

TRANSITION TO A LOW CARBON ECONOMY

Scotland's unrivalled expertise, exceptional experience and renowned engineering heritage combined with abundant natural resources make Scotland natural supply chain partners for renewable energy and low carbon projects worldwide. Today, Scotland is a knowledge hub for energy exploration and production, for power system engineering and a host of modern, renewable energy technologies and systems – placing Scotland at the forefront of the challenge to decarbonise the global economy.

Scotland's ambition is to fully realise the long-term, sustainable economic potential of world-leading low carbon innovation. This means making the shift to a truly low carbon economy in Scotland, realising opportunities to increase business productivity, whilst also capitalising on the global opportunities in areas such as subsea engineering and decommissioning.

Scottish Enterprise estimates potential GVA growth to the Scottish economy of £14.4bn (+81%) from £17.8bn in 2017 to £32.2bn by 2027.

STRENGTHS AND CAPABILITIES

Scotland is building a strong reputation for excellence in Low Carbon across a portfolio of interconnected strengths including subsea engineering, renewable energy, local energy systems, low carbon transport, water and waste technologies, sustainable construction and industrial biotechnology:

- **Subsea Engineering:**

Scotland has the largest concentration of offshore engineering expertise in the world outside of Houston. Driven by our strong heritage in Engineering and the Oil and Gas expertise centred around our **Aberdeen** hub, we've built the world's largest concentration of subsea engineering with around half of all subsea installations in the world located in the North Sea.

Our subsea engineering capabilities are strong, wide and deep, spanning the range of specialist services throughout the Life of Field including feasibility studies, front-end engineering and design, equipment procurement, investment and construction, enterprise asset management, inspection, repair and maintenance, decommissioning; and training, testing and consultancy, subsea umbilicals, risers and flowlines; and specialist tooling, sensor control and communication products.

We're home to global centres of excellence in reservoirs, drilling, wells, downhole technology and subsea. For example, the [Oil and Gas Technology Centre](#) (OGTC), based in **Aberdeen**, aims to be a centre of excellence for oil and gas field life extension and decommissioning and hosts [The Innovation Hub](#), one of the most advanced facilitation spaces in the country.

The sector has huge growth potential in global markets such as subsea mining, defence, renewable energy and aquaculture.

- **Wind Energy:**

Scotland is at the forefront of deepwater and floating offshore technologies, maximising the potential from our unique natural resources, including 12,000km of coastline, more than 790 islands and around a quarter of Europe's offshore wind crossing our country. Scotland currently has 313MW of operational offshore wind capacity and with several projects under construction or contracted, that figure should rise to 2300MW (2.3GW) by 2023. A further 5 GW of projects are in development and these will be competing for Contracts for Difference (CfD) in allocation rounds in the early 2020s, with project commissioning dates out to 2030. The world's most powerful turbine

was recently installed atop innovative suction jacket foundations at **Aberdeen** Offshore Wind Farm and the world's first floating windfarm has just been commissioned in the waters off Peterhead.

In addition, we're home to the UK's largest onshore wind farm in **East Renfrewshire**, a facility that produces 539MW – enough to power 300,000 homes – and have 1.2 gigawatts of onshore wind currently under construction which is expected to deliver an annual turnover of £580 million.

• **Marine Energy:**

Scotland is a global leader in the development and deployment of marine renewables. Standing at an estimated marine energy resource of 33GW, our marine renewable energy reserves are amongst the best and most exploitable in the world and offer a wealth of associated investment opportunities.

We lead the world when it comes to developing, testing and generating electricity from marine devices with full-scale prototype wave and tidal energy generators at sea, connected and delivering energy to the UK market. The [European Marine Energy Centre](#) (EMEC) in **Orkney** is the first of its kind, and has 14 full-scale, grid-connected test berths, providing developers of wave and tidal converters with purpose-built, accredited open-sea testing facilities. **MeyGen** is the largest tidal stream array in the world with a rated capacity of 6MW. Sited in the Pentland Firth, one of the most powerful tidal areas in the world, situated at the northern tip of the UK between mainland Scotland and the Orkney Islands this project is at the forefront of the development of the marine energy industry in Europe. Scotland also hosts an important community focused tidal array in Shetland led by **Edinburgh** based Nova Innovation, and the site also has the world's first community owned tidal turbine.

Inverness based Wave Energy Scotland's technology support programme is almost at the point of getting devices into the water and the support model hailed as a success with European Commission looking to replicate it at EU level.

The [Energy Technology Partnership](#) (ETP), brings together the combined might of Scotland's Universities on marine energy devices, offering a world class range of modelling and testing facilities across:

- **Resource Modelling** - including numerical and statistical evaluations of wave and tidal energy sites.
- **Tank Testing** – including the world class [FloWave](#) tank testing facility at the **University of Glasgow**, capable of simulating both currents and waves; and the [Kelvin Hydrodynamics Laboratory](#) for large scale tests at the **University of Strathclyde**.
- **Computational fluid dynamics modelling** - The **Universities of Strathclyde and Edinburgh** use a combination of bespoke and commercial software packages to conduct computationally intensive modelling.
- **Economic modelling and assessment** - The [Fraser of Allander Institute](#) at the **University of Strathclyde** carries out research on the regional and Scottish economy with a focus on energy issues.
- **Machine design** - [Edinburgh's Institute for Energy Systems](#) has a strong focus on the ability to extract power from the sea, including novel direct drive linear and rotary electrical generators and related devices.

- **Environmental Impact modelling** - The **University of the Highlands and Islands** (SAMS and ERI at Thurso) and **Heriot-Watt's ICIT campus** are active in modelling the environmental impact of marine energy of the flora and fauna found in the sea.

• **Energy Systems:**

Scotland is the vanguard of developing new low carbon energy systems with a strong drive to deliver the transition to a low carbon future. We're home to over 200 energy systems companies including Smarter Grid Solutions and Route Monkey, both based in **Glasgow** and Logan Energy and Solo Energy, based in **Edinburgh** - and unique R&D facilities for testing and demonstrating technology and solutions in energy systems, focussed on the neighbouring Power Networks Demonstration Centre and National High Voltage Direct Current HVDC) Centre at Cumbernauld in the **Glasgow** City Region.

Energy systems projects on the ground include:

- Eastheat in **Edinburgh** which aims to reduce fuel poverty through intelligently controlled combinations of solar PV panels and heat batteries
- The Hillpark district heating system in **Glasgow** which utilises an intelligently controlled air source heat pump to integrate the electricity and heat networks in the area.
- [RUGGEDISED](#) in **Glasgow** will focus on the development of a Smart Street to address the challenges Glasgow faces from ageing infrastructure, fuel poverty and air pollution; by integrating planned regeneration and development with smart city capabilities. The Smart Street will include: district heating, an innovative roof mounted solar PV canopy, ducted wind turbines, energy arbitrage, power storage, EV charging, and smart grid controls.
- [The Perth-SEN](#) (Smart Energy Network) project aims to
 - Reduce Perth and Kinross Council's (PRK) energy costs – by trading energy across the grid between unconnected council buildings to optimise its use and maximise its value.
 - Develop new income streams for the council through the utilisation of battery storage assets for selling services to the grid, such as demand-side response services.
 - Reduce PKC's carbon footprint in line with the Scottish Governments Energy Strategy to have all building at (near) zero carbon by 2050.

Several significant new developments are also going to include significant opportunities to demonstrate innovative new local energy systems including [Perth West - A National Eco Innovation Business Park & Sustainable City Expansion](#) which is a living lab offering opportunities to investors, developers and businesses to test and apply technologies in a real-life context, working with energy giant SSE and global transport company, Stagecoach, both headquartered in **Perth**.

• **Hydrogen Fuel Cells**

Scotland is at the forefront of hydrogen-based innovation, leading pioneering pilot projects such as the **Aberdeen** Bus Project, the Aberdeen Exhibition & Conference Centre Fuel Cell project and Scottish Gas Network's Aberdeen Vision Project. A hydrogen bus project has also been developed in **Dundee**.

• **Low Carbon Transport**

We're building specialist strengths in low carbon transport matching Scottish capabilities across vehicle manufacture, retrofitting and component manufacture, biofuel production, refuelling

infrastructure supply, grid services provision, electric vehicle charge point installation and mobility services to global growth opportunities. **Dundee** has a leading role in the development of electric vehicle use - taxis, public sector fleet as well as the installation of large scale charging stations. A new partnership involving Michelin, Dundee City Council and Scottish Enterprise is driving the transformation of the company's **Dundee** site into a centre for innovation in low carbon transport. **Inverness**, too, has a fleet of electric buses serving routes within the city.

The Scottish Govt has also announced that the A9, Scotland's longest trunk road, will be an "[electric highway](#)" with a network of fast charge points as part of its £3bn upgrade to dual carriageway from Perth to Inverness.

Transport Scotland, Scottish Government and Scottish Enterprise are working together to develop an action plan for the low carbon transport sector, that will enable a number of major economic opportunities to be realised in Scotland. These opportunities include the development of high value manufacturing industry across road, rail and maritime subsectors, based on the transition to a low carbon future for transport. The Hyseas Project is the first Hydrogen Ferry in the world, to be developed and built in **Glasgow** and be demonstrated in Orkney.

• **Water and Waste Water Technologies**

Worth an estimated £1.8 billion, the Scottish water sector has key strengths in design and consenting, construction, plant fit-out, network and treatment maintenance and sludge management. Anchored by Scottish Water, which is itself investing £3.9 billion over the period 2015-21, there are around 350 companies working across the sector in Scotland many of whom are active in international markets. Scottish Water are supported by specialist research across our Universities and HIEs much of which is co-ordinated by CREW, Scotland's Centre of Expertise for Waters, based in **Aberdeen**. The [Hydro-Nation Water Innovation Service](#) is working to accelerate the development and commercialisation of home-grown technologies in both domestic and overseas markets. It includes dedicated water (Gorthleck Development Centre, near **Inverness**) and wastewater (Bo'ness Development Centre, near **Falkirk**) test centres run by Scottish Water Horizons to allow new equipment and technologies to be tested at an operational scale and facilitate their commercialisation. The [Urban Water Technology Centre](#) (UWTC) based within the Abertay University in **Dundee** carries out research and consultancy work associated with wastewater and environmental management.

• **Sustainable Construction**

Sales of low carbon building technologies, and the increasing adoption of offsite construction methodologies, are projected to increase from £1.1bn to £1.9bn by 2020, supporting 12,000 jobs in Scotland. The [Construction Scotland Innovation Centre](#) has developed an [Innovation Factory](#), a 35,000 sq. ft. facility located in **Glasgow**, which is designed to support construction related businesses to collaborate and innovate. Based within **Napier University's** School of Engineering and the Built Environment, the [Institute for Sustainable Construction](#) (ISC) encompasses several leading built environment applied research centres. The Institute works with key industry organisations, businesses and in the last three years has supported over 300 companies.

• **Industrial Biotechnology (IB)**

Scotland is recognised for its established strengths in Biotechnology. The sector continues to generate strong growth with key ambitions driven by [Chemical Sciences Scotland](#) to grow industrial biotechnology-related turnover in Scotland to £900m.

Our chemical sciences research base is consistently ranked among the top three in the world in terms of productivity and influence, and **Glasgow** is home to [Scotland's IB innovation centre, IBioIC](#), a single point of access to 14 universities across Scotland which helps foster the commercialisation of biotech solutions in both the chemical and life sciences sectors. In addition, the [Scottish Bioresource Mapping Tool](#) is leading a pioneering approach to mapping bioresources, providing potential investors with uniquely detailed information on the 27 million tonnes of bioresources arising every year in Scotland.

CROSS-OPPORTUNITY STRENGTHS

Scotland has a unique portfolio of interconnecting capabilities across our strong sectors of global expertise. The mix of abundant natural and engineered assets alongside expertise put Scotland at the forefront of low carbon technologies. This is all backed up by a pioneering commitment from the Scottish Government to make Scotland a global leader in low carbon, and a desire from the private sector from across Scotland to realise the full potential that exists. These companies range in size and span different sectors including biotechnology firms such as Celtic Renewables, and Alexander Dennis who design, manufacture and supply lower emission buses on a global scale.

STRONG GOVERNMENT LEADERSHIP

In May 2018 the Scottish Government introduced a new Climate Change Bill that increases their low carbon ambition even further. The new bill proposes a 90% reduction target for all greenhouse gases which means net zero emissions of carbon dioxide by 2050, effectively making Scotland carbon neutral. The Scottish Government is committed to driving the decarbonisation of Scotland's economy while growing the economy, increasing the wellbeing of the people of Scotland and protecting and enhancing the natural environment. The Scottish Government has committed to continue to invest in Scotland's low carbon infrastructure through the [Low Carbon Infrastructure Transition Programme](#) and [Scotland's Energy Efficiency Programme](#).

All of this is underpinned by global assets infrastructure, infrastructure assets and capabilities

SCOTLAND'S ASSETS

- **Oil and Gas Sector:** The knowledge and skills of the oil and gas supply chain will be crucial to the transition to low carbon energy, particularly in areas such as subsea engineering, project management and cabling in challenging environments.
- **Ports:** Scotland's [network of ports](#) offer valuable opportunities for the energy industry. Ports across the country offer a range of infrastructure, facilities, skills and supply chain to support the oil & gas, decommissioning, subsea and renewables industries.
- **Abundant resources:** our abundant resources are powering the growth our renewables industry:
 - 10.8GW pipeline of renewables under construction, awaiting construction or in planning
 - 25% of Europe's entire onshore wind resource crosses the seas around Scotland
 - 10GW of renewable electricity capacity
 - 68.1% of Scotland's total electricity demand met by renewables sources
 - Scotland has over 60% of the UK's onshore wind capacity
 - Scotland has 85% of the UK's hydroelectric energy resource and a total hydro generation capacity of 1,5GW

- **Academic strengths:**
 - Scotland has one of the highest concentrations of universities in Europe, with four regularly featuring in the top 200 universities in the world. Over 50% of the population has further education, more than anywhere else in the UK.
 - Our world class innovation centres bring together leaders in industry and academia. Facilities including laboratories, workshops and specialised equipment throughout Scotland's Higher Education Institutions (HEIs) are made available for companies to hire and make use of as part of their product development process. Providing independent product analysis, developing new and efficient processing techniques and testing prototypes. Relevant innovation centres: [Industrial Biotechnology Innovation Centre](#), [Hydro Nation Water Innovation Service](#), [The Oil and Gas Innovation Centre](#), [Construction Scotland Innovation Centre](#)
 - The [Energy Technology Partnership](#) (ETP) is the largest and most broad-based energy research partnership in Europe, comprising 600 researchers across 13 universities
 - The **University of Strathclyde's** [Advanced Forming Research Centre](#) is a globally-recognised centre of excellence in innovative manufacturing technologies. The centre employs 133 highly skilled engineers, researchers and business professionals, and is home to the [Lightweight Manufacturing Centre](#). The Centre, to be set up in **Renfrew**, will produce lightweight materials which are increasingly being used in the aerospace, automotive, oil & gas and renewables industries to increase efficiency and performance and help reduce carbon emissions.
 - The [Power Networks Demonstration Centre](#) in **Cumbernauld** aims to accelerate the adoption of innovative research and technologies from early stage research into business as usual adoption by the electricity industry. Research includes smart grids, asset management, Communication and Systems Integration, Network and Demand-Side Management, Power Electronics and Distributed Energy, Protection and Control as well as Sensors and Measurement.
 - Scotland has over 700 renewables scientists, engineers and academics
- **Strong international partnerships:** Scotland has several Energy and Low Carbon Memoranda of Understanding in place with companies / institutions in the Middle East and Asia, to help develop joint renewables and low carbon initiatives, including:
 - Masdar in Abu Dhabi
 - Science & Technology Park / ECCI in Hong Kong
 - The Nippon Foundation in Japan