

Summary - Scotland's Net Zero Roadmap (SNZR)

Net Zero

Scotland's Net Zero Roadmap (SNZR) will be an important part of our efforts to tackle climate change, by helping Scotland's industry reduce its greenhouse gas emissions and contribute to the target of net-zero emissions by 2045 in Scotland and 2050 in the UK as a whole. The most common greenhouse gas is carbon dioxide (CO₂), of which Scottish industry emits around 11.9 megatonnes (Mt) annually – 28% of the country's total emissions. SNZR will help industries to find a way to reduce the amount of CO₂ they produce and prevent what can't be avoided reaching the atmosphere using carbon capture and utilisation or storage (CCUS).

Overall, what might SNZR look like?

We estimate that **4 million tonnes of CO₂** could be captured and stored in Scotland **per year** from the mid-2020s - just over a third of current industrial emissions and a massive increase from essentially zero CCUS at present. SNZR will ultimately allow different industry sectors across the whole of Scotland to identify the optimal decarbonisation strategy for them, ensuring that each remains competitive in the global market and supporting the just transition of the workforce and local communities to a net zero economy. Combining CCUS with electrification and other replacements for fossil fuels, the roadmap is expected to deliver a resilient infrastructure that will connect into other decarbonisation efforts across the rest of the UK and Europe.

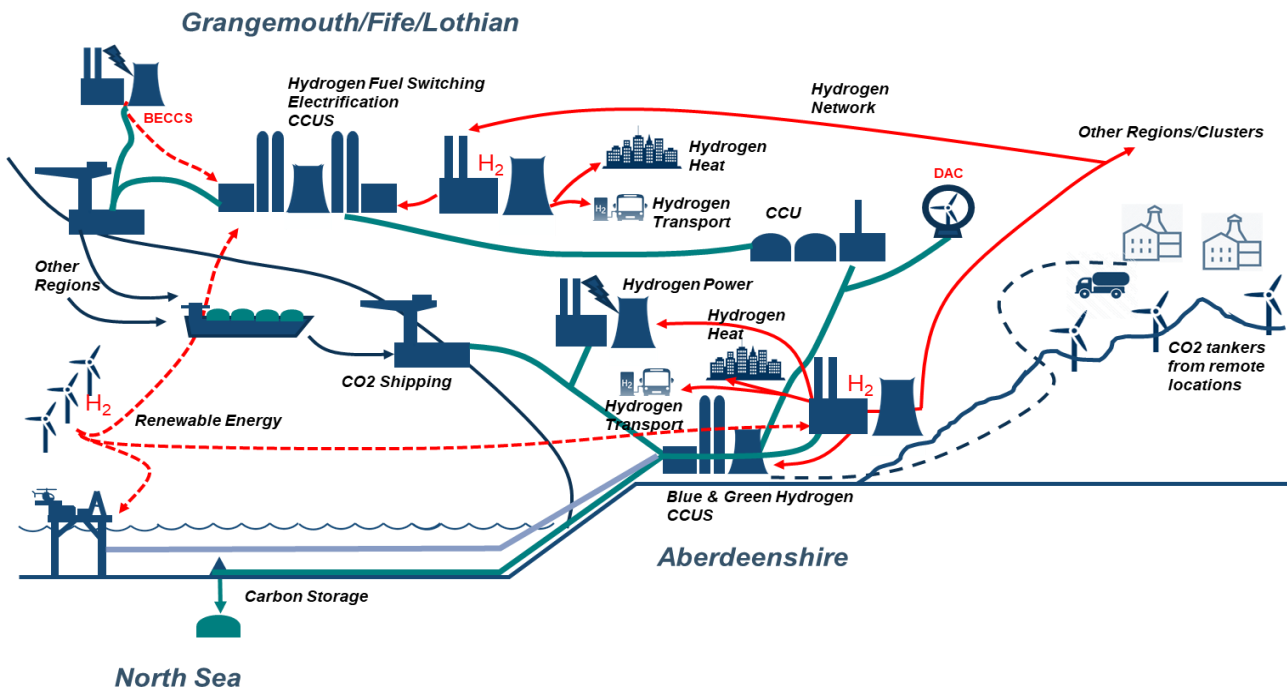


Figure 1: A Net Zero Scottish Industrial Cluster Connected to other Regions and Clusters

Greenhouse Gases

The emission of greenhouse gases (GHG) into the atmosphere is the primary cause of climate change. GHG include carbon dioxide (CO₂), methane and nitrous oxides, mainly produced from transport, energy supply,

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agriculture, manufacturing and the built environment¹. CO₂ accounts for over 80% of UK greenhouse gas emissions, and considerable effort is being devoted to reducing or removing CO₂ emissions. However, for some sectors, including manufacturing, it will not be possible to avoid CO₂ emissions in the short-term; so the means of capturing and either using or storing these emissions needs to be developed, thus preventing their release to the atmosphere.

A Roadmap to Industrial Decarbonisation – SNZR

In this context, Innovate UK has established an Industrial Decarbonisation Challenge Fund. This is supporting initiatives across six UK regions to develop roadmaps for the decarbonisation of industrial clusters. Scotland's Net Zero Roadmap (SNZR) is one of these, and has received funding for initial work (Phase 1) to understand the scale of industrial CO₂ emissions in Scotland, the options to address these, the barriers to their implementation and the appetite for industry to adopt solutions. Phase 1 took place between April and July 2020 and it has designed the approach for Phase 2, when the actual roadmap will be developed.

Why do we need a Roadmap?

The UK needs industrial decarbonisation roadmaps to ensure that it maintains a competitive manufacturing industry that can thrive in a net-zero future. While there can be similarities between clusters of industry, each industrial region of the UK has its own unique qualities. Each roadmap will include a number of actions and identify those responsible for their delivery. Interim targets towards 2045 and 2050 will also be identified that take account of a number of decarbonisation options, allowing Government and others to measure progress and take early corrective action if necessary and also share success stories and best practices that can be implemented across other regions.

Where are Scotland's Industrial Emissions?

In 2018, greenhouse gas emissions in Scotland were the net equivalent of 41.6 million tonnes of CO₂². Of these, 11.9 million tonnes of CO₂ were emitted by industry. The SNZR team mapped these emissions and found that around 80% lie within a corridor highlighted in blue on the map, which covers Lothian in the South, through Grangemouth (3.8 million tonnes) in the Central Belt to St Fergus (2.3 million tonnes) in the North East of Scotland. It is these emissions that SNZR is focusing on.

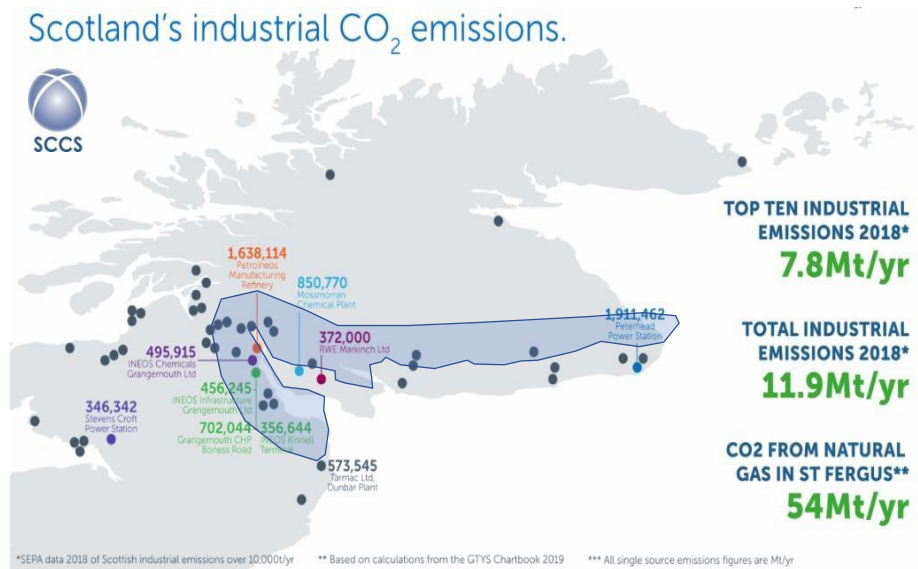


Figure 2: Geographic Scope of the Core Scottish Cluster

¹ The vast majority of methane and nitrous oxide emissions come from agriculture and waste management
² This figure takes account of any CO₂ 'sinks' such as tree planting

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What Needs to be Addressed?

SNZR needs to understand the perspectives of industrial emitters to be confident of success. With this in mind, an extensive consultation was undertaken during phase 1. This consultation identified five factors that the roadmap would need to consider in its development:

1. More defined Government fiscal and regulatory policies; so that industry can develop viable financial and business models
2. Integrated flexible fuel and energy solutions and efficiency gains that take account of different development timelines and the rate of adoption in different sectors
3. Granularity of information at a local level to allow emitters to understand the options available to them
4. Availability of a range of decarbonisation options to allow each emitter to develop their own optimum decarbonisation strategy
5. Provision of a range of decarbonising projects across Scotland (Project Acorn³ being only one of these)

Industry emitters and stakeholders identified that poorly defined Government policy was by far the most important barrier to industrial decarbonisation, as shown in Figure 2.

However, it was also clear that a number of different technical solutions would need to be developed and their viability in different settings determined. In this regard, carbon capture and storage (CCS) was seen as more important than carbon capture and utilisation (CCU), but was closely followed by hydrogen fuel switching and electrification, as shown in Figure 3.

SNZR identified a number of different technology options that are at various stages of commercialisation but could be implemented during the roadmap for industrial decarbonisation in Scotland (Figure 4).

How important are the following to realising SNZR?

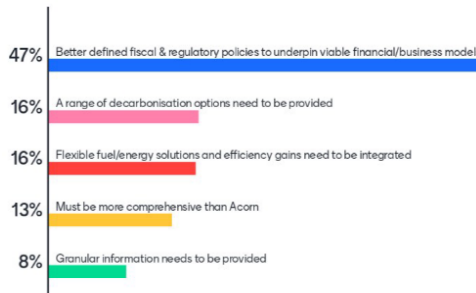


Figure 3: Key Factors in Delivering SNZR According to Stakeholders

Which technology pathway/s would help meet your organisation's Net-zero objectives?

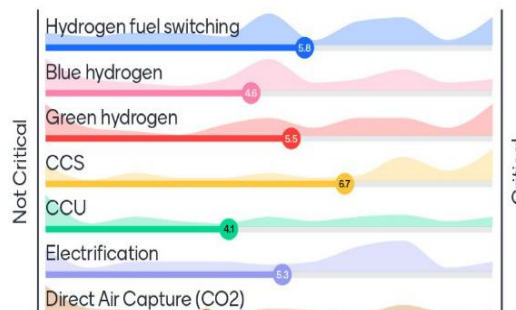


Figure 4: Technology Prioritisation

³ Project Acorn will be the UK's first large scale carbon capture and storage (CCS). It intends to repurpose existing onshore and offshore gas pipelines and disused North Sea oil and gas fields for the transport and storage of CO₂

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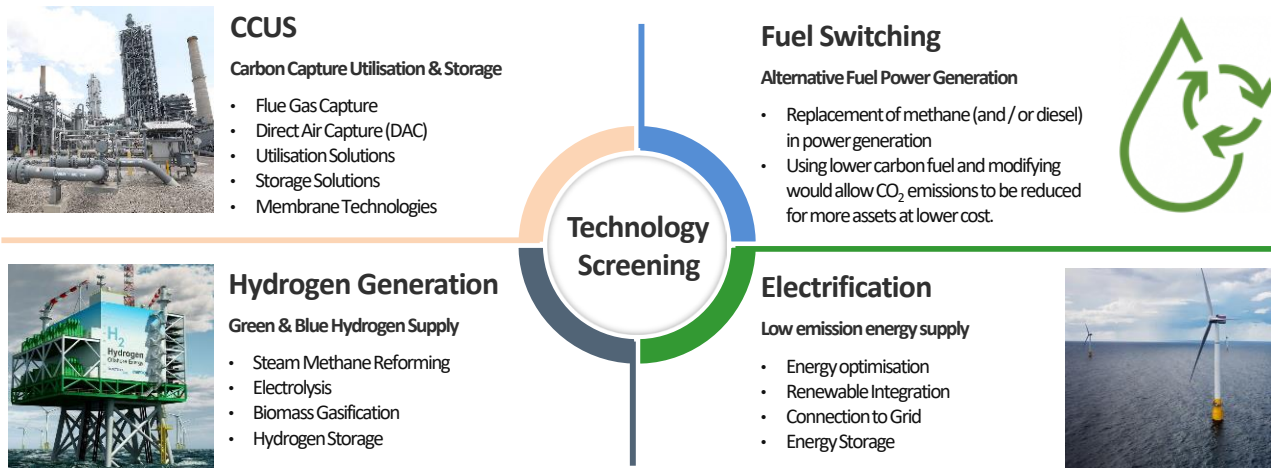


Figure 5: Technologies that could be Implemented as part of SNZR

These were subject to high-level modelling, to understand how different technologies might be implemented across the whole of the Scottish cluster, in terms of timing and to understand the potential impact of different fiscal and regulatory policies on decarbonisation. As a result, six initial scenarios were developed that map potential impacts on industrial decarbonisation based on the timing of different decarbonisation actions (e.g. CCUS, hydrogen fuel switching and electrification):

Scenario	Fuel Switching	Efficiency	Process emissions	H ₂ production	CO ₂ transport	Non-industry: heat	Non-industry: transport
Base-case	Baseline	Moderate	CCUS Early	Blue, local, early	Feeder 10, early	Electricity, Hydrogen, DHN	Electric cars, H ₂ trucks
Soft Start	Biomass, electricity	High	CCUS Later	Blue, local, early	Feeder 10, later	Electricity, Hydrogen, DHN	Electric
Local H₂ network	Hydrogen	Low	CCUS Later	Blue, local, early	Feeder 10, early	Electricity, Hydrogen, DHN	Electric cars, H ₂ trucks
H₂ economy	Hydrogen	High	CCUS Early	Blue, national, early	Feeder 10, early	Hydrogen	H ₂
Renewables push	Biomass, Electricity, Hydrogen	Low	CCUS Early	Green, national, early	Feeder 10, later	Hydrogen, Electricity, Biomass	Electric
CO₂ shipping	Baseline	Moderate	CCUS Early	Blue, local, early	Shipping, No Feeder 10	Electricity, Hydrogen, DHN	Electric cars, H ₂ trucks

Figure 6: Proposed Scenarios to be Investigated in Phase 2 of SNZR⁴

These scenarios will allow the cluster as a whole, and individual emitters, to understand the implications of different technology combinations and timings on overall progression towards decarbonisation, and to develop customised solutions. These scenarios and the underlying tools will be further developed in Phase 2 of SNZR allowing technical, economic, regulatory, and societal aspects to be considered.

⁴ Feeder 10 is a gas pipeline between the Central Belt and the North East of Scotland; DHN = district heating networks

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An application was submitted to Innovate UK in July 2020, and results of this should be known in the Autumn.

About the SNZR Project

SNZR is led by NECCUS, Scotland's industry-led alliance for carbon capture utilisation and storage, and in Phase 1 included Optimat, Scottish Carbon Capture and Storage (SCCS) at the University of Edinburgh, the Oil and Gas Technology Centre, the Centre for Energy Policy at the University of Strathclyde, Pale Blue Dot Energy, SGN, Costain and the Energy Systems Catapult.

SNZR received support from Innovate UK's Industrial Decarbonisation challenge and from Crown Estate Scotland for its work to date.

For further information, please contact NECCUS (info@neccus.co.uk).

Interested in learning more?

If you want to know more about the results from the initial phase of the Roadmap project, the project partners have provided some summary reports on key aspects of the Roadmap design. These reports cover:

1. SNZR Cluster Baseline Emissions Data
2. SNZR Stakeholder Engagement
3. SNZR Technology Scanning
4. SNZR Technology Scale and Cost Reduction
5. SNZR Technology Prioritisation
6. SNZR Energy Systems Modelling

These reports can be found in the Roadmap section of the NECCUS website (info@neccus.co.uk).

SNZR Project – Phase 2

NECCUS, has submitted a joint bid to Innovate UK as part of the Government's Industrial Decarbonisation Challenge Fund scheme, to deliver the Net Zero Roadmap for Scotland. The joint bid involves 12 organisations covering some of world's largest energy technology and services companies, the lead organisation in an anchor Net Zero Scottish project (Acorn), the national centre of expertise for modelling energy systems, a national technology centre supporting the energy transition, and some of Scotland's leading Universities. In addition, the bid would be part funded by existing industrial organisations covering the Power, Petrochemicals, Oil & Gas, Energy Networks, and Renewables sectors.

The 12 partners organisations are: NECCUS, Aker Solutions, Costain, Doosan Babcock, Energy System Catapult, Halliburton, Optimat, Pale Blue Dot, the Oil & Gas Technology Centre, University of Edinburgh, University of Strathclyde, and Wood.

The project will collaborate with the rich vein of existing decarbonising projects in the region, and expertise from global Net Zero projects, which many of the partner organisations are taking a lead role on. We aim to identify future actions Scotland can take to accelerate the green recovery, including identifying opportunities for inward investment and how to take advantage of low carbon infrastructure to provide a service for the rest of the UK and Europe. We will also develop UK leadership in decarbonisation technologies and the transition of existing world-class supply chains into new business areas.

The project team hope to commence work on the Roadmap delivery in January 2021, with the project expected to take 24 months to fully deliver on its objectives, with interim results being released during this time.

SNZR, September 2020



SGN
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optimat

