HyLAW London Workshop

Application Area 3: Electricity & Gas Grid Issues

HyLAW
Hydrogen law

Grant Agreement No 737977

Electricity & Gas Grid Issues - Coverage

Introduction – what's covered in this session:

For **electricity grid issues** it's about:

- Electrolyser connection (as a consumer)
- Legal status of power-to-gas plants
- Role of Power-to-Gas plants in the electricity balancing markets

For the **gas grid**, it covers Transmission and Distribution operator access and:

- Legal framework allowing hydrogen injection
- Permitting process to connect/inject hydrogen
- Payment arrangements
- Gas quality requirements
- Safety requirements for connection/injection of hydrogen
- Safety requirements regarding end-user equipment

Electricity Grid Issues – electrolyser connection

Legal framework - Hydrogen production via e-grid connected electrolysis requires open and fair grid access. **EU Legislation** framework impacting grid access has been introduced via three 'energy packages:

- Directive 96/92/EC (subsequently revoked by the third Directive as below) was based on Directive 96/92/EC (concerned common rules for the internal market in electricity, promoted the independence of the transmission system operator, and laid down the rules relating to the organisation and functioning of, and access to, the wholesale electricity market);
- Directive 2003/54/EC, (also subsequently revoked by the third Directive as below) was based on Directive 2003/54/EC (concerning common rules for the internal market in electricity (Electricity Directive)), focused on the concepts of unbundling and third-party network access); and
- The third energy package comprised two Directives (Directive 2009/72/EC and Directive 2009/73/EC) and three Regulations (Regulation (EC) No 714/2009; 715/2009 and 713/2009) to further open up the gas and electricity markets in the European Union with the separation of companies' generation and sale operations from their transmission networks (and thereby independent distribution networks). It also provided for the establishment of a National Regulatory Authority (NRA) for each Member State and for the Agency for the Cooperation of Energy Regulators (ACER) which provides a forum for NRAs to work together;
- Complemented by Commission Regulation 2016/1388 for establishing a **network code on demand connection** – giving the legal basis for regulatory authorities to ensure that objective and non-discriminatory technical rules would establish minimum technical design and operational requirements for the connection to the grid system. It came into force on 7th September 2016 as binding and directly applicable in all Member States

Electricity & Gas Grid Issues – electrolyser connection

Legal framework – UK moved early on the opening and unbundling of electricity and gas markets to promote competition

- Electricity Act 1989 set out the overall framework for public supply and reorganisation of the electricity industry. Note that Scotland has separate, parallel arrangements adn that nuclear power was assigned to a separate (public) company to operate in the generation sector. CHAPTER 29 - to provide for electricity market supply and to make new provision with respect to the supply of electricity through electric lines and the generation and transmission of electricty through networks and connections to those networks
- Utilities Act 2000 provided for the establishment and functions of the Gas and Electricity Markets Authority and the Gas and Electricity Consumer Council; to amend the legislation regulating the gas and electricity industries; and for connected purposes
- Gas and Electricity (Internal Markets) Regulations 2011 update to the DCUSA for the UK to reflect the modifications made to the standard conditions of the electricity distribution licences following implementation of the third energy package - Distribution Connection and Use of System Agreement (DCUSA) DCP110: Electricity and Gas (Internal Markets) – the DCUSA. provides a single centralised document that relates to the connection to and use of the distribution networks and is a contract between generation distributors and suppliers in Great Britain

Electricity Grid Issues – electrolyser connection

Assessment

- Electrolyser connection arranged via the relevant licensed electricity Distribution Network Operator (DNO) where the electrolyser is connected
- Common steps apply and the procedure is overseen – in the context of 'access fairness' and transparent pricing by the UK regulatory authority – the Office for Gas & Electricity Market (OFGEM)
- The typical HyLaw experience is that there was no significant difference in connecting an electrolyser to the e-grid as for any other industrial or similar load

Recommendations

- For the UK, no specific recommendations to be made
- More widely, the HyLaw recommendations is that the operational framework for electrolyser plant connection, installation and operation under existing legal code and regulatory frameworks needs clarification, coherence and consistency in approach, procedures and time/cost terms

Electricity Grid Issues – Power to Gas plant

Assessment

- An electrolyser based PtG facility would typically include an electrolyser directly connected to the e-grid or directly connected to a renewable energy system (wind, solar) to draw electricity for electrolyser operation (installed examples have a power consumption for the electrolyser of around 3-400 kW) to generate hydrogen. The hydrogen can be temporarily stored and then supplied to fuel cells, ICE turbines or other power-electric generation system, or injected into the gas grid.)
- The current EC legal framework has no provision for P2G systems under either e-grid or gas grid common rules for grid and market access (along with transmission, distribution, and supply arrangements) and no Partner Member State (including the more advanced regulatory frameworks implemented in Germany, France and Austria) has an established and coherent regulatory approach to P2G systems.
- The HyLaw assessment is that where PtG operations do take place across Partner Member States it is 'by exception' or under a delineated / time specified demonstration programme, which requires a unique set of arrangements and negotiations across multiple regulatory and safety agencies and e-grid / gas grid network operators for permission to connect / operate. Otherwise, formal PtG operation is simply not permitted as an integrated system.
- While there is no clear and unequivocal legal position for PtG facilities recognized across both e-grid and gas grid networks, PtG systems face a regulatory gap and a substantive barrier to PtG technology deployment

Electricity Grid Issues – PtG load balancing

Assessment

- An electrolyser based Power to Gas (P2G) plant could potentially operate to provide ancillary services and specifically for e-grid demand side load balancing ancillary services required to enable the integrity and stability of the transmission or distribution system, as well as the power quality (frequency and voltage), to be maintained within set network limits and which would typically be part of regulated (mandatory) network requirement. There are three recognized ancillary services, for which payment might be applicable to the P2G operator:
    - automatic Frequency Restoration Reserves (aFRR) - to enable the exchange of balancing energy from frequency restoration reserves and replacement reserves;
    - balancing energy from frequency restoration reserves with manual activation (mFRR);
    - frequency containment reserves (FCR)
- UK Electrolyser operation is in principle covered, specifically the turn down aspect of electrolyser operation (Demand Side Response)
- More generally, an electrolyser based P2G plant could provide a balancing service to 'switch-on' the electrolyser when the network has excess power (using electricity to generate hydrogen); and to generate power (using stored hydrogen or SNG) when the grid has less power than needed to maintain load/frequency. This would necessarily exclude Primary Reserve provision (typically for large scale generators) and mainly cover Secondary Reserve provision – but a legal definition and system performance envelope is needed

Electricity Grid Issues – PtG load balancing

Recommendation

- Electricity grid connection for electrolysers is understood and covered under most legal frameworks. Recognition of the basis for the provision of ancillary services via electrolysers is blurred, not well understood (on a technical and operational basis) and, in the hyLaw experience, interpreted differently across Partner states, such that electrolysers are mostly recognized as relevant technologies for ancillary services but not in PtG configuration.
- The lack of legal recognition of PtG systems flows through to permitting and siting arrangements for PtG associated hydrogen storage, with significant variations of treatment that would be applied, including the UK. This constrains the formulation of a coherent policy framework to support deployment through financial or other measures – even to avoid the potential for double charging of taxes and fees (only DE has measures to avoid double charging from gas and electricity networks and gives priority in gas network access by legally treating hydrogen and synthetic methane as biogas).
- Participation in ancillary services requires a minimum scale and early programmes may be sub-economic; a supportive legal framework is needed to encourage and sustain scale-up at the local, regional and national level
- To ensure wider utilization of electrolysers and PtG plant in the provision of ancillary services it is essential that the operational framework and technical capabilities (and merits) are harmonized and more coherently framed and should meet all applicable EC regulatory frameworks – and similarly for the UK

Gas Grid Issues

Legal framework

It is increasingly recognized that the injection of hydrogen from renewable sources in the natural gas network would effectively enhance the transport and storage capacities of the existing gas network infrastructure for indirect electricity transport, for energy storage and for meeting decarbonisation targets.

There are however widely varying national approaches to managing natural gas composition for safety purposes (in transport, storage and in use by gas appliances) along with controls / provision for connecting hydrogen injection facilities

- European national gas grids and transmission/distribution networks have been liberalized and opened to market competition over the past 20+ years. Directive 2009/73/EC) and three Regulations (Regulation (EC) No 714/2009; 715/2009 and 713/2009) provides for access to gas markets and clear procedures applicable to granting authorisation for transmission, distribution, supply and storage of natural gas, including LNG.
- This does not immediately carry over to allowing network access for hydrogen injection and the process chain for PtG is more legally complex and there is no clear and unequivocal legal position for PtG, leading to a diversity of approaches to recognition of PtG plant and hydrogen injection at legally acceptable levels. While the legal framework has specific transmission level and distribution level Directives and Regulations, there is no specific coverage that regulates H2 injection that applies at either level across the EU and within the UK

Gas Grid Issues

Legal framework UK

The UK regulatory framework is set via

- **Gas Act** 1996 (Privatisation and unbundling of the gas industry; limiting the market power of British Gas; extending competition to industrial and domestic markets to obtain benefits of competition in terms of market entry and in benefits to customers)
- **Gas Safety Management Regulations** 1996 (The GSMR sets the UK gas quality specification and the Wobbe index (WI) range appropriate for the UK, including a 0.1%vol H2 concentration limit)
- **Pipeline Safety Regulations** 1996 (Enacted ahead of EC Directives covering gas grids and safety requirements such as ATEX and subsequently updated in line with ATEX Directive 2014/34/EU)
- **Utilities Act 2000** (Provided for the establishment and functions of the Gas and Electricity Markets Authority and the Gas and Electricity Consumer Council; to amend the legislation regulating the gas and electricity industries; and for connected purposes – subsequently to become the Office For Gas & Electricity Markets (OFGEM) as the sector Regulator)

Gas Grid Issues

Assessment

- Regulatory frameworks have typically been drawn up around **natural gas** and network safety and operational procedures are managed at the national level with the TSO & DSO obliged to meet **national** technical and safety body requirements for operational infrastructure (pipelines, compression, valves and junctions, etc.) which have been configured and maintained over time to a specific gas quality standard (based on calorific value / Wobbe Index);
- Adding hydrogen, renewable or otherwise, to the gas stream would change the calorific value of the gas and thereby the basis for delivering gas under contract to major users or into distribution networks and require differing flow monitoring / measurement equipment and/or revisions to regulated national gas transmission pricing and payment terms – and may constrain international gas flow arrangements
- There are widely varying national limits for hydrogen concentrations in the gas grid, set either by primary legislation or in accordance with long standing safety standards or/and gas quality standards. These limits range from a 'minimal' background concentrations of hydrogen at 0.1%vol and up to 'high' concentrations of 6% or up to a maximum of 10%.vol.
- No gas network allows for 100% hydrogen in pipeline flows (100% H2 must be blended down to acceptable levels)
- Within HyLaw, some Partner MS have no specific concentration level set for hydrogen (BL, DK, BU, RO, ES) and/or follow locally stipulated safety requirements which would typically proscribe low H2 concentrations in the natural gas stream

Gas Grid Issues

Assessment

- Even where injection of hydrogen is permitted, there is a diversity of arrangements as to whether the injection level can be at 100% H2 (as in DE) or must be blended down to the acceptable gas quality / composition prior to injection
- There are no requirements formally in place now for amending hydrogen thresholds to meet energy sector de-carbonisation objectives (although RED II will cover gas networks)
- Initiatives to validate gas grid operation with significantly higher hydrogen thresholds are though being trialed (DE, FR, I, NL & UK) but there is no apparent coherence as to how these are being configured and if/how common technical, safety and regulatory issues are being addressed to define a wider 'safe and practical basis' for adoption across the EU. This should be a priority to ensure a 'level playing field' for P2G deployment and avoidance of local barriers to P2G services.
- There is no formal, clear and coherent payment framework in place across Partner MSs for hydrogen transmission, covering connection fees and charges, or covering remuneration for hydrogen supplied/injected
- While there are no pricing principles in place for otherwise regulated gas networks, and in particular for a level of clarity on valorization of hydrogen rich gas flows (up to and beyond the current highest limit of 10%vol H2), then P2G systems have no business case justification basis and may not proceed beyond demonstration projects.

Gas Grid Issues

Assessment

- There is considerable diversity across Partner MSs in their approach to, and with no clear framework for, grid connection arrangements for hydrogen connection facilities and the cost attribution thereof between different involved parties, although Germany provides a potential template for a supportive payment framework where Hydrogen and SNG are already included in the definition of biogas in Energy Industry Act, subject to the condition that they primarily originate from renewable energy sources, so that the payment privileges/incentives are applicable only for the injection of renewable hydrogen, and the share of costs for gas grid connection follows a defined arrangement between the (PtG) operator and network entity
- There is no body of experience on **safety issues** and additional requirements for injecting hydrogen rich gasses into the gas grid. P2G is still a relatively new approach and of the 27 P2G projects currently underway (http://europeanpowertogas.com/projects-in-europe), most are mainly at the proof of concept and technical / operational / safety assessment stage
- Higher hydrogen compositions may require modification to, or replacement of, **end-user gas equipment** which had initially been designed for operation with conventional natural gas and the calorific value and flame and heat characteristics of the natural gas spectrum
- From a **regulatory perspective**, the Gas Appliance Directive (EU Gas Appliances Directive 90/396/EEC) and subsequently the Gas Appliance Regulations ((EU) 2016/426), covers all industrial and consumer appliances. The GAD/GAR defines (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 are safe. It 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

Gas Grid Issues

Recommendations

- A coordinated EU wide review of the **safety and technical integrity** limitations for hydrogen connection and injection into the gas grid needs to be linked with a review of the current regulatory framework shaping gas grid operations and pathways to enhanced hydrogen utilization.
- This should be linked with current national initiatives to validate gas grid operation with significantly higher hydrogen thresholds that are being trialed (DE, FR, NL & UK) and where there is no apparent coherence as to how these are being configured across common technical, safety and regulatory issues, to **define a wider 'safe and practical basis' for regulatory framework adoption** and network implementation, nationally for the UK, and across the EU
- A coordinated review of **HNG measurement and administrative requirements** across EU Member States is needed to identify a coherent basis **for modified billing arrangements** for hydrogen – which would take account of the differing calorific value of hydrogen blends and potentially pure hydrogen in the gas grid. Arrangements for bio-gas that have recently been established and cover real time measurement, monitoring and reporting arrangements may provide a template for a carry-across to hydrogen / H2NG mixtures and should be considered for amendment and adoption by regulators
- Establish a coordinated review of hydrogen gas **safety requirements** across EC Member States to identify 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

Gas Grid Issues

Recommendations

- For end-user **gas appliance equipment**: there is no clear position on the threshold at which overall appliance design and individual component changes will need to be made to gas appliances at different concentration levels and varying legal code strategies could be applied (limit the hydrogen concentration at a specific point, eg 10vol.% or within a Wobbe index range and no change to GAR) or allow a transition to much higher hydrogen concentrations and require changes under the GAR to H2 tolerant gas appliances)
- An EU wide assessment is essential covering both the acceptable safety and operational threshold of current generation end-user appliances by main category (domestic, commercial, industrial) for higher levels of hydrogen in the gas stream in conjunction with a status quo supply chain assessment of economic impact if modifications are needed in certain categories of end-user equipment. This should be coordinated with the national initiatives underway to validate gas grid operation with significantly higher hydrogen thresholds that are being trialed (DE, FR, NL & UK) and where the impact on gas appliances is also assessed.
- **CNG vehicles and CNG refueling stations**: an EU wide assessment is needed to identify and assess the impact and implications of increased hydrogen levels in the gas stream and, as necessary, to identify a cost-effective alternative to gas quality modification at CNG vehicle re-fueling sites or/and for CNG cylinder specification and technical note revision. This needs also to be validated for the UK

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