Paper 9/1 – Innovation in Scotland
For information

1. Purpose

1.1 This paper provides Commissioners with a high-level overview of the landscape for innovation in Scotland.

2. Background

2.1 The paper briefly outlines the role of innovation in meeting climate change targets, and delivering a just transition. The current evidence base for Scotland is outlined along with the policy context. Finally, recommendations for innovation policy from the IEA and CCC are outlined.

2.2 This paper does not give a comprehensive account of the impact that Covid-19 or Brexit will have on the innovation system in Scotland.

Innovation for net-zero in Scotland

2.1 While technologies in use today can deliver a large amount of the emission reductions required for us to meet our climate change targets, they are insufficient on their own to take us to net-zero. A major acceleration in innovation is needed if Scotland is to meet its target of net-zero emissions by 2045.

2.2 Energy efficiency and renewables are fundamental for achieving climate goals, but there are large portions of emissions that will require the use of other technologies. Much of these emissions come from sectors where the options for reducing them are limited – such as agriculture, shipping, trucks, aviation and heavy industries like chemicals. Decarbonising these sectors will largely demand the development of new technologies not yet in use, and many of the clean energy technologies available today need more work to bring down costs and accelerate deployment.

2.3 Innovation is the key to fostering new technologies and advancing existing ones, and is not the same as invention. After a new idea makes its way from the drawing board to the laboratory and out into the world, there are four key stages in the innovation pipeline. But this pathway to maturity can be long, and success is not guaranteed:

- **Prototype**: A concept is developed into a design, and then into a prototype for a new device (e.g. a furnace that produces steel with pure hydrogen).
- **Demonstration**: The first examples of a new technology are introduced at the size of a full-scale commercial unit (e.g. a system that captures CO2 emissions from a cement plant).
- **Early adoption**: At this stage, there is still a cost and performance gap with established technologies, which policy attention must address (e.g. electric and hydrogen-powered cars).
- **Mature**: As deployment progresses, the product moves into the mainstream as a common choice for new purchases (e.g. hydropower turbines).

How innovation can help reach net-zero emissions goals faster

2.4 The International Energy Agency have argued that if governments and companies want to move more quickly towards net-zero emissions, progress on early stage technologies will need to be accelerated. Failure to do so risks pushing the transition to net-zero further into the future, or increasing the overall cost of the transition. The pace of innovation in coming decades will depend on the policies governments put in place today.

2.5 Aligning investment cycles with net-zero targets can create large markets for new technologies and avoid huge amounts of “locked in” emissions. For some sectors, 2045 is just one investment cycle away, making the timing of investments and the availability of new technologies critical.

The Covid-19 crisis could cripple or catalyse innovation

2.6 Innovation involves a wide range of participants, but governments have a pivotal role that goes far beyond simply funding research and development. Governments set overall national objectives and 'missions', and are vital in determining market expectations, ensuring the flow of knowledge, investing in essential infrastructure, and enabling major demonstration projects to go ahead.

2.7 At a time when faster innovation is needed, the Covid-19 pandemic risks delivering a setback. However, it may also present a strategic opportunity for government to ensure that industries come out the crisis stronger and ready to supply future domestic and international markets.

Role of innovation in a just transition

2.8 Innovation will play a crucial role in meeting our climate change targets presenting a number of specific just transition issues:

1. **Employment**: technological development and change do not necessarily have a positive impact on employment, but there are opportunities attached to being at the forefront of the technology frontier in clean energy. Expertise in emerging industries like marine, hydrogen etc may allow new businesses to be created and grow but this growth is likely to be contingent on a wider supportive policy framework. Innovation may also help maintain current levels of employment in sectors such as heavy industry.

2. **Consumers**: some of the technological innovations happening in the energy sector to help us manage a cost-effective net-zero system have a direct interface with consumers. These include new technologies such as smart meters, peer-to-peer trading and battery storage. While adoption of these can be beneficial to consumers, there are social justice questions relating to how the benefits of these will be distributed among the population, and whether some consumers are at risk of being 'left-behind'. [Centre for Sustainable Energy: Exploring social justice in the future energy system]

3. **Finance**: innovation is done at risk and it can be difficult for companies to fund this themselves. The public sector, through several channels, provides support in the form of loans, grants etc to fund innovation that supports its broader strategic goals (such as climate change). There are questions surrounding both the appropriate balance of public sector support, and whether the benefits from successful publically-funded projects are sufficiently captured by the public sector.

Evidence base – current position

2.9 The available evidence shows that Scotland's overall innovation performance is mixed, with areas of real strength but also some notable challenges.

2.10 In 2018, Gross Expenditure on R&D (GERD) in Scotland was 1.65% of GDP, placing Scotland in the third quartile among OECD countries. GERD as a share of GDP has been growing, however, increasing by 0.03% between 2017 and 2018. [Gross expenditure on research and development Scotland 2018]

2.11 A large proportion of Scotland's GERD is attributable to the Higher Education sector, relative to the rest of the UK and international comparators. The proportion of R&D spend attributable to the HE sector in Scotland is amongst the highest share for OECD countries.

2.12 Scotland has traditionally performed poorly when it comes to business expenditure on R&D (BERD). BERD reached £1.4 billion in 2018, up 6.4% (+£82 million) in real terms from 2017. However, despite growth over a number years Scotland still only ranks eighth out of the twelve UK regions in terms of BERD spending as a share of GDP in 2018.

2.13 A separate source of evidence comes from the UK-wide Innovation survey. The most recent version of the survey covers 2016-2018 and showed 32% of enterprises in Scotland were innovation-active, a decrease from 45% in the previous 2014-16 survey.

2.14 The proportion of enterprises in the energy sector reported to be innovation-active increased by 0.6% in the latest version of the survey to 43.6%. [BERD estimates for the energy sector in 2018 was £75 million]. This is considerably below levels from the start of the decade. It's not possible to say from these figures what is driving this but changes in demand for oil and gas and the associated supply chain impact may be one explanation.

2.15 Of possible constraints to innovation, the cost of finance was reported of 'High Importance' by the largest proportion of Scottish enterprises involved in innovation (17.2%), followed by availability of finance (16.6%).

Percentage of broader innovators that rated constraints as of 'high importance' in Scotland and the UK: 2016 – 2018 (top five reasons)

Constraint	Scotland	UK
	2016-2018	2016-2018
Cost of finance	17.2	18.1
Availability of finance	16.6	18.4
Direct innovation cost too high	15.3	18.3
Excessive perceived economic risks	12.8	13.2
Outcome of EU referendum	12.4	15.4

Policy context

2.16 Encouraging innovation within low carbon energy is a vital element in Scotland's response to the Global Climate Emergency. This was made clear in the report from the Advisory Group on Economic Recovery, which highlighted the importance of innovation as a key growth area. The Scottish Government agrees that Scotland's world-leading innovators can play an important role in decarbonising our energy system as well as delivering economic benefit during our Just Transition.

2.17 Scotland has a strong track-record on innovation. However, there is scope to accelerate and further develop our competitive advantage in this space. Over the next year, the Scottish Government will set out a new challenge-based approach to energy innovation. This will provide a clear direction on how Scottish innovators can capitalise on their solutions with the backing of the Scottish Government and its enterprise agencies.

2.18 Innovation challenges will be set to not only grow our low carbon energy capacity, but to ensure renewable technologies can be integrated into our energy system without detriment to consumers. Public sector support will be co-ordinated to maximise the effectiveness of our investments in developing solutions which can reduce emissions whilst securing economic benefit and jobs in Scotland.

2.19 Hosting the Cleantech Forum Europe in Scotland as well as COP26 next autumn provides an excellent target for the Scottish Government to exhibit our strong framework for innovation support.

Case study – Marine Energy in Scotland

2.20 Marine energy provides an outstanding opportunity to create a strong, green industry in Scotland. The tidal stream industry could generate a net cumulative benefit to the UK of £1.4bn and support 4,000 jobs by 2030. While a less mature technology than tidal stream, wave energy could add a net positive contribution to the UK economy of £4bn and support 8,100 jobs by 2040.

2.21 Scotland is a world leader in marine renewable energy innovation as a result of consistent and committed funding and support from the Scottish Government. Scotland is home to a number of world leading tidal energy projects, which are demonstrating performance and reliability.

2.22 Two projects are currently benefitting from support we are providing through the Saltire Tidal Energy Challenge Fund. £3.4 million was provided to Orbital Marine Power demonstrate the O2 2MW tidal turbine. Key parts of the device are being fabricated in Fife and Orkney, using steel from Motherwell, and assembled in Dundee.

2.23 Simec Atlantis were awarded £1.5 million to install a subsea hub for the next phase of development of the MeyGen project in the Pentland Firth, the world's largest tidal stream power project. The pioneering hub has connected multiple tidal turbines to a single export cable, a vital step in reducing costs for large tidal energy arrays. The innovative technology also has the potential to be applied in floating offshore wind and wave energy.

2.24 To develop technology in wave energy, the Scottish Government have invested over £50 million since 2014 through our internationally recognised Wave Energy Scotland (WES) programme that specialises in stimulating early stage R&D and innovation. Through its competitive procurement programme, WES has supported a range of projects focused on Wave Energy Converters which is helping Scotland take great strides in this area. WES has collaborated with over 200 organisations across 13 countries and will continue to be a key contributor in Europe post EU-exit with its prominent role in the European Commission supported programme, EuropeWave.

2.25 Maintaining Scotland's lead in marine energy is of strategic importance to the Scottish Government. We are determined to continue progressing to ensure we can capitalise on the economic opportunities of marine energy both domestically and in the global export market.

The International Energy Agency

2.26 The IEA has written widely on energy systems innovation and recently outlined five principles for policymakers in this area:

1. **Prioritise, track and adjust.** Review the processes for selecting technology portfolios for public support to ensure that they are rigorous, collective, flexible and aligned with local advantages.
2. **Raise public R&D and market-led private innovation.** Use a range of tools – from public research and development to market incentives – to expand funding according to the different technologies.
3. **Address all links in the value chain.** Look at the bigger picture to ensure that all components of key value chains are advancing evenly towards the next market application and exploiting spillovers.
4. **Build enabling infrastructure.** Mobilise private finance to help bridge the funding gaps that exist by sharing the investment risks of network enhancements and commercial-scale demonstrators.
5. **Work globally for regional success.** Co-operate to share best practices, experiences and resources to tackle urgent and global technology challenges, including via existing multilateral platforms.

Committee on Climate Change

2.27 The CCC have also highlighted the role of innovation in meeting net-zero. In addition to technology they also highlight the need to consider innovation in institutions, business models, policy design and behaviours.

2.28 In the case of technology, the highlight that that in addition to supporting research and development (R&D) on innovative solutions, policy will need to drive innovation through several other channels [Committee on Climate Change report 2019]:

1. **Learning-by-doing:** In many cases, the biggest driver of cost reduction will be deployment at scale, both through reduced technology costs and reduced cost of capital - both of these effects have been apparent in the last decade for offshore wind.
2. **Policy design:** Market frameworks and regulation each have a role in driving innovation, for example the Contracts for Difference auctions for power generation and in flue-gas desulphurisation driven by air quality regulations.
3. **Supporting infrastructure development:** Many potential innovations will need to interact with the wider system, including supporting infrastructure. In some cases the infrastructure already exists (e.g. the electricity grid), but in other cases, such as hydrogen and CCS, infrastructure is not yet available to provide this support.

Annex A – Scotland's innovation landscape (adapted from the Muscatelli report)

University specific strategy and activity	Sector or technology specific institutes such as University of Strathclyde's Oil and Gas Institute
	Contract R&D
	CPD
	Consultancy
Scotland specific funding	Scottish Funding Council (SFC) innovation voucher scheme (SME focus) + advanced innovation vouchers
	Innovation centre programme – collaborative projects, industrial PhDs, MSc placements

	Scottish Government programme and initiatives – for example National Institute for Manufacturing
	SFC strategic funding, including university innovation fund
	Scottish Enterprise – for example, high growth ventures programme, R&D grants
	Highlands and Islands Enterprise
	Converge Challenge
	Scottish Institute for Enterprise
UK wide funding	Industrial strategy challenge fund
	Knowledge transfer partnerships
	Strength in places fund
	Research councils
	City deals
	Catapults
	Industrial PhDs
European Commission	Horizons 2020
	ERDF