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SCCS

The Production of Low Carbon Gas – Consultation Response

SCCS response to the Carbon Connect consultation on the production of low carbon gas

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1 Scottish Carbon Capture and Storage

Scottish Carbon Capture & Storage (SCCS) is a research partnership of the British Geological Survey, Heriot-Watt University, University of Aberdeen, the University of Edinburgh and the University of Strathclyde. SCCS researchers are engaged in innovative applied research and joint projects with industry and Government to support the development and commercialisation of carbon capture and storage (CCS) as a climate change mitigation technology.

As the role of CCS in decarbonising gas for heat supply is primarily its ability to enable low carbon hydrogen production, SCCS's response to the Carbon Connect's consultation on the future of gas[1] focuses on hydrogen and not biogas or bioSNG. However, it is worth noting that the application of CCS to biogas production could enable negative emissions, which are important in the context of the Paris Agreement ambition to reach net zero emissions.

2 General enquiry questions

2.1 What opportunities and benefits are offered by the use of low carbon gas as a route to decarbonise heat supply? What are the potential costs and problems associated with using low carbon gas?

There is a growing body of evidence to demonstrate that low carbon gas can provide a more cost-effective option than full electrification for decarbonisation of the UK's heat supply.

Around £3.8 billion was invested in the GB gas networks (Totex) between 2010 to 2014[2], primarily on upgrading the gas distribution network to polyethylene. However, analysis by the UK Energy Research Centre (UKERC) has concluded that, in order to meet the UK's 2050 climate targets, gas consumption without CCS must be phased out over the energy system over the next 35 years and removed almost entirely by 2050[3]. Repurposing the newly upgraded gas distribution network to low carbon hydrogen would provide a decarbonisation pathway for the heating sector and prevent the infrastructure from becoming a "stranded asset" in a decarbonised economy. Furthermore, a 2016 study by KPMG concluded that the cost of a fully electrified heating system could be up to three times the amount of repurposing the existing gas grid, due to the need to decommission gas infrastructure and significantly reinforce electricity networks. This could amount to an additional cost to the consumer of over £200bn to 2050[4].

Biogas, bioSNG and hydrogen could all be used in a decarbonised gas system. However, as the Energy Research Partnership points out, more needs to be understood about the availability of feedstock for bioenergy as demand from other sectors could restrict its use at scale for heat[5].

[1] http://www.policyconnect.org.uk/cc/future-gas-series-part-2-production-low-carbon-gas
[2] Delivering UK Energy Investment: Networks, DECC.
[3] The future role of natural gas in the UK (UKERC 2016)
[4] KPMG, 2050 Energy Scenarios: The UK Gas Networks role in a 2050 whole energy system, 2016
[5] Energy Research Partnership, The Transition to Low-Carbon Heat, 2017

Hydrogen production from natural gas through steam methane reforming (SMR) is well established. Furthermore, the Air Products SMR at Port Arthur, Texas[6] has demonstrated successful commercial-scale CCS on an SMR. Currently, this is the most readily available and cost-effective route to producing low carbon hydrogen at scale[7].

One issue that will need to be resolved regardless of the option taken to decarbonise heat is public perception. Any solution will be more expensive than the use of unabated natural gas, which accounts for 80% domestic heating in the UK. Communicating the need to move to a decarbonised heat source and clarity of the cost associated with each option will be key. Ultimately, any increase in unit cost will need to be countered by energy efficiency measures, both for buildings and appliances, that can limit impact on overall bills.

2.2 What policy levers are available to Government to guide the decarbonisation of heat; why and how could they be used to support the increased use of low carbon gas?

We understand that the Government is currently undertaking a Heat Strategic Options Review that will produce a report in 2018. The review aims to enable Government to make a "strategic decision" on decarbonising heat by the early 2020s.

It is clear from the £25 million the Government has committed to its Hydrogen for Heat Programme that the hydrogen is being considered as a serious option to decarbonise domestic and industrial heat in the UK. As outlined above, steam methane reforming with CCS is the most promising method for the cost-effective production of low-carbon hydrogen at scale for the foreseeable future. If cost-effective low-carbon hydrogen is to be used at a large scale in the 2020s and 2030s, access to CO_2 storage must be guaranteed.

Through the Clean Growth Strategy the Government has restated its commitment to deploying carbon capture, utilisation and storage (CCUS) in the UK subject to sufficient cost reduction. A substantial programme of work is being undertaken within Government to enable a deployment pathway to be published by the end of 2018. This pathway will need to take into account potential volume demand for CO_2 storage from hydrogen production, and must ensure that CO_2 transport and storage infrastructure is in place to allow for low carbon hydrogen production in the correct timeframe.

One way to reduce the cost of CCS would be to re-purpose existing oil and gas pipelines for CO_2 transport, rather than build new ones. For example, it has been estimated that repurposing the Atlantic and Cromarty pipeline to transport CO_2 to the Captain X storage site beneath the UK North Sea (as part of the Acorn project, which is currently undergoing a feasibility study) would save the project £100 million compared to building a new pipeline[8]. However, current policy around oil and gas decommissioning does not sufficiently support this, and instead allows decommissioning to go ahead where pipelines have the potential to be reused. The Government could introduce a presumption that pipelines be preserved for re-use, unless it can be demonstrated that there is no potential for this.

Pilot schemes will need to test the use of 100% hydrogen in groups of households. In these areas, Government could use planning powers and buildings standards to require new houses to be built "hydrogen-ready"; it could also use public procurement powers to drive investment in hydrogen-ready systems in public buildings. In the shorter term, blending of low carbon hydrogen into the natural gas network at small volumes (6% by energy; 20% by volume) is possible without any changes to appliances and would enable a market to be created. New standards would need to be created for higher hydrogen blends.

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[6] https://www.globalccsinstitute.com/projects/air-products-steam-methane-reformer-eor-project
[7] Zero Emissions Platform, Commercial Scale Feasibility of Clean Hydrogen, 2017
[8] Pale Blue Dot & Axis Well Technology, Captain X Site Storage Development Plan, March 2016

2.3 What should the different roles be for national and local government in managing the decarbonisation of heat and the use of low carbon gas? Are there other organisations that will need to play a key role?

While central government has a role in ensuring that heat decarbonisation is achieved in line with the UK's legally binding climate change targets, there will likely be a strong regional role in defining solutions depending on geography and demographics.

There are several nascent projects in the UK that are located in areas of heavy industrial activity, which could form CCS "clusters" based around shared CO_2 transport and storage infrastructure. These include the Caledonia Clean Energy Project, in Grangemouth, which is considering flexible hydrogen supply, power and CCS; Liverpool-Manchester Hydrogen Cluster proposed by Cadent Gas, which is looking at producing low carbon hydrogen for industry and heat combined with CCS; the Teesside Collective proposal for an industrial cluster including capturing and storing CO_2 from existing steam methane reformers; and the H21 Leeds City Gate project.

In order for CO_2 storage to be accessible to a range of emitters, it is now widely accepted that there is a need for shared transport and storage infrastructure. This was proposed in the form of a state-owned "T&S Co" by the Parliamentary Advisory Group on CCS in 2016[9]; other models could take the form of a public private partnership or a Regulated Asset Base[10]. The CCUS Cost Challenge Task Force will provide recommendations on business models as part of its report to Government in July.

While infrastructure and strategic issues will be the responsibility of central government, local government will have an important role to play in supporting the roll-out of decarbonised heat and low carbon gas through planning, and through making its own estate (both public buildings and social housing) available as a heat or low carbon gas customer.

Where householders are required to make changes to accommodate low carbon gas – either through purchasing new appliances, or having existing appliances adjusted – local government will have a key role in making this happen, as it has done in area-based schemes to provide energy efficiency measures, such as insulation. This should include awareness raising and communications to encourage householders to take part, and to allay any concerns; acting as a trusted broker to coordinate and co-fund works across a geographical area; and identifying hard-to-reach households to ensure full coverage.

2.4 How can low carbon gas best be employed across the whole energy system, especially with regard to storage potential?

Low carbon hydrogen could play a unique role in a decarbonised energy system as it can be used as an energy carrier for power, heat, transport and as a feedstock for industrial processes. The ability to store hydrogen in a similar way to natural gas, i.e. in salt caverns or depleted gas fields, means that hydrogen could enable seasonal and long-term energy storage in the way natural gas does now.

The Zero Emissions Platform (ZEP) demonstrated in its 2017 report on hydrogen that producing hydrogen at scale through SMR and CCS would enable a market for low carbon hydrogen, which could also incorporate hydrogen derived from renewable energy through electrolysis later on[11].

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[9] http://www.ccsassociation.org/news-and-events/reports-and-publications/parliamentary-advisory-group-on-ccs-report/

[10] Pale Blue Dot, CO_2 Transportation and Storage Business Models Summary Report, 2018

[11] Commercial Scale Feasibility of Clean Hydrogen", Zero Emissions Platform , 2017

2.5 How should a potential transition to the use of low carbon gas to provide heat be funded? Are there any particular costs or savings associated with the use of low carbon gas to provide heat? How does this compare to other solutions?

All decarbonised heat options are likely to cost more than unabated natural gas. However, the use of decarbonised gas for heat does help to overcome a significant cost associated with having to build excess electricity generation to meet winter peak heat demand, which, as outlined above, could mean a saving of £200bn to 2050.

A key consideration will be communicating widely the need to decarbonise domestic heat, the options available and the associated costs to the public to enable widespread acceptance, whether funding comes from consumer bills or general taxation. It will be important to offset any cost to the consumer with greater energy efficiency measures, which are also crucial for meeting climate targets.

2.6 What lessons could be learnt from other large-scale infrastructure programmes, such as the transition from town to natural gas, the introduction of combi boilers, the digital switchover, the iron mains replacement programme, or the rollout of smart meters

There will be two main elements to the move to low carbon gas: changes in gas production and distribution at the national or regional infrastructure scale (including the need for CCS infrastructure to support hydrogen production); and uptake at the individual level, be that households, businesses, the public sector or industry. The former element can be driven by regulation and incentives – as, to an extent, can uptake by industry, business and the public sector – but uptake by individuals will require a different approach that cannot assume “rational” economic decision-making.

Fully replacing natural gas with hydrogen would require household appliances to be replaced[12] or adjusted. This is comparable to the switch from town gas to natural gas several decades ago but may be more difficult to achieve in a modern consumer-driven society. Households are accustomed to having choice – albeit “nudged” by incentives and marketing campaigns – and there will always be some that refuse to participate, which means that Government would need to consider compulsion, which may be politically unpalatable.

There are parallels with the digital switchover, which had a nationwide marketing campaign, working with local partners to communicate with hard-to-reach groups[13]. Likewise, area-based schemes to provide home insulation and other energy efficiency measures provide parallels. However, the switching off of the analogue TV signal could safely be carried out on time, even if not every household had moved to digital. This could not be the case with a move to hydrogen: the price of not engaging with the digital switchover was the inconvenience of losing the television signal, whereas the price of not converting appliances for hydrogen would be a risk to personal safety.

3 The production of low carbon gas questions

3.1 What different ways are there to make (i) biomethane; (ii) bioSNG; (iii) hydrogen; and what are their relative advantages and challenges?

Hydrogen allows for full decarbonisation of heating. The production of large-scale biomethane and bioSNG will eventually lead an increased use of land to provide the feedstock, which may lead to

[12] http://www.policyconnect.org.uk/cc/sites/site_cc/files/report/676/fieldreportdownload/nextstepsforthegasgridweb.pdf

[13] Case study here: https://www.campaignlive.co.uk/article/case-study-digital-switchover/891095

competition with food production and nature conservation (not necessarily in the UK if the bio-feedstock is imported).

3.2 How can these methods be improved and encouraged to maturity?

Hydrogen boilers and cookers could be rolled out in local heating networks, isolated from the grids, to evaluate distribution and end-consumer usage. This would allow lessons to be learned on hydrogen demand, the potential for short-term storage within the distribution network and the impact of production swings on end users.

3.3 How affordable and practical are the different methods of producing low carbon gas at scale?

Hydrogen is currently produced at scale through steam methane reforming of natural gas. This process captures CO_2 as a by-product that is usually vented to atmosphere, but could equally be stored, enabling low carbon hydrogen production.

Establishing a market for low carbon hydrogen would enable further innovation to take place. One potential example is producing hydrogen from natural gas through autothermal reforming (ATR); another is electrolysis using renewable electricity. While electrolysis is currently much more expensive than SMR and CCS, and would require large amounts of excess renewable energy to enable production at scale, in future the two methods of generation could work complementarily[14], although the economics of only using a hydrogen production asset at times of peak renewable electricity generation would need to be overcome.

3.4 Where could and should low carbon gas production be located?

As discussed throughout this response, large-scale production of low carbon hydrogen will require CCS. The Government's Clean Growth Strategy highlighted four areas of industrial activity, which could form CCS "clusters" with shared CO_2 transport and storage infrastructure based on their geographic location. These are Grangemouth, South Wales, Teesside, and Merseyside[15]. Yorkshire & the Humber is another potential "cluster" location.

The Government could choose to import hydrogen, but this would mean opportunities for job and wealth creation associated with the production of low-carbon hydrogen would be lost from the UK.

3.5 What are the next steps required to develop and deploy CCUS technology and infrastructure for use with low carbon gas in the UK?

The Department for Business, Energy and Industrial Strategy (BEIS) is currently conducting a Heat Strategic Options Review. For hydrogen to be selected as the preferred route for decarbonisation of heat policy, the availability of supporting CO_2 transport and storage infrastructure must be guaranteed and this will require decisions to be taken within the current Parliament.

By providing clear policy signals, support for early projects and clusters to progress with feasibility/FEED studies, and collaborating with stakeholders around the commercial model and policy/regulatory framework, the UK Government can provide the confidence needed to drive investment in CCS infrastructure.

SCCS supports the Government's intention to publish a deployment pathway for CCUS by the end of 2018; however, greater definition on the intended volume of CO_2 stored and timeline to achieve this is

[14] Zero Emissions Platform, Commercial Scale Feasibility of Clean Hydrogen, 2017
[15] UK Government, Clean Growth Strategy, 2017

needed. The development of a full-chain CCS project in the power sector can take between seven to 10 years – and we assume the development timescale for a hydrogen project would be similar – but could be significantly reduced by a stable policy framework.

For the first CCS projects to come online in the mid-2020s, and for the technology to be available at scale in the 2030s, significant progress on existing and new CCS projects will be required within this Parliament. This timeline is backed up by the Committee on Climate Change, who have proposed that, in order to capture the estimated 19 million tonnes of CO_2 per year required by 2035, CCS capture contracts need to be awarded by 2020, covering a mixture of industry applications, power and, potentially, hydrogen production, alongside a separate approach to CO_2 transport and storage infrastructure development[16].

The timely development of appropriately sized CO_2 transport and storage infrastructure will be a critical factor in developing a UK CCS industry, with opportunities for emitters to access cost-effective CO_2 infrastructure on commercial terms in the longer term. Initially, the appropriate distribution of cost and risk between Government and the private sector on CO_2 storage must be resolved. Potential business models for transport and storage are set out in a report commissioned by Government and published in January 2018[17]; these options will be further explored by the Government and Cost Challenge Task Force over the coming months.

In the absence of a sufficiently high carbon price, a support mechanism will also be needed to incentivise CO_2 capture and/or production of low carbon products.

4 Further information

SCCS is happy to provide further information in support of this submission. Please contact Rebecca Bell, Policy and Research Officer, on rebecca.bell@sccs.org.uk or 0131 651 4647.

[16] Decarbonisation of Power Sector report ahead of 5th Carbon Budget (CCC, 2015)
[17] Pale Blue Dot, 2018