

SSAC Hydrogen Briefing Note - Opportunities and challenges associated with hydrogen's role in the delivery of future energy systems in the context of a Just Transition

SSAC ENERGY PROJECT

ROUNDTABLE PROGRAMME

TUESDAY 5TH JULY 2022
10.30-12.30

10.30-10.40	Welcome and aims of the day Technical challenges with the sourcing, storage and supply of hydrogen	Professor John Underhill - SSAC Project Lead (Chair)
10.40-10.50	Socio-economic questions about hydrogen as an energy vector	Professor Jan Webb, University of Edinburgh
10.50-11.05	Policy Overview followed by Q&A	Anthony Kinsella, Scottish Government (SG)
11.05-11.15	Q & A	Chaired by Professor Underhill
11:15-11:55	<p>Breakout Groups</p> <p>Attendees will be split into two breakout groups – both looking at a set of five questions outlined below.</p> <p>Breakout Group 1 to address Q1-3 and complete 4-5 if time allows. Breakout Group 2 to address Q3-5 and complete 1-2 if time allows.</p> <p>Q1. What are the key messages to communicate in the near future to the general public about possible roles for hydrogen in the energy mix? (e.g. safety/ cost/ environmental benefits?)</p> <p>Q2. What reassurance can be given? (e.g. presumably cost is uncertain but re safety? Is there evidence?)</p> <p>Q3. What are the major infrastructure changes that would be required to incorporate hydrogen into the energy mix for a) heating b) transport and c) storage and what is a rough timescale for achieving those between start of investment and delivery?</p> <p>Q4 Who do you regard as the key users for hydrogen in the near future, and why? How do you expect hydrogen price to influence demand? If</p>	

	there is a public subsidy for hydrogen users, how should that be paid for?	
	Q5. What can SG do to stimulate investment?	
11:55-12:25	Plenary and summing up	Professor Jan Webb
12:25-12:30	Next Steps and thanks	Scottish Government & Professor Maggie Gill

List of participants at virtual Roundtable

Kevin Mallin	Heat Vault and Geolorn Ltd
Audrey Maclver	Highland and Islands Enterprise
Barbara Whiting	SGN
Roddy Wilson	SSE
David Evans	Offshore Energy UK
Dr Jamie Stewart	University of Strathclyde
Ally Scott	SGN
Oonagh O'Grady	SSE
Frazer Scott	Energy Action Scotland
Harry Bradbury	Imaginatives Group
Gioia Falcone	University of Glasgow
Kirsten Gardner	SGN
Dr Graeme Hawker	University of Strathclyde
Jim McOrmish	SP Energy Networks
Erin Law	Forth Ports
Helen Melone	Scottish Renewables
Stew Horne	EST Scotland
Ann Loughrey	Fuel Poverty Panel
Irina Bonavino	Scottish Enterprise
Dr Carlos Fernandez	Robert Gordon University
Tom Baxter	University of Aberdeen
Mike Robinson	Royal Scottish Geological Society
Elizabeth Leighton	Existing Homes Alliance

Grant Spence	Costain
Professor John Irvine, St Andrews University	Professor John Irvine, St Andrews University
Dr Alfonso Martinez-Felipe, University of Aberdeen	Dr Alfonso Martinez-Felipe, University of Aberdeen

Summary of Breakout group answers to questions

Notes from Breakout Groups:

Q1. What are the key messages to communicate in the near future to the general public about possible roles for hydrogen in the energy mix? (e.g. safety/ cost/ environmental benefits?)

- General awareness was highlighted to be key to create confidence and engagement within communities. There was a general feeling that this is not happening on hydrogen to a large scale. Some speakers asked for more transparency on the scale of the changes needed.
- The H100 project at Fife is a good practice to explain to future hydrogen users (beyond the technical aspects). In related to domestic heat, the debate may vary case by case.
- There were concerns about sequencing the information to different stakeholders, in line with the progress of the supply chain (e.g., there is no actual market yet, hence the message could be lost for companies if it gets too early). Equally, all actors need to be prepared. This means that we need to identify early customers/users at this stage.
- Messages should highlight benefits on jobs creation, industry transition, etc.
- Need to know what's in it for everyone
- SGN H100 trial is looking at customer acceptance – insights beyond health and safety
- Customers don't understand the options to decarbonise their heating system, need education on hydrogen specifically
- Most customers are on gas heating so don't need to make transformational changes
- What are the principles of 'how' we communicate?
- How do we ensure transparency?
- How do we think about how the communication impacts on the customer?
- Early use customers are likely to help set the scene (e.g. industry etc)
- Success story of renewable generation can be used
- Need to be clear on specific uses, cost benefits, safety implications. Not a solution forever.
- Industry will be first consumer – can work out the kinks before going to the public
- Need to avoid communicating too early. Communicating prior to knowing the full opportunity is a risk. Start planning early, communicate at the right time.
- Q1 & 4 dovetail together – we need to be clear on priorities for hydrogen and its uses, it seems that it is very questionable about how wide an application

hydrogen will have on domestic heating. Therefore, we need to take it off the table to remove the uncertainty for consumers so they know their pathway for decarbonisation.

- Heat is arguably the most challenging issue we have because of huge variation in demand (winter vs summer). A key conclusion is you wouldn't choose to electrify heat in totality which would require a huge amount of infrastructure which would be underutilised: even with a high electrification solution we were relooking at retaining all of the gas grid, having it less utilised and using hybrid boilers. Infrastructure requirements need to be considered as well as price and technology, and this is hard to accurately estimate. Whilst Catapult energy model scenario tools are useful, they are simplified representations and are not as accurate as the tools the transmission and distribution companies use.
- Disagrees with what we have just heard – show him the evidence; he feels that influential organisations are pushing hydrogen to their own benefit, but not for consumers. Two fundamental questions for consumers: is it safe and how much will it cost? He doesn't see the evidence coming forward of safety and cost.
- Regarding costs, we do not know how much it will cost to electrify, but H21 project gives some ideas for hydrogen which was holistic. Wales & West work will be published, which is a joined-up engineering analysis. Not easy to understand what algorithms Catapult were using.
- While we don't have numbers, we can say for sure that blue hydrogen will cost more than natural gas.
- The best bit of evidence is the National Grid energy scenarios which look across the gas and electricity networks. He disputes the fact that all electrification is not possible, it is;
- SG needs to look at what pathways are possible and then talk to Ofgem and networks about how it's possible and managed. Regarding a highly decentralised grid, there is huge potential in Scotland for local balancing to manage the high demands of heat, making electrification possible. Future energy scenarios provide a really good starting point for this; last year ones said that hydrogen heating homes would only be possible from 2035 onwards, which is not a good timetable for SG targets. Can we wait for hydrogen, which might be 5 years late? Sequencing is therefore very important. Regarding costs: costs are actually well known, we do know the costs of electrification, we do know the costs of electrolysis, which is not good for 20 years, but improves after 2050, which further emphasises sequencing.
- There are uncertainties with all new technologies. The thing we need to look at is what is going to be happening in 30-50 years? We need initial investment, so we need to ask if it is going to be viable or not?
- Concerns around heating make sense because of efficiency and end user concerns, it leaves space to forget about the main uses of hydrogen from a high efficiency point of view, which is decarbonisation heavy industry in substituting grey hydrogen, so the decarbonisation agenda should still be emphasised. Export opportunities, could this be used to decarbonise industry abroad? As public sector we have to be vector agnostic, so the public respond better to this than a partial view.

- Prioritising hydrogen; thinking about where the highest impact on hydrogen will be. ESO modelling is the best evidence across the industry, there is a lot of things which come out of it which do not go into the report. There is stuff missing in the FES regarding operability and practical constraints; nobody is asking what they are not telling people – how do we operate at a fully renewable electricity system? This hasn't been done. There is a real risk of an inoperable grid in 15 years – this isn't being talked about publicly. This is advice that needs to be taken into account by SG.

Q2. What reassurance can be given? (e.g. presumably cost is uncertain but re safety? Is there evidence?)

- Safety seems to be the greatest concern from general audience (i.e., major incidents in the past). Current projects should be emphasised as examples of safe practises (H100, hydrogen stations – Aberdeen H2 buses).
- Cost was also an area of concern, for end-users but also industries. It is important to go beyond the LCoF, and see the overall system integration (i.e., costs of all energy sources/vectors). There was also a comment to reflect the high energy density of hydrogen vs cost, i.e., it will be profitable at some point (looking into the rest of costs)
- It is really important to avoid energy poverty, and make sure no one is left behind (some sectors/areas will be more difficult to abate/connect in a H2 economy: installation of domestic heat? These customers must also benefit from the Energy transition)
- Some speakers mentioned that it would be important to look at other sectors/business that had to start from “scratch” (offshore wind?).
- General audience education in some technical aspects is paramount to help customers/communities make informed decisions.
- H2 is as safe as natural gas, need to communicate that risk and educate people on their heating system
- People don't know that their systems produce emissions
- People aren't as aware natural gas is dangerous because it has been in their homes for so long
- The infrastructure, financing and business models will allow us to bring down the LCOE, and reassure customers of future costs
- Infrastructure costs for network are being shared now through RAB model
- Look to offshore wind as point of evidence of how costs will come down with scale
- Cost of hydrogen is relatively high now, but the energy density is high so the costs will come down
- The cost of system interplay is more important than siloing costs, consider the implications
- Timing for delivery of hydrogen SGN projects is based around 2030 Scotland targets
- SGN will change to hydrogen ready gas network
Customer evidence from H100 starting to arrive from Q1/Q2 2023

Q3. What are the major infrastructure changes that would be required to incorporate hydrogen into the energy mix for a) heating, b) transport and c) storage and what is a rough timescale for achieving those between start of investment and delivery?

- There were some reflections on how tight time is to implement some 2030 targets. Some speakers mentioned there was “decoupling” between policy prepared by Government(s) and actual projects running.
- SGN working to replace old gas pipelines with poly(ethylene) in some locations (due to safety revision?), which would be 100% applicable for H2 (targeting 2032).
- Infrastructure installation will depend on scale and (energy) source, and it is key to promote collaboration.
- There was a comment on changing the billing model: “We will need a change to billing and customer infrastructure as well as physical infrastructure.”
- Referencing the NE cluster report, which sets out a roadmap for hydrogen transition. This roadmap is high level – but from a heat perspective the transition relies on decisions made by BEIS to enable progress in Scotland’s transition and for decarbonisation targets to be hit from a gas perspective.
- For 100% hydrogen – there would be some early input, but the approach would be a major shift on a sectoral basis – this would be the best way to prep the network to switch over in a number of weeks, however, this is ambitious and relies on resilience and supply factors.
- BEIS decisions certainly an issue; they are also reliant on market solutions in this context. We have noticed a number of technical challenges about the existing gas network during a changeover, so upgrades to existing infrastructure may be needed.
- Our team is looking at end-to-end process, e.g. including leakage, water shortages in Scotland, suitability of existing network and so on, there is a need to check if current network can run hydrogen or if upgrades are needed, which is all part of ongoing work, esp. with NGN because of our integrated system – important that there is a joined up approach. An evidence base is being gathered by BEIS, and the goal is to be as prepared as possible by the time that they make a decision so we can hit the ground running rather than having to scramble
- There is a huge amount of complexity to deal with around the hydrogen question, we need to step back and think about our wider approach to this. For example around public engagement – it is premature to think the public is informed enough; and there are far too many uncertainties around storage, reliability, the energy input required for desalination, there will be huge resource and upscaling challenges. For example there is not large enough electrolyser production to support this at the moment. Need much larger capacity production internationally for this technology to work for us to reach hydrogen economy.
- Hydrogen is not a panacea, and heat is the wrong place to start, would be better placed to use starting off in heavy transport and industry instead if we are going to use it – the jury is still out regarding its practical application in other areas. There is not enough joined up thinking about how it would

actually be implemented and used, e.g. questions about storage, desalination and so on. More analysis is needed on this area.

- Yes it is important that we focus on the highest value industry such as transport potentially
- We are in early days of hydrogen so we are all just putting ideas out there for consideration. There is no cure all – but the UKG is coming out with their hydrogen business model and we are just looking to start talking about the future of hydrogen. With regards to storage; a possible solution is using a singular depleted gas field which would have capacity
- Regarding transport; there is concern from hauliers of the challenges of hydrogen, any refuelling network would have to be really consistent across country for it to work as an alternative
- Need to differentiate between new and existing infrastructure, clarity needed. We need to be transparent with public about how it will be used, and potential environmental impact. Also issues like leakage has a cost that must be factored in, and there will be more competition in renewables market e.g. CCUS requires huge amounts, this will be a costly issue and these challenges must be communicated. There must be a realistic roadmap of commercially available infrastructure so SG can plan more effectively
- Risk hydrogen will get pushed to edge of system and not be mainstreamed
- Scotland risks outsourcing the supply chain, like with initial wind industry. Green jobs should be a priority.
- Significant Electricity network changes needed to support electrolysis
- It does fit with 2030 targets
- Needs case is required for the infrastructure which considers the users and the production
- Storage is going to be vital for infrastructure
- Production at scale will need port and vessel infrastructure

Q4. Who do you regard as the key users for hydrogen in the near future, and why? How do you expect hydrogen price to influence demand? If there is a public subsidy for hydrogen users, how should that be paid for?

- Hydrogen first movers and hard to decarbonise sectors, and smaller areas of the economy should be involved – e.g. agriculture, forestry, marine vessels, should be approached and involved. Smaller scale things aren't often given the option but should be provided option of hydrogen. Gas – to – hydrogen is a huge challenge, but what about smaller systems? Need to match demand and supply.
- Contamination and dispersion, CCUS etc – technology must be scaled up gradually, hydrogen storage for example must be demonstrated...
- Public subsidy should be directed at the most cost effective pathway to get to net-zero and eradicate fuel poverty – some investment and trials in home heating is not well spent. There are a lot of studies which indicate it will be more expensive for consumers than heat pumps, so it is not cost effective and is a distraction. For example, the Fife project: what will happen to the consumers if they are left on hydrogen and it will cost them more than if they get heat pumps?

- This is about prioritisation, where exactly is hydrogen needed, and to which degree is it a good use of money?
- Agreement on this; we have studies that cannot be checked or challenged and have people promoting things in isolation without comparing alternatives. We are not properly doing the engineering for the whole system, and until we do we don't know if any of these strongly held opinions are correct or not: we need people to run the numbers and work it out, but are a long way away from this.
- Industry, marine, aviation etc. are not the main carbon emitters in Scotland, it is heat and transport, so we need to get after the fabric of our houses and move over to electric vehicles. The distraction of marine, aviation and heavy industry is a distraction and not big-ticket issues.
- High level cost/benefit analysis of different vectors should allow us to reach our targets better

Q5. What can Scottish Government do to stimulate investment?

- Lots of emphasis on supply but not demand, need to be clear there are lots of "off-takers" and there needs to be a clear roadmap for this – who needs it, what for, and how long?
- Localised production of green hydrogen could be helpful, policy decisions could be made to draw energy from other areas for this system. Investment would be difficult re: large-scale international investment due to significant competition, Scotland would struggle to compete (larger competitors e.g. USA and South Korea, and geographical constraints of supply); so low export potential. We need to focus on specifics of how industries will actually use hydrogen