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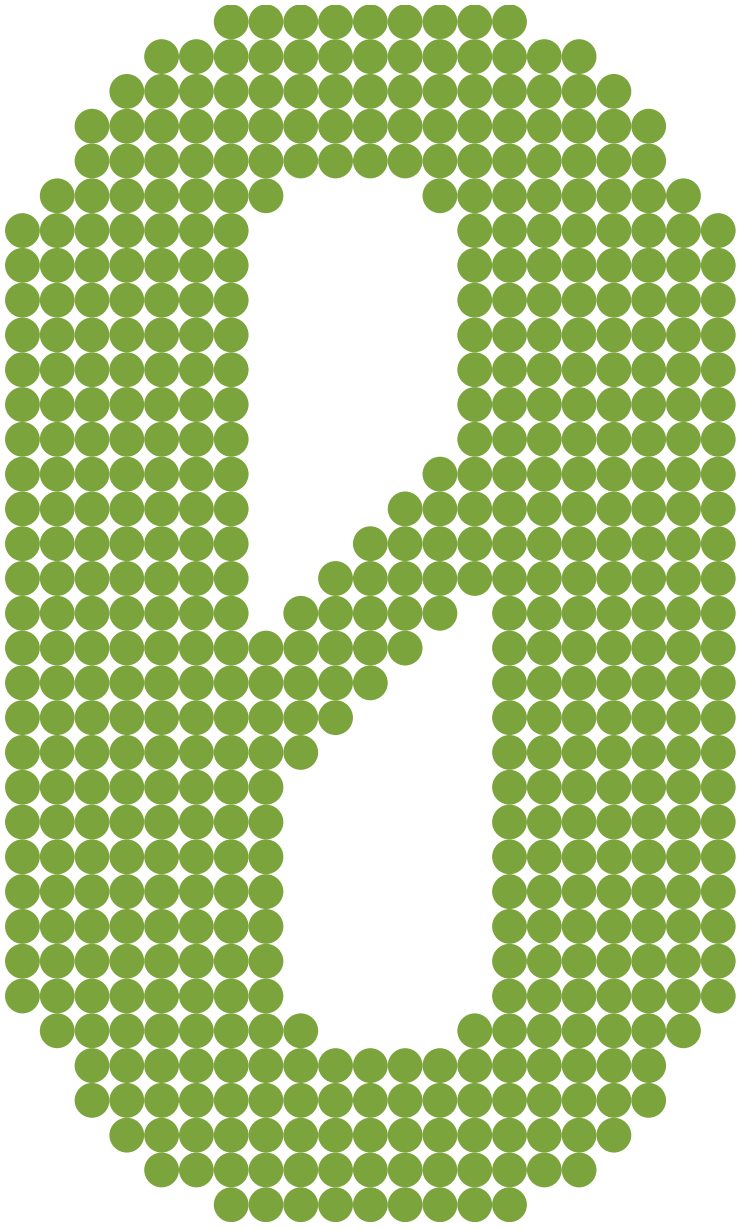

ZEROING IN: CAPTURING THE OPPORTUNITIES FROM A UK NET ZERO EMISSION TARGET

CONTENTS

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With thanks to our membership for their input and the following for their additional contributions: Committee on Climate Change, Grantham Research Institute on Climate Change and the Environment, International Airlines Group, Mineral Products Association, National Farmers' Union, Trade Union Congress, UPS and others. Individual recommendations cannot be attributed to any of the above.

ALDERSGATE GROUP

The Aldersgate Group is a politically impartial, multi-stakeholder alliance championing a competitive and environmentally sustainable economy.

Our members include some of the largest businesses in the UK, leading NGOs, key professional institutes and politicians from across the political spectrum. We believe that economic success, both now and in the future, depends upon a political and economic framework that delivers a healthy environment and sustainable use of resources, good environmental performance at the organisational level, growth, jobs and competitive advantage in rapidly growing environmental sectors.

Our policy proposals are formed collaboratively and benefit from the expertise of our members who span a wide range of industry sectors and public interests. Our breadth and collegiate approach allows us to formulate progressive policy positions to benefit all organisations and individuals.

ORGANISATION MEMBERS

While members support this publication and provided extensive input, individual recommendations cannot be attributed to any single member and the Aldersgate Group takes full responsibility for the views expressed.

EXECUTIVE SUMMARY

A net zero emissions target can deliver significant economic and industrial growth opportunities for the UK, if supported by a comprehensive policy package.

There is real momentum for 'net zero', with support amongst governments and leading businesses around the world. Following the landmark Paris Agreement in 2015, in which signatory countries agreed to achieve "a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century", stakeholders are beginning to consider how to deliver that commitment. The UK government has said that it will "need to take the step of enshrining the Paris goal of net zero emissions in UK law—the question is not whether, but how we do it",[1] and many countries including France, Sweden, Norway and the European Union have committed to or are considering a move towards carbon neutrality, alongside cities, states and regions like Berlin, California, Copenhagen and Washington DC.[2]

The UK is currently committed under the Climate Change Act 2008 to reduce its emissions of greenhouse gases by at least 80% by 2050 compared to 1990 levels. **Increasing this target to achieve net zero emissions requires the UK to firstly significantly accelerate the action it is already taking** in areas such as the power sector and buildings to achieve the 80% target. Secondly, the UK must rapidly tackle more complex areas to decarbonise, such as heavy industry, long-distance transport and agriculture.[3] Infrastructure designed today will have lifecycles of 20 years and upwards, so **a net zero target needs to be set in the near future to help businesses invest cost-effectively and avoid locking in emissions.**

The challenge ahead is significant, but so is the opportunity. The Aldersgate Group's engagement with a broad cross-section of businesses, many of whom have already set their own net zero commitments and science-based targets, has demonstrated **optimism that there is a significant industrial and export opportunity for the UK if it is an early mover in setting a net zero target**, as long as it is underpinned by a supportive policy package. For example, the UK could broaden its current strengths in the low carbon economy and become a leader in manufacturing zero carbon building materials, batteries, low carbon advisory and financial services and the development of carbon capture and storage.

This report sets out how the UK can make the most of the net zero opportunity by firstly providing the background to net zero in the UK, and then identifying key actions the government should take now to meet existing carbon budgets and set a good foundation to increase ambition. It then considers how government can develop a bolder innovation policy, establish frameworks to expand the UK market for low carbon infrastructure, goods and services, and encourage more cross-industry collaboration to identify opportunities for accelerated emissions reductions. The report features case studies of ultra-low carbon innovation around the world throughout to demonstrate the feasibility and new market opportunities of delivering a net zero target in the UK.

1 Rt Hon Andrea Leadsom MP, Hansard HC Deb 14 March 2016 vol 607 c725

2 See a full list of sub-national targets here: track0.org/cities-regions

3 Vivid Economics (November 2018) *Keeping it cool: how the UK can end its contribution to climate change*

Key recommendations to government from this report include:

1 **Tackle low regret policy options now, which are essential to meet current carbon budgets and to provide a strong foundation for achieving more ambitious emission cuts.** This should include completing the cost-effective decarbonisation of the power sector, providing clarity on an increasing carbon price in the 2020s, addressing energy efficiency in buildings and industry through the introduction of binding regulatory standards and fiscal incentives, and accelerating the roll-out of zero emission vehicles through tightening emission standards and targeted grants.

2 **Set a zero carbon target as soon as possible with cross-party consensus** to provide businesses with the clarity they need to inform long-term and capital intensive investment decisions. Government should work with industry to set sector-based decarbonisation roadmaps underpinning this target, following the example of the Swedish fossil free industry roadmaps.

3 **Develop an ambitious and strategic innovation policy focused on trialling critical technologies at scale,** particularly for carbon capture and storage and hydrogen. The government's innovation policy should move beyond the fear of failure and be based on the recognition that successful and unsuccessful trials both provide valuable lessons to inform good policy making. Targeted support must be focused not only at the R&D stage but also at the deployment stage of innovation.

4 **Set a strategic direction for innovation and system planning.** A granular understanding of energy requirements and availability of feedstocks is needed to support whole-system decarbonisation. For example, in planning for the increasing electrification of heat, transport and industry.

5 **Drive the market for zero carbon infrastructure, products and services through targeted revenue support and product standards, informed by domestic and offshore emissions on a lifecycle basis.** Such measures will play a key role in stimulating the growth of domestic zero carbon supply chains and help to reduce the UK's imported emissions, while ensuring there is a level playing field in the market.

6 **Support local delivery with a comprehensive, long-term funding strategy,** and improve capacity within Local Enterprise Partnerships to deliver local low carbon growth through technical assistance and training. Local authorities should be required to establish a strategy to contribute to the national net zero target.

7 **Support the workforce in the UK's transition to a net zero economy,** mapping potential investment decisions against regions facing high unemployment risk. Government should also work with low carbon industry to understand their future skills needs and ensure the UK has a pipeline of skilled workers for new and growing industries.

8 **Encourage greater business collaboration within sectors and across value chains** through government's convening power, setting up organisations like the National Industrial Symbiosis Programme. Government can also encourage collaboration through product standards and encouraging Scope 3 emissions measurement.

9 **Incentivise land use change for greenhouse gas removals,** such as tree planting, through the new environmental land management scheme after the UK withdraws from the Common Agricultural Policy. Government must consider how best to kickstart a private investment market in natural capital and greenhouse gas removals.

10 **Use the UK's diplomatic reach and new trade policy to promote the adoption of net zero targets globally.** Recognising that tackling climate change is a global issue, the UK should build on its extensive diplomatic network of climate attachés to promote the adoption of net zero targets. Any future independent trade policy should ensure that trade agreements support the delivery of a UK net zero target and promote growing trade in low carbon goods and services.

ONE SETTING A UK NET ZERO EMISSIONS TARGET

Alongside scientific consensus and international momentum, there is a strong business case for the UK to become an early mover on net zero.

The UK's climate framework and the 1.5°C goal

The **Climate Change Act (CCA)** was a cross-party piece of legislation passed in 2008 that has been widely hailed as a world-leading and comprehensive framework for tackling climate change, thanks to its level of ambition underpinned by interim carbon budgets, and regular stocktakes via an annual progress report. It set a legally binding target of reducing the UK's greenhouse gas (GHG) emissions by at least 80% by 2050 compared to 1990 levels. It also established the independent Committee on Climate Change (CCC) to provide advice on the delivery of this target and set out five-yearly carbon budgets to provide a clear, cost-effective roadmap to meet that goal.

Since then, the landmark **Paris Agreement in 2015** increased international ambition, aiming to hold increases in global average temperature to "well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C".[4] During the Paris Summit (COP21), the parties also asked the advisory **Intergovernmental Panel on Climate Change (IPCC)** to consider the impacts of global warming of 1.5°C compared to 2°C (see right) and to model the pathways for meeting this more ambitious goal.

IPCC FINDINGS ON 1.5°C

The IPCC Special Report (SR15),[5] published in October 2018, found that at the current rate of global temperature increases, 1.5°C will likely be breached between 2030 and 2052. Crucially, **every additional 0.1°C of warming makes a meaningful difference**, with worse heatwaves, flooding, droughts, sea level rise and negative biodiversity impacts expected at 2°C of warming compared to 1.5°C. It also modelled that to achieve no or limited overshoot of 1.5°C **global net anthropogenic CO_2 emissions must decline by about 45% from 2010 levels by 2030 and reach net zero by around 2050** (2045–2055).

The IPCC found that current Nationally Determined Contributions (emission reduction pledges) made by signatory countries under the Paris Agreement are in line with 3°C temperature rise. SR15 also notes that time is of the essence: the greater the emission reductions achieved by 2030, the better the chance to limit global warming to 1.5°C.

© UNFCCC

4 UNFCCC (December 2015) *Paris Agreement*

5 IPCC (October 2018) *Special Report on Global Warming of 1.5 °C*

Following the release of SR15, the UK Minister of State for Energy and Clean Growth, **Rt Hon Claire Perry MP asked the CCC to provide advice on the UK's long-term climate change targets**, including "the date by which the UK should achieve a net zero target", and/or "a net zero target in order to contribute to the global ambitions set out in the Paris Agreement", including whether now is the right time for the UK to set such a target. The CCC has also been tasked with advising the government on the expected costs and benefits for a range of emission reduction scenarios, versus meeting current CCA targets. The letter was co-signed by the Scottish and Welsh governments and supported by Northern Ireland officials.[6] The CCC is expected to publish its advice in Spring 2019.

The Aldersgate Group's working understanding is that the additional 20% of net emission reductions to meet net zero is likely to come from full decarbonisation of electricity, surface transport and heat, far greater decarbonisation of heavy industry (with an important role for Carbon Capture and Storage) and investment in other forms of GHG removal technologies, such as afforestation and peatland restoration. Areas that have previously not been a significant focus for decarbonisation, such as agriculture (see page 37) and long-distance transport will also require greater attention.

WHAT IS NET ZERO?

'Net zero' or 'carbon neutral' are widely used terms but lack a common definition across sectors, and may variously refer to CO_2 emissions or GHG emissions. The Paris Agreement calls for a "balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century".[7]

At its most straightforward it refers to a reduction of GHG emissions to the greatest extent possible, with any unavoidable remaining emissions removed through greenhouse gas removal technologies, including natural carbon sequestration from trees and soil, or technologies like carbon capture and storage.

International momentum towards net zero

The idea of net zero is gathering momentum amongst the UK's partner nations:

- The European Parliament backed a motion for a net zero target by 2050 and the Commission indicated a preference for a pathway to net zero emissions by 2050;
- France has proposed legislation on carbon neutrality by 2050;
- New Zealand's proposed Zero Carbon Bill is set to be introduced in the next few months and will set a date of 2050;
- Sweden's Climate Act sets a legal net zero GHG target by 2045;
- Norway has agreed a net zero GHG goal by 2030.

A Carbon Neutrality Coalition was set up in 2016 and as of September 2018 had 19 countries as signatories including Germany, France, Spain, Canada and the UK, and 32 cities, including London, Berlin, Copenhagen, New York City, Paris, San Francisco, Sydney and Toronto.

6 https://bit.ly/2AZSChw

7 UNFCCC (December 2015) *Paris Agreement*

Undeniably, countries have not all pulled in the same direction. United States President Trump indicated his intention for the US to withdraw from the Paris Agreement, and the new Brazilian President Bolsonaro has suggested that Brazil is also likely to withdraw. Meanwhile, the UN Environment Programme's 2018 Emission Gap report showed a sobering gap between current policy scenarios and what is needed to meet a 1.5°C pathway[8] and China's CO_2 emissions grew 3% last year, the largest increase in its emissions in over five years.[9] Despite those tensions, progress in international negotiations prevails, with a set of rules to implement the Paris Agreement unanimously agreed at the COP24 summit in Katowice in December 2018. The momentum to ratchet up ambition at COP26 in 2020 remains promising. While there will inevitably be leaders and laggards in this transition, the international direction of travel is moving towards net zero emissions.

The business case for a net zero target

Setting a net zero target backed by supportive policies will expand the market demand for zero and ultra-low emission infrastructure, products and services. If managed well, it will galvanise significant private sector innovation and provide strong foundations to support long-term, sustainable growth for the UK.[10]

In our engagement with a broad cross-section of UK industry, the Aldersgate Group has found that businesses believe there to be greater potential for innovation and industrial growth opportunities in seeking to deliver net zero emissions compared to an 80% reduction, due to the truly transformative approach required. Companies are setting their own net zero targets and at the time of writing, over 540 companies globally have committed to or set science-based emissions reduction targets.[11]

Industrial opportunities

A great deal of research has already been done on the business case for decarbonisation, such as opportunities for market ownership and competitive edge for early movers to meet increasing global demand.[12] Expenditure on new low carbon infrastructure around the world is already anticipated to be £65tn by 2030 under a 2°C scenario, while on the basis of the UK's existing 80% emission reduction target, the low carbon economy could contribute around 8% of UK Total Output by 2030, rising to around 13% by 2050.[13] These opportunities are likely to become even greater in a 1.5°C world.

8 UNEP (November 2018) *Emissions Gap Report 2018*

9 Unearthed (28 February 2018) 'China's CO_2 emissions surged in 2018 despite clean energy gains'

10 University of Cambridge Institute for Sustainability Leadership (September 2018) *Aiming for zero: A growing business movement*

11 sciencebasedtargets.org

12 See for example: Grantham Research Institute on Climate Change and the Environment (April 2017) *UK export opportunities in the low-carbon economy*

13 Ricardo Energy & Environment (March 2017) *UK business opportunities of moving to a low carbon economy*

LESSONS FROM FOSSIL FREE SWEDEN

The Swedish government launched a Fossil Free Sweden initiative ahead of COP21 with the aim of becoming one of the world's first fossil free nations. **Over 350 companies, municipalities, regions and organisations are taking part in the initiative and so far 11 industries have set out their own roadmaps towards "fossil freedom and increased competitiveness".**[14]

The roadmaps set out when and how the industries will become fossil free, what technological solutions need to be developed, what investments need to be made and what obstacles need to be removed. For example:

- the **construction and civil engineering** industry believes that it can halve emissions by 2030 using existing technologies, and reach net zero by 2045 using technologies currently under development;
- the **concrete** industry intends to halve its climate impact in 5 years, with climate neutral concrete available by 2030 and all concrete in Sweden becoming climate neutral by 2045;
- the **aviation** industry intends to use biofuels to achieve fossil free domestic aviation by 2030 and all flights departing from Swedish airports are to be fossil free by 2045.

The process adopted by Sweden in realising its net zero commitment provides a positive precedent for how the UK could develop an industry-led and evidence-based strategy to deliver net zero. Engaging industries to set their own roadmaps together in partnership with their value chains demonstrates a good model for public-private collaboration, anchored in business growth and innovation.

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Being in the early vanguard of countries to set a legally binding net zero target builds on and reinforces the UK's reputation as a world leader on clean growth and climate change action, shoring up its global reputation as it seeks to redefine its position on the world stage outside of the EU.

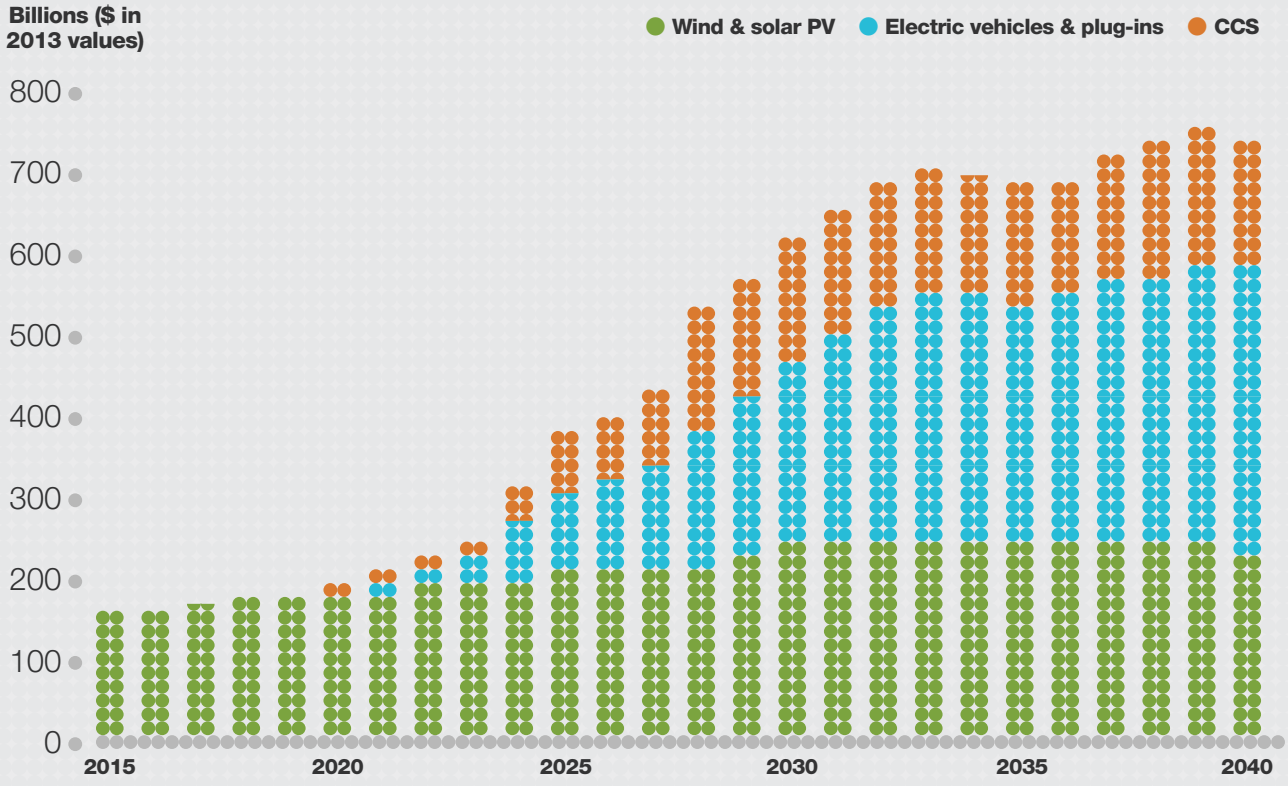
However, the UK's competitors are also actively investing to seize a greater share of this market. For example, China invested $1.1tn in energy efficiency in 2016 – half of the global total that year – and Chinese firms make up more than half of the global energy service market.[15] Meanwhile Germany, Denmark, Spain and Portugal have developed an advantage in wind turbine manufacturing over the UK (based on patent data).[16] **The UK must therefore take a proactive industrial approach to support its continued competitiveness and stake its claim to the zero carbon economy.**

14 Fossil Free Sweden (February 2018) *Roadmap for fossil free competitiveness: a summary of roadmaps from Swedish business sectors*

15 Carbon Brief (9 January 2018) 'China leading on world's clean energy investment, says report'

16 Bruegel (2016) *An approach to identify the sources of low-carbon growth for Europe*

GLOBAL INVESTMENT IN RENEWABLES, CCS & ELECTRIC VEHICLES IN A 2°C SCENARIO



Source: IEA (2015) World Energy Outlook

Avoided costs and co-benefits

There is significant research on the avoided costs and co-benefits associated with taking action on climate change too. Researchers from Stanford University modelled **the likely benefits of remaining within 1.5°C to be in the range of tens of trillions of dollars globally, more than 30 times greater than the costs of doing so**.[17] The landmark Stern Review in 2006 found that the overall costs of climate change will be equivalent to losing at least 5% of GDP each year[18] while the Energy Transitions Commission estimates that reaching net zero CO_2 emissions by mid-century would cost just 0.5% of global GDP.[19]

A scoping review of a wide range of health and environmental impacts of the UK's fourth carbon budget for the CCC estimated that it would deliver more than £85bn from 2008 to 2030 in terms of health, energy security, economic development, social capital and natural capital.[20]

Keeping global temperature increases to 1.5 degrees will help safeguard our investment portfolios and protect our customers savings. The long-term negative financial consequences of climate change are far, far greater than the short-term financial risks of transitioning to the Paris Agreement.

STEVE WAYGOOD, CHIEF RESPONSIBLE INVESTMENT OFFICER, AVIVA INVESTORS

WHAT WE HEARD FROM BUSINESS

In writing this report, the Aldersgate Group engaged a cross-section of business stakeholders in emissions intensive industries and 'hard to decarbonise' sectors, through roundtable discussions and bilateral meetings. The findings of this report are drawn from those conversations, where we heard the following:

- I'm really excited by the challenge – it's a challenge for sure, but it's really motivating for me.
- We will grapple with it and we will succeed but we've got to realize that 2050 in carbon and investment terms is tomorrow. We need to introduce a net zero target by 2021–2022.
- We both have to do it, and we can do it.
- The industry accepts the science and we know we have to play our part.

17 Burke, M. et al (23 May 2018) 'Large potential reduction in economic damages under UN mitigation targets', *Nature 557*, pp.549–553

18 Stern, N. (2016) *The Stern Review on the Economics of Climate Change*

19 Energy Transitions Commission (November 2018) *Mission Possible*

20 Aether (June 2016) *Scoping study on the co-benefits and possible adverse side effects of climate change mitigation: Final report*

TWO LAYING THE FOUNDATIONS FOR ACHIEVING NET ZERO

To put the UK on a credible pathway to achieve net zero emissions, the government must urgently pursue low regret action in areas such as the power, building and transport sectors.

Meeting net zero GHG emissions in the UK is already feasible based on existing technologies, provided deployment and commercialisation of technologies currently in development is rapidly accelerated.[21] To put the UK on track to target 1.5°C cost effectively, the UK must take appropriate near-term, no regret action now, much of which is already required under its existing climate targets.

We cannot and should not adopt a 'wait and see' policy. It would undermine the UK's ability to achieve net zero emissions cost-effectively and jeopardise the UK's competitiveness in an increasingly decarbonised global economy. As the IPCC's SR15 report says, **the greater the emission reductions achieved by 2030, the better the chance to limit global temperature increases to 1.5°C.**[22] Analysis from Green Alliance shows that waiting until after 2032 to act would mean a 70–120% increase in effort in the 2030s and 2040s to meet net zero in the UK.[23]

BEHAVIOUR CHANGE

While this report does not tackle behaviour change in detail, it must be mentioned that **many critical actions for decarbonisation to net zero will require far greater public engagement** – from making different lifestyle choices, including in travel and consumption, to investing in energy efficiency in their homes, reuse of resources and signalling concern to politicians and financial services. There has been an almost unprecedented level of public engagement in the issue of plastic pollution in recent years. The government can build on this platform to boost public support and responsibility for delivering a net zero target through greater public education and communications. Focusing on near-term actions can help to generate a greater sense of urgency.

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21 Vivid Economics (November 2018) *Keeping it cool: how the UK can end its contribution to climate change*

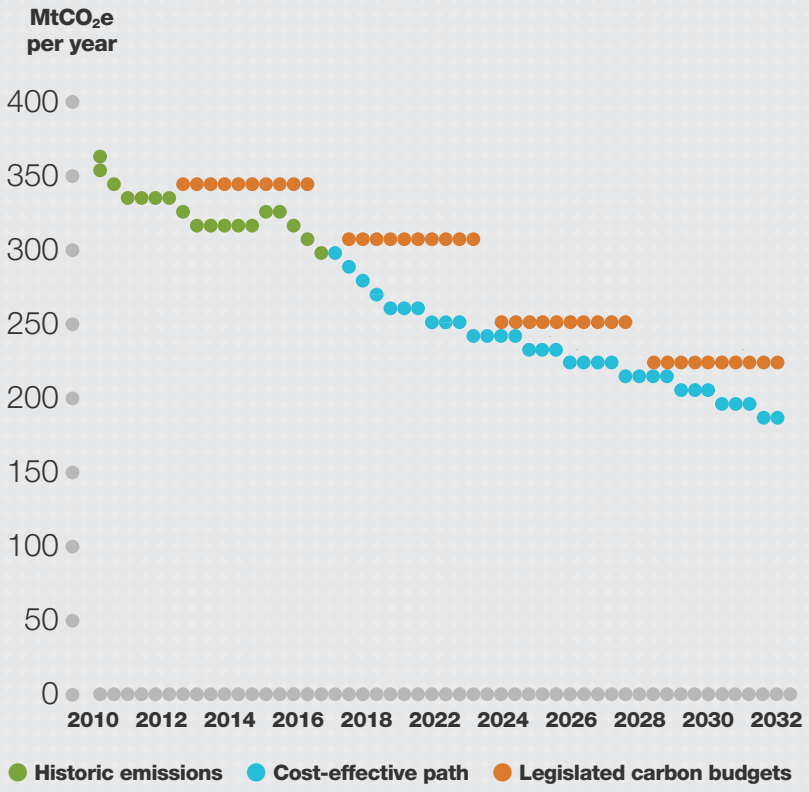
22 IPCC (October 2018) *Special Report on Global Warming of 1.5°C*

23 Green Alliance (2018) *How can the UK stop contributing to climate change*

Low regret short-term action

There are key low regret policy options that the government should adopt in the near term to set the UK on a feasible pathway towards 1.5°C. **At a minimum, the UK must first meet its fourth and fifth carbon budgets**, which cover emission reductions for the years 2023 to 2032 but are currently not on track to being met.[24] To deliver decarbonisation in the most cost-effective way, even to meet the 80% reduction target, **the UK must achieve deeper emission cuts than those set in the carbon budgets.**[25]

THE COST-EFFECTIVE PATH TO MEET THE FOURTH AND FIFTH CARBON BUDGETS



Source: CCC June 2018 Progress Report

24 CCC (June 2018) *Progress Report to Parliament*

25 Ibid.

To meet the UK's current targets and ensure a credible platform for achieving net zero emissions, low regret priorities for government in the near term include:

1 **Accelerating emissions reductions in the power sector while supporting competitive industrial electricity prices.** This requires increasing renewable energy generation capacity and storage in the UK, including providing a route to market for mature forms of renewables such as onshore wind and solar generation. The UK should secure continued participation in the internal energy market and ensure efficient access to EU markets through electricity interconnection, optimising the use of renewable energy sources across national borders. UK industrial electricity consumers must be allowed to benefit from providing system-related services, such as demand-shifting and frequency support.[26]

2 **Establishing a robust carbon price** to improve the economics of decarbonisation and greenhouse gas removal (GGR) technologies[27] by resuming the carbon price escalator. This should take effect as coal retires from the UK system in the early 2020s, with an appropriate support mechanism for electro-intensives where justified.[28]

3 **Prioritising energy efficiency to reduce energy and thermal demand** in commercial and domestic buildings and industrial applications. This includes a trajectory of tightening energy efficiency standards in existing buildings to drive large-scale retrofitting in the 2020s, setting truly world leading energy efficiency standards for new buildings in the Future Homes Standard and introducing well-timed fiscal incentives such as stamp duty rebates to boost the market for energy efficient homes.[29] Government can encourage best practice in manufacturing efficiency across industry.[30]

4 **Rolling out low regret options to decarbonise heat in buildings.** This should include building all new homes with low carbon heating by 2025[31] as set out in the Spring Statement, rolling out heat pumps to properties off the gas grid as well as extending low carbon heat networks in cities and injecting biomethane into the gas grid.[32] As discussed later in this report, this should be accompanied by large scale pilot projects to investigate the potential of hydrogen to cut building heat emissions.

5 **Developing a holistic approach to reducing surface transport emissions.** This requires reducing car dependency through improved public transport provision and incentivising uptake of zero emission vehicles for consumers and industry, supported by a sufficient and interoperable national charging infrastructure. It also requires moving freight from road to rail and developing solutions for fleet and heavy transport options.[33]

6 **Rapidly implementing the new Resources and Waste Strategy**. Key commitments announced in the strategy that must now be delivered include the roll-out of extended producer responsibility schemes, new product standards and an improved public procurement policy that incentivises more resource efficient product and infrastructure design.[34]

26 For more see: UCL (February 2018) *UK industrial electricity prices: competitiveness in a low carbon world*

27 Royal Society & Royal Academy of Engineering (September 2018) *Greenhouse Gas Removal*

28 UCL (February 2018) *UK industrial electricity prices*

29 Aldersgate Group (March 2018) *Increasing investment in commercial energy efficiency* and *Increasing investment in domestic energy efficiency*

30 Green Alliance (2017) *Lean and clean building manufacturing excellence in the UK*

31 CCC (February 2019) *UK housing: fit for the future?*

32 Aldersgate Group (December 2016) *Briefing: decarbonising heat in buildings*

33 Aldersgate Group (March 2019) *Shifting emissions into reverse gear: priorities for decarbonising transport*

34 Aldersgate Group (June 2018) *No time to waste: an effective resources and waste strategy*

7 **Overseeing 5G infrastructure roll out and supporting data connectivity.** The ICT sector could enable a 24% reduction in UK carbon emissions annually whilst adding £122bn in sustainable economic benefits, including £63.5bn in cost saving opportunities through smart systems and logistics.[35] Government must act as a digital champion, including meeting its target of deploying smart meters in all homes that want one by 2020, and enable the market to install 5G networks rapidly.[36] Government will also have to develop a robust data privacy governance framework in tandem with connectivity roll out.

> The Paris Accord was a great moment of hope as countries came together to tackle the challenge of climate change. The IPCC report confirms that it is possible to achieve what we need to, but only if everyone responds with speed and ambition. It is not too late, but there can be no delay.
>
> 
>
> **BENET NORTHCOTE, DIRECTOR OF CORPORATE RESPONSIBILITY, THE JOHN LEWIS PARTNERSHIP**

8 **Investing in land use to support decarbonisation.** The UK should ramp up investment in greenhouse gas removal methods which provide co-benefits, such as crop productivity and biodiversity enhancement.[37] This could include improving soil carbon sequestration, habitat restoration and afforestation to help achieve net zero emissions whilst also delivering existing government commitments under the 25 Year Environment Plan.

9 **Using the UK's diplomatic reach and new trade policy to promote the adoption of net zero targets and trade in low carbon goods and services.** Recognising that tackling climate change is a global issue, the UK should build on its extensive diplomatic network of climate attachés to promote the adoption of net zero targets in line with the recommendations of the IPCC. COP26 will be a significant opportunity in this process. When developing any future independent trade policy after it leaves the EU, the UK government should also ensure that its future trade agreements support the delivery of a net zero target and promote growing trade in low carbon goods and services.

The Aldersgate Group has set out its detailed policy asks for these areas in separate reports and briefings, which can be found at www.aldersgategroup.org.uk/our-reports.

35 Accenture & BT (May 2016) *The Role of ICT in Reducing Carbon Emissions in the UK*

36 National Infrastructure Commission (December 2016) *Connected Future*

37 Royal Society & Royal Academy of Engineering (September 2018) *Greenhouse Gas Removal*

THREE: TAKING A BOLD APPROACH TO INNOVATION

An ambitious UK strategy on innovation will be critical to delivering net zero emissions and making the most of the industrial opportunities arising from this transition.

Delivering a net zero target will require an innovative approach to decarbonisation, both in terms of (i) deploying new technologies that are currently not commercialised and (ii) making better use of existing processes. As moving from invention to widespread deployment generally takes place over many decades, in both cases the short timescale for achieving net zero emissions means that the cycles of innovation must be significantly accelerated.

Supported by a complementary report the Aldersgate Group commissioned from Vivid Economics and the UK Energy Research Centre,[38] this section argues that the UK needs a bold innovation policy which incentivises the trial of key technologies like CCS and hydrogen at scale, provides funding for R&D and deployment and commercialisation, supports adoption of new processes and models, and sets a clear strategy for rapid whole-system decarbonisation. **Given the scale of the challenge, government innovation policy must move beyond the fear of failure and towards the recognition that both successful and unsuccessful pilot projects provide valuable lessons to inform good policy making.**

ACCELERATING ZERO CARBON INNOVATION IN THE UK

A report from Vivid Economics and the UK Energy Research Centre (UKERC) commissioned by the Aldersgate Group to sit alongside this report sets out several lessons for government to accelerate innovation to deliver a net zero target. The report draws lessons from past innovations including the digitalisation of banking, the establishment of central heating and the gas network in the UK, steel production in South Korea, wind development in Denmark and the UK and the failure to date of CCUS deployment.[39]

It finds that government innovation support is required due to a coordination failure between firms that means valuable information about new inventions is typically not shared. As a result, the rate of innovation is slower than the optimal level.

Key actions to accelerate low carbon innovation in the UK are:

1. **Increase ambition in demonstrating complex and high capital cost technologies**, such as at-scale investment commitment in the 2020s for CCUS, demonstrators for Direct Air Capture and the feasibility of using hydrogen for heating.

2. **Create new markets to catalyse early deployment and move towards widespead commercialisation**, such as through CfDs for power sector CCUS and obligations on fossil fuel suppliers to capture and store carbon emissions, accompanied by a clear strategy and institutional support for the development of necessary infrastructure.

38: Vivid Economics & UKERC (April 2019) *Accelerating innovation to meet net zero*

39: *Ibid.*

3 **Use concurrent innovations happening in the digital sector to improve system efficiency and make new products more accessible and attractive to customers.** For example, using digital technologies to increase flexibilty and accelerate customer take-up of smart low carbon heating, while passing on cost benefits to consumers.

4 **Use existing or new organisations to accelerate innovation in critical areas and co-ordinate early stage deployment.** Third party institutions can bring together the right actors and promote knowledge sharing, counteracting corporate drivers to maintain exclusivity over innovation knowledge. Institutions with a clear mandate are also needed to coordinate efficient deployment in complex areas with multiple infrastructures, such as low carbon heat and coordinating CO_2 capture, transport and storage infrastructure.

5 **Harness trusted voices to build consumer acceptance.** Past rapid consumer transition have been facilitated by trusted institutions that provide a combination of information, technical assistance and addressing consumer concerns (e.g. around safety). Expanding the role of existing trusted organisations and setting up a reliable system of certification can build trust in new technologies. Early, genuine, open and transparent public engagement is needed where technologies are very novel and likely to elicit feelings of risk, such as CCUS and DACCS.

6 **Align innovation policy to strengthen the UK's industrial advantages and increase knowledge spillovers between businesses and sectors.** Tying innovation to economic development and reducing costs for customers can accelerate the pace of development. In the UK, technology spillovers are likely to be high in CCUS, heating, ventilation & air conditioning (HVAC), wind, biofuels and batteries. These areas should be prioritised to drive additional productivity benefits and contribute to growth.

Supporting the deployment of complex technologies

Several of the key technologies required to accelerate decarbonisation are fairly well understood and should be prioritised in UK innovation policy. It is widely agreed that hydrogen and CCS are likely to play a major role in global decarbonisation[40] and particularly in allowing the UK to meet a net zero target. **The UK needs a detailed strategy to rapidly explore the full potential application of hydrogen in industry and heat, as well as the possible applications in transport and flexibility in the power system.** This should build on existing scoping work like the H21 Leeds City Gate project.[41] France has pursued an ambitious hydrogen strategy, aiming to use 10% decarbonised hydrogen in industry by 2023 as well as aiming to deploy 5,000 hydrogen powered Light Commercial Vehicles by 2023.[42] This gives a sense of the scale of pilots that the UK must embrace.

This must go hand in hand with a credible commitment to scaling up CCS in the UK to commercial scale, given that in the initial stages CCS will likely be required to produce sufficient volumes of clean hydrogen.

CCS will also be vital in its own right to achieve net zero emissions where residual emissions cannot be reduced, in particular in industry and long-distance transport. As the CCC notes, "the Government should not plan to meet the [80% reduction by 2050] target without CCS" and "deeper reductions requiring the deployment of CCS will be needed to meet the aims of the Paris Agreement".[43] However, CCS deployment has been beset by delays to date. Greater consistency in policy support will be vital for commercialisation.

While the government's November 2018 CCUS Action Plan argues that "no technology can proceed at any price",[44] **when valuing the price government must not simply look at CAPEX but also consider a range of other important factors**: the potential for future market leadership in what will be a globally important industry,[45] the fact that the UK already has suitable transport and storage infrastructure,[46] the potential to grow productivity in the UK's foundation industries and the risk that a late adoption of CCS could result in steeper and more expensive decarbonisation. BEIS' own estimates put the cost of meeting the 80% target by 2050 without CCS at an additional £30bn.[47]

Greater cost effectiveness of CCS can be facilitated by introducing a robust price on carbon, or a scheme similar to the 45Q policy in the US which pays a credit of $50 per tonne of carbon dioxide permanently sequestered[48] to help establish a market for CCS and allow the cost to come down as the market matures.

40 Energy Transitions Commission (November 2018) *Mission Possible: Reaching net-zero carbon emissions from harder-to-abate sectors by mid-century*

41 Northern Gas Networks (July 2016) *H21 Leeds City Gate*

42 Gouvernement.fr (4 June 2018) 'Hydrogen Plan: "making our country a world leader in this technology"'

43 CCC (January 2018) *An independent assessment of the UK's Clean Growth Strategy – from ambition to action*

44 CCUS Cost Challenge Taskforce (July 2018) *Delivering clean growth*

45 Royal Society (May 2017) *The potential and limitations of using carbon dioxide*

46 Royal Society & Royal Academy of Engineering (September 2018) *Greenhouse Gas Removal*

47 National Audit Office (January 2017) *Carbon capture and storage: the second competition for government support*

48 Congressional Research Service (August 2018) *Carbon Capture and Sequestration (CCS) in the United States*

Learning by doing and trialling new technologies at scale

There is a perception amongst business that government is not sufficiently focused on making forward-looking decisions at this critical time in the industrial transition. Where challenges are complex and have multiple potential solution pathways, **government should pursue a 'learning by doing' agenda.** This has been demonstrated in markets like China and South Korea, which have leapt ahead of the rest of the world in technological innovation doing exactly this. For example, China's local and national investment in an electric bus market has created significant learnings for Chinese manufacturers like BYD, which now supplies around two thirds of the electric buses in the US.[49] Similarly, South Korea made a strategic decision to invest in steel manufacturing in the 1960s envisaging future export potential and in doing so became an innovator and leading exporter of steel worldwide.[50]

The short timescales for achieving net zero emissions and the global race to develop new low carbon technologies and services mean that **government must not wait to have the definitive 'right' answer on a number of difficult areas before acting. The UK must start trialling different solutions at scale**, using already existing pre-commercial technologies to gather evidence, improve understanding of best practice, skill up the supply chain, spread consumer understanding and develop governance principles around new technologies. For example, if the UK were to install hybrid heat pumps, heat networks and hydrogen in one million homes each, there would still be 22 million homes left to treat. The UK must start trying different solutions at scale now in order to have a well-informed plan for full decarbonisation of heating. **While early pilot projects may not deliver the ideal desired outcome, well-designed and managed pilots have inherent value in generating lessons learned, through both technical and operational successes and failures.**

49 TechCrunch.com (11 July 2018) 'BYD and Generate Capital launch $200M electric bus leasing JV in the US'

50 Vivid Economics & UKERC (April 2019) *Accelerating innovation to meet net zero*

TRIALLING NEW AVIATION FUELS

Aviation emissions have been historically challenging to decarbonise, due in part to their inherently international nature, increasing demand for air travel and a lack of commercially viable alternative fuels to date.

Progress is now being made through industry trials. In October 2018, British airline Virgin Atlantic flew its first flight from Florida to London powered by biofuel made from industrial waste gases converted to ethanol, estimated to have the potential to reduce emissions by at least 65% compared to conventional jet fuel, and all Virgin Atlantic UK outbound flights aim to fly with a 50% biofuel mix by 2025. British Airways is also partnering with Velocys to invest in a renewable jet fuel plant, converting post-recycled waste with the expectation of reducing GHG emissions by over 60%. Such alternative fuels can provide a useful hybrid solution for aviation emissions in the short to medium-term.

Airports are also taking steps to enable decarbonisation. For example, Heathrow airport is incentivising cleaner aircraft technology (e.g. by offering free landing fees for the first commercially viable electric flight – worth £1m), improving and modernising operational efficiency (e.g. reducing waiting time for planes looking to land, thus reducing the amount of fuel needed), developing sustainable aviation fuels, and investing in carbon offsetting methods, such as working with peatland restoration projects in Lancashire.[51]

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51 BusinessGreen (3 December 2018) "We've got to earn the right to grow': Heathrow unveils 'carbon neutral' roadmap"

Increasing government's risk appetite

HM Treasury public spending guidance and concern over negative headlines creates an excessively cautious approach to expenditure of public funds, for fear of poor public investment. Whilst this is understandable, it acts as a barrier to taking a proactive learning by doing approach, prevents valuable experience to inform good policy making and often increases the cost of deployment of new technologies in the long term.[52] It is worth noting however that Treasury's public spending guidance does allow different departments to make decisions on their own acceptable levels of risk appetites. The guidance states that the **risk and opportunity analysis 'should avoid excessive caution, since it can be as damaging as unsuitable risk taking'** with a normal assessment considering the dangers of maintaining the status quo, amongst other issues.[53]

Given the urgency of accelerating decarbonisation and cutting the cost of new technologies to meet net zero, **BEIS should increase its risk appetite to support innovation and deployment of critical technologies**, supported by adequate funding for low carbon technology trials in the 2019 comprehensive spending review.

While the private sector tends to have a greater appetite for innovation risk and is already undertaking pilot projects to achieve deep decarbonisation, government must not simply hope that the market will deliver. **New targeted partnership funding models between the public and private sector must be developed** to share investment risk through government's access to low capital cost finance, while taking advantage of business expertise to create a permissive and forward-looking innovation ecosystem in the UK.[54] Potential models include co-investing with the private sector at the development stage to crowd in other funding, direct government funding of development costs to be refinanced by the private sector on successful completion of a project, or providing government guarantees to repay early-stage development funding provided by the private sector in the event of a failure to complete the project.[55]

Providing innovation funding for R&D and deployment

Research commissioned by the US Department of Energy found that for every $1m spent on basic research on new technology, another $10m is required to scale up that technology and $100m is required to move that technology into large-scale manufacturing.[56] Government should therefore engage with industry to understand how best to structure funding to facilitate best use of innovation investment.

The UK suffers particularly from the 'valley of death' funding gap,[57] where promising start-ups or new technologies are successful at the research stage but fail to reach commercial viability and receive investment. For example, the UK fledgling marine energy industry had first mover advantage but a lack of support from government for deployment is moving expertise abroad.[58] Currently, 60% of all funding rounds in Britain above £10m involve an American investor,[59] taking innovation benefits out of the UK.

Retaining the benefits of the low carbon transition in the UK therefore requires targeting different pots of funding at different stages of innovation development, and in particular at the scale up and large-scale manufacture or deployment stages of innovation. **The power generation sector has shown that meaningful and targeted support at both the innovation and market deployment stage can accelerate the development and cost reduction of new technologies, particularly in offshore wind.**[60] The level of support seen by the power generation industry now needs to be extended to industry to support its transition in a stable way.

The two-staged approach to DfT's advanced fuels competition provides a good model to allow demonstration projects at a lower value initially, with additional higher-level funding available for the most promising solutions.

52 ETI (November 2018) *Still in the mix? Understanding the role of Carbon Capture Usage and Storage*

53 HM Treasury (July 2013, revised March 2018) *Managing Public Money*

54 Aldersgate Group (March 2018) *Towards the new normal: increasing investment in the UK's green infrastructure*

55 Aldersgate Group private briefing (February 2019) *Directing green finance towards infrastructure* (available on request)

56 Johnson Matthey (29 November 2018) 'A battery material capable of powering a revolution'

57 House of Commons Science and Technology Committee (March 2012) *Bridging the valley of death: improving the commercialisation of research*

58 RenewableUK (February 2017) *Ocean energy race: The UK's inside track*

59 The Economist (6 April 2017) 'British tech firms suffer from impatient investors'

60 The Times (11 September 2017) 'Cost of energy from offshore wind halves'

INNOVATIVE PROCESSES IN STEEL MANUFACTURING

Steel accounted for around 7% of global emissions in 2014[61] and is a vital component of many low carbon technologies, such as offshore wind turbines. Under current projections, CO_2 emissions from the steel industry will increase by up to 25% by 2050 thanks to population and urbanisation trends.[62]

In Sweden, power company Vattenfall, mining company LKAB and steel manufacturer SSAB have set up a joint venture company **HYBRIT, to create a fossil fuel-free process for steel manufacturing**, supported by the Swedish Energy Agency. The project, currently in a trial pilot study, aims to replace the coke in blast furnaces with direct reduction using hydrogen gas produced by electricity from fossil-free sources of energy.[63]

The pilot will be completed in 2024, followed by tests in a demonstration plant. It is **anticipated that in 2035 fossil-free steel production will be commercially viable.** The initiative could reduce Sweden's total CO_2 emissions by 10% and those in Finland by 7%. Moreover, HYBRIT believes that large-scale hydrogen production and storage will allow for flexibility in power consumption on a large scale and boost the wider hydrogen economy. To become cost competitive against traditional counterparts, fossil-free steel must be supported by greater renewable generation reducing electricity prices, and an increased carbon price through the European Union's Emissions Trading Scheme.

In the UK, **Liberty Steel is hoping to pioneer GREENSTEEL** through a £700m investment programme over three years (from 2017) to recycle scrap steel by melting it down with electric arc furnaces powered by renewable biomass pellets, rather than coal-fired blast furnaces. The electricity will be provided by renewable generation also owned by parent company Liberty House. Liberty has ambitions to increase its steel making capacity from 1.1 million tons a year to 5 million tons a year, around half of the UK's current total production. Liberty plans to use renewable sources at its main steel recycling plant in Rotherham and has launched a metal recycling business, Liberty Metal Recycling with a processing centre at Newport with the intention of recycling 5 million tonnes of metal a year in the UK.[64]

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61 IEA workshop (20 November 2017) 'Steel and CO_2 – a global perspective' https://bit.ly/2SbMXzD

62 Hybrit (February 2018) *Summary of findings from HYBRIT Pre-Feasibility Study 2016–2017*

63 www.hybritdevelopment.com

64 https://bit.ly/2RflVFS

Technical assistance in developing innovative processes and business models

Delivering net zero emissions will not only require technological innovation, but also the development of new business models and more efficient processes to reduce resource use and drastically cut the lifecycle impact of products. A move towards the circular economy can reduce 40% of CO_2 emissions from heavy industry whilst reducing resource input.[65]

However, **adopting new processes and business models can be complex and risky**, particularly as businesses often have no policy incentive to do so. Recent Aldersgate Group research, based on its involvement in the REBus resource efficiency business pilot projects,[66] found that **businesses (especially SMEs) tend to require both technical support and targeted innovation funding** to trial new approaches. Government can support this, learning from the Dutch Green Deal and the European Commission's Innovation Deals to provide businesses with free technical advice to develop new business models and engage consumers in the process.[67] Reversing a recent trend of chopping and changing the institutions charged with technology development, consistency for existing organisations providing technical advice is necessary to help build up institutional expertise and capability to improve long-term innovation outcomes.[68]

Allowing for controlled real-world trials can also help to accelerate innovation in products and processes safely, particularly in industries with strict consumer protections and long certification periods, such as food, finance, manufacturing and passenger transport. For example, the Future Cities Catapult launched a new programme to enable companies with innovative products and services that could improve air quality, energy efficiency or comfort within a building to pilot their products and services in the real-life setting of the Urban Innovation Centre, filled with sensors and tools to measure impact. Similarly, the 'Regulatory Sandbox' developed by the Financial Conduct Authority (FCA) which has been widely viewed as a success[69] allows innovating companies to trial new products, services and business models in a controlled environment, reducing the time to market while allowing the FCA to ensure it is identifying appropriate consumer protection safeguards in parallel. Using this model, additional 'sandbox' style institutions could be established to aid 'learning by doing' at the early stage of development in highly regulated industries.

65 ETC (November 2018) *Mission Possible*

66 See www.rebus.eu.com

67 Aldersgate Group (January 2017) *Amplifying resource efficiency: UK edition*

68 Green Alliance (2013) *Nurturing UK cleantech enterprise*

69 Deloitte (2018) *A journey through the FCA regulatory sandbox: The benefits, challenges, and next steps*

RETHINKING MANUFACTURING IN A NET ZERO WORLD

Emissions from the manufacturing sector are already being reduced by embracing circular economy models that reduce the amount of raw material being used in production and designing in a way that reduces lifecycle impact. For example, carpet tile manufacturer Interface has introduced an innovative 'Proof Positive' carpet tile using plant derived carbon converted into a durable material that stores carbon. This is a carbon negative technology in a pilot stage that, if applied more widely across manufacturing, Interface believes could play a transformative role in reversing climate change.

The Proof Positive tile can be re-used multiple times. One application, the backing product 'CircuitBac Green' is already commercially available and can have a total recycled and bio-based content as high as 87%, depending on the overall design. Interface is now working on scalability but must get supply chains on board.

Going further still, Interface is making use of biomimicry to translate high performance ecosystem metrics into performance metrics for factories. It currently has two pilot projects, in the US & Australia, which attempt to replicate the natural conditions of the environment in which that factory has been built, so the factory essentially functions as a forest having a restorative impact. For example, if the original site played a role in water purification, the factory may be designed to encourage behavioural changes in water usage, purify the water through wetlands and roof gardens, catch the water, innovatively managing the effluent of the facility, etc. In this way, the manufacturing process can have net zero environmental impact.

© Interface

Setting a strategic direction for innovation and system-wide decarbonisation

The government must take a strategic approach to system planning. Where limited resources are in conflict, clear government guidance on innovation priorities will be essential. For example, with the increasing electrification of heat, transport and industry, careful planning and guidance on grid capacity, transmission and encouraging greater demand response will be vital to support the deployment of these methods of decarbonisation.

Similarly, residual waste-derived fuels and biofuels are being explored by multiple industries to be used as a more sustainable feedstock for their processes, from aviation fuels to chemical processes. However, the current supply of residual waste is currently insufficient to meet demand from all these industries, while government policy is rightly pressing for a reduction in residual waste through the Resources and Waste Strategy. Meanwhile, depending on how they are sourced, biofuels can take up land that can otherwise be used for crop production or the removal of greenhouse gases (e.g. through afforestation).

Setting **clear innovation priorities based on a granular understanding of energy requirements, availability of feedstocks and the alternative potential solutions available to different industries** will therefore be essential to avoid the deployment of conflicting technologies and support whole-system decarbonisation. This may need to be coordinated at a local or combined authority scale to do so at least cost. The Energy Systems Catapult found that heat decarbonisation through Local Area Energy Planning could be achieved for less than 15% of the cost of decarbonising electricity alone.[70]

70 Energy Systems Catapult (December 2018) *Local Area Energy Planning: Supporting clean growth and low carbon transition*

FOUR: ESTABLISHING THE FRAMEWORKS TO DELIVER NET ZERO

A net zero target must be underpinned by a comprehensive policy framework that expands the market for low carbon infrastructure, goods and services in the UK.

With the right policy package in place, a net zero target can strengthen the UK's position as a leading provider of low carbon infrastructure, products and services as well as accelerating innovation. A comprehensive policy framework requires setting a clear and reliable direction of travel, introducing low carbon product and infrastructure standards informed by lifecycle emissions, empowering local government to deliver emission reductions and having a strategy to support the UK's workforce in the transition to net zero emissions.

Setting a clear direction of travel that business can rely on

Alongside the low regret actions set out earlier in this report, **the government should commit to increase the ambition of the long-term decarbonisation target as soon as possible** after receiving advice from the CCC. There is strong political and grassroots support: at the time of writing nearly 200 MPs from across the major political parties have already publicly supported the UK setting a net zero greenhouse gas emissions reduction target before 2050[71] and a March 2018 poll from Conservative think tank Bright Blue found that 64% of UK adults agree that the UK should aim to cut its carbon emissions to zero in the next few decades.[72]

64% OF UK ADULTS AGREE
THE UK SHOULD AIM TO CUT ITS CARBON EMISSIONS TO ZERO IN THE NEXT DECADE

71 www.theclimatecoalition.org/joint-letter

72 Bright Blue (April 2018) *Public attitudes to UK climate leadership – Ten years since the Climate Change Act*

A legally binding target supported by cross-party consensus is essential to support long-term business planning and cost-effective investment, and will send a clear message to industry on the future opportunities in the UK. Setting a direction of travel in a timely way will also help offset some of the dents to investment confidence that have flowed from government decisions in recent years. The cancellation of the £1bn CCS competition after a stop-start approach, sudden cuts to subsidies for onshore wind, solar generation and biomass and the cancellation of the zero carbon homes standard in 2015 have all contributed to undermining investment confidence in the low carbon sector in the UK.[73]

A multi-decadal target may lack a sense of urgency however. **Government should work with industry and relevant stakeholders to develop sector-based roadmaps to net zero** following the example set by the development of the Swedish fossil free industry roadmaps (see pg 9), to allow businesses to set appropriate targets and measure progress in a consistent way, with processes established for regular reporting on progress and updates to the roadmaps.

Setting standards to expand the UK low carbon market

Government policy has a powerful role in creating markets, as it has done for renewable power and electric vehicles in the UK. Government must embrace the role of policy to boost the market for zero carbon infrastructure, goods and services if the UK is to achieve net zero emissions.

Gradually tightening market standards will be key to achieving this. Firstly, **well-designed and well-enforced environmental standards and regulations can result in the development of entirely new markets or spur innovation in existing ones.**[74] For example, the EU's highly successful Ecodesign Directive set energy efficiency criteria for a range of products, achieving a 18% reduction in average energy consumption by 2020 against business as usual, and saving consumers $3 for every $1 spent on average.[75]

Secondly, standards informed by **a robust understanding of lifecycle emissions that include domestic and offshore emissions can also help to create a level playing field between companies** to deliver net zero emissions. Ensuring that all infrastructure and components produced for use in the UK comply with these low carbon standards can guard against unintended consequences and ensure that UK businesses investing in low carbon business models and processes are not undermined by competitors who are not required to meet similar standards.

This could be supported by a clear, standardised definition of net zero including lifecycle analysis and lifecycle costing to facilitate better understanding of environmental performance.

Taking the example of buildings, currently there is no policy or economic incentive for individuals or companies to consider operational costs and emissions, undermining the investment case for zero carbon factories and buildings. 'World-leading' energy efficiency standards for new domestic buildings by 2025 in the Future Homes Standard should incorporate operational use of energy. This should form the basis of a net zero operational emissions standard for new (commercial and domestic) buildings by 2030 and all buildings by 2050. This could ensure energy efficient design and use while driving a market for retrofitting.[76]

Separate zero carbon standards on lifecycle emissions of buildings set within an ambitious timeline (with the support of CCS technology) would incentivise innovation to reduce the embodied emissions in key materials such as steel and cement.[77] This must be enabled by a robust industry-agreed mechanism for assessing embodied impacts in building materials and systems. Such standards would drive the growth of a UK supply chain to manufacture ultra-low carbon building materials. It would also help expand UK expertise in low impact building design, such as modular design, lightweighting and repurposing of buildings when their original use has come to an end.

73 House of Commons Energy and Climate Change Committee (March 2016) *Investor confidence in the UK energy sector*

74 BuroHappold Engineering (December 2017) *Help or hindrance? Environmental regulations and competitiveness*

75 The Economist (October 2016) 'The EU is reviewing the policy that makes its appliances so energy efficient'

76 Aldersgate Group and UK Green Building Council (July 2017) *Energy efficiency in the UK's buildings*

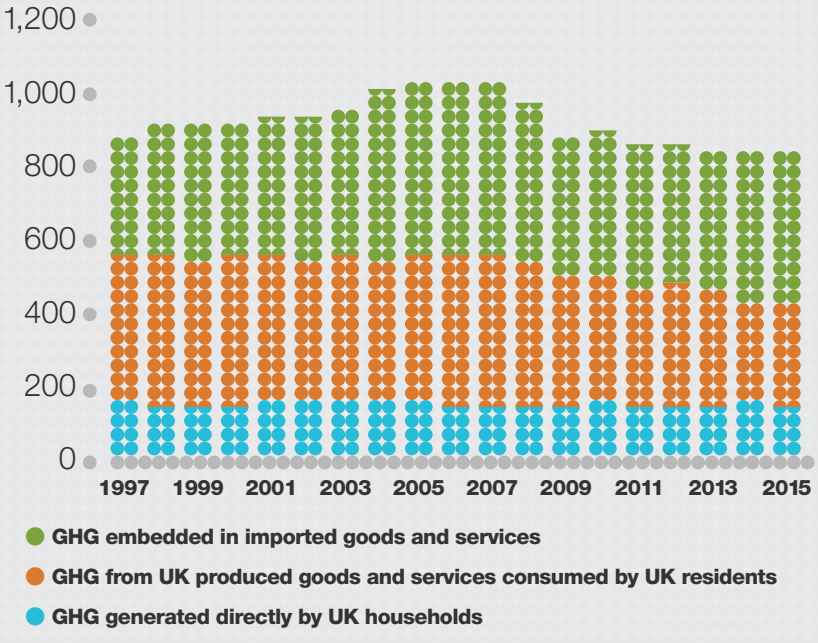
77 Greater resource efficiency in the construction sector could reduce the emissions overshoot of the fourth carbon budget by more than half, and the fifth carbon budget by 40%, largely from substituting high carbon materials with low carbon materials. Green Alliance (2017) *Less In More Out*

TACKLING IMPORTED EMISSIONS

The UK currently imports around 300m tonnes CO_2, making up approximately 43% of its total emissions. Reaching net zero in the UK will therefore require tackling the issue of imported emissions. This can be achieved by setting stringent emissions standards on infrastructure and products, based on domestic (onshore) and offshore emissions on a lifecycle basis. The UK government should also work closely with its key trade partners to promote a growing global trade in low carbon goods and services.

UK GHG CONSUMPTION EMISSIONS BY SOURCE, 1997–2015

Million tonnes CO_2 equivalents



Source: Defra (May 2018) UK's Carbon Footprint 1997–2015

Enabling local delivery of national policy

Many of the decisions to deliver decarbonisation, such as urban planning, heating and mobility systems take place at the regional or local level, with appropriate solutions defined by the resources available in the area.[78] Meanwhile, many of the co-benefits of urban climate action are local and near-term,[79] such as improved air quality, reduced fuel poverty, shorter travel times, new jobs, and better health. For example, the North of England already has over one third of England's low carbon jobs and generates nearly 50% of England's renewable energy.[80] Manchester City Region estimates a significant deep retrofitting campaign in the region has the potential to create 55,000 jobs.[81] Taking a place-based approach to tackling climate change can help to ground the abstract global nature of climate change impacts and build grassroots support for a net zero target.

78 Aldersgate Group (December 2016) *Briefing: decarbonising heat in buildings*

79 Grantham Institute (March 2019) *Co-benefits of climate change mitigation in the UK: What issues are the UK public concerned about and how can action on climate change help to address them?*

80 IPPR (December 2017) *Net-zero North: Delivering the decarbonisation mission in the North of England*

81 Greater Manchester (2018) *Greater Manchester's Springboard to a Green City Region: A carbon neutral, climate resilient city-region with a thriving natural environment and circular, zero-waste economy*

Local authorities

Local authorities should be required to establish a strategy to contribute to the national net zero target to ensure that the zero carbon transition is delivered across the country. **This must be supported by adequate and stable funding:**[82] 10% of local authorities with social care responsibilities will have no financial reserves left by 2020 if spending and funding continue at the current rate.[83] As the National Audit Office has recognised, long- and short-term financial uncertainty creates risks for value for money as uncertainty encourages short-term decision-making and undermines strategic planning.[84]

National government should therefore set out a comprehensive, long-term and stable funding strategy for local governments. This should include both revenue and capital funding and introducing a capacity-building and training programme for local authority staff to deliver low carbon growth. The government should set out a five-year devolved funding programme (replacing ad-hoc grants) and allowing for accruals of unspent funds across financial years, augmented by greater retention of local taxes. This would allow local authorities to fund local infrastructure projects like coordinated sustainable local transport strategies[85] and help deliver the national target. Where other sub-national funding pots are granted, such as the newly announced Stronger Towns Fund and the City and Growth Deals, government could require a certain percentage to be spent on decarbonisation.

LEPs and regional coordination

Local Enterprise Partnerships (LEPs) have been tasked with delivering Local Industrial Strategies and are well placed to gather evidence of barriers to local low carbon investment. As Clean Growth is one of the key pillars of the Industrial Strategy, the Department for Business, Energy and Industrial Strategy **(BEIS) must ensure that all LEPs across the country have equal and sufficient technical support and expertise to deliver decarbonisation.**[86] The government's regional workshops on green finance are a good example of how this could be achieved.[87]

A working group convening several LEPs, regional political leaders, corporate stakeholders, universities, professional institutions and investors could help to coordinate low carbon developments on a regional basis, looking in particular at reskilling programmes in areas with at-risk workforces and through local educational curricula. Cities and local authorities with an interest in becoming net zero should join international initiatives like C40 and the Climate Neutrality Coalition which seek to provide local governments with the resources and capacity to decarbonise.

Supporting the UK workforce in the transition to net zero

The necessary change of business models and technologies to meet net zero emissions is an opportunity to deliver a net job increase in the UK. A transformation towards a more circular economy could create 520,000 net jobs in the UK by 2030[88] and the UK Offshore Wind Deal is expected to grow the sector's skilled workforce to 27,000 by 2030, creating opportunities across the UK.[89]

However, **the zero carbon transition will likely result in a change of the nature, required skills and location of some jobs in the UK, creating transition risks for the UK workforce – particularly workers in energy intensive industries.** Research by the Grantham Research Institute has found that around 10% of workers in the UK have skills that could be more in demand in the green economy, while another 10% of workers, particularly in construction, transport and manufacturing are likely to need reskilling – making up around 6 million people directly affected by the green economy, with impacts felt particularly in the East Midlands, West Midlands and Yorkshire and the Humber.[90]

82 https://bit.ly/2D6ZObQ

83 National Audit Office (March 2018) *Financial sustainability of local authorities 2018*

84 Ibid.

85 Aldersgate Group (March 2019) *Shifting emissions into reverse gear: priorities for decarbonising transport*

86 Britton, J. & B. Woodman (August 2014) 'Local Enterprise Partnerships and the low-carbon economy; Front runners, uncertainty and divergence', *Local Economy 29:617*

87 www.uk100.org/category/green-finance

88 Wrap (September 2015) *Economic Growth Potential of More Circular Economies*

89 Offshore Wind Sector Deal: Written statement – HCWS1382

90 Grantham Research Institute on Climate Change and the Environment (February 2019) *Investing in a just transition in the UK: How investors can integrate social impact and place-based financing into climate strategies*

Government must therefore carefully consider how the UK workforce can be supported to benefit from the economic opportunities arising from a net zero target. This social dimension of decarbonisation is often referred to as the 'just transition'.[91]

To manage social transition risks, **the government should identify parts of the low carbon economy where the UK is particularly well placed to grow its supply chains, and in which geographic areas these jobs are likely to be created.** This should be mapped against how sectoral transition pathways are likely to impact on employment, with plans made accordingly to support the growth of new industries with similar skill sets as declining industries in the same parts of the country. There are already successful examples of this transition, with over one third of marine engineers working in offshore renewables transitioning from the oil and gas sector.[92]

The Scottish Just Transition Commission, established to look at how to maximise the opportunities of decarbonisation in terms of fair work and tackling inequalities, has been tasked with actively considering employment issues when developing climate policies, and designing and delivering low carbon infrastructure with the aim of creating decent, high value work.[93] Similar bodies could be usefully set up in areas of the UK with the greatest transition challenges.[94]

Greater dialogue between new or evolving businesses and communities will also be key to ensure there is grassroots buy-in to the opportunities associated with the zero carbon economy, demonstrating how more and better jobs are being delivered.

To ensure the UK's future workforce has appropriate skills for the zero carbon economy, the **government should integrate and encourage greater inclusion of sustainability at all levels of the educational system**, in the national curriculum, apprenticeship programmes, higher education and in particular through lifelong learning, which provides a natural platform for workers to adapt to new technologies and industries. **Engaging with low carbon industry on their future skills needs** will help to ensure the UK has an attractive pipeline of skilled workers for new and growing industries.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91 The Just Transition is codified in the Preamble to the Paris Agreement 2015, the Silesia Declaration 2018 and is implicit in the Sustainable Development Goals – especially SDG 8 on decent work and economic growth.

92 The Telegraph (11 September 2016) 'Former North Sea oil workers are finding a second wind in renewables'

93 news.gov.scot/news/leading-the-way-to-a-low-carbon-future

94 New Economics Foundation (November 2018) *Working together for a Just Transition*

SECURING SKILLS FOR A NEW INDUSTRIAL REVOLUTION

Ørsted and Siemens Gamesa have been instrumental in growing the Humber offshore wind cluster. Siemens Gamesa has invested £310m in their wind turbine blade manufacturing facility in Hull, supported by Ørsted's strong pipeline of projects off the Humber. Siemens Gamesa has recently celebrated the 500th blade off the production line. By the end of 2019, Ørsted will have invested well over £1bn directly in the Humber region and over £14m building its new East Coast Hub – the world's largest operations and maintenance base.

These investments are bringing significant economic benefits to the region, creating thousands of high-skilled jobs in building and operating offshore wind farms and catalysing investment in the supply chains around the North East.

At its Hull facility, Siemens Gamesa has created over 750 ongoing jobs in blade manufacturing, assembly and servicing facilities. Significant investments have also been made in education and training facilities, such as half a million pounds invested in the Hull College Group for a new state-of-the-art facility to train the wind turbine blade factory workforce and further investment in new University Technical Colleges in the region. In 2016, Siemens Gamesa made 14 four-year advanced apprenticeships available and in 2017, Ørsted announced it was partnering with the Grimsby Institute to deliver a 3-year wind turbine technician apprenticeship scheme, comprising of one year of classroom-based learning followed by two years working on site.

In the recently signed Offshore Wind Sector Deal, skills and training formed a substantial part of the agreement. The industry committed to creating a new skills and training accreditation framework with a sector-wide standardised curriculum. **This included developing an 'Offshore Energy Passport' that will enable offshore workers to move more easily between the renewable and extraction industries.** The industry also agreed to develop a mechanism to more easily facilitate the transfer of former military personnel into the workforce.

In addition to facilitating the development of skills, Ørsted is also focused on supporting the development of a competitive and sustainable UK supply chain. Working closely with its strategic suppliers as well as business support organisations, Ørsted's Hornsea Two supply chain event attracted over 420 individual businesses, many of whom were new to offshore wind.

The Humber is just one example of an offshore wind cluster, with many more developing across the UK. Industry players like Ørsted and Siemens Gamesa are playing a leading role in the development of the Offshore Wind Sector Deal which promises to strengthen the UK's position as a world leader in renewable energy and unlock further opportunities.

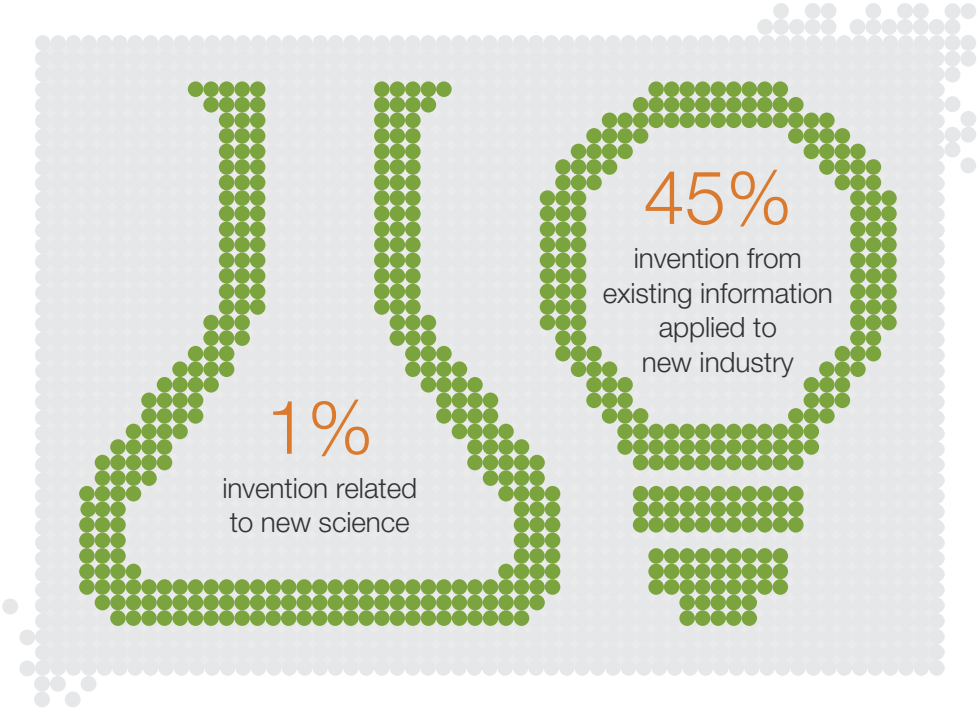
FIVE SUPPORTING COLLABORATION TO ACCELERATE EMISSION REDUCTIONS

Through policy levers and its convening power, government can encourage collaboration within and across sectors to identify opportunities to accelerate emission reductions.

The urgency for achieving net zero emissions means we do not have time to follow the usual multidecadal innovation cycle to develop a 'silver bullet' technology. However, a great deal of progress can be achieved through cross-industry and cross-value chain collaborations. **Only 1% of invention is related to new science, and 45% is derived from information that exists already but is new to an industry.**[95]

Innovation is not the only way to achieve reductions though. Improving efficiencies and having a full value chain pull in the same direction is also critical. For example, a recent study found that cement industry emissions can be reduced by up to 80% by 2050 compared to 1990 levels at low or negative cost (and net zero achieved with CCS) if all the different actors in the construction value chain work together to deploy low carbon technologies and maximise efficiency at each stage of production and construction, for example by implanting kiln improvement, improving concrete mix design and using alternative fuels.[96]

The government can encourage greater business collaboration and work with industry to identify opportunities for emission reductions across value chains by developing policies such as market standards and corporate disclosure, playing a facilitative role to support information exchange and by supporting a clusters approach to tackle industrial emissions.



95 Innovate UK blog (10 July 2017) 'Cross sector collaboration is essential to solving innovation problems'

96 ETH Zurich & Ecole Polytechnique Federale de Lausanne (October 2018) *A Sustainable Future for the European Cement and Concrete Industry: Technology assessment for full decarbonisation of the industry by 2050*

Using standards and emissions measurement to engage value chains

Introducing standards based on lifecycle analysis, as recommended in section 4, can encourage greater collaboration across the value chain by forcing companies to investigate each stage of their emissions sources. Industry feedback to the Aldersgate Group has highlighted the EU Vehicle End-of-Life Directive as one particularly successful example of this, bringing together all elements of the vehicle manufacturing supply chain, from mining to original equipment manufacturers. However, **current regulation does not incentivise taking a whole lifecycle approach in most industries, meaning opportunities for innovation are missed.** This could be initially addressed through the UK's recent Resources and Waste Strategy by introducing stricter lifecycle standards for product design.

> We require an unprecedented level of collaboration with the progressive evolution of policies for regulated and unregulated markets to enable the best technologies, ideas and business models to be shared and adopted.
>
> 
>
> **CHRIS FRY, DIRECTOR OF INFRASTRUCTURE & REGENERATION, RAMBOLL[97]**

Government should also **strongly encourage companies to undertake Scope 3 GHG emission measurement and reporting** through the new Streamlined Energy and Carbon Reporting regime to encourage businesses to consider how reductions can be achieved through engagement targets across their supply chains[98] particularly when combined with high level reduction targets. Strengthening reporting regulations to include lifecycle emissions may also help to identify opportunities for emission reductions. The world's largest shipping group, Maersk, has committed to become net zero by 2050, aiming not to buy carbon offsets. In doing so, it has also challenged the entire industry and supply chain to introduce commercially viable carbon neutral vessels by 2030 to avoid emission lock in.[99]

97 Ramboll (30 October 2018) 'Infrastructure's pathway to zero carbon'

98 Science Based Targets (November 2018) *Value Change in the Value Chain: Best Practices in Scope 3 Greenhouse Gas Management*

99 FT (4 December 2018) 'Maersk pledges to cut carbon emissions to zero by 2050'

DRIVING DOWN EMISSIONS THROUGH SUPPLY CHAIN ENGAGEMENT

Telecoms giant BT is using its purchasing power to reduce emissions through its supply chain. For example, it is introducing a climate clause in supplier contracts, ensuring that suppliers demonstrate carbon savings during the term of their contract with BT. BT also expects suppliers to meet its standards for managing environmental impacts and has set a science-based target to reduce the carbon emissions associated with its supply chain by 29% by 2030 against 2016/17 levels. Purchasing of renewable energy is a fundamental part of BT's environmental sustainability approach and BT therefore encourages suppliers to purchase renewables.

BT also runs a Game Changing Challenge competition, where key suppliers compete to pitch ideas to a panel of BT senior leaders who look for innovative environmental projects. ADVA, a networking equipment supplier, won the Challenge in 2018 with the use of artificial intelligence to improve energy efficiency through predictive maintenance of equipment. Since its introduction in 2012, BT's Better Future Supplier Forum has catalysed sustainable, profitable innovation and the Game Changing Challenge has served to shine a light on the very best ideas and practices.

© BT Group

Convening business platforms and partnerships

Government can encourage greater collaboration by supporting new partnerships between and across industries. One way it can do this is through providing funding for industry initiatives. For example, the European Offshore Wind Deployment Centre (EOWDC) in Aberdeen was developed by a consortium of renewable energy developers, supported by €40m funding from the European Commission. It trials technologies to reduce the cost of offshore wind, including innovative installation methods, operational methods and physical design – creating the world's most powerful turbines at commercial scale.[100]

Another way to encourage collaboration is by **using its convening power to bring different stakeholders together.**[101] For example, the Catapult network established by Innovate UK brings together businesses, scientists and engineers to work on late-stage research and development, providing access to expert technical capabilities, equipment, and other resources required to take innovative ideas from concept to reality. Similarly, the National Industrial Symbiosis Programme (NISP) acted as an independent

100 https://bit.ly/2RG7cA7

101 Vivid Economics & UKERC (April 2019) *Accelerating innovation to meet net zero*

facilitator, bringing together businesses in various sectors and of differing sizes to find uses for waste streams and reveal new commercial opportunities by sharing assets, resources, logistics and expertise. NISP facilitated material exchange over a given geographic area of 12 UK regions overseen by a national executive, coordinating synergies between regions and providing for the exchange of best practices and mutual benefits. In four years, NISP diverted more than 5.2m tonnes of industrial waste from landfill, prevented the use of 7.9m further tonnes of raw material, delivered member cost savings of £131m and generated £151m in new sales for participants.[102] Given the success of this convening model to date and following the findings of an EY review on the catapult network,[103] we suggest the relevant Catapults integrate a net zero purpose or theme and that where specific cross-industry issues exist, ah-hoc working groups are established to enable further opportunities for collaboration.

CO-PROCESSING OF WASTE IN CEMENT KILNS

Suez and CEMEX have entered into a collaborative partnership to share their expertise in their related industries and supply the UK's largest cement kiln in Rugby with Climafuel®. This is a solid recovered fuel, produced from sorted and blended residual, municipal and commercial waste to meet CEMEX's strict specification needed to replace fossil fuels in the cement manufacturing process. It diverts 400 kiltonnes of waste from landfill each year and the process of co-processing, the combination of simultaneous material recycling and energy recovery in a thermal process, means that there is no residual ash to dispose of as it forms part of the final product. In addition, the use of Climafuel® helps CEMEX reduce its process emissions and its carbon footprint related to its use of fossil fuels providing a successful example of an effective industrial symbiosis practice.


© Suez

102 https://bit.ly/2RJ1PjH

103 EY (November 2017) *UK SBS PS17086 Catapult Network Review*

Supporting industrial clusters

One area where collaboration is particularly fruitful is in industrial clusters.[104] Silicon Valley in the USA is the most famous example of a regional cluster in grouped technologies creating innovation spillovers.[105]

Closer to home, Teesside is host to 58% of the UK's chemicals industry and responsible for 20,000 jobs and £4bn of exports per year. There is a cluster of leading energy intensive industries in Teesside working together to create the 'Teesside low emissions industrial zone', through the development of shared emission reduction infrastructure. By sharing infrastructure, logistics, energy and utilities, and by exchanging raw materials, products and residual and waste materials, companies in the cluster can operate more efficiently. This enables them to reduce their costs and strengthen their competitive position.

The cluster has scoped out how post-combustion CCS could be achieved within individual plants. With the recent arrival of the Clean Gas Project – a large gas fired power plant and CCS infrastructure being developed by members of the Oil and Gas Climate Initiative (OGCI) – the Tees Valley aims to become the first industrial cluster to demonstrate commercial full-chain CCS and allow for the large-scale production of decarbonised hydrogen from Natural Gas. This could be an important economic opportunity for the region, building on existing skills and infrastructure and securing renewed investment for the industries in the area.

The UK has set a mission to have the world's first net zero carbon cluster of heavy industry. **Ongoing, stable funding and support from government across the UK's industrial regions can help to develop key industries in the UK and help to secure a competitive low carbon industrial base going forwards.**

104 See for example, the chemicals cluster around Rotterdam in the Netherlands https://bit.ly/2Grl1zs

105 Research by Bruegel found that in four key low carbon technologies, between half and a quarter of patents are applied for by people or companies less than 50km away from the addresses given in cited relevant patents. Bruegel (2016) *An approach to identify the sources of low-carbon growth for Europe*

IN DEPTH: AGRICULTURE & LAND USE

Hard to decarbonise sector in depth: agriculture & land use

Agriculture makes up 10% of UK GHG emissions and has not been a major focus for decarbonisation so far, in part due to the disaggregated nature of farming in the UK. However, at the 2019 Oxford Farming Conference, the National Farmers Union stated that the UK agriculture industry should aim to achieve "net zero" climate impact by 2040 or earlier. This will require a combination of policies and practices focused on three key areas:

- improving farming's productive efficiency
- increased carbon storage on UK farmland
- GHG credits for avoided emissions and GHG removals through BECCS and other processes

There are means of reducing the environmental impact of livestock farming, for example through feed additives to reduce methane emissions from ruminants or increasing the use of insect-based animal feed with a lower environmental impact than the currently used fishmeal or soy. The efficiency of fertiliser use may be boosted through innovative developments such as the move towards agri-robotics and greater use of 'precision agriculture'.

The John Lewis Partnership has partnered with the Small Robot Company (SRC), which is designing small, automated robots that may be able to replace inefficiencies of use and environmental damage such as soil compaction associated with large machinery. The three robots – Tom, Dick and Harry – will be trialled at the Waitrose & Partners farm in Hampshire, to gather data, weed and plant seeds. The robots can care for each plant individually, giving them the optimum levels of nutrients and support with no waste. By being smaller and lighter they cause less damage to the soil and the level of detail and precision allows them to be less impactful on plants, wildlife and the environment. The increased efficiency has the potential to increase yields and reduce costs by 60%, thus potentially increasing farming revenues by up to 40%.[106]

One thorny issue related to agriculture emissions has been around behaviour change and meat consumption. The market is beginning to cater to a change in diets which can help reduce total emissions if farmers follow these market trends. Tesco doubled its vegan food range in late 2018 to respond to a 25% increase in sales, and to capture a £310m market for meat-free food products.[107] **Government could consider further supporting this by issuing guidance on healthy amounts of meat, along the lines of the government's five-a-day campaign around fruits and vegetable portions, and building on best available evidence**, such as The Lancet's Planetary Health diet,[108] considering the potential health benefits for the UK's population too.

106 Waitrose & Partners press release (18 December 2018) 'Robocrop: farming robots begin trial at the Waitrose & Partners farm in Leckford'

107 Tesco news release (15 October 2018) 'Wicked Kitchen to more than double its range as demand for plant-based food soars'

108 The Lancet (January 2019) *Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems*

© Small Robot Company/Waitrose & Partners

In addition to decarbonising agriculture, bio-based fuels and products can aid the decarbonisation of other sectors through greenhouse gas removals, using sustainably sourced biomass as an alternative energy feedstock coupled with carbon capture, or by increasing the use of sustainably grown and engineered timber in the construction industry. The UK will require around 100 $MtCO_2$ of GGR to reach net zero by 2050, one third of which is likely to be deployed in Scotland by pursuing mature options like tree planting and carefully testing less mature options like enhanced mineral weathering.[109] Allowing robust UK-based GGR offsets can help hard to decarbonise industries offset emissions in the short term while technologies are developed and commercialised, as long as this is not taken as an excuse not to make full efforts to decarbonise at the same time.

Currently, there is no market for GHG removal to drive such shifts in land use. Land managers must be incentivised to use their land for GGR rather than traditional agricultural activity. A carbon price or a Natural Infrastructure Scheme (NIS) offering land based carbon credits could help to create a market.[110] Defra must consider how best to kickstart a private investment market in natural capital and greenhouse gas removals.[111]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109 Vivid Economics (January 2019) *A climate of possibility: Harnessing Scotland's natural resources to end our contribution to climate change*

110 Green Alliance & National Trust (February 2016) *New routes to decarbonise land use with Natural Infrastructure Schemes*

111 Aldersgate Group (November 2017) *Increasing investment in natural capital*

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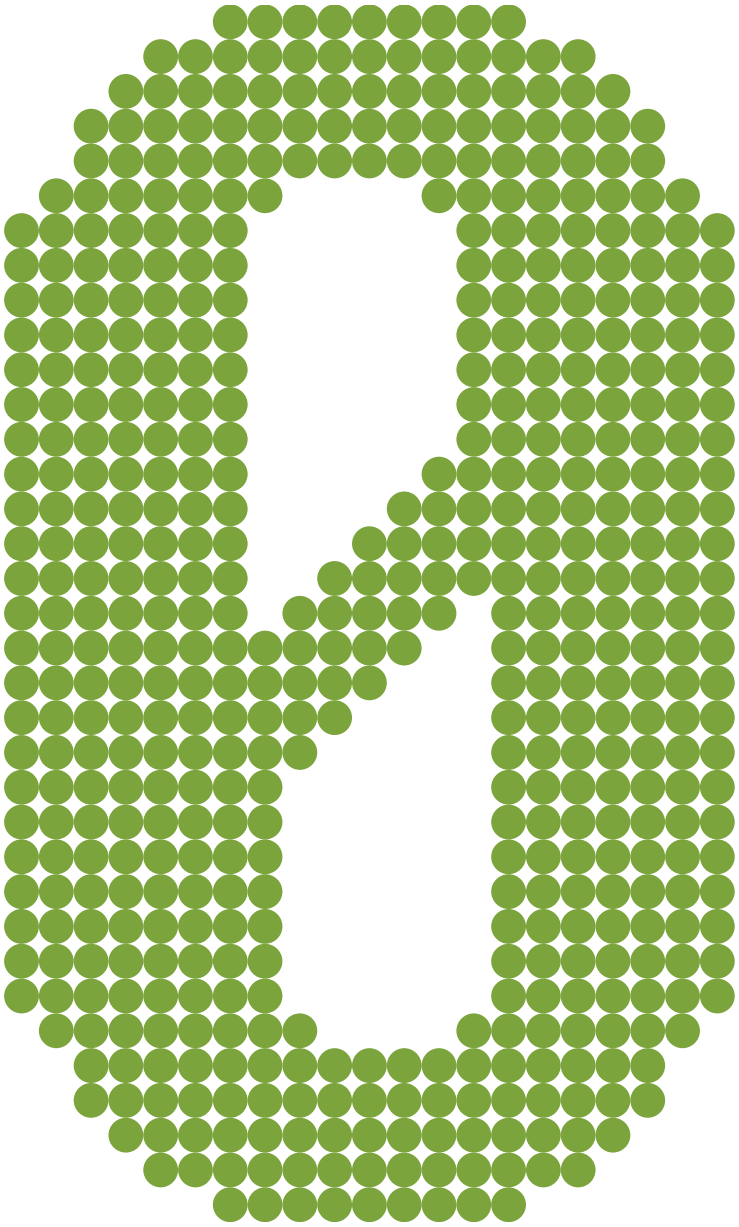

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