DELIVERING NET ZERO

Building Britain's resilient recovery

Edited by Ryan Shorthouse and Patrick Hall





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Contents

	Acknowledgements	7
	Foreword Mark Naysmith	8
	Introduction Ryan Shorthouse and Patrick Hall	13
PART ONE	TRANSPORT	
	Driving green growth Transport decarbonisation George Freeman MP	19
	An electric moment? Cars Joanna Furtado	27
	Greener skies Aviation <i>John Holland-Kaye</i>	32
	On track? Rail <i>Tim Wood</i>	36
	Unchartered waters? Shipping Robin Mortimer	40
PART TWO	LAND	
	Conservation nation Nature Tony Juniper CBE	47
	Capturing carbon Land <i>Mark Bridgeman</i>	51

	Turning to nature Nature-based solutions Sam Hall	57
PART THREE	UTILITIES	
	From adolescence to market maturity? Renewables Professor Michael Grubb	64
	A digital and democratic destination? Electricity Clementine Cowton	70
	Warm welcome for low carbon heating Beyond gas Sarwjit Sambhi	75
	Powering net zero Nuclear Paul Spence	81
	Going carbon negative Biomass Will Gardiner	85
	Breaking ground? Water Christine McGourty	91
PART FOUR	BUILDINGS	
	A deeper green Urban design Nicholas Boys Smith	97
	Intelligent infrastructure Engineering Hannah Vickers	101
	Raising standards Homes Steven Heath	105

	Decarbonised designs Architecture <i>Gary Clark</i>	111
PART FIVE	INDUSTRY	
	Healthy profits Retail <i>Peter Jelkeby</i>	117
	Clean consumption Chemicals Stephen Elliot	122
	Scaling up a solution Carbon capture and storage Corin Taylor	128
PART SIX	WASTE	
	Growing greener Food waste <i>Richard Walker</i>	135
	A recycling revolution Plastic waste Dr Peter Maddox	139
	A steely solution? Metals Dr Richard Curry and Gareth Fletcher	144
PART SEVEN	FINANCE	
	A global venture Green finance Shaun Kingsbury CBE	152
	Investing in the future Investment Nigel Wilson	156
	Innovative investing Public finance Dr Ben Caldecott	161

	Selling British green goods Exports Graham Stuart MP	165
PART EIGHT	GOVERNMENT	
	A climate leader? HM Treasury <i>Alasdair MacEwen</i>	171
	Creative clusters Mayors Ben Houchen	177
	The decarbonisation decade for councils Local government Barny Evans	181
PART NINE	INNOVATION	
	Nudging to net zero? Behavioural change Professor Nick Chater	188
	Sorting Whitehall Government reform <i>Laura Sandys</i>	193
	Transformative thinking Technology <i>Professor Richard Lanyon-Hogg</i>	198

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Foreword

Mark Naysmith

To say that decarbonisation has climbed up the societal, political and business agenda over the last year would be an understatement. And while the current global sanitary crisis and its economic and societal consequences are front and centre of our minds today, I believe we will see a redoubling of efforts to drive net zero in the post-pandemic landscape.

"COP26 will be our chance to showcase a blueprint for delivery that the UK can be proud of"

Unlike other agendas, this one is not going away. In my view, similarly to a global pandemic, how we respond will define how we are perceived as an industry and as a country for a generation.

It is for this reason that the delivery of the net zero economy is where I am looking to focus the minds of our 8,200 UK engineers, environmentalists, planners and consultants. But while our sector is a critical player in the planning and delivery of the net zero economy, we will not be able to do it alone.

Collaboration between government, local authorities, academics, investors, infrastructure and building owners and operators, manufacturers and the public is going to be key. This is the reason why

I saw this collaboration with Bright Blue, to produce a collaborative manifesto for net zero delivery in the UK as a timely and necessary endeavour.

Collaboration between different generations will also be essential. Indeed, today's students, graduates and apprentices will be tomorrow's project directors, board members and chief executives. There is an expectation from all, for us to act on the climate challenge now, and in a socially just and inclusive way.

Greta Thunberg's generation want to be part of this movement, and my ambition is that this generation see the built and natural environment as an attractive career sector for them, where they can contribute to this important agenda. This would further drive the diversity of mind sets in our industry, while enabling generational collaboration in solving society's most complex, yet exciting challenge.

The good news is that we are not starting from scratch on the road to net zero carbon by 2050. The UK has reduced its CO₂ emissions by around 20% since 2010 and has (so far) met the Committee on Climate Change's carbon budgets.¹

From driving new mobility technologies and smart transport systems, high speed rail and hydrogen, heat pumps roll-out and environmental net gain, WSP is delighted to accompany public and private sector clients delivering the transformational projects helping to advance this agenda today.

This is not a reason to be complacent, however. As the UK starts the "decade of renewal" ² and delivers on the Chancellor's "infrastructure revolution", ³ we currently aren't on target for the next carbon budget and are now having to deal with aspects of our economy that are harder to decarbonise. Should we be panicking?

^{1.} Committee on Climate Change, "Reducing UK emissions – 2019 progress report to parliament", https://www.theccc.org.uk/publication/reducing-uk-emissions-2019-progress-report-to-parliament/(2019).

^{2.} HM Treasury and The Rt Hon Sajid Javid MP, "Spending round 2019: Chancellor Sajid Javid's speech", https://www.gov.uk/government/speeches/spending-round-2019-sajid-javids-speech (2019). 3. Ibid.

Not if net zero delivery becomes embedded in everything we plan, design and deliver going forward. Not if we remain intent on breaking new ground and beating expectations – just as we did with renewable energy deployment and coal phase-out in the 2010s. Not if we take on energy efficiency, heat and transport decarbonisation, including maritime and aviation, and embedded emissions. Not if the public sector sees procurement as a lever to drive net zero.

This starts with ensuring the organisations leading this transition put their own house in order. For this reason, WSP, along with many of our clients and peers, are committed to being carbon neutral by 2025, and this target is led by our executive leadership team.

We have already made significant reductions in our emissions, driven by action on how and when we travel, the energy efficiency of our offices and embracing new ways of working, while empowering our people along the way. As well as the carbon benefits, it has also reduced our costs and made us more competitive and sustainable. Win wins always make business sense, especially when they generate a first mover advantage.

One person that recognises this is our Prime Minister. In his victory speech, he embraced the notion that his election was amongst other things, a vote for a zero carbon UK, recognising that prosperity and environmental sustainability really do go hand in hand.⁴

The only meaningful debate today is around how we deliver on the net zero agenda, and whether we should accelerate the process. COP26 will be our chance to showcase a blueprint for delivery that the UK can be proud of.

We already have an exciting projects pipeline, and a clear understanding of what needs to be delivered to achieve our goal. On the generation front, we know we need about 30-40GW of offshore wind

^{4.} Boris Johnson, "Full transcript: Boris Johnson's speech on the steps of Downing Street", https://www.spectator.co.uk/article/full-transcript-boris-johnson-s-speech-on-the-steps-of-downing-street (2019).

to be deployed.⁵ Interestingly, we anticipate a future where energy bills reduce rather than increase, which will help to keep the public on board in this transition and increase their acceptance of the huge residential retrofit challenge this country faces.

On the transport front, we have no choice but to move away from combustion – and quickly. The progress of the new mobility agenda, combining electrification with connected and autonomous vehicle technology, as well as the successful delivery of projects like HS2 and Northern Powerhouse Rail, will make a big difference, especially in taking freight and regional commuting onto rail and away from the roads.

"Collaboration between government, local authorities, academics, investors, infrastructure and building owners and operators, manufacturers and the public is going to be key"

In the heating sector there are two pathways; electrification or hydrogen. As an active player in this area, we believe that new building regulations are likely to drive electrification through heat pumps first, but that hydrogen will pick up following successful trials in several cities that Bright Blue have previously highlighted,⁶ including Hynet, which we are delighted to be working on.

Ultimately, all of the above will only occur if local authorities take the driving seat in ensuring the net zero agenda forms part and parcel of everything they do at a local level. Many of them have rightly declared climate emergencies, and now need to act upon these. Many are now working with WSP to explore how they will do this, with our 'Lead, Enable, Inspire' framework helping leaders to devise sustainable workable plans.

^{5.} Department for Business, Energy and Industrial Strategy, "Offshore wind sector deal", https://www.gov.uk/government/publications/offshore-wind-sector-deal/offshore-wind-sector-deal (2020).
6. Wilf Lytton and Ryan Shorthouse, "Pressure in the pipeline: decarbonising the UK's gas", https://brightblue.org.uk/wp-content/uploads/2019/02/Pressure-in-the-pipelines.pdf (2019).

The proactivity of local authorities will help keep the public on board and increase the chances that the transition will be socially inclusive and just. As WSP's Barny Evans notes in his essay for this collection, the 2020s will be the decade when decarbonisation really begins to affect the public's daily life, and managing their expectations, perception and support will be key.

In the end, all decarbonisation plans require sustained and secure investment, and perhaps more importantly, that money spent is viewed as such. Any sterling wisely spent on the net zero transition will undoubtedly lead to positive returns for the UK's economy and society, and it is good to see politicians starting to recognise this. As HM Treasury prepares to review the expected costs of the transition to net zero, I hope that it is framed as an investment rather than a cost, and a key facet of the regional prosperity agenda. Indeed, the net zero transition is not only a matter for urban centres, but a real opportunity to level up the country.

As you read through the many fascinating essays which follow, and whether you are a policymaker, journalist, academic, environmentalist, engineer or investor, please bear in mind that in the end, we are undertaking this transition out of necessity, but also to ensure we collaboratively deliver a country made of places that are less polluted, fairer, more inclusive and prosperous.

Mark Naysmith is the UK Chief Executive Officer of WSP, a world leading professional services firm.

Introduction

Ryan Shorthouse and Patrick Hall

Last year, the Government unveiled its legislation committing the UK to a legally binding target of net zero greenhouse gas emissions by 2050,¹ a policy designed to ensure this country is compliant with the 2015 Paris Agreement goal of limiting global average temperature rise to 1.5°C above pre-industrial levels. In doing so, the UK became the first major economy in the world to commit to such an ambitious target.² Since then, other major economies have followed suit, including Japan, France, Sweden and Norway.³

This new, legal emissions target was recommended by the UK's independent climate advisory body, the Committee on Climate Change (CCC). It was also advocated in Bright Blue's 2018 report *Hotting up*, which showed a firm majority of the public (64%) supporting moving towards zero emissions in the decades ahead.⁴ In this report, we argued that there was a sound scientific, technological and political case for

Department for Business, Energy & Industrial Strategy and The Rt Hon Chris Skidmore MP, "UK becomes first major economy to pass net zero emissions law", https://www.gov.uk/government/news/ uk-becomes-first-major-economy-to-pass-net-zero-emissions-law (2019).
 Ibid.

^{3.} Akshat Rathi, "These countries have committed to a net-zero emissions goal – could it solve the climate crisis?", https://www.weforum.org/agenda/2019/07/the-growing-list-of-countries-committing-to-a-net-zero-emissions-goal/ (2019).

^{4.} Sam Hall and Phillip Box, "Hotting up", https://brightblue.org.uk/wp-content/uploads/2018/05/ Hotting-up.pdf (2018).

transitioning to a zero carbon economy by the middle of this century. Not only is deep decarbonisation an environmental necessity, we argued, but an economic opportunity.

"Once the immediate health crisis from COVID-19 reduces, there will be a need to lead Britain to a stronger and more resilient economy"

By 2050, this country will have to contribute zero carbon to the atmosphere. Any emissions emanating from any sector of the UK's economy which fail to have been mitigated through low or zero-carbon practices must be offset by an equal amount. Common examples of offsets include natural solutions, such as planting trees, and technological solutions, including carbon capture and storage. The new net zero legislation also enables purchasing domestic and international carbon permits to compensate for remaining emissions produced in the UK

The UK has reduced its emissions by just over 40% since 1990, whilst the economy grew 75% over this same time period,⁵ showing that the goals of environmental action and economic growth need not be in conflict. But though such progress should be welcomed, a long and difficult road to prevent catastrophic climate change lies ahead.

Achieving net zero emissions by 2050 will not be easy. Latest provisional estimates indicate UK territorial greenhouse gas emissions to be 435.2 metric tonnes of carbon dioxide equivalent (MtCO₂e).⁶ This makes the UK one of the top 20 largest emitters of greenhouse gases globally.⁷ Large parts the UK's economy remain rooted in fossil fuels,

^{5.} Committee on Climate Change, "Reducing UK emissions: 2019 progress report to parliament", https://www.theccc.org.uk/wp-content/uploads/2019/07/CCC-2019-Progress-in-reducing-UK-emissions.pdf (2019), 12.

^{6.} Department for Business, Energy & Industrial Strategy, "2019 UK greenhouse gas emissions, provisional figures", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/875485/2019_UK_greenhouse_gas_emissions_provisional_figures_statistical_release.pdf (2020), 5.

^{7.} Global Carbon Atlas, "Territorial (MtCO2e)", http://www.globalcarbonatlas.org/en/CO2-emissions (2019).

and hard-to-abate sectors present significant challenges to achieving the necessary and urgent deep decarbonisation. Fresh thinking is required on how to deeply decarbonise key economic sectors. For instance, the buildings sector requires huge investment in areas of the housing stock with low levels of energy efficiency, whereas the transport sector requires across-the-board electrification and the development of alternative fuels for propulsion, such as hydrogen.

To achieve a net zero economy, the Government has made a good start, phasing out the remaining coal-fired power stations, recently removing restrictions on new onshore wind energy development, ending gas heating in new homes, and driving the roll-out of more efficient boilers.⁹

However, much more needs to be done. In particular, this decade is crucial: the state and market both need to provide significantly more investment and incentives to facilitate deep decarbonisation. The Government has set five-yearly carbon budgets to ensure it remains on track to achieving net zero 2050 and limiting global temperature rise. The first carbon budget ran from 2008 to 2012, and the fifth carbon budget will run from 2028 to 2032 – there are currently no carbon budgets beyond this date. Although the UK government has met the first and second carbon budgets, and is on track to outperform the third, it is – by its own measures – going to fall short of meeting the fourth and fifth carbon budgets on the basis of its policies and plans to date. 12

Politicians and policymakers are rightly focussed on the immediate and tragic COVID-19 crisis. But this pandemic strengthens the case for action on the challenge of this century – climate change. Governments, businesses and communities need and will be expected to do more to mitigate and build

^{8.} Committee on Climate Change, "Reducing UK emissions – 2019 progress report to parliament", https://www.theccc.org.uk/publication/reducing-uk-emissions-2019-progress-report-to-parliament/ (2019), 12.

^{9.} Ibid., 11-12.

Committee on Climate Change, "Carbon budgets: how we monitor emissions targets", https://www.theccc.org.uk/tackling-climate-change/reducing-carbon-emissions/carbon-budgets-and-targets/ (2020).

^{11.} Ibid.

^{12.} Committee on Climate Change, "Reducing UK emissions", 11.

resilience to disruptive crises, especially those that have been predicated for a long time. Next year, the UK will alongside Italy co-host the important United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties 26 (COP26). As the President of COP26, the Rt Hon Alok Sharma MP, recently stated: the world needs to "come together to ramp up momentum towards a climate resilient zero carbon economy."¹³

We need to keep thinking about and acting on climate change. This essay collection brings together nearly 40 leading chief executives, politicians, academics and thought leaders from across the private, public and third sectors to highlight policies and projects across different economic sectors that are supporting and could support the journey to net zero.

This essay collection is broken down into different sections by sector, following a similar typology outlined by the CCC¹⁴: transport; land; utilities; buildings; industry; waste; finance; government; and, innovation.

We do not claim that these essays cover every single part of the UK economy, nor provide all the imaginative ideas needed to achieve net zero emissions by 2050. Sometimes, we disagree with the analysis and ideas offered. In addition, there are lots of organisations working hard to devise and implement ideas to achieve deep decarbonisation. But this collection does showcase the thinking and work of some leading organisations, especially in the private sector.

We hope that this essay collection will provide inspiration to politicians, policymakers and practitioners – especially in advance of COP26 – to implement innovative programmes and policies to ensure our market-based economy can meet our net zero commitments.

Indeed, the transition towards net zero is often seen as a leftist policy, requiring vast amounts of government-led investment and intervention.

^{13.} Department for Business, Energy & Industrial Strategy and The Rt Hon Alok Sharma MP, "COP26 president closing remarks at Peterberg climate dialogue", https://www.gov.uk/government/news/cop26-president-closing-remarks-at-petersberg-climate-dialogue (2020).

^{14.} Committee on Climate Change, "Climate change risk assessment 2022", https://www.theccc.org.uk/publications/third-uk-climate-change-risk-assessment/ (2020).

Yet, this neglects the progress that has been made on decarbonisation to date and could further be made in the future through well-regulated markets with sensible incentives from government. We believe this current Conservative Government urgently needs to encourage and promote market-based reforms to yield substantial economic and environmental benefits in the journey to net zero.

Delivering net zero is a challenge, but it is also an opportunity. Creating a low carbon economy, and its associated jobs, means that just as the UK once was the birthplace of the industrial revolution, so too can it foster a new era of green growth. Once the immediate health crisis from COVID-19 reduces, there will be a need to lead Britain to a stronger and more resilient economy. Undoubtedly, green industries should play a leading role in this.

"The UK has reduced its emissions by just over 40% since 1990, whilst the economy grew 75% over this same time period"

The Government has signalled its determination to move towards a net zero economy, with the Prime Minister, the Rt Hon Boris Johnson, using his inaugural speech to mention that the UK will "no longer make any contribution whatsoever to the destruction of our precious planet brought about by carbon emissions". Time to deliver on that promise. And quickly.

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Madeline Cuff and Michael Holder, "Boris Johnson: we will lead the world in delivering net zero", https://www.businessgreen.com/bg/news/3079582/boris-johnson-we-will-lead-the-world-indelivering-net-zero (2019).



Driving green growth Transport decarbonisation

George Freeman MP

The COVID-19 pandemic – and the state of emergency it has triggered across the world – is an urgent wake-up call to the implications of economic globalisation. When the immediate pandemic is through, we will need to have a serious conversation about the implications COVID-19 has had on international and national resilience of our increasingly global economy. That shouldn't stop at the global supply chain for personal protective equipment (PPE) or the impact of Chinese dietary customs on global biosecurity. The crisis of COVID-19 shines a fresh and alarming spotlight on the other major issue of global resilience: the risk of climate change.

As we face the immediate threat of large-scale death, disease, economic damage and societal disruption, the issue of climate change might seem irrelevant. Indeed, the combination of empty streets, clean air, satellite images of vanishing smog and the urgent need to restore global economic growth is already leading some to dismiss the green agenda as a luxurious indulgence we can ill afford. They are profoundly wrong.

We would be wiser to treat the COVID-19 crisis as a warning of what happens when we take resilience for granted. If we want to prevent the disastrous rise in global temperature which scientists are telling us unambiguously is coming unless we take action, we need to make the

post-COVID-19 recovery a moment to seriously embrace the economics of resilience at the heart of our economic system. And, specifically, to make the post-COVID-19 recovery one that is based on clean, smart, sustainable and resilient green growth.

Central to this is the key policy question of how to deliver on our net zero commitments in a way which accelerates economic growth and job creation in new sectors whilst contributing to a healthier and more productive economy and society.

If – as I have argued elsewhere – the Brexit vote was a change moment requiring us to revisit our economic model as an increasingly finance and service-orientated economy serving the European bloc to embrace a more global trade-based economic model, then questions of biosecurity, resilience and sustainability become more important. In a world where low-cost Chinese and Asian developing economies take the lion's share of mass manufacturing, the UK will need to build a strong global franchise based on our strengths in key sectors such as life science, agritech and cleantech: the technologies and innovations which will support sustainable economic growth. In the next 30 years, when the world goes through the agricultural and industrial revolutions we pioneered here in the UK over the last 300 years, it will need a host of new technologies to drive sustainable growth.

"The market for clean growth – whether technology, consulting or legal – is already huge and only set to get bigger"

On net zero, the key question is all about delivery. The UK has already accepted the case for action and for leadership. We have made the net zero targets legally binding. All our attention must look at how we convert that national and global goodwill into concrete action.

We have a basic choice ahead of us. Do we follow or do we lead? Following would mean doing just enough to stay out of trouble and hide in the pack. Leading means gripping this crisis and showing the

world how to reach that net zero future. As an MP and citizen, I strongly believe it has to be the latter. Not just because of our global responsibility, but also because it's good business.

"We would be wiser to treat the COVID-19 crisis as a warning of what happens when we take resilience for granted"

This has been the central theme of my career in both industry and politics since leaving Cambridge 35 years ago. Through a fifteen-year career in high growth technology, company venture capital and ten years in frontline politics – from being Parliamentary Private Secretary (PPS) at the Department of Energy and Climate Change in 2010, Chair of the All Party Group on Agricultural Science and Technology and Inclusive Growth, through to Minister for Life Science and Agritech, UK Trade Envoy, Chair of the Prime Minister's Policy Board and most recently the UK's first-ever Minister for the Future of Transport, leading our 'Transport Decarbonisation Strategy' – I know first-hand that we have a unique opportunity in the UK.

No market is likely to be bigger than the market for clean energy alternatives to dirty, expensive and unsustainable fossil fuels.

As we leave the EU Single Market to become a more globally oriented trading economy, we need new markets we can plug into. The market for clean growth – whether technology, consulting or legal – is already huge and only set to get bigger.

If we use our net zero targets as the spur to a national economic mission to lead the world, we can lay the foundations for major new markets. Brexiteers need precisely this sort of opportunity. They should be grabbing it. There are huge opportunities for so-called 'left-behind' places like Teesside, parts of Northern Ireland and Humberside to become vibrant 'New Energy Hubs'.

In decarbonisation there is a significant opportunity for the UK to help lead in the science and technology of clean growth. And after the successful decarbonising of our energy sector in the last decade, nowhere is this now more urgent than in transport. Alongside agriculture and housing, transport is the biggest emitting sector, responsible for 28% of our CO₂ emissions.¹

That's why I was so delighted when the Prime Minister asked me to go to the Department for Transport to frame a 21st century 'Transport Decarbonisation Strategy' – which I'm delighted the Transport Secretary, Grant Shapps MP, rightly launched in March rather than delay as a result of the COVID-19 crisis.

By embracing that strategy – and delivering it through a combination of metrics, digitalisation and place – I believe we now have the chance to lead the world. It is time to make our commitments a reality.

The UK 'Transport Decarbonisation Strategy' needs at its heart two key elements. First, a proper industrial strategy for UK leadership in the R&D, financing, testing, data collection and enlightened regulation of transport technology and innovation in the pipeline.

Second, a place-based strategy for empowering people and places around the country to embrace cleaner, greener, healthier transport choices.

For too long the UK political and policy debate has been conducted in silos. One group of activists making a passionate case for lower, slower growth and more tax and regulation to tackle polluters. And the other group making a lazily optimistic and complacent economic argument – largely by entrenched interests who have much to lose from the disruptive effects of new entrants – that we can stand back and allow the market to adapt on its own to consumer demand.

We need to break the stale debate and silo'd 'capture' of the climate change debate and embrace a much more responsible and business-like mission to both drive growth and sustainability.

^{1.} Department for Transport, "Decarbonising transport: setting the challenge", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/878642/decarbonising-transport-setting-the-challenge.pdf (2020), 10.

In the UK, I believe that means embracing both an active 'Industrial Strategy for Technology Leadership', but also a bold programme of devolution and freedom for local places to embrace the healthier travel options most households and neighbourhoods want.

If we do both, we have a chance of achieving the goal. One without the other – an industrial strategy without city and place-based leadership, or the reverse – will simply not work. It needs both to stand a chance of succeeding.

But how do we then deliver? What are the levers we can pull to make this happen? I believe there are three delivery mechanisms. First, place. Second, metrics. Third, digitalisation.

The importance of place needs to be put at the heart of UK transport policy. The modal structure of the Department for Transport (DfT) – four divisions by transport mode (aviation, maritime, road and rail) – reflects a longstanding and disastrous separation of transport policymaking from the needs of places. Fundamentally, transport is all about connectivity of places. The main aim of all those using transport is about getting from A to B. Bad transport holds back people and places. People who use public transport care more about their local transport than national. But in the UK we develop policy – and delivery – through an overly centralised and silo'd model of modal separation.

This heavy traditional Whitehall functional model of departmental modal silos – road, rail, shipping and aviation – mitigates against both place-based solutions, local leadership and the uptake of innovation through Testbeds.

Highways England and Network Rail are largely place-blind. Their focus is on big national "schemes". As national quangos they are accountable to civil servants in DfT silos, not the communities who are paying for and actually need the transport. But DfT is massively London-focused. The staffing ratio tells its own story: thousands of civil servants in the capital, and how may in the West Midlands? One.

This is a massive problem for delivering more enlightened and innovative transport systems, and the decarbonisation which will fail without it. We will not deliver decarbonisation unless we make the UK a more attractive testbed for 21st century transport and mobility innovation.

To do that we must liberate and harness people's willingness to do things for their own places more than for the government, and allow local leaders to try new approaches. We need to change the planning and development paradigm away from car dependency, and car and home ownership, and insist on much more joined-up place-based transport tech planning. We must break down the national stats and targets into smaller local regional bite sizes, including highlighting the best and spotlighting the worst practice. Finally, we must identify the key people and places where we need to deliver, as well as the ten dirtiest stations, motorways, ports, airports, and make people much more accountable.

The second key decarbonisation delivery pillar is metrics. Successful delivery against targets requires proper data and metrics. We will never deliver decarbonisation without clear metrics and data for place-based carrot and stick at both a government and personal level. We need clear rewards and penalties.

"We need to break the stale debate and silo'd 'capture' of the climate change debate and embrace a much more responsible and business-like mission to both drive growth and sustainability"

As we have seen in healthcare, clear and trusted data has enormous power to drive changes in behaviour. Think of such simple yet life-changing innovations such as heartrate monitors and calorie counting.

The transport decarbonisation agenda lacks any clear universal metrics or data. We need a global, universally respected metric. The UK has a huge opportunity to develop this metric and then lead the global sector of developing standards around it. A simple metric like 'emissions per passenger kilometre' (EPPK) would be completely transformational. By incorporating it into all modes and places as the metric, we could

start to compare and drive progress and change. For example, it could be built into the local government funding settlement to create an incentive for councils to build more energy efficient homes.

The third pillar is the power of digitalisation. Harnessing the power of digital is as important as – and goes hand in hand with – data and metrics. It is vital at all levels.

At a national level, digital signalling on the railways and digital road pricing and traffic management are all key to improving capacity and reducing emissions. At a regional and city level, clear data on the daily congestion and pollution patterns is key to managing the decrease of both.

At a personal level, too, all the behavioural insights show people are much more likely to change habits when they can see the benefit. The more bespoke and real it can be $-\pm100$ at the end of the year or ±10 the end of the month – the better. This insight inspired my work on a Green Carbon Citymapper app and the insistence that it should be at the heart of the DfT Transport Decarbonisation Strategy'

During my time as Minister, this approach – insisting that the stale silos of green or growth is tackled with a much more integrated plan for both industrial strategy leadership and place-based devolution – was being welcomed by both industry and green campaigners. It holds the possibility of a real win-win: unlocking both UK industrial R&D and technology leadership, healthier local transport choices, and planning to achieve our net zero legal targets.

The level of support – from both industry and green campaigners – suggests this approach offers the best hope for UK leadership in this area. One thing is for certain. We simply cannot afford to dither or delay any longer.

Action must be taken now before it's too late. Not just because the levels of congestion, pollution and obesity have risen to appalling and genuinely unsustainable levels in the UK. But also because the COVID-19 crisis has revealed how shockingly vulnerable our globalised economy has become and that we need to be much more pro-active in building resilience into our post-COVID-19 recovery. The future is ours

to shape. Together, it's time to seize this unique opportunity for a more globally resilient model of post-COVID-19 economic growth.

George Freeman MP is the Member of Parliament for Mid Norfolk. He has served as Minster of State for the Future of Transport at the Department for Transport, Chair of the Number 10 Policy Board, Minister for Life Sciences at the Department of Health and Business, UK Trade Envoy and Parliamentary Private Secretary at the Department for Energy and Climate Change.

An electric moment?

Joanna Furtado

There is a pressing need to move fast in decarbonising our transport sector. Transport is the largest source of UK emissions, with cars alone contributing 15% to the UK's total carbon footprint. Cars and vans also produce more than a quarter of the UK's air pollution, which costs lives and, in monetary terms, as much as £54 billion a year.

"Accelerating EV sales in the fleet sector would ensure a readier supply to the second hand market and lower income households"

The COVID-19 pandemic has thrown up profound challenges to the transport sector. In the last few months, demand for transport, including trains, buses, roads and aeroplanes have collapsed to unprecedented low levels. While it is difficult to predict the impact of COVID-19 on transport demand in the longer term, in the short term, airports,

^{1.} Department for Transport, "Decarbonising transport: setting the challenge", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/878642/decarbonising-transport-setting-the-challenge.pdf (2020), 11-12.

^{2.} World Health Organisation, "Economic costs of deaths from air pollution (outdoor and indoor) per country, as a percentage of GDP", http://www.euro.who.int/__data/assets/pdf_file/0008/276956/PR_Economics-Annex_en.pdf?ua=1 (2010).

airlines, and some vehicle manufacturers face bankruptcy without additional bail-outs by the government.

Despite these challenges and the uncertainties, the sheer scale of the changes that have taken place in society over the last few months make possible radical pathways to transport decarbonisation. People have seen the effect that reducing car use has had on air, noise and light pollution. The Government has shown courage in delivering huge public investment packages during the crisis, including by taking stakes in transport systems like the railways. What is important now is that the government harnesses the new reality and uses it to accelerate a transition to a more sustainable system. The case for strong ambition on sustainable transport from the government has never been clearer.

So what needs to be done? There needs firstly to be a dramatic overhaul of the national fleet, including a switch to zero emissions vehicles like Electric Vehicles (EVs). The UK has made some progress in accelerating a transition to EVs: there are 200,000 EVs on the road in the UK and the 2035 phase out date for petrol and diesel cars and vans is one of the most ambitious in the world.³

But even so, the UK is falling behind other countries, particularly on manufacture of EVs and their parts (such as batteries). Although vehicle manufacturing generates significant economic activity outside the south east, the automotive sector currently contributes much less to the UK than to other major economic sectors. This is because countries such as Germany have a significant lead in the manufacture of conventional vehicles. But this is not the case for EVs: in 2019, a fifth of all electric vehicles sold in Europe were produced at the Nissan plant in Sunderland. A growing demand for low carbon vehicles worldwide means there is potential for the UK to capture a significant part of the global market by 2030, which could contribute as much as

^{3.} House of Commons Library, "Electric vehicles and infrastructure", https://commonslibrary.parliament.uk/research-briefings/cbp-7480/ (2020), 3-9.

£95 billion to the UK economy.4

But this requires a proper package of support for manufacturers. We suggest a new 'auto-industry retooling fund', which helps existing car manufacturers build up the right skills and invest in new technologies to switch their production lines to purely electric models. It should also provide new investment to support the development of new supply chains for the manufacture of EVs, including building new gigafactories to manufacture EV batteries. This could be a major part of a stimulus package for car manufacturers post COVID-19.

"A UK ZEV mandate would ensure that manufacturers were able to meet the growing domestic demand for electric vehicles"

Alongside the support and investment for manufacturers, we need new regulation to help drive the transition to cleaner vehicles. California and eight other North American states have used a zero emission vehicle (ZEV) sales mandate, which requires a minimum proportion of their cumulative annual sales to be battery EVs, to drive electric vehicle production. China adopted a similar approach alongside a robust credit trading mechanism, and now produces 45% of all EVs globally.⁵ A UK ZEV mandate would ensure that manufacturers were able to meet the growing domestic demand for electric vehicles. Sales targets of 15% by 2022, 45% by 2025 and 85% by 2030 will spur domestic manufacturing and competition, meet growing UK demand and guarantee a strong supply of electric vehicles for the European market.

Measures to stimulate demand for EVs are also important. These should include maintaining the current tax-related incentives for

^{4.} Green Alliance, "Britain's trading future: a post-Brexit export strategy led by clean growth", https://www.green-alliance.org.uk/resources/Britains_Trading_Future.pdf (2018).

International Energy Agency, "Global EV outlook 2019", https://www.iea.org/reports/global-evoutlook-2019 (2019).

new EVs, but should also ensure that lower income households can benefit from the transition. Most low income households buy cars from the second-hand market. Fleet operators are major suppliers to the second hand car market, but less than 3% of their purchases are electric. Therefore, accelerating EV sales in the fleet sector would ensure a readier supply to the second hand market and lower income households. Regulation can help to drive a greater supply of EV models from manufacturers and faster uptake of EVs by fleet operators.

Improving public transport is the other critical part of a deep decarbonisation strategy for transport. We will not be able to decarbonise transport without reducing demand for private car usage and increasing demand for public transport, particularly as low carbon public transit like electric buses and hydrogen-powered trains become more cost-effective. Unlike many other low carbon transport programmes, public transport benefits lower income households as much as those with higher incomes.

"A growing demand for low carbon vehicles worldwide means there is potential for the UK to capture a significant part of the global market by 2030, which could contribute as much as \$95 billion to the UK economy"

Finally, COVID-19 has seen cities all over the world turning roads into cycling and walking paths, to maximise the space that the public have to safely travel and exercise within the city. This has shown how important active travel can be to the health and happiness of cities, and provides a strong case for continuing investment in the infrastructure needed to make walking and cycling attractive, convenient and easy to use for everyone in cities across the UK.

In the long-run – despite the great tragedy of the global pandemic, and the chaos it has caused – perhaps there is a way we can build our transport infrastructure back to be more resilient, safer, and better for

the planet. There are the shoots everywhere of a great green transition, and so much to be gained by nurturing those. Let's make sure we don't miss out.

Joanna Furtado is a Policy Advisor at Green Alliance, an independent think tank and charity focused on ambitious leadership for the environment.

Greener skies Aviation

John Holland-Kaye

The impact of the COVID-19 outbreak has been sudden and significant for the global economy and for the aviation industry. It is having an extraordinary effect on how we live, travel and interact with each other.

Climate change also represents an existential threat for our society and for aviation. It remains one of the greatest challenges facing our generation. The race to decarbonise our economy is one that we will always wish we had started sooner and run faster.

"Sustainable Aviation Fuel is the key way to accelerate reductions in carbon over the next 10 to 15 years and to get us on track for net zero by 2050"

We can look back and see that we failed to respond to the warning signs of a pandemic. We cannot afford to do the same on climate change.

Aviation will be fundamental to the UK economy recovering. It is one of the sectors in which the UK leads globally, and the Government should support it to survive and thrive. But the Government can also help aviation to build back better by rapidly accelerating the use of Sustainable Aviation Fuels (SAFs).

To do this, the Government should set ambitious SAF targets and invest

UK funds in an urgent programme of building SAF production with the goal that the UK has the world's largest SAF industry by 2030. This will build a UK lead in a globally competitive sunrise sector and support the UK to "level up" through targeted investment across the regions and nations of the UK.

Aviation is a force for good in the world and the advent of affordable air travel has changed our lives beyond recognition. Our modern supply chain relies on aviation – anything high value, with a short shelf life or that is required just in time, such as vital medical supplies, is transported on a plane. Aviation gets aid to those who need it and carries exports from developing countries, lifting millions of people out of poverty. It also connects people and improves understanding of different cultures.

Our challenge is to protect the benefits of aviation in a world without carbon.

Aviation represents around 2% of global carbon emissions but that could rise significantly as other sectors decarbonise. Improvements in integrated rail networks, video conferencing and carbon pricing may have a modest impact on overall growth, but we are not going to stop people from flying and nor should we. Instead, we should focus on decarbonising flight itself.

We have already made a good start in decoupling aviation growth from emissions. By investing billions of pounds in new aircraft technology, airlines have been able to grow passenger numbers in the UK by 25% since 2005 while reducing carbon emissions by 3%.² Further improvements in aircraft and engine design will help. The UK Government's planned airspace change and the EU's Single European Sky programme are capable of reducing emissions by up to 10%.³ However, we need to recognise that more radical change is needed and work together to deliver it.

Sustainable Aviation, "Decarbonisation roadmap: a path to net zero", https://www.sustainableaviation.co.uk/wp-content/uploads/2020/02/SustainableAviation_CarbonReport_20200203.pdf (2020), 10.

^{2.} Ibid., 11.

^{3.} Ibid., 51.

Sustainable Aviation Fuel is the key way to accelerate reductions in carbon over the next 10 to 15 years and to get us on track for net zero by 2050.

SAF means second generation biofuels or fully synthetic fuels, both of which deliver carbon lifecycle benefits of at least 70% and up to 100%. Second generation biofuels are technologically proven and are already being used successfully. There is, in principle, sufficient feedstock available globally from agricultural, forestry and domestic waste to meet the needs of global aviation. Synthetic fuels are made by combining carbon with renewably produced hydrogen. SAF has the huge advantage that it can be blended with kerosene and use existing fuel supply lines, airports and aircraft – so the faster we can increase supply, the faster we can decarbonise flight.

Accelerating production of Sustainable Aviation Fuels will help build a UK lead in globally competitive technology, skills and businesses in a sunrise sector. It will also help level up the UK. Parts of the north, of Wales and of Scotland have exactly the kind of industrial skills and sites needed to produce SAF and create green jobs for the future. By 2035, the "Sustainable Aviation" coalition estimates that SAF production could generate up to £2.7 billion and support 18,800 jobs.⁴

But we face the classic chicken and egg predicament of limited, high-cost production and hence limited demand. The UK Government can and should take a real lead here, acting ahead of European or global steps to accelerate a green recovery and to take advantage of the market opportunity.

The Government should do several things. First, prioritise second generation biofuels for aviation and make a rising SAF target part of UK and European policy. Second, take policy steps – including shaping the UK's "Air Passenger Duty" – to make SAF viable for UK airlines, even if they act first, given the differential with kerosene. Third, invest UK funds, and mobilise wider private funds, in an urgent programme of building SAF production with the goal that the UK has the world's largest SAF industry by 2030.

^{4.} Ibid., 35.

The UK can also take a lead at COP26 on solving this global challenge. The UK aviation sector announced its commitment to net zero 2050 in February – the first part of the global aviation sector to do so – when "Sustainable Aviation" (a group of airlines, airports and manufacturers) published a decarbonisation strategy. COP26 can be a focus for a global, high ambition coalition to commit to net-zero aviation, promote ambitious targets for SAF deployment and broker commitment between industry governments on the plan to get there. COP26 can send a clear signal to the next ICAO Assembly in 2022 in support of a net zero goal for global aviation.

"Our challenge is to protect the benefits of aviation in a world without carbon"

At Heathrow, we are taking a leading role. We are already carbon neutral for our own infrastructure and have a plan to get to zero emissions. We are investing in peatland restoration and woodland creation projects in Scotland, Wales and England to create negative emissions. We have varied our landing fees to incentivise cleaner and quieter planes. We are promoting carbon offsetting to consumers. This is all part of our Target Net Zero plan.⁵

By working together with the aviation industry to accelerate sustainable fuels, the UK Government can show real leadership on a global issue, create a new industrial sector, and protect the benefits of aviation for future generations.

John Holland-Kaye is the Chief Executive Officer of Heathrow Airport Limited, a major international airport.

Heathrow, "Target net zero: Heathrow's plan for the critical decade ahead", https://www.heathrow.com/content/dam/heathrow/web/common/documents/company/heathrow-2-0-sustainability/heathrow-target-net-zero.pdf (2020).

On track?

Rail

Tim Wood

Being the largest greenhouse gas emitting sector, accounting for 33% of all UK greenhouse gas emissions in 2018, transport has a significant role to play in meeting commitments to reduce emissions, in particular carbon emissions.¹ The Rail Industry is working collaboratively to decarbonise rail travel through electrification, more efficient trains and low carbon innovations.

Our challenge is how to resolve the dilemma of reconciling the apparently unstoppable growth of passenger and freight traffic with the pollutants that this transport produces. There is no time to lose. Rail passengers have doubled on the UK network over the past 20 years and a similar rise is predicted as we approach the middle of this century.²

Transport for the North (TfN), as the UK's first sub-national transport body, has a key role in ensuring that the transport industry helps meet the challenge of a net zero carbon UK economy. We want to see a low carbon northern transport network, including a zero carbon public

^{1.} The Department for Business, Energy & Industrial Strategy, "2018 UK greenhouse gas emissions, provisional figures", www.assets.publishing.service.gov.uk/government/uploads/system/uploads/ attachment_data/file/790626/2018-provisional-emissions-statistics-report.pdf (2019).

 $^{2.\} Office\ of\ Rail\ and\ Road,\ "Passenger\ rail\ usage",\ www.dataportal.orr.gov.uk/statistics/usage/passenger-rail-usage\ (2020).$

transport network, by 2050 or before.

The remnants of heavy industry and energy production is contributing towards the North being a major contributor of carbon emissions, and levels of air pollution in cities are now above the safe legal limit, which has associated consequences for public health and economic productivity.

"We need to explore how businesses can make a sustainable return on investment in developing the technologies that will help us all to clean up our act"

TfN supports the series of government policies and proposals to meet the UK's emission reduction targets as set out in the 'Road to Zero Strategy' and 'Clean Growth Strategy', as well as the Government's recent pledge to remove diesel trains from the network earlier than planned.³

'Northern Powerhouse Rail', as an electric network, will play a huge role in both cutting rail emissions as well as delivering a modal shift away from fossil fuelled cars across the North. Building a new world class northern rail network, that transforms east-west connectivity, will be the biggest investment in northern infrastructure since the industrial revolution. If we get it right, we will take up to 64,000 cars off the road each and every day and add 35,000 seats per hour at peak times.⁴

By increasing the capacity of the network between our city regions and large towns we can free up substantial new capacity to run more local services on branch lines – bringing better connectivity to more places and in turn encouraging more people off the roads.

We also want to see the trial of new rail traction technology in the North when it is commercially available, to reduce the dependency on diesel-powered rail units and, potentially, reduce the overall running

^{3.} UK Parliament, "Publications – transport committee", www.parliament.uk/business/committees/committees-a-z/commons-select/transport-committee/publications/?session=31&sort=true (2019).

4. Transport for the North, "The potential of northern powerhouse rail", https://transportforthenorth.com/wp-content/uploads/Potential-of-NPR_TfN-web.pdf (2018).

costs of the railway.

Introducing bi-mode and new electric trains on the rail network in the north of England will cut carbon emissions by 30%.⁵ Increasing the ability of the railway network to spread the benefits of electric powered trains onto more lightly used sections of line, whilst retaining the benefits of electrically powered services, should be further explored.

TfN will work with operators to ensure that current and future rail franchises undertake sustainability improvements on both rolling stock and station infrastructure.

In truth, battery and fuel cell-powered trains could complement electrification. The role of innovation is crucial, both big and small. Relatively minor, yet significant investments, such as solar panels and LED lighting at rail stations, on streets, on strategic road networks, and on dedicated cycle and walking routes, will reduce the carbon impacts on the communities where they are located.

The North's transport hubs, such as its 575 rail stations, are also places where large numbers of vehicles are left for several hours, and working with Network Rail, train operators and the Government, we want to see a huge expansion in electric charging points at the UK train stations over the years ahead.

"Our challenge is how to resolve the dilemma of reconciling the apparently unstoppable growth of passenger and freight traffic with the pollutants that this transport produces"

For freight there is a need to reduce journey times to make transport by rail more competitive and attractive compared to other modes and greater flexibility with train paths so that goods can be moved when suppliers or customers require them. Transport of biomass by rail from ports to power stations is currently slow and inefficient, which impairs its overall environmental case. For the end-to-end freight journey to be as efficient

^{5.} TransPennine Express, "Sustainability", www.tpexpress.co.uk/about-us/our-plan/sustainability (2020).

as possible, the North needs better surface access to ports, airports and intermodal terminals. But we also badly need more capacity to achieve this. It is an indictment of our present rail network that there are currently no suitable routes across the Pennines that can accommodate the largest inter-modal deep-sea shipping containers on standard wagons.

TfN also acknowledges that total national carbon reduction levels may need to be even deeper, according to recent advice from the Committee on Climate Change (CCC). We need to plan ahead, identifying the most appropriate targets for the North's transport, as sufficient lead time will be necessary for current approaches to be modified and tested. We need to explore how businesses can make a sustainable return on investment in developing the technologies that will help us all to clean up our act.

With increased investment in the whole of the transport network, the North will support the achievement of a net zero 2050 target or before. This target means that national road transport emissions will need to be near zero, almost every vehicle on the road will need be of an ultra-low emission type, and rail will need to be decarbonised by 2050.

We can do it. It needs the will and the ambition of everyone connected to the transport industry to ensure that the industry can support a sustainable and prosperous future for us all. We owe it to our children to succeed.

Tim Wood is the Northern Powerhouse Rail Director at Transport for the North, a sub-national transport body in the United Kingdom providing transport infrastructure across the North of England.

Unchartered waters? Shipping

Robin Mortimer

Amidst the terrible human impact, and long-term economic consequences of COVID-19, one of the few upsides of the current period has been an improved environment, particularly improved air quality. It is wrong to assume that environmental concerns are a luxury the economy cannot afford. Greater flexibility throughout the workplace through harnessing the use of technology and reducing fuel consumption should remain a focus going forward.

In the coming months, the Government and industry have a unique opportunity to recalibrate the public policy, regulatory and fiscal system to deliver sustained investment in low carbon infrastructure.

Emissions from international shipping are just under one billion tonnes a year and rising – currently equal to around 2.2% of the global total emissions. To put that into context, if that were a country, 'Global Shipping' would be in the top 10 countries in the league table of major emitters. In the UK context, shipping emissions account for around 3%

^{1.} International Maritime Organisation, "Greenhouse gas emissions", http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/GHG-Emissions.aspx (2020).

of the UK total, just under $14mtCO_2$ pa.² In addition, ports around the world also contribute to national emissions through cargo handling and ancillary operations.

"By bringing international emissions within national targets, as Bright Blue has argued, this will inevitably drive the political action required"

Until recently, the maritime sector has been largely outside the mainstream discussion on tackling climate change – with the focus on achieving international sector-wide agreements, with lower hanging decarbonisation fruit available in power generation, other transport modes and other sectors. The policy shift to net zero 2050 changes that. If we are serious about achieving complete decarbonisation across global and national economies, no sector can be ignored or off limits.

The International Maritime Organisation (IMO), the only major United Nations (UN) organisation based in the UK, has in the last few years taken a lead in setting an ambition for international emissions – a 50% target for emission reductions, on a 2008 baseline.³ That ambition needs to be put in context: a do nothing scenario would see shipping emissions rise by between 50% and 250% given anticipated growth in global trade.⁴

Coming back to the UK context, the recent Committee on Climate Change (CCC) report *Net Zero – the UK's contribution to stopping global warming*, argued that it would be technically feasible to eliminate 96% of shipping emissions (domestic and international emissions attributed

(2014).

Committee on Climate Change, "Net zero – the UK's contribution to stopping global warming", https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/ (2019), 147.

^{3.} International Maritime Organisation, "UN body adopts climate change strategy for shipping", http://www.imo.org/en/MediaCentre/PressBriefings/Pages/06GHGinitialstrategy.aspx (2018).

4. International Maritime Organisation, "Third IMO GHG study 2014", http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Greenhouse-Gas-Studies-2014.aspx

to the UK under agreed international methodologies) by 2050, with the residual offset by domestic sequestration measures.⁵ This assumes that there is a radical and rapid shift to new forms of propulsion – for example, based on ammonia or hydrogen fuels.

The most fundamental driver of action on climate change is societal pressure. A new high of 85% of the public were concerned about climate change in the summer of 2019.⁶ The political parties reflected this mood, with the 2019 election manifestos a bidding war for the most ambitious commitments on climate change, following the enshrining of net zero 2050 in law.

But how many of the public, if asked, would consider emissions from shipping a concern? I presume the answer might be low. That reflects a low level of public awareness of the vital role that shipping plays in global and Britain's trade. Ninety five percent of our food, fuel, materials and goods arrive by sea.⁷ Yet, this is not widely understood and the sector is largely invisible to the general public.

"A do nothing scenario would see shipping emissions rise by between 50% and 250% given anticipated growth in global trade"

So the sector itself must take a leadership position if it is to decarbonise on the scale required, both working to better inform the public about the role it plays and having a robust dialogue with civil society on the pace, costs and consequences of cutting its emissions.

Whilst public awareness and pressure is the underlying precondition for change, the immediate and necessary driver will be clear and

^{5.} Committee on Climate Change, "Net zero", 23.

^{6.} IPSOS Mori, "Concern about climate change reaches record levels with half now 'very concerned'", https://www.ipsos.com/ipsos-mori/en-uk/concern-about-climate-change-reaches-record-levels-half-now-very-concerned (2019).

^{7.} Department for Transport, "UK port freight statistics: 2018", https://assets.publishing.service.gov. uk/government/uploads/system/uploads/attachment_data/file/826446/port-freight-statistics-2018. pdf (2018).

sustained international, national and local policy frameworks. This in turn will incentivise the scale of private investment required over a 30year period.

We are beginning to see the first shoots of this through the IMO's adopted goal at international level and in the UK through 'Maritime 2050' – the first long-term strategy for the sector in many years, published in 2019.8 But this policy framework, and the resources to underpin it, needs to go much further to create the necessary change.

Major British ports have made strides forward in reducing their environmental impact, principally through deploying less resource intensive equipment, while moving materials inland by ship has a 50 times smaller carbon footprint than by road. But we need to go further.⁹

To take one small example: a small number of ports around the world incentivise cleaner, more modern, vessels through 'green tariffs'. The Port of London is the first to do so in the UK, with a green tariff introduced in 2018.¹⁰

Ideally, we would see a coherent long-term global approach to such incentives, informing the research and procurement practices of governments and private shipping companies out to 2050 and beyond. This still seems some way off.

One important issue yet to be resolved in the national policy debate in the UK is how far emissions from international shipping – and aviation, in fact – should be accounted for in national decarbonisation plans. In setting the world's first legally binding net zero national target in 2019, the UK Government showed real ambition. However, neither international shipping nor international aviation emissions are included within five year carbon budgets, or the 2050 goal. There is

^{8.} Department for Transport, "Maritime 2050: navigating the future", https://assets.publishing.service. gov.uk/government/uploads/system/uploads/attachment_data/file/872194/Maritime_2050_Report. pdf (2019).

^{9.} World Shipping Council, "Carbon emissions", http://www.worldshipping.org/industry-issues/environment/air-emissions/carbon-emissions (2020).

Port of London Authority. "Green tariff", https://www.pla.co.uk/environment/Air-Quality-and-Green-Tariff/Green-Tariff (2017).

logic to this. Unlike the power sector, for example, where action mainly rests at national level – we can choose how many offshore windfarms to develop – international shipping is outside the direct control of any national government. However, politically, the argument for exclusion is less strong. By bringing international emissions within national targets, as Bright Blue has argued, 11 this will inevitably drive the political action required – whether this is the UK adopting a strong leadership role in international fora, or using national policy levers to incentivise new technology uptake. And if other countries follow suit, the risks for the 'first mover' will be quickly reduced.

"A small number of ports around the world incentivise cleaner, more modern, vessels through 'green tariffs'"

Finally, a word on how this evolving context looks from a port operator perspective. A major challenge is the level of uncertainty about how technologies will develop and therefore what are the best investment decisions in the short-term. One example of this is the lively debate about ship-to-shore power, such as for cruise or cargo ships. Most research is pointing to hydrogen, ammonia or methanol (in some form) as the long-term solutions for low emission shipping. Does it therefore make sense to invest huge sums now in connecting terminals to the electricity grid, often requiring significant upgrades in local grid and generating capacity, if future vessels will be running on a zero-emission fuel? In some cases, the pressing need to address local air quality problems may make such investments compelling. But in others it may be better value-for-money to invest in longer term research or deployment of alternative fuel vessels.

In conclusion, the shipping and ports sector has not been at the forefront of the debate on climate change for the last 30 years. This

^{11.} Sam Hall and Phillip Box, "Hotting up: strengthening the Climate Change Act 10 years on", https://brightblue.org.uk/wp-content/uploads/2018/05/Hotting-up.pdf (2018).

reflects both the complexity and low-profile of this most international of sectors, but this is changing fast with clear targets being set at an international level and reflected in national policies. It also seems inevitable that the digitalisation of supply chains and the better use of data will only accelerate the pace of change. The next stage must be the development of more detailed policy frameworks and incentives to drive investment decisions to meet the hugely ambitious goals for 2050.

Net zero provides a most powerful organising signal to achieve this and to focus the political will needed. Port operators will likewise need to be alive to the long-term goal and base investment decisions with a 2050 frame in mind.

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PART TWO: LAND



Conservation nation Nature

Tony Juniper CBE

Reaching our ambition to achieve net zero greenhouse gas emissions by 2050 will require orchestrated economy-wide action, including in relation to how we manage the land. This poses a challenge of unprecedented complexity, not least because in addition to climate change mitigation and adaptation, there are multiple other objectives linked with land use.

"Action towards net zero emissions could also be carried forward through measures to improve soil health"

These include other environmental goals such as the headline commitment in the government's 25 Year Environment Plan to be the first generation to improve the state of the natural environment, a new farming policy focussed on the delivery of environmental public goods, and demanding tree planting targets.¹

A core element of the overall planning framework needed to do this will be an ambitious new Nature Recovery Network. Working in parallel

 $^{1. \} HM\ Government, "A\ green\ future: our\ 25\ year\ plan\ to\ improve\ the\ environment", https://assets.\ publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf\ (2018).$

with plans for other essential national needs, the Nature Recovery Network would enable the efficient targeting of resources and help to ensure high quality outcomes.

Establishing such a network was set out as an aim in the 25 Year Environment Plan, launched by the then Prime Minister in January 2018, and is expected to receive legal underpinning via the Environment Bill presented to Parliament in early 2020. It clearly has huge potential for integrating different strands of policy and, if done well, would help the country realise more benefit from the natural environment.

The value we derive from the natural environment for society and the economy is truly vast. That value is seen in how natural systems are vital for our water security, the extent to which healthy biodiversity is vital for farming via pollination and soil, and in the ways that access to beautiful and wildlife rich natural areas contribute to public health and wellbeing, as well as being a vital asset for tourism. On top of that our natural systems also hold hundreds of millions of tonnes of carbon and assist in rendering society more resilient in the wake of what are already inevitable climate changes.

Many of these benefits can often be realised from the same landscapes. For example, upland peat bogs and salt marshes can reduce flood risk and at the same time are massive carbon stores. They are vital for our wildlife, and in the case of upland peatlands, supply clean water to many towns and cities. The uplands and coasts are also magnets for walkers and thus contribute to health and wellbeing.

These multiple benefits will be more cost-effectively realised if different financial flows can be combined to deliver them, for example: money invested by water companies; private sector carbon offset funds; public incentives for tree planting; development projects that fund a net gain for biodiversity; NGO money for nature recovery; and, public investments in farming businesses for the purchase of public goods. Combining these, to achieve multiple benefits, is likely to achieve more for society than if each of these budgets is spent separately to one another.

A vital strategic framework for joining up both the outcomes and the funding and delivery partners will be the new Nature Recovery Network. This can be done through harnessing two complementary approaches, one a national mapping exercise, the other a bottom-up, partnership-building process. This dual track has the potential to transform our effectiveness in land-based action for net zero, while simultaneously pursuing other goals with the same financial resources.

When it comes to the first part, the national mapping exercise, it would be necessary to create a fully up-to-date baseline assessment of what we have – a kind of 'Doomsday Book' of natural assets. It would give a broad assessment of the health of those assets and set out where resources for their conservation, recovery and expansion might be most wisely targeted. A further map layer would convey a sense of opportunity as to what benefits might be sought in different parts of the country.

For example, in some geographies, nature recovery might be desirable to reduce flood risk while increasing carbon storage in the land, in blanket bogs and forests. In some urban fringes, the creation of wildlife and carbon-catching habitats might be most beneficial for public access and enjoyment. In all cases, and to gain the most ecological benefit from investments, there will be a desire to reconnect fragments of habitats to create larger areas for wildlife and carbon-catching, while also creating corridors along which species might move as the climate changes. Tree planting targeted to reconnect fragments of ancient woodland would be one priority in that regard.

Nature recovery plans would also help to frame action in farmed landscapes, for example the enhancement of hedges, to make them thicker and denser, more trees added into field margins, and woodlands established on the least productive land. Action towards net zero emissions could also be carried forward through measures to improve soil health.

Soil holds huge quantities of carbon and it could be storing a lot a more, if only soil health were improved. Soil carbon is held in the organic matter it contains, composed mainly of plant remains at various stages of decomposition. By adopting practices that increase this material – such as low till methods – carbon-rich material can be increased. Elevated soil organic matter also enables the soil to hold much more water, thereby helping to reduce flooding and increasing the resilience of crops to drought.

"A vital strategic framework for joining up both the outcomes and the funding and delivery partners will be the new Nature Recovery Network"

For this to work, then, it will be important to see the Nature Recovery Network as a whole government undertaking, and one to which the highest strategic importance is attached. It will also need to be conceived within a wider understanding of optimum land-use, for example in relation to infrastructure provision and housing. We should have high confidence that this is possible to do, not least because of the many large-scale habitat restoration projects already underway across the country which point to the power of partnership in securing integrated outcomes.

Should we invest in the innovative thinking and practical action needed to establish a national Nature Recovery Network, then more of these partnerships will emerge. Natural England, the Environment Agency and Forestry Commission in England, and the comparable bodies in the other nations of the UK, can assist and lead this process, but only if investment is made to equip these organisations with the capacity needed to do the work. In the greater scheme of things that would need only to be a modest investment, and one that would bring very much greater returns, not only in relation to net zero, but also a host of other essential goals.

Tony Juniper CBE is the Chair of Natural England, a non-departmental public body in the United Kingdom which advises the Government on matters of the natural environment in England.

Capturing carbon Land

Mark Bridgeman

Agriculture and land-use hold the key to meeting the UK Government's net-zero target, but it needs innovative and well-resourced policies to capitalise on the willingness of farmers and landowners to use their land differently.

"Government policies must encourage new business models that incorporate multiple land uses, with ongoing income guaranteed for maintenance"

The dry weather of summer 2018 and the continuous, widespread flooding of winter 2019-20 have brought into stark relief how devastating a changing climate will be for farmers and landowners, who often have their home, business and livelihood all wrapped up in the land.

Finding ways to feed the global population, projected to reach nine billion by 2050, without contributing further to the climate and nature crises we are tackling, will be the focal point of the next decade.¹

While agriculture contributes around 10% of total UK greenhouse gas

United Nations Department of Economic and Social Affairs, "World population prospects 2019: highlights", https://population.un.org/wpp/Publications/Files/WPP2019_10KeyFindings.pdf (2019).

(GHG) emissions, it is the only sector with the ability to naturally absorb and store carbon in our trees and soils. The agricultural industry is rapidly innovating and adopting new technologies to improve efficiency and reduce GHG emissions, but arguably we can make the greatest difference by putting nature at the heart of our climate change action. Nature-based solutions – such as planting trees, restoring peatland and improving soil health – are ready for deployment and provide a raft of co-benefits for the economy, biodiversity, climate resilience and public health.

"Around 90% of the greenhouse gas emissions from the sector are methane or nitrous oxide"

Post-Brexit, and on the cusp of a new agriculture policy, these solutions need long-term government support.

It's acknowledged by the UK Government and the Committee on Climate Change (CCC) that agriculture is a 'hard to reduce' sector of the economy.³ Around 90% of the greenhouse gas emissions from the sector are methane or nitrous oxide.⁴ Unlike carbon dioxide, these gases cannot be reduced to zero without stopping food production altogether. Agriculture, however, can have a role to play in reaching that net-zero target.

There is a huge amount of research and development into how we can reduce emissions while still producing food. The UK is leading the way on much of this, and the GHG intensity of UK-produced food is significantly lower than other countries, with beef being around twice as

^{2.} Department for Environment, Food & Rural Affairs, "Agricultural statistics and climate change 9th edition", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/835762/agriclimate-9edition-02oct19.pdf (2019), 16.

^{3.} Committee on Climate Change, "Net zero – the UK's contribution to stopping global warming", https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/(2019), 147.

^{4.} Department for Environment, Food & Rural Affairs, "Agricultural statistics and climate change", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/835762/agriclimate-9edition-02oct19.pdf (2019), 16.

efficient as the global average.⁵ It is extremely important that we engage in knowledge sharing and best practice – globally, nationally and at farm level – to increase adoption of low-carbon farming practices. Accurate accounting methodologies and standards will be increasingly important to demonstrate improvements and benchmark progress.

In the arable sector, crop systems emit nitrous oxide through the manufacture and application of nitrogen-based fertilisers. Around half of these emissions happen on-farm.⁶ Between 10-30% of nitrogen fertiliser is not utilised by crops, so techniques to increase the precision of application and allow more nitrogen to be taken up by the plant will naturally result in less 'lost' to the atmosphere or waterways.⁷

Many practices can mitigate the carbon dioxide emissions that occur when cultivation releases some of the carbon stored in soils, and these are already being taken up by farmers across the country. They include: minimum or low tillage, which is now being practiced across half the arable land in England; precision farming – variable rate applications based on Geographic Information System (GIS) and crops sensors; lower-emission fertiliser; improved storage and use of manures and slurries; more nitrogen fixing legumes in rotations; and cover crops.⁸

New technology and techniques, including plants bred to need less nitrogen, nitrogen fixing crops and technologies that make better use of manures and slurries are being pioneered here. Increasing knowledge exchange, sharing best practice, and creating standards across the country will increase the uptake of these techniques.

In the livestock sector, cattle and sheep produce methane through their digestive process. These methane emissions account for more than

^{5.} Committee on Climate Change, "Land use: policies for a net zero UK", https://www.theccc.org.uk/publication/land-use-policies-for-a-net-zero-uk/ (2020), 47.

^{6.} Farm Carbon Toolkit, "Fertiliser application", https://www.farmcarbontoolkit.org.uk/toolkit/fertiliser-application (2020).

^{7.} Ibid.

^{8.} Kamal Alskaf, Debbie Sparkes, Sacha Mooney, Sofie Sjögersten and Paul Wilson, "The uptake of different tillage practices in England", Soil Use and Management (2019), 27-44.

50% of the emissions from agriculture.9

A large number of studies are looking at animal husbandry, livestock diets, vaccines and rumen inhibitors, all aiming to reduce the amount of methane produced by cattle and sheep.¹⁰ If global meat and dairy consumption levels remain the same, it will be critically important that these new potential technologies are invested in, as many could provide the silver bullet we need.

At the moment, the only conclusive way to reduce emissions from livestock is through productivity improvements and efficiency gains that reduce the amount of GHG emitted per unit of product. Productivity improvements could reduce emissions by 11.5 million tonnes CO₂e/year across agriculture in the UK, but are currently hindered by gaps in skills, rural infrastructure and connectivity.¹¹ A strong government strategy and policies encouraging knowledge exchange and research and development at farm level could overcome these barriers.

A net zero target requires deep reductions in emissions from all business sectors, with any remaining sources offset by removal of CO₂ from the atmosphere. While there is a lot of research and development looking into carbon capture and storage techniques, these are still a long way off wide-scale deployment. As it stands, the only sector of the economy able to offset those remaining emissions is agriculture and land use. Farmers and landowners are already contributing in this way

^{9.} Department for Environment, Food & Rural Affairs, "Agricultural statistics and climate change", 18.
10. Department for Environment, Food & Rural Affairs, "Science and research projects", http://sciencesearch.defra.gov.uk/Default.

aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14952 (2010); University of Reading, "Animal research: changing cow diets to cut greenhouse gas emissions", https://www.reading.ac.uk/news-and-events/releases/PR806131.aspx (2019); Fiona Harvey, "GM could help cut livestock emissions, say scientists", https://www.theguardian.com/environment/2019/nov/28/gm-could-help-cut-livestock-methane-emissions-say-scientists (2019); Harper Adams University, "Dietary strategies to reduce ruminant methane production", https://www.harper-adams.ac.uk/research/project/5/dietary-strategies-to-reduce-ruminant-methane-production (2020); Josh Gabbatiss, "Feeding cows seaweed cuts 99% of greenhouse gas emissions from their burps, research finds", https://www.independent.co.uk/environment/cows-seaweed-methane-burps-cut-greenhouse-gas-emissions-climate-change-research-a8368911.html (2018).

^{11.} Committee on Climate Change, "Land use", 35.

^{12.} Committee on Climate Change, "Net zero", 16.

by maintaining the existing carbon stores in soils, enhancing carbon storage, and sequestration through woodland creation and management and restoration of peatland.

"While agriculture contributes around 10% of total UK greenhouse gas (GHG) emissions, it is the only sector with the ability to naturally absorb and store carbon in our trees and soils"

Arguably, these nature-based options are the opposite of 'cutting-edge' or 'innovative' – they have been harnessed for generations and require no smart phones, complicated user manuals, or technical scientific knowledge. However, we need a cutting edge and innovative policy landscape to deliver these solutions at scale. The tax and planning systems must be adapted to bring them in line with net zero goals and encourage land use change. Alongside this, funding schemes must be looked at to make sure these nature-based solutions are financially viable in a fraught and uncertain political landscape.

Tree planting offers the biggest potential, with the CCC calling for ambitious planting targets of up to 50,000 hectares per year up to 2050.
Landowners are ready and willing to get started with planting, but they need certainty that it is the right option for their land. A farm system with forestry and woodland incorporated could include commercial forestry, small copses, agro-forestry, shelter belts and hedgerows. All can contribute to reaching our climate targets and have big co-benefits for biodiversity, flood alleviation, and soil quality. For many farmers and landowners, planting trees requires taking agricultural land out of production which naturally has an impact on profitability and land values. Government policies must encourage new business models that incorporate multiple land uses, with ongoing income guaranteed for maintenance.

^{13.} Ibid., 156.

The Country Land and Business Association (CLA) was a significant contributor to this year's CCC's land use report. Our vision for 2050 is an industry where forestry and woodland is an attractive commercial land use choice. We made the case for an emissions trading scheme, where the heavy emitters of carbon dioxide in the private sector pays for the carbon stored in trees, while the public benefits, including biodiversity, flood alleviation and public health, are rewarded through government environmental land management schemes. The CCC incorporated these ideas into their recommendations and emphasised that this is a sector worth investing public money in, given the impact it could have.

Climate emergency and nature crises go hand in hand. Unintended consequences, such as damaging domestic food production, exporting emissions and degrading our natural environment further, must be considered now, in planning the new policies.

"A large number of studies are looking at animal husbandry, livestock diets, vaccines and rumen inhibitors, all aiming to reduce the amount of methane produced by cattle and sheep"

Net zero cannot be achieved without farmers and landowners. CLA members take great pride in being good stewards of the land, but they cannot tackle this global crisis without support. The CLA is calling on the UK government to transform the policy landscape to reach net zero, improve biodiversity, help the economy and increase the resilience of our valued and valuable landscape.

Mark Bridgeman is the President of the Country Land and Business Association, which represents 30,000 land-based businesses in England and Wales.

Turning to nature Nature-based solutions

Sam Hall

The two greatest environmental challenges of our age are climate change and biodiversity loss. The stakes are high. Without urgent action to eliminate greenhouse gas emissions, we face rising sea levels, hotter temperatures, and an intensification in dangerous extremes of weather, which will impose great economic and social costs on people around the world. At the same time, we risk a continuing steep decline in our wildlife, both in terms of diversity and abundance, depriving future generations of untold natural wonders. Tackling these threats remains just as urgent in the aftermath of COVID-19.

"Nature-based solutions can do a lot, but they must be part of a wider set of measures if we are to respond comprehensively to the climate and nature crises"

Both problems share one cause in common: the degradation and destruction of carbon-rich natural ecosystems. They also, happily, share a common solution: nature restoration. By protecting, restoring, and expanding, at scale, natural ecosystems, on land and at sea, we can store huge amounts of carbon and provide vital habitats for endangered wildlife. These 'nature-based solutions' are cost-effective, and they

deliver wider benefits, such as enhanced resilience to climate change. By safeguarding habitat for wildlife which is apart from human populations, they can also reduce the risk of future zoonotic disease transmission.

In the UK, the two most important terrestrial nature-based solutions are woodland and peatland. New woodland has the greatest potential to sequester additional carbon from the atmosphere. The UK currently has 13% tree cover – one of the lowest levels in Europe. This figure has increased since the nadir of the First World War, but planting rates remain low as farmers have been reluctant to put their land into forestry. In addition, much new woodland in the 20th Century was large-scale conifer plantations, which have provided good carbon benefits but poor biodiversity benefits.

"By protecting, restoring, and expanding, at scale, natural ecosystems, on land and at sea, we can store huge amounts of carbon and provide vital habitats for endangered wildlife"

One of the main reasons for our low afforestation rate has been the Common Agricultural Policy's system of direct payments, which rewards farmers for keeping as much land as possible in agricultural production. Another is the felling license regime which requires trees to be replaced when they are cut down. This in effect means that tree planting is a permanent land use change, as farmers are unable to convert land back to agricultural production in the future.

Phasing out direct payments, as proposed in the Agriculture Bill, is therefore a critical first step. At the same time, the Government should proceed with developing an attractive Environmental Land Management (ELM) scheme that rewards farmers for planting trees on their land. As outlined in a Bright Blue report I co-authored, ELM

^{1.} Forestry Commission, "Forestry statistics 2019", https://www.forestresearch.gov.uk/documents/7435/Complete_FS2019_zIuGlog.pdf (2019).

should use market mechanisms, such as auctions, where feasible, to get the best value for public money.² Similarly, private-sector funding sources should be levered in, for instance by putting a carbon levy on airlines as proposed by the Committee on Climate Change (CCC) and requiring a minimum level of tree cover for new developments as the Woodland Trust has called for.³

"We must fully audit the UK's blue carbon assets and begin integrating them into our national carbon accounts"

It was very welcome that last year's Conservative Party manifesto committed to set up a £640 million 'Nature for Climate Fund'. The much-needed step change in tree planting levels can now begin during this parliament. Woodland creation in Green Belt areas and along our waterways should be a priority for the fund, to maximise the benefits of trees for people and nature. The fund should also support new approaches to woodland creation, for instance natural regeneration, where new trees are left to grow from seeds in the ground rather than through the artificial planting of saplings. New woodland takes longer to establish through natural regeneration, but it is cheaper, uses much less plastic, and has higher resilience to pests and diseases.

Peatland is the UK's largest existing terrestrial store of carbon. It can sequester additional carbon, but only when in good condition and at a slower rate than trees. Peat covers 12% of the UK's land area, and contains more carbon than the forests of the UK, France, and Germany combined.⁴ Much of it is degraded at the moment because of poor

^{2.} Ben Caldercott, Sam Hall and Eamonn Ives, "A greener, more pleasant land: A new market-based commissioning scheme for rural payments", http://green.brightblue.org.uk/s/A-greener-more-pleasant-land-r3tf.pdf (2017).

^{3.} Committee on Climate Change, "Land use: policies for net zero UK," https://www.theccc.org.uk/wp-content/uploads/2020/01/Land-use-Policies-for-a-Net-Zero-UK.pdf (2020); Woodland Trust, "Emergency tree plan for the UK: How to increase tree cover and address the nature and climate emergency," https://www.woodlandtrust.org.uk/media/47692/emergency-tree-plan.pdf (2020).
4. Office for National Statistics, "UK natural capital: peatlands", https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/uknaturalcapitalforpeatlands/naturalcapitalaccounts (2019).

management practices, such as inappropriate draining and burning. If it is not in its natural wet condition, peatland emits carbon dioxide rather than sequestering it.

"The UK currently has 13% tree cover – one of the lowest levels in Europe"

We must act therefore to turn peat from a climate problem to a climate solution. Government should ban the most harmful management practices, such as burning and extraction for use in horticulture. They should also make peatland restoration a priority for funding in the new Environmental Land Management scheme and the Nature for Climate Fund.

A neglected type of nature-based solution is 'blue carbon'. Blue carbon is a marine (rather than terrestrial) habitat that stores huge amounts of carbon. Examples include saltmarsh and seagrass meadows. Despite blue carbon's huge potential to store carbon – more so than terrestrial forests – it gets relatively little government attention. This is because blue carbon is not included in the UK's carbon accounting framework. Unless blue carbon is accounted for, and improvements count towards meeting statutory carbon budgets, policies and funding to restore these critical marine habitats are unlikely to be forthcoming. As a first step, we must fully audit the UK's blue carbon assets and begin integrating them into our national carbon accounts.

"Peat covers 12% of the UK's land area, and contains more carbon than the forests of the UK, France, and Germany combined"

One example of blue carbon, saltmarsh, is an important coastal habitat for a diverse range of fish invertebrates and birds. It can be created and restored through managed coastal realignment, where seawater is allowed to permanently breach coastal defences and flood

an area of land. When the Environment Agency evaluates options for new coastal defences, it should give more weight to nature-based solutions like saltmarsh that deliver multiple benefits for carbon, wildlife, and climate resilience.

Globally, nature-based solutions have vast potential. They can provide over 30% of the global climate mitigation effort required to limit temperature rise to 1.5 degrees. This agenda is a huge opportunity for the UK Government to demonstrate international leadership. Last summer, the UK Government allocated over £100 million of UK aid to support nature-based solutions in developing countries. Ministers also are set to prioritise nature-based solutions at the rescheduled UNFCCC COP26 in Glasgow and at the CBD COP15 in China next year.

"The Government should proceed with developing an attractive Environmental Land Management (ELM) scheme that rewards farmers for planting trees on their land"

In addition to these welcome steps, the Government should consider creating new due diligence requirements for big businesses with supply chains abroad. New legislation could mandate companies over a certain size to audit their suppliers and overseas operations, to ensure their activities are not contributing to deforestation. As Britain develops its own independent trade policy, this measure presents an opportunity to use our new freedoms to enhance the global environment.

One important caveat to nature-based solutions is that they are not enough on their own to solve either problem. Stopping climate change requires the near-elimination of greenhouse gas emissions from across the

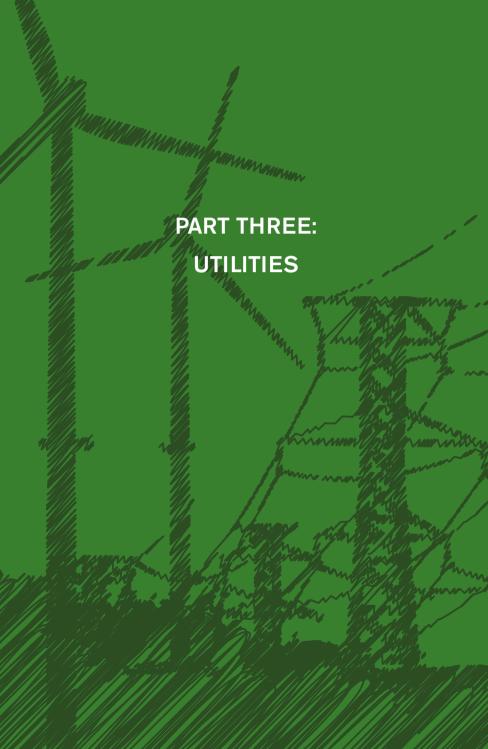
^{5.} Bronson Griscom et al, "Natural climate solutions", PNAS (2017), 11645-11650.

^{6.} Department for Environment, Food & Rural Affairs, Department for International Development, The RT Hon Alok Sharma MP, The RT Hon Oliver Dowden CBE MP, The Rt Hon Lord Zac Goldsmith, "Prime Minister announces ambitious package of support to protect and restore the world's forests", https://www.gov.uk/government/news/prime-minister-announces-ambitiouspackage-of-support-to-protect-and-restore-the-worlds-forests (2019).

economy, particularly the burning of fossil fuels. Stemming biodiversity loss necessitates more sustainable approaches to development and agriculture, as well as steep reductions in environmental pollution. Nature-based solutions can do a lot, but they must be part of a wider set of measures if we are to respond comprehensively to the climate and nature crises.

Nature-based solutions are a critical part of our response to climate and ecological crises. We must start work implementing them at once.

Sam Hall is the Director of the Conservative Environment Network, a forum for conservatives who support conservation and decarbonisation.



From adolescence to market maturity? Renewables

Professor Michael Grubb

The climate change strategy mapped out by the Committee on Climate Change (CCC) in 2008 placed low carbon electricity centre-stage, as the necessary precursor to decarbonising other sectors including transport and large parts of heat and industry. The 2010s stand as the decade which started to deliver this vision, principally through remarkable strides in renewable energy.

In 2019, renewables together generated over one third of UK electricity, compared to 6.5% a decade earlier. Even more remarkable, in 2009 the majority of this was from hydro and biomass, with wind and solar the minor components; a decade later, wind and solar comprise a quarter of total UK generation, with biomass accounting for another 9%.

With roughly constant nuclear output (around 17%),³ the combination of falling demand and rising renewables has steadily squeezed the space for fossil fuel generation. Until 2013, gas took the brunt of this but subsequently, due to falling gas prices and the UK carbon price floor, coal has effectively been killed off.

^{1.} Department for Business, Energy & Industrial Strategy, "Fuel used in electricity generation (ET 5.1

⁻ quarterly)", https://www.gov.uk/government/statistics/electricity-section-5-energy-trends (2020).

^{2.} Ibid.

^{3.} Ibid.

After a surge of solar and onshore wind early in the decade, the big story became offshore wind. This in principle offers a huge resource, the physical potential being many times the scale of UK electricity demand. Not even included in national statistics in 2009, offshore wind has grown at 20% a year for the past five years, and already supplies 10% of UK electricity.⁴

"Diversity and flexibility will become increasingly important to manage a secure system, and this will also require policy reform"

Only five years ago, the UK's efforts on offshore wind were widely castigated for their expense, costing around £140 per megawatt hour – comparable to the highest retail electricity prices. At the most recent auction however, in September 2019, the cost had plummeted to barely £40 per megawatt hour – less than half UK industrial electricity prices and comparable to the current wholesale electricity market price. Given the cross-party consensus on the need to cut CO₂ emissions and deliver the targets enshrined in the UK Climate Change Act, the development of offshore wind now appears to be one of the great success stories in energy and industrial policy. Given focus with Tony Blair's commitment to an ambitious renewable energy target for 2020, legally enshrined in the European Commission's 2008 Renewable Energy Directive, the Coalition Government of 2010-15 nurtured wind energy through all means available. Targets matter, especially when enshrined in law.

Against this background, and following the Prime Minister's commitment, the Conservative Party 2019 Manifesto stated that the UK's "Offshore wind industry will reach 40GW by 2030" – an installed

^{4.} Ibid.

^{5.} Michael Grubb and Paul Drummond, "UK Industrial Electricity Prices: Competitiveness in a low carbon world", https://www.ucl.ac.uk/bartlett/sustainable/sites/bartlett/files/uk_industrial_electricity_prices_-_competitiveness_in_a_low_carbon_world.pdf (2018).

^{6.} Department for Business, Energy & Industrial Strategy, "Fuel used in electricity generation".

capacity equal to current *average* electricity demand.⁷ Taking account of wind's variability, together with onshore wind and solar, this would mean variable renewables supplying at least half of UK electricity, balanced mainly by gas, biomass and nuclear.

The remarkable progress to date owes much to the UK's 2013 Electricity Market Reform (EMR) which introduced a structure of 15-year fixed price contracts for renewables. Supported by the Crown Estates, Ofgem, and the Carbon Trust, on siting, connection, and innovation respectively, this unleashed industrial investment: the competitive pressure of auctioned contracts, combined with industrial learning across the North Sea basin, led to the extraordinary cost reductions.

For renewable energy to reach its full promise, however, both the industry and policy will need to evolve rapidly – to confront new challenges, and to exploit new opportunities.

Onshore wind remains cheaper, and local or farm-sized renewables can also make an important contribution. Auctions for mature renewables could now be implemented to include all these sources, with separate auctions or complementary strategies used to support the less developed and riskier large-scale options like floating turbines or other marine sources.

"In 2019, renewables together generated over one third of UK electricity, compared to 6.5% a decade earlier"

Solar could be integrated into new housing developments. The UK could still consider developing some of its major tidal resources, most likely starting with Cardiff Bay, if these are treated as infrastructure investments along the lines of HS2. The experience of offshore wind gives hope that other marine energies – wave, and tidal stream – might see similar breakthroughs if we made parallel effort, though the physical resources are more limited. All these would add useful diversity.

^{7.} Conservative Party, "Conservative Manifesto 2019", https://vote.conservatives.com/our-plan (2019).

However, the mainstay is likely to be delivering the offshore wind commitment, which means *quadrupling* current capacity by 2030.8 This (and beyond) could involve a choice of huge developments on the Dogger Bank – the large area of shallow water in the middle of the North Sea – or using floating wind turbines which are currently much more expensive.

Such volumes will obviously require greater attention to the variability of these renewables to date. This has not been a problem except in specific areas, such as the dramatic rise in solar in the south-west, which lacked the transmission capacity to export surplus to the rest of the country. Renewables have, almost all the time, simply been able to displace the bulk fossil fuel generation, and there has been enough other plant on the system to assure power, whatever the wind and solar output.

Ironically, the first hint of the complexities emerged not through a lack, but rather a surplus, of renewables when wholesale electricity prices went negative one Sunday afternoon in 2019. There was enough solar, wind and nuclear generation – along with some minimum-run other plants that could not easily be disconnected – that in effect they competed for the right to sell, and get their (supported) price.

To deal with variability and energy sources at multiple levels in the system, from small scale to huge offshore, and growing demand (such as from EVs) and roles for distributed and flexible demand, the future will require strengthened transmission and (in places) distribution systems. There would be large system benefits also from more extensive and integrated interconnections with continental Europe.

Beyond this however, although wind energy usefully matches our *seasonal* needs (more wind and demand in winter), diversity and flexibility will become increasingly important to manage a secure system, and this will also require policy reform.

^{8.} Department for Business, Energy & Industrial Strategy and The Rt Hon Claire Perry, "Offshore wind energy revolution to provide a third of all UK electricity by 2030", https://www.gov.uk/government/news/offshore-wind-energy-revolution-to-provide-a-third-of-all-uk-electricity-by-2030 (2019).

By 2030, we will still need other options – 'backup' for cold, calm winter peak hours – more than 40 gigawatts of it. There will also be growing periods when wind, solar and nuclear together are supplying substantially more than the UK needs at that moment.

There are many options for delivering that technically. Greater diversity of sources, as indicated. Storage, of various forms. Perhaps, more biomass and waste plants, generating zero carbon but 'firm' electricity. Greater interconnection with the continent, for two-way bulk power flows reflecting complementary patterns of demand output. More demand-side response, not just from industry but from the growing fleet of EVs that could be plugged in through smart, two-way connections. We will need gas to provide bulk balancing, and a variety of other options that only 'run' part of the year.

The key challenge for the next decade is that we do not yet have the policies in place to incentivise these developments. Without them, renewable energy will increasingly hit roadblocks.

The policies that have fostered the renewables revolution will need reform if it is to be sustained and expanded towards a zero carbon electricity system. We could plausibly double our renewable energy capacity based on the EMR, and clearly we need more auctions to maintain momentum, broadened to include all renewables as above.

The central fact remains that the traditional electricity market is not fit for a low carbon system: a market based mainly on the fuel costs of running traditional power stations cannot be the mainstay when the fuel for more than half the system is free, being wind, solar or ocean.

Renewable energy is now cheaper partly because the long-term contracts reduce the risks from volatile and uncertain wholesale prices, including the risk of very low or negative prices ('cannibalisation') at times of high renewables. Research by Professor David Newbery estimated that the investor certainty from long term contracts itself reduced the cost of capital by several percentage points, saving potentially billions of

pounds.9 Policy needs to go forwards, not backwards.

Professor Dieter Helm suggested that renewable generators should be required to pay for their own backup by merging Contract for Differences (CfDs) and the capacity market, but this is an inefficient solution to only part of the problem. Backup is a property for a system, in which no source is 100% secure (and demand also varies and offers growing flexibility). Complementarity, diversity and flexibility are the keys to a robust system. For mature renewables, a better solution would be to move to a fully-fledged investment market based around long-term contracts on both supply and demand, regulated to ensure it purchases and allocates the costs of buying the balancing services required from the traditional spot market and demand-side response.

"The UK could still consider developing some of its major tidal resources, most likely starting with Cardiff Bay, if these are treated as infrastructure investments along the lines of HS2"

Renewable energy – notably wind and (especially on a global scale) solar, has surpassed all expectations. From their childhood of the 2000s, renewables have emerged in the 2010s as the boisterous, energetic and optimistic teenagers of the energy revolution, with offshore wind as the biggest and strongest for Britain, yet still visibly immature. A renewable future beckons, but leaves no room for complacency.

Michael Grubb is a Professor of Energy and Climate Change at University College London.

^{9.} David Newbery, "Evaluating the case for supporting renewable electricity", *Energy Policy* (2018), 120, 684–696.

Dieter Helm, "Cost of energy review", https://www.gov.uk/government/publications/cost-of-energy-independent-review (2017).

^{11.} Michael Grubb and Paul Drummond, "UK industrial electricity prices"

A digital and democratic destination? Electricity

Clementine Cowton

"We have ten years to save the planet." This oft-repeated rhetoric has not proved particularly motivating. The task seems too enormous even to imagine, so why bother?

It's easy to understand why people feel demoralised. Procuring renewable power through state-run auctions, centralised solutions, and allowing regulators and monopoly grid companies to dictate the pace of change are the traditional approaches to the decarbonisation of electricity. These solutions can feel distant and disempowering to citizens, many of whom are now ridden with climate anxiety. And history tells us that large, centralised infrastructure projects of this type are expensive and, even worse, very slow.

Decarbonisation poses a headache for traditional, centralised electricity networks. Grids must finely balance supply and demand; and the proliferation of variable renewable generation is pushing their capabilities to the limit. Rather than being able to pull a lever to ramp up supply, peaks in generation are increasingly, and inconveniently,

^{1.} Jillian Ambrose, "Low demand for power causes problems for national grid", *The Guardian*, https://www.theguardian.com/business/2020/apr/16/low-demand-for-power-causes-problems-for-national-grid (2020).

mismatched with peaks in consumption. Windy winter nights see vast amounts of virtually free power being wasted, while the 4-7pm 'rush hour' on the network is getting harder to manage. Further, the COVID-19 crisis has proven that consumer behaviours can change in an instant to respond to societal and economic pressures, throwing out carefully calculated assumptions.

At a local level, network companies are terrified that their underinvestment in digitalisation and lack of visibility of their own systems leaves them highly exposed to the shift to Electric Vehicles (EVs). A full EV charge consumes about the same energy as the average household does in a week. If everyone on the same street comes home and plugs their car in at the same time, they could blow a substation.

Centralised, 'dumb', industry-centric approaches to these challenges include: state over-procurement of expensive low carbon generation; paying capacity market subsidies to new gas power plants to dispatch dirty power only during rush hour; giving network companies the power to override consumer choice and 'throttle' their EV charging; and, allowing network companies to charge consumers for expensive extra wires 'ahead of need' rather than manage their existing grids more efficiently. The extra cost to British energy customers by 2050 of this model is estimated to be in the tens of billions.² It is an approach that completely ignores the interests and choices of consumers. And all evidence to date suggests it probably won't work.

"Algorithms maximise the utilisation of resources, and thus keep prices down overall"

So instead, where can we find examples of rapid, disruptive systemic transformation that empowers and improves the lives of our citizens

Carbon Trust and Imperial College London, "An analysis of electricity flexibility for Great Britain", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/ file/568982/An_analysis_of_electricity_flexibility_for_Great_Britain.pdf (2016).

- done by them rather than to them? And can these examples teach us anything about how to achieve inclusive decarbonisation of our economy, particularly when that economy is undergoing rapid systemic disruption as a result of the COVID-19 pandemic?

"Windy winter nights see vast amounts of virtually free power being wasted, while the 4-7pm 'rush hour' on the network is getting harder to manage"

We can start by looking no further than our own streets: ride-hailing. The digitalisation of mobility, embodied by ride-hailing services such as Uber, has had such a monumental impact that it has decimated the business models of traditional modes of transport. The travel behaviour of whole populations has completely transformed almost overnight through the cheerful embrace of previously unimagined technologies, leaving regulators scrambling to keep pace.

It may not at first seem obvious why the mobility shift onto ride-hailing apps has anything to do with an economy-wide shift to net zero. There are also ways in which this example provides a cautionary tale: the inability of regulators to keep up with its pace of change has led to labour rights disputes and a worsening carbon footprint. But many of the challenges in increasing the penetration of renewable power onto the electricity grid – and from there the decarbonisation of homes, businesses and transport – mirror the dynamics that ride-hailing services have so successfully turned into their advantage.

Taxis spend much of their time empty, hunting for a fare. When that fare does arrive, it will generally be during rush hour or a rain shower, or just after last orders at the pub. At these times, the ensuing lack of availability and extra traffic reduces the utility of the service. The regulator can attempt to roughly define when these popular slots will be and set prices higher – but the end result is still very inefficient and, as a result, very expensive to customers.

Instead, ride-hailing services use digital technology to manage supply

and demand in real time, responding dynamically to constraints through 'surge pricing' and rewarding customers with *much* lower fares if they are prepared to wait. Algorithms maximise the utilisation of resources, and thus keep prices down overall. And customers are completely in control, with a more enjoyable and convenient service to boot.

The digital technologies that could underpin a similarly dynamic system already exist in energy. Octopus Energy's Kraken platform has allowed customer service to respond seamlessly to the challenges of lockdown, with the tech to enable flexible home working and telephony baked into the system from the beginning. The same platform is the foundation for a plethora of smart tariffs, particularly Agile Octopus, that have already been proven to dramatically shift customer consumption outside of peak times by empowering them to respond to variable pricing.³ Indeed, in a mirror image of 'surge pricing', Agile sometimes actually pays customers to consume electricity during 'plunge price' events when there is too much wind generated electricity on the grid. During the COVID-19 crisis, when consumer behaviour has shifted rapidly, Agile has helped the grid to respond to rapidly reduced demand by paying customers to charge in the middle of the day.⁴

In turn, an ecosystem of smart products has sprung up to enable people to manage their appliances automatically for the best price. Ohme's smart cable optimises EV charging times to Agile's Application Programming Interface (API), driving down the cost of ownership of an EV; while Nibe's heat pump uses electricity to heat homes during cheap times so that they stay warm during expensive times – demonstrating an affordable pathway to the decarbonisation of buildings.

In this world, the system must revolve around the customer. Like the taxi trade, traditional suppliers will need to undergo total cultural

^{3.} Octopus Energy, "Agile Octopus: a consumer-led shift to a low carbon future", www.octopus. energy/agile-report (2018).

^{4.} Barry Collins, "A rare lockdown upside: homeowners being paid to use electricity", https://www.forbes.com/sites/barrycollins/2020/04/20/a-rare-covid-19-upside-homeowners-being-paid-to-use-electricity/#799d6f883ac5 (2020).

reform to survive and thrive in a demand-led, democratised economy. Instead of a 'take it or leave it' business model based on the guaranteed returns of a regulated price, 'suppliers' will need to metamorphose into genuine 'retailers', fighting to offer useful products and intuitive user experiences at attractive prices.

Most importantly, to persuade people to share their data and change behaviour to optimise their homes, businesses and vehicles, successful retailers will have to earn enormous levels of trust – putting the power squarely in the hands of customers.

This offers a tantalising glimpse of a better future. If policymakers and regulators can anticipate and harness the transformative power of digitalisation and democratisation, trust consumers, provide the right incentives to empower people to change their behaviour and reward them when they do, we will be able to transform our power system within ten years to one that is zero carbon, cheaper and more secure, while putting citizens squarely in the driving seat.

Clementine Cowton is the Director of External Affairs at Octopus Energy Group, an international technology business and low carbon electricity and gas retailer based in the United Kingdom.

Warm welcome for low carbon heating Beyond gas

Sarwjit Sambhi

COVID-19 has shown us all how vulnerable the world is to external shocks. Through driving a focus on science, international co-operation and changes to the way we live our lives, it mirrors the adjustments that are needed to tackle climate change.

Now, as we start to think about what a post COVID-19 recovery should look like, we have the opportunity to make climate change front and centre of that recovery. "Building back better" will allow us to tackle the climate crisis head on, building a sustainable economy with long-term job opportunities across a wide range of sectors.

"Emissions from heat now account for over a third of UK emissions – the single largest contributor"

As the largest domestic energy supply and services business in the UK, we have a unique opportunity to make an impact on climate change, as well as a huge responsibility to do so. For several years we have been taking steps to enable our customers to use energy more sustainably, through smart metering and thermostats, Green and Electric Vehicle (EV) tariffs, and the installation of EV charge points.

This decade, we need to broaden our collective focus to all emissions

sources, especially those that are harder to tackle. Of all those sources, heat is the most challenging. Emissions from heat now account for over a third of UK emissions – the single largest contributor.¹

"If we want consumers to stop buying boilers and swap to a costlier low-carbon alternative, the additional capital cost required needs to be funded by an incentive scheme"

Up until now, most of the progress we have made in reducing emissions has been based around cleaning up our power system, with minimal impact on individual homes. Householders still receive the same availability of electricity, delivered through the same sockets, as they did in the days of coal.

But the next leap forward, in tackling heat decarbonisation, now requires action at the level of the individual and their home. Put another way, getting to net zero by 2050 requires about 2,000 households to become net zero each day between now and then. That is no easy task. If we are to succeed, we must take immediate action. Consumers can already reduce their carbon footprint today. For example, a Hive smart thermostat can save each home up to 0.5 tonnes of carbon annually with minimal impact.² Switching to a high efficiency combination boiler can also save a similar amount. But more significant saving will require the creation of a new, well-functioning market for low carbon heating options.

To get there, we must focus first on those housing segments which present the best customer opportunities today, both in terms of cost as well as comfort.

With that in mind, it cannot be right that we continue to install costly and polluting oil heating systems in off-grid homes, when cheaper to

^{1.} Department for Business, Energy & Industrial Strategy, "Clean growth – transforming heating" https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766109/decarbonising-heating.pdf (2018), 13.

^{2.} Based on reduction in consumption for an average gas heated home.

run, low-carbon alternatives are already available.

Of the roughly 25 million individual homes in the UK, around four million are off-grid. We need regulations to phase out oil boiler installs and allow green gas installations or heat pumps to replace them. That is why we have already announced a partnership with Calor earlier this year, supplying green gas tanks to those off-grid homes who currently demand them.

Elsewhere, c.200,000 new homes are being built every year, and the Government has ambitions to increase that rate.³ That means every new home built needs to be as close to zero carbon as possible if we are to avoid locking in new carbon emitting housing stock into our economy. Building new homes, designed from the ground up to be low carbon, is both the most economic and efficient way to save carbon. It has already been proven at scale overseas.

We know that the Government has proposed a new *Future Homes Standard* that will ban gas connections in new homes from 2025 while significantly tightening building regulations. That is clearly welcome, but there is no real reason to delay its full implementation for five years, not least of all as developers had previously expected to comply with a similar standard in 2013.

We are already pressing ahead. Centrica now has well established partnerships with housing developers and we will be making announcements about our involvement in new low carbon housing developments over the coming months.

Beyond off-grid and new build homes, the greater challenge of decarbonising heat remains the approximately 20 million homes reliant on the gas network, which vary wildly in terms of age, energy efficiency and design.

A first, simple step to reduce emissions here would be to increase the

^{3.} Ministry of Housing, Communities & Local Government, "Government announces new housing measures", https://www.gov.uk/government/news/government-announces-new-housing-measures (2018).

volume of green gas in our network, by injecting higher volumes of green gas such as biomethane and hydrogen into the network, as Bright Blue has advocated.⁴ To support this, the existing gas quality standards need to be updated and more must be known about the future of the non-domestic Renewable Heat Incentive (RHI), which incentivises green gas today, as well as the Green Gas Levy announced by the Chancellor at the March budget. We stand ready to play a role, given our position as a major investor in the UK's biomethane supply.

That leaves us with the far from insignificant task of swapping out gas boiler systems in the existing 20 million gas connected homes, which vary wildly in terms of age, energy efficiency and design. Decarbonising these homes will be costlier and more challenging than upgrading off grid homes and building low carbon new ones.

Previously, the consensus view was that these homes would simply all need to be electrified. More recently there has been a dawning realisation that to do so would require a national energy efficiency retrofit programme at an unprecedented scale, as well as the large-scale replacement of radiators in many homes. On top of that, we now know that electrifying all heat demand would present a significant challenge for the grid, particularly as EVs are becoming more and more popular.

"We need regulations to phase out oil boiler installs and allow green gas installations or heat pumps to replace them"

There needs to be a different answer. The Committee on Climate Change (CCC) provided one last year when it recommended continuing use of the gas grid through rolling out hybrid heat pumps, with a recommendation of more than 10 million hybrids in peoples'

 $^{4. \} Wilf \ Lytton \ and \ Ryan \ Shorthouse, "Pressure in the pipeline", https://brightblue.org.uk/wp-content/uploads/2019/02/Pressure-in-the-pipelines.pdf (2019).$

homes by the middle of the next decade.⁵ These hybrid systems combine small capacity gas boilers with air source heat pumps. They operate to allow the gas boiler to meet peak heat demand, providing the high temperature heat householders are used to and expect. They do not require swapping out radiators or extensive energy efficiency upgrades to homes, and they keep the pathway and optionality open for a hydrogen future for the gas network, which is looking increasingly important, particularly to support industrial heating requirements.

"Getting to net zero by 2050 requires about 2,000 households to become net zero each day between now and then"

This is all very encouraging, but there remains a key issue – cost. Hybrid systems are more expensive than conventional gas boilers, so there is no reason why many customers will opt for them today.

This is where public policy is needed. All of our experience in working with customers tells us they want upfront incentives and not long-tail payments if they are to change buying behaviours. That's why the government's domestic RHI, which offers a seven-year tariff incentive for renewable heating, has failed to deliver the investment that was expected from the scheme.

Simply put, if we want consumers to stop buying boilers and swap to a costlier low-carbon alternative, the additional capital cost required needs to be funded by an incentive scheme, at least until the point at which the costs of new systems fall.

Offering an up-front grant stands to save the government money compared to continuing with the expensive domestic RHI model. It will also make the scheme more accessible to those on lower incomes.

^{5.} Committee on Climate Change, "Net zero – technical report", https://www.theccc.org.uk/publication/net-zero-technical-report/ (2019).

With funding for the existing RHI scheme ceasing in March 2022, and the need to deliver a step change in low-carbon heating installations, the Government has no time to lose in announcing a more impactful successor scheme.⁶

The drive to net zero is more than the current zeitgeist: it is imperative the UK takes action and embraces it as an opportunity, especially as we plan for a post COVID-19 economic recovery. I am extremely excited about the role that Centrica will play in this transition. With our current workforce of 10,000 trusted British Gas engineers safely delivering over 100,000 high-efficiency boiler changes annually, coupled with our investment, innovation and our understanding of customers, we are well placed to play a significant part in addressing the challenge ahead.

We have a unique opportunity to deliver, in partnership with government, the investment and innovation needed to tackle emissions from heat and put the UK on a pathway to a sustainable future.

Sarwjit Sambhi is the Chief Executive of Centrica Consumer, the customer-facing division of Centrica's Energy Supply, In-Home Servicing and Home Solutions businesses.

^{6.} HM Treasury, "Budget 2020: delivering on our promises to the British people", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/871802/Budget_2020_Print.pdf (2020).

Powering net zero Nuclear

Paul Spence

What does the UK becoming net zero really mean?

It means being smarter and more efficient in how we use resources and energy. And it means making the right choices around the UK's energy mix. In short, it means our future has to be electric.

Transitioning to a low carbon economy means batteries replacing fossil fuels in our cars, and heat pumps displacing gas boilers in our homes and businesses. It means investing in clean technologies to generate more low carbon power.

"Sweden and France both cut their emissions rapidly by using nuclear power"

According to the Committee on Climate Change (CCC), the UK needs to quadruple its low carbon production in order to deliver net zero by 2050. They believe the increase will need to come from a combination of renewable sources, alongside 'firm' low carbon generation.

^{1.} Committee on Climate Change, "Net zero: The UK's contribution to stopping global warming", https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf (2019).

Renewables, including solar and wind, will provide the majority of the UK's low carbon power – the CCC suggests around 60%. EDF, Britain's largest producer of low carbon electricity, operates 36 wind farms and one of the largest batteries in the country. The benefits of renewables are obvious – they are quick to build, and increasingly cost efficient. We believe the UK should do everything it can to maximise the contribution that renewables make.

In future, Carbon Capture and Storage (CCS) will likely have a role, offsetting carbon emissions from industry and energy generation using gas. But by far the biggest and most proven available source of 'firm' low carbon power is nuclear.

Nuclear offers reliable, low carbon power all year round whatever the weather without producing direct carbon emissions. It's the cheapest source of firm low carbon power and a proven technology used by countries around the world – more than 400 nuclear reactors operate globally.³ Sweden and France both cut their emissions rapidly by using nuclear power. By contrast, Germany's decision to close its reactors has left it reliant on coal and unable to meet its greenhouse gas targets.

The UK's existing fleet of nuclear power stations, operated by EDF, prevent 20 million tonnes of carbon emissions each year. Seven of eight of these power stations – which produce around 20% of the UK's energy – are due to come to the end of their operational lives by 2030.⁴ That means the UK has a decade to replace this low carbon source with new energy infrastructure.

EDF is already building Hinkley Point C, the UK's first new nuclear power station in a generation, which will produce low carbon electricity to meet 7% of UK need, enough to power six million homes. Electricity generated by the plant will offset nine million tonnes of carbon dioxide

Ibid.

^{3.} World Nuclear Association, "Plans for new reactors worldwide", https://www.world-nuclear.org/information-library/current-and-future-generation/plans-for-new-reactors-worldwide.aspx (2020).

4. World Nuclear Association, "Nuclear power in the United Kingdom", https://www.world-nuclear.org/information-library/country-profiles/countries-t-z/united-kingdom.aspx (2020).

emissions per year, or 600 million tonnes over its 60-year lifespan. The construction project has restarted Britain's nuclear industry, creating more than 5,000 jobs and training 500 apprentices already, and delivering a significant boost to the UK economy – to date, contracts worth £90 million have been awarded to firms in the North East, £27 million to firms in the East of England, and £15 million to firms in Wales.

Hinkley Point C uses EPR technology, an evolution of the pressurised water reactor design which the UK has used before at Sizewell B in Suffolk. It is the first of the new nuclear projects that the UK needs. It offers an opportunity to build a second station using the same design and workforce at substantially lower cost.

Our proposed new power station at Sizewell C, in Suffolk, would make an equal contribution to the UK's low carbon energy needs and enable the East of England to realise the same benefits in investment in the region, jobs and skills. A clear way forward on financing new nuclear projects is now needed – EDF's proposed model uses the reduction in risk of building a second-of-a-kind project to raise capital at lower cost.

Securing investment for new low carbon energy infrastructure should be a key pillar of the UK's plan for how to pay for net zero. Major infrastructure projects in housing, transport and energy will also help to rebuild the UK economy once the current COVID-19 crisis is over, creating thousands of jobs and delivering investment into towns and regions.

A new nuclear power station at Sizewell C could also play a role in creating new sources of energy. Clean hydrogen, whose only by-product is water, has enormous potential to replace fossil fuels in transport, industry and heating and inject extra flexibility into the grid.

Clean hydrogen is achieved by splitting water into its constituent parts. Because it provides a constant supply of low carbon power, nuclear is the most cost-effective way to do this without producing carbon emissions.

The CCC believes that by 2050, the UK will need the equivalent hydrogen capacity as today's fleet of gas-fired power stations.⁵ EDF

^{5.} Committee on Climate Change, "Net zero".

have already looked at the feasibility of trialling hydrogen production using electrolysers connected to one of our nuclear power stations – Heysham, in Lancashire. Compared to other technologies, progress in developing hydrogen technology has been slow. But we believe that with further development, hydrogen production might be possible at each of the UK's nuclear power stations.

"Nuclear offers reliable, low carbon power all year round whatever the weather without producing direct carbon emissions"

Net zero will be the words on everyone's lips when the UK hosts the global climate summit, COP26. Setting ourselves on the path to net zero by securing a flexible, low carbon energy mix is one of the ways that the UK can demonstrate international leadership in tackling climate change.

Paul Spence is the Director of Strategy and Corporate Affairs at EDF, an integrated energy company in the United Kingdom, with operations spanning electricity generation and the sale of gas and electricity to homes and businesses throughout the United Kingdom.

Going carbon negative Biomass

Will Gardiner

We are living through unprecedented times and this year is set to be very challenging. Amid the battle against COVID-19, and the need to find ways to help revive the economy, we can't lose sight of the climate emergency that we also face. In fact, the need to reboot our economy and create a green economy can work hand in hand.

This year is a pivotal year for the UK and other countries as they step up their efforts to prevent global temperatures rising more than 1.5 degrees.

We are running out of time and it's clear we will need many different solutions to bring emissions down and avoid the tragic consequences of climate change.

"Negative emissions technology is the key to delivering net zero"

It's no longer enough to just be carbon neutral – balancing out emissions in one area with savings or offsets in another. We also need negative emissions technologies, which remove more CO_2 from the atmosphere than we put into it. They are one of the vital solutions that must be deployed if we are to make a difference.

That's why Drax, the British company I lead, announced a world-

leading ambition to be carbon negative by 2030 by pioneering the negative emissions technology, bioenergy with carbon capture and storage (BECCS).¹ We were the first company in the world to announce such an ambition when I spoke about it at the UN Conference of the Parties 25 (COP) in Madrid at the end of 2019.

"The Humber is uniquely placed to seize this opportunity to become the first zero carbon economy in the world"

At the start of this year, the technology giant Microsoft followed in our tracks by also announcing their plan to also go carbon negative by 2030.² This was an important endorsement of the need for companies to strive for carbon negativity from a leading global corporate, which marked a new stage in the climate debate.

The carbon negative concept isn't new. But we are one of the first companies in the world to use carbon negative technology which has the potential to turn the Humber, one of the UK's most important industrial regions – and its most carbon intensive – into a net zero industrial hub and a centre for clean growth and jobs, while also helping the UK meet its net zero target.

Drax's journey to become carbon negative began more than a decade ago. At the time our plant in North Yorkshire was the largest coal power station in Europe. Drax generated 7% of the UK's power, making it a key national strategic asset.³

However, even then it was clear that burning coal would have to end, so we began a journey to replace coal with sustainably sourced biomass. Making that a reality was a huge technical challenge, which

^{1.} Drax, "Drax sets world-first ambition to become carbon negative by 2030", https://www.drax.com/press_release/drax-sets-world-first-ambition-to-become-carbon-negative-by-2030/ (2019).

^{2.} Microsoft, "Microsoft announces it will be carbon negative by 2030", https://news.microsoft.com/2020/01/16/microsoft-announces-it-will-be-carbon-negative-by-2030/ (2020).

^{3.} Drax, "Inside Drax: annual report and accounts 2010", https://www.drax.com/wp-content/uploads/2016/09/2010-Annual-Report-and-Accounts-for-the-year-ended-31-December-20101.pdf (2011).

many said couldn't be done – but with government support, our skilled and innovative team of engineers succeeded in transforming the power station. We have reduced our carbon emissions by more than 85% since 2012 and Drax is now the UK's largest renewable power generator and the biggest decarbonisation project in Europe.⁴

In a landmark move for Britain's energy transition, we announced in February that we would stop using coal to generate power next year – years ahead of the government's deadline.

The wood pellets we use to produce the renewable power that millions of UK homes and business rely on, come from working forests that are replanted or naturally regenerate. These forests supply industries – such as construction and furniture making – with high grade timber. We use their residues, sawdust from sawmills and offcuts. We also use thinnings – small diameter trees which are removed to help the bigger trees grow and other non-commercial trees which are felled when the higher value trees are harvested. The forests we source from are thriving – creating an increasing carbon sink as they grow year on year.

Practising sustainable forest management means new tree growth absorbs CO₂ from the atmosphere at an equal or greater rate than is released through combustion. Trees absorb carbon dioxide from the atmosphere, and when that wood is burnt, the same carbon that has already been absorbed from the atmosphere is returned as CO₂. No new carbon is released from underground. This maintains a closed carbon cycle with no net increase in atmospheric CO₂ levels.

Our world-leading sourcing is based upon guidance from forestry experts and NGOs to ensure that we only use fibre that can deliver carbon benefits in a timeframe which supports the fight against climate change. It is underpinned by the latest scientific evidence and overseen by a strict regulatory regime.

Last year we set up an independent advisory board of scientists,

Drax, "Enabling a zero carbon lower, lower cost energy future", https://www.drax.com/annualreport/enabling-a-zero-carbon-lower-cost-energy-future/ (2019).

academics and forestry experts, led by Sir John Beddington – formerly the UK government's chief scientific adviser – to ensure the Drax's biomass sourcing is in line with the latest science and best practice. This group has found that Drax's biomass sourcing policies are in line with the 'Forest Research' report, which is widely considered to be the industry gold standard. Our next ambition is to be the world's leader in negative emissions.

In 2018, we started working on a ground-breaking trial utilising bioenergy with carbon capture and storage – otherwise known as BECCS. We were one of the first power stations anywhere in the world to do this, proving our capability to capture a tonne of CO_2 per day.⁶

The challenge now is to look at how we can use BECCS on a commercial scale. That means that we will be removing more CO₂ from the atmosphere than we produce in our operations – creating a negative carbon footprint for the company within a decade. Once fully operational, the project could massively increase its environmental contribution by delivering over 16Mt of negative emissions each year by 2035. This would represent a significant proportion of the negative emissions the UK needs to deliver against its zero carbon targets.⁷

Crucially, if the UK can deliver negative emission on that scale, we will provide more time for sectors like aviation and agriculture, which are likely to prove harder to decarbonise in the years ahead. Negative emissions technology is the key to delivering net zero.

Drax Power Station would also become the anchor for a net zero industrial cluster. That is why we are working with major firms – including National Grid and Equinor – on plans for a 'Zero Carbon

^{5.} Drax, "Drax's new biomass policy paves the way for world-leading sustainability standard", https://www.drax.com/press_release/draxs-new-biomass-policy-paves-the-way-for-world-leading-sustainability-standard/ (2020); Forest Research, "Carbon impacts of biomass consumed in the EU: supplementary analysis and interpretation for the European Climate Foundation", https://www.drax.com/wp-content/uploads/2019/10/CIB-Summary-report-for-ECF-v10.5-May-20181.pdf (2018).
6. Drax, "Carbon dioxide now being captured in first of its kind BECCS pilot", https://www.drax.com/press_release/world-first-co2-beccs-ccus/ (2019).

^{7.} Drax, "Creating a zero carbon Humber", https://www.drax.com/energy-policy/capture-for-growth-zero-carbon-humber-report/#chapter-4 (2020).

Humber'. With the right policy and investment framework we can deliver on the Government's ambition of creating an industrial scale CCS cluster by the mid 2020s and the world's first carbon negative industrial cluster by 2040.8 With CCS in place, the Humber will become a logical place for hydrogen production, ensuring that the hydrogen is produced in a carbon neutral way.

The cluster would protect around 55,000 jobs in the region's traditional industries and create many more by building the infrastructure and attracting new industries and companies from around the world to the world's first zero carbon region. Development would help to further boost the region's economy, increasing export opportunities of world leading clean growth technologies and furthering the UK's expertise in the fight against climate change.

The Humber is uniquely placed to seize this opportunity to become the first zero carbon economy in the world. It can be a catalyst for other regions in the UK too.

To date, the project has secured over £5 million of government funding. BEIS described Drax's plans as "an innovative project [which] represents a major milestone in efforts to roll out carbon capture at scale by the 2030s." The UK Government is currently developing an effective negative emissions policy and investment framework to help make that happen. Drax believes this should include support for multiple carbon capture clusters in the UK, including the Zero Carbon Humber; a policy and investment framework to incentivise BECCS and other technologies to remove carbon from the atmosphere; and, a regulated asset base (RAB) based model to support transport and storage.

^{8.} Department for Business, Energy & Industrial Strategy and The Rt Hon Claire Perry, "World-first carbon 'net zero' hub of heavy industry to help UK seize global economic opportunities of clean growth", https://www.gov.uk/government/news/world-first-carbon-net-zero-hub-of-heavy-industry-to-help-uk-seize-global-economic-opportunities-of-clean-growth (2018).

^{9.} Zero Carbon Humber, "Zero carbon Humber", https://www.zerocarbonhumber.co.uk (2020). 10. Drax, "£5m boost to scale up ground-break carbon capture pilot at Drax, UK's largest power station", https://www.drax.com/press_release/5m-boost-scale-ground-breaking-carbon-capture-pilot-drax-uks-largest-power-station/ (2019).

Having pioneered the use of sustainable biomass, we now produce 12% of the UK's renewable electricity.¹¹ With the right negative emissions framework, we can do much more. By removing millions of tonnes of emissions from the atmosphere each year we can do some of the heavy lifting for harder to decarbonise sectors.

The Government's 2050 net zero target may seem a long way in the future. But the time to act is now. Made even more crucial by the need to give a real stimulus to the economy after COVID-19, the Government has the perfect opportunity to give our carbon capture cluster plan the green light, support jobs in the north of England and demonstrate support for the role of negative emissions in delivering the UK's net zero goal.

Will Gardiner is the Chief Executive Officer of Drax Group, a British electrical power generation company.

^{11.} Drax, "Carbon emissions", https://www.drax.com/sustainability/carbon-emissions/ (2020).

Breaking ground?

Water

Christine McGourty

Water runs our world. Yet in our day to day lives we barely give it a second thought. That is sure to change as the effects of climate change take hold.

Already this year a record high temperature of 18.3 °C has been recorded in Antarctica, at the north west tip of the continent, one of the fastest warming regions on Earth. I had the privilege of travelling there with scientists from the British Antarctic Survey almost 20 years ago, to interview the world-leading British experts studying the effects of the changing climate.

They now estimate that since the 1950s, a total of 28,000km² of ice shelf has been lost from this area – in volume, that's the equivalent of the UK's household water needs for more than 1,000 years.²

These are unprecedented times and the world has completely changed in just a few months – perhaps permanently. Given the unique circumstances it is only right that we have directed our attention and

^{1.} Graham Readfearn, "Antarctica logs hottest temperature on record with a reading of 18.3C", *The Guardian*, https://www.theguardian.com/world/2020/feb/07/antarctica-logs-hottest-temperature-on-record-with-a-reading-of-183c (2018).

 $^{2.\} British\ Antasrctic\ Survey,\ ``The\ Antarctic\ peninsula's\ retreating\ ice\ shelves",\ https://www.bas.ac.uk/wp-content/uploads/2015/04/ice_shelf_science_briefing.pdf (2015).$

our resources to tackling the COVID-19 outbreak. However, while our focus might be on this current crisis, we must not lose momentum in tackling the existential crisis that is climate change. We simply can't afford to.

COP 26 may have been delayed but it still represents a huge opportunity for the UK to demonstrate leadership, ambition and determination in the race to tackle climate change. The UK Government's 2050 net zero carbon target is an important step forward, and now a concerted effort across the entire economy will be needed to deliver on this commitment. For its part, the water industry stands ready to play a key role and has pledged to achieve net zero carbon emissions for the whole sector by 2030.³

English water companies announced this ambitious goal in April 2019 – a transparent and definitive pledge that no other sector has matched. And the water companies in England will be working closely towards this 2030 goal with their counterparts in Wales, Scotland and Northern Ireland, who have their own commitments on decarbonisation. The water industry is the first industrial sector in the UK – and possibly the world – to commit to a net zero carbon future by this early date.

As custodians of a commodity so essential to all our lives, water companies know their role is key. The Chief Executive of the Environment Agency, Sir James Bevan, last year delivered a stark warning of the very real risk of the country running out of water within 25 years due to a warming climate and a growing population. Water companies are acutely aware of this existential challenge and are determined to act to address it.

Our 2030 net zero carbon commitment demonstrates the industry's ambition on decarbonisation, but water companies already have a strong history of leadership on this issue. Take, for example, the industry-wide

^{3.} Water UK, "Water industry takes significant first step in drive to be carbon zero", https://www.water.org.uk/news-item/water-industry-takes-significant-first-step-in-drive-to-be-carbon-zero/ (2019).

^{4.} Environment Agency and Sir James Bevan, "Escaping the jaws of death: ensuring enough water in 2050", https://www.gov.uk/government/speeches/escaping-the-jaws-of-death-ensuring-enough-water-in-2050 (2019).

standardised process of carbon accounting, which requires companies to detail exactly how much carbon they emit and what form this takes. In place for the last decade, this will provide an important baseline of data for future decisions.

Now the industry is taking its first significant step on the journey to net zero, announcing a major project, working with two international consultancies, Ricardo and Mott MacDonald, to develop the comprehensive action plan that will help us reach this ambitious goal over the next decade.

There is no shortage of questions and challenges along the way, to take just a few: how will we deal with the emissions from the biological breakdown of sewage during the treatment process? What role will land management play? What is the right pace and approach for greening fleet vehicles?

There are no easy answers but that won't stop us from driving forward with pace and passion. It won't be a route map that sets out a 'one size fits all' course. In the water sector, companies can face very different challenges, depending among other things on their location and population. Northumbrian Water, for example, is in a relatively wet, sparsely populated area of the country, unlike the far drier areas served by Anglian or Affinity Water.

So, each company will have its own route and methodology for reaching the net zero target with the overarching action plan providing a framework to shape the approach.

"The industry has announced plans to plant 11 million trees by 2030, and many water companies are working closely with partners to protect peatland, an invaluable ecosystem and an important store for carbon"

And there's much work already underway. Renewable energy has been an area of significant focus. Anglian Water recently completed the company's largest solar array at its recycling plant in Jaywick, Essex.

The 3,312 solar panels will reduce carbon emissions by over 300 tonnes in the first year.5 And Yorkshire Water's £72m energy and recycling facility at Knostrop wastewater treatment works in Leeds creates enough electricity to run 55% of the site, the equivalent of powering 7,600 homes.⁶ There are huge opportunities for the sector to generate renewable energy through existing assets.

"The water industry stands ready to play a key role and has pledged to achieve net zero carbon emissions for the whole sector by 2030"

Many companies, including SES Water and Northumbrian Water, are increasingly using electric vehicles at their sites and in their fleets, while others are also turning to green finance to ensure their investments support their sustainability agenda. Yorkshire Water launched the world's first Stirling sustainability bond last year and has now raised more than £800 million under its new Sustainable Finance Framework.7 In 2018, South West Water signed £80 million worth of green financing deals with Société Générale and Natwest.8

The water industry is also a large landowner - collectively, water companies in England own 140,000 hectares of land. The recent Climate Change Committee (CCC) report set out the need for a radical rethink on land use, and the water sector is keen to work with the CCC on this agenda. The importance of effective management of this land is essential for the sector to meet its carbon commitment. The industry

^{5.} Anglian Water, "Anglian Water completes biggest solar energy project to date", https://www. anglianwater.co.uk/news/anglian-water-completes-biggest-solar-energy-project-to-date/ (2019). 6. Yorkshire Water, "New £72m AD plant will help Yorkshire Water reduce carbon footprint and

keep customer bills low", https://www.yorkshirewater.com/news-media/2016/knostrop-sludgeinvestment/ (2016).

^{7.} Kelda Group, "Sustainable finance", https://www.keldagroup.com/investors/sustainable-finance/

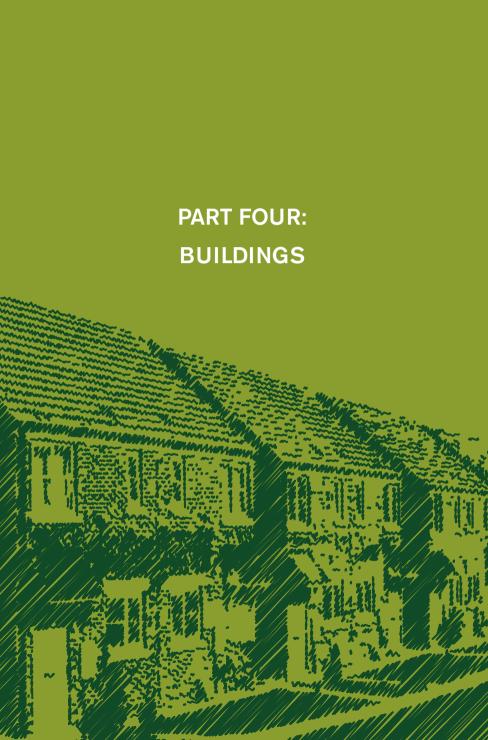
^{8.} Pennon, "Pennon signs pioneering £80m green finance deals with Societe Generale and NatWest", https://www.pennon-group.co.uk/media/news/pennon-signs-pioneering-%C2%A380m-greenfinance-deals-societe-generale-and-natwest (2018).

has announced plans to plant 11 million trees by 2030, and many water companies are working closely with partners to protect peatland, an invaluable ecosystem and an important store for carbon.

There is much to do to deliver on this ambitious goal for the sector. It will require innovation and collaboration across all companies in the wider sector, including contractors and suppliers. The industry is well-positioned to play a key role in decarbonisation, working with the UK government and other sectors too.

Water plays a central role in our lives and in the past, present and future of this blue planet that we all live on. The industry intends to do its part to tackle climate change and contribute to a sustainable future for generations to come.

Christine McGourty is the Chief Executive of Water UK, the water and sewerage industry's trade body for the United Kingdom.



A deeper green Urban design

Nicholas Boys Smith

All my adult life 'the environment' has been the dog that hasn't quite barked. Is that now changing? The UK has committed to becoming a net zero carbon country by 2050 and the Act passed both the House of Lords and the House of Commons unopposed. But if there is political consensus in principle, are we at risk of a lack of systematic joined-up thinking about what actually makes places sustainable? I fear that we are in at least two ways.

"The embodied energy in the bricks of a typical Victorian terraced house could drive a car more than ten times around the world"

The first is to do with *scale*. Discussions with architects and engineers often focus on improving energy efficiency in buildings without discussing *where* that building is. Discussions with transport planners too frequently end up in a simplistic fixation with maximising density to enhance use of public transport. Put differently, the focus has been on the smallest and the largest scales; what we might term the scale of the *building* and the scale of the *location* but not on the middle scale of the *place* or urban form. However, evidence suggests that this missing tier is critical to understanding the interrelationship between human activity and levels of energy usage.

For example, there has been much research showing that mass transport is more energy-efficient than cars. It leads policymakers to conclude that maximising density is therefore simplistically 'green.'

Also important is the energy consumed by buildings either keeping them warm or keeping them cool. Seventy per cent of energy use in European residential buildings is related to insulation.²

However, available research also strongly indicates that how you deliver density, the form of buildings, and how they interact with the wider place is also very important. For example, different shapes and forms of building have very different inherent efficiencies. Recent research has shown that higher buildings actually tend to be far less energy efficient per metre cubed – and in a range of different climates. Similar patterns have emerged in both the UK and Hong Kong.³ Possible reasons include wind exposure increasing with height, which in turn increases the rate of draft infiltration meaning inside air needs more heating and cooling. Solar gain can also mean tall buildings require more cooling in the summer.

Research has also shown that buildings can tend to become less energy efficient when they are wider than 14-15 metres in depth ('deep plan space'). This is the point at which buildings must be air conditioned, which increases their use of electricity.

Research over many years has also shown that human behaviour is often more important than building efficiency in determining energy usage.⁴ We would suggest, for example, that you open your window more on a quiet street with clean air than a traffic-thronged one. And

^{1.} Peter Newman and Jeffrey Kenworthy, Sustainability and Cities: Overcoming Automobile Dependence (Washington DC: Island Press, 2009).

^{2.} C Lok, C Tsang, Ricky Chang and Danny Li, "Electricity use characteristics of purpose-built office buildings in subtropical climates", Energy Conversion and Management (2004), 829-844; UCL Energy Institute, "High-rise buildings: energy and density", https://www.ucl.ac.uk/bartlett/energy/news/2017/jun/ucl-energy-high-rise-buildings-energy-and-density-research-project-results (2017).
3. Ibid.

^{4.} Robert Socolow, "The twin rivers program on energy conservation in housing: highlights and conclusions", *Energy and Buildings* (1978), 207-242; David Harrje and Richard Grot, "Instrumentation for monitoring energy usage in buildings at Twin Rivers", *Energy and Buildings* (1978), 293-299.

a particularly pleasant street is more likely to encourage you to ditch your car and walk. We sometimes talk about 5mph streets, with textured composed facades and variety in a pattern, versus 60mph streets with facades of sheer glass.⁵ A well-placed tree can also provide natural shade to buildings in summer and reduce energy demand.

"Seventy per cent of energy use in European residential buildings is related to insulation"

My second concern is about resilience over time. One of the most energy intensive, carbon non-neutral things we humans do is build a building. The embodied energy in the bricks of a typical Victorian terraced house could drive a car more than ten times around the world.⁶ Reusing such a house rather than destroying it could significantly reduce its lifetime energy consumption. Building a two-bedroom house from scratch uses up to the equivalent of 80 tonnes of CO₂. In comparison, refurbishment uses only eight tonnes.⁷ Even with the highest energy-efficient specification, the new build would take over 100 years to catch up. And that begs an important question that is almost never asked: what types of buildings and places are re-purposed beyond their initial use and why? How do we get better at recycling buildings not just bags?

The evidence suggests that buildings and places we find beautiful and adaptable get preserved and looked after. Those that we find ugly or hard to repurpose get pulled down. Compare the history of Gilbert Scott phone kiosks (now being converted into mini-libraries, coffee bars, and defibrillators) with that of their ugly 1980s replacements (now all swept away by technological change). Or compare the streets and squares of historic London now sailing into the twenty first century whilst 1960s

Nichols Boys Smith, "Heart in the Right Street", https://www.academyofurbanism.org.uk/heart-inthe-right-street/ (2016).

Parliament UK, "Select committee on culture, media and sport written evidence", https://publications.parliament.uk/pa/cm200506/cmselect/cmcumeds/912/912we59.htm (2006).

^{7.} Mike Bernes-Lee, "What's the carbon footprint of...building a house", *The Guardian*, https://www.theguardian.com/environment/green-living-blog/2010/oct/14/carbon-footprint-house (2010).

concrete office blocks have lasted less than a lifetime.

Yet are we building for the long term? I have personally worked with engineers in their early sixties on projects pulling down places they helped to create when there were in their twenties. And a witness recently told the Building Better Building Beautiful Commission which I co-chaired: "I was working on a PFI project... and we were told by the contractor to put in a more expensive material that looked cheaper because there was real sensitivity about anything in the NHS looking expensive."

This is insane. By all means, let's use materials that insulate well and encourage public transport. But to move beyond 'Gizmo Green' to 'Deep Green' we also need to think about time and scale. It might be that the most behaviourally intuitive and cost-effective way of 'greening' our design and development industries is to make sure we create beautiful places in which people want to walk and beautiful buildings which can last more than a generation.

"Recent research has shown that higher buildings actually tend to be far less energy efficient per metre cubed"

'Fine-grained' developments are likely to cost less to heat and cool not just because of their material but because of their shape and how they interact with the streets and gardens around them. That has certainly been true historically. Historic Roman or Islamic cities kept cool not through air conditioning but through design, a network of narrow high streets and internal courtyards which kept out the sun.

If we want to create places sustainably, we need to do things that someone is not trying to sell us.

Nicholas Boys Smith is the Director of Create Streets, a social enterprise and research organisation co-creating popular, beautiful places. Nicholas was also co-chair of the Government's Building Better Building Beautiful Commission.

Intelligent infrastructure Engineering

Hannah Vickers

Engineers have a long tradition of working for the benefit of the environment. Some of the most impressive ancient Egyptian and Roman projects were about bringing water to parched lands. Victorian sewers, which took the system to every single home, were adopted across the Western world, helping to remove filth and disease from the streets. The engineers who designed the iconic Battersea Power Station in the 1930s introduced pollution control technology into the structure's chimneys – a world first.

"Encouraging and nurturing innovation will be a key to our success"

We will need to call upon this innovative spirit and tradition once more if we are to meet the unprecedented challenge that net zero poses to our society.

The legally binding target that we are now working towards will lead to a radical reshaping of the economy. This will change the way we work, live and play, and has profound implications for those working in our industry. Our members are the businesses which design, deliver and manage our national infrastructure – everything from roads,

trains, schools and hospitals – and as such will be at the forefront of this challenge.

Buildings are responsible for more than 40% of global energy usage, and as much as one third of greenhouse emissions, while construction materials account for around a third of waste to landfill. It is clear we will need to explore new designs, construction methods, materials and processes as we help society meet the system and market challenges of reaching net zero.

However, the challenge is even greater owing to the fact that 99.5% of infrastructure is a 'system of systems', where any changes have knock-on effects across the entire system. For example, if we decide to use hydrogen trains to cut rail emissions, then we will need to factor in the production and storage of it. Thankfully, engineering consultancies understand system interactions inside out.

The Committee for Climate Change (CCC) makes it clear that a net zero society is technically feasible. However, we will need all of the ingenuity that engineers are famous for in order to successfully reshape our entire economy to meet the target. In a world where infrastructure projects take decades, 30 years is the blink of an eye and decisions that we will soon need to take will have profound long-term effects as we risk 'locking in' carbon emissions. There will be difficult questions on issues such as energy reduction, use, production, as well as the capture and storage of remaining carbon emissions.

It is clear, even at this early stage, that encouraging and nurturing innovation will be a key to our success. There are plenty of great examples of how this is already happening in our sector, whether it is using modular construction methods, encouraging timber structures for homes and offices, designing for performance, introducing

^{1.} Global Alliance for Buildings and Construction, International Energy Agency and UN Environment Programme, "2019 global status report for buildings and construction" https://www.worldgbc.org/sites/default/files/2019%20Global%20Status%20Report%20for%20Buildings%20 and%20Construction.pdf (2019), 3; WRAP, National Federation of Builders and Envirowise, "Reducing your construction waste", http://www.wrap.org.uk/sites/files/wrap/Reducing%20your%20 construction%20waste%20-%20a%20pocket%20guide%20for%20SME%20contractors.pdf (2019), 2.

sustainable drainage schemes (SUDS) which use natural features to manage floods, or maximising the positive effects of natural light through intelligent design.

"Open data on customer use and asset performance will help us to reduce the impact of our buildings and processes in ways that were unimaginable only a few years ago"

Our industry isn't lacking in innovation, quite the opposite. What is much harder, however, is getting buy-in from clients to turn this innovation into commercial reality and delivering that environmental benefit.

Like all organisations, we will need to reassess our processes and outputs, but it will be in our role as an industry facilitator that we will have the most impact. This is why we have launched our net zero campaign, which brings together business leaders and experts with those of our sister business group, the Environmental Industries Commission (EIC).

The campaign will bring us together to strategically dismantle our processes and reassemble them to help us build the carbon-free buildings and infrastructure of the future. It will explore what needs to happen to ensure we have the industry capacity and market structures to unleash innovation. Finally, we will demonstrate how better planning can maximise low carbon opportunities.

There are some areas which clearly stand out as being ripe for innovation.

Urban planning needs to be realigned to focus on net zero outcomes and is a fundamental issue for delivery of the target. The rules and regulations around planning will need to focus on decarbonisation. We will also need more innovative 'lateral net zero thinking' at master planning levels to avoid cutting off opportunities. For example, building tramways which makes the subsequent digging of a heat network prohibitively expensive.

Second, it is clear that commercial relationships, whether with public

or private clients, will need to change. We will have to switch the focus from price to incentivising value, specifically net zero considerations. This also touches upon the work of another Association for Consultancy and Engineering (ACE) campaign, the Future of Consultancy, which is currently developing a range of alternative sustainable business models focusing on value creation, for the industry to take forward.

The challenges are huge but there are many reasons to be optimistic. Legally binding targets will help to shift thinking on this issue from all stakeholders – whether the Mandarin in Whitehall or the project manager on a building site. Open data on customer use and asset performance will help us to reduce the impact of our buildings and processes in ways that were unimaginable only a few years ago. Our sector is awash with great ideas, ingenious thinkers and world-leading designers, engineers, technicians and environmental experts.

While we may have missed out on a great opportunity to demonstrate our expertise on a global stage owing to the postponement of COP26, we should nevertheless recognise that rising to the net zero challenge will allow British engineering to firmly establish itself as a world leader in yet another field.

Hannah Vickers is the Chief Executive of the Association for Consultancy and Engineering (ACE), which represents the companies large and small who design, deliver and manage the UK's national infrastructure.

Raising standards Homes

Steven Heath

Consider the enjoyment of a nice meal expertly served with a welcoming smile versus the purchase of a second hand car. At the point of payment, one will elicit a sense of satiated satisfaction. The other will hold a sense of excitement, but also anxiety. Imagine that purchase: a few impotent tyre kicks – "yes, they appear inflated"; and, perhaps a look under the bonnet: "I wonder what that bit does?" The issue: there is no apparent mechanism by which the buyer can be assured of the quality of the car they are buying.

"House builders need support if they are to deliver 200,000 – 300,000 new, resilient, low carbon homes per-year"

The unhelpful phrase 'Caveat emptor' (buyer beware) invites the question: "Well, just how should I 'beware'... qualify as a mechanic and lug my own testing gear around forecourts before I buy?"

This information asymmetry between buyer and seller, and its ability to erode trust in a market, was identified by Nobel Prize winning economist George Akerlof. He argued an inability to identify a low quality product – in his words a 'lemon' – would drive an ever higher

proportion of 'lemons' in a market.1

Luckily, he offered solutions from robust warranties and regulation to technologies designed to identify a quality product from a lemon. Today's second hand car dealerships offer AA roadside assistance packages, while dealerships are often attached to the original manufacturer's brand. Buy a car that's less than eight years old, then sensor data across the vehicle's lifetime, and the lifetime of all similar vehicles, is likely available.

"Rather than offer theoretical home efficiency improvements by subsidising 'insulation' or 'draught proofing' and assume a CO_2 saving, policy should be designed to pay only for 'proven' improvements"

This combination of technology, warranty and brand protection has allowed risk in the second hand car market to be transferred away from the consumer and onto the seller and its supply chain.

Can we say the same of the new build home market? Information asymmetry between the buyer and seller is apparent in what represents perhaps the biggest purchase of many consumers' lives. In theory, new build warranties and building regulations protect buyers. Yet reports suggest this is not the case: "The problem Persimmon has encountered...is a systemic nationwide problem, which is a manifestation of poor culture coupled with the lack of a Group build process (a rigorous regime of Group controlled build, based on clear drawings and specifications supported by an appropriate supervision and inspection regime)."

Other coverage suggests it is unfair to single out Persimmon. If the quote describes the current situation, the challenge set to us by the

George Akerlof, "The market for "lemons": quality uncertainty and the market mechanism", The Quarterly Journal of Economics, (1970), 488-500.

^{2.} Persimmon Homes, "Findings of the independent review", https://www.persimmonhomes.com/corporate/media/397416/findings-of-the-independent-review.pdf (2019), 4.

climate emergency means we should also expand our definition of 'quality'. Traditionally seen as a "wonky light switch" or "dodgy paint job" snagging list, high quality must grow to encompass whether the consumer has got the "fabric energy efficiency the design promised" or whether the "ventilation system is performing as specified and the home airtightness matches the specification".

This is where Akerlof's technology innovation must be unleashed to work in favour of the consumer. If regulation does not support the roll-out of such measurement technologies, unintended consequences may include: poorly installed insulation combined with electric heating driving up occupant bills (also creating an avoidable need for additional electricity generating capacity); to inadequate indoor air quality; or even increased fire risk.

Government has sketched out a requirement for a 31% reduction in emissions from new homes beginning later in 2020 and an aspiration to reduce new home emissions by 80% by 2025.³ But it has not set out a credible pathway that allows developers to deliver 250,000 such homes a year by 2025.

We argue innovation, supported by good regulation, holds the key. Our proposed pilot outlines a roadmap by which new home performance risk can safely be moved away from new home buyers (and society as a whole, which bears the cost of under-performance in terms of emissions reduction) on to the new home supply chain. We also believe this innovation, if incentivised correctly, can support a similar shift in risk away from the consumer in the energy efficiency home retrofit and commercial retrofit markets.

We must also declare an interest. We have invested five years and many millions in developing such quality assurance tools; we would like to put them to work.

^{3.} Ministry of Housing, Communities & Local Government, "The future homes standard: changes to part l and part f of the building regulations for new dwellings", https://www.gov.uk/government/consultations/the-future-homes-standard-changes-to-part-l-and-part-f-of-the-building-regulations-for-new-dwellings (2019).

Knauf Insulation proposes a staged pilot to ensure real performance design targets on airtightness, ventilation and fabric thermal performance are met. House builders need support if they are to deliver 200,000 – 300,000 new, resilient, low carbon homes per-year.

First, in 2021. The top 10 private house builders agree to design and achieve an 80% reduction in 2% of their new builds, reflecting the 2025 ambition (the remaining 98% to meet the proposed 31% target). The same standard would apply to 5% of social housing starts.

To address Information Asymmetry between buyer and seller, all pilot homes will be measured through post-completion testing of the fabric thermal performance, ventilation and air-tightness targets, with results compared to the original design intent.

Then, in 2022, the obligation would grow to the top 20 builders and 4% of starts and 15% of social housing starts. Next, in 2023, the obligation would grow to the top 20 builders and 8% of starts and 20% of social housing starts. Finally, in 2024, the obligation should rise to 10% of all new private homes and 50% of all social housing – ultimately growing to 100% of all new homes by Government's proposed 2025 Future Homes Standard.

By implementing these standards in a 'learn small, scale fast' approach, the industry offers a market to new home verification technologies, upskills workers on 'new' measure supply chains and significantly diminishes the risk of low-quality work.

Focusing on private sector housebuilding, such a pilot might deliver 26,200 homes over four years built to a verified Future Homes Standard at a cost of £117 million. This R&D cost may be offered to developers in tax breaks but, however funds are found, the pilot would set the bulk of UK house builders on a pathway to genuinely delivering high performing homes at scale.

Equally important, the pilot establishes an early stage market for services offering 'assured outcomes' rather than the tick-box compliance exercises that currently underpin home Energy Performance Certificates (EPCs). As the UK's leading insulation manufacturer, we are challenged

not to 'sell insulation' but support developers to offer 'proven home efficiency performance' as a service.

Crucially, such a market offers the base load to build similar services out to new markets:

First, home retrofits – rather than offer theoretical home efficiency improvements by subsidising 'insulation' or 'draught proofing' and assume a CO₂ saving, policy should be designed to pay only for 'proven' improvements. This moves risk away from the home owner and on to the supply chain, perhaps even allowing the 'able-to-pay' market to truly believe in the benefits offered and cover costs outside of government support.

Second, commercial retrofit – often seen as the hardest market to crack as no building type, or occupancy pattern, is the same and a bespoke approach is likely required each and every time. If a new 'energy services' market grew in the 27 million homes market, then regulating action on the commercial stock is de-risked. Existing providers would be able to tweak domestic service business models rather than expect a new industry to grow.

"Information asymmetry between the buyer and seller is apparent in what represents perhaps the biggest purchase of many consumers' lives"

Most energy policy approaches to date have settled on subsidising, regulating or obliging individuals or entities to undertake activities which only theoretically reduce carbon emissions. Yet, no measurement is taken on site so there is little by way of assurance for buyers, or Government's CO₂ balance sheet, that they are getting what they pay for. So the key challenge in both the domestic and commercial retrofit

^{4.} The domestic Energy Performance Certificate is based on SAP software which estimates CO2 emission from buildings with a similar 'estimated' approach taken in commercial or public buildings using SBEM software. These software packages underpin multiple policy tools from the Energy Company Obligation in retrofit to Building Regulations.

sector is: how to roll out technologies which can de-risk creating multiple 'lemon markets'?

Steven Heath is the Technical and Strategy Director at Knauf Insulation Northern Europe, the United Kingdom's leading insulation manufacturer creating energy-efficient solutions for buildings. Knauf Insulation is a member of MIMA (Mineral Wool Insulation Manufacturers Association), the UK's industry trade body for non-combustible, breathable glass and stone wool insulation and member of the EEIG (Energy Efficiency Infrastructure Group).

Decarbonised designs Architecture

Gary Clark

The current COVID-19 pandemic has infected millions of people, resulting in hundreds and thousands of deaths worldwide. It has laid bare the fragility of national emergency planning and the global economy to extreme events.

That has meant many governments have printed emergency money to support our livelihoods in the short term. But it has also shown the positive side of humanity with innumerable acts of kindness and support. The most striking positive impact of remote working is on the environment. Pollution levels in all our great cities are at record lows, and the Himalayas are once again visible from the cities of the Punjab. Global carbon emissions as a result will fall to record lows this year.

"A target of 40% reduction in potable water use should be set for all buildings by the use of extensive on-site water storage and re-use of rainwater"

As countries are considering lifting lockdowns, we must use this terrible event as a moment of reflection on what we are doing to ourselves and our planet. We cannot return to normal as if nothing has happened. The COVID-19 pandemic statistics are chilling, but in hindsight, will

be overshadowed by the estimated impact on humanity and the global economy by extreme climate events to come.

This year will be a defining moment in human history where we can still decide what sort of future our children and grandchildren will inherit. Our children, including through Greta Thunberg, have already voiced their fears and demand that we 'responsible adults' take action. This message is even more true today than before the COVID-19 outbreak.

"In all projects, we should target significantly enhanced biodiversity and urban green cover including productive landscapes within land ownership"

This is also the UK and devolved governments, and especially the architectural and construction industry's, opportunity to lead the world by example. We must commit to a radical transformation of our industry, which still emits 40% of the UK's carbon emissions – around 150 million tonnes of CO₂e annually using total UK emissions in 2017 of 373 million tonnes.¹

The 'Architects Declare Community' has led the way and has over 800 practices pledging to address climate change. We therefore need to offer the government a commitment that we will reduce our carbon emissions to zero as soon as possible. I and many others believe that the first step is to target net zero carbon for all new and deep retrofit buildings by 2030. This is encapsulated into the Royal Institute of British Architects (RIBA) '2030 Challenge', which was launched in October 2019.²

At the moment, the 2030 Challenge is voluntary, but this will change in the next few years to become a mandatory position. For example,

^{1.} UK Green Building Council, "Climate change: UKGBC's vision for a sustainable built environment is one that mitigates and adapts to climate change", https://www.ukgbc.org/climate-change/ (2020); Department for Business, Energy & Industrial Strategy, "2017 UK greenhouse gas emissions, final figures", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/776085/2017_Final_emissions_statistics_-_report.pdf (2019), 7.

^{2.} Royal Institute of British Architects, "2030 climate challenge", https://www.architecture.com/about/policy/climate-action/2030-climate-challenge (2020).

the RIBA awards will, in the future, align with the 2030 Challenge, and therefore by 2030, we can see the very real prospect of a project that will have to demonstrate net zero carbon performance before being considered for an award.

"Clients and government should prioritise the extensive refurbishment of existing buildings that avoid knocking them down"

In my role as Chair of the Sustainable Futures Group, I am genuinely struck by the profoundly positive change towards sustainability, not only in RIBA but in the wider profession, since I began my own journey in sustainable architecture over 30 years ago. However, we cannot waste the next few years being bogged down in professional procrastination and bureaucracy, and we must come together in the spirit of collaboration that defines any great crisis or emergency.

So, what needs to be done, by whom and by when?

The RIBA's *Sustainable Outcomes*, authored by myself with significant contributions from leading sustainability consultants in the UK, defines the key outcomes, metrics and targets for a sustainable future. Essentially, this gives the DNA of a sustainable project and signposts the strategies and tools to deliver these outcomes.³

The RIBA's 2030 Challenge, also authored by myself, defines an aggressive yet realistic trajectory to achieve net zero for new and deep retrofit buildings by 2030.⁴ You may be wondering if this is possible, but look no further than two Stirling Prize winning projects – 2019 winner Goldsmith Street, Norwich, and the 2014 winner Everyman Theatre. Both of which have achieved the 2030 target without renewables or offsetting.

^{3.} Royal Institute of British Architects, "RIBA sustainable outcomes guide", https://www.architecture.com/-/media/GatherContent/Test-resources-page/Additional-Documents/RIBASustainableOutcomesGuide2019pdf.pdf (2019), 47.

^{4.} Royal Institute of British Architects, "2030 climate challenge".

The RIBA has also published a suite of sustainability guides to accompany the new RIBA *Plan of Work 2020*: RIBA *Sustainability Strategy Overlay*, RIBA Sustainable Outcomes and the RIBA *Plan for Use*.

For more detailed practical guides there are many organisations releasing great guidance such as the UK Green Building Council, London Energy Transformation Initiative, Better Building Partnership and Passivhaus Trust, to name a few. We do need to be mindful that all the guides use the same sustainability principles to avoid creating confusion within the construction industry.

However, there is still so much more that needs to be done this year. I am working hard in the background with many other groups and individuals on a series of key actions which provide clear evidence to the government of how we can achieve net zero carbon targets.

Our key actions include: planning to create a 'Knowledge Hub', which will become an online database of the energy use and carbon emissions of buildings; creating sustainable design Continuous Professional Development (CPD) modules in collaboration with construction professional bodies such as the RIBA and volunteer groups; rewriting the architectural curriculum objectives to make it more sustainable; developing embodied carbon benchmarks for different types of buildings in collaboration with several professional bodies; and, creating an online collection of exemplary sustainable buildings in collaboration with several construction industry professional bodies.

"We must commit to a radical transformation of our industry, which still emits 40% of the UK's carbon emissions"

In addition to this, we will continue to lobby government and civil service departments to legislate the 2030 Challenge and to ensure that the building regulations are aligned with the UK carbon reduction trajectory.

Furthermore, we are challenging all architects to help their clients read the energy meters and tune up the performance of their previous buildings. Research has shown that 20% energy and carbon reductions are possible.⁵

Clients and government should prioritise the extensive refurbishment of existing buildings that avoid knocking them down. Government, clients and the design team should target a display energy certificate A-rating and a 50% reduction in embodied carbon target for non-domestic buildings, whilst targeting Passivhaus levels of energy use for domestic buildings.

There is more still that can be done. A target of 40% reduction in potable water use should be set for all buildings by the use of extensive on-site water storage and re-use of rainwater. We should all be mindful of health and wellbeing, and use the principles of the International Well Building Institute 'Well Building Standard' to maintain the health of building occupants. And finally, in all projects, we should target significantly enhanced biodiversity and urban green cover including productive landscapes within land ownership.

We are challenging all architects to sign up to the RIBA 2030 Challenge and declare their buildings' operational data. We hope that government, clients and other professional bodies will follow the RIBA lead in this matter.

In conclusion, this is the defining moment where we can make a difference and create a sustainable future for the next generation. If we do not act now, then future generations will be faced with frequent climate events that will kill or displace millions of people, and in the worst-case scenario – the collapse of land and water ecosystems – we face the very real prospect of an extinction catastrophe.

Gary Clark RIBA, BREEAM, LEED AP is the Chair of the Royal Institute of British Architects' Sustainable Futures Group, as well as Principal and Regional Leader of Science and Technology at HOK London Studio.

^{5.} DELTA, "Smart meter benefits: role of smart meters in responding to climate change", https://www.smartenergygb.org/en/-/media/SmartEnergy/essential-documents/press-resources/Documents/Role-of-smart-meters-in-responding-to-climate-change---May-2019.ashx (2019), 21.



Healthy profits

Retail

Peter Jelkeby

At IKEA, we are inspired by a simple vision: to create a better everyday life for many people. But in a world of growing inequality, climate emergency and resource scarcity, it's evident that a better life can only mean one that respects the limits of the planet.

"Currently, businesses are simply not being encouraged to invest in energy efficiency, due to a lack of incentives, support and information"

While the COVID-19 pandemic represents the biggest immediate threat to our way of life today, it is crucial that we don't lose sight of the existential threat of the climate emergency.

Climate change is no longer a distant threat, but a visible reality. It's one of the biggest challenges that humanity faces and it's affecting the lives of millions of people around the world. Meanwhile, with the global population expected to reach nearly 8.5 billion by 2030, we're putting an even greater pressure on the planet's resources.¹

^{1.} United Nations, "World population prospects", https://population.un.org/wpp/Publications/Files/Key_Findings_WPP_2015.pdf (2015), 8.

IKEA has long been committed to addressing climate change, but we are also aware of the role we play in the mass consumption equation: the total IKEA climate footprint is an estimated 0.1% of the world's greenhouse gas (GHG).²

"Retail and wholesale are inherently dependent on free global trade flows for goods and services, but also for securing high environmental standards"

As a global retailer, we have a unique opportunity to lead the way by being a good example for positive change in society, taking meaningful actions that, through our scale, have a tangible impact.

In our 2018 *People and Planet Positive* strategy, IKEA set out an ambition to become a fully circular and climate positive business by 2030, built on clean, renewable energy and resources, and reducing more greenhouse gas emissions than we emit.³

In order to have a significant impact, we need to bring our customers on this journey with us, so we have set the global ambition of inspiring and enabling more than one billion people to live a better everyday life within the limits of the planet.

In the UK, we have been able to effectively demonstrate how addressing the climate crisis can align with continued growth and prosperity through a combination of actions and ambitious initiatives.

As a company, we have always believed that waste is a resource, but are now taking this further to become a fully circular business. By 2030, all IKEA products will be made from renewable, recyclable and/or recycled materials; and they will be designed to be re-used, refurbished, remanufactured or recycled, following circular design principles. Last year, we eradicated single-use plastics in our total product range, including straws.

^{2.} IKEA, "Sustainability report FY18" https://preview.thenewsmarket.com/Previews/IKEA/DocumentAssets/535135.pdf (2018), 27.

^{3.} Ingka, "Becoming people & planet positive", https://www.ingka.com/sustainability/ (2020).

2019 was also the year we opened our most sustainable store to date at IKEA Greenwich, London. Having been built to the highest environmental standards, the store achieved a Building Research Establishment Environmental Assessment Method (BREEAM) 'Outstanding' rating – making it one of only two retail units accredited at this level globally.

IKEA Greenwich is also a hub and meeting point for the local community and is home to IKEA's first 'Learning Lab', a dedicated space where we hold sustainable-living workshops and where customers can learn how to prolong the lives of their products by upcycling and repairing them. This is a concept which we're hoping to be able to scale-up, to become an integral part of all IKEA stores. So far, we have already increased the number of furniture and textile items taken back to the stores, with our recovery teams helping give products a second life. We are committed to developing more retail concepts and meeting places that help customers, communities and local businesses lessen their impact on the environment.

However, we need help from the government to strengthen the direction by putting the right infrastructure, incentives and targets in place. This includes taking the lead in waste management, because the current fragmented landscape dependent on hundreds of local authorities does not allow businesses to take any substantial actions. Overall, we expect 2020 to be a pivotal year for the implementation of a nation-wide resources and waste strategy.

At IKEA, we strive towards 100% renewable energy for electricity, heating and cooling, and high energy efficiency in all IKEA operations.

In 2019-20, Ingka Group, which includes IKEA Retail (UK), generated renewable energy equivalent to 93.4% of the energy used in our operations, up from 81% last year.⁴ Our recent investments in wind

Ingka, "Bringing IKEA to more people in new ways: annual summary & sustainability report FY19", https://www.ingka.com/wp-content/uploads/2020/01/Ingka-Group-Annual-Summary-Sustainability-Report-FY19.pdf?1 (2019), 68.

and solar power put us on track to exceed our 2020 target to generate more renewable energy than the energy we consume.

We also want to see greater ambition around the adoption of electric vehicles (EV) and phasing out of petrol and diesel vehicles, which must be part of plans to improve air quality in our towns and cities. Again, the lead should come from government to enable and incentivise the roll-out of a workable EV infrastructure. Becoming more accessible to people, particularly those in cities, is a key part of our retail strategy in the years ahead and commitments around 100% emission-free last mile deliveries are central to those plans.

Without doubt, more action is also needed to drive energy efficiency in commercial buildings and accelerate the up-take of low-carbon heat technologies. Currently, businesses are simply not being encouraged to invest in energy efficiency, due to a lack of incentives, support and information. Equally, we need the Government to revisit how we engage homeowners and domestic generators with new and innovative ways to leverage and access historically low costs for renewable energy, and to lead the way on developing battery storage technology to support this.

As a multinational business, we rely on free and fair trade. The global trading environment has changed substantially over recent years, with protectionism and economic nationalism dominating the trade policy debate. IKEA believes that the WTO is the ideal platform for simplifying and harmonising complex rules of origin, and encouraging e-commerce, but it is also the best way to avoid a confusing set of overlapping bilateral agreements.

Retail and wholesale are inherently dependent on free global trade flows for goods and services, but also for securing high environmental standards. We recognise that the UK's future trading relationships will either support or significantly detract from the UK's climate positive ambitions and so urge the UK not to lose sight of these in the negotiations to come.

For the UK, the 2020s is the decade in which we will need to deliver

clear leadership by setting a great example. Many elements are in place already, but for IKEA to achieve our goals, we urge the Government to set a detailed and ambitious plan for how it aims to hit the net zero target by 2050, and working backwards from that date, how it will support businesses in their efforts to become fully sustainable – in a scenario where being sustainable is not at odds with being profitable.

When the UK hosts COP26 next summer, it's likely the world will be a very different place. When recovering from the aftermath of this global pandemic, we could go back to business as usual, or worse still, we could see governments and industries ramping up regressive policies and production that generates even more CO₂ and inflicts greater damage on our environment and people.

As nations and communities start to recover from the COVID-19 crisis, it will be more important than ever for consumers, businesses and governments to enact and implement ambitious climate positive policies.

We need to move beyond the idea that big businesses can only do harm to the planet and enable business to be a force for good. All of us have an important part to play. This is why at IKEA, we are determined to show that it is good for business to be a good business.

While we are fortunate to be in a position that enables us to start investing today, we need the government to incentivise the whole retail industry to do the same – especially at a time when Business Rates, changing consumer habits, and political and economic uncertainty are forcing companies to tighten the belt. Now is the right time to galvanise bold and ambitious climate leadership and build a movement for positive change.

Peter Jelkeby is the Country Chief Executive Officer and Chief Sustainability Officer of IKEA UK and Ireland. IKEA UK and Ireland is part of Ingka Group, one of 12 different groups of companies that own and operate IKEA sales channels under franchise agreements with Inter IKEA Systems B.V.

Clean consumption Chemicals

Stephen Elliot

Ninety six percent of all manufactured products have chemical industry content, which makes our industry a major contributor to the UK economy. We are a competitive and diverse sector, adding £19 billion to the UK economy each year and providing high value jobs in regions of the UK targeted for growth in the Conservative Government's election manifesto. And, we are an innovative sector, creating the advanced materials and technologies which will underpin the transition to net zero.

According to the Committee on Climate Change (CCC), UK industry can decarbonise by 2050 through the decarbonisation of our electricity grid, the large-scale deployment of hydrogen for heat, the roll-out of carbon capture and storage (CCS), and ongoing progress in energy efficiency improvement.³

As a sector we are rising to that challenge, not just through the reduction of our own emissions – we have reduced our emissions by

^{1.} Chemistry Council, "The chemistry council sector deal", http://ukchemistrygrowth.com/wp-content/uploads/2019/11/Chemistry-Council-Sector-Deal-041119-1.pdf (2019), 7.

^{2.} Chemical Industries Association, "The CIA manifesto: Britain at work", https://www.cia.org.uk/Portals/0/Documents/CIA%20Manifesto%202019.pdf (2019), 6.

^{3.} Committee on Climate Change, "Reducing UK emissions: 2019 progress report to parliament", https://www.theccc.org.uk/publication/reducing-uk-emissions-2019-progress-report-to-parliament/ (2019).

over 70% since 1990 ⁴ – but through the provision of goods which reduce emissions throughout the economy. It has been calculated that for every tonne of greenhouse gas released in our sector, our products save two tonnes in their end use, for example as insulation, low-emission fertilisers, lightweight materials and biofuels.

"A focus on consumption emissions would put the UK in a leading position, allowing it to have a real impact on global emissions"

Jointly, with government, we have produced a chemical sector 'Decarbonisation Roadmap Action Plan',⁵ which highlights the actions required for us to reduce our emissions footprint, and we are now working closely with the Department for Business, Energy and Industrial Strategy (BEIS) to renew our approach in light of our country's ground-breaking net zero target.

In late 2019, we submitted our proposal for a sector deal through the Chemistry Council, a joint industry and government initiative to promote investment in the UK. The deal, which is aligned with the 'Grand Challenges' of the UK's Industrial Strategy and particularly the clean growth agenda, would see £500 million of government spending matched to £500 million already committed by our sector.

This would be invested in the science and engineering behind innovative sustainable materials, like the sourcing of the strategic feedstock ethylene oxide from biological sources here in the UK. Ethylene oxide is a critical raw material for over 40 industries and is currently imported from overseas fossil sources.

^{4.} Chemical Industries Association, "The chemical industry: delivering a low carbon future 24 hours a day", https://www.cia.org.uk/Portals/0/Documents/Publications/Low%20carbon%20 brochure_2015_MR.PDF?ver=2017-01-09-143808-563 (2015), 2.

^{5.} Department for Business, Energy & Industrial Strategy, "Chemicals sector joint industry – government industrial decarbonisation and energy efficiency roadmap action plan", https://assets. publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/651230/chemicals-decarbonisation-action-plan.pdf (2017).

Batteries will be key to the further electrification of heat and transport and we have committed investment to improve the current generation of Li-ion battery technology, to develop methods to recycle them at their end-of-life and also to create the next generation of battery storage.

We have also committed to investing in kick-starting the hydrogen economy. Hydrogen is a flexible, low-carbon energy vector which could be used to decarbonise heat, power, energy storage and transportation. As a sector, we already produce large quantities of hydrogen via steam methane reforming and electrolysis, and are now looking at opportunities to use the molecule for heat and as a feedstock to reduce dependence on fossil hydrocarbon sources.

Finally, the funds from this new sector deal would be used to roll-out the technology needed to recycle waste into valuable chemical feedstocks, helping us to close the loop and move toward a circular economy.

The sector deal represents a national strategy for the chemicals sector, but there is a lot going on at a regional level too. Our industry is characterised by clusters of plants, which make efficient use of resources by sharing infrastructure and streamlining energy and material flows. These clusters are located on the North East and North West coasts, where our raw materials are brought into the UK. This makes us well placed to take advantage of new offshore wind capacity, to supply us with electricity or green hydrogen, as well as natural gas to make blue hydrogen. It also gives us the opportunity to repurpose our heritage oil and gas assets, to capture and store carbon permanently underground.

"The greatest contribution we can make to the reduction of global emissions would be to increase output from cleaner UK manufacturing, and supply the world with zero-carbon goods at a price which outcompetes their carbon-intensive equivalent"

Our clusters are already deploying their own strategies for regional decarbonisation, including the North West Hydrogen Cluster and HyNet

projects in the North West, the Net Zero Teesside project in the North East, the Zero Carbon Humber project in the Humber Estuary and the North East CCUS (NECCUS) in Scotland. Fully developed, these projects would abate 100 million tonnes of CO_2 each year by 2040.6

In their 2019 progress report to Parliament, the CCC outlined policy recommendations for the decarbonisation of industry, including a funded mechanism for fuel switching and CCS, the award of capital support for industry decarbonisation, and plans to reduce demand for carbon-intensive products.⁷

These policies are critical because, as the CCC's advice states, industry decarbonisation has an annual cost of the order of £5-10 billion and trade-exposed, energy intensive industry like chemicals require a level-playing field to compete globally. If the cost of decarbonisation in the UK is too great, then industry will be forced to relocate overseas, which would not help to reduce global emissions, and would be damaging to the UK economy.

"There is no credibility in the Climate Change Act if it leads to industry being offshored"

The UK's historic focus on pricing territorial emissions and decision to ask energy consumers to pay the cost of decarbonising energy has already driven manufacturing overseas. The recent Office for National Statistics (ONS) report on UK greenhouse gas emissions shows that whilst the UK's territorial emissions have decreased significantly over the last 20 years, our consumption emissions remain on a level

^{6.} Figure is based on the publicly available data concerning all projects referenced.

^{7.} Committee on Climate Change, "Reducing UK emissions: 2019 progress report to parliament", https://www.theccc.org.uk/publication/reducing-uk-emissions-2019-progress-report-to-parliament/ (2019).

^{8.} Committee on Climate Change, "Net zero: The UK's contribution to stopping global warming", https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf (2019), 30.

comparable with 1990.9

According to the Department for Environment, Food & Rural Affairs (Defra)'s UK carbon footprint published in March 2020, UK greenhouse gas emissions related to imported products are 18% higher than in 1997 when their records began, whereas UK production emissions attributable to UK final consumption decreased 31%. ¹⁰ This tells us that UK industry is cleaner than elsewhere, but UK manufacturers are losing out to overseas production.

"Whilst the UK's territorial emissions have decreased significantly over the last 20 years, our consumption emissions remain on a level comparable with 1990"

A focus on consumption emissions would put the UK in a leading position, allowing it to have a real impact on global emissions. The creation of industrial investment zones, with access to affordable and reliable sources of clean energy and emission removal infrastructure, would attract investment in the production of low-carbon goods for export, reducing the global footprint of consumption. This requires public investment in UK infrastructure, which would have crossbenefits for the decarbonisation of transport and households.

The CCC included consumption emissions for the first time in their 2019 progress report to Parliament, because they understand that there is no credibility in the Climate Change Act if it leads to industry being offshored. We need the Government to do likewise: to begin relating our net zero target and policies to our consumption emissions, to drive a real reduction in emissions and to preserve a thriving manufacturing base here in the UK.

^{9.} Office for National Statistics, "The decoupling of economic growth from carbon emissions: UK evidence", https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/compendium/economicreview/october2019/thedecouplingofeconomicgrowthfromcarbonemissionsukevidence (2019).

10. Department for Environment, Food & Rural Affairs, "UK's carbon footprint 1997 – 2017", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/879310/Consumption_emissions_March_20_v5.pdf (2017), 1.

We should consider how consumption-based measures, such as labelling, product standards and carbon border adjustment mechanisms, could help create a market for low-carbon goods and allow manufacturers to pass through the cost of decarbonisation to the consumer. We should also protect domestic producers who have cleaner processes, but face higher costs related to the decarbonisation effort. This could be through access to bilateral carbon offsetting via Article 6 of the 2015 Paris Agreement, or it could be through exemption from the policy cost of energy decarbonisation, as recommended by Professor Dieter Helm in his 'Cost of Energy' review.¹¹

"If the cost of decarbonisation in the UK is too great, then industry will be forced to relocate overseas, which would not help to reduce global emissions, and would be damaging to the UK economy"

The greatest contribution we can make to the reduction of global emissions would be to increase output from cleaner UK manufacturing, and supply the world with zero-carbon goods at a price which outcompetes their carbon-intensive equivalent. This would represent successful societal decarbonisation and provide a model for others to follow.

Stephen Elliot is the Chief Executive of the Chemical Industries Association, the organisation that represents chemical and pharmaceutical businesses throughout the UK.

 $^{11.\} Dieter\ Helm, ``Cost\ of\ energy\ review", http://researchbriefings.files.parliament.uk/documents/CDP-2018-0101/CDP-2018-0101.pdf\ (2017).$

Scaling up a solution Carbon capture and storage

Corin Taylor

Carbon capture and storage (CCS) is a technology and infrastructure system that captures carbon dioxide (CO₂) from industrial processes, power stations and hydrogen production; compresses the CO₂ to high pressure; transports it through a pipeline; and stores it permanently in an underground geological formation, often under the seabed. This makes sure that the CO₂ does not enter the atmosphere and contribute to climate change.

CCS has been used around the world for decades, with around 35 million tonnes of CO₂ captured globally last year. If we are to meet net zero emissions in the UK, it will need to be adopted at huge scale. It is worth emphasising that while emissions will fall substantially this year as a result of the COVID-19 restrictions, they will bounce back as economic activity recovers. And to the extent that the pandemic encourages a re-localisation of supply chains, emissions from industry are likely to rise, not fall.

To understand the role that CCS can play, we need firstly to appreciate the successes and failures of Britain's decarbonisation policy to date.

^{1.} International Energy Agency, "Carbon capture, utilisation and storage", https://www.iea.org/fuels-and-technologies/carbon-capture-utilisation-and-storage (2020).

Since 1990, climate emissions from electricity generation have fallen by almost two thirds – with a coal-to-gas switch and the rapid growth of renewables to thank. But other sectors have not seen anything like the same reductions – emissions from homes have only fallen by 16%, and emissions from transport are down just 2% on 1990 levels.²

"CCS is one of the only options to decarbonise other industrial processes"

But it is with industry that we perhaps have the hardest challenge. Over recent decades, we have offshored manufacturing to other countries, which means that the production-related emissions still occur, but are counted somewhere else. Looking at the UK's emissions from the *consumption* of goods and services in this country, regardless of where they are made, our emissions have barely fallen since 1990 – and we import 80 million tonnes of CO₂ a year from China alone.³ To give one distressing example, when the Redcar steelworks closed in 2015, 2,000 people lost their jobs,⁴ but that one plant closure led to half of the fall in industrial emissions the next year.⁵ This is not an ethical or sustainable way to decarbonise.

It can be tough to grasp the scale of the effort needed to achieve net zero in more difficult sectors. In industry, it means that every furnace, every kiln, every factory, will need to eliminate its emissions. In trucks, trains and ships, where batteries are not so suitable, it means finding alternative ways to completely eliminate diesel and fuel oil. And for all

^{2.} Department for Business, Energy & Industrial Strategy, "Final UK greenhouse gas emissions national statistics," https://data.gov.uk/dataset/9568363e-57e5-4c33-9e00-31dc528fcc5a/final-uk-greenhouse-gas-emissions-national-statistics (2020).

^{3.} Office for National Statistics, "The decoupling of economic growth from carbon emissions: UK evidence", https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/compendium/economicreview/october2019/thedecouplingofeconomicgrowthfromcarbonemissionsukevidence (2019). 4. Ian McNeal, "Redcar steelworks closure contributes to sharp drop in UK carbon emissions", *Teesside Live*, https://www.gazettelive.co.uk/news/teesside-news/redcar-steelworks-closure-contributes-sharp-12696855 (2017).

Samuel Cooper and Geoffrey Hammond, "Decarbonising UK industry: towards a cleaner economy", Institution of Civil Engineers (2018), Paper 1800007, 3.

of us, it means changing the central heating systems in around 1 million homes a year between now and 2050 – we will all have no choice but to heat our homes in a different way from how we currently do.

CCS is crucial to achieving these changes in practice. First, capturing and storing the emissions from producing hydrogen from natural gas is currently the most cost-effective way to supply low carbon hydrogen at scale.

For heavy transport, hydrogen can be used in trucks and trains to replace diesel, with a fleet of hydrogen trains already working well in Germany, and it can also be used to power ships as a replacement for fuel oil. For industry, hydrogen can be used to replace natural gas as a heat source for processes where high temperatures and flames are needed, such as glass manufacturing, or as a feedstock in steelmaking to replace coke. And for homes, hydrogen could replace natural gas in the gas grid, with the installation of new hydrogen boilers, but without the wholesale changes to peoples' central heating systems that would be needed for heat pumps or other electrification options.

Second, CCS is one of the only options to decarbonise other industrial processes. Cement manufacturing is a major cause of climate change, responsible for 8% of global emissions,⁶ and the only way to get to net zero in this sector is to capture the CO₂ emissions from the process of turning limestone, gypsum and fly ash into cement.

"CO₂ has been safely stored beneath the seabed for around a quarter of a century"

Third, as the electricity sector grows, and as more variable renewables are added to the mix, there will be a need for reliable backup power when the wind doesn't blow. This will need to last much

^{6.} Elisheva Mittelman, "The cement industry, one of the world's largest CO2 emitters, pledges to cut greenhouse gases", https://e360.yale.edu/digest/the-cement-industry-one-of-the-worlds-largest-co2-emitters-pledges-to-cut-greenhouse-gases (2018).

longer than batteries, which can provide backup power for only a few hours – for example, between 18 and 25 January 2020, wind output was less than half of its potential. CCS-enabled gas power generation provides that option, especially if the UK's existing nuclear fleet is not fully replaced.

Fourth, CCS can provide negative emissions, if it is used in combination with bioenergy such as at the Drax power station, or for direct air capture. Negative emissions will be essential to offset any residual emissions from installations that are just too difficult to decarbonise.

Britain is blessed with abundant storage capacity in the North Sea and East Irish Sea, which has been assessed by the British Geological Survey and others. It is estimated that 78 billion tonnes of CO_2 could be stored in total – just the most accessible 15% of this would be enough for 100 years of UK CCS needs.⁸

At the same time, CO_2 has been safely stored beneath the seabed for around a quarter of a century. In Norway, the Sleipner project started up in 1996, and is storing about a million tonnes a year.⁹

DNV GL, as a global maritime and energy risk management company with 150 years of experience of challenging offshore environments, has been heavily involved in CCS from the start. We wrote the first recommended practices for safely capturing, transporting and storing $\rm CO_2$ beneath the seabed, and we have carried out 150 CCS projects around the world over the last 20 years. Our work has shown that, carried out properly, CCS is practical at large scale. ¹⁰

Despite all this evidence, CCS is yet to go ahead at scale in Britain. There are challenges in funding and co-ordinating CCS projects, given the need to share infrastructure, with multiple facilities connecting to

^{7.} Gridwatch, "G.B. national grid status", https://www.gridwatch.templar.co.uk/ (2020).

^{8.} Michelle Bentham, Tom Mallows, Jonathan Lowndes and Andrew Green, "CO2 storage evaluation database (CO2 stored). The UK's online storage atlas", *Energy Procedia* (2014), 5103-5113.

^{9.} British Geological Society, "CO2 storage – Sleipner field beneath the North Sea", https://www.bgs.ac.uk/science/CO2/home.html (2020).

^{10.} For further information, visit: https://www.dnvgl.com/feature/carbon-capture-storage-ccs.html

the same CO₂ pipeline. But there are now five major projects at feasibility stage in the largest industrial clusters, which combined could reduce emissions by tens of millions of tonnes a year.

Acorn in Scotland, HyNet in the North West, Net Zero Teesside and Zero Carbon Humber would all capture emissions from multiple facilities in the area and produce low carbon hydrogen at scale, which could also be used by other sectors, such as ships and trucks, or transported to homes via the gas grid. And the emerging South Wales Industrial Cluster project could see CO₂ captured from the giant steelworks at Port Talbot and shipped to suitable storage sites in the East Irish Sea. All these projects need to go ahead if we are to meet net zero. And by doing so, Britain can become a leader in the green industrial markets of the future.

The Committee on Climate Change (CCC) net zero report, which was followed shortly after by the net zero legislation, concluded that a major effort would be needed across all sectors to eliminate emissions – electricity generation would need to double, hydrogen production increase ten-fold, and up to 175 million tonnes of CO₂ would need to be captured and stored every year.¹¹ As the CCC concluded, CCS is a "necessity not an option".¹² Globally, the International Energy Agency has found that around 2,000 CCS plants will be needed by 2050 to comply with the Paris Agreement.¹³

It is crucial, then, that CCS is supported through a viable investment framework. The Government's 2020 Budget announcement of £800 million to fund CCS infrastructure in at least two clusters¹⁴ is a great

^{11.} Committee on Climate Change, "Net zero – technical report", https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Technical-report-CCC.pdf (2019), 21.

^{12.} Committee on Climate Change, "Net zero – The UK's contribution to stopping global warming", https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf (2019), 23.

^{13.} The SDS envisages over 3 billion tonnes of CO2 captured each year by 2050, which equates to around 2,000 large-scale CCS plants, if each plant captured 1.5 million tonnes of CO2 each year: International Energy Agency, "World Energy Outlook 2019", https://www.iea.org/reports/world-energy-outlook-2019 (2019).

^{14.} HM Treasury, "Budget 2020: delivering on our promises to the British people", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/871799/Budget_2020_Web_Accessible_Complete.pdf (2020), 81.

start, and the Department for Business, Energy and Industrial Strategy (BEIS) is working on a business model for funding the operational costs of running a CCS system.¹⁵ It is essential that this is announced soon to give confidence to investors. With the economy currently in a very weak position as a result of COVID-19, support for decarbonising industry could help manufacturing to recover.

"Capturing and storing the emissions from producing hydrogen from natural gas is currently the most costeffective way to supply low carbon hydrogen at scale"

Ultimately, just as we saw with renewables, the cost of CCS can be reduced substantially through economies of scale, technological development, and lower financing costs as investments become less risky. If we have the confidence to push ahead with CCS at scale, despite our current economic difficulties, Britain can reduce emissions substantially, and get to net zero practically.

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^{15.} Department for Business, Energy & Industrial Strategy, "Carbon capture, usage and storage (CCUS): business models", https://www.gov.uk/government/consultations/carbon-capture-usage-and-storage-ccus-business-models (2019).



Growing greener Food waste

Richard Walker

Last year, the UK Parliament demonstrated its awareness of our environmental crisis by declaring a climate emergency. Its central policy: the commitment to a new and improved target of reaching net zero carbon emissions by 2050.

"Food waste accounts for 8% of total greenhouse gas emissions, so reducing it is one of the top solutions to fixing the climate emergency"

The recent COVID-19 pandemic has shown us the devastating impact on people and communities of our carbon-emitting economy stalling. We still clearly need to reduce emissions, but now more than ever we need to do so in a way where some of the potentially negative consequences on people's lives are mitigated and minimised.

So what then needs to be done?

First, food waste needs to be urgently tackled. One of the most frustrating aspects of leading a food and drink business during the COVID-19 pandemic is seeing the millions of pounds' worth of food being thrown away as a result of panic buying. While the crisis showed the issue in stark relief, it has been an ongoing problem for years: the

average UK household throws £70 worth of food in the bin every month¹ and, globally, 30% of all food produced is never eaten.²

Not only is this a moral crisis when so many struggle to afford food, it's an environmental one too. Food waste accounts for 8% of total greenhouse gas emissions, so reducing it is one of the top solutions to fixing the climate emergency.³ Unlike many of today's problems, it's something that we can all individually take control of, every day, in our own homes. Making small changes to the way we shop, plan and cook our meals, can have a positive impact on both our wallets and the planet.

Second, as part of the Environment Bill, the Government needs a radical target to reduce the production of single use plastic – say by 50%. This should be combined with the rapid rollout of a nationwide Deposit Return Scheme (DRS), but a simple scheme focusing on the real problem of plastic rather than trying to encompass every type of container in a way that would add to the pressure on our already vulnerable high street. At Iceland, we decided to take an industry-leading approach by committing to being plastic packaging free in our own label range by the end of 2023, becoming the first supermarket in the world to do so.

The Environment Bill's proposed new Office for Environmental Protection (OEP) needs to have teeth by being made independent and empowered to act as a watchdog. It needs to be accountable to Parliament, rather than the government of the day, and to have the power to issue fines where these are needed to drive change. The Environment Bill needs to introduce long-term, legally binding targets to restore nature, improve air and water quality, and cut down resource use.

Third, the business community needs to be made to invest in our environment as well as its corporate growth. A simple concept to enforce this was proposed to me by my friend James Byrne from the Wildlife

^{1.} Love Food Hate Waste, "It all adds up", https://www.lovefoodhatewaste.com/article/it-all-adds (2020).

^{2.} Kate Lyons, Glenn Swann and Cath Levett, "Produced but never eaten: a visual guide to food waste", *The Guardian*, https://www.theguardian.com/environment/ng-interactive/2015/aug/12/produced-but-never-eaten-a-visual-guide-to-food-waste (2015).

^{3.} Zero Waste Scotland, "Scotland's food waste reduction action plan", https://www.zerowastescotland.org.uk/food-waste/reduction-action-plan (2020).

Trusts: a de minimis levy on any good sold, which would go towards a new 'Nature Restoration Fund'.

Conservationists know exactly where the problems are and what to do about them – the challenge is having enough of a war chest to enact their plans at scale. Such a fund would allow them to help to reverse the catastrophic decline in biodiversity that we are currently experiencing. It is also the best chance we've got of helping to address climate change. Forests, grasslands and wetlands are in fact our greatest climate technology, in their proven ability to store carbon, regulate weather patterns and reduce emissions.

Finally, there is no way to tackle climate change without the Government taking specific action on fossil fuels. The science is clear and yet we continue with a system that is designed to maximise fossil fuel exploration and burning. We have at most 10 years left to transition to a clean energy future, or face irreparable damage to our planet.⁴ The oil and gas industry is the most heavily subsidised in the world, globally enjoying \$5.3 trillion of support each year.⁵ In the UK alone, taxpayers have provided some £6.9 billion to oil, gas and coal companies under an export guarantee scheme since 2000.⁶ These subsidies must be tapered down urgently, and be redirected towards investment in green technologies, promoting new industries and employment opportunities, as well as supporting workers through the transition.

We need a serious data set so that we can track our progress. Per capita GDP growth is carefully tracked and published every quarter. Why not CO₂ emissions? If we care, then let's measure it. The late Hans Rosling, in his bestseller *Factfulness*, talked about his success in lobbying

^{4.} Intergovernmental Panel on Climate Change, "Special report: global warming of 1.5 °C", https://www.ipcc.ch/sr15/ (2018).

^{5.} David Coady, Ian Parry, Nghia-Piotr Le and Baoping Shang, "Global fossil fuel subsidies remain large: an update based on country-level estimates", https://www.imf.org/en/Publications/WP/Issues/2019/05/02/Global-Fossil-Fuel-Subsidies-Remain-Large-An-Update-Based-on-Country-Level-Estimates-46509 (2019).

^{6.} Ian Johnston, "Fossil fuel firms' multi-billion-pound state subsidies revealed in accidentally leaked secret files", The Independent, https://www.independent.co.uk/environment/fossil-fuel-firms-billionpound-uk-state-subsidies-oil-gas-firms-leak-climate-change-environment-a7690966.html (2017).

the Swedish government to do this, which they have done since 2014, making Sweden the first and so far the only country to do so.⁷ Every nation around the world should be tracking, reporting and comparing its carbon emissions on a per capita basis.

"The average UK household throws \$70 worth of food in the bin every month"

The year 2020 has been a hugely challenging one for our country and the whole world. But it has also shown how government can be a bold force for good and how communities and individuals can come together to enact real, positive change. We need to harness these collective strengths to tackle our climate crisis before it becomes one we can't overcome.

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^{7.} Hans Rosling, Factfulness, (Hodder & Stroughton, London: 2018).

A recycling revolution Plastic waste

Dr Peter Maddox

If there are two environmental issues that have dominated global headlines in the past few years, they're climate change and plastic pollution. The principal problem caused by plastic is not carbon emissions but litter, killing marine life and damaging ecosystems on land and in the water. Even so, most current plastics are ultimately made from fossil fuels, so they're an integral part of the carbon agenda. However, plastics have the potential to be part of the solution to climate change. Here are four suggestions for how to make that happen between now and 2050.

"While packaging accounts for more plastic than any other single sector in the UK economy, it only covers just under half (49%) of the problem"

While commentators have rightly pointed out the serious damage that plastics can do when they end up as marine litter, I want to acknowledge the valuable role that plastic packaging plays. First, it protects goods as they travel round the economy. Second, plastic food packaging reduces food waste, which is highly relevant to the climate change debate: if food loss and waste were a country, it would be the third largest emitter

of greenhouse gases after China and America.¹ The carbon impact of plastic food packaging is in most cases much smaller than the carbon saved by not wasting the food it's protecting.²

"Adopting the mantra 'Go plastic free' at all costs can be counter-productive"

More generally, adopting the mantra 'Go plastic free' at all costs can be counter-productive. If, for example, you swap your plastic bottle of mineral water for a single use glass one, the carbon impact of the packaging will go up significantly, even if you diligently recycle the glass bottle afterwards. Why? Because glass takes a lot of energy to manufacture – and it's extremely heavy.

So, in the immediate term, I want us not to throw the baby out with the bathwater. We absolutely need to tackle plastic pollution, but let's do it on the basis of solid evidence of what works.

WRAP's response to the public call for action on plastic pollution was to work with the Ellen MacArthur Foundation to set up the UK Plastics Pact (UKPP) in April 2018, with the objective of creating a circular economy for plastics in the UK. A world-first, the UKPP has brought together 85 members from across the entire supply chain, who between them account for two-thirds of consumer plastic packaging in the UK. They have committed to work together to achieve four targets by 2025.

First, eliminate problematic or unnecessary single-use packaging items through redesign, innovation or alternative (reuse) delivery models. Second, make 100% of plastic packaging reusable, recyclable or compostable. Third, ensure that 70% of plastic packaging is effectively recycled or composted. Fourth, reach an average of 30% recycled content across all plastic packaging.

^{1.} United Nations Environment Programme, "Minimizing food waste", www.unenvironment.org/regions/north-america/regional-initiatives/minimizing-food-waste (2020).

^{2.} Waste and Resources Action Programme, "Packaging design to reduce household meat waste", www.wrap.org.uk/sites/files/wrap/packaging_design_to_reduce.pdf (2011), 31.

All four targets will help reduce the carbon impact of plastic packaging over the next five years. Eliminating problematic plastics saves the carbon associated with manufacturing such items – and in June 2019, UKPP members agreed to phase out eight types of problematic plastic by the end of this year, which will eliminate over one billion single-use plastic items completely.³

Equally, making all plastic packaging reusable, recyclable or compostable – and then ensuring that a higher proportion is actually reused, recycled or composted – will cut carbon; each tonne of plastic packaging recycled saves up to one tonne of greenhouse gases (measured as $\rm CO_2$ equivalent), for example.⁴ And incorporating more recycled material into plastic packaging also saves carbon, compared to making it from virgin materials.

WRAP has developed a roadmap for industry to follow, helping them to identify the main problems, develop the evidence base to support action, and then implement change. And we regularly monitor and report on progress, so that we and our stakeholders can see whether we're on track – and do something about it if we're not.

The UKPP should transform the plastic packaging sector in the UK between now and 2025, producing significant carbon reductions in the process. But what about after 2025?

In the medium term, beyond the 2025 deadline of the UKPP, I expect to see radical changes taking place in response to the innovative policy agenda which the UK Government set out in its *Resources and Waste Strategy* in December 2018, and confirmed in the Environment Bill in January 2020. This sets an ambitious direction of travel through to 2035.

I would highlight four policies in particular. First, extended producer responsibility (EPR) for UK packaging – this will require packaging

^{3.} Waste and Resources Action Programme, "The UK plastics pact report 2018/19", www.wrap.org. uk/sites/files/wrap/The-UK-Plastics-Pact-report-18-19.pdf (2019).

^{4.} Department for Business, Energy and Industrial Strategy, "Greenhouse gas reporting: conversion factors 2019", www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019 (2019).

producers to pay the entire costs of dealing with their material at end of life. It should encourage them to eliminate the worst forms of plastic packaging, and design the rest for lower environmental impacts.

Second, consistency of collections – this will require all English local councils to collect the same core set of materials for recycling, so that householders know what can be recycled, wherever they are in the country. It should drive up plastic recycling rates significantly.

Third, the plastic packaging tax – a tax on plastic packaging containing less than 30% recycled content, which will encourage packaging producers to recycle more plastic into their products.

Finally, the Deposit Return Scheme (DRS) for drinks packaging – the imposition of a deposit when buying packaged drinks should encourage consumers to return the empty packaging after use, ensuring that it gets recycled.

All of these policies will generate carbon savings.

On the same timescale, I want us to focus our attention beyond plastic packaging to all the other forms of plastic that arise in the economy. While packaging accounts for more plastic than any other single sector in the UK economy, it only covers just under half (49%) of the problem.⁵

The remaining 51% of non-packaging plastics comes from various sectors, including construction, vehicles and electronics.⁶ If we're serious about tackling plastic pollution in its totality, we will also need policy interventions that address these other sectors. The UK Government has already committed to introducing EPR for vehicles and electronics, so the main area that will need additional focus is construction.

Beyond 2035, I expect there will be new challenges and the need for new innovations, if we are to tackle the final problems standing in the way of reaching net zero for plastics.

^{5.} Waste and Resources Action Programme, "Plastics market situation report 2019", www.wrap.org. uk/sites/files/wrap/WRAP_Plastics_market_situation_report.pdf (2019), 2. 6. Ibid., 7.

At a strategic level, though, I think we will need to look beyond plastics as a material for use in packaging and other sectors. Most of the concerns I've discussed above are directly related to our current model of consumption. If we're going to reach net zero, we will need to ask fundamental questions about that model. In particular, how can we best meet the needs of society in a way that's compatible with net zero? It may be that the answer to this question involves a fundamental rethink of the products and services we demand, with major consequences for the resources we use and the wastes we produce. By thinking carefully, perhaps we'll consign plastic pollution to the dustbin of history.

"Each tonne of plastic packaging recycled saves up to one tonne of greenhouse gases"

Plastic pollution is one of the public's main environmental concerns today. It links directly to the net zero agenda, because today's plastics ultimately come from fossil fuels. However, I am convinced that current and future innovations in technology, policy and our approach to consumption will enable plastics to be an integral part of a net zero world. WRAP is busy creating that reality.

Dr Peter Maddox is a Director of WRAP, a UK charity working with governments, businesses and communities to deliver practical solutions to improve resource efficiency.

A steely solution? Metals

Dr Richard Curry and Gareth Fletcher

The UK's commitment to achieving net zero carbon emissions by 2050 is ambitious and requires significant innovation and lateral thinking to achieve. The target is achievable, the question is: will it be achieved without introducing long-term damage to our standard of living, finances and overall sustainability and self-reliance as a country?

In a global economy, where other countries will exploit lower manufacturing costs from cheap carbon energy sources without additional Carbon Capture Usage & Storage (CCUS) premiums, the role and alignment of policy and technology is key. Simply closing or allowing carbon emitting industry to die out is not the solution as we lose control of the outsourced carbon dioxide (CO₂) we create. We also lose the manufacturing skills and jobs, cash leaves the country, and reliability of supply is lost.

The current European carbon taxation system exacerbates this process and leaves industries that produce highly engineered products at commodity prices within a global market, heavily effected by global oversaturation due to the Asian growth slowdown, unable to invest in decarbonisation just as key technologies are maturing. The future of the UK metals industry, its ability to safely process waste and the hydrogen economy are inexplicably linked when considering the path to net zero.

The metals industry, particularly steel, offers a huge opportunity to positively demonstrate the UK's commitment to achieving net-zero.

"The steel industry is responsible for the majority of the greenhouse gas emissions for Industrial Processes in the UK"

The smaller UK metals casting and forging facilities with capacities less than one million tonne per annum currently use electric arc (EAF) or induction furnaces to refine the product. These smaller manufacturing units provide smaller scale, high-value products used in aerospace, automotive and functional castings for other industrial processes.

The larger sites produce stainless and speciality steels, where recycled steel is used to provide the raw iron units and supplemented by various sources of reduced iron (at high carbon and cost premium due to manufacturing process) to dilute the effects of unwanted alloying and contaminant elements. If connected to a zero carbon national grid, or purpose-built green energy supply, only very low-level CCS would be required.

Due to the relative lack of emissions, such sites are already benefitting from the UK's changeover to renewable electricity. However, the much higher relative electricity costs compared with mainland Europe and rest of the world, and modest wage expectations, can make global price competitiveness difficult.

The larger UK sites are where the opportunities are far greater to eliminate carbon output and provide additional benefit to the greater UK energy infrastructure. The two remaining UK integrated steel plants (British Steel, Scunthorpe and Tata Steel, Port Talbot) use blast furnace technology to refine iron rich minerals into liquid iron, using solid carbon fuels such as coal and coke. These plants purify the liquid iron, add alloying elements, cast and roll the material into the final product.

Integrated plants are highly efficient and already capture, recycle and reuse waste emissions for on-site energy and chemical exports. As a rule

of thumb, integrated sites emit two tonne of CO₂ for every tonne of steel produced.¹ At maximum output capability, for the UK this equates to over 12 million tonne of CO₂ per annum.² The steel output from these sites goes directly into many mass produced, low cost, lightweight, high-value products such as packaging, automotive bodies, construction, and rail. The majority of these products cannot be made using arc furnace technology due to the process' unavoidable introduction of high nitrogen levels and metallic impurities from recycled steel.

In the US, the EAF-based mini-mills have failed to produce packaging and automotive body grades, even when using high levels of reduced iron, artificially introducing carbon to the liquid metal, and mimicking the Basic Oxygen Steelmaking (BOS) process in an attempt to flush the nitrogen out. Such processes negate the intrinsic benefits of the EAF process and consume an equivalent or greater level of carbon through reduced iron production and carbon additions than the integrated process.

"A shift in policy to reward and assist industrial generators of H2 as part of the government's energy strategy would significantly help industry and give the UK a head start in the H2 Economy"

The steel industry is responsible for the majority of the greenhouse gas emissions for Industrial Processes in the UK (MtCO₂e).³ Most of the actual CO₂ emissions are from two single sources: in Port Talbot and Scunthorpe, both providing roughly 50%.⁴ Thus, the UK has a

^{1.} International Energy Agency, "Energy technology perspectives 2016," https://www.iea.org/reports/energy-technology-perspectives-2016 (2016).

^{2.} World Steel Association, "Crude steel production monthy", https://www.worldsteel.org/steel-bytopic/statistics/steel-data-viewer/MCSP_crude_steel_monthly/GBR (2020).

^{3.} Department for Business, Energy & Industrial Strategy, "Annex: 2018 UK greenhouse gas emissions, final figures by end user and fuel type", https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/875522/Annex_1990-2018_UK_GHG_Emissions__final_figures_by_end_user_sector__by_fuel_and_uncertainties_estimates.pdf (2020), 11.

^{4.} Unpublished Annual Output Plan 2019: British Steel 2.8Mt/annum, Tata Steel Strip UK 3.7Mt/annum

fantastic opportunity to invest in CCS, retain control of our actual carbon usage, continue our industrial heritage, and exploit the complexities of these plants.

The technology is already available to provide CCS. Practical demonstrations for CCU have been published in the media since 2018, specifically reuse of captured CO₂ as fuel following investment from the UK Government's 'Future Fuels for Flight and Freight' grant. However, there is currently no long-term business model or major collaboration announced for any reuse technology. Simply pumping the CO₂ into the ground directly or by mineral stabilisation is at best a short-term fix, but will at least buy time for more effective solutions to be developed.

To make the business model work, a revisit to the current carbon taxation policy is required that will make all industrial metal producers on a global market equal in terms of CO₂. The need for CO₂ tracking through life from mineral excavation, processing, delivery use to recycling is one way that the balance can be redressed. Work is currently being carried out throughout the UK as part of the government-funded SUSTAIN project to use Industry 4.0 and smart scanning to realise such tracking technology.⁵ Additional UK research as part of the SUSTAIN, RICE and FLEXIS projects is looking towards not only producing fuels, but dyes and proteins for feedstock following the separation of CO₂ from the steelmaking gas emissions.⁶

The steelmaking sector could contribute to significantly reduce the current plastics crisis with the greater use of plastics providing an alternative carbon source to coal and coke, reducing the hidden carbon burden behind extraction and transportation of these fuels across the world: ultimately releasing less carbon due to the heightened H2 content within plastics. The emitted CO_2 can be captured and stored and

^{5.} SUSTAIN, "Theme 1 – emissions management and utilisation", https://www.sustainsteel.ac.uk/emissions-management (2020).

^{6.} Reducing Industrial Carbon Emissions, "Helping Welsh industries to reduce carbon dioxide emissions and drive a stronger, greener economy", https://rice.cymru/en/; Flexis, "Meeting the energy demands of the future", https://www.flexis.wales/ (2020).

renewed. Again, policy needs to be set to make plastic disposal through industrial processes, preferably where CCSU is applied to the emissions. Research in this area has been investigated globally and recent industrial trials have proven successful both in Germany and the UK. However, without significant policy change regarding the benefits of doing so, it remains more cost-effective and competitive to use fossil fuels.⁷

The UK's current energy strategy aims to eliminate our reliance on fossil fuels for power generation, industry, transport fuel and domestic heating. In the UK, both transport fuel and non-national grid power generation outstrips the 60 gigawatt (GW) electrical generation capacity by several times.

Our future renewable and storage options need to be increased by more than four times than currently anticipated to cater for domestic gas replacement – without also factoring in the process losses. If hydrogen (H2) is to also replace liquid transport fuels then we would need twice the current available electrical power to produce the fuel through electrolysis or new chemical method. Currently H2 is produced at several sites in the UK from natural gas with significant CO_2 emission which negates the clean image of H2.

The metals sector can contribute significantly to the UKs current energy strategy by providing a stepwise increase in H2 capability, as the H2 generation technology is selected and developed (with additional green electricity capability) to provide sufficient capability for public and industrial sector needs. The consistent high production volumes produced as an industrial by-product will complement the variable generation through solar and wind and lessen the burden on storage and ramp-up for high demand periods.

Research into the Sorption Enhanced Water Gas Shift Process (SEWGS) has proven that high yields of H2 can be produced by utilising

^{7.} Ann Carpenter, "Injection of coal and waste plastics into blast furnaces", https://www.usea.org/sites/default/files/032010_Injection%20of%20coal%20and%20waste%20plastics%20in%20blast%20furnaces_ccc166.pdf (2010).

^{8.} Grant Wilson, "On-line energy charts, http://energy-charts.org/chart_downloads/, (2019).

the unreacted CO in the off gasses of the blast furnace and other steelmaking processes. Equilibrium carbon gas emission from the blast furnace is roughly split 50:50 between CO and CO₂, giving high yields of potential H2 production due to the water gas shift at 400°C.⁹ The process is currently under investigation through the FLEXIS project, and pilot scale activities are being progressed by steel companies SSAB and Tata Steel with European Funding.¹⁰

"The future of the UK metals industry, its ability to safely process waste and the hydrogen economy are inexplicably linked when considering the path to net zero"

Estimates of 300 megawatts (MW) of H2 from large blast furnaces are achievable, which could be incorporated into the national gas grids or utilised as local H2 fuel sources, providing green H2 as part of an essential industrial process with modest investment. In comparison, the recently commissioned Fukushima Hydrogen Energy Research Field (FH2R), installed on a 180,000m² site using 20 MW solar power generation, can currently only produce 10 MW through electrolysis.¹¹

A shift in policy to reward and assist industrial generators of H2 as part of the government's energy strategy would significantly help industry and give the UK a head start in the H2 Economy.

The metals industry, steel in particular, is not the problem. Conventional carbon taxation policy and outsourcing is not reducing the actual carbon burden of the UK, merely displacing it. Rather, the complexity of the steelmaking process and the value of the end-product to our modern lifestyle places it in a key position to provide many solutions to current waste disposal, green fuel and energy provision, and even feedstock and material synthesis. Until superior technologies have

ECN, "Process intensification: SEWGS case", https://www.ecn.nl/news/item/process-intensification-sewgs-case/index.html (2015).

^{10.} Step Wise, "Project description", https://www.stepwise.eu/project/ (2017).

^{11.} Toshiba, "Press releases & news", https://www.toshiba-energy.com/en/info/info2020_0307.htm (2020).

DELIVERING NET ZERO

been considered and matured, we should refrain from disregarding our current strengths and invest in them, using technology and innovation to strengthen the UK industry and its economy.

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A global venture Green finance

Shaun Kingsbury CBE

In a recent video message as part of a movie trailer for his upcoming film on climate change, Sir David Attenborough looks thoughtfully at the camera, and in a voice we have all grown up listening to, explains very clearly that: "The moment of crisis has come, humans have overrun the world".

Governments around the world are declaring a climate emergency and from Greta Thunberg to Extinction Rebellion, we have activists on the streets of the world's largest cities imploring us all to act.

In the UK, we were one of the first industrialised nations to put a net zero commitment into law for 2050. However, this transition can only be successful if we have capital that gets behind this transformation. That will only happen at scale if the capital can make an appropriate risk adjusted return.

But this sustainable investment stuff isn't easy. These are new markets, new technologies, new regulations. Put all of that together and it makes it a pretty risky and difficult place to invest capital. The money needs to go into businesses that will take market and technology risk and scale quickly. If they are to have a significant impact, then these businesses will require lots of capital and this isn't always a fit for risk averse fund managers. Yes, venture capital firms take these types of risks, but they

typically invest relatively small amounts of money relative to the scale that will be needed.

We need a new class of investor, a specialist investor, one that only invests in sustainable businesses, but that can do so at considerable scale. We have many large investment funds who have billions to invest, but typically these are diverse and generalist funds. We have large international banks who are truly worldwide, but again they are generalists. While many of these institutions are now shying away from financing large carbon emitters, either because of the risk of stranded assets and impairments or because of potential reputational damage with stakeholders, they only put a few percentage points of their capital to work in sustainable investments – which of course is a large amount of money, so long may this continue! Nonetheless, we need to do this all differently, but how?

In 2012, I was asked by the UK Government to establish and build the UK Green Investment Bank Plc, or GIB as it became known. It was then the world's first 'Green Investment Bank'. Over the next five years, as a specialist investor, we became the leading financier in the UK in the clean energy space. We put nearly £3.5 billion to work alongside more than £9 billion of private capital to build out over £12 billion of clean energy assets.

"We need to see the establishment of an international and privately backed Green Investment Bank"

As a focused investor, one that could not be distracted by other sectors or other business areas, we quickly became the market leader, beating all of the other well-established funds and banks. We clearly established that we could be both green and profitable. We also proved our business model was a winner. We showed that a focused player with expert knowledge of the markets, technologies and regulation could beat the established but generalist players.

It was my hope that, by creating a successful business at GIB, we

could create a model that would be admired and copied by governments around the world. Indeed, there are now some 20 similar government-sponsored entities all over the world, with many more governments considering building their own version of a GIB.

"We need a new class of investor, a specialist investor, one that only invests in sustainable businesses"

However, the GIB model has a couple of deficiencies. First, it is funded by governments, which by definition means it has limited amounts of capital. This issue has only been exacerbated by the COVID-19 issue which will leave governments all over the world with less capital to invest into climate solutions. Second, governments have geographic limits – for example, the Connecticut Green Bank will focus on projects in Connecticut.

In order to take away these two major constraints, we need to see the establishment of an international and privately backed Green Investment Bank. We need a new institution which can see the opportunity and set out to challenge the old-world order of finance. Just like the UK Green Investment Bank became the UK investment leader, deploying more capital in its sectors than other existing players, an international Green Investment Bank, backed by private capital and with a model to be both green and profitable, could become the leading investor in the space. It would understand the risks and it would 'lean in' to solving the problems. It could invest internationally and at scale, and it could help to create and develop the businesses that will make a difference.

I guess I'm advocating for the creation of a Tesla for the world of Green Finance. A specialist sustainable financing firm that takes on the established players. Despite all of its well-documented trials and tribulations, Tesla has done more to move the electric vehicle to be mainstream than any of the existing motor manufacturers, many of which have been around for a hundred years. It has shown that if you create a specialist company, one that is not beholden to its legacy

markets or products, and one that has no existing business to protect, it can make a huge difference. We need to take the same approach to green finance. We need to create a Tesla of Green Finance.

Returning again to the movie trailer, Sir David leaves us with a message of hope: "If we act now, we can put it right". I share his optimism. In this decade, I believe we will see real progress, but we need significant amounts of green finance and a new specialist international bank to invest and deploy this capital and take the risks that this journey will require.

Shaun Kingsbury CBE is the Former Chief Executive Officer of the UK Green Investment Bank Plc, a specialist in green infrastructure principle investment and project delivery.

Investing in the future

Nigel Wilson

Climate change, like the COVID-19 pandemic, is a challenge that will require a superlative effort combining: the best thinking provided by science, public policy, and economics – including behavioural economics; the most effective delivery and implementation, by the public and the private sectors; and, the application of huge financial resources, where again there are both public and private sector elements.

Almost everyone agrees with the scientific mainstream about the scale and urgency of the climate change challenge. Greta Thunberg, David Attenborough and others have campaigned forcefully and successfully. Legal & General has invested billions in renewable and alternative energy, and we will redouble our efforts, but the market still lacks a clear 'how to' guide to achieving targets in line with the 2015 Paris Agreement, or hitting the legislative net zero target.

"We need the ability to invest more from pension funds"

The finance sector can fill gaps and address challenges. Finance is often about understanding detail, and the long haul. Here are five areas where financial thinking is moving forward, and where thoughts are

already, or soon could be, actionable.

First, metrics. Lord Kelvin noted that what gets measured, gets done. Investors and lenders need to have reliable, definitive data on the carbon or climate impacts of the businesses they back, just as they need to have good and universally recognised financial audit data. With this data, investors can push for decarbonisation, and risk managers can avoid carbon-heavy 'stranded assets' (such as oil reserves) which will become obsolete or inaccessible as we decarbonise. Asset managers can develop ever more effective Environment, Social and Governance (ESG) products so these become the mainstream, steering more institutional money into climate-friendly investments and vice-versa. Bank lenders and capital markets can use this data to price more green loans and bonds to support climate-friendly activities.

"Decarbonising infrastructure, retrofitting energy inefficient housing, and providing green jobs in the UK's cities and regions were already in the Government's strategic purview before COVID-19: they must now be prioritised and their operational delivery accelerated"

There is huge progress on metrics, much of it being led by the Bank of England which is acutely aware of the relationship between climate and financial risk. Task Force on Climate-related Financial Disclosures (TCFD) reporting however, needs to become mandatory and metrics reliable enough to prevent 'greenwashing' or over-claiming of environmental benefits.

Second, asset allocation frameworks. While a financial risk management framework for carbon is a realistic and imminent prospect, we still lack asset allocation frameworks to guide investment decisions. This is crucial, given the amounts of money potentially in play: the UK's corporate (defined benefit – DB) and personal (defined contribution – DC) pensions were worth over £2.5 trillion at the turn

of 2020.¹ While there have been market declines since, the overall trend over the next few years is for rising contributions in the DC, so a template is needed for how to invest this for maximum climate benefit.

"If finance and markets are to remain relevant and useful to younger generations, all of us – including investors, governments, central banks and regulators – must deliver"

This is where science and public policy need to come together with finance. Investors need certainty, or at least a high degree of probability. Therefore, we need clear and defined policy positions on, for example, the roll-out of electric or hydrogen fuel cell vehicles and charging points, the retrofitting – and financial incentives for retrofitting – of domestic housing, and on the preferred mix of sources for generation (for example, whether or not it includes nuclear fusion), plus long-term regulatory and pricing models. Will domestic gas be disconnected, or will there be an intermediate phase with added green hydrogen? Is there government backing for carbon capture and storage?

Third, financial scale and innovation. A clear distinction can be drawn between climate initiatives which are already scalable and those at an earlier stage, and this is key to financial modelling for those investments. For example, offshore and onshore wind generation is scientifically and technologically proven, mature, and economically self-supporting. Technology will improve further, but essentially this is a perennial debt investment which will scale up further. Legal & General has invested billions in debt to fund established offshore wind, but it is a scale-up and we and the market could do more. Alternatives like wind, hydro and solar require a different financing model to hydrocarbon generation: there is more upfront capital expenditure and less ongoing operational

^{1.} Office of National Statistics, "Wealth and assets survey in Great Britain April 2016 to March 2018", https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/incomeandwealth/bulletins/pensionwealthingreatbritain/april2016tomarch2018 (2019).

expenditure, so it is ideal for capital market models.

Compare this with Electric Vehicle (EV) charging, still a nascent industry in early roll-out. Our investment in Podpoint, now with EDF, is in equity, as are our investments in Oxford PV (photovoltaic cells), Kensa (ground source heat pumps) and Tokamak (nuclear fusion): all growth companies. To facilitate the expansion of companies like these, we need the ability to invest more from pension funds – so-called 'VC into DC' to improve their access to finance. We have seen the growth in the UK of Fintech, encouraged by financial regulators using the 'sandbox' to encourage innovation: this is a template for decarbonisation too.

Fourth, embedding. To maximise effectiveness, financing decarbonisation needs to be congruent with government's broader economic priorities. Investment in decarbonisation should help generate economic growth. It will be delivered with far greater scale and pace if it is economically as well as environmentally and socially useful. Decarbonising infrastructure, retrofitting energy inefficient housing, and providing green jobs in the UK's cities and regions were already in the Government's strategic purview before COVID-19: they must now be prioritised and their operational delivery accelerated.

The beneficiaries should be our great towns and cities, the science driven by our great universities and entrepreneurs. This is 'levelling up' and local government is well-attuned to this, across party lines. Andy Street in the West Midlands, Andy Burnham in Manchester, Marvin Rees in Bristol, Ben Houchen in Teesside and Nick Forbes in Newcastle – all can catalyse climate investment in their cities; so let's get models up and running, and the finance will be forthcoming.

Fifth, and finally, inspiring the generations. The need to recover post COVID-19 is an opportunity and a huge challenge. The health crisis has focussed mainly on older, more vulnerable people, but the economic crisis will hit younger generations hardest – they will inherit the cost of lost output and higher health spending. If there is any upside to the pandemic, it has been to show how quickly the results of less carbon use are felt by the environment. The agendas come together and it is for all

of us to help fund and deliver the climate transition in which the same younger generation have the greatest vested interest.

This is perhaps the most important point of all; if finance and markets are to remain relevant and useful to younger generations, all of us – including investors, governments, central banks and regulators – must deliver. It is a mighty challenge, but we have to do it.

Nigel Wilson is the Chief Executive of Legal & General, a British multinational financial services company.

Innovative investing Public finance

Dr Ben Caldecott

Governments and government-backed entities will have an important role to play in helping to finance the transition to global environmental sustainability.

The sheer quantity of capital required is one reason. In the energy sector alone, meeting the Paris goal of keeping average global temperatures to well-below 2°C could require US\$1.5 trillion of additional investment per year from now until 2050, up from a total of around US\$1.2 trillion of investment last year. This story is replicated in other sectors and already constrained private sector balance sheets are probably unable to efficiently raise all the capital needed.

Further, at any given time in different parts of the global economy there will be challenges to accessing capital cheaply and efficiently, even for profitable investments. Poor access to capital can be the result of temporary or structural problems, or a combination of both.

In developing countries this is mainly the result of underdeveloped

^{1.} David McCollum, Wenji Zhou, Christopher Bertram, Harmen Sytze de Boer, Valentina Bosetti, Sebastian Busch, Jacques Despres, Laurent Drouet, et al, "Energy investment needs for fulfilling the Paris Agreement and achieving the Sustainable Development Goals", *Nature Energy* (2018), 589-599; Barbara Buchner, Alex Clark, Angela Falconer, Rob Macquarie, Chavi Meattle and Cooper Wetherbee, "Global landscape of climate finance 2019", https://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2019/ (2019).

capital markets and poorly capitalised domestic financial institutions. Developed economies, even those with the most sophisticated financial systems and deepest capital markets, like the UK, also face problems, ranging from a lack of experience in underlying technologies through to temporary collapses in confidence.

COVID-19 makes all of these issues much harder to deal with and will almost certainly increase the need for a dramatic scaling up of public financing for everything, including the very capital-intensive longer-term transition required to tackle climate change and the other environmental challenges facing humanity.

Public financing covers a number of different areas. First, infrastructure finance – the role of public financing in different stages of infrastructure projects, from development through to operation. Many countries have very well-established infrastructure banks, including KfW in Germany, Caisse des Dépôts in France, BNDES in Brazil, and the China Development Bank. In the UK we don't really have a state infrastructure bank and have instead relied heavily on the European Investment Bank.

Second, business finance – the role of public financing in supporting company growth and development, from start-ups and SMEs through to large multinational enterprises. In the UK, the British Business Bank established in 2014 helps to provide this function for start-ups and SMEs.

Third, personal finance – enabling individuals to borrow for education, skills or home investments that provide public and private goods, for example energy efficiency. The student loan system in the UK is a highly concessional form of public finance.

Fourth, export credit – government guarantees and loans provided by Export Credit Agencies (ECAs) to help companies export goods and services. The UK has the world's longest running ECA, UK Export Finance (UKEF), which was established in 1919.

Fifth, insurance – supporting insurance provision, particularly for risks that are uninsurable or prohibitively expensive to insure through private markets. For example, in the UK we have FloodRe to provide flood insurance coverage to domestic properties deemed at significant risk of flooding.

"The current pandemic gives us the jolt we need to reimagine public finance in a suitably ambitious way"

Sixth, development finance – delivering combinations of the above through Multilateral Development Banks (MDBs) and Development Finance Institutions (DFIs) focused on developing and emerging economies. The UK is a shareholder in many MDBs, including the World Bank, Asian Development Bank, Inter-American Development Bank, European Bank for Reconstruction and Development, and Asian Infrastructure Investment Bank. The UK's DFI is the Commonwealth Development Corporation (CDC).

The COVID-19 pandemic increases the urgency of thinking through the role of public finance. How should public financing be provided through these institutions, do they have the right mandates, and do they have the financing capacity to see us through the current crisis and beyond?

A quick government review of UK public financing and public finance institutions should be urgently undertaken to ensure we get this right. It should examine seven recommendations.

First, creating a publicly owned UK infrastructure bank, focused on providing concessional finance for large infrastructure projects, as well as very large but much more diffuse infrastructure programmes, such as energy efficiency in homes.

Second, a much more expansive role for the British Business Bank, including the provision of concessional transition loans and structures to help businesses make investments that help them deliver net zero while making them the most productive and efficient in the world.

Third, a new national revolving fund for energy and resource efficiency, similar to the Salix scheme for the public sector, but for the private sector.

Fourth, expanding UK Export Finance's products and services so it

can much more proactively support new and emerging supply chains, as well as the products and services required to meet net zero carbon emissions globally.

Fifth, new collective insurance schemes and mechanisms, including those that can help to scale up investment in domestic climate resilience.

Sixth, CDC and MDBs becoming Paris Agreement aligned and being given significantly more capacity to support the transition in developing and emerging economies, where the future of the global environment will be won or lost.

Seventh, the principle of avoiding carbon lock-in and stranded assets. Public financing for companies in polluting sectors should be aimed at supporting a proactive transition to net zero.

"Meeting the Paris goal of keeping average global temperatures to well-below 2°C could require US\$1.5 trillion of additional investment per year from now until 2050"

We are seeing government dramatically increase the availability of public financing to help companies deal with the unprecedented COVID-19 demand and supply shock to the global economy. As we think about public financing in the economy, both nearer and longer term, we should consider how we scale and reform its different elements in a complementary way. The current pandemic gives us the jolt we need to reimagine public finance in a suitably ambitious way.

Dr Ben Caldecott is the founding Director of the Oxford Sustainable Finance Programme and an Associate Professor at the University of Oxford, as well as Co-Chair of the Global Research Alliance for Sustainable Finance and Investment and a Senior Advisor to the Chair and CEO of the Green Finance Institute.

Selling British green goods Exports

Graham Stuart MP

The UK sparked and powered the first Industrial Revolution in the late eighteenth century and, by doing so, transformed human welfare and opportunity right around the world – and grew prosperous while doing so.

"We need a global trading system which removes tariff and non-tariff barriers to low carbon goods and services, so that the take up of best-in-class solutions is accelerated rather than delayed"

Meeting the climate challenge offers another opportunity for the UK to lead at home and, having developed the technologies, services and products required to move our emissions to net zero by 2050, export them to the rest of the world for the betterment of mankind and increased prosperity at home.

I would argue that only by building the UK's domestic capability, and integrating exports in all our planning, can we hope to deliver our domestic targets in a financially sustainable way.

We start from a strong position. We were the first major country to put emissions reductions into law (in 2008) and to legislate for net zero by 2050 (in 2019). We have led the developed world in growing our economy while reducing emissions. Since 1990 we have cut emissions by 44% and grown our economy by two thirds. Which means we have reduced emissions more than any other G7 nation since then and still been one of the fastest growing economies in that time.

"DIT has a major role in shaping global trading systems and promoting UK low-carbon exports around the world"

The pivotal role played by the UK in securing the Paris Agreement in 2015 has made the context for green exports more favourable still, as 195 countries seek to meet their commitments. In energy alone, the International Energy Association (IEA) estimated that \$13.5 trillion investment will be required globally between 2015 and 2030.³

Every sector of the economy has a part to play and developing solutions for housing, transport, manufacturing, and the building of smart cities offers enormous opportunities for both goods and service providers alike. Other countries are following our lead but sustaining our position at the front of the pack will make us an innovation leader and benefit from what economists call the 'Home Effect'.⁴

That is why we have put low carbon and research and development (R&D) at the heart of our Clean Growth and Industrial strategies. The low-carbon sector is growing far faster than the rest of the economy. UK exports are estimated to be able to grow to between £60 billion and £170 billion by 2030.⁵ In the Department for International Trade (DIT),

Committee on Climate Change, "Net zero: the UK's contribution to stopping global warming", http://theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf (2019).

^{2.} Ibid.

^{3.} International Energy Association, "Climate pledges for COP21 slow energy sector emissions growth dramatically," http://iea.org/news/climate-pledges-for-cop21-slow-energy-sector-emissions-growth-dramatically (2015).

^{4.} Gordon Hanson, and Chong Xiang, "The home market effect and bilateral trade patterns", http://nber.org/papers/w9076.pdf (2002).

^{5.} Ricardo Energy & Environment, "UK business opportunities of moving to a low carbon economy", http://theccc.org.uk/publication/uk-energy-prices-and-bills-2017-report-supporting-research/ (2017).

we now have a dedicated Clean Growth Team focused not only on export growth, but on using our innovation leadership to attract inward investment and strengthen our ecosystem further.

If the world is to keep global temperatures below 2 degrees centigrade (and ideally below 1.5), then we need a global trading system which removes tariff and non-tariff barriers to low carbon goods and services, so that the take up of best-in-class solutions is accelerated rather than delayed. That is not, however, where things stand. Instead, we have increased trade conflicts, minimal global trade growth, economic stagnation and, as a result, reduced investment including in low-carbon innovations.

Never before has it been so important for the UK to have a dedicated international trade department and to speak up for free trade and a global rules-based system. They are not only a good in themselves, but essential to the low-carbon transition. We now have our own seat at the World Trade Organisation (WTO) and are determined to be a free trade champion and advocate for reform and renewal.

DIT has a major role in shaping global trading systems and promoting UK low-carbon exports around the world. In UK Export Finance we have the world's oldest and best export credit agency. In recent months, UKEF has agreed £230 million in support for a large-scale windfarm off the coast of Taiwan – which will contribute significantly to their target to produce 20% of power from renewable sources by 2025.6 UKEF has also provided a guarantee worth £47.6 million for Solarcentury to build two large solar farms in Spain.7 UKEF support for £244 million worth of health projects in Zambia, including the construction of 108 rural healthcare clinics powered, in part, by solar energy was also announced

^{6.} UK Export Finance, "£230 million in UKEF support for offshore wind farm in Taiwan", http://gov.uk/government/news/230-million-in-ukef-support-for-offshore-wind-farm-in-taiwan (2019).
7. UK Export Finance, "UK solar company secures funding to build two major solar plants in Spain", http://gov.uk/government/news/uk-solar-company-secures-funding-to-build-two-major-solar-plants-in-spain (2020).

in January at the UK-Africa Investment Summit (AIS).8

At the AIS, the Prime Minister announced that the UK will no longer provide any new direct Official Development Assistance (ODA), investment, export credit or trade promotion support for thermal coal mining and coal power plants overseas.⁹

The 2019 Conservative Party election manifesto laid out an ambition for the UK to sign Free Trade Agreements (FTAs) with countries comprising 80% of our trade within three years. Since its formation in 2016, DIT has grown its negotiating capability significantly and is ready, now, to deliver multiple negotiations in parallel to meet this objective. These FTAs offer many opportunities to further our low-carbon objectives and grow UK exports while we are at it. We will seek provisions which promote trade in low-carbon sectors, goods and services, support R&D collaboration and maintain both parties rights to regulate in pursuit of decarbonisation.

We will also look to include environmental provisions which support climate action in other areas such as air quality, biodiversity, sustainable forest management and ozone depleting substances. It's worth noting that existing US trade agreements have environmental provisions including, inter alia, measures on air quality, biodiversity and sustainable forests.

The level of investment required for the world to meet its Paris Agreement contributions is enormous. This too provides an export opportunity for the UK. London is, by some way, the leading international green finance centre. The depth of innovation, products and capital focused on sustainable finance, combined with world-renowned legal expertise and capabilities in emerging markets, is unmatched.

Last year, we launched the Green Finance Strategy and established the Green Finance Institute, a public-private body to bring together key

^{8.} UK Export Finance, "UK exports boost critical infrastructure projects in Africa", http://gov.uk/government/news/uk-exports-boost-critical-infrastructure-projects-in-africa (2020).

^{9.} Prime Minister's Office, 10 Downing Street and The Rt Hon Boris Johnson MP, "PM hosts first ever UK-Africa Investment Summit in London", http://gov.uk/government/news/pm-hosts-first-ever-uk-africa-investment-summit-in-london (2020).

^{10.} The Conservative & Unionist Party Manifesto, Get Brexit done: unleash Britain's potential, (2019), 57.

actors in the sector not only from the UK but across the world. DIT's financial services team is working with the Carbon Trust to see how we can improve the communication of our green finance offer. This summer, we are scheduled to host the inaugural Global Resilience Summit, highlighting the UK's expertise in delivering resilience finance solutions both for the public and private sectors. We are determined to consolidate London's green finance lead, and Mark Carney has agreed to lead on this work at COP26.

"Never before has it been so important for the UK to have a dedicated international trade department and to speak up for free trade and a global rules-based system"

The world faces a formidable challenge in tackling climate change. The UK is uniquely positioned to lead the green industrial revolution and build prosperity as a result. We must continue with domestic policies that drive increased R&D, innovation, emissions reductions and first mover advantage in the UK, but also ensure that our dedicated trade department, DIT, seeks to remove trade barriers, strengthens the global trading system and maximises low-carbon UK exports for the benefit of both the planet and British prosperity.

Graham Stuart MP is the Parliamentary Under-Secretary of State at the Department for International Trade, and the Conservative Member of Parliament for Beverley and Holderness.



A climate leader? HM Treasury

Alasdair MacEwen

Environmentalists often point out that the Treasury has a chequered record on environment and climate issues. "They [The Treasury] treat it with suspicion" says Chris Stark, the Chief Executive of the Committee on Climate Change (CCC).¹ And it's true that, over the past decade, HM Treasury's climate and environment policymaking has been patchy.²

The House of Commons' Environmental Audit Committee (EAC) examined HM Treasury's relationship with sustainability in 2016 and was less than complimentary. Accordingly, the Department's outstanding policy contribution was its work on the Stern Review in 2006 but since then, policy has been heavily influenced by the whims or motivations of particular chancellors.

The Treasury needs to return to having a much more active role across government and particularly on decarbonisation and industrial strategy, as the changes required to achieve net zero emissions are fundamental and the impacts of failing on the UK economy will be even greater.

^{1.} House of Commons, "Treasury committee: Oral evidence: decarbonisation and green finance – the economic opportunity, HC 2233", http://data.parliament.uk/writtenevidence/committeeevidence. svc/evidencedocument/treasury-committee/decarbonisation-and-green-financethe-economic-opportunity/oral/103489.html (2019).

^{2.} Caroline Binham, "Javid renegs on green pledges in guidance to regulators", *Financial Times*, https://www.ft.com/content/6a6ad92a-0081-11ea-be59-e49b2a136b8d (2019).

HM Treasury appeared peripheral in the decision making and policy development process when the Government's new Industrial Strategy was developed in 2017 – this is perhaps one of the reasons it has almost been forgotten. A new overall government economic strategy for decarbonisation needs to be developed that will envelop much of the original objectives of the 2017 Industrial Strategy and one which dovetails with the stimulus and recovery responses to the current public health crisis. Decarbonisation plans for each individual government department should be secondary to an overall strategic, whole-of-government plan. Each department should be obliged to conform to it.

There are signs that the culture is changing. Last year, the Treasury initiated an internal review on how to decarbonise the economy, with a dedicated and relatively senior team to lead it, and it has begun to make positive sounds about a bevy of climate-related issues, from energy efficiency to Electric Vehicles (EVs), even modifying its 'Green Book' to include natural capital, and for the first time, looking for a new national infrastructure strategy with net zero incorporated as a long term goal.

The second visible change has to come in the policy response to the COVID-19 pandemic.

The pandemic has provoked a rapid reaction from Treasury. Increasing spending in order to prevent the collapse of UK businesses, alongside similar responses from governments worldwide, demonstrated the capacity of the state to act quickly, decisively, and arguably effectively. It also shows that the Treasury does have the capacity to spend at scale when crisis looms. In monetary policy (the Bank of England's responsibility) very low interest rates also mean that, decades from now, public debt can be repaid.

The last few weeks have so far proved the fact that governments and central banks have it within their power to defeat an even more damaging crisis such as irreversible climate change. The current crisis should prompt the Treasury to reassess the severe economic risks which climate change poses.

If almost everyone agrees that more action is required to reach the

ambitious goal of a net zero economy by 2050, along what broad themes should action be taken?

"Setting the scorecard against a net carbon contribution could fundamentally change policymaking"

First and foremost, an economic recovery plan is urgently required to dig the UK out of its economic hole. It is absolutely critical that this plan aids – without hindering – the UK's full transition to a net zero carbon emissions economy.

Certain sectors of the economy will be hit harder than others by the current crisis and unemployment will almost certainly rise significantly, so any focus must be on how to ease the labour market. And despite the prospect of 'onshoring' returning some employment to the UK, growing automation and robotics means that employment levels may never return to recent levels. The UK lags behind other major G7 economies in terms of infrastructure investment, and this is where the Treasury should promote rapid scale up.³

To target those suffering the most, and for speed, it should first consider an energy efficiency and heat programme for UK homes (especially while there is overcapacity in the construction sector). Rapid improvements to low carbon public transport infrastructure – where passenger congestion may now become an even bigger issue – and improving infrastructure for EVs along with optimising fiscal incentives and regulation should follow. Regulation around vehicle emissions and air pollution and projects which grasp the benefits of public health, low carbon and economic growth should be prioritised.

A prolonged period of 'lockdown' and increased remote-working could have a lasting impact on aviation and road traffic, and after the pandemic the Treasury should not overly favour carbon intensive sectors,

 $^{3.\} House of Commons, "Infrastructure policies and investment", https://commonslibrary.parliament.uk/research-briefings/sn06594/ (2019).$

instead considering a Universal Basic Income which shelters those who suffer from employment changes or job loss. Treasury bolstering and extension of the Carbon Floor Price (getting the carbon price right is obviously crucial) could help focus decarbonisation policy overall, especially in a time of falling EU carbon prices. All revenues should be redistributed to those hardest hit by the labour market transformation and shock. Any tax relief for energy-intensive sectors must now be conditional on finding genuine low carbon solutions, but long-term international cooperation on this is also crucial. And planning for the 'hardest to abate' sectors, the Treasury should be exploring incentives for using hydrogen for freight and industry, prioritising it now for particularly hard-hit sectors such as steel or cement.

Important costs are involved in decarbonisation but the assumption in former Chancellor Philip Hammond's leaked letter ⁴ to then Prime Minister, Theresa May, that these will be entirely or largely borne by the public sector is entirely unfounded ⁵. There are also economic benefits to decarbonisation, and to harness this, a sophisticated cost-benefit scheme should be drawn up and be subject to regular revision.

"Treasury does have the capacity to spend at scale when crisis looms"

If anything, economic decarbonisation will accelerate growth when it is most needed. The costs of acting too late will be far greater than all others, mirroring in some ways the lack of resilience or preparedness of the COVID-19 crisis currently upon us. The Treasury-led 2006 Stern Review was the best demonstration of this possibility. Much academic work also acknowledges that rational long-term decision making is

^{4.} Jim Pickard, "UK net zero emissions target will 'cost more than £1tn", Financial Times, https://www.ft.com/content/036a5596-87a7-11e9-a028-86cea8523dc2 (2019).

^{5.} Ambrose Evans-Pritchard, "Hammond's £1 trillion bill for hitting net zero is innumerate nonsense", *The Telegraph*, https://www.telegraph.co.uk/business/2019/06/12/hammonds-1-trillion-bill-hitting-net-zero-innumerate-nonsense/ (2019).

the most difficult to carry out well and this has been the problem with developing climate change policy. The current Treasury review has been explicit that it intends to instil a long-term approach – the stakes are higher than ever and all analytical tools should be mobilised to confront an existential threat. To be clear, absolutely no cost-benefit analysis worth its salt would ever consider runaway environmental collapse as the cheaper option.

Changes in Treasury practices are needed in order to adapt to the huge demands of effective decarbonisation. The Budget and the Spending Review, where departmental budgets are set, are crucial policy levers. Currently, HM Treasury uses a 'scorecard' to measure how each new policy is aligned with public sector net borrowing. Setting the scorecard against a net carbon contribution could fundamentally change policymaking, so that every Treasury policy had to be evaluated against its carbon impact, guaranteeing that even when rapid policymaking is needed – as in the current pandemic – that decarbonisation is centrally considered, not just an 'add on'. The Government Economic Service could also give greater focus to environmental and climate training for officials, and to ensure structural changes are consistent, further changes are needed to the Green Book.

Beyond installing a carbon scorecard, which would enhance ministerial scrutiny and accountability, a remedy for more consistent climate policymaking at all levels would be to further centralise climate policy within the department's remit. The title and responsibilities of the Chancellor could, for example, be amended to include climate change, with the Treasury becoming the lead department on decarbonisation policy. And in line with new thinking on how organisational leaders work best, Permanent Secretaries could be restricted to fulfilling two or three central

^{6.} Office for Budget Responsibility, "Breifing paper no. 6: policy costings and our forecast", https://cdn.obr.uk/27814-BriefingPaperNo_6.pdf (2014).

^{7.} UK Parliament, "Sustainability and HM Treasury inquiry", https://www.parliament.uk/business/committees/committees-a-z/commons-select/environmental-audit-committee/inquiries/parliament-2015/sustainability-hm-treasury-inquiry-15-16/ (2016).

objectives for their institutions, one being a decarbonised economy.8

President Macron recently attempted to give more emphasis to climate in government by designating the energy minister as the third most senior in government. This failed because even though climate rose in the policy hierarchy it was not sufficiently part of the finance minister's remit. Instead, the Treasury should be the climate leader within government, not its auditor. Without climate policy centralised and integrated into financial and fiscal levers, the capacity for change will be inadequate, precisely because climate action is fundamental to the UK's future functioning and economic viability.

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^{8.} Elsbeth Johnson, Step up, step back: how to really deliver strategic change in your organisation, (London: Bloomsbury Business, 2020).

Creative clusters Mayors

Ben Houchen

The environmental issues created by the world's CO₂ output invariably led to many of the social and economic challenges that have dominated global political discourse over the past few years. Balancing the costs of reaching net zero with protecting the social liberties and financial independence of the individual, as well as growing the economy and funding public services, meant our Government had its work cut out before the fallout of the COVID-19 pandemic was even on the horizon.

"CCUS could account for 7% of the necessary global emissions reductions planned by 2040"

Political and business leaders around the word must now contend with what might be a humanitarian and financial crisis unparalleled since the global wars of the 20th Century. It is incumbent on us to steer a course back to prosperity, though perhaps not business as usual, while fending off opportunist efforts from extremist fringes to sell their flawed ideologies as a solution to the current crisis.

The combination of our need for a post COVID-19 economic recovery, our ambitions to reach net zero by 2050 and the UK's exit from the European Union present a complex web of challenges and a set of

new opportunities, including those of mass industrial decarbonisation. While low carbon trends in transport and eco-conscious consumer products are well known and positive, the industrial side of protecting our environment is often out of sight and all too frequently out of mind.

In my region, the Tees Valley, the 'Net Zero Teesside' project aims to create the world's first net zero industrial cluster by 2030. Each year, the project will capture up to six million tonnes of carbon dioxide emissions, roughly equivalent to the annual energy use of up to two million UK homes.¹

Businesses in Teesside's chemicals and process sectors saw the need to collaborate and decarbonise some years ago and have been working together to draw attention to the need for industrial-scale Carbon Capture, Utilisation and Storage (CCUS) solutions. They are now joined by the 'Oil and Gas Climate Initiative', a partnership of some of the world's largest energy firms. Together, with the right backing from government, these companies can not only sustain and grow England's new industrial heartland, but develop and demonstrate the technology that will decarbonise the world.

Thousands of well-paid workers and their families in the Tees Valley depend on these industries for their income, but so does our wider society. Our chemicals and process industry firms produce carbon-intensive but also essential products, as well as the raw materials that are the building blocks of modern life. These include the fertilisers that ensure we have the food we need, to the eco-friendly fuels of the future, and the recyclable plastics that make up so many products.

On a global scale, the case for CCUS is also compelling. According to the International Energy Agency (IEA), CCUS could account for 7% of the necessary global emissions reductions planned by 2040.² It is also widely regarded as more cost effective than other solutions to global

^{1.} Net Zero Teeside, "Net zero Teeside: the UK's first decarbonised industrial cluster", https://netzeroteesside.com/ (2020).

 $^{2.\} International\ Energy\ Agency,\ ``Carbon\ capture,\ utilisation\ and\ storage",\ https://www.iea.org/fuels-and-technologies/carbon-capture-utilisation-and-storage\ (2020).$

warming currently in use.

Our Government and the international community have rightly set ambitious targets for carbon reduction. This means that companies in carbon intensive industries and the communities they call home have a choice: adapt, grasp the opportunities and grow; or, reach net zero as a consequence of industrial decline.

The people who elected me to serve them did so with the expectation that I would stand up for the Tees Valley's industry and they will not accept anything less. 'Net Zero Teesside' is exactly the kind of project that delivers on their wishes, not only preserving what we have, but giving us the opportunity to create new jobs and growth in decarbonising the rest of the world.

Indeed, climate change can only really be tackled internationally. This means we cannot simply allow our own CO₂ heavy companies to fade away to meet our own carbon reduction targets, while buying cheap products from abroad manufactured by processes which don't meet the environmental standards we expect at home.

A great example of this is the fertiliser produced in the Tees Valley. Various factors mean it costs slightly more than alternatives made in China, but even before we have a working CCUS solution, it is still far less polluting than them.

"The combination of our need for a post COVID-19 economic recovery, our ambitions to reach net zero by 2050 and the UK's exit from the European Union present a complex web of challenges and a set of new opportunities, including those of mass industrial decarbonisation"

The control we will now have over our own trade policy gives us the choice to prioritise goods produced in an environmentally friendly manner, which would surely encourage the world's polluters to meet our standards. In fact, by supporting 'Net Zero Teesside' to become the

world's first decarbonised industrial cluster, the Government could not only aid economic recovery in the wake of COVID-19, but re-shore essential industries. Bringing these sectors home would not only mean many thousands of skilled jobs in the more deprived communities of the UK, it would secure our supply chains against the type of international disruption we have seen so recently.

"The control we will now have over our own trade policy gives us the choice to prioritise goods produced in an environmentally friendly manner, which would surely encourage the world's polluters to meet our standards"

I am working to bring hydrogen fuelling stations for both road and rail vehicles to the Tees Valley, which we can be sure will reduce the area's carbon output. I am also keen to back local businesses and international investors, creating the green technologies and jobs of the future. On top of this, we are working with local authorities and gas infrastructure companies to look at how hydrogen, produced by decarbonising natural gas, can heat thousands of homes across the North of England.

I know many of my fellow mayors, 'blue-wall' Conservative MPs and local Government leaders are keen to progress these initiatives. We are engaged in discussions about them with ministers and experts at the highest levels of government. Now we need action on a national level to back 'Net Zero Teesside', and provide Contracts for Difference for hydrogen power to give it the boost this scheme gave offshore wind. This would allow us to cut the carbon from our existing industries, while using CCUS to open up a huge wealth of new green energy.

Ben Houchen is the Mayor of Tees Valley.

The decarbonisation decade for councils Local government

Barny Evans

From buses to bins to potholes, local government is for many the visible face of our nation's administrative structure, handling essential, yet sometimes mundane, aspects of day-to-day living.

But in the midst of the recent climate emergency declarations by two thirds of our local authorities, and as the ink committing the UK to net zero by 2050 was drying in the Statute Book, they're suddenly in the driving seat of one of the most progressive, radical and complex transformational agendas of our times.¹

"Delivering net zero may well be the agenda through which local government regains its purpose as an agent of change"

As the guarantors of local people's quality of life, local leaders have rung the alarm bell on the need to act fast on climate. And with this, they have shifted the dial away from target setting and signalling to action.

^{1.} Declare A Climate Emergency, "List of councils who have declared a climate emergency," https://www.climateemergency.uk/blog/list-of-councils/ (2020).

Yet, are they ready for what lies ahead? And, are industry and the public fully versed on what this entails?

In short, it very much depends. The good news is that they are not alone, and collaboration with industry and communities will help to level it up.

"About a quarter of local authority spending is with local Small and Medium Enterprises (SMEs) – and this is an opportunity to set decarbonisation standards for these companies' operations, thus also boosting their overall competitiveness"

We all recognise that the 2020s must be a decade of delivery on decarbonisation. And, while I echo this sentiment, I believe that what will make this decade memorable is the moment when decarbonisation goes public.

This will present both opportunities and challenges, but this is also why it makes so much sense for local authorities to be at the heart of this transition.

During this decade, vehicles will switch to electric and new homes will use heat pumps, not gas boilers. The way we buy energy will change, as well as how we sell different amounts at different times to very different organisations. As decentralised generation and electrification increase, local communities' participation in the decarbonisation of our energy system will increase.

For most of us, this will bring huge benefits but also risk leaving some of us confused or, worse, behind. As a provider of services and the most connected administrative structure with the public, local authorities will be at the coal-face of it all. Part of their remit will be in gaging how well this transition goes, acting as the guarantor of its fairness and inclusivity, and as the catalyst for its penetration in day to day life.

In short, delivering net zero may well be the agenda through which local government regains its purpose as an agent of change. That could be

providing electric vehicle charging points, energy efficiency advice, planning policy, convening local groups and more. The script has yet to be written.

So, what should local authorities aim to do?

To guide parish councils and combined authorities alike, WSP has developed a simple structure: 'Lead, Enable, Inspire', which aims to capture the different ways local authorities can work to decarbonise themselves and their areas. Here is what we mean by it.

First, they should 'Lead'. Local authorities are significant energy users and therefore large emissions emitters. Their first task ought to be to demonstrate how they're getting their own house in order, before setting targets for others.

The 'Lead' element refers to areas under direct control of individual councils, such as their own building stock and vehicle fleet as well as the street lighting, schools and buses they directly procure and control. Most councils are committing to dealing with Scope 1 and 2 emissions, essentially gas and electricity use, with a varied approach to transport emissions.

It is important to remember that to be zero carbon will almost certainly require the use of offsets of some kind and establishing an approach to this early on is important. Will investments outside the region be acceptable, for example? What standards will be insisted upon?

The advantage of direct control is that the council can act to deal with these sources of emissions without the requirement to involve others but, as a rule of thumb, local authorities will only represent 1% to 2% of the energy and emissions in an area. This is the symbolic nut to crack that will provide them with the social licence to move on to the remaining 98%.

Second, they should 'Enable'. When it comes to decarbonising the region itself, the ability of a local authority resides mainly in the enabling of actions. This is a crucial area and not to be overlooked. For example, local planning policy can set standards around walking and cycling provisions, electric vehicle charging, renewable energy and public transport. Moreover, the standards the local authority sets to procure goods and services can have an enormous impact on driving

changes among business.

The local authority's supply chain is an area waiting to be challenged. Although many large companies will have policies and procedures, about a quarter of local authority spending is with local Small and Medium Enterprises (SMEs) – and this is an opportunity to set decarbonisation standards for these companies' operations, thus also boosting their overall competitiveness.

There are also ways to enable, many of which will show leadership. For example, a local authority may switch to providing electric pool cars or bikes for staff to use for essential travel. These electric vehicles will need parking and charging facilities. Once they are in place, the authority may allow the public or businesses to use these charging facilities or even the vehicles themselves when they are not required, enabling others to reduce emissions, while possibly raising further revenues to invest into the transition. Finally, they should 'Inspire'. While inspiration is the most intangible element of a local authority's ability to act, it is also the most far reaching. Here, local authorities can act as nuclei and convenors for associations and investment models, lending their premises, credibility and even credit-worthiness.

For example, residents may be distrustful of companies offering energy efficiency measures in homes, but local authorities are trusted and therefore can work with providers to develop accreditations and act as central points of contact to build trust in what they are doing.

Another example is the electrification of heat. It is likely most buildings will have to switch from gas boilers to heat pumps to provide heating and hot water. While this is an engineering challenge, there is also a supply chain issue which can be mitigated by local authorities.

Only about 20,000 heat pumps are installed annually in the UK and that is likely to need to be more like one million a year by 2030.² By bringing together social landlords, manufacturers, training providers and installers into one room, there is the opportunity to develop a

^{2.} WSP calculation

bespoke local supply chain and contribute to regional prosperity. What local authority would shy away from that?

The strategy is important, but it is nothing without implementation. An area of focus for WSP is how to implement the decarbonisation strategies we have developed for local authorities and companies.

For private companies, the implementation is directly within their control and they can normally choose the method of financing. With local authorities, only the directly controlled assets can be changed directly, but the huge opportunities around EV charging, bus fleets, housing standards and retrofit, switching from gas boilers to heat pumps, and increasing walking and cycling will all require investment, some of which will not pay back directly.

"It is important to remember that to be zero carbon will almost certainly require the use of offsets of some kind"

Developing a robust set of public and private investment routes to deliver the transition we are seeking should now be a priority. There are already some funding streams available, such as Salix, but the scale and complexity of the investment required to achieve our aims in the 2020s will require something new, and local authorities and organisations like ourselves need to collaborate to work this out.

The impacts of going zero carbon may seem only to affect our energy system and how we use it, but this will have more profound impacts. We should expect these developments to reinforce the city centre renaissance we have seen over the past twenty years. Noise and air pollution, which still blights many parts of our towns and cities, will be greatly improved.

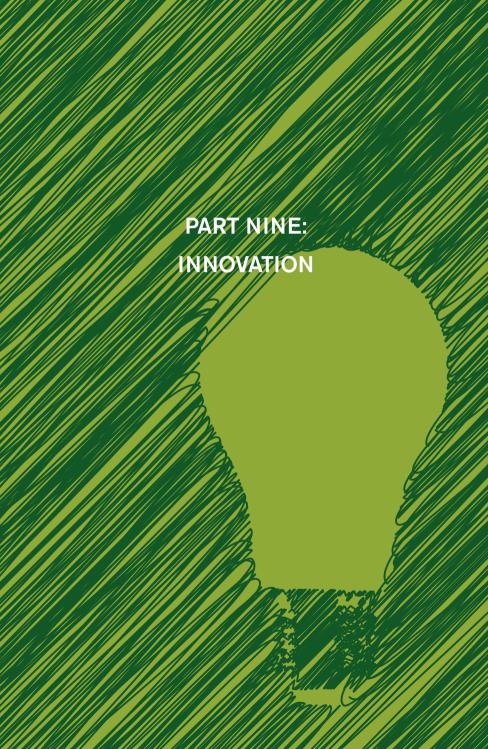
Climate change and the challenge it represents are often portrayed as something purely negative; where we can only minimise the damage. What it has also kick-started is a revolution in our energy system that will make us more productive, reduce air and noise pollution, and reduce the geopolitical relevance of energy.

Clearly, while local authorities have had a tough decade, the 2020s

DELIVERING NET ZERO

offer an opportunity for revival as well as a new societal purpose, if they embrace this transition. So what are we waiting for?

Barny Evans is Head of Sustainable Place, Energy and Waste at WSP, a world leading professional services firm.



Nudging to net zero? Behavioural change

Professor Nick Chater

The UK has thirty years to get to net zero. The scale of the change required is huge, for society, business and individual lives. But the world is, of course, continually in flux. Stepping back in time, in jumps of 30 years, to 1990, 1960, 1930, 1900 and further back, is a useful reminder that thirty years is plenty of time for enormous shifts in almost every aspect of life.

The COVID-19 pandemic reminds us how suddenly, and unexpectedly, our assumptions and our lives can be upended. The challenge now as the world begins to rebuild in the wake of the pandemic will be to generate a coordinated shift to achieve the specific, and vital, objective of reaching net zero by 2050.

"A basic lesson of behavioural science is that actions often come before attitudes and beliefs"

What do we know about human behaviour that may help? I want to highlight four key points, focusing on: a vision of the future, co-benefits, actions not attitudes, and prices, real and virtual.

Understanding the scale and impact of climate change is crucial to reinforce the conviction that 'business as usual' is not an option. But fear of the future will lead to paralysis. Instead, collective action requires a positive, credible and coherent vision of what a carbon-neutral 2050 society might look like. A vision of the future can develop its own momentum. For example, if it is clear that Electric Vehicles (EVs) will replace petrol and diesel, then EVs are more likely to become perceived as cutting edge and aspirational. Petrol and diesel will rapidly seem outdated.

"Purchase and activities are not labelled with carbon impacts – so making the right choices can be extremely difficult"

The same is true for: the shift to wind and solar; the introduction of heat pumps; the use of hydrogen in parts of the economy; the move towards zero-carbon homes; building cycle lanes; planting woodland; and, many more. Government, businesses and individuals want to be part of the future, not stuck in the past; so creating a clear vision of the UK in 2050 is of crucial importance.

It is clearly far easier collectively to coordinate on a vision of the future which has broad popular appeal. It is therefore crucial to focus on the very considerable co-benefits of climate action. Many of the changes required before 2050, while disruptive and costly, will also have huge benefits, independent of climate objectives. If prices continue on their current paths, it is quite possible that renewables will be very much cheaper than fossil fuels. EVs may become not only cheaper to run, but easier to maintain, cheaper to buy, and longer-lived than conventional vehicles. Increasing cycling (including e-bikes), walking, and public transport will help dramatically improve urban air quality. More plantbased diets may be good for our health, but also may be attractive purely on the grounds of taste and variety. And more remote working, rather than the relentless grind of commuting, may improve productivity and enhance leisure opportunities. A net zero UK in 2050 will be a healthier and happier place in which to live. Support for the changes over the next three decades will depend on how well we are able to articulate the wider benefits to our lives. A basic lesson of behavioural science is that actions often come before attitudes and beliefs. We do what we have always done, or what others do – and we scramble together a justification only when we are asked why. Merely changing beliefs and attitudes is therefore insufficient to change behaviour. For example, many people who are very concerned about climate change continue to take frequent long-haul flights for leisure, without any sense of conflict. We need collectively to shift our sense of 'appropriate' behaviour: the kinds of actions and choices that we feel are acceptable in ourselves and others. Thus, most of us feel we 'should' recycle, and most of us do; but we typically have only the haziest idea of what happens to our recycling or the nature and scale of any resulting environmental benefits.

As individuals, we need new social norms for flying less, moving away from meat, using public or green transport, and so on; but similar points apply, of course, to businesses and governments. Public information campaigns and, crucially, legislation, often lead the way: witness shifts to compulsory use of seat-belts, away from smoking and drink driving. But, ultimately, it is crucial that changes of norms are agreed by society itself – changing too quickly or in inappropriate ways, can lead to substantial backlash, as illustrated by the 'gilet jaune' response to environmentally motivated diesel tax increases in France.

Finally, imagine a supermarket with no prices; you just put whatever you want in the trolley, and walk out. But then you are told: you are spending way too much! You must cut back urgently. But cut back on what?

With respect to carbon emissions, this is the position of most consumers, business, and even branches of government. Purchase and activities are not labelled with carbon impacts – so making the right choices can be extremely difficult. A theoretically appealing economic solution could be a realistically high carbon price uniformly applied across the global economy, embodying a 'polluter pays' principle, and disincentivising polluting activities. But such a global agreement is not in prospect.

An alternative, and very different, approach is a behavioural one. We

all know how to budget with money. So it makes psychological sense to translate the problem of budgeting with carbon into a familiar, monetary form: creating purely 'virtual' prices reflecting the carbon impacts, but, crucially, in units of currency.

The concept could be very simple. Let's call 1 'carbon pound', £C1, the amount of carbon emitted by the average pound spent. So, on average, a good or service costing, say, £1 and emit £C1 units of carbon; so if a household spends £20,000 a year on an average basket of goods and services, that would be £C20,000 carbon pounds. Notice carbon pounds are completely different from the important economic idea of carbon pricing – there, carbon is incorporated into normal prices. Here, carbon impacts are represented in terms of money.

Now imagine that everything we buy were priced both in pounds (which we'd actually pay), and in carbon pounds (so we can keep track of our emissions). So, to be carbon-frugal, we just need to buy things for which the carbon pounds are, as much as possible, lower than the actual pounds; and we need to avoid flights where £400 ticket could easily equate to £C4,000 of carbon. Indeed, a family of five might 'blow' their entire annual carbon budget with a single holiday in California. The great virtue of the carbon pound is that they are in units we already understand---they translate the intangible carbon-equivalent kg of CO_2 into the familiar world of hard cash.

"Collective action requires a positive, credible and coherent vision of what a carbon-neutral 2050 society might look like"

I'd love the carbon pound to catch on; I'd love us to start thinking about budgeting with carbon, just as we think about budgeting with our money. Knowing (roughly) carbon pound values would then become like knowing calories in food – very useful if you want to keep your consumption under control. Perhaps retailers might even have to print carbon pounds on their products; and that would be a powerful

incentive for manufacturers to drive down their carbon footprint.

Getting to net zero by 2050 will require concerted action, and dramatic changes: technology, regulation, economics, and political will are all essential. Policies that go with, rather than against, the grain of human behaviour may be the difference between success and failure.

Professor Nick Chater FBA is a Professor of Behavioural Science at Warwick Business School.

Sorting Whitehall Government reform

Laura Sandys

Our commitment to net zero is a world beating ambition and has galvanised businesses, NGOs and government departments to start seriously developing short, medium and long term plans – more of the latter than the former. However, this cannot be seen without recognising that the world has changed due to COVID-19.

Our realisation of our vulnerability has significantly increased — we know that we are not invincible. Safety first will be demanded by the public and they will expect Governments to anticipate, mitigate and protect them from unexpected, unpredictable and destructive risk. Climate change is neither unexpected nor unpredictable but is most certainly destructive. We cannot hide from the fact that climate breakdown will impact our whole economy and will have a devastating effect on all of our communities. So Government taking on its new responsibilities to be "risk manager in chief" needs to re-designate climate change, not as economic transition, but as a Health and Safety risk that needs to be addressed throughout all policy and with urgency. All policies and measures must start to meet clear thresholds of being "Climate Safe", or "Climate Hazardous".

However, becoming "Climate Safe" is not a pain but should be regarded as an economic, health and societal gain – it should sit at the heart of

shaping a new modern "future fit" economy. While tragically we can expect to see economic wreckage all around us in the next few months, we have a clear choice of what sort of economy we want going forward. I would urge government to embrace the low carbon transformation as a modernisation project for the economy, moving from an old fashioned 19th Century economic model into a 21st Century economy. While we will need to support some of our older fashioned businesses we must use our limited resources to focus primarily on creating a modern, highly productive, efficient, healthy and clean economy. Net Zero requires us to become hyper efficient, always striving to get more from less, focusing on productivity and full utilisation of all resources. This should be music to Conservative's ears.

There are four key areas of policy and government practise that need to change – shinning a light on both the opportunities of the new economic model while never underestimating the seismic impacts of climate change. We need to make climate a health and safety issue, mitigate for those that might be left behind, embrace net zero as an exciting modernisation agenda, and abandon GDP as an old fashioned and inappropriate metric of economic success.

Prior to COVID-19, one of the best developments was the establishment of the net zero unit in the Treasury. Without the Treasury understanding that decarbonisation is a market opportunity here and abroad, all the excitement and hullabaloo will hit the Treasury brick wall. Now they have to understand it at speed and need to reshape the underlying "plumbing" of the economic system to modernise how we value investment.

Decarbonisation at the heart of the COVID-19 recovery will in turn release the growing appetite for the private sector to invest, innovate and build strong low carbon businesses. The Treasury have to see decarbonisation as an investment not an expense – and a short term investment at that – as the potential for climate safe innovation, low carbon products and services will rise both here and abroad – an economy that is future fit and world leading.

But our approach must be fair too as the public do have a veto on net zero policies. We need to understand that there will be winners and losers through this transformation, and we need to avoid repeating the mistakes of the past and leaving communities behind. Decarbonisation can and should be seen as a strong regeneration tool that can breathe new life into communities that have been side lined, but this has to be done carefully with risk assessments – not to slow down the transformation but to incorporate appropriate mitigation for those impacted. There is a particular example that will hit us very quickly after the lockdown is lifted. The oil and gas sector are facing a double whammy of low oil prices today and demand into the future expected to be weak. There are many excellent jobs in the sector, concentrated in particular regions. With the combination of COVID-19 and decarbonisation, we need to establish a clear plan to migrate these jobs and repurpose the supply chain to support the transition.

At the heart of this transformation we need to measure economic activity totally differently. Net zero is a concept that runs counter to current growth metrics, and needs to focus on turbo charging productivity, driving our economy to deliver more from less. We need to abandon the very 19th Century metric of GDP which has always delivered perverse outcomes. Take, for example, the 10 years that Japan had virtually no growth – except for one year, which was in the aftermath of the Kobe earthquake due to the investment just to restore the area to its original state. Not exactly growth in any other person's terms.

"Government should task the British Standards Institution to strip the carbon gold plated standards from the top 10 largest carbon emitters"

This new "balance sheet" needs to account for the value that decarbonisation will deliver; wider economic and societal benefits which

^{1.} Justin Kuepper, "What you can learn from Japan's lost decade", https://www.thebalance.com/japans-lost-decade-brief-history-and-lessons-1979056 (2019).

need to be measured and costed properly. These could include: energy efficiency; water efficiency; more productive use of resources which reduce imports; new business opportunities capturing new growing markets in higher margins; and low carbon products and services. Let's also add into the positive bucket the improvement of the public health due to better air quality, healthier food, and less fuel poverty. If all these were properly costed, there would be strong monetary reasons to transform.

"Decarbonisation at the heart of the COVID-19 recovery will in turn release the growing appetite for the private sector to invest, innovate and build strong low carbon businesses"

In the negative bucket are the costs of climate change across the economy and society – a large number if we get this wrong. This includes: the economic vulnerability of being invested in products and services that will be seen as old fashioned; facing carbon border tariffs on carbon intensive exports; natural disasters at home and abroad, the significant increase in global migration and the ongoing NHS costs of not addressing the health outcomes of our current trajectory.

We can also do some plumbing that the public and even the public purse would not feel or even notice. We must decarbonise the wide range of standards embedded deep in our systems. The FIRES project from Cambridge is doing some extraordinary work identifying the multiple standards that are totally unnecessary and consume significantly more carbon than needed, such as the steel intensity of our construction (which we import from China), the carbon intensity of our gas supply set to support North Sea Gas quality, and many more.² Government should task the British Standards Institution to strip the carbon gold plated standards from the top 10 largest carbon emitters. This is how

 $^{2.\} UK\ Fires, ``Absolute\ zero", http://www.ukfires.org/wp-content/uploads/2019/11/Absolute-Zero-online.pdf (2019).$

government can do some of the heavy lifting without asking consumers to fight their way to the least carbon intensive choice.

"Government taking on its new responsibilities to be "risk manager in chief" needs to re-designate climate change, not as economic transition, but as a Health and Safety risk"

These plumbing reforms should fit right into Dominic Cummings' philosophy around systems design and there is no better test than how we can address climate change, deliver net zero and at the same time deliver a vibrant modern economy. What is exciting is if we get these right, businesses and consumers will be able to take on the baton, accelerate, amplify and identify the new opportunities that lie ahead. But government must do the initial re-engineering.

The impacts of climate change are not pretty, and while I would never downplay the dramatic impacts of climate change, we also have to see that there is an optimistic vision for how we decarbonise. This is a modernising transformation, towards an efficient, productive, dynamic and future fit economy – with significant benefits for the public – not just their purse.

Laura Sandys CBE is Chair of the Energy Data Taskforce, Chair of the Food Foundation and former MP for South Thanet.

Transformative thinking Technology

Professor Richard Lanyon-Hogg

Questions are now arising about the damage brought about by social media, exploitation of data privacy and mental health issues associated with device addiction. However, it is being argued that without sustained innovative development, the resources we need to continue advancing prosperity, health, welfare and meeting climate targets will not be available.

Compound this with the COVID-19 pandemic, and what we all face, wherever we live, is an extreme and tragic disruption that will force businesses to transform themselves. It will turbo boost digital transformation – the Fourth Industrial Revolution (4IR). People's habits are going to change, they'll travel less, supply chains will become more local. And people will attune to 'local' and 'home' working. These new COVID-19 driven trends will force companies to revamp their technology and spend more on transformation. Uncertainty is not an excuse anymore; but challenges remain.

As a patent holder in wireless technologies, I can attest that it is getting ever harder to conceive, invent and bring to market something that is truly revolutionary. The sheer dominance of the global technology companies stifles out innovation due to their market presence, financial weight and the capacity to influence the movements of government,

industry and the consumer.

Investigating data on research and development activity, Stanford University found that the productivity of science and discovery has been falling for several decades. The data suggests that there are many times more people engaged in R&D; but their average productivity has declined by a factor of 40 over several decades. This suggests that ideas are getting harder; but you could also surmise that at a macro level we are faced with the twin challenges of a stifled market and little agility to materialise an idea.

And yet here we are in 2020, in our second decade of a data-driven transformation of society and there is little we can do to stop it. The developments in the field of Artificial Intelligence (AI), such as the uncoupling of intelligence from consciousness, are moving so fast that it is impossible to imagine what the future might hold. The dystopian view of who 'we' will be anymore perhaps amounts to nothing more than an accumulation of information points, living in a virtual and augmented world as the natural world around us slides into oblivion.

Is technology our salvation to all the world's social and environmental woes? Some technologies are truly revolutionary; they transcend the simple pragmatism to produce effects that would have seemed miraculous to earlier generations. But they take time to reshape the economic systems around us, and sometimes much more time that you'd expect. No discovery fits that description more aptly than electricity, barely comprehended at the beginning of the 19th century but harnessed and commodified by the end. In manufacturing, this didn't materialise until the 1920s when factories were reconfigured.

So too with computing; those that merely invested in computers didn't see the same benefits as those that reorganised themselves around the then new technologies. So too with the Fourth Industrial Revolution, those that reorganise themselves around digitisation will

^{1.} Nicholas Bloom, Charles Jones, John Van Reenen and Michael Webb, "Are ideas getting harder to find?", American Economic Review (2020), 1104-1144.

reap the bigger benefits.

The manifestation of individuals and businesses digital transformation will take many forms. COVID-19 is highlighting that workers and teams from across all sectors have quickly become comfortable with remote working, digital communication tools and collaboration over distances. Technologies such as Digital Twins and remote Augmented Reality are not new; but mass adoption is ever more likely.

In responding to the pandemic, business and countries now recognise that a renewed emphasis must be urgently applied to the shortening of supply chains. The necessity to dramatically reduce the risk of supply failures will lead to an invigorating of local sourcing with 'reshoring' rising up the political, economic and social agenda. Uncertainty is no longer an excuse for poor investment in digital transformation; individuals and businesses will want to boost their productivity as their new potential values emerge.

The climate crisis and the COVID-19 pandemic are exposing the fragility of our society. This will quickly lead to society demanding moral changes and governments directing change through legislative instruments. Irrespective of the business sector, there are many known technologies that offer a platform to conjoin the world of Operational Technologies and Information Technologies. The challenge with all of this will be identifying business, technical and architectural leadership within companies and across ecosystems to materialise the possibilities, mitigate the threats and handle the many challenges.

However, as we urge the acceleration of the 4IR, until the circular economy sustainably materialises, more precious resources will need to be extracted from the land beneath our feet, with more historically locked sunshine being released into the atmosphere. So how might we tackle the sustainability of 4IR? Some eight decades ago, the American educationalist Abraham Flexner published an essay, *The Usefulness of Useless Knowledge*. In it, he suggested that the most powerful intellectual and technological breakthroughs usually emerge from research that initially appeared 'useless', without much relevance to real life. He

further argued that these 'useless' endeavours should be supported, even if they did not produce an immediate payback, because otherwise the next wave of innovation would simply not occur.

"The sheer dominance of the global technology companies stifles out innovation due to their market presence, financial weight and the capacity to influence the movements of government, industry and the consumer"

Flexner argued: "Curiosity, which may or may not eventuate in something useful, is probably the outstanding characteristic of modern thinking. It is not new. It goes back to Galileo, Bacon and Newton, and it must be absolutely unhampered".²

As we explore how we make the 4IR more sustainable, it is a powerful point to ponder, especially given the financial austerity and requirements of an immediate payback within many organisations. Here in the UK, it is getting harder to secure funding for basic research as monies are increasingly directed towards the Innovate UK route, with research being required to be close to the application.

All of this makes it understandably hard to justify spending on 'frivolous' research. The management theories of blue-sky thinking and serendipity are under threat; but if we are to make the necessary breakthroughs in 4IR sustainability, we need everyone to swim against the tide and engage in what may be viewed as seemingly undirected research. Yes, we can sweat the small stuff and follow a marginal gains philosophy to turn innovation into a predictable process; tweak your activities, gather data, embrace what works and repeat. But reflecting on Flexner's essay, another possible way to break through all the barriers of progress is to embrace a different kind of innovation: the long shot. If marginal gains are a nudge, the long shot is an entirely new way of doing

Abraham Flexner, The usefulness of useless knowledge, (New Jersey: Princeton University Press, 1939), 2.

things. Consider the long shot innovation a new territory, a marginal improvement on the colonisation. Universities have a role to play.

If we are to move to a more sustainable 4IR future, time is not our friend. Good ideas may percolate slowly; but we mustn't allow ourselves to squander the wisdom of the past. The status quo is comfortable for those who perceive they have control. We cannot allow ourselves to become less dynamic, allowing ourselves to be in a position where we don't explore new ideas willingly. If the sustainability of 4IR is only grasped at, in desperation only when we have no choice, it will be too late.

I also worry that the technical behemoths will bend, stretch and apply their vision of a sustainable future. Would you trust the future of the planet to a set of organisations with which the public have little trust, whether that's their custodianship of our personal data, or the financial institutions that failed a decade ago with a global financial crisis that shattered trust in large companies? Globally, citizens' expectations are rising and many are demanding action with the scientific evidence indicating that companies have little time for "woke-washing' and 'smoke-and-mirrors'.

"COVID-19 is highlighting that workers and teams from across all sectors have quickly become comfortable with remote working, digital communication tools and collaboration over distances"

Perhaps the way ahead is a renewed period of 'enlightenment'. Imagine a time in which new economic ideas were developing rapidly; this was the late 18th century Britain. History never repeats itself, but it does serve as a reminder that the recent past may not be as novel as we like to think. In 1784, in the Turk's Head Tavern, London, a group

^{3.} Intergovernmental Panel on Climate Change, "Summary for policymakers of IPCC special report on global warming of 1.5°C approved by governments", https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/ (2018).

simply known as 'The Club' were drawn from across the artistic, literary, academic and political communities. Members ranged from moral and political thinkers such as Adam Smith and Edmund Burke with historians, artists and dramatists also present.

At the centre of The Club was the literary giant Samuel Johnson and the man who immortalised his words of wisdom, James Boswell. At its heart it was an "atmosphere of relaxed thoughtfulness" which ultimately shaped lives through thought and conversation. Perhaps we need a renewed period of 'enlightenment', with people from all domains of life gathering all over Britain's industrial landscape, inspired by the belief that broad thinking and discussion is an indispensable way to tackle the urgent sustainability challenges that are upon us.

To conclude, we know what has been gained from technology; let us not lose what previous generations and we have enjoyed; least of all let us not forget what may be lost.

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Leo Damrosch, The club: Johnson, Boswell, and the friends who shaped an age (New Haven: Yale University Press, 2019).

Last year, the UK became the first major economy in the world to commit to net zero emissions by 2050. Whilst there has been some progress towards this target, the UK is currently not on track to achieving this.

Deeper decarbonisation of the UK economy is required. This collection of essays, authored by leading chief executives, politicians, academics and thought leaders from across the private, public and third sectors, highlights policies and projects across different economic sectors that are supporting and could support the journey to delivering net zero.

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