HyLAW

Horizontal Position Paper
Gas Grid Issues

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Background:

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.

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1. Introduction and Summary – Gas Grid Issues

Utilizing hydrogen derived from renewable energy sources and blended into natural gas grid networks is increasingly recognized as a means of meeting energy sector decarbonization targets (CO2 reduction of natural gas based heating and power), for energy storage, for enhancing the transport and storage capacities of the existing gas network infrastructure, and for indirect electricity transport. Flexibility and adaptability across both e-grids and gas grids across Europe is also acknowledged as vital to allow for future strategic fuel switching and the avoidance of lock-in, 'stranded asset' costs for grid infrastructure.

Converting (surplus) electric power via an electrolyser connected to the e-grid (or from a renewable energy source) into hydrogen and then injection of the hydrogen into the gas grid is referred to as 'Power to Gas' (PtG).

The PtG process most typically involves the local gas Distribution Service Operator (DSO) for blending and delivering hydrogen rich natural gas across local network connections and customers, but may also involve use of the national high pressure, long distance, gas grid network managed by a Transmission Service Operator (TSO) and which may have a network interface with international gas grid connections.

The legal framework involved thereby requires broad coverage across gas grid network access (on a regulated utility basis); a framework for permission to connect to the gas grid and inject/blend hydrogen into the grid together with a financial / payments and billing regime for receipt, transport and supply of hydrogen or hydrogen rich natural gas meeting quality requirements to customers. It also necessarily must cover safety regimes for temporary hydrogen storage facilities, and the connection, blending and injection of hydrogen to the gas grid – along with safety regimes for domestic, commercial and other end-user equipment connected to the gas grid.

European gas grids have been liberalized and opened to market competition over the past 20+ years via Directive 2009/73/EC and three subsequent Regulations (Regulation (EC) No 714/2009; 715/2009 and 713/2009) giving access to gas (and electricity) markets and clear operational and pricing procedures. These, though, have been based on storage, transmission, distribution and customer based supply of **natural gas**. The regulatory framework has not carried over to network access for hydrogen injection. This has caused barriers in four main areas:

First, the process chain for PtG is complex and there is no clear and unequivocal legal position for PtG. Gas grid network safety and operational procedures are managed at the national level leading to differing approaches to recognition of PtG plant and hydrogen injection at legally acceptable levels and divergent national and network level approaches apply to 'acceptable' procedures for hydrogen injection/blending.

Second, legally mandated national limits apply for hydrogen concentration in the gas grid. These vary from a 'minimal' level (reflecting the typical background concentration of hydrogen in natural gas) at 0.1%vol – 0.5%vol.; a 'low' level of 1%vol to 4%vol; and a mid to high concentration of 6%vol to 10%vol. Where maximum hydrogen concentrations are not legally mandated, the hydrogen concentration limits are based on accepted (national) safety norms for natural gas and which would limit hydrogen to (considerably) less than 10%vol..

Third, payment and billing arrangements for natural gas are based on the calorific value of the gas (measured by agreed procedures in kWh). The application of this methodology is not consistent for PtG based hydrogen rich gas flows.

Fourth, a change to natural gas composition with higher hydrogen concentrations would result in a differing fuel calorific value which impacts the flame and heat characteristics for gas burning appliances – possibly leading to the need for modification or replacement of end-user equipment on an operational safety basis.

These four areas collectively represent a substantive barrier to PtG activities and will need to be addressed at a national and Europe wide level via the recommendations set out below.

2. Overview of the legal framework

Directive 2009/73/EC and three subsequent Regulations (Regulation (EC) No 714/2009; 715/2009 and 713/2009) provide for access to gas (and electricity) markets and set clear operational and pricing procedures for grid access and operation, but have been based on storage, transmission, distribution and customer based supply of natural gas**.** There is no specific legal coverage that allows for, or regulates, hydrogen injection into the gas grid at either a Distribution level or Transmission level *across* the EU.

The primary legal instruments setting the legal framework for hydrogen and PtG activities (covering financial / payments and billing regime; safety regimes for temporary hydrogen storage; for connection, blending and injection of hydrogen to

the gas grid; and safety regimes for domestic, commercial and other end-user equipment connected to / supplied by the gas grid) are as follows:

Regulation (EC) No 713/2009 of the European Parliament and of the Council of 13 July 2009. This establishes an Agency for the Cooperation of Energy Regulators to assist in various regulatory tasks. Article 8 specifically sets the Agency's "Tasks as regards terms and conditions for access to and operational security of cross border infrastructure" thus making it a relevant stakeholder in the regulatory landscape of hydrogen gas transmission and distribution.

Regulation (EU) 2015/703 of 30 April 2015 establishing a network code on interoperability and data exchange rules. This aligns the complex technical procedures used by network operators within the EU, and network operators in the Energy Community and other countries neighbouring the EU. This Regulation may also apply at entry points from and exit points to third countries, subject to the decision of the national authorities.

Commission Regulation (EU) 2017/460 of 16 March 2017 establishing a network code on harmonized transmission tariff structures. The network code enhances tariff transparency and tariff coherency by harmonizing basic principles and definitions used in tariff calculation, and via a mandatory comparison of national tariff–setting methodologies against a benchmark methodology. It also stipulates publication requirements for information on tariffs and revenues of transmission system operators.

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (RED). This Directive establishes a common framework for the promotion of energy from renewable sources. It sets mandatory national targets for the overall share of energy from renewable sources in gross final consumption of energy and for the share of energy from renewable sources in transport. It lays down rules relating to statistical transfers between Member States, joint projects between Member States and with third countries, guarantees of origin, administrative procedures, information and training, and access to the electricity grid for energy from renewable sources. It establishes sustainability criteria for biofuels and bioliquids.

ATEX Directive 2014/34/EU - covering equipment and protective systems intended for use in potentially explosive atmospheres. It defines the essential health and safety requirements and conformity assessment procedures (Article 4) to be applied before products are placed on the EU market and is significant for the engineering of hydrogen production plants. It covers *inter alia* equipment and protective systems intended for use in potentially explosive atmospheres, such as temporary storage of hydrogen and plant for injection of hydrogen into the grid. The Directive requires employers to classify areas where hazardous explosive atmospheres may occur into zones, related to the likelihood of an explosive atmosphere occurring. It also requires manufacturers to design their equipment to be suitable for use within their customer's explosive atmosphere. Equipment manufacturers thereby rely upon users to provide information about the classification of the zone and the flammable substance(s) within that zone.

Regulation (EU) 2016/426 of the European Parliament and of the Council of 9 March 2016. This Regulation applies to all appliances burning gaseous fuels used in any domestic, commercial or industrial premises e.g. for cooking, refrigeration, air-conditioning, space heating, hot water production, lighting; and for controlling devices or regulating devices and sub-assemblies thereof, designed to be incorporated into an appliance or to be assembled to constitute an appliance (fittings). All relevant appliances and fittings are obliged to meet technical conformity in design and production (for 10 years); and manufacturers are obliged to monitor and sample test appliances and recall non-conforming appliances and fittings; and to provide instructions for incorporation or assembly, adjustment, operation and maintenance relevant appliances and fittings.

3. Conclusions

The gas sector legal framework itself is coherent and comprehensive. However, the framework has specifically been drawn up around facilitation of natural gas based operational procedures and market related activities for transmission, distribution and supply of natural gas on a utility basis. The regulatory framework has not carried over to network access for hydrogen injection. Network safety and operational procedures for gas grids are managed at the national level and there are differing national limits legally mandated for permissible hydrogen concentration levels within gas flows and differing national approaches to permission to inject hydrogen and payment arrangements for injected hydrogen.

In particular:

- There is considerable variance in rules and procedures where hydrogen injection is allowed (whether to blend down to a legal hydrogen concentration limit or to a safety dictated level) with the consequence that permitting

of hydrogen injection is considered on a case by case basis and PtG plant installations are typically operated 'by exception' on a time limited, demonstration basis only;

- All current transport, supply and pricing/billing of natural gas is based on the calorific value of the gas, measured in kWh, as the determinant of the amount of energy involved. The calorific value is measured continually across natural gas networks (at up to 100+ locations for a national network) and the determination of the calorific value is made in accordance with international standard ISO 6976. The Wobbe Index of natural gas is also calculated under ISO 6976 and this is a critical property in relation to the safe operation of gas burning appliances.
- The injection of hydrogen into the gas grid will change the calorific value of the gas flow. Accurate measurement of hydrogen rich natural gas blends is required for billing and payment, to ensure that a hydrogen mix is safe for transport and distribution in pipeline safety terms, and to ensure that concentrations would not unduly impact the safe operation of gas fired appliances

Acceptable safety threshold levels for hydrogen rich gas blends, for injection and distribution purposes and as limit for safe operation of gas fired appliances, have not been set on a Europe-wide basis. 100% hydrogen is under consideration for some regional networks. A threshold of up to 20%vol.[1] hydrogen was considered as potentially acceptable for the UK and the review of gas grid hydrogen composition is underway in Belgium, Bulgaria, Germany, Latvia, and the UK.

4. Recommendations

From a broad policy perspective to ensure comparable treatment and a 'level playing field across the EU, the framework for permitting PtG plant and grid connection / injection requirements between the hydrogen supplier and the gas grid operators should be included within relevant EU regulatory frameworks.

A common approach to managing gas safety and compliance requirements for grid connection and operation is essential. A coordinated EU wide review is needed to establish a consistent basis for all relevant hydrogen safety and compliance matters (generation sites, blending, connection and injection and related equipment and operations) for hydrogen blends and potentially pure hydrogen flows in the gas grid. Specifically, setting an acceptable upper threshold on hydrogen concentrations is needed to allow for network planning as there is no body of evidence to work with. This would necessarily involve EU nominated safety bodies, together with JRC, Agency for the Cooperation of Energy Regulators (ACER), and both hydrogen and natural gas industry entities.

There are no pricing principles in place across otherwise regulated EU gas networks for cost allocation and tariff arrangements to support the renewable aspects (via wind and solar energy and electrolysis) of PtG systems. These would need to include incentives for renewable hydrogen and offset costs feed in and connection to the gas grid. A Guarantee of Origin framework for the grid operator is critical to provide a business case justification.

Concerns around the safety and operational threshold of end-user gas burner appliances (domestic, commercial, industrial) requires ccoordination with national initiatives to validate gas grid operation with significantly higher hydrogen thresholds (DE, FR, NL & UK). A supply chain assessment of economic impacts, if modifications are needed, would be key to this. Gas Appliance Regulation revisions to allow (a transition to) higher hydrogen concentrations may therefore need to be implemented.

[1] UK Health & Safety Executive – Health & Safety Laboratory, 2015: '*Injecting hydrogen into the gas network – a literature search.*' The report concludes that "concentrations of hydrogen in methane of up to 20% by volume are unlikely to increase risk from within the gas network for from gas appliances to consumers or members of the public".