HyLAW

National Policy Paper - Bulgaria

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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. It is a flagship project aimed 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.

This National Policy Paper provides public authorities with country specific benchmarks and recommendations on how to remove these barriers.

1.2. Policy Summary at National level

The Energy Union is one of the 10 priorities of the Junker Commission. It requires accelerated transition to a clean and efficient energy system, since two thirds of the greenhouse emissions result from energy production and use. For the realisation of this ambitious European goal formulated in the Strategic Energy Technology Plan (SET Plan), in 2016 the Commission developed the Energy package "Clean energy for all Europeans"[1] which introduces specific measures and instruments and involves every member state to develop its own Frame program, based on the proposed measures.

As a member state, Bulgaria announced the development of a low-carbon and resource-efficient economy as a priority in the "National Strategy Bulgaria 2020" and adopted the updated requirements of the "Policy framework for climate and energy for the period from 2020 up to 2030"[2].

Poor on carbon fuels, Bulgaria becomes a region with excellent opportunities for the development of renewable energy sources (RES) which can be beneficial for its economy. In 2014 the country became one of the 9 EU countries that have reached the 2020 National overall targets of 16% energy from renewable sources in the gross final consumption of energy. According to the official data of Eurostat[3], by 2016 the production of electricity from RES covered 18.8% of the gross domestic consumption with domination of the hydropower. However, the share for transportation is lower than the planned 10%. The excellent climate conditions and the geographic location of Bulgaria provide for intensive use of wind and solar energy which reflects in an increase of their share. Wind energy in Bulgaria can be produced at 3.3% of the total area of the country – mountain ridges and peaks above 1000 m, as well as at the Black Sea coast - Cape Kaliakra and Cape Emine. The sunny days in the different regions of the country are between 230 and 290 per year. Currently, Bulgaria has about 5 GW RES installed power[4] which is approximately 40% from the total installed power and 19% in terms of produced electricity. It is obvious that an increase of the renewable energy efficiency is necessary and the problem solving approach is the storage of the produced "green energy". In addition to the purely economic factors it should be stressed that according to the European Environment Agency in the last several years Bulgaria is classified as the country with the most polluted air in Europe. The only solution is the gradual and economically viable transition to sustainable energy technologies for a decarbonised economy, which would also have a positive impact on the efficiency and competitiveness of the energy sector and the economy of the country as a whole.

In this aspect hydrogen as energy storage solution emerges as a key factor with a vast potential for decarbonisation of the energy system accelerating the growth and integration of renewable energy in the energy mix. It can serve as a link between the electricity, heat and mobility sectors, offering new opportunities in energy flexibility, reliability and security.

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[1] Clean Energy for All Europeans (COM(2016) 860 final) https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/COM-2016-860-F1-EN-MAIN.PDF

[2] The Policy framework for climate and energy in the period from 2020 up to 2030 http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2014/swd_2014_0015_en.pd

[3] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_ind_335a&lang=en

[4] http://www.dker.bg/PDOCS/EWRC_Report_EC_16.pdf

In respect to the development of hydrogen technologies in Bulgaria, a strong and positive input is coming from the Bulgarian scientific community, since it is the most informed societal group, being part of the European Research Area (ERA) and working intensively on European projects. In 2014 the Bulgarian Academy of Sciences (BAS) became a member of: (i) Fuel Cells and Hydrogen Joint Undertaking (FCH JU), by joining Hydrogen Europe Research, and (ii) the European Energy Research Alliance, (Joint Programs "Fuel Cells and Hydrogen" and "Energy Storage"). This membership brought to (i) deeper involvement, (ii) enhanced awareness, (iii) communication with the local and executive authorities and (iv) initialisation and activation of contacts with the Bulgarian industry with potential interest for introduction of hydrogen technologies.

In Bulgaria, as in some other countries, there is localised production of hydrogen for industrial applications with domination of water electrolysis. An exception is the production of Hydrogen in the Burgas refinery (owned by the company LukOil), where reforming is applied. Unfortunately, there is a delay in the demonstration and deployment of hydrogen technologies in other application niches. However, in the last 2 years a sharp increase of the political awareness is registered which reflects positively on the interest coming from industry. The new strategic documents, such as: "Energy Strategy of the Republic of Bulgaria", "Innovation Strategy for Smart Specialisation", "National Research Strategy and its Action Plan Indicators"; "Science and Education for Smart Growth", "Operational Program Innovations and Competitiveness", "Innovation Strategy for Smart Specialisation (IS3)", "National Plan for Encouragement of the Production and Accelerated Introduction of Ecological Vehicles" etc. include texts for acceptance and support of the hydrogen technologies as national priority.

The Presidency of Bulgaria (January – June 2018) gave the latest strong input towards the establishment of a national Program uniting the efforts of the different sectors for overcoming the hurdles for the introduction of a new, innovative, but still expensive and financially risky technology. The FCH JU Summit (27-28 May 2018) in Sofia with a demonstration of the two hydrogen cars of the FCH JU and the Air Liquide portable refuelling station increased the political and public awareness and pushed forward the joint activities for the introduction of the first demonstration projects in hydrogen mobility. Sofia Municipality and the Bulgarian Port Infrastructure signed the Memorandum of Understanding with FCH JU. The establishment of the Bulgarian Association on Fuel Cells, Hydrogen and Energy Storage in 2018 and its membership in Hydrogen Europe National Associations offers a common platform uniting the activities of the research community, the industry, the local and national authorities, NGOs and the general public. Bulgaria is one of the 14 countries that introduced hydrogen refuelling infrastructure in the National Framework Strategy for the alternative fuels market related to the introduction of the updated Directive 2014/94/EU. In September 2018 the Ministry of Education and Science granted the Distributed Infrastructure "Energy Storage and Hydrogen Energetics" aiming to ensure scientific support for the first demonstration projects which are planned to be implemented through the National Program "Low-carbon Energy for the Transport and Household". In parallel the legislative and administrative framework for hydrogen refuelling stations is under intensive development. An Operational Interdepartmental Working Group is already working on the preparation of Ordinance for the introduction of Hydrogen Refuelling Stations (HRSs). It includes representatives of the: Ministry of Regional Development, Ministry of Transport, Ministry of Economy, and Bulgarian Academy of Sciences. It should be noted that the produced Materials in HyLAW are already of great use and serve as a basis for the preparation of the document.

The preliminary analysis of the approaches applied in different countries (Germany, UK, France) shows that for the Bulgarian economic conditions an approach with lower initial investments based on suitable market segments is more appropriate and less risky for the economy. The Bulgarian industry becomes increasingly interested in both technological development and production. In the field of transport the hybridisation approach is accepted as reasonable because of its faster market introduction. It will develop and combine expertise in both batteries and fuel cells mobility which needs also the development of the appropriate infrastructure. The interest in applications in the transport sector, especially in public transport, opens the question for hydrogen production for transport with emphasis on renewable energy. In addition to the transport, the Bulgarian industry announces interest in production of hydrogen from RES for grid balancing. An emerging attention is observed also form the natural gas distributors for hydrogen injection in the gas grid and use of fuel cells for combined heat and power in buildings.

The selected topics for the presented policy papers reflect the increasing industrial interest and economic environment, as well as the new obligations of Bulgaria as member state for the introduction of hydrogen in the national energy mix. More detailed documentary information about the identified applicable legislation, regulations, as well as legal barriers in different application areas and analysis by countries can be found in the HyLAW free access online database (https://www.hylaw.eu/database).

2. Hydrogen as a fuel – properties and characteristics

Hydrogen is playing an increasingly important role as an energy vector and fuel which can ensure a stable link between the electricity, heat and mobility sectors with safe, competitive, available and sustainable energy supply. According to Directive 2014/94/EU[5] hydrogen is accepted as one of the alternative fuels. On 14 June 2018, the Commission, the Parliament and the Council reached a political agreement for a 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 a target for renewable energy in transport, which is set to at least 14% by 2030. The production of hydrogen from renewables is recognised as a transport fuel of non-biological origin by Directive (EU) 2015/1513[6].

The legislative introduction of hydrogen in Bulgaria can be significantly accelerated by increase of the public awareness emphasising on policy makers that are responsible for the legislative framework, as well as on national and local administration which is responsible for the preparation of the national regulations. That is why this document aims at brief introduction of hydrogen as a fuel. It stresses on specific properties and characteristics that explain some of the safety regulations and requirements for its production, storage, transportation and application.

2.1. Overview and assessment of current legal framework

When people hear the word "hydrogen", most commonly the next word that emerges in their minds is a "bomb", which *a priori* reduces their interest to support its introduction. However, an understanding of hydrogen properties is crucial for the proper design of a facility or workplace. Knowing the specific properties of hydrogen, the work place can be configured to mitigate hazards by understanding and taking advantage of some of its characteristics.

Hydrogen is used most often in gaseous form and thus transported and stored in this form (200/300 bars for storage; 350 or 700 bars for refuelling). Table 1 gives the characteristics of hydrogen, dry natural gas and propane[7].

Hydrogen has many characteristics which are significantly different from conventional fuels and which are important to be taken into account in the process of designing and installing a hydrogen or fuel cell system:

- High diffusivity: Hydrogen is 14 times lighter than air and very diffusive. Unlike the heavier gaseous fuels, if a leak occurs in an open or well-ventilated area, its diffusivity and buoyancy reduce the possibility to form a flammable mixture in the vicinity of a leak. Being light, hydrogen will concentrate in the elevated space of an enclosed space, while Liquefied Petroleum Gas (LPG) will concentrate on ground level and compressed natural gas (CNG) – at lower elevation. If there is unprotected electrical equipment there is a risk of explosion. Locating all potential ignition sources below the level of the source from which hydrogen could leak and ensuring adequate ventilation will prevent the risk. Since hydrogen diffuses more rapidly through air than CNG and LPS, it will disperse more rapidly if released. This may be used as a strong safety asset, when harnessed with appropriate design of the application area.
- Flammability range: Hydrogen forms explosive mixtures with air in a wide range: 4% v/v low explosive limit (LEL), up to 75% v/v upper explosive limit (UEL), which is a disadvantage in comparison to CNG and LPG. However, in case of low momentum release, the dispersion of hydrogen will strongly decrease the probability for the formation of a flammable mixture.
- Ignition energy is (0,02 mJ) – which is much less than that of CNG and LPS.
- Rapid burning flame: the maximum burning velocity of the hydrogen-air mixture is about 8 times greater than that for CNG and LPG mixtures with air. However, this rapid rate means that hydrogen fires transfer less heat to the surroundings than other gaseous fuels and this reduces the risk of creating secondary fires in neighbouring materials.
- Invisible flame: this makes detection difficult. However, the low emissivity of hydrogen flames reduces the heat transfer by radiation to objects near the flame and thus reduces the risk of secondary ignition and burns. Human physical perception of this heat does not occur until direct contact is made with the flame.

[5] Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32014L0094

[6] 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 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32015L1513

[7] A Comparison of Hydrogen and Propane Fuels, DOE Hydrogen Program, http://cafr1.com/Hydrogen_vs_Propane.pdf

- Possibility of detonation: hydrogen/air mixtures have a great propensity to detonate. However, due to the rapid dispersion of hydrogen, this is likely to occur in a confined space.
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Table 1. Comparison of the characteristics of hydrogen, dry natural gas and propane

Gas properties:	Hydrogen	Methane	Propane
Chemical Formula	H_2	CH_4	C_3H_8
Molecular Weight	2.016	16.04	44.097
Gas Density (kg/m3) @ STP	0.0808	0.643	1.767
Diffusivity (m2/sec) x 105	6.11	1.60	1.00
Combustion Properties:			
Stoichiometric Fuel Volume Fraction %	29.5%	9.48%	4.03%
Lower Heating Value (MJ/m3)	9.9	32.6	81.2
Lower Heating Value (MJ/kg)	118.8	50.0	46.35
Adiabatic Flame Temperature (K)	2380	2226	2267
Flamability Limits (Volume %)			
Lean Limit:	4%	5.3%	2.2%
Rich Limit:	75%	15%	9.5%
Max. Flame Velocity (m/sec)	3.06	0.39	0.45
Min. Ignition Temperature (K)1	845	905	766
Min. Ignition Energy (10-5 J)1	2.0	33	30.5

An important issue for transport applications is the hydrogen purity. It is defined by ISO 14687-2:2012 which is referenced as mandatory for EU member States in the Alternative Fuels Infrastructure Directive 2014/94 and respectively harmonised in Bulgaria. However, hydrogen quality cannot be monitored and verified on the territory of Bulgaria due to the lack of a specialised laboratory. Having into account that only several laboratories in the world are prepared to certify the quality of the produced hydrogen, this procedure cannot be introduced locally. In addition, the requirements of the standard are higher than the needs of fuel cells for transport applications. Currently, a pre-standardization process for updating the impurity levels is in progress.

2.2. Conclusions

Hydrogen is not more dangerous than other flammable fuels, including petrol and natural gas. All flammable fuels must be handled responsibly. Like LPG and natural gas, hydrogen is flammable and may be dangerous under specific conditions. Hydrogen can be used safely when simple guidelines are followed and the user has an understanding of its behaviour. If properly used, some of its disadvantages from the safety point of view may be turned into advantages.

2.3. Policy Recommendations

The necessity for the establishment of legislative and administrative framework for the introduction of hydrogen technologies in Bulgaria is already emerging. A quick acceleration of this process is expected. Since there is still no updating of national laws and regulations concerning hydrogen and its applications, the good knowledge of its properties and behaviour will facilitate the development and harmonisation of the required administrative frame for its introduction and will prevent from unnecessary restrictions which may hamper that process.

The problem with the validation of hydrogen quality should be solved in a more collaborative way on EU level. Bulgaria may start an initiative for the establishment of a regional laboratory for verification of hydrogen purity for transport applications.

3. Hydrogen production in the context of hydrogen refuelling stations

Hydrogen production can be: (i) centralised, i.e. realised by production at one location in quantities that cover needs distributed in a large number of points of use, which requires hydrogen transportation and (ii) localised, i.e. production for a given application at the same location which eliminates transportation. For hydrogen refuelling stations both approaches can be applied. The initial investments for HRS with localised production are bigger, but the transportation is eliminated. Usually, the introduction of HRSs starts with external hydrogen delivery followed by further extension with electrolyser for localised production.

In Bulgaria there is no centralised hydrogen production. Currently, gaseous hydrogen is imported in bottles (200 bars) mainly from Italy, Greece and Germany. However, with the establishment of HRSs infrastructure there will be a business case for centralised production. In addition, there already is interest for hydrogen production from hydropower.

3.1. Overview and assessment of current legal framework

The localised production of hydrogen in Bulgaria is well established for industrial applications. It is regarded as industrial activity and the production facilities are localised in industrial areas according to the existing legislation (Spatial Development Act, Law on Environmental Protection and the corresponding Regulations).

The main technology for hydrogen production is water electrolysis with the exception of hydrogen production in the refinery of LukOil in the city of Burgas where hydrogen is produced by reforming. Although the accent is on production of hydrogen for transport, it should be stressed that the recast Renewable Energy Directive, adopted in December 2018, creates a very strong incentive for fuel suppliers to introduce renewable hydrogen as part of either their fuel supply portfolio or as part of their production process of conventional fuels.Article 25 imposes an obligation on fuel suppliers to ensure that the share of renewable energy within the final consumption of energy in the transport sector is at least 14 % by 2030 (minimum share). This is far more than what can be achieved with advanced bio-fuels alone and will require the integration of renewable hydrogen. As fuel suppliers are allowed to take into account renewable hydrogen also when it is used as intermediate products for the production of conventional fuels in order to reach their target, it becomes clear that investments in increasing the capacity to produce renewable hydrogen will be welcome and why not reinforced by the legislative tools..

Bulgaria is one of the 14 countries that introduced hydrogen refuelling infrastructure in the National Framework Strategy for the alternative fuels market (NFS) related to the implementation of Directive 2014/94/EU. A process is running for the development of a legislative base for its realisation which puts in a front position the establishment of a Legal and Administrative Process (LAP) for:

- Centralised production of hydrogen by electrolysis for refuelling stations with accent on the production of "green hydrogen". The production facility may be on the territory of a RE installation, which should be already certified as industrial zone, as well as in another territory, more convenient for further transportation. From land use perspective the installation should be included in the Specific land use plan according to the existing procedures of the Law on Spatial Planning. Another important step is the Environmental Impact Assessment, which will be discussed in more details below, as well as the Certificates of origin for the RE used for the production of "green" hydrogen.
- Localised hydrogen production by electrolysis on the territory of a refuelling station.

Since at the moment the introduction of hydrogen production by electrolysis on the territory of a refuelling station is under administrative discussion, this case will be analysed in more details. Some of the discussed LAPs concern also centralised production in volumes below the industrial ones defined in Annex 4/4.2 of the Environmental Protection Law (EPL).

There is a good LAP for CNG and LPG refuelling stations, as well as for integrated stations which permits their building in urban territories. This practice should be accepted for the HRS. The localisation of the HRS will be discussed in Policy Paper 3. The production of Hydrogen on the territory of the HRS is connected with the Environmental Impact Assessment which is an individual procedure for every production process included in Annexes 1 and 2 of the EPL. In principle there is no text for hydrogen production by electrolysis, which is an electrochemical process. The description included in Annex 1/10b concerns "integrated chemical installation for production in industrial volume, using processes of chemical conversion", i.e. it describes for instance hydrogen production by reforming and does not refer to hydrogen production via electrolysis. It is obvious that the production of hydrogen by an environmentally friendly technology should not cause territorial restrictions and could follow a

simplified assessment procedure. Hydrogen flammability is a subject to Regulation № Iz-1971 from 29 October 2009 on the Structural and Technical Rules and Rules for Ensuring the Fire Safety which also concerns petrol stations, CNG and LPG stations.

According to Directive 1513/EC/2015 the so called "green hydrogen" for transport falls in the category "renewable liquid and gaseous transport fuels of non-biological origin" which means "liquid or gaseous fuels other than biofuels whose energy content comes from renewable energy sources other than biomass, and which are used in transport". According to this definition a Guarantee of Origin is needed to verify the "zero" carbon hydrogen production. The current Bulgarian LAP ensures Certificate of Origin following Regulation № RD-16-1117of 14 October 2011 on the Conditions and Rules for Issuing, Transfer, Revocation and Recognition of the Guarantees for the Origin of Renewable Energy, which is a good starting point. The Regulation can be improved with more direct texts for hydrogen production.

3.2. Conclusions

Although there is not a special LAP for hydrogen production by electrolysis, the current Bulgarian legislation cannot be regarded as a barrier for this technological process. However, since decisions are taken locally, and hydrogen technologies are not well recognised, there is probability for unnecessary restrictions. That is why a specialised Regulation for HRSs, including localised production of hydrogen, is necessary. As a first document on this topic, it will serve as an information source for the local administration.

The reinforcement of the administrative procedures with an appropriate legislative frame will increase the interest and confidence of the Bulgarian industry for developing this innovative technological niche and thus will contribute to the Pan-European process for decarbonised economy, as well as for implementation of the Bulgarian obligations as a member state.

3.3. Policy Recommendations

Hydrogen production on the territory of HRS, as well as centralised production of hydrogen in non-industrial volumes by electrolysis, is a non-emitting environmentally friendly process. Thus it should not cause territorial restrictions and could follow a simplified assessment procedure. However, since the Specific Land Use Plan and the Environmental Impact Assessment are defined in a local scale, it could be useful if at EU, or at National level there is document (description) that hydrogen can be produced in different ways and some of the methods, as water electrolysis, do not generate emissions. It will serve as a reference document which will help local services which are not well aware about hydrogen to avoid unnecessary precautions that may retard the introduction of hydrogen technologies. In the moment there is preparation of a Regulation for the introduction of HRSs, so it is appropriate to include this information in the document.

The definition for "green hydrogen" should enter in the future Regulation for HRSs, since the current Bulgarian LAP ensures Certificate of origin following Regulation No RD-16-1117of 14 October 2011 on the Conditions and Rules for Issuing, Transfer, Revocation and Recognition of the Guarantees for the Origin of Renewable Energy.

4. Hydrogen Refuelling Stations

Bulgaria is one of the member states with no fuel cell electric vehicles (FCEV) and no hydrogen refuelling stations. However, in the National Framework for Alternative Fuels and the Corresponding Infrastructure, there is a planning for the introduction of FCEV in the transport network and for the development of HRSs. Up to 2030 at least 4 HRSs should be built which will cover the requirements for HRS on every 200 km.

4.1. Overview and assessment of current legal framework

Bulgaria has well developed LAPs for the LPG and CNG refuelling stations which is a prerequisite for the development of similar regulations for the HRS infrastructure. According to the Spatial Planning Act (Article 169, Paragraph 4) the Ministry of Regional Development and Public Works work separately, or together with other competent ministries on issues to the corresponding Ordinance. This procedure is already in initial stage of development – an Operational Interdepartmental Working Group, including representatives of the Ministry of Regional Development and Social Works, Ministry of Transport, Ministry of Economy, Bulgarian Academy of Sciences, is in operation. The HyLAW analytical reports are a useful working tool.

It is expected that the Ordinance will define as a first stage the requirements and technical rules for the design, construction and entering in operation of HRSs using pressurised gaseous hydrogen or hydrogen stored in the form of

metal hydrides in compliance with the requirements of Directive 94/2014/EU. They are adopted by the Bulgarian legislation through harmonisation and implementation of the standards specified in Annex II point 2 "Technical specifications for hydrogen filling points for motor vehicles" of the Directive and mandatory for the construction of a hydrogen refuelling point in Bulgaria (ISO / TS 19880-1: 2016, BDS ISO 14687-2: 2016, BDS EN ISO 17268: 2017).

It is expected that the preparation of the Ordinance will adhere to the laws and regulations concerning rules, norms and activities based on hydrogen (when existing), as well as to those related to the construction of gas stations (LPG and CNG), taking into account the specifics of hydrogen as an energy carrier. The document will concern stand-alone and integrated HRSs. In respect to the fuel delivery, the Regulation will relate to HRSs with on-site production of hydrogen by electrolysis with accent on production of "green hydrogen" and by delivery in gaseous state in cylinders under pressure or in solid state as metal hydrides. Thus, the production and storage of hydrogen can be regarded as activities that are not causing environmental damages.

4.2. Conclusions

The similarity of hydrogen as a fuel to other gaseous fuels (LPG and CNG) with well-developed LAPs is a solid base for adaptation of the Regulations developed for their infrastructure in the new Regulation for HRS. This will facilitate the development of the corresponding Ordinance and will decrease the changes in other regulations which concern the procedures for permission, design, implementation, control and introduction in operation.

The availability of a regulation for HRS will also serve as a useful guideline for the administrative procedures connected to the building of a HRS which should be realised (for a first time) by distributed regional administrative structures in conditions of limited public awareness.

In accordance with Regulation No. 1 of 30.07.2003 on the Nomenclature of Construction Types, and in similarity with the other refuelling stations, HRSs should belong to Constructions form First category, letter "d", and will follow the rules of Regulation № Iz-1971 from 29 October 2009 on the Structural and Technical Rules and Rules for Ensuring the Fire Safety which concern also petrol stations, CNG and LPG stations.

HRSs are produced by a limited number of companies with high competence and responsibilities. The manufacturer should sign a Declaration of Conformity guaranteeing product development, personnel training and maintenance (up to 5 years) following the Regulation for Prevention of Large Emergencies with Dangerous Substances and Limitation of Their Consequences which follows The SEVESO 3 Directive[8] and in accordance with the standards set out in Annex II, point 2 of Directive 94/2014/EU and other European directives and standards concerning the construction of refuelling stations.

4.3. Policy Recommendations

The development of a special Regulation on the Conditions and Order for the Design, Implementation, Control and Introduction in Operation of HRS which follows both the existing legislation for petrol and gas stations and the specifics of hydrogen as a fuel, is highly recommended. This approach will eliminate possible legislative and administrative complications which may retard the introduction of hydrogen in the mobility sector.

It is important to define that HRS can be built on the territory of existing RSs as a non-integrated or integrated facility. This will accelerate the permitting procedure, eliminating the need for changes in the Detailed Land-use Plan, which in principle is a long term procedure.

The adoption of the texts for Petrol, LPG and CNG refuelling stations from Regulation № 7 from 22 December 2003 on the Rules and Regulations for the Construction of the Different Types of Territories and Land-use Plan, will ensure permission for building of HRSs in urban and commercial territories, as it is for the other types of refuelling stations.

In parallel with the development of the Special Regulation for HRS, small changes, such as addition of "hydrogen" or „hydrogen refuelling station" etc., will be needed in other related regulations to mark the introduction of hydrogen as an alternative fuel (Regulation № 1 from 30.07.2003 on the Nomenclature of Construction Types; Regulation №o RD-02-20-2 from 20 December 2017 for Planning and Design of the Communication-Transport System of Urban Areas; Regulation for Special Use of Roads; Regulation № Iz-1971 from

[8] Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32012L0018

29 October 2009 on Structural and Technical Rules and Rules for Ensuring the Fire Safety; Regulation № 7 from 22 December 2003 on the Rules and Regulations for the Construction of the Different Types of Territories and Land-use Plan).

Since the production of hydrogen by water electrolysis and its storage are environmentally friendly and non-emitting, they do not cause territorial restrictions, and thus, the Environmental Impact Assessment could follow a simplified assessment procedure. The Specific land use plan and the Environmental Impact Assessment are defined in a local scale, so it could be useful if at EU or at National level there is document (description) that hydrogen can be produced in different ways and some of the methods, such as water electrolysis, do not generate emissions. It will serve as a reference document which will help local services/administrations that are not well aware about hydrogen, to avoid unnecessary precautions that may retard the introduction of hydrogen technologies. It will be appropriate that this information is included in the Regulation for the introduction of HRSs, which is planned to be prepared soon.

For HRSs the appropriate NACE code is 47-30. 01 „Retails of fuels for land vehicles with engines and motor cycles" (gasoline, fuel oil, diesel, biodiesel, LPG, CNG, etc.).

It will be beneficial if authorised representatives of the Ministries (Ministry of Transport, Ministry of Regional Development and Social Works, Ministry of Economy, Ministry of Energy) and Municipalities join the voluntary Working Structures established with the help of the FCH JU and Hydrogen Europe (Mobility Working Group, Regions and Cities Initiative, Deployment of HRSs and others) which aim at initialising self-organisation of combined efforts for hydrogen introduction in the transport sector of different territories.

5. Hydrogen transportation

In Bulgaria there is no centralised hydrogen production, while the localised one is applied for industrial applications. Local needs for stationary application of hydrogen are additionally ensured by import of gaseous hydrogen (most often in bottles and bundles under pressure 200 bars). There are a large number of companies that distribute hydrogen: SIAD, EKOMAX, MESSER BG, LINDE BG, AIR LIQUIDE BG etc.. They use road transport which follows the national regulations, as well as those of the country where hydrogen is produced and transported for Bulgaria. Currently, gaseous hydrogen is imported mainly in bottles (200 bars) from Italy, Greece, Germany. However, with the establishment of HRSs infrastructure there will be a business case for its centralised production and distribution.

5.1. Overview and assessment of current legal framework

Since hydrogen has very low volumetric energy density at standard temperatures and pressures, for cost efficiency, it is stored and transported as compressed gas, cryogenic liquid or chemical compound, such as metal hydride. It is expected that gaseous hydrogen will be the most used form for transport and usage in Bulgaria in the next 10 years. The presence of Bulgarian SME for production of metal hydrides (Lab Tech Ltd) opens a niche for production and transportation of hydrogen in the form of metal hydrides. The main technology for centralised hydrogen production is expected to be water electrolysis applying renewable energy. The production installation can be in the vicinity of the RES, or close to the HRS. There is already interest for centralised production of hydrogen from hydropower.

Currently, the EU practice for short distances (200-300 km) and smaller quantities of hydrogen (up to about 500 kg) supports the use of single cylinders (bottles), multi-cylinder bundles or long cylindrical tubes, installed on trailers (tube trailers), transported by trucks[9] . The maximum quantity is determined by the truck weight limitations. Those distances and quantities are acceptable for centralised production in Bulgaria, since the longest distances are about 500 km and the first refuelling stations will not need bigger quantities of hydrogen, taking into account the prognostic numbers of hydrogen vehicles up to 2030, marked in the NFP.

There are no special texts for limits of the vessels pressure. However, this may become a potential administrative barrier for transportation of hydrogen at pressures higher than 200 bars, which will be exception from the current practice of 200 bars and may bring to unnecessary precautions, or even to prohibition. The quality of the pressure vessels is controlled by the Regulation on the Equipment, Safe Operation and Technical Supervision of Pressure Equipment.

The safety road transport regulations are formulated in Regulation № 40 for the Conditions and Procedure for Road Transport of Dangerous Goods (September 2017) which follows the European Agreement on the International

9 DeliverHy-Optimisation of Transport Solutions for Compressed Hydrogen (FCH JU project); https://cordis.europa.eu/project/rcn/101991/repo

Carriage of Dangerous Goods by Road (ADR[10]) and Directive 2010/35/EU[11]. The responsible authority is the Executive Agency "Automobile Administration" at the Ministry of Transport.

5.2. Conclusions

At the moment, the regulations for road transportation of gaseous hydrogen in bottles and tubes, as well as in the form of metal hydrides meet the current demands. The Bulgarian legislation is harmonised with the European one, following the main Directives[10,11]. Hydrogen is not specifically mentioned, since it enters in the category of flammable gases. However, with the introduction of hydrogen mobility it is expected that centralised production of hydrogen will be developed and the intensity of hydrogen transportation on national level will increase. This may bring to some administrative barriers connected with the technological development in direction transportation at higher pressure and bigger volume.

Presently, gaseous hydrogen is already transported also at 300 bars and the tendency is towards further increase of the pressure. Lightweight composite gas cylinders at 700 bars and higher volume tubes (up to 10,000 l) are under intensive development.

5.3. Policy Recommendations

Although the current LAPs are appropriate for gaseous and metal hydrides hydrogen transportation, some administrative barriers may appear with the intensification of the local hydrogen transportation, concerning bigger volumes and higher pressures, since at the moment hydrogen goes under the umbrella of flammable gases and is not treated as alternative fuel. One precaution could be the periodic updating of Regulation № 40 for the Conditions and Procedures for Road Transport of Dangerous Goods for vehicles transporting hydrogen in respect to access to road infrastructure such as tunnels, bridges, parking areas, and increased hydrogen pressure and volume, to standards and practice of other countries. This measure will avoid decisions on a case by case basis and will prevent from unnecessary restrictions or prohibitions.

6. Hydrogen powered fuel cell road vehicles – first steps

Bulgaria is a country where there are still no hydrogen powered fuel cell electric vehicles with the exception of the 2 students' demonstration cars which participate in the annual competitions organised by Shell (Shell Marathon). However, Bulgaria is one of the 14 countries that accepted hydrogen as alternative fuel and included in their NFP the establishment of HRSs infrastructure. The short term goal is to overcome the transition phase of Research/Development and to go towards deployment. Since Fuel Cells and Hydrogen are not still market technologies, they need active national support which is marked in the official document as a measure and which is in the beginning of its realisation with the start of the first demonstration project for fuel cell range extender on trolleybus of Sofia Municipality, granted by the Ministry of Education and Science (December 2018).

6.1. Overview and assessment of current legal framework

On European level for stimulation of the Member states for achieving the goals for 30% cut in greenhouse gas emissions (from the 1990 levels) by 2030, the European Union has adopted several important documents which offer a pathway towards decarbonisation of the transport sector.

Alternative Fuel Infrastructure Directive 2014/94/EU (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 is obliged to submit to the Commission a report on the implementation of its national policy framework by 18 November 2019, and every three years thereafter informing about:

- direct incentives for the purchase of AFVs or for building the infrastructure,

[10] European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) 2017 https://www.unece.org/fileadmin/DAM/trans/danger/publi/adr/adr2017/ADR2017e_web.pdf

[11] 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

- 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.

Although AFID does not oblige Member States to build refuelling infrastructure for hydrogen vehicles, Bulgaria included its establishment as a priority goal.

The Clean Vehicle Directive 2009/33/EU[12] and its revised version COM(2017)653[13], as part of the Clean Mobility Package, provide a definition for clean light-duty vehicles based on a combined CO_2 and air-pollutant emissions threshold. The proposed revision will 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 combined CO_2-air pollutant emission-thresholds (light-duty vehicles) and alternative fuels (heavy-duty vehicles).

The topic "Clean technologies with accent on the transport and energetics" was included as a priority in the National Strategic documents in 2012, and was used as a basis for the development of the NFP – a document that overcomes the national frame and becomes part of the European platform.

The first legislative initiatives concerning hydrogen mobility concern:

- Registration of hydrogen powered vehicles- the procedures are regulated in accordance to Regulation I-45 from 24.03.2000.
- Approval of the type of hydrogen powered vehicles – the procedure is performed according to Regulation № 60 from 2009 which follows Regulation (EC) No 79/2009[14] of the European Parliament and of the Council from 2009, related to the type-approval of hydrogen-powered motor vehicles, including motor cycles and amending Directive 2007/46 / EC14 (OJ L 35, 4.02.2009).
- Harmonisation of Regulation (EC) No 134/2014 of the Commission from 2013 for supplement to Regulation (EU) No 168/2013 of the European Parliament and of the Council – in relation to the requirements concerning the environmental characteristics and characteristics of the propulsion system and amending Annex V (OJ L 53, 21.2.2014), technical requirements for testing for L-category vehicles operating on hydrogen are laid down. The Regulation also includes a definition of "Alternative Fuel Vehicle".
- Harmonisation of Regulation (EC) No 79/2009 for the hydrogen equipment used for L-category vehicles.
- Harmonisation of Commission Regulation (EC) No 406/2010 from 26 April 2010 implementing Regulation (EC) No 79/2009 which ensures manufacturers to submit on a voluntary basis hydrogen powered EC application for the whole vehicle type approval.
- Hydrogen mobility will enter in the Investment program for climate (IPC) which follows Directive 2009/33 / EC promoting clean and energy efficient road transport vehicles.

However, the above mentioned measures are not sufficient for fast implementation of hydrogen mobility due to the high investments in comparison with the LPG vehicles, which requires funding support on national level.

In respect to the other requirements (tax incentives, public procurement, non-financial incentives etc.), the initiatives should follow those which are already established for the electric vehicles on batteries – such as exemption from annual tax, 30% reduction in product charge etc.). For stimulating the emerging hydrogen electric vehicles market, environmental bonus should be introduced (as it is in Germany).

Since hydrogen powered vehicles have on-board storage of high pressure, according to ADR (Annex A) they are classified as dangerous goods. The fuel cell electric and hydrogen combustion vehicles are assigned to UN No. 3166. However, according to the special provision 666 of Chapter 3.3 vehicles assigned to this number, as well as any

[12] 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 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0033&from=EL

[13] COM (2017) 653: 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 https://eur-lex.europa.eu/legal-content/EN/HIS/?uri=CELEX%3A52017PC0653

[14] REGULATION (EC) No 79/2009 of the Europe an parliament and of the council of 14 January 2009 on type-approval of hydrogen-powered motor vehicles, and amending Directive 2007/46/EC https://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:035:0032:0046:en:PDF

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, in case certain equipment safety conditions are met. For them there are no tunnel restrictions, neither special parking requirements. Every country may introduce additional provisions not included in the ADR, if they are included in the national legislation for vehicles engaged in domestic carriage of dangerous goods and are not in conflict with the provisions of ADR. This procedure should be performed in Bulgaria.

6.2. Conclusions

The analysis performed in the NFP selects a pathway for introduction of hydrogen powered mobility via national demonstration projects based on hybridization of electric vehicles from the public transport sector. Since in Bulgaria the trolleybus transport is well developed, the selected type of vehicle is a trolleybus. Its development and demonstration will pave the way towards approval, registration and exploitation of hydrogen vehicles, marking and overcoming eventual legislative, administrative, regulatory, maintenance and other barriers and operational difficulties. It is expected that hydrogen mobility will enter first in the public transport applying different financial mechanisms (public procurement, additional financial support etc.). Eventual bus fleets will stimulate the development of HRS infrastructure.

6.3. Policy Recommendations

Taking into account the big number of Directives and Regulations of the EC and the amendments, it should be beneficial if in addition to the harmonised procedures described in the NFP a detailed survey on the European legislation on hydrogen powered vehicles is done by the Ministries responsible for the implementation of the Program.

A harmonisation of the ARS in respect to the national legislation for vehicles engaged in domestic carriage of dangerous goods should be performed. For instance the parking of LPG fuelled cars which is restricted for closed parking areas should be adapted also for hydrogen fuelled cars.

On political level strong support mechanisms should be introduced combining financial and non-financial incentives (free of taxes, environmental bonus for purchase etc.) with restrictions towards high polluting vehicles – for instance prohibition for entering in the centre of the town.

A positive step will be the participation of authorised representatives of the Ministries (Ministry of Transport, Ministry of Regional Development and Social Works, Ministry of Economy, Ministry of Energy) and Municipalities in the voluntary Working Structures such as the Mobility Working Group, Regions and Cities Initiative, Deployment of HRSs etc. which are established with the help of FCH JU and Hydrogen Europe for supporting the self-organisation for hydrogen introduction in the transport of different territories.

7. Hydrogen Injection in the Gas Grid

This policy paper aims at giving some information on the topic Power to Gas (P2G) in respect to hydrogen injection in the gas grid, which is recently discussed intensively in Bulgaria by gas grid distributors. It has several aspects: technical, legislative and economic.

Due to the unified European legislation based on Directive 2009/73/EC[15] and three Regulations (Regulation (EC) No 714/2009; 715/2009 and 713/2009) which establish common rules for the transmission, distribution, supply and storage of natural gas and set rules related to the organisation and functioning of the natural gas sector, access to the market etc., there are no barriers for the installing of a grid connected electrolyser to generate hydrogen to be transported / stored in the existing gas infrastructure, i.e. for hydrogen injection. The connection should be made at local level (where the electrolyser is to be installed) via the (low voltage) Distribution Network Operator (DNO). This paper does not concern the procedures for the production and storage of hydrogen (in case it has to be stored and not directly injected), neither the methanation of hydrogen (produced via electrolysis) to generate CNG. The discussed legislative, technical and economic issues concern directly the injection of the produced or stored hydrogen into the gas grid both at the:

[15] Directive 2009/73/EC of the European Parliament and of the Council 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC of https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0073

- Transmission Service Operator (TSO) level where the TSO is typically responsible for managing and maintaining the national high pressure, long distance gas grid network and provides the network interface with any international gas grid connection and
- Distribution Service Operator (DSO) level, where the DSO is typically responsible for managing and maintaining the local, regional low pressure gas grid network and provides the network interface with those seeking to establish gas injection facilities and those seeking gas off-take facilities.

Since there is no unified set of procedures, the process chain for P2G and hydrogen injection is complex and diversified.

7.1. Overview and assessment of current legal framework

In Bulgaria natural gas consumption is increasing with intensive application in the residential sector. Not all of the municipalities in the country have access to the gas grid. However, the big towns where the main pollution comes from the heating have a reliable gasification system. The national gas transmission network is built in a ring-shaped form of high pressure gas pipelines with a total length of 1835 km., three compressor stations with total installed capacity 49 MW, one underground gas storage facility, 115 exit points and maximum working pressure 54 bars. The transit gas transmission network comprises high pressure gas pipelines of total length of 930 km, six compressor stations and total installed capacity of 270 MW.

The topic for hydrogen injection in the gas grid is a hot topic at European scale, but it is still outside the national priorities and the legislative, regulatory and administrative frame. Thus, the information included in this section is based on the best European practices.

The update of the Renewable Energy Directive for the period 2021 – 2030 (RED II) defined a new RE target of 32% and annual increase of 1.3 % of renewables share in heating and cooling in respect to the level achieved in 2020 which may be ensured by „the physical incorporation of renewable energy in energy and energy fuel". Obviously, the injection of "green hydrogen" in the gas grid can support the realisation of this target. However, RED II does not give definition for renewable gas. In the case of hydrogen there is a definition in Directive 2015/1513 concerning renewable liquid and transport fuels of non-biological origin, whose energy content comes from renewable energy sources other than biomass, and which, however, is used in transport. Since the conversion of energy from one energy carrier to another could lead to double counting, unlike biogas injected into the gas grid, hydrogen and synthetic methane are still not included in the renewable share for heating and cooling. This barrier should be overcome faster on national level - Germany has advanced position based on bio-gas, since water electrolysis for production of hydrogen and related methanation, when the electricity comes for RES, are included in the definition for bio-gas[16,17] and the privileges are applicable for the injection of renewable hydrogen and synthetic methane in important technological and economic aspects (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). In any case presently there are no comments on additional financial benefits for the potential sustainability of hydrogen with the exception of Germany due to the above mentioned reasons.

No legally binding certification system for renewable hydrogen and synthetic methane is in place. The certification body TÜV SÜD has issued a 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 and energy sources which can be used and determines the greenhouse gas reduction potential of green hydrogen. However, the standard is voluntary.

A basic moment in the injection procedure is the permitted concentration of hydrogen in the gas grid. It varies significantly between Member States (where there are defined limits). In a large number of countries, including Bulgaria, hydrogen injection into the gas network is generally not allowed, or more correctly, is not treated as an option and the expectations are that no permission could be given due to the lack of information and available harmonised documents. Neither international nor European standards define rules for admissible concentration of hydrogen in the natural gas network. The CEN standard EN 16726: 2015 summarizes "At present it 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 limits vary from 0,1% for UK and other countries up to 6 and 10% respectively in France and Germany. For the current levels of hydrogen / H2NG mixtures no additional safety requirements have been indicated as necessary. For increased hydrogen concentrations the perspective is for

[16] Verordnung über den Zugang zu Gasversorgungsnetzen (Gasnetzzugangsverordnung - GasNZV), https://www.gesetze-im internet.de/gasnzv_2010/index.html

[17] Verordnung über die Entgelte für den Zugang zu Gasversorgungsnetzen (Gasnetzentgeltverordnung - GasNEV), https://www.gesetze-im-internet.de/gasnev/index.html#BJNR219700005BJNE004002301

enhanced sensor / monitoring and safety case requirements. Additional restrictions arise connected with national regulations, or application areas. For instance, the calorific value of the gas after injection increases (Wobbe index). Intensive studies performed in Germany show that operation of gas appliances with hydrogen admixture up to 10 vol.% is possible without adaptation of the devices (nozzles etc). Similar findings have been made in the UK (up to 14 vol.%) and a full hydrogen supply chain assessment is underway covering the technical development requirements and costs of new appliances as part of a 'hydrogen for heat' transition program. Germany indicates a formal arrangement for monitoring and billing of hydrogen / H2NG mixtures where the calorific value can be determined with gas quality measuring devices (currently gas chromatography).

For Germany, technical standards acknowledge infrastructure elements and appliances with lower tolerances such as porous rock, underground storages, gas turbines, vehicle CNG cylinders type 1. The applicable hydrogen 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. The UNECE Regulation 110 (Compressed and liquefied natural gas components) and the DIN 51624 establish a threshold of up to 2 Vol. % hydrogen for the vehicle fuel CNG.

The EU Gas Appliances Directive 90/396/EEC[18] and subsequently the Gas Appliance Regulations ((EU) 2016/426) which cover all member states already define (in generic format) the requirement to demonstrate that any gas–fired appliance (and the fittings intended to be incorporated within those gas appliances) to be sold in the EU is safe. The GAD/GAR applies equally to all gaseous fuels including hydrogen, town gas, biogas, natural gas, propane and or butane to be used / burnt within a gas appliance. As already mentioned a variety of studies has recently been made around this issue and research results in Germany and UK have shown that for the moment operation of gas appliances with the used hydrogen admixtures (up to 10 vol.% for Germany and up to 14 vol. % for UK) is possible without adaptation of the devices

7.2. Conclusions

The new target of 32% renewable energy defined in the updated Renewable Energy Directive (RED II), as well as the requirement for annual increase of 1.3 % of renewables share in heating and cooling in respect to the level achieved in 2020 put the topic of hydrogen injection into the gas grid in a leading position for fulfilment of the new targets. However, there are many technical, legislative and economic barriers which have to be quickly overcome. The most advanced country working in this direction is Germany. The achievements show that some of the barriers on European level can be overcome on national level.

The gaps and discrepancies on European level concern:

- The lack of unified definition for renewable gases of non-biological origin, since the only existing definition concerns fuels for the transport sector. To overcome this barrier Germany includes hydrogen produced by water electrolysis with RE in the definition for biogases (Energy Industry Act).
- Guarantees of origin system for renewable gases of non-biological origin will stimulate final consumers to buy renewable hydrogen. In this aspect the Regulation № RD-16-1117 from 14 October 2011 on the terms and rules for issuing, transfer, revocation and recognition of guarantees for the origin of renewable energy is a good basis for improvement in this direction.
- Development of EU standards for the acceptable concentration of hydrogen in the gas mixture. Based on the current practice, on national level the definitions for gas quality could be modified including the allowable hydrogen concentration. However, the lack of unified regulation may cause cross-border problems.

7.3. Policy Recommendations

The interest of the gas distributors in hydrogen injection should be taken into account from the policy makers and interdepartmental working group should be established for:

- Analysis of the current SoA.
- Acquaintance with the best practices and business cases, including the results from the running projects in the FCH JU, as well as national projects (Germany, UK, Italy).
- Legislative and regulatory initiatives.

[18] Council Directive 90/396/EEC of 29 June 1990 on the approximation of the laws of the Member States relating to appliances burning gaseous fuels, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31990L0396

- Improve the Regulation for guarantees for the origin of renewable energy, which will support the centralised production of hydrogen in Bulgaria for different applications.

8. Residential Stationary Fuel Cells (FC m - CHP)

Stationary fuel cells are highly efficient distributed generation technology, i.e. they produce power and heat at the site of the consumers and for the purpose of their immediate supply with energy, thus meeting the demand for heating, hot water and/or cooling in buildings while generating electricity which can be used to cover the customers own demand or to be injected into the electricity grid and sold. They are operating on natural gas, biogas and hydrogen and can be divided in three categories:

- Residential, or micro-combined heat and power (micro-CHP): for single family homes and small buildings (0,3 - 5 kW);
- Commercial: Mid-sized installations for commercial and larger buildings (5 - 400 kW)
- Industrial: Large scale installations for industrial use (0,3 - 10 MW).

This policy paper concerns provisions and procedures for installation and connection of the most mature category fuel cell - micro CHP, operating on natural gas from the gas grid.

This application deals with the legal and administrative provisions and procedures for installation and connection of residential stationery fuel cells to the electricity and natural gas grids and to the electrical systems of the buildings, as well as with the existing support mechanisms for their broad market penetration.

8.1. Overview and assessment of current legal framework

In Bulgaria there are no operating installations of FC micro - CHP. However, in the last year an increased interest was marked, especially from the municipalities, due to the high level of air pollution in the towns coming from the applied heating. In the frames of the National Research Program "Low Carbon Energy for the Transport and Household" one or two installations will be put in operation for technical demonstration and check of the readiness level in respect to the administrative procedures such as connection agreement to the electric grid, where there is a possibility to sell electricity produced by the fuel cell unit and connection to the gas grid.

FC micro-CHP has potential to play a key role in decarbonisation of heat in buildings. The main advantages of the micro-CHP FC systems are the high total (85-95%) and electrical (50-60%) efficiencies and ability to run on conventional heating fuels generating fewer harmful emissions for the environment which can be additionally or totally reduced with blending of natural gas with hydrogen, or application of pure hydrogen respectively. However, while Japan has already deployed more than 230 000 units, Europe has about 2000 installed units mainly due to the project ENE.FIELD (1 046 units from 10 suppliers at 10 European markets) and the currently running PACE project where the installation of another 2 500 units by 2021 is planned with the aim for market installations of 10 000 units per year after 2022 which will ensure the needed cost reduction (current costs of 14000 to 25000 €/kW). It is Europe's largest deployment of FC micro-CHP to date, and has allowed manufacturers to start reducing costs and build markets. Generating their own electricity allows homeowners to cut energy costs by 800 – 1 300 €/y and to reduce dependence on electricity prices. Nevertheless, higher deployment volumes are still required to drive further down the costs. For the installation of a FC micro-CHP unit the following requirements have to be fulfilled:

- The building should have a main gas connection.
- The building should have a central heating system.
- The building should be connected to the electricity grid.
- The building should have an internet connection.

Thus there are no limitations for installation in many Bulgarian towns. It should be marked, however, that the two European demo projects do not include installation in countries from South-East Europe.

In respect to the connection to the electrical and gas grid the work has to be performed by professionals with an appropriate qualification for work with electric devices and trained and qualified gas installers. For Bulgaria, as well as for the other European countries, there are no structural barriers or regulatory gaps associated with the gas grid connection requirements and procedures, as well as with qualification requirements for professionals, performing the connections of stationary fuel cells to the electrical systems of the buildings or to gas networks.

However, the number of installed FC micro-CHP units across Europe is still very limited. One of the reasons might be that there is no common EU framework for installation of FC micro-CHP units in buildings or for their connection

to the gas grids. Stimulation is coming from the Energy Efficiency Directive 2012/27127[19] which establishes binding measures for promotion of energy efficiency within EU and requires Member States to adopt simplified grid procedures for micro-cogeneration units. In addition, Member States have to ensure that the electricity grid operators in charge of dispatching the generating installations in their territory provide priority or guaranteed access to the grid, guarantee the transmission and distribution, and provide priority dispatch of electricity from high-efficiency cogenerations.

Since the FC micro-CHP systems must compete with well-established technologies, a non-discriminatory and technology-open policy and legal frameworks at EU and national level are needed in order to support the market-uptake phase. Fuel cells working on natural gas have to be treated in the same way as any other high-efficiency micro-cogeneration unit. The same preferential treatment as for power units generating electricity from renewable sources is needed for FC micro-CHP operating on green gases incl. hydrogen in order to achieve high market penetration rates within a reasonable period of time.

8.2. Conclusions

Despite the undeniable advantages of the FC micro-CHP systems (high energy efficiency, smart grid capability) their presence on the market is limited so far. Only a supportive policy and legal framework can accelerate the transition of the micro-CHP sector from emerging technology to full-scale commercialisation. The fuel cell micro-CHP systems have to be recognised as one of the key technologies capable to deliver greenhouse gas emission reductions, energy savings, integration of renewable energy sources and smart grid solutions. Obviously, a long-term support approach including not only direct financial support but also the recognition of fuel cells in the energy efficiency policy mechanisms will be beneficial.

In addition, the FC micro-CHP systems have to be accepted as an eligible technology in the national public procurement rules for purchase of products with high-efficiency performance in the government buildings. The public sector constitutes an important driver to stimulate market transformation towards high-efficiency technologies. Buildings owned by public bodies account for a considerable share of the building stock and have high visibility in public life.

The main legislative acts promoting the improvement of the energy performance of buildings within the EU and with importance for the commercialisation of FC micro-CHP systems are the Energy Efficiency Directive[20] and the Energy Performance of Buildings Directive[21]. The Energy Efficiency Directive 2012/27 establishes a set of binding measures to help the EU to reach its 20% energy efficiency target by 2020. Member States should set up an energy efficiency obligation scheme. This scheme requires energy companies to achieve yearly energy savings of 1.5% of annual sales to final consumers[22]. CHP are recognized as promising technologies with significant potential for saving primary energy. The Energy Efficiency Directive requires Member states to take the necessary measures to ensure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels. The EU countries must draw up lists of national financial measures to improve the energy efficiency of buildings and ensure that all new residential buildings are “Nearly Zero-Energy Buildings” after 2020. The two Directives are transposed into national legislation of all partner countries, but it is up to national political makers whether and how to implement support measures for the FC micro-CHP systems as high efficient and low-emission technology. It is the right moment support measures for FC micro-CHP to be introduced in the Bulgarian package of measures for increased energy efficiency performance.

It is important to stress that there is already a new EU Directive 2018/84423 amending the Energy Performance of Buildings Directive and the Energy Efficiency Directive which aims to promote the use of smart technologies in buildings, to streamline existing rules and accelerate building renovation. Member States shall link their financial

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19 Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC

20 Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0027

21 Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32010L0031

22 https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive/obligation-schemes-and-alternative-measures

23 Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2018.156.01.0075.01.ENG

measures for energy efficiency improvements in the renovation of buildings to the energy savings achieved due to such renovation. These savings shall be determined by comparing energy performance certificates issued before and after renovation. The Directive introduces a "smart readiness indicator" which will measure the buildings capacity to use new technologies and electronic systems, adapt them to the needs of the consumer, optimize its operation and interact with the grid. The Directive entered into force as of 9 July 2018 and has to be transported into national law within 20 months.

However, even with Directive 2018/884 it depends on national implementation of the Directives, whether the FC micro-CHP systems will be recognised as an eligible technology for reducing the CO2 emissions of the buildings, achieving energy saving and providing smart grid solutions. An overarching support policy and legal framework is crucial for the large-scale deployment of the FC micro-CHP systems. The serious economic barriers and regulatory gaps can be overcome through systematic long-term support approach including not only direct financial support but also the recognition of fuel cells in the energy efficiency policy mechanisms. Simplified grid connection procedures and guaranteed access to the grid for electricity produced from high-efficiency micro-CHP systems, as well as supportive measures for the produced electricity can further contribute to successfully overcome the roll-out phase.

In the majority of Member States, including Bulgaria, there are no available support mechanisms for FC micro-CHP systems. In this aspect, Germany has put in place the most extensive support mechanism for FC micro-CHP systems. In addition to the financial incentives for high-efficiency cogenerations (the feed-in tariff, tax-incentives and incentives for self-production, a dedicated program KfW43324 for funding the purchase of stationary fuel cells up to 5 kW was established. Other countries as Austria, Belgium, France, Italy and UK support FC micro- CHP systems through mechanisms applicable for all cogeneration units, such as feed-in tariffs or certificates. CAPEX support is available in Austria and Germany.

8.3. Policy Recommendations

As a new-comer in the process of deployment of FC m-CHP Bulgaria is in the position to have benefits being following the best practices. Fuel cells for combined heat and power have to be defined as a national priority for decarbonisation of the heating/cooling system in Bulgaria which should be combined with effective measures, including demonstration project(s) for increase of the public and political awareness. An integrated policy and legal approach, recognising the energy efficiency and the smart grid functionality of the residential stationary fuel cells and their promotion as high-efficiency micro-cogenerations should be introduced. This can be realised in the forthcoming transposition of the new Directive 2018/844 into a national law where FC micro-CHP systems will be introduced as smart technology that follows also the requirements of the other Directives[25,26], being an eligible technology under the Energy savings obligations.

A recommendable direct measure for the acceptance of FC m-CHP as an eligible technology is its introduction in the national public procurement rules for purchase of products with high-efficiency performance in the government buildings, since the public sector constitutes an important driver to stimulate market transformation towards high-efficiency technologies. Buildings owned by public bodies account for a considerable share of the building stock and have high visibility in public life.

The promotion of effective and dedicated support mechanisms for fuel cell micro-CHP, following the best practices of other countries will foster the deployment mechanism, including provision of guaranteed access to the grid, guaranteed transmission and distribution and priority dispatch of the electricity produced from high - efficiency FC micro-CHP systems and creation of support mechanisms for the uptake of this electricity.

As a near-term measure an attempt supported by the Government should be done for joining the FCH JU project PACE as end user of 10-15 FC m-CHP units.

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[24] Best practices: KfW 433 programme driving the Fuel Cell micro-Cogeneration sector closer to mass market uptake in Germany http://www.pace-energy.eu/best-practices-kfw-433-programme-driving-fuel-cell-micro-cogeneration-sector-closer-mass-market-uptake-germany/

[25] Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0027

[26] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32010L0031

9. Appendix

9.1. Glossary

ADR	European Agreement concerning the International Carriage of Dangerous Goods
AFID	Alternative Fuels Infrastructure Directive
AFV	Alternative Fuels Vehicles
BAS	Bulgarian Academy Of Sciences
BimSchG/V	Federal Immission Control Act/Ordinances
C_3H_8	Propane
CH_4	Methane
CHP	Combined Heat and Power
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
DIN	German Institute for Standardisation
DNO	Distribution Network Operator
DSO	Distribution Service Operator
EPL	Environmental Protection Law
ERA	European Research Area
EU	European Union
FC	Fuel Cell
FCEV	Fuel Cell Electric Vehicle
FCH JU	Fuel Cells And Hydrogen Joint Undertaking
GAD	Gas Appliances Regulation
GAR	Gas Appliances Directive
H_2	Hydrogen
H2NG	Hydrogen-Natural Gas Mixtures
HRS	Hydrogen Refuelling Station
IPC	Investment Program for Climate
IS3	Innovation Strategy for Smart Specialisation
ISO	International Organisation of Standardisation
Kg	Kilogram
l	Litre
LAP	Legal And Administrative Process
LEL	Low Explosive Limit
LPG	Liquefied Petroleum Gas
LPG	Liquefied Petroleum Gas
NACE code	Nomenclature des Activités Économiques dans la Communauté Européenne
NFP	National Framework Programme
NFS	National Framework Strategy
NGOs	Non-governmental Organizations

Nm^3	Normal Cubic Meter
P2G	Power-to-gas
RED	Renewable Energy Directive
RED II	Proposal for a Recast of the Renewable Energy Directive
RES	Renewable Energy Sources
SET Plan	Strategic Energy Technology Plan
SoA	State of Art
TSO	Transmission Service Operator
UEL	Upper Explosive Limit