Evidence to Business, Energy and Industrial Strategy Committee Inquiry: Carbon Capture, Usage and Storage: Supplementary

2 November 2018, Prof S Haszeldine, Scottish Carbon Capture & Storage,

Key points: RAB business models, gas networks, transport pipe re-use and decommissioning

1. Creating clusters of CO2 transport to storage was recommended by the CCUS Task Force.
2. Transport through pipe infrastructure is recommended to be operated by RAB (regulated asset base) methods.
3. It is unclear to existing gas network operators, that they have the remit to invest in such RAB.
4. It is unclear to hydrocarbon companies that they wish to enter into a RAB.
5. Is Government able to *clarify and enable who has the legitimacy and authority to create a new CCS RAB and how this will be achieved?*
6. One demand for CO2 storage services which is potentially very large, is the production of hydrogen from methane. This will depend on the ability to sell hydrogen into the UK gas distribution network. But for any hydrogen to be placed in the distribution network, it is necessary for standards of gas content to be altered. These are the GSMR (Gas Safety Management Regulations) Schedule 3 (1996). This change is considered by many to need Parliamentary time, rather than being in the control of Ofgem. What action is Government taking to enable this, before gas networks decide in 2019 on investment plans for their next 5 year budget period? *A delay will dis-able gas networks from being hydrogen customers, and customers for CCS.*
7. The cost of developing CO2 transport can be reduced by re-use of existing pipes.
8. A decommissioning process operates offshore to remove unwanted pipes.
9. It is apparent that the novel re-use of pipes, re-purposed from gas and oil to CO2 transport, or as hydrogen stores, is not adequately considered in decommissioning.
10. Government needs to, urgently, create a method by which oil company (or onshore) pipe owners can transfer ownership of selected identified pipes to a holding organisation, which can keep pipework for 5 to 15 years, until CCS developments emerge.
11. The benefit of pipeline re-use rather than rip-out for Acorn CCS project, is a cost saving of £150 Million, reducing the price of a £450M project to a £300M project.
12. Similar benefits are probable to occur with additional offshore pipes in Scotland, East England, and North West England. The OGA (oil and gas authority) appears to give re-use an extremely low priority, meaning that *public finances will bear extra charges.*
13. The CCUSTF recommended Clusters as a geographic approach to CCS, with a business disconnect between Capture operators and Transport and Storage operators. Criteria for Clusters were suggested in the CCUSTF Report, but BEIS have not yet confirmed that these criteria can inform the choices of which regional clusters are ready to undertake further

design, costing, and lead to development. An Answer to this question will enable CCUS developers to undertake speculative work assessing a region to be suitable for CCS development. *Can BEIS confirm that the Cluster criteria identified in the CCUSTF report are valid, and will form the basis of regions being able to progress, simply by ensuring that they meet the identified criteria ? Whats missing in the business*

In the larger sense of "business model" there is a lot of attention by Government on reducing costs. But *very little attention on creating value*. If a value can be placed on CO2 stored, then the CCS business will rapidly emerge. The value needs to be durable, and investable. This can be driven by simple Government regulations. Examples of potential regulation in the control of Government are:

• Lower carbon content standards in methane gas networks - encouraging hydrogen substitution;

• Procurement mandates for low-carbon concrete used in public-funded construction - encouraging creation of low carbon cement;

• Targeted carbon pricing on selected economic activity, to nudge user change (as with coal at power plant);

• A *Certificate awarded free to each tonne of carbon*, with a mandate to store a percentage of each tonne mandated by Government. This may start at 0.25% of each tonne, effectively invisible to a single user. This creates a demand for CO2 storage across the whole economy, so that all industries share the burden. The CO2 Certificates are discharged by payment to a Transport and Storage Operator who aggregates across the UK economy, sufficient to create and operate a CCS transport and storage RAB, initially at 1 Million tonnes per year; rising through time with Government mandate.

What actions is BEIS taking to create markets which will incentivise profitable storage of CO2?

SCCS briefing

Gas pipe Standards, Gas Safety Management Regulations and Hydrogen Blending,

Requested Evidence to Business, Energy And Industrial Strategy Committee Inquiry: Carbon Capture, Usage and Storage

16 November 2018, Professor Stuart Haszeldine, Scottish Carbon Capture & Storage,

1 Summary

Gas networks carry the majority of UK energy supply. These can be readily converted from methane to hydrogen, pilot projects and works are underway, with safety as the primary criterion. However a regulatory blockage is that the GSMR (Gas Safety Management Regulations) set in 1996 are extremely restrictive on variation of UK gas supply. Less than 0.1% hydrogen can be incorporated into UK gas supply, so that existing pilot tests can only be undertaken on limited isolated networks. Coupled with this, charging of customers is currently by calorific value of a gas based on a flow weighted average in a very small number of billing zones within the UK (specified within the Control of Thermal Energy Regulations, CoTER. There are only 13 zones. Scotland for example is one zone, which requires all gas sources into that network to be enriched or deriched to the prevailing gas quality for the entire zone. This methodology has to change to allow blending of Hydrogen into the network. Both these key pieces of out-dated legislation will block demonstrations and rollout of hydrogen blending or conversion. And so will block decarbonisation progress. Funds for hydrogen blending and conversion should be included in the control period bids by gas networks, which will become settled in late 2019, for 2021-26 spending. GSMR and CoTER regulations can only be altered by Government, the Health and Safety Executive and Ofgem respectively. That needs Government action. Guarantee of GSMR and CoTER changes will enable investment to be agreed by Boards of gas networks. Both GSMR and CoTER are on the decarbonisation critical path to adoption of Hydrogen as an energy carrier through the existing gas infrastructure, be it through blending or full conversion.

2 Gas and Heat

Heat energy supply to industry and especially domestic users in the UK is provided by natural gas through pipe networks. The gas is transported long distances by high pressure large diameter pipes; this Transmission network is dominantly owned and operated by National Grid and sometimes by regional gas providers. Gas is then

distributed regionally by intermediate (<7bar) and medium (<2bar) pressure pipes, owned and operated by regional gas networks, some of these pipes are iron, and will need replaced. Gas is distributed locally by a low pressure network (less than 75 mbar) owned and operated by regional gas networks. The low pressure network was formerly a mix of pipework, with some iron mains dating from pre 1900. The iron mains risk reduction programme (IMRRP) has been funded by the Regulated Assets and in each control period budgets for more capital expenditure. During the years since 2000, the replacement of iron mains by polyethlyene pipes is believed to be the UK's largest civil engineering programme. This network carries the great majority of UK energy at any one time, typically four times the energy transmitted through electricity networks. And at times of peak demand the gas network ramps up or down in supply at rates which the electricity network cannot match - even with closely controlled dispatchable power plants (of which 42% power capacity typically is produced by gas burning, fed by the high pressure gas grid). And at times of peak load, such as the Beast from the East in March 2018, the domestic gas network supplied 6 times more energy than the electricity network.

UK energy supply can be considered as gas volume, storage and flux management, with a much smaller amount of useful electricity operating lights, appliances, and a small amount of heat.

3 Pipes replacement

The purpose of Iron Mains replacement, has been driven by safety, to eliminate leakages of natural gas from the network into buildings and property. By chance, it appears that these polyethylene yellow pipes are also potentially suitable to carry up to 100% hydrogen. Hence a powerful case is made that conversion of the gas pipe network from natural gas to hydrogen can benefit from £ tens Billion of sunk costs in an existing infrastructure. An analogy can be made with the conversion of the towns gas system in the 1960's to 1970's, which converted more than 10million households over a 10 year period. The proposition to convert from methane to hydrogen is expected to take longer, because more residences are involved, with public more cautious about giving agreement, and with tighter safety standards to demonstrate and meet. This should not be viewed as "simple" because detailed records from gas networks show that different vintages of pipework and valves and joints may need selective spot replacement.

Testing and development since 2014 has shown the gas network operators, that it is feasible to convert the low pressure network and its customers from natural gas to hydrogen. Safety is the overwhelming criterion. This work is now investable by gas network Boards, but needs to be permitted and incentivised.

4 Regulation blockages

However a critical problem has emerged. The content of gas though UK public networks is tightly controlled by a specified mix of substances and by energy values (Wobbe Number). The regulation is Schedule 3 of GS(M)R 1996 which sets the gas quality requirements <https://www.legislation.gov.uk/uksi/1996/551/contents/made>.

This regulation is set by Secretary of State dating from the era of British Gas, and not by Ofgem, as regulator of the gas supply industry. The content of hydrogen must be equal to or less than 0.1%, and the Wobbe number must lie 47.2 to 51.41 Mjoules/m^3. This derives from the specification of North Sea gas, which gradually displaced towns gas from mid 1960's to mid 1970's. Now in 2018, less than half of UK piped gas is from the UK North Sea, and the composition of gas from the different fields from the North Sea has more variation than ever. Different sources of natural gas with other combustible gases are available from imports, and from renewable sources and biomass, or different low carbon hydrogen sources. These are essential to include if the gas network is to be converted to lower carbon. Widening and adapting the GSMR specification will enable a flexible mix of gases to be used, which reduces cost for consumers and opens up the gas market to new sources. To change the GSMR requires action by the HSE, which requires permission from central Government, because of the way GSMR was legislated. There is a need to devolve power and responsibility for control of specification to the Institution of Gas Engineers and managers (IGEM).

Schedule 3 of GSMR is a barrier to facilitating change to a lower carbon economy. The regulation can be circumvented by special application to the regulator for exemption. But this requires, time, money and opportunity cost. Since early 2016, a "Gas Quality Standard" working group has met with BEIS (DECC), Ofgem and HSE, funded by the NIA Network Innovation Allowance from the regulated assets. The project website is < https://www.igem.org.uk/technical-standards/working-groups/gas-quality.aspx>. The proposal is that GSMR be amended, retaining the duty of compliance for gas conveyor companies and that the gas quality specification be transferred to a new IGEM standard, with oversight by HSE. There is also a requirement to change legislation, because charging of customers will need to be by energy value of the gas mix, not by simple volume of a single gas as now. To quote Carbon Connect July 2018 *" research is being undertaken to establish the volume of hydrogen that could be safely blended - possibly up to 20% by volume (equivalent to 6-7% of energy) - with no change to existing infrastructure. This will, however require changes in regulation and consumer pricing to pay by energy density rather than gas flow, as currently "* <https://www.igem.org.uk/media/579698/futuregasseriespart2theproductionoflowcarbongasweb.pdf>

The conversion of domestic dwellings to a different gas mix has been investigated from 2014 by a completed practical conversion of >1100 households in Oban, which is a town sized network, not on the UK mains supply, and with a mix of customers and socio-economics statistically representative of the larger UK. Here LNG tankered in is blended to supply gas, and so requires a different gas quality mix <https://www.sgn.co.uk/Oban/> This has identified the regulatory issues and methods for their resolution. Conversion was subsequently rolled out to 3 other mainland independent undertakings, and has now supplied some 8000 customers for 5 years with a wider range of gas and with a rolling exemption.

An example of a blocked project is Aberdeen Vision. This project is looking at St Fergus as a strategic location for Hydrogen blending to feed across the UK, because 35% of gas now enters the UK, mostly from Norway, through St Fergus, resulting in a proposal to feed 2% hydrogen into the UK gas transmission grid and blend up to 20% into the distribution network based on the Hydeploy Project <http://www.smarternetworks.org/project/nia_sgn0134>. This project intends to gain low cost hydrogen from Steam Methane Reforming of methane, which would remove CO2 to storage via the ACORN CCS project at St Fergus in NE Scotland.