HyLAW

Position paper on the national strategy to create a regulatory framework for hydrogen and its applications – France

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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 Context and summary

Public policy guidelines and the perspectives of industrialists in France

As an energy carrier, hydrogen has the promise to forward both France's ecological and energy future by decarbonising greenhouse gas (GHG) intensive sectors, improving air quality, and supporting the deployment of renewable energy whilst building up job-creating industries to stimulate the local economy.

On June 1st 2018, Nicolas Hulot, the Minister for an Ecological and Solidary Transition, officially unveiled a National Plan for the Deployment of Hydrogen for the Energy Transition (hereafter National Hydrogen Plan). This plan is a marker point in hydrogen's evolution. For the first time, hydrogen figures in France's energy strategy.

For years, industrial actors active in the hydrogen sector have sought to develop a shared perspective for the future of hydrogen and its role in the energy transition. This perspective is consolidated in the National Hydrogen Plan. It agrees that hydrogen is critical to the success of the energy transition. It asserts that hydrogen can significantly contribute to achieving the objectives defined in the July 2017 Energy Climate Plan – namely: reaching carbon neutrality by 2050 and banning diesel and petrol vehicle sales as of 2040.

An ambitious but realistic outlook for hydrogen's future in France.

This ambitious outlook was (first) presented in a prospective study undertaken by AFHYPAC, 11 industrial partners and the French Centre on Atomic Energy (CEA) and published in April 2018[1].

In the views of this feasibility study, by 2050, carbon-free hydrogen could meet 20% of the final energy demand and 18% of the national vehicle fleet could run on hydrogen. Moreover, carbon-free hydrogen could diminish CO2 emissions by 55 million tons (Mt) per year. This economy is 1/3 of the emission reduction effort France must undertake to meet the target set in the 2017 Climate Plan as compared to the trajectory France is currently on[2].

By 2030, carbon-free hydrogen and fuel cells could constitute a self-standing industry with an estimated turnover of 8,5 Billion euros (Bn €) with over 40,000 employees. By 2050, the sector could reach 40 Bn € turnover and employ more than 150 000 people. Such an evolution could partly offset expected job destruction in the automotive sector.

Carrying out this vision would place France amongst the world leaders in the hydrogen and fuel cells sector. It would allow the country to contribute fully to new economic openings for Europe in a hydrogen market, and in those markets related to it, now growing at world level (in China, South Korea, Japan, Europe, etc). France has much potential in the

1 "Developing hydrogen for the French economy", A Prospective study – AFHYPAC (2018). Available in English at the following link : http://www.afhypac.org/documents/publications/rapports/Afhypac_Etude%20H2%20Fce%20GB_def.pdf

2 According to the European Reference Technology Scenario (RTS)

manufacturing and production of hydrogen equipment and creation of components and materials. Such strengths as these, if followed, could account for 6,5 Bn € worth of export revenue by 2030[3].

Even so, realizing this demands that both industrialists and government concentrate their efforts to expand the hydrogen-based sector. Over the upcoming decade, some 8 Bn € should be allocated across the value chain. This would amount to 800 million euros (M €) annually or 2.5% of all investments in 2016 aimed at decarbonising France. Such investment would open the way for the following objectives to be achieved over the decade up to 2018:

- In the transport sector: deploy 400 hydrogen stations of varying size together with 200 000 electric and fuel cell vehicles with early priority for public sector transport (e.g. trains and buses), taxi fleets and utility vehicles;
- In the building sector: meeting between 0,5% and 1% of the French gas demand with hydrogen injected into the natural gas grid;
- In the industrial sector: demonstrate the consumption of carbon-free hydrogen in generating heat for large-scale industrial applications (petrochemical, steel smelting, etc);
- Increase electrolyser capacity to reach 0,8 - 1 GW.

Carrying out this policy calls for a stable, balanced and purpose-built regulatory framework. This regulatory framework will demand coordination between industry, policymakers, financial interests and research institutes. Carbon-free hydrogen holds an important promise in achieving a low-carbon energy system. To meet this promise, long-term and adequate support policies similar to those provided to other emerging technologies are required so carbon-free hydrogen can become economically competitive and widely available.

The National Hydrogen Plan

The National Hydrogen Plan presented by the Minister for an Ecological and Solidary Transition on June 1st is framed by this vision.

Integrating an increasing share of renewable energy into the energy system is key to accomplish the energy transition. However, hydrogen is the sole means of storing renewable energy in large quantities over a long period.

What is at stake is nothing less than the creation of a competitive French carbon-free hydrogen industry which can meet grid balancing requirement and decarbonise, in the first, the important absorption markets which are industry and transport.

In France, hydrogen is consumed – essentially by industry - to the tune of 1 Mt per annum. Today, for the great part, hydrogen is produced from natural gas with steam reforming. This process consists in breaking up the methane molecules into hydrogen molecules with water vapor. This means of producing hydrogen emits annually more than 11 Mt of CO2 in France. This represents 3% of total annual French CO2 emissions and close to 26% of its industrial CO2 emissions.

Decarbonising the hydrogen production process is a major issue to reduce CO2 emissions. For hydrogen to play its just part in the energy transition, the National Hydrogen Plan sets 3 objectives:

- Create a carbon-free industrial track;
- Draft new plans to store renewable energy on isolated sites;
- Develop a zero-exhaust plan for transport.

100 M€ have been assigned to implement this plan. These funds will be available as of 2019 and distributed via the French Environment and Energy Management Agency (ADEME). They are a further step to expand the scale of operation and develop the industry.

Creating a suitable regulatory framework

3 "Developing hydrogen for the French economy" A Prospective study – AFHYPAC (2018). Available in English at the following link: http://www.afhypac.org/documents/publications/rapports/Afhypac_Etude%20H2%20Fce%20GB_def.pdf

To implement the National Hydrogen Plan but also to bring about the large-scale use of hydrogen as an energy carrier with multiple end-uses, close cooperation between industrial actors in the hydrogen sector and policy-makers is critical to design an enabling regulatory framework.

Such cooperation is already vested in the AFHYPAC via the: "Commitments for Green Growth" initiative co-piloted by the French Research Centre on atomic energy (CEA), the Ministry of Ecology and Solidary Transition's (hereafter Ministry for Ecology) Directorate General on Energy and Climate Issues (DGEC) and the General Commissariat on Sustainable Development (CGDD) and ADEME. In its negotiation with industry, a project team, composed of civil servants from different ministries, will represent the French State. This initiative will lead to the creation of mutually binding bilateral agreements between industry and government to help develop the sector.

Drawing up the appropriate regulatory framework will be key to the success of this undertaking both in respect of the industrial partners and the general public.

The National Hydrogen Plan has already put forward some recommendations to this end.

The current legislative, technical, environmental, safety and fiscal framework dealing with hydrogen as an industrial gas or chemical substance is sufficiently robust to deal with hydrogen current industrial needs and applications. It is neither sufficiently extensive nor supportive to enable its deployment as an energy carrier in its own right nor for certain end-users.

The critical path forward to allow these evolutions has already been identified by actors in the hydrogen industry.

A summary of the priorities the future regulatory framework will have to make provision is set out in this document

Regulatory framework: Evolving priority areas

Hydrogen Mobility

1/ Distributing hydrogen in refuelling stations

- Refuelling stations which sell only hydrogen

  The legislation dealing with the distribution of hydrogen in refuelling stations is currently being implemented: it will be covered by a newly created ICPE[4] status, under heading 1416: refuelling stations distributing gaseous hydrogen, and a Ministerial Ruling for General Prescription (AMPG) which was published on October 22nd and will be operative as of January 2019. This AMPG was co-developed by the Ministry for Ecology and industrial hydrogen actors represented by the AFHYPAC.

  Once this new regulatory framework comes into effect, hydrogen station operators and project developers will be consulted to determine whether further regulation might not be required.

- Multi-fuel refuelling stations

  Although the aforementioned AMPG includes multi-fuel refuelling stations, empirical evidence has yet to be collected to determine the legislation's applicability and whether specific regulatory measures might be needed.

2/ Supporting zero-emission mobility

Without infringing technological neutrality, it is reasonable to permit hydrogen by:

- Including the aforementioned National Hydrogen Plan's objectives in the multi-annual Energy Plan (PPE)5;
- Incorporating in the future General Law on Mobility all those objectives linked to electric mobility as well as all measures to encourage the uptake of very low-carbon mobility options by all interests engaged in mobility planning;

[4] The ICPE legislation covers all Installations Registered for the Protection of the Environment. It is the French transposition of the SEVESO III Directive.

[5] The PPE is a key building block in France's energy policy. It sets targets over 4-year periods for the evolution of the energy sector (for example: capacity of photovoltaics objective, nuclear power plant closures…)

- Extending all tax advantages associated with electric mobility (bonus-malus, over-amortisation, etc) to all types of mobility including maritime and river
- Ensuring, as of 2019, that the 100 M € funds be available via calls for projects to provide investment supporting the industry and transport sectors' decarbonisation objectives.

3/ Removing regulatory barriers for hydrogen vehicle use and parking

- Hydrogen vehicle parking in closed lots

  Strico sensu, parking hydrogen vehicles in closed buildings is not forbidden by the law. However, the relevant national public authority - the General Direction for Civil Security and Crisis Management (DGSCGC) from the Ministry of the Interior[6] -, recommends not parking in closed parking spaces. More data on the impact of fires on hydrogen vehicles in a closed space are required as are specific tests before a definitive decision can be taken.

  AFHYPAC is currently in discussion with the DGSCGC on this matter.

- Driving hydrogen (heavy and light) vehicles through tunnels

  Under what conditions and for what type of tunnels hydrogen buses and heavy vehicles may circulate through tunnels has to be defined with the Ministry for Ecology, the Ministry for Transport and the Centre for Tunnel Studies (CETU).

4/ Identifying and lifting constraints and limitations for hydrogen mobility in the maritime and railway sector

- No regulatory framework for hydrogen use in the railway sector exists. It remains to be drafted.
- Simplify the homologation and authorisation procedures for the different types of boats with hydrogen aboard whether for sea or river transport.

Hydrogen Production

1/ Hydrogen production via electrolysis

Producing hydrogen with electrolysis does not emit any polluting emissions, as defined in the Industrial Emissions Directive (IED). As such, collaboration with the General Directorate on Risk Prevention (DGPR) from the Ministry for Ecology is sought to identify the adequate way to address the environmental dimension while providing electrolyser operators with sufficient freedom.

Security issues associated with this production process are addressed under heading ICPE 4715. Further regulation is unnecessary.

2/ Hydrogen traceability

The National Hydrogen Plan proposes to implement, as of 2020, a hydrogen traceability system in line with the revised Renewable Energy Directive's – known as REDII- recommendations.

The players in the hydrogen sector wholeheartedly support this proposal and call for an ambitious application. As part of the transposition of the future European framework on guarantees of origin and renewable fuels produced with electricity traceability (articles 19 and 25 of RED II), France should defend the advantages it holds to produce decarbonised hydrogen. This future framework should allow actors to evaluate their hydrogen's GHG emissions and thereby their contribution to emission reduction efforts.

The following are recommended:

- Enshrine in legislation two definitions / statuses for hydrogen: one for low-carbon hydrogen and the other for renewable hydrogen. Both should be grounded on studies carried out at European level. These definitions (low-carbon and renewable) should be extended to synthetic methane.

[6] The Ministry of the Interior is the government department responsible for internal security, territorial administration and public liberties.

Such stipulations should consider their hydrogen's GHG content and, for synthetic methane, also on the CO2 source.

- Create a Guarantee of Origin System adapted to the different gas conditions which decouples point of production from point of consumption thereby providing all access to these new gases (following the model used for biomethane), whilst ensuring alignment with standardisation initiatives at the European level.

3/ Hydrogen in industrial applications

The 100M€ fund operated by ADEME is in part intended to cover the difference in cost between hydrogen produced by steam methane reforming and renewable or low-carbon hydrogen produced via electrolysis so as to make carbon free hydrogen a cost-effective option for the industrial sector. However, these funds alone will not be sufficient to achieve the 2023 objectives.

For the industrial sector to reach the 2023 goal of 10% carbon-free hydrogen, other measures are required:

- Remunerating the services provided to the power system by (flexible) electricity providers irrespective of their consumption volume or their tension at their real value

This request is in keeping with the National Hydrogen Plan's 5th measure: "To identify the services provided by hydrogen to define their value. For continental metropolitan France, RTE[7] and ENEDIS[8] will be given the mission to identify the value of these services provided to the grid by electrolysers and both the existing and required means to valorise these services".

4/ Highlighting hydrogen's environmental footprint in current GHG regulation

Lined up with measure 3 of the National Hydrogen Plan, the objective is to differentiate hydrogen depending on its means of production by:

- Including hydrogen in the carbon database managed by ADEME;

- Considering hydrogen as an energy carrier, like electricity or vapour, at the national and international level.

Injecting Hydrogen in gas transport and distribution networks

The National Hydrogen Plan asks all relevant parties to: "determine the technical and economic conditions acceptable for hydrogen injection into the natural gas network", requesting a report by natural gas distributors, storage operators and network operators on this subject. This measure will lead to the definition of technical rules and support mechanisms for the injection of new gases in the natural gas transport and distribution networks and for their local use which will support the development of Power-to-Gas which converts electricity produced from renewable sources.

Complementary to this report, interim filed results, expected in early 2019, from innovative demonstration power-to-gas projects will provide answers to these questions. Projects include: GRHYD, Jupiter1000 and Methycentre. This last project is the first project which combines a methanisation with a methanation unit. The electrolysers running in all 3 projects can double their power capacity during peak renewable electricity production time. They can thereby provide system services to the grid and will do so.

These results will improve the understanding of the conditions under which hydrogen can be safely and economically injected into the natural gas grid. Hydrogen, like biomethane, contribute to decarbonising natural gas supply. To support this effort, it is recommended to:

- Establish a feed-in tariff for the injection of carbon free hydrogen into the natural gas grid comparable to that granted to biomethane,

[7] RTE is the national electricity transport grid operator.

[8] ENEDIS the main electricity distribution grid operator in France.

The FenHyx project, led by GRTGaz[9], will study the hydrogen and methane admixture. FenHyx will identify the technological barriers in the deployment of hydrogen solutions at scale and to define the conditions for power-to-gas injection into the natural gas grid. In this, it holds the potential to bring together all of the actors across natural gas value chain for all natural gas final applications.

Synthetic methane produced through renewable hydrogen methanation is a means to bind, transport and exploit CO2. It can be injected into and used by -without limitation- natural gas infrastructure and applications thereby resulting in important savings when compared to other technologies which require important infrastructure investments. When synthetic methane will have been adequately characterised and defined, especially according to the CO2's source, it will become relevant to implement a traceability system comparable to biomethane's:

- <u>Implement a guarantee of origin system for synthetic methane to ensure its traceability (comparable to biomethane's).</u>

[9] GRTGaz is one of two operators of the French natural gas transport network.

2. Hydrogen production

2.1. Summary and perspective on the current regulatory framework

The French regulatory framework covering hydrogen production arises from the transposition of two European Directives:

- The SEVESO 3 Directive ;
- The IED Directive.

⇒ The SEVESO 3 Directive (Directive 2012/18/EU of the European Parliament and of the Council of July 4th 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC), covers accidental risks caused by the use of certain specific chemical substances. Hydrogen is among these substances.

⇒ The IED Directive (Directive 2010/75/EU of the European Parliament and of the Council of 24th November 2010 on industrial emissions (integrated pollution prevention and control), commonly referred to as the IED Directive), sets comprehensive guidelines to prevent and moderate industrial and agricultural pollution at European level.

One of the underlying principles of the IED Directive is to call upon the best available techniques (BAT) to prevent pollution. All Member States must base maximum emission values upon BAT-performances in the regulation governing these installations' permitting conditions.

The IED Directive supersedes Directive 2008/1/CE, known as Directive IPPC, covering integrated pollution prevention and control.

The IED Directive specifically includes "hydrogen produced in industrial quantities" but does not define the amount this corresponds to.

DG Environment published a guide to help appraise whether substances produced under heading 3420 were produced in "industrial quantities" and therefore potentially governed by the IED Directive.

The current regulation, resulting from these two Directives' transposition, is as follow:

⇒ A specific heading in ICPE regulation is dedicated to hydrogen (heading 4715). The administrative procedure defining the permitting conditions for hydrogen production units in France depends on how much hydrogen is produced:

- ○ Under 100 kg: there is no procedure;
- ○ Between 100 kg and 1 ton (1 T): the "declarative procedure" applies;
- ○ Beyond 1T: the "authorisation procedure" (risks and environment) applies.

⇒ The environmental authorisation procedure applies as soon as the first gram of hydrogen is produced, irrespective of the production technology.

An interpretation rider was published by the DGPR for the DREAL to help the latter determine whether a given hydrogen production can be qualified as "industrial" or not. Particular attention is given to hydrogen production with electrolysis. However, this document does not set a threshold below which the environmental authorisation procedure is non-systematic.

Hydrogen production via electrolysis can only be partially exonerated from the TURPE (the name of the French transmission network users' tariff) if production volumes are more than 200 T/ year.

Unlike electricity and biomethane, there is currently no national or European legislation enabling hydrogen's traceability disclosing its primary energy source or the resource responsible for its production.

2.2. Conclusions

In practice, which procedure of authorisation applies to a hydrogen production unit is determined on a case-by-case basis by the national policymaker's local representative. In the French case, this is the regional representation of the Ministry for Ecology known as the DREAL. The Ministry has not set guidelines for the DREAL to interpret this regulation.

In this context, (public and private) hydrogen project holders, regardless of application -mobility, stationary, energy storage, industrial, etc.- lack regulatory visibility and are therefore exposed to regulatory risks.

A project's administrative process can have a considerable impact on the project's viability. In the case of an authorisation procedure, the inspection process can take between 12 to 18 months. Furthermore, the results are uncertain as they largely depend on the public inquiry and administrative instructions. The administration may request additional security and or impact assessment suits which, beyond delays, can substantially increase the project's costs.

The authorisation procedure is inadequate for projects that seek to produce "small quantities" of hydrogen (for example: inferior to a 1T/day), - an amount which is coherent with regulation ICPE 4715). This could be a considerable drawback for future hydrogen production projects for any end-use.

⇒ The DGPR points out that guidelines clarifying the notion of "hydrogen produced in industrial quantities" which might include a threshold value, would allow them to provide the DREAL with official instruction through an interpretative rider.

Yet, legal analysis undertaken by l'AFHYPAC with the support of a recognised expert in environmental law, reached the following conclusions:

⇒ By its very nature and considering the IED Directive's historical legal background, hydrogen production via electrolysis ought to be excluded from its scope as it is non-polluting according to this Directive's definition.

Guidelines defining the threshold of what constitutes "industrial quantities" of hydrogen should be published by the Commission. No such guideline has been published to date.

Current economic and tax policy supporting decarbonised hydrogen production is insufficiently attractive for industrialists to offer such hydrogen produced via electrolysis with renewable electricity or biomass as an energy input to their clients. With the current level of economic incentive, the industry's decarbonisation objectives as set in the National Hydrogen Plan are unlikely to be met.

A traceability mechanism for hydrogen produced by electrolysis from renewable and carbon-free energy sources as well as biomass is critical to support the deployment of decarbonised hydrogen for both industrial and mobility applications.

2.3. Recommendations

1/ Hydrogen production via Electrolysis

Hydrogen production via electrolysis is non-polluting, according to the IED Directive. As such, l'AFHYPAC wishes to collaborate with the DGPR to define how to address environmental issues related to hydrogen production via electrolysis whilst safeguarding electrolyser operators' freedom to operate.

Safety issues concerning this production process are covered by heading ICPE 4715 (the transposition of the SEVESO III Directive in French law). Further regulation is not necessary.

2/ Hydrogen traceability

The National Hydrogen Plan proposes to implement a hydrogen traceability system by 2020 which will be aligned with the European regulatory framework (recast of the RED II Directive on renewable energy)

The players in the hydrogen sector wholeheartedly support this proposal and call for an ambitious application. As part of the transposition of the future European framework on guarantees of origin and renewable fuels produced with electricity traceability (articles 19 and 25 of RED II), France should defend the advantages it holds to produce decarbonised hydrogen. This future framework should allow actors to evaluate their hydrogen's GHG emissions and thereby their contribution to emission reduction efforts.

The following are recommended:

- Enshrine in legislation two definitions / statuses for hydrogen: one for low-carbon hydrogen and the other for renewable hydrogen. Both should be grounded on studies carried out at European level. These definitions (low-carbon and renewable) should be extended to synthetic methane. Such stipulations should consider their hydrogen's GHG content and, for synthetic methane, also on the CO2 source.

- Create a Guarantee of Origin System adapted to the different gas conditions which decouples point of production from point of consumption thereby providing all access to these new gases (following the model used for biomethane), whilst ensuring alignment with standardisation initiatives at the European level.

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- Remunerating the services provided to the power system by (flexible) electricity providers irrespective of their consumption volume or their tension at their real value

This request is in keeping with the National Hydrogen Plan's 5th measure: "*To identify the services provided by hydrogen to define their value. For continental metropolitan France, RTE*[10] *and ENEDIS*[11] *will be given the mission to identify the value of these services provided to the grid by electrolysers and both the existing and required means to valorise these services*".

4/ Highlighting hydrogen's environmental footprint in current GHG regulation

Lined up with measure 3 of the National Hydrogen Plan, the objective is to differentiate hydrogen depending on its means of production by:

- Including hydrogen in the carbon database managed by ADEME;
- Considering hydrogen as an energy carrier, like electricity or vapour, at the national and international level.

[10] RTE is the national electricity transport grid operator.

[11] ENEDIS the main electricity distribution grid operator in France.

3. Hydrogen storage

3.1. Summary and current regulatory framework

The current regulatory framework in France is based on the transposition of the SEVESO 3 Directive. Its key elements are as follows:

⇒ There is a hydrogen-specific heading in the ICPE regulation: heading 4715. The authorisation procedure applicable to hydrogen storage units varies depending on the volume of gaseous and pressurised hydrogen generated at an industrial site.

- Under 100 kg: no applicable procedure;
- Between 100 kg and 1 T hydrogen: declaration procedure;
- Beyond 1 T: authorisation procedure (risks and environment).

Decree 12/02/98 covering the general regulation applicable to installations classified for environmental protection (ICPE) and subject to the declaration procedures under heading 4715 applies in the following conditions:

Any installation subject to the declaration procedures for its permitting must respect the following implantation conditions:

- If implanted in an open space or under a porch, the distance between the installation and the property limit and any other building cannot be less than 8 meters;
- If installed in a closed space, the distance between the installation and the property limit and any other building cannot be less than 5 meters.

These conditions do not apply to gas hydrogen storage equipment nor to the hydrogen production unit if they are separated by a solid wall composed of incombustible materials fire-resistant for up to 2 hours, of at least 3 meters high and separated from the storage with a canopy in incombustible materials and with a firewall of 1-hour resistance and at least 3 meters on a horizontal plane. This wall must be prolonged on both sides by protective, one-piece walls built in incombustible materials and with a firewall of 1-hour resistance which is of 3 meters height and at least 2 meters length.

These conditions currently apply specifically to industrial sites using hydrogen. Their application is non-problematic and poses no particular difficulty. Meeting these requirements is non-problematic for industrial sites and holds no particular technical challenge.

Liquid hydrogen, however, is subject to Circular 24-05-76 on Liquid Hydrogen, replaced by Circular DPPR/SEID/AL-07-0275 of 25th July 2007 on risk evaluation and on the effective distance required around depots of inflammable liquid and fire-prone liquids are different. Regulation covering liquid hydrogen is set out in the Circular of 24/05/76 relative to liquid hydrogen storage, repealed by Circular DPPR/SE12/AL-07-0257 of 23rd July 2007. It evaluates the risk and the distance needed to provide security in environments with inflammable liquid and gas deposits.

These requirements apply depending on the storage deposit's capacity, its distance with the building's fence (in which the liquid hydrogen storage reservoirs are located) and the buildings or other infrastructures close to the site. The distances which need to be respected can be quite substantial depending on the quantity of hydrogen and the type of establishments located in the vicinity. As a rule, the distance is around several dozen meters. This implies that storing liquid hydrogen in a dense urban environment is prohibited.

3.2. Conclusions

Regulation on gas and liquid hydrogen storage is well established for industrial hydrogen applications.

In practice, hydrogen users and operators can comply with current regulation as long as the hydrogen production unit is located on an industrial site.

However, were these requirements extended to non-industrial sites and applications - to hydrogen storage in refuelling stations, for example – regulatory adjustments would be required.

to regulate new hydrogen use, a dedicated ICPE heading was published on 23rd October 2018.

3.3. Recommendations

See the chapter « hydrogen distribution in refuelling-stations”

4. Hydrogen transport

4.1. Summary and current regulatory framework

Hydrogen is generally transported by road. Transporting hydrogen by road is governed by the European Agreement on the International Carriage of Dangerous Goods by Road (more commonly referred to as the ADR agreement)

The ADR is an international agreement regulating the cross-border transport of dangerous substances between signatory States.

Vehicles transporting dangerous substances can be controlled in each signatory State according to the regulation of the State where the vehicle is controlled. All European Members States are signatories to this agreement (Directive 2008/68/CE).

Under the terms of this agreement, compressed hydrogen is defined according to a specific taxonomy: ONU n°1049 (« compressed hydrogen and methane admixtures » is classified under the code ONU 2034), it is a class 2 product with a classification code IF, and etiquette code 2.1. and danger class of 23.

Compressed hydrogen can be transport in the following containers:

- Steel Bottles (under pressure transportable containers with a capacity inferior to 150 litres of water)
- Cylinder racks (a series of bottles bound together, linked with a collecting piping and transported as a single piece of equipment with a maximum capacity of 3000 litres of water)
- Tubes (pressurised transportable containers without welding with a capacity between 150 and 3000 litres of water)
- Pressurised barrels (transportable pressurised containers welded together with a capacity of between 150 and 1000 litres of water).

Regulation for each combination of compressed hydrogen transport option is subject to certain specific conditions.:

- Pressure Bottles: Their test pressure must be superior or equal to 200 bar and must be 1,5 times superior to their operating pressure. If the bottles are made of an aluminium alloy, they must be 3,5 mm thick. If they are made of steel, they must be 2 mm thick. Their capacity cannot exceed 85 litres of water

  The bottle container's manufactured duration must be ten years. They must be controlled by a certified, type B, body or, potentially, by the internal audit services of a control or inspection authority. The lifetime of these bottles may be extended to 15 years if made of aluminium alloy and if specific production conditions are respected.

  The cylinder rack must be filled in dedicated filling centres equipped with a quality control system. Bottle compliance with conception and usage standards by the accredited control organism (or the authorities' internal audit services) must follow norm EN ISO/IEC 17020: 2012.

There is no regulation capping the maximum pressure at which hydrogen may be transported.

Bottles, tubes, pressurised casks and cylinder racks construction must abide by the conception regulation and be homologated. Hydrogen is not exempt from the ADR agreement's specifications. This implies that any hydrogen transported by road, irrespective of the quantity, must meet these specifications.

<u>Pressure Bottle layout during transport</u>

During transport, bottles can be either:

- Lying down, across the vehicle;
- At the front of the vehicle, lying across the vehicle;

- Bottles with diameter of more than 30 cm can be placed length-wise with the tap protection systems toward the middle of the vehicle;
- Bottles laid down must be securely attached and fastened;
- Bottles can also be placed vertically if they are sufficiently stable and held together with appropriate gear.

Other means of transport

Regulation regarding container production and control is the same as bottles'. There is no maximum hydrogen pressure imposed for its transport either.

Particular requirements apply to the personnel responsible for transporting hydrogen. These requirements are:

- All personnel must be adequately trained;
- All vehicles must be equipped with a portable lighting ATEX system;
- Whilst loading and unloading, all combustion heating apparatus must be switched off;
- The build-up of static electricity must be avoided;
- The vehicle must be inspected and parked in isolation if the load exceeds 10 000 kg or 3000 litres.

The special case of metal hybrid transportation

ADR regulation does not apply to electricity storage and production equipment (for example: lithium batteries, electric condensers, asymmetric condensers, storage solutions with hybrid metals, fuel cells, etc.) which are either:

- Installed in a vehicle transporting such dangerous materials and used either for its propulsion or to make part of its equipment work;
- Integrated within equipment to ensure such equipment functions or is used during transport (for example: a laptop).

Hybrid metals which are specifically listed in the ADR agreement are the following:

- Magnesium hybrid (n° ONU 2010)
- Hydroreactive metal hybrids N.S.A (n° ONU 1409)
- Inflammable metal hybrids (n° ONU 3182)

Hybrids can be transported in different containers as long as precise conditions are respected, particularly for pressurised containers. This is the case for example for hybrids used for hydrogen storage. These requirements are detailed in the ADR agreement's Annex 1.

These requirements are:

- Under pressure containers and their packaging materials must be in keeping with the substances which are transported;
- Conception, control and homologation rules are the same as apply to under pressure reservoirs containing gas;
- Inflammable Metal hydrates cannot be transported in "bags".

Access to tunnels for vehicles transporting dangerous materials, including hydrogen, may be limited depending on the tunnel's classification. Each tunnel is classified by the Ministry for Transport according to its own specific characteristics. Limitations on tunnel access for vehicles running on hydrogen is, as yet, not addressed by legislation.

4.2. Conclusions

Road transport of hydrogen is currently encompassed by legislation on dangerous materials transport (the ADR agreement). Such regulation is suitable for merchant hydrogen transport for industrial and mobility applications (for example gaseous hydrogen supplied to hydrogen refuelling stations).

ADR regulation was not intended to cover materials and products used as an energy feedstock or fuel for vehicles. However, a clarification on whether this legislation applies for the new uses of hydrogen, notably for mobility, would be useful, particularly for buses and heavy-duty vehicles. As the quantities of on-board hydrogen can exceed several dozen kilos, regulatory authorities might consider that ADR regulation should apply to this category of vehicle. If such judgement were applied, it would raise significant barriers to the use of these vehicles on a daily basis because their access to certain key road infrastructure could be limited (for example: tunnels, closed parking lots, etc).

4.3. Recommandations

Current regulation covering road transport of hydrogen meets the sector's expectations for hydrogen used for mobility and industrial applications. No particular adaptation or modification has been identified at the time of writing.

However, whether and to what extent current regulation on transport of dangerous materials applies to hydrogen vehicles should be clarified, particularly for hydrogen buses and heavy-duty vehicles, and with regards to tunnel access tunnels and to other confined environments.

It is currently unclear whether ADR regulation applies to hydrogen road transport or not. Granting access to vehicles transporting hydrogen to certain road infrastructure (such as tunnels) on a case-by-case basis must be avoided. This approach would make road transport with hydrogen driven vehicles far more complex.

5. Delivering hydrogen by road

5.1. Summary and current regulatory framework

In consultation with hydrogen sector stakeholders, the DGPR of the Ministry for Ecology has begun drafting regulation on hydrogen delivery to refuelling stations.

This concerted initiative has led to the publication on October 22nd 2018 of:

- A Decree leading to the creation of a new heading under the ICPE regulation (heading n°1416) on hydrogen distribution in refuelling stations for mobility applications;
- A Ministerial Ruling for General Prescriptions (AMPG) which sets localisation criteria (distances between the service station's different equipment and the site's property limits, particularly for the hydrogen terminals), and technical prescriptions refuelling stations will have to abide by.

The authorisation procedure associated with a hydrogen service station involves a "declaration with control". Instruction lead times for this procedure are less long than the "procedure of authorisation".

To define adequate security criteria inside the service station and with respect to the area open to the public, different risk scenarios were modelled. The security requirements are based upon the scenario with the most critical risk. These rules were therefore drawn up and dealt with the case where a flexible segment of the pressurised distribution pipe leaked hydrogen into the atmosphere and instantaneously broke into flames.

Subsequent regulation will cover those refuelling stations which:

- distribute hydrogen up to 700 bars pressure and a maximum flow rate of 120 g/s;
- distribute hydrogen at a flow rate inferior to 20 g/s

Based upon current service station standards, this regulation applies to refuelling stations for buses and personal vehicles.

Multi-fuel stations selling hydrogen are also covered by this regulation. The only provision which specifically targets multi-fuel stations is a minimum security distance between the hydrogen and other fuel pumps.

This new regulation also applies to existing hydrogen refuelling stations and those under construction which have a construction permit. 36 months will be granted to these stations so they may comply with this new regulation. Complying with the new regulation will be difficult for some existing hydrogen refuelling stations. Respecting the distances between hydrogen and non-hydrogen pumps is, in some cases, challenging. This issue must be brought to the policymaker's attention so as to adapt the compliance conditions for the existing refuelling stations concerned.

The AMPG comes into effect on January 1st 2019.

5.2. Conclusions

The new regulation fills the prior regulatory void on hydrogen distribution in refuelling stations. The chosen authorisation procedure will enable the deployment of hydrogen service station within a relative limited delay. The regulatory framework provides clarity and safety to public and private stakeholder wishing to build and operate hydrogen distribution infrastructure.

This initial regulatory framework must demonstrate its robustness and applicability in practice with the anticipated deployment of upcoming hydrogen refuelling stations. The experience of project developers will be used to evaluate the necessity of both evolutions and adaptations.

Conditions to be followed through on this regulation will have to bear in consideration:

- Existing and planned refuelling stations
- Multi-fuel stations

5.3. Recommandations

Stations distributing hydrogen alone

The AMPG was drafted by the MTES services in close collaboration with the hydrogen sector's stakeholder represented by l'AFHYPAC.

Once the regulation is implemented, service station operators and project holders will have to be consulted to determine whether further legislative modifications are needed.

Multi-fuel stations

Although current AMPG covers multi-fuel stations, whether it may apply in practice and whether further adjustments as indeed the creation of a separate regulation may be required will need to be determined once real-life experience is to hand.

6. Injecting hydrogen into the natural gas network

6.1. Summary and current regulatory framework

The current regulatory framework governing non-natural gas injection into the natural gas transport and distribution network is covered by Decree n°2004-555 of June 15th 2004 on: "the technical prescriptions applicable to gas transport, distribution, storage and coupling". It states that:

Natural gas transporters, distributors and exploiters of liquified natural gas infrastructure and holders of natural gas storage claims set the technical requirement - as referred to in the 5th paragraph of article 22 and at the 1st paragraph of article 22 of the law of January 3rd 2003- which gas operators and distributors must respect.

These requirements must ensure both network interoperatibility and non-discriminatory network access. The aim of these requirements is to guarantee the security of individuals and goods, safeguard the environment and ensure the network's safe operation as defined by the Decrees of May 23rd 1962, October 15th 1985 and 12th April 1999.

They determine conditions for:

- pipeline design and construction: types of materials, diameter, length, resistance to pressure under operating conditions;
- connection equipment: types of materials, means of assembly, type of security equipment;
- metering and control equipment;
- gas at the point of network entry and at the point of connection with different installations: composition, higher heating value, combustion aptitude, temperature, pressure, smell, purity;
- the exploitation, control and maintenance of installations;
- procedures of intervention.

Gas transport network operator (GRTGaz) technical specifications

Following through the its obligations defined in Decree n°2004-555 of June 15th 2004, GRTGaz published technical guidelines which set gas' physicochemical criteria:

- To inject natural gas into the transport network;
- To inject other gases.

Conditions applying to natural gas are: the higher heating value, the Wobbe index, density, water dew point, hydrocarbon due point, total sulphur content, mercaptan sulphur content, sulphur content H2S +CO2, CO2 content, tetrahydrothiophene (THT) content, Oxygen content and impurities.

In addition to meeting the natural gas requirements, other gases must meet complementary injection criteria vis a vis the maximum content of certain gases and chemical elements. For hydrogen, the share before injection must be lower than 6% molar.

Depending on the gas, maximum values on other elements present which may damage GRTGaz's equipment can be defined. GRTGaz may require the local authority, competent on the territory where the gas will be injected, to support the project on the grounds that the gas is not a public health or an environmental risk nor will it jeopardise the equipment's safety. The upstream operator is responsible for obtaining such support.

If, at a later date, the competent authority challenges its initial backing, it must inform GRTGaz within 15 calendar days by registered mail.

In such a situation, injection of the gas mentioned may be immediately suspended without further formality by GRTGaz.

Higher heating value upper limit

The higher heating content of gases other than natural gas can vary substantially. As a result, the upstream operator must explain to GRTGaz what measures it will put in place to mitigate fluctuations which may disrupt equipment connected to its network proper operation.

The distribution gas network's (GrDF) technical guidelines

Physicochemical criteria to inject gases into the distribution network are identical to those of the transport network.

At present, there is no specific technical or fiscal regulation on hydrogen injection into the natural gas distribution and transport networks in France.

6.2. Conclusions

The technical and fiscal regulatory framework governing the injection of gases other than natural gas into the natural gas transport and distribution networks is not suited to projects aiming to inject hydrogen produced from renewable energy or biomass into the natural gas grid, nor for the needs of power-to-gas projects. The regulatory framework must be revised if the deployment objectives defined in the National Hydrogen Plan are to be met.

Beyond technical aspects, future regulation must include a tariff for hydrogen injection into the natural gas grid.

To this end, hydrogen sector stakeholders and policymakers must share: a common outlook, hypotheses on hydrogen production units' investment and running costs, and an understanding of the tax policy which applies to energy sources and to resources mobilised to produce hydrogen. These are the preconditions to define a supportive tariff acceptable by all. The feed-in-tariff for hydrogen injection – if such a design is chosen- ought to cover investment costs and ensure a rate of return on investment comparable to that of other renewable energy injection projects -such as biomethane- which already have a purchasing tariff and variable revenues.

A national approach to adapt the fiscal and tariff policy should be preferred since there appears to be no common views on this at European level. Delays in bringing about a common viewpoint are likely to be too long to guarantee the projects' economic viability and therefore to achieve the National Hydrogen Plan's deployment objectives.

6.3. Recommendations

The National Hydrogen Plan asks all relevant parties to: *"determine the technical and economic conditions acceptable for hydrogen injection into the natural gas network"*. To this end, a report by natural gas distributors, storage operators and network operators is requested. This measure will lead to the definition of technical rules and support mechanisms for the injection of new gases into the natural gas transport and distribution networks and for their local use which will support the development of Power-to-Gas which converts electricity produced from renewable sources.

In addition to this report, interim field results, expected in early 2019, from innovative demonstration power-to-gas projects will provide answers to these questions. Projects include: GRHYD, Jupiter1000 and Methycentre. This last project is the first project which combines a methanisation with a methanation unit. The electrolysers running in all 3 projects can double their power capacity during peak renewable electricity production time. They can thereby provide system services to the grid and will do so.

These results will improve the understanding of the conditions under which hydrogen can be safely and economically injected into the natural gas grid. Hydrogen, like biomethane, contribute to decarbonising natural gas supply. To support this effort, it is recommended to:

- Establish a feed-in tariff for the injection of carbon free hydrogen into the natural gas grid comparable to that granted to biomethane.

The FenHyx project, led by GRTGaz[12], will study the hydrogen and methane admixture. FenHyx will identify the technological barriers in the deployment of hydrogen solutions at scale and to define the conditions for power-to-gas injection into the natural gas grid. In this, it holds the potential to bring together all of the actors across natural gas value chain for all natural gas final applications.

Synthetic methane produced through renewable hydrogen methanation is a means to bind, transport and exploit CO2. It can be injected into and used by -without limitation- natural gas infrastructure and applications thereby resulting in important savings when compared to other technologies which require important infrastructure investments. When synthetic methane will have been adequately characterised and defined, especially according to the CO2's source, it will become relevant to implement a traceability system comparable to biomethane's:

[12] GRTGaz is one of two operators of the French natural gas transport network.

- Implement a guarantee of origin system for synthetic methane to ensure its traceability (comparable to biomethane’s).