is only mentioned as a possible alternative fuel among others and is not considered as one of the key solitons for decarbonisation of maritime transport.

At international level, (i.e. within the competence of the International Maritime Organisation (IMO), the International code for safety of ships using gases or other low-flash point fuels (IGF code)[48] contains mandatory provisions for design and operation of ships using low flashpoint fuels. As hydrogen has a flashpoint below 60°C, the IGF code generally applies. Nevertheless, the fuel cells and the hydrogen as a fuel are not specifically addressed in the IGF code (natural gas as fuel is specifically covered).

Presently, the use of hydrogen as a fuel and hydrogen fuel cells is not explicitly covered by IMO rules. The regulatory gap applies to both propulsion (main or auxiliary) as well as the use for heating, cooling and other power generation purposes. Continued regulatory work has been agreed under the IGF Code working group. This includes agreeing on the definition of the fuel cells (n.b. natural gas fuel cells), however this does not include hydrogen powered fuel cells, which are currently not on the agenda of the IMO.

[46] Third IMO GHG study 2014

[47] Second IMO GHG study 2009

[48] Resolution MSC.391(95) (adopted on 11 June 2015)

In the absence of specific provisions, according to the IGF code, the use of other low flashpoint fuels including hydrogen can be approved based on alternative design approach with regard on ship and system design.

The alternative design assessment is regulated by the Convention of Life at Sea (SOLAS II-1/55). The alternative design is a process by which the safety, reliability and dependability of the systems must be demonstrated to be equivalent to that achieved with new and comparable conventional oil-fuelled main and auxiliary machinery. The equivalence of the alternative design shall be demonstrated by a risk-based assessment and approved by National Maritime Authorities (Federal Maritime and Hydrographic Agency) (Bundesamt für Seeschifffahrt und Hydrographie).

The IMO Circulars developed at the level of the Maritime and Safety Committee, MSC.1/Circ.1212 and MSC.1/Circ.1455 provide guidance to perform the Alternative Design Approval Process. The criteria to be applied include:

- Equivalent level of safety to relevant IGF Code chapters (acc. IGF Ch.2)
- Fulfilment of the goals and functional requirement
- Risk assessment as required by IGF code chapter 4

The process has five stages: 1) Development of a preliminary design, 2) Approval of a preliminary design, 3) Development of final design, 4) Final design testing and analyses, and 5) Final approval. The guidelines describe the process in detail and include comprehensive technical, risk and environmental assessment, with broad stakeholder involvement. In addition, the classification rules for fuel cell installations issued by the largest relevant classification societies can be used as guidance by assessment[49].

6.2. Conclusions

The absence of specific rules for the design approval of fuel cell vessels using hydrogen as a fuel is a major obstacle for the commercial deployment of hydrogen and hydrogen fuel cells in the maritime sector.

The alternative design approval process is currently the only means for approval of hydrogen fuel cell vessels for maritime use. This process implies much higher cost, regulatory uncertainty and delays (estimation of more than one extra year for approval as compared with other, more established technologies).

In the absence of specific rules for hydrogen as a fuel for sea-faring vessels, the deep decarbonization of the maritime sector by 2050 is in serious danger of becoming unattainable, as LNG and LPG technologies cannot achieve such a deep reduction in greenhouse gas emissions on their own.

Considering an average lifetime of 30 years of vessels, the deployment of hydrogen and hydrogen fuel cell vessels needs to take off, at an accelerated pace, from 2020 in order to meet the demand for new, greener vessels and have a chance to realistically meet the commitments made for cutting greenhouse gas emissions.

However, given the extremely lengthy procedures at IMO level and the absence of any on-going procedure to negotiate codes covering hydrogen fuel cells, a specific, international regulation for the sector is years away.

A concerted effort is necessary by all regulatory actors involved to put the matter on the agenda of the IMO and establish codes and regulations in time for commercial deployment of the technologies.

6.3. Recommendations

Initiation of a procedure for development of requirements and regulations for storage and use of hydrogen as a fuel and hydrogen powered fuel cells in ships

[49] For example, DNV GL Rules for Fuel Cell Installations (Part 6, Ch.2, Sec.3) and Low Flashpoint Liquid Fueled Engines (Part 6, Ch. 2, Sec.6)

7. Legal status of power to gas

7.1. Overview and analysis of the legal framework

Power to Gas (PtG) is a highly effective cross-sectoral system solution allowing to integrate renewable energies in several sectors of economy. Hydrogen production by electrolysis of water and synthetic methane production by methanation are the two-core processes of PtG. Hydrogen and synthetic methane from renewable electricity can be used in mobility, industry, heat supply and electricity generation.

As an electricity storage technology, PtG can contribute to compensating the increasing fluctuations in electricity generation from wind and solar energy and facilitate long-term use of electricity which could not be integrated directly into the electricity grid at times of particularly high renewable generation. And unlike other energy storage technologies, PtG can both store and transport energy. By storing hydrogen or substituting natural gas in the existing natural gas pipeline network and associated underground storage facilities, the stored energy can be discharged where and when it is needed most.

The PtG process chain is increasingly recognized as having a significant role in decarbonizing and sustaining energy independence in European energy systems.

The cross-sectoral nature of PtG links it to both electricity and gas networks and markets, and thus to correlated EU legislation included under the 2009 Third Energy Package and proposed Clean Energy for all Europeans Package of 2016. The unbundling rules on separation of energy supply and generation from the operation of transmission networks in current Electricity Market Directive 2009/72/EC[50] and Natural Gas Market Directive 2009/73/EC[51] apply for PtG plants. Both directives have been transposed into German law by the German Energy Industry Act.

As PtG is not only an energy conversion activity which produces a gaseous energy carrier, but also an energy storage technology, more legal issues are raised under the proposal for a Recast Electricity Market Directive[52].

The proposal states that transmission and distribution electricity system operators shall not be allowed to own, manage or operate energy storage facilities. However, Member States may grant exemptions if an approval has been given by the national regulatory authority (Federal Network Agency) and if the energy storage facility is necessary for the tasks of the system operator. The new rules for unbundling of energy storage from network operation are complementary to the existing unbundling rules.

According to the proposal „energy storage“ means, in the electricity system, deferring an amount of the electricity that was generated to the moment of use, either as final energy or converted into another energy carrier.

It should be cleared if PtG plants falls under the energy storage principles of the Recast Electricity Market Directive. Therefore, a clear definition for PtG should be developed at EU level and the ownership unbundling rules for PtG in European electricity and gas legislation should be clarified.

In Germany, a legal definition of PtG is also missing. The PtG plants are treated as end users in the electricity system, as far as the generated hydrogen is not used for power recovery, and as producers in the natural gas system. The end user status leads in principle to charging in the price of the electricity used various energy charges and allocations (for example network charges, EEG -, cogeneration -, offshore apportionments, electricity tax etc.)

The PtG plants used for energy storage of renewable energy as long as the stored gas is then used to generate electricity are exempted from the EEG - apportionment for the purchased electricity from renewable energy sources under the Renewable Energy Act (§61k (1) (2), from electricity and gas network charges according to Energy Industry Act (§118) and from electricity tax for electricity, used for electricity production according to Electricity Tax Act (§9)[53]. The Cogeneration- apportionment is reduced according to Cogeneration Act(§27b)[54].

However, only a few of the PtG plants currently in operation, construction or planning are used for energy storage and power recovery. The most of the PtG plants produce fuels or are used solely for hydrogen generation and use (as

[50] Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC

[51] Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC

[52] Proposal for a Directive of the European Parliament and of the Council on common rules for the internal market in electricity COM (2016) 864

[53] Stromsteuergesetz (StromStG)

[54] Gesetz für die Erhaltung, die Modernisierung und den Ausbau der Kraft-Wärme-Kopplung (Kraft-Wärme-Kopplungsgesetz - KWKG)

a row material). These plants are exempted from network charges and can reimburse the electricity tax paid for the electricity used according to the Electricity Tax Act (§9a), but they are charged with fees and various apportionments (EEG-apportionment).

In general, the possibilities for PtG plants to take renewable electricity from the public supply grid, evidenced by means of guarantees of origin are legally limited for the most applications of PtG due to the lack of legal incentives (renewables in heating sector and in industry) or due to legal constraints (production of renewable fuels). These limitations and the high electricity price due to the payable EEG-apportion are the main obstacles to the widespread market deployment of PtG technology.

The product costs of a PtG plant are largely determined by the electricity price. In 2014, the energy costs in relation to the total value of the products amounted to around 26 percent for the production of industrial gases[55].This ratio is 70% for the PtG plants due to the production process. Therefore, it is important to reduce the price of the electricity used in PtG process, provided that it comes from renewable energy sources.

Production of industrial gases including hydrogen is included in the list of the electro - and trade intensive sectors in Annex IV of the Renewable Energy Act. For companies in these sectors the EEG - apportionment can be reduced (up to 15% resp. 20%) for the following calendar year upon an annual application to the Federal Office of Economics and Export Control (BAFA) according to § 64 of Renewable Energy Act, if they can prove in the application process that over the most recent three completed financial years:

- more than 1 GWh of electricity was consumed,
- the electricity cost intensity was at least 14% (companies according to list 1) or at least 20% (companies according to list 2),
- certification of the energy or environmental management system (potential for reducing energy consumption) was in place.

Further, for electricity intensive companies the Cogeneration- and StromNEV – apportionments (§27 of Cogeneration Act, §19 of StromNEV[56]) and the apportionment for loads that have to be switched off (§18 of Ordinance for interruptible loads [57]) can be reduced. Production of hydrogen as a fuel and as a raw material is not included in the list of electro- and trade intensive sectors and therefore EEG- apportionment is due.

7.2. Conclusions

At present, there is no legal definition for PtG either at European nor at national level. In view of the provisions of current Natural Gas Market Directive 2009 and proposed definition and ownership regime for energy storage under the Recast Electricity Directive, there is a need to clear to what extend and whether PtG is both a gas production activity and an energy storage. It should also be clarified to what extend and whether the gas network system operators are allowed to operate a PtG plant as storage facility, when this could be also considered as a gas production plant.

In addition, current regulatory frameworks at European and national level do not enable the commercial use of PtG plants. The business cases for PtG are hindered by fees, taxes and various apportionments, including EEG-apportionment.

The electricity price in Germany for commercial end users is high and a big part of it is built by EEG-apportionment (appr. 23,6% in 2017). Hydrogen as a gas produced from renewable energy for mobility or industry can contribute to meet the renewable energy targets set at EU and national level and therefore its production by electrolysis as a fuel or raw material has to be included in the list of electro- and trade intensive sectors as to reduce the EEG- apportionment for the electricity used.

The list of electro-and trade intensive sectors in Annex 4 to the Renewable Energy Act is based on the List in Annex 3 to the Guidelines on State aid for environmental protection and energy 2014-2020 of the European Commission, for which an aid in the form of reduction in support of renewable energy can be granted. Therefore, as a first step, the list of eligible sectors in European Commission Guidelines has to be extended with production of hydrogen as fuel and as raw material and then Annex 4 to the Renewable Energy Act has to be amended accordingly. In order to ensure the necessary investment security in the market introduction phase of the PtG plants and technology, it is

[55] Source: Federal Statistical Office

[56] Verordnung über die Entgelte für den Zugang zu Elektrizitätsversorgungsnetzen (Stromnetzentgeltverordnung -StromNEV)

[57] Verordnung über Vereinbarungen zu abschaltbaren Lasten (Verordnung zu abschaltbaren Lasten - AbLaV)

advisable to design the approval for the reduction of the EEG-apportionment for the electricity purchased from the grid for PtG plants on a multiyear basis.

7.3. Recommendations

Creation of a clear and unified legal definition for power to gas and clarification of the ownership unbundling rules for power to gas under the EU gas and electricity legislation

Initiation of a regulatory change of the Guidelines on State aid for environmental protection and energy of the European Commission after 2020 as to include the hydrogen production by electrolysis as a fuel for mobility and as a raw material for industry in the list of electro intensive sectors, eligible for aid in form of reduction in support of renewable energies, and introduction of a subsequent corresponding amendment to the Annex 4 of the EEG and a multi-year permit for reduction in the EEG-apportionment for the electricity purchased from the grid

Establishment of a legal framework allowing and promoting PtG plants to use renewable electricity from the public supply grid, certified by means of guarantees of origin

8. Hydrogen injection into the public gas grid

8.1. Overview and analysis of the legal framework

As part of its Clean Energy for all Europeans package, the European Commission proposed in 2016 an update of the Renewable Energy Directive for the period 2021 – 2030 (RED II). The final compromise document was agreed among EU Institutions on 14 June 2018.

In addition to the new binding renewable target of at least 32% of EU final consumption in 2030, some other key changes to the promotion of renewables in the EU introduced by RED II are relevant to the integration of gas from renewable energy sources into the gas grid:

- guarantees of origin (GOs) are extended to cover renewable gases. This would provide a consistent means of proving to final customers the origin of renewable gases, including renewably produced hydrogen, and would facilitate greater cross- border trade in such gases,
- annual increase of 1.3 % of renewables share in heating and cooling starting from the level achieved in 2020 is introduced; One of the possible measures is „the physical incorporation of renewable energy in energy and energy fuel, supplied for heating and cooling",
- the Member States, where relevant, shall assess the need to extend the existing gas network infrastructure to facilitate the integration of gas from renewable energy sources and require system operators to publish the connection tariffs to connect production plants for renewable gases in a transparent and non-discriminatory way.

The RED II does not provide a definition for renewable gases. It contains only the definition set out in Directive 2015/1513 concerning renewable transport fuels of non-biological origin, which energy content comes from renewable energy sources other than biomass.

Renewable hydrogen and synthetic methane could contribute to the achievement of national energy targets if they could be count towards the share of energy from renewable sources in a certain sector (electricity, heating and cooling, transport). As the conversion of energy from one energy carrier to another could lead to double counting the electricity and gas from renewable sources could be counted only once towards renewable share in electricity, heating and cooling, or transport. Unlike biogas injected into gas network, hydrogen and synthetic methane are currently not eligible to be counted towards the renewables share in heating and cooling.

Further, the permitted concentration of hydrogen in the gas grid varies significantly between Member States and in a large number of EU-countries the hydrogen injection into the gas network is generally not allowed. Neither international nor European standards define rules for admissible concentration of hydrogen in the natural gas network. The CEN standard EN 16726: 2015 summarises "At present is not possible to specify a limiting hydrogen value which would generally be valid for all parts of the European gas infrastructure and, as a consequence, it is recommended case by case analysis". The absence of regulations creates a severe market barrier in the EU towards the injection and use of renewable hydrogen in the gas grids.

In Germany, hydrogen produced by electrolysis of water, and synthetically produced methane, when the electricity used for electrolysis and the carbon dioxide or carbon monoxide used for methanation are largely derived from renewable energy sources i.e. at least 80% [58], are included in the definition of biogas according to §3(10c) of the Energy Industry Act. The privileges for biogases, regulated in part 6 of Gas Network Access Ordinance[59] and in §19(1), §20a and §20b of the Gas Network Charges Ordinance[60] are applicable to the injection of renewable hydrogen and synthetic methane (privileged connection, privileged injection, elimination of feed-in fees, fixed payment for avoided grid costs, allocation of costs to be borne by gas network operators).

There is no legally binding certification system for renewable hydrogen and synthetic methane in place. The certification body TÜV SÜD has issued the Standard CMS 70 (Version 12/2017) for certification of green hydrogen which can be used for various applications of hydrogen. The standard defines the feedstocks, energy sources and production methods which can be used and determines the greenhouse gas reduction potential of green hydrogen. However, the standard is voluntary.

In general, the German legislation does not limit the hydrogen concentration in the natural gas network in Germany. All grid users are required to ensure the gas which they feed in is compatible with the grid. The technical requirements for that are always based on the latest version of the German Association of Gas and Water Supply (DVGW) Worksheets (DVGW G 260 and G 262). According the actual DVGW Worksheets G 260 (Gas quality) and G 262 (Use of gas from renewable resources in public gas supply) the injection of hydrogen in the public grid is allowed as long as the concentration remains below 10 Vol.-%. The technical standards (UNECE Regulation 110[61] (Compressed and liquefied natural gas components) and DIN 51624) acknowledge infrastructure elements and appliances with lower tolerances such as porous rocks, gas turbines, CNG vehicles. The applicable threshold may therefore drop down to 2 Vol.-% or even 1 Vol.-% hydrogen admixture. The gas network operator sets the hydrogen limit for injection depending on the actual existing downstream applications on a case-by-case basis. It is possible that network operators outside Germany may refuse to feed in hydrogen at cross-border connection points or may apply more stringent thresholds than apply under German law. At present, as there are no uniform European regulations, the law of the receiving country applies in each case." If an international network operator violates a country's national law or if national law violates higher-ranking EU law on non-discriminatory access to the gas grid – perhaps because exclusion of hydrogen injection or more stringent thresholds are not technically justified in specific cases – the basic rule is that the national regulatory authorities and courts in the neighbouring state have jurisdiction for the German network operator".[62]

The use of renewable energies in heating sector is regulated by the Renewable Energies Heating Act[63]. Under its provisions, owners of new buildings are required to cover a certain percentage of their heat demand with renewable energy, to undertake alternative compensatory measures such as installing additional insulation, or to use combined heat and power systems or district heating. According to §1 (2) the share of renewables in heating shall be 14% by 2020. Hydrogen and synthetic methane are not included in the list of renewable sources in § 2 (1) or in the alternative compensatory measures in § 7 of Renewable Energies Heat Act and cannot be count towards the share of renewable energies in buildings.

8.2. Conclusions

A common definition for renewable gases at EU level has to be adopted including biogases and renewable gases of non-biological origin. It is important to clear whether the carbon used for production of synthetic methane is required to originate from renewable sources or it could be fossil carbon captured at the end point.

In Germany at present, the renewable hydrogen and synthetic methane are included in the definition of biogases in Energy Industry Act and benefit from their privileged treatment in respect of gas grid injection. In other legal acts

[58] BT DS 17/6072, p.50, http://dipbt.bundestag.de/extrakt/ba/WP17/362/36234.html

[59] Verordnung über den Zugang zu Gasversorgungsnetzen (Gasnetzzugangsverordnung - GasNZV)

[60] Verordnung über die Entgelte für den Zugang zu Gasversorgungsnetzen (Gasnetzentgeltverordnung - GasNEV)

[61] Regulation No 110 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of I. specific components of motor vehicles using compressed natural gas (CNG) in their propulsion system; II. vehicles with regard to the installation of specific components of an approved type for the use of compressed natural gas (CNG) in their propulsion system

[62] Bundesnetzagentur 2014, Position paper on the application of the regulations on the feed – in of biogas to the injection of hydrogen and synthetic methane into gas grid.

[63] Gesetz zur Förderung Erneuerbarer Energien im Wärmebereich (Erneuerbare-Energien-Wärmegesetz - EEWärmeG), https://www.gesetze-im-internet.de/eew_rmeg/index.html#BJNR165800008BJNE000501360

biogas is defined only as a gas obtained by anaerobic digestion of biomass (Renewable Energy Act, Renewable Energy Heating Act). Considering the capabilities of PtG and hydrogen to store energy or to provide ancillary grid services which are not associated with biogas and biogas plants and the current and future development of policies, legal regulations and supportive mechanisms for sectors coupling technologies, a unified definition of renewable gases, differentiating biogases from renewable gases of non-biological origin is required.

At European level should be developed a guarantees of origin system for renewable gases of non- biological origin in order to demonstrate the renewable properties of the electricity used and stimulate certain final consumers to buy renewable hydrogen. The guarantees of origin should allow for the inclusion of additional optional information including greenhouse gas savings, the type of feedstock used and other benefits towards a circular economy. The guarantees of origin must be transferred, independently of the energy to which they relate, from one holder to another. Therefore, it is important that they are mutually recognized among the Member States.

There is a need of agreement on and development of EU standards for the acceptable concentration of hydrogen admixture in the gas grid (gas quality standards). When this parameter differs between the Member States this may hamper the injection of hydrogen in the natural gas network and the cross-border trade. CEN is working toward a harmonized standard for gas quality in the EU. Due to the type II vessels for CNG vehicles, 2% vol. hydrogen in the gas mix is the current basis for discussion.

In Germany, the hydrogen and synthetic methane have to be allowed as eligible means for achieving the renewable energy targets in heating and to be counted towards the renewable energy share in this sector.

8.3. Recommendations

Creation of a clear definition for renewable gases, including and differentiating biogases and renewable gases of non-biological origin at European and national level

Development of a harmonised system for guarantees of origin for renewable gases of non-biological origin

Continuous efforts to agree on admissible concentration of hydrogen in the gas grid and develop relevant gas quality standards

Inclusion of renewable hydrogen and synthetic methane in the definition of renewable energies or in the list of alternative measures in Renewable Energy Heating Act so they can be counted towards the renewable energy share in the heating sector and the obligations for proportionate use of renewable energies to cover the heating and cooling demand of new or substantially renovated public buildings can be met by their use

9. Appendix

9.1. Glossary

ADR	European Agreement concerning the International Carriage of Dangerous Goods
AFID	Alternative Fuels Infrastructure Directive
AFV	Alternative Fuels Vehicles
BAFA	Federal Office of Economics and Export Control
BEVs	Battery Electric Vehicles
BimSchG/V	Federal Immission Control Act/Ordinances
°C	Celsius
CO2	Carbon dioxide
DIN	German Institute for Standardisation
DVGW	German Association of Gas and Water Supply
EEG	Renewable Energy Act
EIA	Environment Impact Assessment

EIGA	European Industrial Gases Association
EU	European Union
FCEV	Fuel Cell Electric Vehicle
FQD	Fuel Quality Directive
GHG	Greenhouse Gas
GO	Guarantees of origin
H2	Hydrogen
HRS	Hydrogen Refuelling Station
IGF code	International code for ships using gases or other low flashpoint fuels
IMO	International Maritime Organisation
ISO	International Organisation of Standardisation
ISO/TC58/SC3	ISO/Technical committee 58/Sub-committee 3
Kg	Kilogram
L	Litre
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MEPC	Marine Environment Protection Committee
Nm3	Normal cubic meter
PHEV	Plug-in Hybrid Electric vehicle
PtG	Power to Gas
RED	Renewable Energy Directive
RED II	Proposal for a recast of the Renewable Energy Directive
SAE	Society of Automotive Engineers
TPED	Transportable Pressure Equipment Directive
TÜV	Technical Inspection Association (Technischer Überwachungsverein)
UNECE	United Nations Economic Commission for Europe