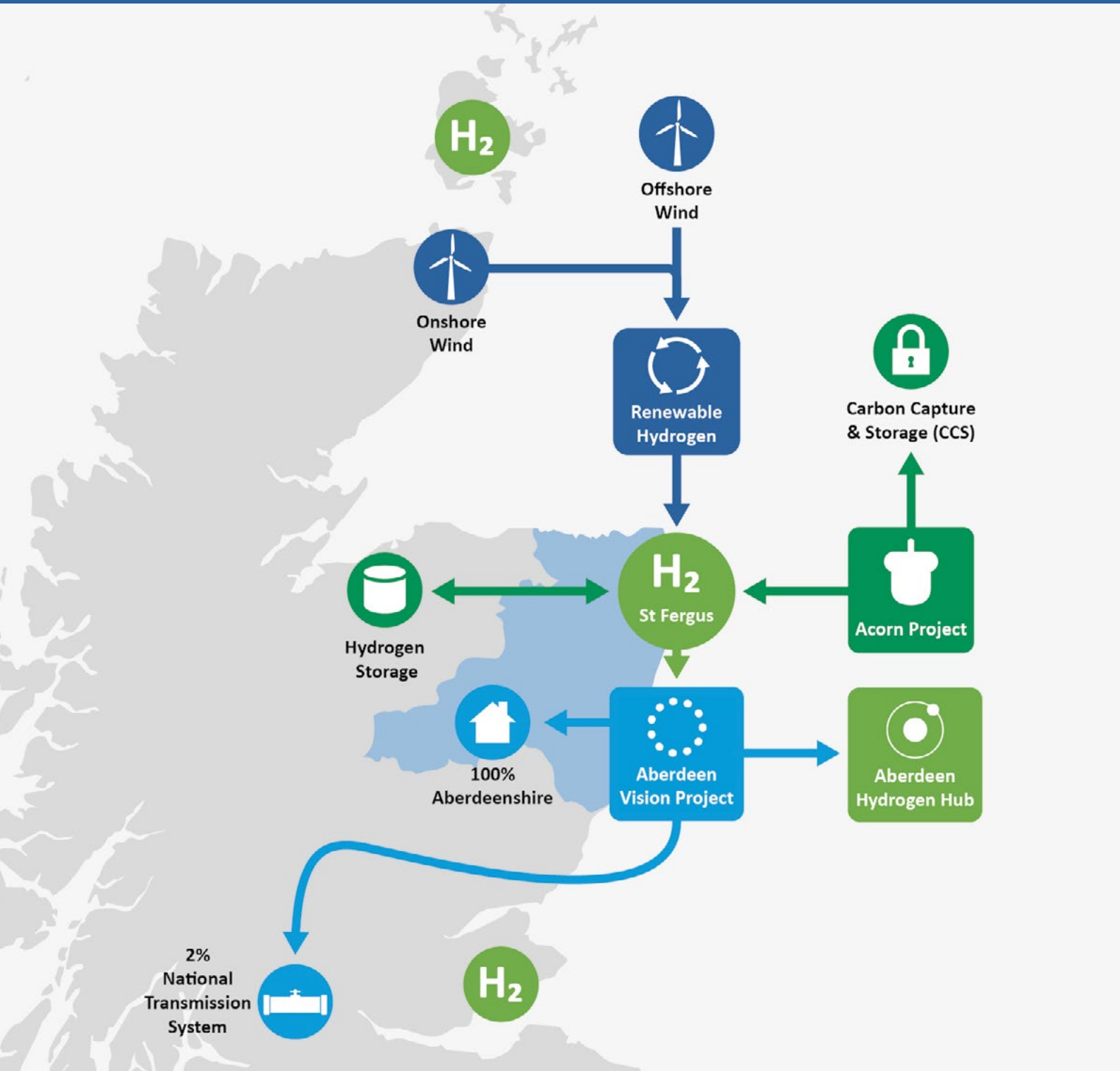


The Hydrogen Coast

A cluster of projects delivering hydrogen innovation and leadership along the East Coast of Scotland to support net-zero carbon emissions targets.



SGN
Your gas. Our network.

nationalgrid

Pale Blue Dot.

The Hydrogen Coast

Introduction

Scotland has the most advanced suite of ready to deliver industrial and domestic decarbonisation projects in the UK. The Hydrogen Coast from Orkney to Aberdeen to Fife is ready to contribute to Scotland being 'net-zero' by 2045 with affordable and deliverable projects which work together to encompass the full transition to a hydrogen economy. The benefits and opportunities of these projects extend well beyond Scotland, acting as a catalyst for other projects and hubs across the UK.

Decarbonising the UK is not only an environmental and social necessity, it is a major economic opportunity. Central to this is the potential to utilise low-carbon hydrogen as a replacement to fossil fuels within the UK's energy networks. The north east of Scotland has significant potential to be a major hydrogen hub in the UK and central to the decarbonisation of the UK. Significant projects are already underway in the region to make this opportunity a reality. This brochure provides information about some of the exciting projects and initiatives to enable hydrogen growth and decarbonise the North East Scotland and beyond.

The role of hydrogen

In the UK, around half our energy is used for heat (heating homes, cooking etc). The majority of this is currently provided by natural gas, which emits carbon dioxide (CO₂) when used. Replacing some or all of this by blending hydrogen into the National Transmission System (NTS) will help reduce CO₂ emissions.

Hydrogen is also a key enabler in the broader energy transition providing a clean energy source for use in transport and industry. Hydrogen can be produced and used in a number of ways offering flexible low-carbon options for deployment across the energy mix.

The role of North East Scotland

The north east of Scotland is the right place, with the right assets and the right projects to lead the way in developing a hydrogen economy. The region is:

- An established world class energy hub with the skills and talent available to deliver a low-carbon hydrogen economy.
- Already using hydrogen within local transport systems.
- Rich in renewable resources which are already being used to generate hydrogen and have significant potential to produce more.
- A key strategic interface between incoming North Sea gas and the national gas transmission system, making it a natural choice for producing and using hydrogen from natural gas with carbon capture and storage (CCS).
- Leading the way for CCS in the UK with access to well research, world class CO₂ stores and the ability to

use decommissioned oil and gas infrastructure to access these stores in a low risk, low cost way

- Able to support the decarbonisation of the major Scottish industrial cluster at Grangemouth through reuse of infrastructure.



Aberdeen is leading the way with hydrogen transport.



The Aberdeen region is a world class energy hub leading a low-carbon economy and at the forefront of hydrogen technology in Europe.

Producing hydrogen in North East Scotland

North East Scotland has massive potential to produce significant volumes of low-carbon hydrogen now and into the future. There are significant marine and wind energy resources available, which, as shown on Orkney through the Surf 'n' Turf project, can be effectively used to create hydrogen for use within energy systems. In addition, the future opportunity to generate significant levels of hydrogen from floating deepwater offshore wind turbines is being explored by the Dolphyn ERM project.

In the meantime, St Fergus has many attributes which make it an ideal location for the production and storage of low-carbon hydrogen from natural gas with CCS and the subsequent blending into the grid and deployment to other applications.

Hydrogen at St Fergus



Natural gas supply

St Fergus is the gas processing terminal for about 35% of the UK's gas and is forecast to continue to be so out to 2040 and beyond.



St Fergus Gas Terminal Industrial Site

The coastal gas processing terminal at St Fergus is an existing industrial site, which is suited to the construction of large scale hydrogen production facilities.



Hydrogen export by blending

Blending hydrogen into the national gas transmission system from one 'unit' at St Fergus will decarbonise 1.4% of the UK's gas and abate 500,000t/yr of CO₂.



CO₂ transport by existing infrastructure

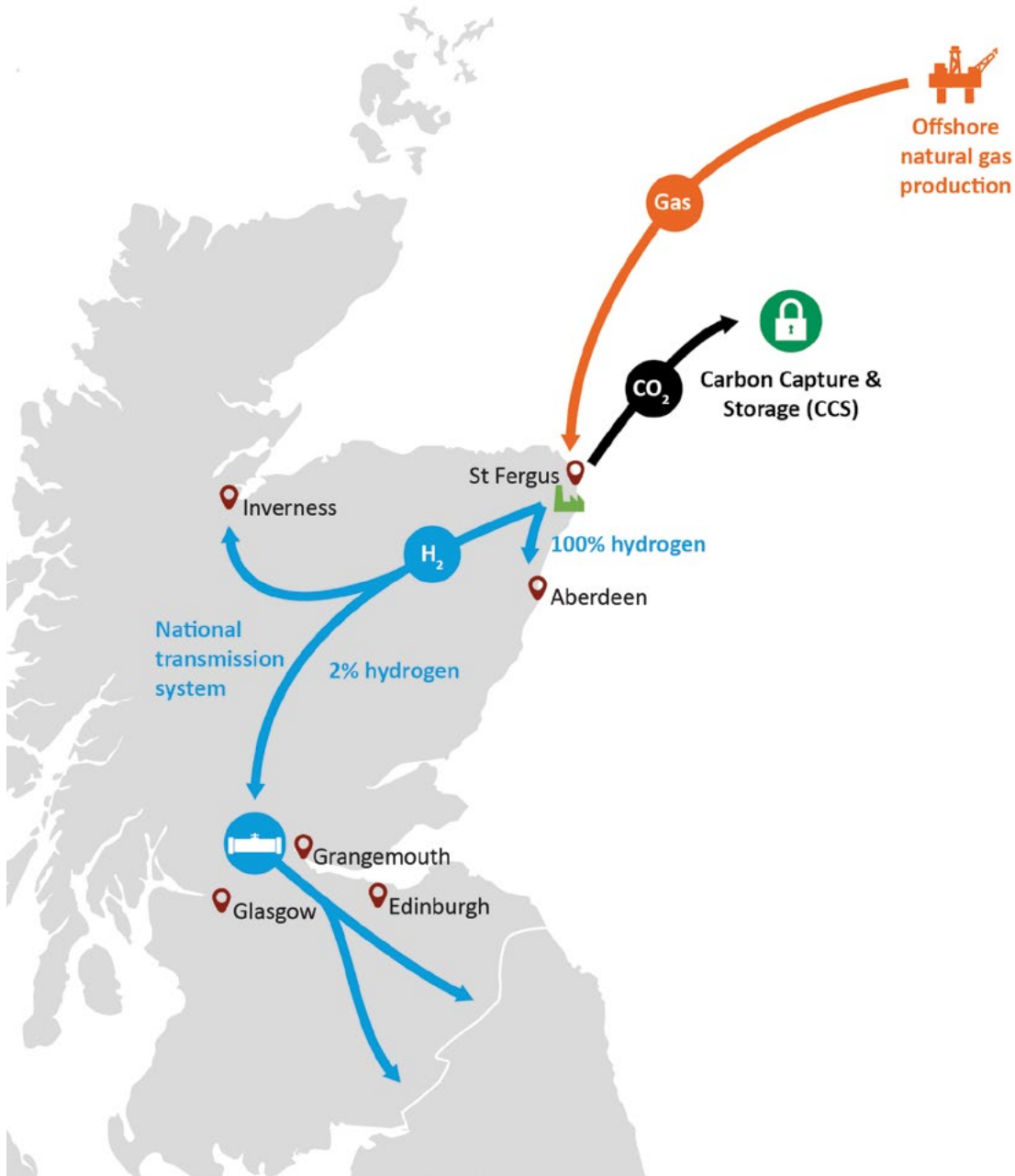
There are three offshore gas transmission pipelines that are no longer required for petroleum use that can be redeployed for offshore CO₂ transport.



CO₂ storage capacity offshore

Scotland has significant quantities of internationally renowned CO₂ storage resource in the offshore area close to St Fergus.





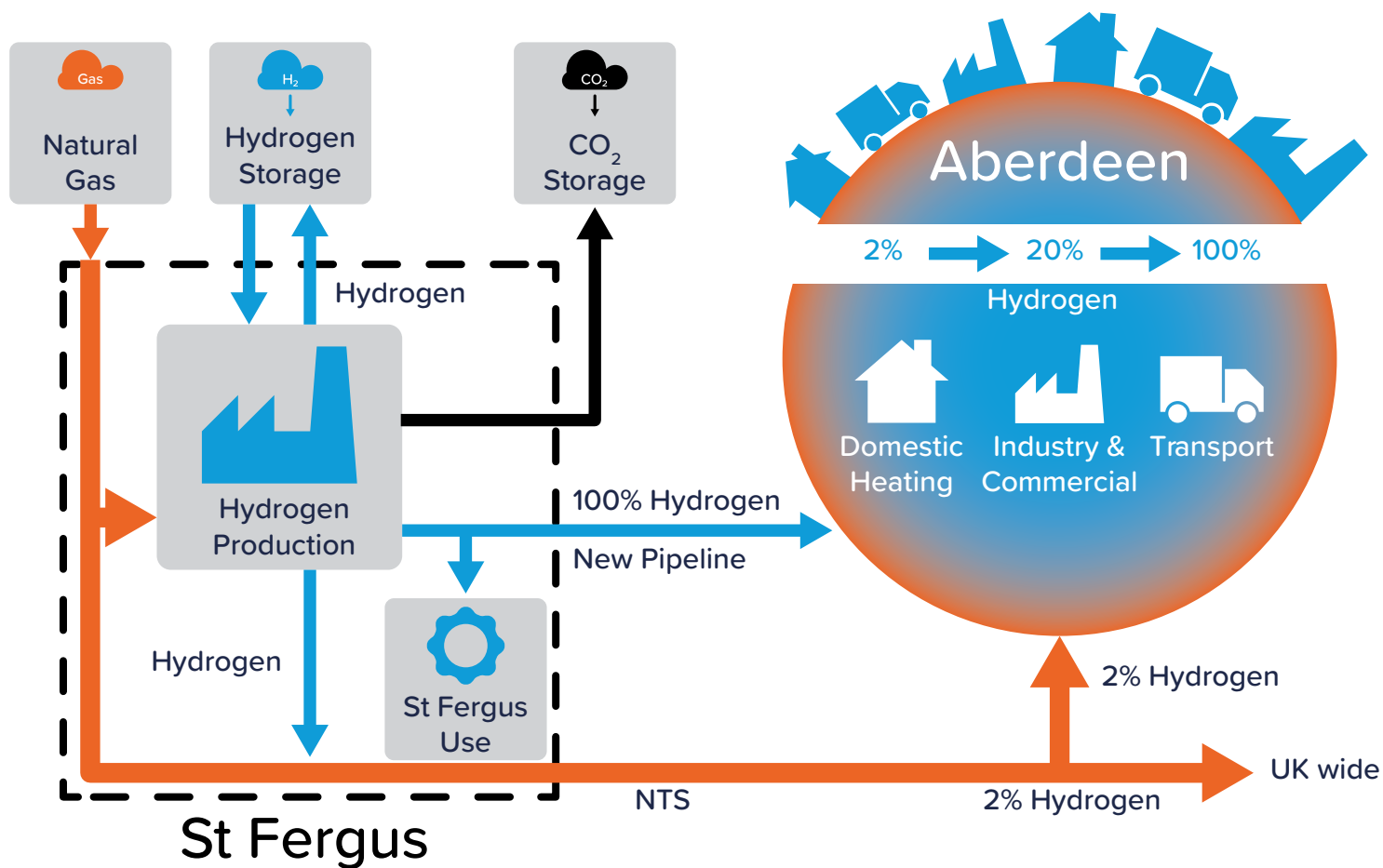
Acorn Hydrogen

The Acorn Hydrogen Project, being led by Pale Blue Dot Energy, with support from UK Government, is a hydrogen production facility being developed at St Fergus.

The facility would take natural gas from the North Sea and process it through methane reformation to produce hydrogen. A by-product of this process is CO₂, which would be captured and transported offshore for permanent storage deep underground below the Central North Sea by the Acorn CCS project.

The Acorn Hydrogen Project plans allow for the phased increase in the production of hydrogen over time, and potential options for hydrogen storage are also being developed. The Acorn Hydrogen project is one of several in the UK looking at hydrogen to replace natural gas. HyNet in North West England and H21 Leeds City Gate Project in Leeds are two of the others with ambitious long-term plans to deliver a hydrogen economy.

The Aberdeen Vision Project



Phased trials

In addition to the Aberdeen Vision Project, the H100 project is also being progressed by SGN. This project is building an evidence base into the socio-economic and technical issues associated with hydrogen deployment, so as to satisfy the needs of customers and stakeholders. Part of this study will include a long-term field trial of 100% hydrogen use in 2-300 houses, on the east coast of Scotland.

Linking supply and demand in the hydrogen economy

Aberdeen City Council has been deploying hydrogen technologies particularly in relation to hydrogen vehicles for over five years. The Council has a clear strategy for supporting hydrogen deployment in the region. In particular, the Council wants to maximise the economic opportunity to the well established, skilled supply chain in the region through the development of a Hydrogen Hub.

The Hub will act a catalyst for the integration and connectivity of the hydrogen economy in the region. The programme will link supply projects with demand projects and seek to support and facilitate these projects as a public sector partner.



The Aberdeen Vision Project

The Aberdeen Vision Project is a collaborative project between SGN, National Grid and Pale Blue Dot Energy. It has developed a phased approach to the use of hydrogen from St Fergus to support the future decarbonisation of national and Aberdeenshire gas transmission systems.

2%

Phase 1

2% hydrogen in the grid

Initially, low concentrations of hydrogen (2%) would be blended into all the natural gas leaving St Fergus. This blended gas can then be transported in the National Transmission System, before being distributed in lower pressure networks to users across Scotland and Northern England. This blended gas can continue to be used exactly as the natural gas is currently.

Although 2% sounds small, because of the large amount of natural gas leaving St Fergus, it would remove 400,000 tonnes of CO₂ per year from the energy system; equivalent to the CO₂ produced by 85,000 cars.

20%

Phase 2

20% hydrogen to Aberdeen

To achieve further decarbonisation a blend of 20% hydrogen could be fed into the gas supply in the Aberdeen and Aberdeenshire region. This would involve building a new pipeline from St Fergus to Aberdeen to transport pure hydrogen which would then be injected at 3 strategic locations to feed the gas distribution system and also provide a local 100% hydrogen hub for transport and other applications.

Most domestic and commercial applications such as boilers and gas cookers will continue to operate safely without any modification. Some specialised industrial or commercial applications may need to adjust their gas facilities.



100%

Phase 3

100% hydrogen

Once operation has been proven at 20%, the low pressure network could look to operate on 100% hydrogen. This would mean entirely replacing natural gas with hydrogen for all the region's heating and other uses. This conversion would require the phased transition of the region's distribution network by area from natural gas to hydrogen.

Other hydrogen transition projects in the UK are currently assessing the changes needed to appliances in order to facilitate this change. It is expected that such a transition would be similar to the changeover from town gas to natural gas which took place in the 1960s and 70s. Converting the North East of Scotland gas system to hydrogen would cut another 700,000 tonnes of CO₂ per year; that's equivalent to the CO₂ produced by 150,000 cars.

Acorn carbon capture & storage (CCS)

Large scale, low-carbon hydrogen can be produced from natural gas with CCS. Acorn CCS is the most advanced CCS project in the UK and offers a low-cost, low-risk CCS project co-located with Acorn Hydrogen at St Fergus. Acorn CCS is designed to be built quickly by taking advantage of existing oil and gas infrastructure and a well understood offshore CO₂ storage site. The CO₂ storage site has been licensed by the UK Government to Pale Blue Dot Energy.

Acorn CCS has multiple options for the capture and import of CO₂ for offshore transport and storage.

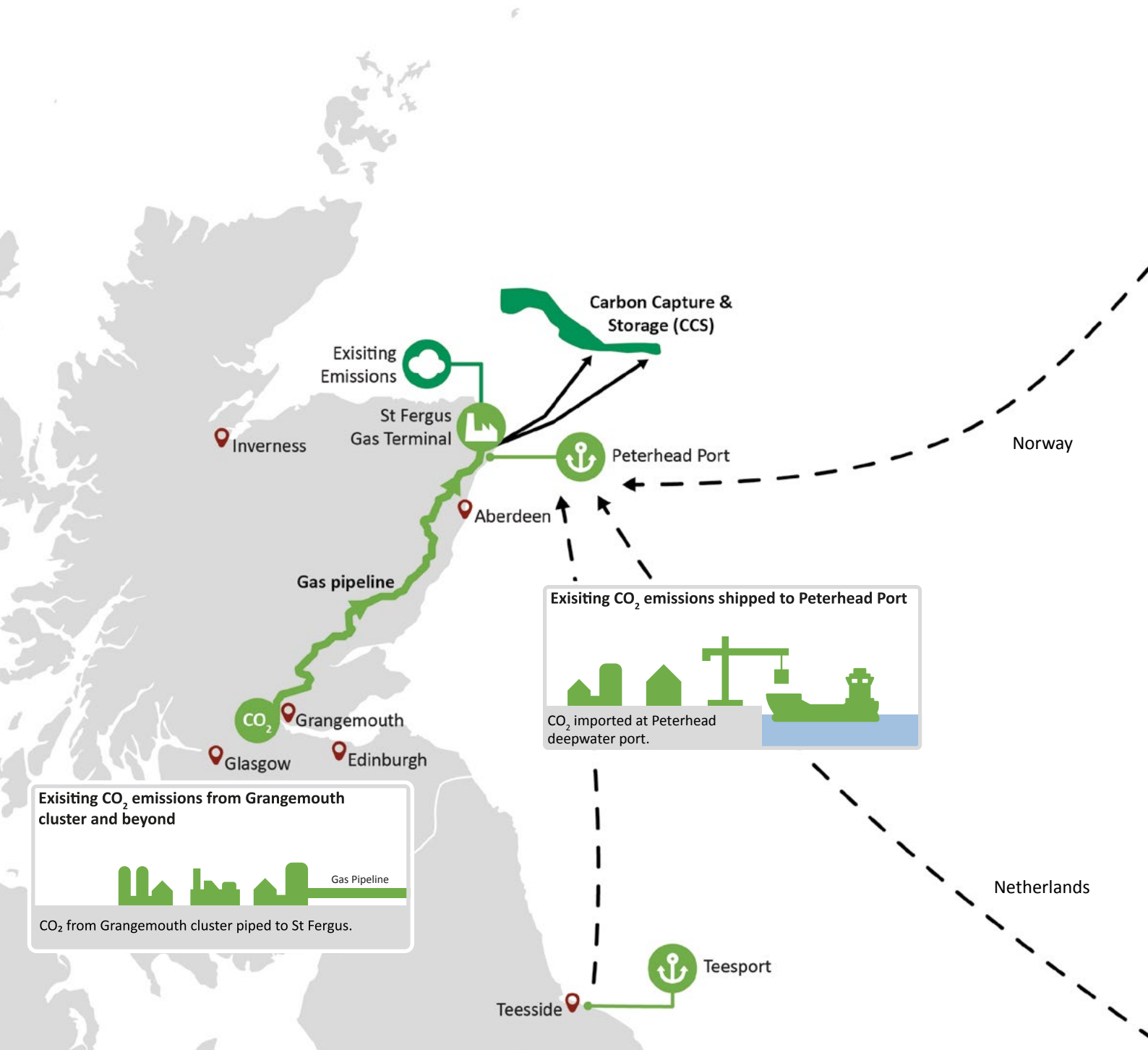
These include:

- The capture of existing emissions at St Fergus
- Emissions from future hydrogen production at St Fergus
- The import of CO₂ by vessel to the deep water port at Peterhead
- Connection to industrial cluster at Grangemouth via an existing onshore gas pipeline.

The Acorn CCS Project has sufficient demonstrable storage capacity to store CO₂ from multiple sources. Importantly, the early delivery of this project can provide initial storage to other industrial regions throughout the UK, allowing them to invest with confidence to deliver a low-carbon economy.



St Fergus gas terminal



A major economic opportunity

The north east of Scotland, with the right support, can rapidly begin to decarbonise energy systems throughout the UK during the early part of the 2020s.

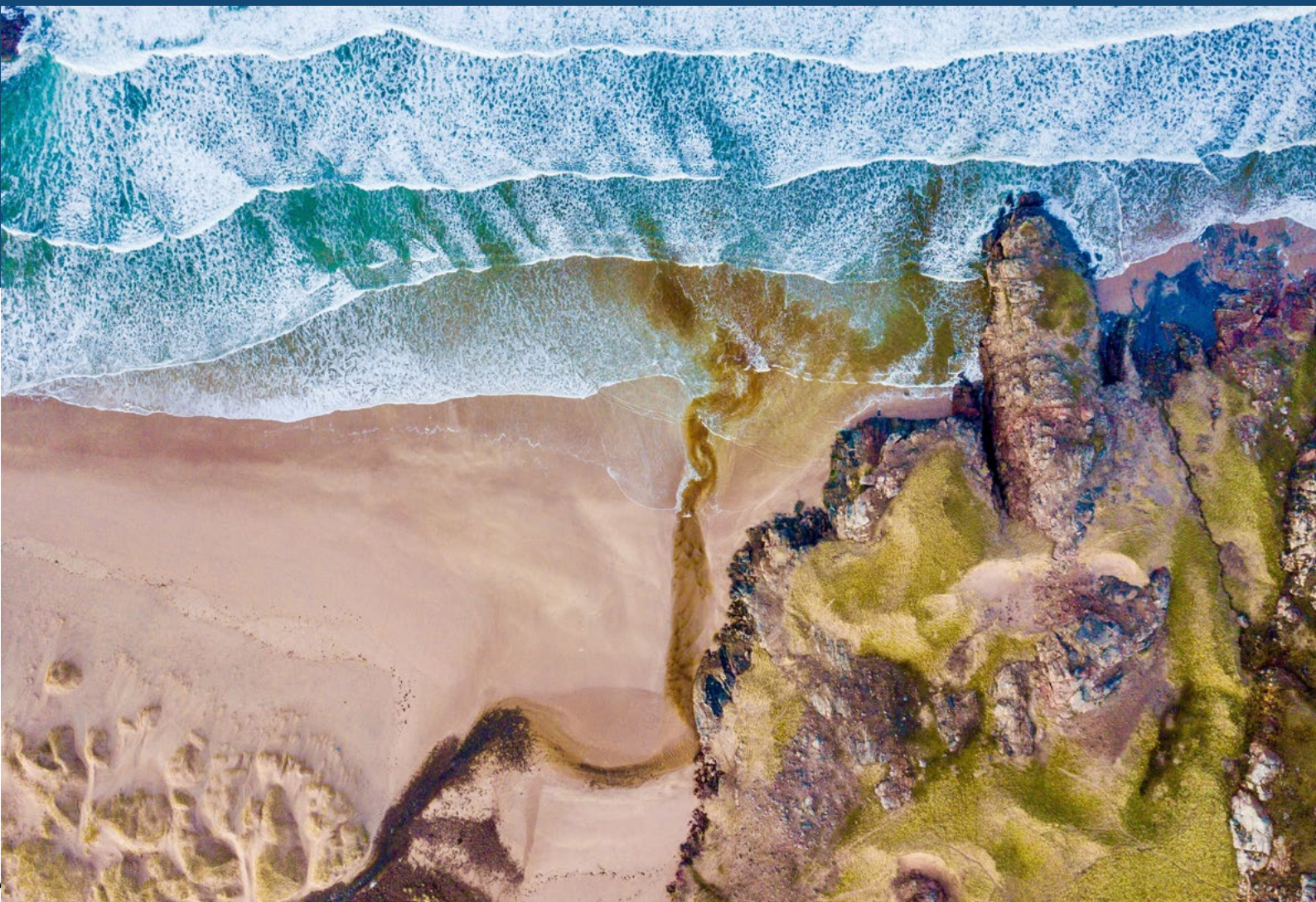
The Hydrogen Coast can catalyse widespread decarbonisation across the whole of the UK and is well positioned to maximise the learnings and opportunities for hydrogen production from renewable sources and in alternative locations. The Hydrogen Coast would provide:

- A major hydrogen production facility with CCS at St Fergus.
- A hub for offshore renewable hydrogen storage with direct connection to the national transmission network.
- An economic opportunity for the deep-water port at Peterhead providing CCS infrastructure for UK-wide decarbonisation projects.
- Energy transition job creation, building on the skills within the region.
- A contribution to decarbonised gas grid nationally and in Aberdeenshire.

The hydrogen economy is a huge economic opportunity for the UK. Ricardo Energy & Environment, in their UK business opportunities of moving to a low-carbon economy work for the Committee on Climate Change (CCC), estimate the low-carbon economy in the UK could grow 11% per year between 2015 and 2030, four times faster than the rest of the economy, and could deliver between £60bn and £170bn of export sales by 2030.

Initial estimates reported by The Centre for Energy Policy at University of Strathclyde in the economic opportunity for a large-scale CO₂ management industry in Scotland report, suggests that by 2030 anywhere between 7,000 and 45,000 UK jobs could ultimately be associated with Scotland, securing 40% of the carbon storage element of a European CO₂ management market.

By 2050 this could rise to between 22,000 and 105,000 jobs and more as the industry extends to low-carbon fuel supply.



The Hydrogen Coast at a glance



45,000
new jobs



by
2030



>100,000
new jobs



by
2050

Potential for 45,000 new CCS jobs by 2030
and over 100,000 by 2050



Home of the largest
hydrogen fuel cell in the UK



2024

Large scale low-carbon
hydrogen production
possible by 2024



Creating demand with
blending and phased gas grid
deployment



Over 40
hydrogen vehicles
& 2 filling stations
already in place



A major economic stimulus to
Scotland and the UK



CO₂

The ability to avoid over
12M tonnes
of CO₂ a year



Combining
established
and emerging
technologies



Supporting a just transition by harnessing
the established regional supply chain

Hydrogen Coast projects

The Hydrogen Coast is happening as a result of the proactive and innovative work being done on projects along the East Coast of Scotland. These leading projects are pioneering the energy transition and paving the way towards net zero.

Hydrogen Coast projects	Project proponents & supporters
Aberdeen Vision Project, Aberdeen	SGN and National Grid with Pale Blue Dot Energy and DNV GL
Acorn Hydrogen, St Fergus	Pale Blue Dot Energy, Department for Business, Energy and Industrial Strategy (BEIS), The Scottish Government
Acorn CCS, St Fergus	Pale Blue Dot Energy, EU Innovation and Networks Executive Agency, BEIS, The Scottish Government and Industry Partners
Aberdeen Hydrogen Bus Project, Aberdeen	Aberdeen City Council, EU High Vlo City and Fuel Cell and Hydrogen Joint Undertaking (FCHJU), Innovate UK, Stage Coach, First Group, The Scottish Government, Scottish Enterprise, Scottish Hydro Electric Power Distribution, SGN
The Hydrogen Hub, Aberdeen	Aberdeen City Council, Scottish Enterprise, Opportunity North East
Surf'n'Turf, Orkney	Orkney Island Council, EMEC Orkney, ITM Power, EU, FCHJU, The Challenge Fund, Scottish Government, Local Energy Scotland, Community Energy Scotland
Dolphyn ERM Project, offshore	ERM, Engie, Tractabel Engie and ODE
H100, Fife	SGN
HyStorPor, offshore	University of Edinburgh
BigHit, Orkney	Orkney Islands Council, EMEC
Flotta Terminal, Orkney	OGTC
HyDIME, Orkney	Ferguson Marine, Orkney Islands Council, EMEC, HSSMI
Methiltoune, Fife	SGN
Dundee Bus Project, Dundee	Dundee City Council

Document supported by



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Pale Blue Dot.