INNOVATION AUDIT OF THE 25 YEAR ENVIRONMENT PLAN

January 2021

CONTENTS

1. FOREWORD

In 2018 and 2019 the Government dramatically set reset the scale of our environmental ambitions. The 25 year Environment Plan was followed by an Air Quality Strategy that went beyond existing targets, and then the first legislated net zero target in the world.

By 2020 we had a new Prime Minister and the biggest quarterly fall in GDP on record, and many expected a quiet dilution and scaling back of these goals. But instead they have been reaffirmed and in some cases accelerated as the Prime Minister has argued that a wholehearted commitment to rapid improvement of environmental outcomes as part of a 'green recovery' and a drive to 'build back better'.

The Government's commitment to this agenda is deeply welcome. But if we are to deliver this green transformation without resorting to either unaffordable levels of public spending or heavy handed regulations that overly cramp our lifestyles then it is vital that we maximise the innovation within the UK's vibrant environmental technology and services sector.

EIC commissioned global consultancy Ramboll to undertake an analysis of the goals enshrined in the 25 Year Environment Plan and identify both the extent to which innovation is essential to meet these goals and to identify the types of innovation most relevant to different environmental objectives.

Although the work was carried out before the pandemic the findings set out in the following pages remain timely and insightful. It's clear from the analysis that some of the targets in the 25 Year Plan (which will shortly be legislated through the Environment Bill) cannot be met without innovation and also that innovation is required not just in physical terms but in digital applications and business models as well.

Working with EIC member firms over the years has shown me the huge amount of creativity and innovation these businesses are able to develop. But it has also shown the critical role of getting regulation right, to create markets that innovation can be deployed into. This is not about the tired argument between deregulation or more regulation. It is getting the detail and nuance of regulations right. Are regulations are properly enforced so that markets are robust and attractive to investors. Are testing and accreditation schemes designed to facilitate the deployment of innovative technologies without imposing excessive cost and delays. These are issues on which EIC remains focused and active.

Lastly my thanks to the EIC members who contributed to the work and to the Ramboll team who carried out it out, in particular Chris Fry, Emma Green and Emma Jones.

Matthew Farrow, EIC.

2. INTRODUCTION AND APPROACH

2.1 The 25 Year Environment Plan

The UK Government, in common with countries around the world, has recognised that industries, economies and societies are changing. The 25 Year Environment Plan (25 YEP) is the UK Government's roadmap for action, committing to improve the environment within a generation.

The 25 YEP arose from a proposal in a Natural Committee Capital (an independent advisory committee to the Government) report in March 2014 and the Government endorsed this recommendation, publishing the final plan, A Green Future: Our 25 Year Plan to improve the environment on the 11 January 2018. The plan is formulated in the context of Brexit and the Government's previous commitments to uphold its obligations under ratified international treaties. The Plan will be legislated through the Environment Bill which is currently completing its Parliamentary stages and is expected to receive Royal Assent in the spring of 2021.

The 25 YEP contains 10 main goals and over 200 actions grouped around 7 themes and provides insight on new and existing strategies, targets, mechanisms and commitments that need to progress in order to meet the goals. The actions range from specific, time bound outputs, such as a commitment to set up a new public body to hold Government to account on the environment; through to radical areas of policy reform.

The 25 YEP also commits to the development of a key set of indicators describing environmental change. This Outcome Indicator Framework was released on the 16 May 2019, along with the 25 Year Environment Plan progress report: January 2018 to March 2019 which sets out progress made since the launch of the 25 YEP. This progress includes: stronger environmental governance through the development of the draft Environment Bill; the progression against targeted 25 YEP goals and actions through the provision of Government strategy and frameworks such as the Clean Air Strategy; the publication of three draft laws – all of which have significant potential to drive improvements to the environment; and the creation of additional funding mechanisms to support people's access to and engagement with nature.

Although positive progress is shown in the initial actions required to deliver the 25 YEP goals and the importance of this should not be underestimated, there is still a long way to go. This is especially the case for some of the more ambitious goals, recognising the complexity of the interacting system that is the environment in the face of a changing political landscape. A central issue is how much of the work to date on the policy framework will enable a broad enough range of parties, across all relevant sectors of the economy, to deliver what is required in terms of environmental improvement, and whether this will be enough to meet our targets with sufficient urgency. Legislative requirements, consumer education and demand and cost incentives/reductions all have important roles to play in helping to achieve a positive trajectory of progression towards goals. The availability and timeliness of technological change and emergence of new business models are also likely to be important in transforming environmental outcomes.

All elements of the 25 YEP can potentially benefit from effective infrastructure and capacity for innovation, from food production and securing our drinking water supply to minimising flooding and reducing pollution. There has been significant progress and advancement within these areas over the past few decades. This is a real opportunity for the UK to exploit and build upon the substantial innovation and technological advances that are underway to deliver the 25 YEP plan and decarbonisation goals domestically as well as potentially in global markets.

This project focuses on the innovation pathways required to progress achievement towards selected goals and targets within the 25 YEP (see Box 1). The project has been commissioned by

the Environmental Industries Commission (EIC), a leading trade organisation for the UK Environment sector and funded by UK Research and Innovation (UKRI).

- SPATIAL DATA ANALYSIS: Explore ways in which national spatial data and geospatial strategies could support and improve the benefits achieved through environmental net gain

- AIR: Legally binding targets to reduce emissions
- AIR: End the sale of new conventional petrol and diesel vehicles
- AIR: Continuous improvement in industrial emissions

- WATER: Reduce abstraction of water from rivers and groundwater
- WATER: Reach/exceed objectives for rivers, lakes, coastal and ground waters
- WATER: Reduce water loss through leakage
- WATER: Minimise bacteria in our designated bathing waters

- RESOURCES: Double resource productivity by 2050

- CLIMATE: Reduce greenhouse gas emissions and the use of fluorinated gases *

- WASTE: Zero avoidable waste by 2050
- WASTE: Eliminate avoidable plastic waste by end of 2042
- WASTE: Meet all existing waste targets
- WASTE: Eliminate waste crime and illegal waste sites
- WASTE: Significantly reduce / prevent all kinds of marine plastic pollution

- CHEMICALS: Eliminate the use of Polychlorinated Biphenyls by 2025
- CHEMICALS: Reduce land-based emissions of mercury to air and water by 50% by 2030
- CHEMICALS: Substantially increase the amount of Persistent Organic Pollutants material being destroyed or irreversibly transformed by 2030
- CHEMICALS: Fulfil our commitments under the Stockholm Convention

Box 1: The Focus of the Innovation Audit of the 25 YEP (showing abbreviated targets)

* Due to the scale and complexity of the topic and work undertaken by the Committee on Climate Change and others, climate was not fully investigated in the project but was given secondary consideration as relevant to the other domains.

2.2 25 YEP 'Line of Sight' to environmental outcomes

As with any long-term strategy or plan, it is essential for the Government to have an effective system for measuring and evaluating progress. In this case that includes monitoring performance against the 25 YEP goals, targets and supporting actions as well as the ultimate outcomes in the change in the state of the natural environment. A recent report by the National Audit Office (NAO) (2019) highlights a number of challenges in the way environmental performance is tracked in terms of performance measures, governance and accountability.

Comprehensive measurement of progress towards the 25 YEP commitments will be multi-layered. It will require intermittent tracking of short terms outputs (such as policy measures introduced and improvements in the ecological status of surface water and groundwater at local level and river catchment level), in addition to an overview of progress against the ultimate outcomes. Robust data management and transparency is key, along with the communication and collaboration between different parts of Government, industry and the public to enable the development of a 'clear line of sight' to show linkages between inputs and outputs to outcomes.

Long term targets are necessary, but not sufficient in themselves. The Department for Environment, Food & Rural Affairs (Defra) has not yet set out expectations for the scale of improvement required by the 25 YEP in the short and medium term. The 'back loading' of action should be avoided to prevent greater financial and environmental costs in the future. Regular progress monitoring should enable any gaps to be identified in current policy measures and other interventions some of which can then be addressed through incentives to enable existing solutions to penetrate the market or for new innovations and technological advancement to be developed.

The UK's commitment to the UN Sustainable Development Goals (SDGs), made in 2015, is also part of the backdrop to measuring the 25 YEP's progress in the medium to longer term. The UN SDGs and 25 YEP together provide the UK with an opportunity to take a strategic view of systemic changes required. This will rely upon significant collaboration between Government departments, industry, consumers and the innovation infrastructure which are crucial for economic growth, sustainable development and responsible consumption and production.

Advancement in the UK's innovation landscape, through the deployment of cost-effective technology can contribute to the goals of the UN SDGs which provide a step in progress towards the 25 YEP. The most pertinent of the SDGs to this is *SDG 9: Industry, Innovation and Infrastructure* which recognises the importance of building resilient infrastructure, promoting inclusive and sustainable industrialisation and fostering innovation. Progression within this domain should lead to improvements in a number of other SDGs as shown in Figure 1. These also have strong linkages with a number of the 25 YEP goals discussed within this report.

Figure 1: SDGs related to the 25 Year Environment Plan.

2.3 The innovation landscape – technological change

The natural environment is a highly complex interconnected system of sub-systems and can be influenced by a number of external drivers of change, such as societal, economic, environmental, political and technological factors. Many drivers for environmental change and improvement can also present new opportunities for businesses and communities as part of the expected global transition to a "clean growth" economic model.

It is widely accepted that the so called 4th Industrial Revolution based on digital technology is underway and that this will ultimately transform how all sectors of the economy operate. This could be harnessed to improve resource efficiency and aid the recovery and regeneration of the natural environment through better management of natural assets. This revolution may result in shifts and disruptions characterised by a range of new technologies linking physical, biological and digital worlds.

Digital technologies have equally large implications for the way society interacts with Governments and the private sector, for example the move from paper to digital transactions. Advances in digital technology have also led to a step change in the volume and value of data being created and managed. In the environmental sector this has expanded the capacity for integrated monitoring, analysis and visualisation at multiple temporal and spatial scales alongside the development of digital design and digital twins (including Building Information Modelling or BIM) for the built environment. These trends provide an ongoing opportunity for innovation in the way information is used and communicated to various audiences to aid decision-making and achieve policy goals more rapidly.

The UK has a strong reputation for science and world-leading research, contained within a diverse innovation ecosystem. With only 0.9 per cent of the world's population, and 4.1 per cent of researchers, the UK accounts for 10.7 per cent of citations[1] and 9.1% of the global patent citation share[2]. It is important that these skills and knowledge are capitalised on to ensure clusters of expertise can create momentum for innovation.

The vital role of innovative products, processes and services that deliver both environmental and economic benefits is widely recognised. However, effective demonstration, deployment and commercialisation of innovation does not always occur.

It is useful to consider the lifecycle of innovations and several papers are particularly relevant in this regard, including Gross et al. (2018)[3] on innovation timescales, the Technology Readiness Levels (TRLs)[4], Innovate UK's categories of research and development, Vivid Economics' work for the Aldersgate Group on technology transformations[5], Taylor and Taylor (2012)[6] on project development lifecycles and the Foreign and Commonwealth Office and Carbon Trust report (2015) on United Innovations[7].

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/801513/International-research-innovation-strategy-single-page.pdf

[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/660855/uk-research-base-international-comparison-2016.pdf

[3] http://www.ukerc.ac.uk/asset/9F4B25BE-742B-4D96-9885270D387E46D0/

[4] https://www.gov.uk/government/news/guidance-on-technology-readiness-levels

[5] http://www.vivideconomics.com/wp-content/uploads/2019/04/Accelerating-innovation-towards-net-zero-emissions.pdf

[6] https://ideas.repec.org/a/eee/proeco/v140y2012i1p541-553.html

[7] https://www.carbontrust.com/media/672125/united-innovations.pdf

The TRLs (shown in Figure 2) provide an indication of the readiness of a technology from fundamental research through applied research, piloting and full operation. The nine stages of the TRL scale can be sub-divided into four sub-divisions as part of a broader innovation lifecycle: Research (TRL 1-3); Development (TRL 4 – 6); Deployment (TRL 7 - 8) and Operations / Market formation (TRL 9).

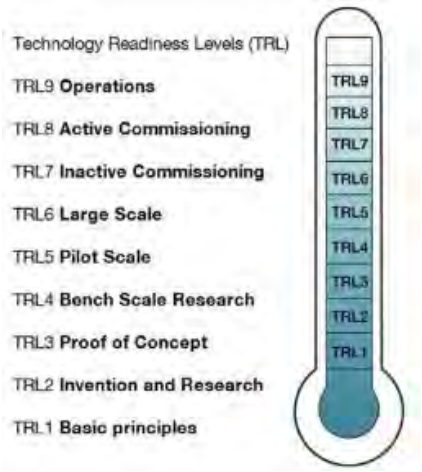

Figure 2: Technology Readiness Levels

The amount of time required for new innovation and technologies to be developed from research, progress through the testing and demonstration stages, early stage operations and deployment and diffusion into the marketplace and industry is very important. To ensure that the intended outcomes are delivered, an understanding of how technologies make an impact upon society and improve the natural environment is required.

The TRL's focus is on bringing a technology to a viable, market ready state i.e. "market formation". Technologies then need to scale up and diffuse across their target markets as equipment is replaced and organisations/consumers upgrade. This can typically last in the order of years to decades depending on many factors. For example, the regulatory regime and structure of a marketplace can significantly affect the commercial viability and rate of diffusion of disruptive technologies and innovation. For technology providers this involves expanding capacity to cope with greater volumes and a higher number of stakeholders, actors and demand.

The stages in the innovation lifecycle that happen after inventing and proving a new technology, namely "market formation" followed by "growth and diffusion", are critically important and have been recognised in designing the bespoke framework for this study presented in Section 2.4.

2.4 The innovation landscape – evolving service and business models in a digital age

Associated with the technological innovation (4th industrial revolution) or alongside it, services and business models are also changing fast. This is highly relevant to environmental domains and the sectors of the economy that interact with it. For example, through its Future of Consultancy campaign the Association for Consultancy and Engineering (ACE) has recognised that the UK is entering a new era of design and delivery in the built environment and the new ways of working that will emerge. Figure 3 highlights some of the changes to consultancy business models that could be associated with this transition.

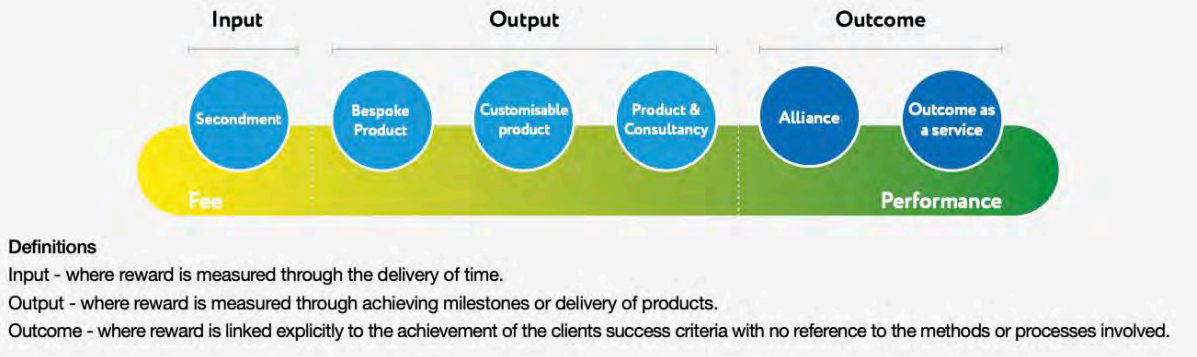

Figure 3: Indicative examples of new business models (source: ACE Future of Consultancy)

Another good example of the extent of potential change that may be associated with greener service and business models relates to resource efficiency. The concept of a more circular economy gives rise to various potential business models (see Box 2) which are not necessarily new but may represent a significant or even fundamental change when applied in sectors of the economy where some resources and associated environmental externalities have not been valued highly. For example, Box 2 demonstrates that technology that is well established in one market can potentially enter another market, providing the opportunity for multiple environmental benefits.

Gary Armstrong, Chair of the EIC Waste Technical Working Group/SLR Consulting provided the following insight on circular economy in relation to the waste industry:

"I think the key to resource efficiency business models is integration in thinking and approach. We are seeing this with our Working Group membership. Partly due to resource efficiency drivers the waste management industry is integrating elements of collection, treatment, disposal and extending communication with materials markets and waste producers. Whilst our environmental consultancy members have the opportunity to use their cross-sector expertise to provide the services and support that help bring all parties together and facilitate this integration."

It is important to recognise that circular business models do not operate in isolation and often companies adopt combinations of business models which can lead to significant environmental benefits. One criticism of the 25 YEP is that it has not differentiated itself from previous polices, in that technology is still segregated and promoted within individual domains, when many issues are cross cutting and advancement in innovation requires a coherent approach. This coherent approach is needed to ensure opportunities and lessons learnt from one industry are communicated in other sectoral value chains.

"Innovation by definition is something new, often this means that it will not fit into an existing framework (eg: regulatory). Therefore, we need a dedicated ecosystem where innovations can be explored without the constraints of the old thinking in order to prove the impact of innovation and encourage change in regulation to benefit the future". (Alex Guslisty, Big Atom)

A move in the direction to a circular economy will foster industrial symbiosis clusters and facilitate cooperation within and across value chains which could fundamentally change the ways in which materials and natural resource are valued. For example, as recognised by PWC's[8] 'The Fourth Industrial Revolution and the Earth' blockchain technology is recognised as an innovation that could increase transparency, scalability and efficiency across different markets, bringing us closer to a truly circular economy.

Five headline business models for a more circular economy

1. Circular supply models, by replacing traditional material inputs derived from virgin resources with bio-based, renewable, or recovered materials, reduce demand for virgin resource extraction in the long run.
2. Resource recovery models recycle waste into secondary raw materials, thereby diverting waste from final disposal while also displacing the extraction and processing of virgin natural resources.
3. Product life extension models extend the use period of existing products, slow the flow of constituent materials through the economy, and reduce the rate of resource extraction and waste generation.
4. Sharing models facilitate the sharing of under-utilised products and can therefore reduce demand for new products and their embedded raw materials.
5. Product service system models, where services rather than products are marketed, improve incentives for green product design and more efficient product use, thereby promoting a more sparing use of natural resources.

Source: Business Models for the Circular Economy Opportunities and Challenges from a Policy Perspective, OECD, 2019

Box 2: Circular economy business models

[8] PWC (2018) 'Building block(chain)s for a better planet. Available at: https://www.pwc.com/gx/en/sustainability/assets/blockchain -for a better-planet.pdf

2.5 25 YEP Innovation Audit – purpose and approach

The objective is to help identify which are the main environmental challenges and where the innovation and enterprise within the environmental sector are most needed. It was recognised at the project inception that the range of information that could be reviewed is potentially vast therefore our main priority was to start to identify a **consensus** position for each 25 YEP environmental domain and understand the **confidence / uncertainty levels** which could be further validated through stakeholder engagement. Research was therefore structured around answering the questions presented in Box 3.

Question 1:	**Analysis framework:**
• Assess the implications of the stated aim/target in terms of pollution reduction/environmental enhancement	• 1A: What are the past trends and what is the direction of travel? • 1B: What policies / actions / strategies are already part of the policy climate? • 1C: In the current policy climate what is the distance from target?
Question 2:	**Analysis framework:**
• Assess from this the extent of the need to substitute existing technology/processes with cleaner/more efficient ones, and/or the need to for system changes which would reduce environmental impacts	• 2A: What are the key problems that need to be addressed? • 2B: What are the options for addressing them in terms of technologies and system changes?
Question 3:	**Analysis framework:**
• Assess whether relevant technology or services in this field was in commercial deployment at scale, or available but not commercially viable at scale without subsidy/regulatory requirement; or at demonstration/concept stage; or at R + D phase.	• 3A: What technologies / services are available / in development? • 3B: At what stage is each innovation in the project life cycle? We intend to use the following classification – development, market formation and commercialization.[9]

Box 3: Research priorities and analysis framework

[9] following a classification provided by the UKERC (Gross et al., 2018).

The underpinning evidence and case studies were gathered through structured desk-based research, including web searches and a focussed UK patent search. In addition, innovation and technology lifecycle frameworks were researched and analysed to feed into the framework developed for this project.

The project was launched at EDIE Live in May 2019, complementing the conference's theme 'turning ambition into action'. EDIE was a successful platform to promote and engage with sustainability and resource professionals to obtain their opinions on the current environmental innovation landscape. The launch was supported by an online qualitative survey which sought views from a wide range of people on environment domains associated with the 25 YEP, including: the key problems that need to be addressed and the technologies and services available or in research and development that could make a significant contribution in terms of meeting the aims and targets.

Key stakeholders were identified for the project and invited to engage and participate in the project as relevant.

- Government departments;
- Professional institutions;
- Trade associations;
- EIC technical working group members and other EIC member company representatives;
- Research catapults;
- Think tanks and not for profit institutions/networks;
- Universities; and
- Consultancies.

The online survey and engagement with specific EIC members and working group chairs yielded 54 responses. Two focus groups were also held as part of the project to initiate a further dialogue with technical specialists on current and future innovation. These focussed on Waste, Spatial data analysis and Air Quality and contributed directly to the evidence base relating to those 25 YEP goals and targets.

Discussions in the focus groups and in other aspects of the project also made use of the concept shown in Figure 4 which is a simplified version of the "wedges approach" first developed for examining policy pathways to climate stabilisation[10]. The approach is based on the idea that a medium to long term goal or target will not be met by a single action but that different policy measures and other activities (including technological breakthroughs) will be required in combination over time. The approach has the advantage of presenting potential pathways and measures in a transparent way for policy makers and stakeholders and it could be utilised further in subsequent phases of this work.

[10] First developed by Pacala and Socolow in 2004. Refer to: Pacala, S. and Socolow, R. (2004), 'Stabilization wedges: Solving the climate problem for the next 50 years with current technologies', Science, Vol. 305.

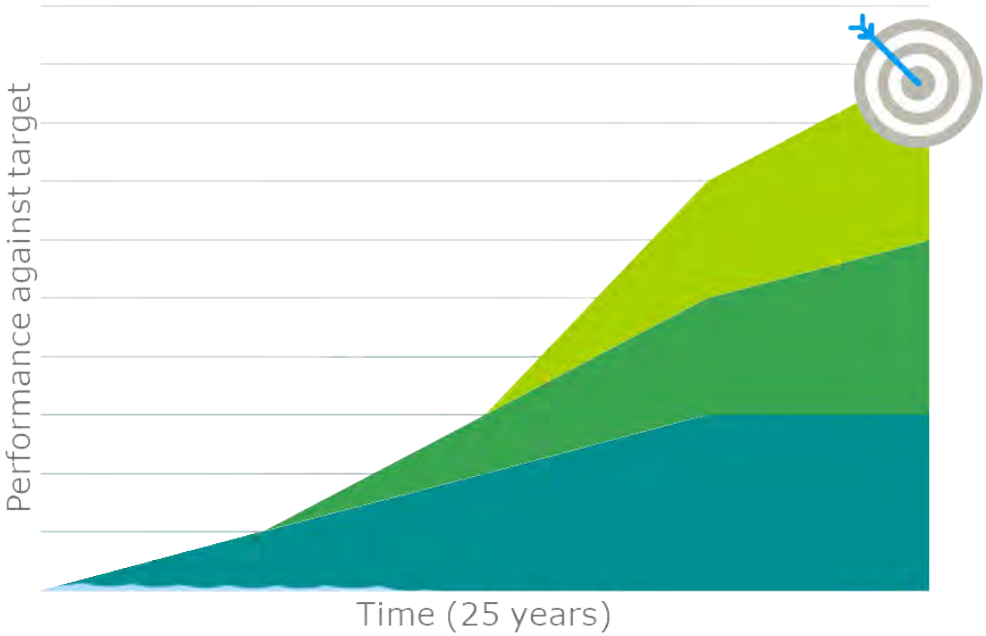

Figure 4: Simplified "wedges approach" for considering policy and innovation pathways towards targets

3. INITIAL FINDINGS FROM THE 25 YEP INNOVATION AUDIT

3.1 The importance of innovation alongside other factors

The uptake of new technologies and/or new services and business models are of course only one mechanism through which the 25 YEP targets can be met. Many other factors play their part including policy and enforcement regimes, consumer/market demand, awareness and behaviour. Some of these factors are directly translated into risks and/or costs in day to day and longer-term decision making in industry, particularly where major capital investments are required in order to change practices. The distribution of those costs and the associated benefits are also important to understand.

In practice, policy measures and technological change, as well as the other various factors, will interact to dynamically drive and respond to change markets and supply chains. A multi-pronged approach will therefore be needed to embed successful change. As Drew Hardy of Groundsure observes in relation to the better use of spatial data:

"It's not enough for this potential new department within the environmental watchdog to be just a data aggregator. They must have the abilities to utilise the full capability of spatial data for monitoring, modelling and analysis, and they must have the power to demand consistency and quality from those who supply data. Crucially, this data must also be made open in order to encourage transparency and innovation across the board. The software, people and skills are already out there. We just need to harness them."

The 25 YEP innovation audit online survey respondents were asked "What would you consider to be the main changes required to meet the aims and targets for your subject area as detailed within the 25 YEP." They were asked to rank four of the most widely relevant and understood generic factors i.e. change in legislation and policy; changes in consumer demand; technological change; and cost reduction such as through commoditisation.

The responses are summarised in Figure 5 which includes aggregated data for the environmental domains of interest to this study. The emerging consensus is that legislation and policy is ranked as the most important factor, with technological change ranked a close second, followed by consumer demand, with cost reduction identified as the least important factor overall.

The top ranking of legislation and policy overall, is replicated in the underlying data for many of the specific domains. Technological change is generally ranked second though is ranked as of highest importance in relation to the cross-cutting domain of spatial data analysis. It is also perceived as almost as important as change in legislation and policy in the water domain which shows some of the most polarised results in terms of the variance between the first/second and third/fourth ranked factors. Conversely the responses for the natural resources domain rank the four factors as being of similar importance.

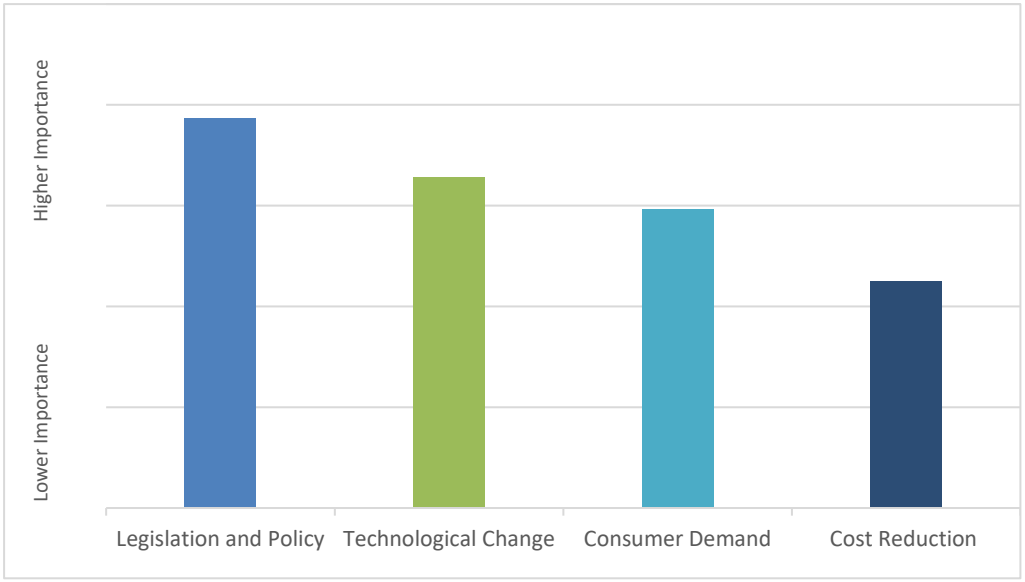

Figure 5: The perceived importance of technological change alongside other changes required to meet the 25 YEP targets (source: averaged data from questionnaire respondents)

The necessary interplay between the four factors described above is illustrated by the example of Mobility as a Service (MaaS) technologies and business models which could contribute to meeting air quality as well as other targets. Consumer acceptance for a new way of purchasing travel (e.g. without owning a vehicle) is needed for MaaS and supportive policy and regulatory regimes (e.g. for sharing operational data about public transport) is also a prerequisite.

Innovation Spotlight: Mobility as a Service

Air Quality improvements through Mobility as a Service (MaaS) schemes.

What is it?

MaaS is the term for the digital platforms through which people can access a range of public, shared and private transport services into a single mobility service that integrates planning, booking and paying for the service and is accessible on demand.

What are the opportunities?

MaaS is being developed in response to the growing demand from users for a convenient transport service. Just as streaming services has changed the way that people pay for, search for and consume media, MaaS could potentially contribute to reducing congestion, improving urban air quality and increased efficiency in transport networks. These potential benefits align with those expected to be delivered by Government strategies such as the Cycling and Walking Investment Strategy and the Future of Mobility challenge, which is part of the Government's Industrial Strategy.

Innovation status and current barriers to further market growth and diffusion?

B (Development) → C (Deployment) → D (Market Formation)

- Financial support for piloting and the development of schemes;
- Legislation and regulatory underpinning;
- Government leadership to support modal shift,
- Lack of data standards at the national level;
- Payment and enforcement mechanisms;
- Lack of incentives for data sharing between sectors.

Related 25 YEP goals:

- Meeting legally binding targets to reduce emissions;
- End the sale of new conventional petrol and diesel vehicles;
- Reduce greenhouse gas emissions and the use of fluorinated gases.

Box 4: Innovation Spotlight: Mobility as a Service

3.2 The types of innovation that may be relevant to fully meeting the 25 YEP targets

Across the seven domains investigated in this innovation audit, more than 150 technologies and services/business models have already been identified and many others could also be relevant. Some innovations are very specific to a particular industry and/or to meeting a particular 25 YEP target, for example the production of refuse derived fuel or development of extended producer responsibility business models. Box 5 presents another example of a specific innovation application, in this case smart tracking for reducing waste and waste crime.

Innovation Spotlight: Smart Waste Tracking

Lifecycle analysis of waste through electronic tracking and radio frequency identification (RFID).

What is it?

Wireless data collection technology enabling tracking of material assets enabling integrated lifecycle analysis in the real world. RFID tags come in many different shapes and sizes depending on the functions and uses. There has been a large progression in recent years in the production of RFIDs in terms of reduced costs and increased information storage capacity.

What are the opportunities?

Through globalisation supply chains have become increasingly complex. RFIDs can improve efficiency through visibility and predictability. This technology poses an opportunity to the public sector to track products from cradle to grave and help tackle waste crime around the UK. Coupled with blockchain and common reporting platforms, it can also help identify opportunities for industrial symbiosis, recycling and reuse of materials throughout the public and private sector.

Innovation status and current barriers to further market growth and diffusion?

D (Growth and Diffusion) → E (Market Formation)

- Data transfer / interoperability with companies existing systems;
- Lack of data standards at the national level;
- Ensuring the correct description and categorisation of waste;
- Real time tracking;
- Legislation and regulatory underpinning;

Related 25 YEP goals:

- Eliminate waste crime and illegal waste sites;
- Zero avoidable waste by 2050;
- Meet all existing waste targets

Box 5: Innovation Spotlight: Smart Waste

Whilst some are very specific to a particular issue, many of innovations that are relevant to the 25 YEP can be grouped into "clusters" that have potential applicability in more than one environmental domain and potentially multiple industry sectors. For example, innovative mechanical processes, the sharing of economy business models (including renting and leasing) or innovations based on artificial intelligence.

Drawing upon the technologies suggested through this research and previous work by PWC and others[11], some 23 innovation clusters have been identified as relevant to the innovations (see Figure 6). These include two cluster categories to capture the more specialist technologies or services/business models that do not fit with another more generic category.

It is important to acknowledge that some technologies and many services/business models will blend the capabilities associated with more than one innovation cluster. Nevertheless, an

[11] https://www.pwc.com/gx/en/issues/technology/essential-eight-technologies.html and https://www.pwc.com/gx/en/sustainability/assets/ai-for-the-earth-jan-2018.pdf

appreciation of these clusters and their main associations with individual technologies and services may provide valuable information to enable the timely and cost effective of the 25 YEP targets. For example, collaborative investment in innovation clusters and associated capabilities that serve more than one environmental domain and multiple targets may have the potential to achieve greater outcomes. Spin-off applications to other environmental targets may also emerge.

The environmental innovation clusters themselves broadly fit into three categories that distinguishes between physical innovation, digital innovation and business model innovation though some of the clusters can fit more than one of the categories. Figure 6 summarises the 23 innovation clusters identified in this study with a few illustrative examples of the specific technology/service applications.

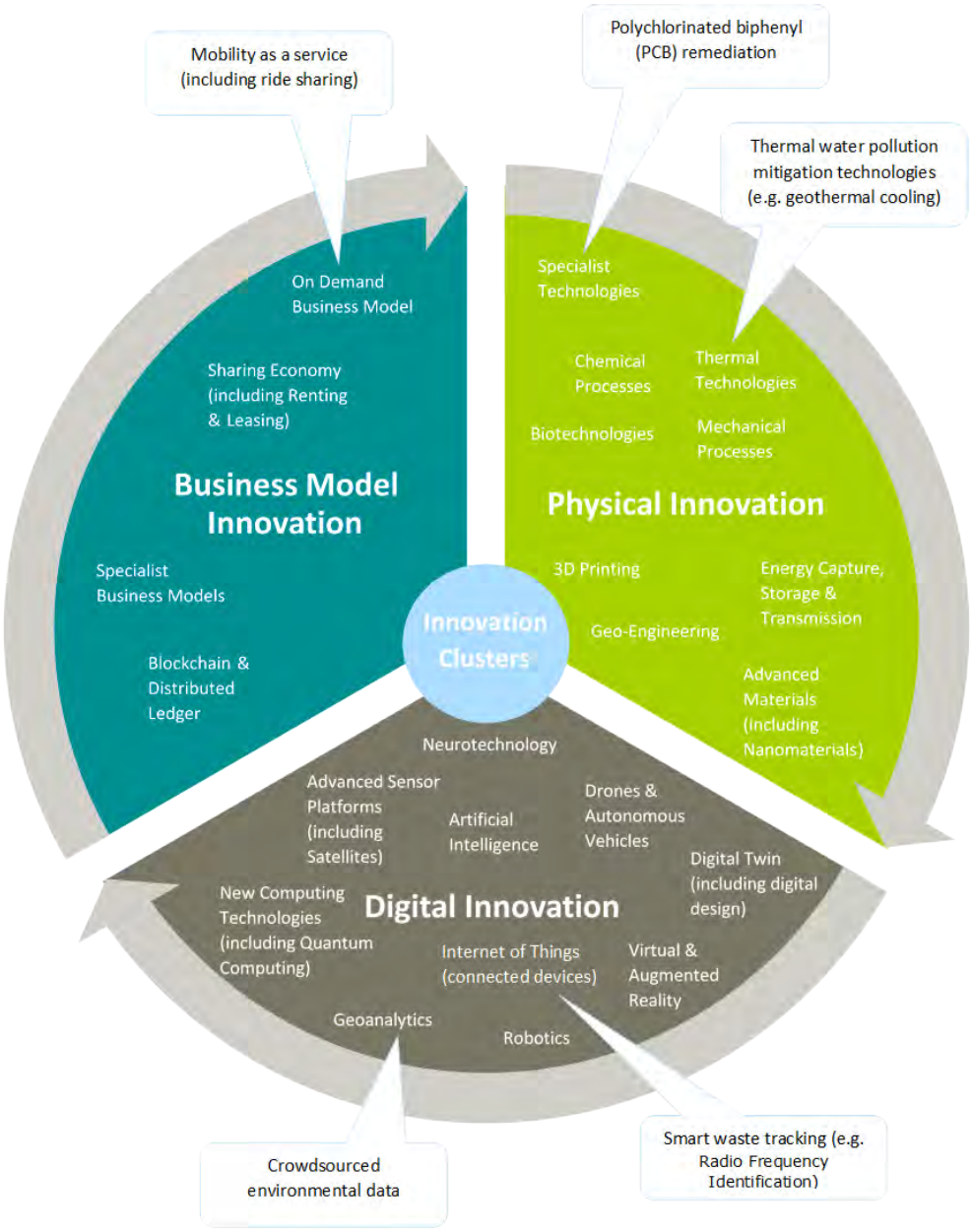

Figure 6: Innovation cluster classification for the 25 YEP targets

3.3 Snapshot of potential technology and service innovations required to fully deliver the selected 25 YEP goals and targets

A picture of the potential need for, and examples of, relevant technology and service innovations has been built up in relation to each of the selected 25 YEP targets. Appendix A provides a summary for each of the domains (i.e. the 25 YEP environmental goals plus the cross-cutting issue of spatial data analysis). In each case the evidence from this innovation audit (i.e. the online survey, focus groups and desktop research) has been summarised to inform an initial qualitative view and rationale about the current trajectory against the target bearing in mind policies, innovations and other actions that are already implemented or are planned/expected. The level of certainty attached to this view is provided, again with an accompanying rationale. Some of the potential innovative technologies and services that are perceived to have the greatest potential to contribute to meeting any gap are then identified.

Table 3.1 provides the picture together across all of the domains investigated, drawing upon the tables in Appendix A. Based on this initial analysis, there are a number of 25 YEP targets that are considered to be largely on track without, obvious significant uncertainty, providing that the existing and planned array of policies, technologies and other actions are followed through. However, in every domain there is at least one target or area in which some gap is expected such that it would be relevant to consider how additional innovative technologies, services and business models can contribute.

Table 3.1: Snapshot of the potential "innovation gap" between the current trajectory and what is required to fully meet the selected 25 YEP goals and targets

25 YEP Goal	Innovation gap snapshot (taking account of the current trajectory & level of certainty against stated targets)	Rationale	Examples of potential innovations that could contribute to meeting 25 YEP targets[12].
Spatial Data Analysis	Some gap expected	This potential gap is associated with the use of spatial data for using natural resources (i.e. doubling productivity) where existing data, analytical metrics and management arrangements are insufficient for managing natural capital (and net gain).	Blockchain; Sensors; AI & machine learning; Data optimisation
Clean Air	Some gap expected	This potential gap is associated with the target of "meeting legally binding targets to reduce emissions of…" ammonia and PM2.5 and the intended outcome to "halve the effects of air pollution on health by 2030" where diverse actions and system level changes are expected to be required.	Mobility as a service; cycling related innovations; diesel retrofit & repowering; sustainable biofuels; low emission tyres.
Clean & Plentiful Water	Some gap expected	This potential gap is most associated with the target to "reduce abstraction of water from rivers and groundwater" and to a lesser extent to "reach/exceed objectives for rivers, lakes, coastal and ground waters" and to "reduce water loss through leakage".	Agricultural AI applications for water use; greywater reuse solutions; remote leakage detection models; trenchless technology.
Using Resources from Nature more Sustainably & Efficiently	Some gap expected	This potential gap is associated with the target of "Maximising the value and benefits we get from our resources, doubling resource productivity by 2050" i.e. for food, fish and timber.	Cross Laminated Timber production; GPS soil sampling; Aquaponics; Gene Editing for crops; Remote ecosystem monitoring.
Minimising Waste	Some gap expected	This potential gap is associated with the targets to "Meet all existing waste targets" and to "eliminate waste crime and illegal waste sites" where progress has plateaued recently.	Industrial symbiosis; Landfill mining; Electronic and Radio frequency tracking; Fibre to fibre technology; Mechanical processing.
Managing Exposure to Chemicals	Some gap expected	The potential gap is associated with the targets to 'reduce land-based emissions of mercury to air and water by 50% by 2030'.	Nanotechnology; Bioremediation and microbial degradation; Copper Sorbents; Thermal desorption.

[12] Note: These examples are taken from the Appendix 1 Report cards. Please refer to these from more information.

3.4 The timing and urgency for innovations in technologies and services

The 25 YEP targets under consideration in this innovation audit are set against a range of timeframes. Some of the earliest date commitments in the plan include to "eliminate the use of Polychlorinated Biphenyls by 2025" as well as meeting existing legislative targets for the near future (in various domains). There are other targets set for 2030 with the remaining targets implicitly or explicitly being associated with the end of the plan period in 2042, or beyond as in the case of the target to double natural resource productivity by 2050.

As described in section 2.3, technological innovation can be time consuming though the actual time required for innovations to progress from fundamental research through to adoption (diffusion) across the target market varies widely. For example, large scale technological transformations such as the UK's adoption of natural gas/central heating and the establishment of wind power (Denmark and UK) have been identified as taking approximately 15 and 50 years respectively in recent research by Vivid Economics for the Aldersgate Group[13]. For new services and business models the lead time will tend to be much shorter and, in both cases, the underlying growth of digitalisation and automation now enables the development cycles to shorten in many cases.

In this innovation audit the potential technologies and services identified to contribute to fulfilling the 25 YEP fall into one of five stages as shown in Figure 7. This framework incorporates the established Technology Readiness Levels (TRLs) and beyond through initial market formation into the full growth and diffusion of the technology or service in relevant markets. It is critical to recognise these later stages for any innovation pathway, and in the case of meeting environmental goals and targets as in the 25 YEP there is a further complicating factor. That is, that the environmental outcomes, as measured by Defra's indicator set once fully developed, may in some cases take an additional period e.g. for natural resources to recover or for health benefits of cleaner air to fully benefit populations with relevant extant health problems.

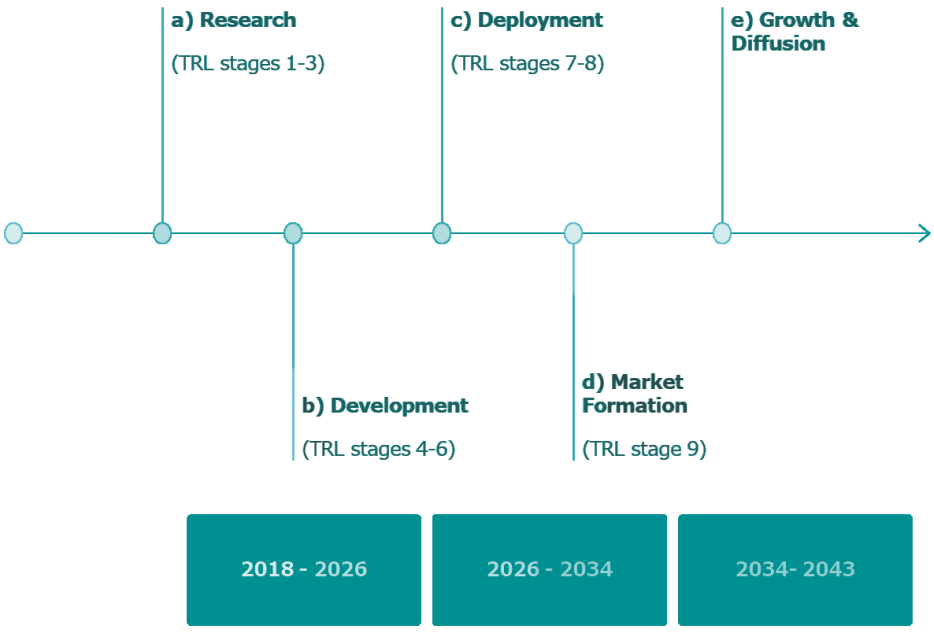

Figure 7: The five stages of innovation and full market diffusion alongside three illustrative 25 YEP periods (source: adapted from Gross et al and Vivid Economics)

[13] http://www.vivideconomics.com/wp-content/uploads/2019/04/Accelerating-innovation-towards-net-zero-emissions.pdf

4. CONCLUSIONS

Four main conclusions have emerged from this work. The evidence base assembled in this rapid innovation audit is only partial and there is no doubt that other ideas will develop as the work continues and more stakeholders from across the environmental industry engage with the topic.

Conclusion 1: There is a need identified for additional action to close the gap between the 25 YEP targets and the changes that are already in place or planned. Whilst this need is perceived to be minor or none for many of the targets, this conclusion does apply across at least one of the targets in all seven environmental domains investigated.

Conclusion 2: Innovation in technologies and services/business models is perceived as an important factor in helping to close this gap to deliver the 25 YEP targets, though this is felt to be not quite as important as changes in policy and legislation. The close ranking of these two factors (first and second of four survey choices) suggests that the timeframes and system-wide implications of fully achieving many of the 25 YEP targets lends itself to a combined approach with appropriate regulation and incentives (or disincentives) to draw through relevant innovations. The "wedges approach" (described in Section 1.5) or similar methodologies may be useful in exploring and communicating the relationship between technological and other innovation breakthroughs alongside other measures.

Conclusion 3: There are a myriad of possible technological and service solutions that could contribute positively to closing the gap against specific targets. There are also a number of generic types of innovation (i.e. innovation clusters) that are likely to provide a common platform for addressing multiple environmental targets. Innovative solutions that are cross-cutting and/or disruptive (e.g. Mobility as a Service and circular economy-based models) may provide some of the most significant contributions to the 25 YEP but will require concerted effort (e.g. to remove unintended barriers in terms of regulations, standards and incentives).

Conclusion 4: There is real urgency to act if additional innovative technologies and services are to be unlocked in time to contribute to meeting the 25 YEP targets. This is due to three factors: i) the pathways involved in achieving the ultimate environmental (and health) outcomes associated with the 25 YEP goals and targets; ii) the need for transformational system change in some domains; and iii) the timeframes involved in taking innovations from research/ development/deployment into formation of and diffusion across markets. The UK's adoption of a net zero target for greenhouse gas emissions by 2050 is likely to be a helpful catalyst for accelerating 25 YEP targets although in some areas (e.g. clean air, waste and natural resource productivity) the inter-relationships need to be better understood so that the implications for meeting goals/targets at different times can be managed.

5. ACKNOWLEDGEMENTS

This work has been funded by UKRI. UKRI brings together the UK Research Councils, Innovate UK and Research England. Thanks also to the edieLIVE team and the many EIC member organisations and stakeholders who have contributed to this work to date, including through the online survey. Particular thanks to those who joined the focus groups including:

Amey, Anthesis, Big Atom, British Retail Consortium, CIWM, Env23, Indaver, Groundsure, Jacobs, Landmark, Mott Macdonald, Ramboll, SLR, Sustainability West Midlands and Veolia.

For any further information about the work please get in touch with Matthew Farrow at the EIC via matthew.farrow@eic-uk.co.uk

APPENDIX A: INNOVATION ANALYSIS FOR EACH ENVIRONMENTAL DOMAIN

Spatial Data

We will explore ways in which national spatial data and geospatial data strategies could support and improve benefits achieved through environmental net gain...

There is no specific target or goal relating to data within the 25 YEP however spatial and geospatial data underpins and can help contribute to progress against all goals.

25 YEP Target	Current trajectory	Rationale	Level of certainty	Rationale
Spatial data for Clean Air	On Track	Legacy data and current data is readily available to help achieve this goal however there are ongoing issues with: • inconsistency in data and disaggregation issues when analysing data across various spatial scales; • ownership of data; • lacking national mandate on data standards, metrics and format; • lack of funding nationally to develop new ways of managing data and communicating best practice; • lack of systematic data sharing platforms to ensure performance data is shared across governmental departments and devolved administrations.	Medium	Uncertainty as to whether system change, funding and ownership pathways will be established in time to support uptake of the relevant technology and innovation.
Spatial data for clean and plentiful water	On Track	Legacy data and current data is readily available to help achieve this goal however there are ongoing issues with: • data sharing and interplay between institutional arrangements within the UK; • identifying priority services for vulnerable groups within the UK and ensuring services are tailored and delivered effectively; • creating a code of practice across the industry; • ensuring contribution from devolved authorities;	Medium	Uncertainty as to whether system change, funding and ownership pathways will be established in time to support uptake of the relevant technology and innovation.

Spatial data for using resources	Missing	Some legacy data and current data is available to help with this goal and future funding is available for supporting innovation e.g. Communitree programme which aims to build an urban tree map, however there are ongoing issues with: • robustness of decisions and outputs from current data in the ability to measure net gain; • establishment of sufficient data to understand the current state of soil heath; • lack of readily available data on the state of the UK's natural capital and extent of priority habitats; • ownership of data; • lacking national mandate on data standards, metrics and format; • lack of funding nationally to develop new ways of managing and sharing data and communicating best practice	Medium	Uncertainty as to whether system change, funding and ownership pathways will be established in time to support uptake of the relevant technology and innovation.
Spatial data for climate change	On Track	Legacy data and current data is available to help with this goal however there are ongoing issues with: • availability of high resolution data; • lack of funding nationally to develop new ways of managing and sharing data and communicating best practice across governmental departments and devolved administrations. • Ownership of data;	Medium	Uncertainty as to whether system change, funding and ownership pathways will be established in time to support uptake of the relevant technology and innovation.
Spatial data for minimising waste	On Track	Legacy data and current data is available to help with this goal however there are ongoing issues with: • inconsistency in data across various spatial scales; • ownership of data; • creating a code of practice across the industry; • Ensuring contribution from devolved authorities;	Medium	Uncertainty as to whether system change, funding and ownership pathways will be established in time to support uptake of the relevant technology and innovation.

Spatial data for managing chemicals exposure	On Track	Legacy data and current data is available to help with this goal. This goal is mainly policy and legislation driven and long term monitoring and registration of chemicals is undertaken.	Medium	Uncertainty as to whether system change, funding and ownership pathways will be established in time to support uptake of the relevant technology and innovation.

Innovative technologies & services that could contribute towards better management and use of spatial data

- Blockchain technology
- AI and Machine learning
- Smart city infrastructure
- Digital twins
- Cloud computing solutions
- Data optimisation
- Improved sensors
- Open data
- Crowdsourced data
- 3D city digital models
- Open source software

Clean Air

We will achieve clean air by...

25 YEP Target	Current trajectory	Rationale	Level of certainty	Rationale
Meeting legally binding targets to reduce emissions of five damaging air pollutants; this should halve the effects of air pollution on health by 2030	**Overall - Missing** **(PM2.5, NH3 – Missing;** **NOx, SO2, VOC - On Track)**	• The Clean Air Strategy[1] was published in January 2019 and measures are identified for reducing emissions to meet legally binding targets by 2030 for some of the pollutants. • Section 10 of the Strategy shows what the actions are expected to achieve in reducing emissions and for what pollutants additional action is required. Further evidence is also required, for example the publication of evidence on how the UK can meet the WHO guideline value of 10µg/m3 PM2.5 due in Spring 2019 has not yet been published. • NH3 (Ammonia) emissions have risen recently. The main UK sources are associated with agriculture which may require significant changes to long standing practices.	**Low**	The UK, and other countries, have failed to meet legally binding targets for air quality in the past. Some of the key challenges are: (i) the diverse range of point and diffuse sources and their atmospheric interactions (e.g. CH3 contributing to PM2.5 in the atmosphere). (ii) implementation & enforcement across the diverse emissions sources. (iii) cost and the degree of systemic change required in some areas.
Ending the sale of new conventional petrol and diesel cars and vans by 2040	**On Track**	• The timeframe for this target is less ambitious than in some jurisdictions (e.g. London) though plug in hybrid and battery electric vehicles (EVs) represent only c.3% of new car sales • Much of the global automotive industry is already adopting production of EVs and other alternative vehicles	**Medium**	Uncertainty relates to the coverage of supporting infrastructure to enable 100% of all types of cars and vans to comply.

[1] Online version: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf

		• Significant work is required to provide the infrastructure to support 100% sale of EV and other low carbon alternative fuels			
Maintaining the continuous improvement in industrial emissions by building on existing good practice and the successful regulatory framework	**On Track**	• The Integrated Pollution Prevention & Control regulatory regime for industrial emissions, is well established and has effectively controlled and reduced emissions. The industry works to Best Available Techniques (BAT) Reference notes (known as BREF notes) which outline the current as well as emerging techniques of relevance to each industrial/agricultural sector.	**Low**	Uncertainty is associated with the change from an EU-led approach to the post Brexit arrangements (i.e. the regulatory regime and capacity to identify and adopt BAT).	

Innovative technologies & services that could contribute towards the clean air target

- Electric vehicles / hybrid vehicles / lug in hybrid electric vehicles (PHEV'S) / range extended electric vehicles
- Connected and autonomous vehicles including the use of digitally simulated environments
- Autonomous aerial and marine transport
- Ride hailing services, ride sharing and MAAS (mobility as a service)
- Vehicle to grid charging
- Low-Emission Tyres
- Real-time vehicle emissions control (e.g. hybrid engine switching in polluted areas)
- Telematics
- QED
- Battery technology for EV cars / smart grid technology for EV cars
- Refuelling infrastructure for hydrogen
- Energy harvesting
- Barriers combining a design for enhanced air dispersion with photocatalytic treatment (plus noise attenuation)
- NRMM Fuel changes and retrofit tech
- NRMM environmental emission permits
- Brizi
- Green Biofuels
- Photocatalytic surface treatments (including Titanium Dioxide) for the abatement of NOx

- Diesel retrofit technologies including particulate filters, selective catalytic reduction (SCR) systems and ammonia generators e.g. for buses and trucks
- Diesel Euro VI System Repower e.g. for buses
- Battery Electric Repower e.g. buses & HGVs
- LPG Conversion and Repower e.g. for taxis
- Bicycle & cycling infrastructure technologies to improve safe cycling use

Water

We will achieve clean and plentiful water by...

25 YEP Target	Current trajectory	Rationale	Level of certainty	Rationale
Reduce abstraction of water from rivers and groundwater	**Missing**	Per-capita consumption of water has decreased since 1999 but has plateaued in recent years. Metering penetration has been gradually increasing across water companies. Water companies have, on average, forecasted a reduction to 123 litres per person per day by 2045 (down from present 141 l/p/d)	**Low**	Unclear whether water companies will meet their forecasted targets and there is a large variation in targets between companies.
Reach/exceed objectives for rivers, lakes, coastal and ground waters	**Missing**	Nearly 50% of groundwater bodies will not reach good chemical status by 2021. 86% of UK rivers do not meet good ecological standard. Pollutant loads to rivers from industry have declined significantly since 1995 however.1	**Medium**	Standards for acceptable nitrate levels in UK drinking water may be too low – percentage of water bodies complying to standards sensitive to this.2
Reduce water loss through leakage	**Missing**	Water companies often fail to meet their leakage reduction targets. Water industry committed to halve leakage by 2050, but national reductions in leakage have stalled in recent years, according to Ofwat[3]. Poor weather conditions and lack of preparation for extreme weather events. Aging infrastructure and lack of implemented leakage reduction technology exacerbates problem.	**Medium**	Ofwat keeps track of estimated leakage with audits. Some leakages may fall outside of water companies' distribution networks and are more difficult to monitor and repair.

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/709493/State_of_the_environment_water_quality_report.pdf
[2] https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/656/65605.htm
[3] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766894/water-conservation-report-2018.pdf

Minimise bacteria in our designated bathing waters	**On track**	Percentage of designated waters meeting minimum standards for bathing has decreased marginally in past two years but remains high (97.9% in 2018).4 New 'Farming Rules for Water' policy introduced by DEFRA in 2018	**Medium**	Environment agency monitors designated bathing waters for changes in quality standards. Effectiveness of new legislation yet to be determined.

Innovative technologies & services that could contribute towards the water targets

- Thermal Hydrolysis for waste water treatment
- Agricultural AI applications to apply algorithms to data on atmospheric conditions and soil moisture to reduce the amount of water needed for agriculture
- Advanced leakage detection using machine learning
- Phosphorus stewardship
- Nutrient trading
- Information database for water resources
- Development of polymers to tackle PFAS pollution
- Water and circular economy
- Remote water leak detection
- Improved permeable pavements
- Blue-Green Infrastructure
- Greywater re-use solutions
- Trenchless technology
- Runoff thermal mitigation strategies

[4] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/763499/EMBARGOED_STATS_bathing-water-release-revised20182.pdf

Resources

We will use resources from nature more sustainably and efficiently...

25 YEP Target	Current trajectory	Rationale	Level of certainty	Rationale
Maximising the value and benefits we get from our resources, doubling resource productivity by 2050	**Missing**	• Agriculture bill and fishing bill are in progress but not yet fully passed; both should provide framework for increased sustainability in both fields but level of uncertainty over agriculture and fisheries still exists given the context of Brexit. • These two fields are under an especially large amount of pressure given an exponentially increasing population. • Regarding fisheries the monitoring technology needs to be wider implemented before true sustainability can be reached. • Currently the level of technology is not sophisticated or widely enough implemented to achieve the target in the timeframe given. • Regarding soil there has been progress towards legislation that could make a large difference but once again until clear evidential change can be seen in replenishing peatland soils it is uncertain that the target will be met. • There have been vast improvements in soil technology however and instruments such as a cosmic ray neutron sensor to detect soil moisture can be used to increase the longevity of soil and monitor when it needs to be left to replenish nutrients. However once again this is being used more elsewhere in the world and is yet to be implemented properly in the UK as an aid to soil fertility preservation. • Absence of data on the state of the UK's natural capital. • The woodland areas of the UK can be preserved better and protected from issues such as the spreading of lethal fungi or illegal logging, this could be done a lot easier with efficient and accurate remote sensory technology. This is not currently one of the government's main forms of action against depletion of woodland sources however; and isn't specified in the 25-year environment plan.	**Medium**	Most of the uncertainty based around the meeting of the target is due to bills and technology not being employed on a wide enough or extreme scale. In all of the aspects of the target there is technology that could make a real difference when trying to fully utilise and preserve the UK's natural capital, but currently investment is lacking.

Innovative technologies & services that could contribute towards the resources targets

- Precision Farming
- CRISPR-Cas9 gene editing for crops
- Soil metrics
- Alternative low carbon liquid fuels
- Natural capital assessment in comparative options assessment
- Reducing risks from low concentrations of asbestos fibres in soil
- Cross Laminated Timber
- Ship to Shore Power
- VMS (Vessel Monitoring Systems)
- Skyview Robotics aerial UAVs
- Cosmic Ray Neutron Sensor for Soil moisture mapping
- GPS soil sampling
- Sustainable retail models
- Aquaponics
- Remote ecosystem monitoring

Waste

We will minimise waste by...

25 YEP Target	Current trajectory	Rationale	Level of certainty	Rationale
Zero avoidable waste by 2050	**On Track**	• Progress on the provision of environmental legislation and strategy encompassing waste management e.g. Our Waste, Our Resources Strategy for England[1]; • Opportunities post Brexit for strengthening and enhancing waste legislation; • Progress on the development of Industrial Strategy Challenge funds to support the delivery of innovative technologies in terms of improving efficiency, cost and effectiveness of existing technologies and developing novel solutions; • Progress in developing industry 'pacts' and raising consumer awareness; • Development of Deposit Return Schemes; • Progress on promoting a move to a circular economy through the Industrial Strategy.	**Low**	Zero avoidable waste definition is currently being formulated alongside The Green Construction Board[1] therefore there is uncertainty currently around the target's scope. Uncertainty on potential future progress against the goal due to current lack of a collaborative approach to waste management across devolved authorities. There are currently a number of barriers to innovation and it is unsure whether these will hinder progress on the current trajectory. The main barriers are: (i) the cost of primary vs. secondary materials; (ii) difficulty in accessing financing and capital investment; (iii) public engagement and awareness; (iv) financial reporting procedures, which often do not prioritise and promote circular business models.

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/765914/resources-waste-strategy-dec-2018.pdf

Eliminate avoidable plastic waste by end of 2042	**On Track**	• Progress on the provision of environmental legislation encompassing waste management e.g. Our Waste, Our Resources Strategy for England. • Extended UK packaging producer responsibility opportunities post Brexit for strengthening and enhancing waste legislation. • Progress on delivering UK government led consultation on household and business recycling in England, Wales and Northern Ireland. • Progress on the development of Industrial Strategy Challenge funds to support the delivery of innovative technologies in terms of improving efficiency, cost and effectiveness of existing technologies and developing novel solutions. • Progress in developing industry 'pacts' and raising consumer awareness. • Development of the Plastics Industry Recycling Action Plan" (PIRAP), an industry action plan which includes: increased collection of recyclable plastics; improve sorting; and developing end markets for recycled plastics. • Development of Deposit Return Schemes	**Low**	Lack of clarity around standards that define the biodegradability of compostable or biodegradable plastics[2]. Uncertainty on potential future progress against the goal due to current lack of a collaborative approach to waste management across devolved authorities. Lack of a sufficient definition of what is included within the scope of the 25 YEP definition of 'Technically, Environmentally and Economically Practicable'.
Meet all existing waste targets	**Missing**	• Progress in meeting the existing waste targets is starting to plateau.	**Low**	Uncertainty on potential future progress against the goal due to current lack of a collaborative approach to waste management across devolved authorities.

2 http://www.wrap.org.uk/sites/files/wrap/Understanding%20plastic%20packaging%20FINAL.pdf

Eliminate waste crime and illegal waste sites	**Missing**	• Stagnated and limited progress due to the lack of funding available. This specifically impacts progress of SME's and has led to stifled innovation. • Digital recording and tracking of waste is not currently advanced enough to prevent the illegal dumping of waste. • Current lack of intelligence analysis and data sharing between enforcement agencies.	**Low**	Lack of intelligence data means it is difficult to predict the future trend trajectory. Uncertainty on potential future progress against the goal due to current lack of collaboration and consistency between devolved authorities at multiple spatial levels.
Significantly reduce / prevent all kinds of marine plastic pollution	**On Track**	• Progress on the UK government providing signatory to international agreements such as the Commonwealth Clean Oceans Initiative aimed at reducing plastic in the marine environment • Progress on the provision of environmental legislation encompassing waste management e.g. proposal for a Directive on the reduction of the impact of certain plastic on the environment and opportunities post Brexit for strengthening and enhancing waste legislation. • Progress in developing industry 'pacts' and raising consumer awareness.	**Medium**	No specific target set by the 25 YEP

Innovative technologies & services that could contribute towards the waste targets

- CHP enabled energy from waste
- Implementing collection infrastructure to increase segregation of materials for recycling (this has been shown to be a key component in decarbonising the waste sector)
- Industrial symbiosis
- Anaerobic digestion - improve pre-treatment
- Anaerobic digestion - reduce costs and improve reliability of two stage processes
- Anaerobic digestion - improve biogas cleansing processes (mainly of corrosive H2S)
- Anaerobic digestion - increase the robustness of the thermophilic process
- Production of refuse derived fuel (RDF)
- Gasification focussed on steam raising using closed - coupled combustion technology
- Gasification focussed on cleaner syngas production
- Higher value products from pyrolysis
- Pyrolysis of end of life plastics

- Digestate Post-Processing options for improvement - hydro-thermal carbonisation
- Digestate Post-Processing options for improvement - product synthesis
- Landfill mining
- Petrochemical plastic free nappies
- Project Ceres
- POMAR - circular economy and resources
- Smart waste - radio frequency end of life tracking
- Fibre to fibre technology
- Lodestar pioneer project
- Pollywood natural tubes
- Robotic sorting techniques
- Product sharing services
- Waste pyrolysis
- Up cycling residual waste
- Extended Producer Responsibility & full net cost recovery
- Biodegradable polymers
- Fibre to fibre technology
- Chemical treatment
- Hydro-thermal carbonisation
- Mechanical processing

Chemicals

We will manage exposure to chemicals...

25 YEP Target	Current trajectory	Rationale	Level of certainty	Rationale
Eliminate the use of Polychlorinated Biphenyls by 2025	**On track**	• Significant progress has been made since 1990 to reduce emissions from PCBs by interventions such as increasing controls on industrial processes, safe disposal. The UK's latest National Implementation Plan to the Convention indicates that PCB emissions had reduced by 97% from 1990 levels[1]. • UK is a party to the Stockholm Convention can no longer produce PCBs and are obliged to stop using this chemical however existing equipment that contains PCBs may continue to be used until 2025. • Environment Agency has progressed working with companies to establish more accurate PCB records and arrange disposal plans. • Although PCBs have not been manufactured and used in the UK for many decades, old PCB-containing equipment continues to exist. • Progress on the provision of environmental legislation and strategy including the development of a UK Chemical's strategy to set out the approach post the UK leaving the EU.	**Medium**	Whilst there is significant legislation based around the reduction and elimination of PCBs and POP use; however these plans are given an element of uncertainty given the possible ramifications of the UK leaving the EU.

[1] https://consult.defra.gov.uk/eu-environment/uk-nip-for-stockholm-convention-on-pops-2017/supporting_documents/UK%20National%20Implemention%20Plan%20for%20the%20Stockholm%20Convention%20on%20POPs%202017.pdf

Reduce land-based emissions of mercury to air and water by 50% by 2030	**Missing**	• The EU has now taken all the necessary legislative measures to ratify the Minamata Convention. • The combustion sector is one of the largest emitters of mercury. Coal is a significant source of mercury to air, and emissions will fluctuate in line with coal usage at power stations, which coupled with projected population growth could create uncertainty in the ability of the UK to meet the goal unless the current uptake and availability of renewable fuels continues to improve. Mercury emissions will however be partially abated by both dust and sulphur dioxide abatement. • Heavy metal pollution in the marine environment is decreasing. The UK's biodiversity indicators shows that between 1990 to 2016, mercury levels have fallen by 90%[2].	**Medium**	Whilst given current levels of coal use the target is unlikely to be met; the probability of reducing land-based emissions in the next 30 years along through the use non-renewable fuel sources as well and the development of mercury removal and abatement technologies means the target could be met with the right commitment.
Substantially increase the amount of Persistent Organic Pollutants material being destroyed or irreversibly transformed by 2030	**On track**	• The Stockholm Convention on Persistent Organic Pollutants (POPs) entered into force on 17 May 2004. • REACH regulation and authorisation of specific POP production and use has increased knowledge of POP material being used, destroyed and irreversibly transformed. • Progress on the development of the UK multi vector source inventories and release estimates. • Progress on the provision of environmental legislation and strategy including the development of a UK Chemical's strategy to set out the approach post the UK leaving the EU.	**Medium**	Lack of a sufficient definition for 'substantially increase' therefore uncertain scope for the target. Whilst there is significant legislation based around the reduction and elimination of PCBs and POP use; however these plans are given an element of uncertainty given the possible ramifications of the UK leaving the EU.
Fulfil our commitments under the Stockholm Convention	**On track**		**Medium**	

[2] https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/980/980.pdf

Innovative technologies & services that could contribute towards the chemicals targets

- Nanotechnology
- Mercury Pollution and Bioremediation technologies
- Chemical recycling of plastics
- Artificial Intelligence and cognitive technology
- DME - digital manufactured enterprise
- Machine learning
- 3D printing
- Bio based chemical development
- Chemical recycling
- Exhaust gas treatment devices
- Brominated Flame Retardents
- PCB de-chlorination processing
- Copper sorbents
- Thermal desorption
- Bioremediation and microbial degradation

Environmental Industries Commission
Alliance House, 12 Caxton Street
London, SW1H 0QL

T: 020 7222 4148

info@eic-uk.co.uk
www.eic-uk.co.uk
Follow us on twitter – @EIC_Updates