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Report summary: Assessment and mapping of the high-potential areas for the use of hydrogen for heat in buildings in Scotland

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This paper summarises findings from research to map areas with high potential for future hydrogen production and, subsequently, areas with a domestic and non-domestic building stock that has high technical suitability to use hydrogen for heating. It identifies nine 'High Potential Areas' (HPAs) in Scotland deemed most able to produce low or zero carbon hydrogen in the near future.

Given the number of hydrogen production projects already in development in Scotland, it would be expected that some areas have clear potential to be using hydrogen for heat before 2030[1].

By identifying areas with both hydrogen production potential and a high density of domestic and non-domestic properties technically suitable for adopting hydrogen for heating, the outputs from this project could be used to estimate the scale of the potential demand for hydrogen for heat that might be anticipated by 2030.

1 Project context and aims

1.1 Policy context

The Scottish Government's Climate Change Plan[2] envelope for buildings requires over a million on-gas homes to convert to zero emissions heat over the next eight years, and for emissions from homes and buildings to fall by 68% from 2020-2030.

Whilst the long-term future of gas remains uncertain, emissions reductions can be achieved in some part with gas blending. Decisions on gas blending, up to 20% by volume, will be taken by the UK Government by the end of 2023[3].

Similarly, the use of 100% hydrogen in heating our homes is dependent on strategic decisions by the UK Government on the future of the gas grid that will not be made before 2026, as firm evidence on safety, feasibility, and cost becomes available.

[1] CXC (2022). *Cost reduction pathways of green hydrogen production in Scotland.* URL: https://www.climatexchange.org.uk/research/projects/cost-reduction-pathways-of-green-hydrogen-production-in-scotland/

[2] Scottish Government (2020). *Securing a green recovery on a path to net zero: climate change plan 2018–2032 – update*. URL: https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/ https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/

[3] BEIS (2022). *Hydrogen sector development action plan.* URL: https://www.gov.uk/government/publications/hydrogen-sector-development-action-plan

1.2 Research aim

This project seeks to identify areas in Scotland that have high potential for using low and zero carbon hydrogen[4] for heat by mapping areas with high potential for future hydrogen production and areas with a domestic and non-domestic building stock that has high technical suitability to use hydrogen for heating. This work has been commissioned given:

- The need to rapidly decarbonise energy systems including heat in buildings which will likely require a range of technologies, including hydrogen.
- The need to continue to build an evidence base for using hydrogen for heat. This project seeks to contribute to this activity by determining areas in Scotland with high potential to produce and utilise hydrogen for heat.
- The deployment of hydrogen for heating is likely to be geography specific in the near-term due to production resources, existing infrastructure, and industrial demand patterns.
- The Scottish Government's Heat in Buildings Strategy includes a commitment to identifying areas most likely to have access to low or zero carbon hydrogen in the future.

2 Methodology

The research sought to correlate hydrogen production and supply potential with the suitability of properties to accept hydrogen, to provide useful evidence for decision makers and to support policy and planning. To do this, we applied a simple two-step approach, as illustrated in Figure 1.

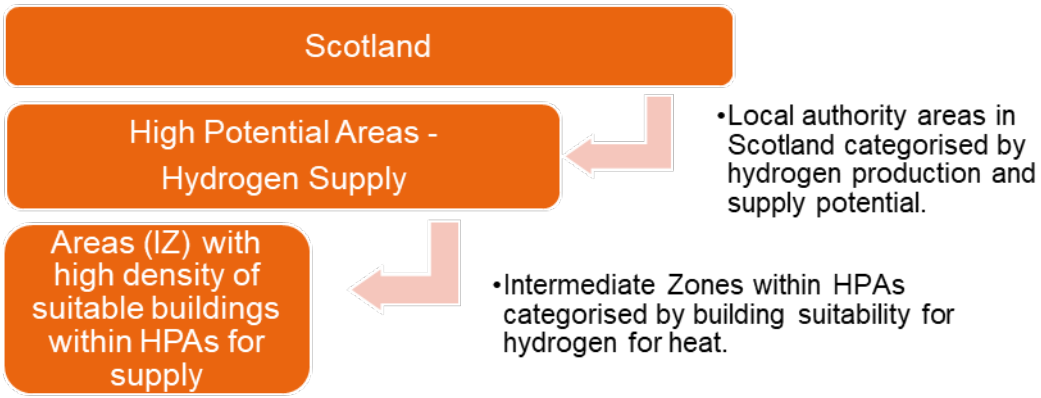


Figure 1: Supply-side and Property Suitability Modelling Approach

To determine the suitability for both hydrogen production (supply assessment) and utilisation (property suitability), we collated a variety of data and assumptions,

[4] i.e. hydrogen produced via renewable-powered electrolysis or carbon-capture enabled natural gas reformation

categorised these data according to a ‘suitability logic’ via decision trees, and then undertook the GIS analysis and mapping exercises (see Figure 2).

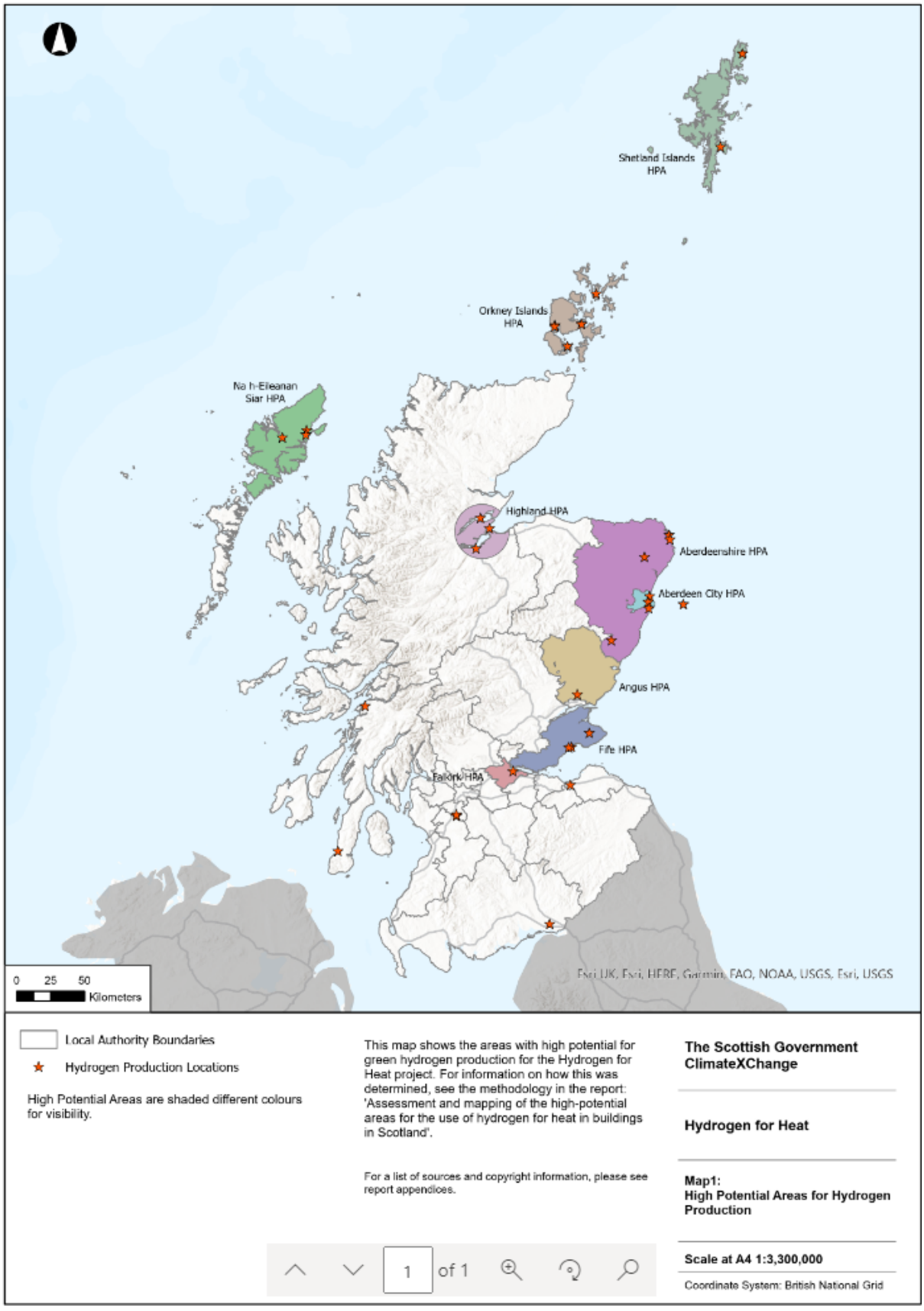
Figure 2: Project Stages

The information used within the analysis was gathered through a combination of literature review of data from 2021 and stakeholder interviews held in early 2022.

3 Findings

The outputs of the analysis have separately identified areas in Scotland where green and blue hydrogen can best be produced based on a range of assumed criteria, datasets retrieved for assessment, and stakeholder discussions. We have sought to address such factors as local renewable energy resources, access to feedstock, and the presence of existing or planned renewable and hydrogen projects.

Subsequently, the project has identified nine ‘High Potential Areas’ (HPAs), as illustrated in Map 1 overleaf, in Scotland deemed most able to produce low or zero carbon hydrogen in the near future (i.e. potential first movers). These are Aberdeen City, Aberdeenshire, Angus, Falkirk, Fife, an area of the Highlands, an area of Na h-Eileanan Siar, the Orkney Islands, and the Shetland Islands.



These HPAs all host at least one existing or planned hydrogen production project, indicating that the corresponding local authorities all have some experience and capability to support future hydrogen developments. Many of the proposed projects in these areas are at significant scale, which would support these areas playing a key role in hydrogen production in 2030 (the target date set by this project).

The results of the Orkney and Shetland local authority areas show that, although they have been found to be HPAs for hydrogen production, the technical suitability of their domestic and non-domestic properties to use hydrogen for heating is low.[5] This is because neither the Orkney nor Shetland Islands host any gas grids. As such, the Orkney and Shetland Islands were discounted from further investigation.

We have delved into each of the remaining HPAs and undertaken assessments of the suitability of domestic and non-domestic properties in these areas to accept 100% hydrogen for heating. This has allowed us to link areas of high hydrogen production potential to potential heat demand centres. We have found that, of the seven remaining HPAs, the majority have favourable percentages of domestic and non-domestic properties with high technical suitability. These are as follows:

1. Aberdeen City 43.7%
2. Aberdeenshire 48.2%
3. Angus 53.6%
4. Falkirk 63.7%
5. Fife 66.2%
6. Highland 54.6%
7. Na h-Eileanan Siar 12.1%

See Annex B for further results.

4 Recommendations

- Socialise the method and results with local authorities and canvas their views on whether they agree with the findings. Determine whether this work is useful in their economic and spatial planning, Local Heat and Energy Efficiency Strategies (LHEES) development, and other strategic work on the net zero and energy transition.
- Include this and similar work as a resource for local authorities in the guidance for LHEES creation.
- The ability to utilise hydrogen in the heat sector will support the building of a hydrogen demand base in Scotland. Given the number of hydrogen production projects already in development in Scotland, it would be expected that some areas have clear potential to be using hydrogen for heat before 2030. This expansion in production could see a decrease in the price of hydrogen to where it may be competitive in the heating sector. A ClimateXChange project investigating cost pathways provides useful insights[6].
- By identifying the areas of the greatest density of domestic and non-domestic properties in Scotland technically suitable to implement hydrogen for heating, the outputs from this project could be used to estimate the scale of the potential demand for hydrogen for heat that might be anticipated by 2030.
- Further analysis could convert this aggregate demand for hydrogen to a potential energy load to be met by hydrogen suppliers, thus allowing stakeholders and policymakers to assess how current targets and ambitions for low and zero carbon hydrogen production (e.g., the 5 GW and 25 GW of renewable and low-carbon hydrogen production capacity by 2030 and 2045, respectively) align with this potential demand.

[5] Technical suitability was assessed on the basis of criteria set out in Annex A.
[6] CXC (2022). *Cost reduction pathways of green hydrogen production in Scotland.* URL: https://www.climatexchange.org.uk/research/projects/cost-reduction-pathways-of-green-hydrogen-production-in-scotland/

Annex A Technical Suitability Criteria

***Table 1*: Domestic categorisation for technical suitability –** Category A and B properties are deemed highly suitable based on their distance to the gas grid and that property type having a safety case.

Category	Distance to gas grid	Property type	Main fuel type	Main heating system
A	On gas grid	Fits Hy4Heat safety case	Mains gas	Wet/boiler heating system
B	Near gas grid (<23m)[7]	Fits Hy4Heat safety case	Any fuel type, except alternative low carbon fuel	Any heating system, except alternative low carbon heating system
C	Distance to gas grid < 2km	Any property type, except multi-occupancy buildings	Any fuel type, except alternative low carbon fuel	Any heating system, except alternative low carbon heating system
D	Long distance from gas grid	Large multi-occupancy buildings	Alternative fuel type	Alternative low carbon heating system

***Table 2*: Non-Domestic categorisation for technical suitability –** Category A, B and C properties are deemed highly suitable based on their distance to the gas grid.

Category	Distance to gas grid	Main heating system	Main fuel type	Multiple units
A	On gas grid	Wet/boiler heating system	Mains gas	Single premise
B	On gas grid	Wet/boiler heating system	Mains gas	Multiple units
C	Near gas grid (<100m)[8]	Any heating system, except heat pump	Any	Any
D	Distance to gas grid between 100m and 20 km	Any heating system, except heat pump	Any	Any
E	Long distance from gas grid (>20km)	Alternative low carbon heating system	Any	Any

[7] Any properties < 23m from gas grid were considered to be in a gas grid area and simpler to connect to gas grid. This is the same assumption as used in ParkPower Green Heat in Greenspaces project, in which off gas properties were classified as being > 23 m from the gas grid.
[8] To calculate 'Near gas grid', the existing gas network was mapped against the centroid of the non-domestic properties. This analysis is limited by the lack of information on Independent Gas Transporters (IGTs). Additionally, using the building centroid may not give an accurate distance.

Annex B Summary of Property Suitability by HPA

***Table 3*: Percent of properties that are highly suitable for hydrogen for heat**

High Potential Area	Combined domestic and non-domestic	Domestic	Non-domestic
Aberdeen City	43.7	42.1	66.6
Aberdeenshire	48.2	48.9	41.2
Angus	53.6	53.9	50.6
Falkirk	63.7	62.9	77.1
Fife	66.2	65.9	69.3
Highland	54.6	54.3	59.1
Na h-Eileanan Siar (Western Isles)	12.1	9.2	32.2

***Table 4*: Number of properties that are highly suitable for hydrogen for heat**

High Potential Area	Combined domestic and non-domestic	Domestic	Non-domestic
Aberdeen City	57,388	51,708	5,680
Aberdeenshire	63,824	59,060	4,764
Angus	35,433	32,185	3,248
Falkirk	51,727	48,420	3,307
Fife	131,283	121,014	10,269
Highland	35,117	32,221	2,896
Na h-Eileanan Siar (Western Isles)	1,660	1,100	560

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