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# A Mission-Oriented UK Industrial Strategy

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UCL Commission for Mission-Oriented  
Innovation and Industrial Strategy (MOIIS)

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May 2019



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# Institute for Innovation and Public Purpose

The mission of the UCL Institute for Innovation and Public Purpose (IIPP) is to change how public value is imagined, practiced and evaluated to tackle societal challenges — delivering economic growth that is innovation-led, sustainable and inclusive.

Growth has not only a rate but also a direction: IIPP confronts this directionality head on. Finding solutions to global challenges requires purposeful organisations to collaborate in fundamentally new ways — across the state, businesses and civil society. Together, they can help reshape markets to produce growth that delivers public value. Building symbiotic eco-systems requires new tools and new forms of collaboration.

IIPP rethinks the role of the state in these collaborations. Rather than just a market-fixer, it can be an active co-creator of value. A mission-oriented approach can be used to set inspirational goals, with dynamic tools — from procurement to prize schemes — to nurture bottom-up experimentation and exploration across different sectors. IIPP's research and teaching helps create the new economic thinking and practical tools to make this a reality.

IIPP is a department within University College London (UCL) — founded in 1826 to solve grand challenges — and part of The Bartlett faculty, known internationally for its radical thinking about space, design and sustainability.





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## What is the MOIIS Commission?

The UCL Commission on **Mission-Oriented Innovation and Industrial Strategy (MOIIS)** was formed in March 2018 to advise the government on how to implement an industrial strategy that identifies the need for innovation and technology to be used to solve grand challenges. MOIIS has considered the four Grand Challenges (Clean Growth, AI and Data Economy, Future of Mobility and Ageing Society) identified in the Government's Industrial Strategy white paper through the lens of the mission-oriented innovation framework, identifying relevant cross-sectoral actors, bottom-up projects, and paths to delivery. Appendix D explains how we worked.

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The MOIIS Commission is chaired by:

- Prof Mariana Mazzucato, Professor in the Economics of Innovation and Public Value, Director, Institute for Innovation and Public Purpose, UCL
- Rt Hon Lord David Willetts FRS, President, Resolution Foundation

The MOIIS Commissioners are: *(in alphabetical order)*

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- Theo Blackwell MBE, Chief Digital Officer, Greater London Authority
- Mike Bracken, Founder/Partner, Public Digital
- Prof Brian Collins CB, FREng, Deputy Convenor of UK Collaboratorium for Research in Infrastructure and Cities (UKCRIC) and Professor of Engineering Policy, UCL
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The MOIIS Commission is hosted by the UCL Institute for Innovation and Public Purpose (IIPP) and also supported by UCL Public Policy. MOIIS was coordinated by Dr George Dibb, Head of Industrial Strategy & Policy Engagement, IIPP.

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# Foreword

by Professor Mariana Mazzucato and Lord David Willetts, co-chairs of the MOIIS Commission

The Commission for Mission-Oriented Innovation and Industrial Strategy (MOIIS), which we co-chair, has been working for the last 14 months helping to formulate a mission-oriented approach to the four Grand Challenges in the UK Industrial Strategy: Clean Growth, the Future of Mobility, an Ageing Society, and the AI & Data Economy.

The competitiveness of the UK depends on the quality of the goods and services it produces. This is fundamentally linked to the technological, institutional and organisational innovations that transform production, distribution and consumption. Linking an industrial strategy to such a system-wide transformation is key.

The founding principle of the MOIIS Commission is that industrial strategy is most effective when it can help galvanise different actors and sectors across the economy to work together to solve problems. We call those problems 'missions'. Like going to the Moon, a mission is either achieved or it is not, but how you achieved it matters just as much. Today's missions are just as much social as they are technological, which means that using industrial policy to tackle the challenges around climate change, inequality and care is central to their success.

Technological innovation requires innovation systems to be in place, with funding and structures across basic research, applied research, and patient finance for companies willing and able to innovate. It also requires demand-side policies that act as funnels for diffusion and deployment. Horizontal policies around research, education and skills are required, but so too are vertical policies. The work of MOIIS on missions radically reimagines the vertical element to be focused on concrete problems that require inter-sectoral, inter-actor and inter-disciplinary solutions.

Missions are not a replacement for support to sectors and technologies. The work we have done on challenges and missions again shows that there is a distinct role for public agencies in supporting sectoral capabilities and, in particular, general purpose technologies in their long journey to market and before their main applications are clear. This must be done in parallel with a challenge-based approach. This is a precondition of its success because, otherwise, there will not be the underlying technological and sectoral capacity on which to draw in order to deliver challenges and missions – America had been developing rockets before President Kennedy defined the mission of getting to the Moon. But the focus of our group and this report is on how best to design challenges and missions.

A mission-oriented approach is not a top-down process. It means fostering dynamic engagement across society on the key challenges that a country faces. It requires government instruments, from procurement to prize schemes, to nurture multiple solutions to solving those challenges.

We can learn from history. Multiple organisations and sectors worked together to try and achieve the mission of enabling satellites in space to communicate. The outcome was the internet. It built on fundamental capabilities (technological and organisational) – leading to a general purpose technology – that were outcomes of cumulative investments over time. Today's challenges are not just technological but also social, involving political, regulatory and behavioural changes. Using a mission-oriented approach to help technology meet such social challenges is the key remit of MOIIS.



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We did not work on every part of industrial strategy, such as the detailed role of catapults or sector deals. Instead, our work was focused on how to use a challenge-based approach to drive innovation and industrial change alongside horizontal policies aimed at advancing education, skills, research, technological and sectoral capabilities. MOIIS met regularly with BEIS and other government departments over the last 14 months to ensure the challenge-based strategy is understood as an inter-departmental one. The HM Treasury (HMT) worked with us to consider what a mission-oriented approach implies for the evaluation of public investments. The Department of Transport hosted a meeting that asked how standards might evolve to reflect a mission-oriented lens.

Our MOIIS report is just the beginning of what we hope to be an ongoing conversation and practice-based learning. The UCL Institute for Innovation and Public Purpose (IIPP) hosted and funded the Commission and will continue to dedicate its resources and global networks to aid the government with a mission-oriented approach. Regardless of whether the UK remains inside or outside of the European Union, its future competitiveness will depend on its ability to foster technological, institutional and organisational changes needed to drive a 21st-century economy. We hope this report helps frame the boldness and the instruments needed for an economic transformation that is as inspirational as it is practical.



**Professor Mariana Mazzucato**  
Founder and Director, UCL Institute for  
Innovation and Public Purpose



**Rt Hon Lord David Willetts FRS,**  
President, Resolution Foundation



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# 1 Introduction and summary recommendations

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## 1.1 A vision for mission-driven growth

Innovation is a key driver of long-term growth. But innovation for what purpose? The most powerful way to shape how innovation benefits society is to change what it is for. The 2017 UK Industrial Strategy presents an opportunity to harness not only our science, technology, arts and industry, but our infrastructure, workforce, and business environment, to drive growth and prosperity to meet societal challenges.

The Industrial Strategy must be supported in the long-term, and this is the moment to reinforce it. ‘Mission possible’ means achieving the goals whilst taking the process and implementation just as seriously.

The United Kingdom stands at an economic cross-roads. British industry faces the substantial obstacles of sluggish growth and productivity. The UK will likely leave the European Union and could face losing access to science funding and key innovation collaborations. At the same time, technologies and innovation can offer solutions to challenges new and old. From clean technologies to self-driving cars, innovation can help us live more sustainable, healthier, and longer lives. The Industrial Strategy is an opportunity to exploit the UK’s competitive advantages and to strategically use every instrument at the disposal of the public and private sectors to support this endeavour. Citizens must be genuinely involved in the needed transition – it cannot be handed down from above.

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What is the best way of structuring this programme of intervention and investment? We believe that by targeting the Industrial Strategy towards missions, it can help steer innovation in the direction of solving societal challenges, as well as generating economic growth, wellbeing and technological spill-overs. The history of innovation teaches us that one way in which technologies as radical as the Internet and GPS came about was as spill-overs along the way to solving a problem. Therefore, as well as investing in science research and technology, government also has a role to play in identifying key societal challenges. This requires new collaborations across and among different sectors, agencies, and disciplines, alongside support for the technologies which will come together to solve these challenges. A mission-led approach must also focus on both supply-side and demand-side factors and for supporting the general purpose technologies that will make solving tomorrows problems possible.

How can this be done? This report sets out a model of how the Industrial Strategy can be structured to bring together these concepts. We need to:

- Use the Industrial Strategy to set cross-sector missions to solve systemic and societal problems
- Build an innovation ecosystem that allows us to support the development of science and technology

Implementing this new, government-wide approach to innovation and Industrial Strategy requires a different policy framework. This will require new ways of working and new capabilities within the public sector. This report sets out what needs to change to implement these recommendations, identifying eight groups of implementation steps for how the Industrial Strategy can:

- Steer the direction of innovation-led economic growth
- Drive the UK's international competitiveness
- Solve grand challenges through cross-sectoral missions
- Support systematically the development of science, technology and the arts
- Nurture sectoral capabilities and absorptive capacity
- Invest in public sector capabilities and work across government
- Connect with citizens, mobilising social and behavioural change
- Leverage and crowd-in other forms of investment.

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### **How to read this report**

The MOIIS Commission makes eight top-level recommendations to government, which spell out how the Industrial Strategy should evolve to deliver innovation-led growth that solves key societal challenges. Each recommendation has a corresponding group of 'implementation steps'. The recommendations and implementation steps are summarised in Part 1 of this report. They are also set out in more detail throughout, and are numbered in the order they appear logically in the text.

Part 2 of this report describes what a mission-oriented industrial strategy is and how it can deliver economic growth while developing solutions to societal challenges. Part 3 presents worked examples of how missions within each of the four Grand Challenges identified by the government can be delivered. Part 4 looks at different structures, agencies, and instruments the government will need to deploy to implement this bold new approach to industrial strategy.

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## 1.2 Eight key recommendations

The UCL Commission on Mission-Oriented Innovation and Industrial Strategy (MOIIS) has set out the following recommendations on how to achieve an industrial strategy that leads to innovation-led growth, with a focus on grand challenges. The UK's Industrial Strategy should:

### Steer the direction of innovation-led economic growth

A challenge-oriented industrial strategy can help achieve an economy that is more inclusive, sustainable, and driven by innovation. By structuring policy to deliver economic spill-overs and harness technological advances, it can also help deliver ambitions in research and innovation, such as the government's target to increase R&D spending to 2.4 per cent of GDP by 2027. To do this, the approach and framework of the Industrial Strategy must be durable, forming a prominent part of the economic plan of this and any future government. **The Industrial Strategy must receive a full and ambitious settlement in spending reviews to ensure its longevity and success. (Recommendation 1)**

### Drive the UK's international competitiveness

In an environment in which the UK is likely leaving the EU and facing broad economic challenges, this opportunity to put the UK at the forefront of strategic technology areas and solutions to global problems must not be missed. **The Industrial Strategy must be used to capture political and social imagination around an economic vision of progress and to drive the UK's future international competitiveness. (Recommendation 2)**

### Solve grand challenges through cross-sectoral missions

The framing of missions must provide a bold, targeted way to address challenges which bring together multiple sectors and stimulate bottom-up innovation. Formulating missions within the grand challenges is the best way to stimulate cross-sectoral innovation – technological, social, and creative – and to produce a definite roadmap for delivery. **Cross-sectoral missions must be developed and clearly prioritised with transparent delivery plans. (Recommendation 3)**

### Support sectoral capabilities and absorptive capacity

Intersectoral collaboration on missions must be built upon sectors that have the capacity to be at the forefront of organisational and technological changes and whose firms can recognise, respond to and shape those changes and develop appropriate business models to capture value from them. **It is essential for industrial policy to understand and address specific sectoral system failures that inhibit the ability of existing firms and potential entrants from shaping and capturing value from emerging technological and market opportunities. (Recommendation 4)**

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## Systemically support the development of science, technology and the arts

The Industrial Strategy must champion a dynamic innovation system, which includes support for strategic, applied and basic research, including institutions like Catapult centres that support technology development. It must also support general purpose technologies and capabilities needed for implementation and application of technology towards missions. **There must be a programme of support for general purpose technologies that complements a separate ambitious programme focusing on grand challenges and missions. (Recommendation 5)**

## Invest in public sector capabilities and work across government

A mission-oriented industrial strategy works best when it is implemented across all departments. By being cross-sectoral and inter-departmental, it can effectively foster and influence the way in which tools – from grants, loans and procurement policy – can be used to crowd-in bottom-up experimentation. This should include dedicated autonomous grand challenge teams which require dynamic capabilities. **The machinery of government must become more agile and work across silos between departments to take a new and innovative approach to industrial and innovation policy spurred by missions and grand challenges. (Recommendation 6)**

## Connect with citizens, mobilising social and behavioural change

Citizens must be engaged in the creation, selection, implementation, and assessment of missions to ensure that a mission-oriented industrial strategy solves problems that matter to them. An industrial strategy designed around grand challenges and support for general purpose technologies can capture the imagination of citizens and provide a framework to mobilise supporting social and behavioural change. **Government should use innovative technologies and the Grand Challenge programme to connect innovation to citizens and citizens to innovation. (Recommendation 7)**

## Leverage and crowd-in other forms of investment

An ambitious industrial strategy structured around solving grand challenges and stimulating technology development can increase business expectations of growth in new areas stimulating private sector investment, increasing wealth creation. **Catalytic public investments can leverage private-sector investments through a mission-oriented industrial strategy. (Recommendation 8)**

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## 1.3 Eight implementation steps

To adopt a new challenge-oriented and outcome-driven approach to industrial strategy, this report proposes action in the following areas and groups of implementation steps. The machinery, frameworks, and structures of government must change and adapt in the following ways:

### Steer the direction of innovation-led economic growth

The government should undertake a review of policy measures and instruments, and their potential to align with each of the Grand Challenges and missions, and to support general technology development. Alignment across government should include a systems-wide approach to fiscal and tax environment, regulation and standards, business investment and procurement.

**(Implementation step 14)**

To support the Industrial Strategy through demand-side stimulus, public procurement should be reformed across government to drive bottom-up innovation. This requires new dynamic metrics that go above and beyond short-term cost-effectiveness in procurement decisions.

**(Implementation step 18)**

BEIS and the HMT must develop alternative models of policy evaluation and appraisal that go beyond a cost-benefit approach. These methods must account for dynamic effects and go beyond conventional market-fixing methodology, allowing active market-shaping or market-creating through the Industrial Strategy to solve socio-economic Grand Challenges.

**(Implementation step 5)**

Systems modelling or systems mapping should be explored between BEIS and HMT as a framework for understanding, evaluating, and assessing policy interventions aimed at tackling Grand Challenges. **(Implementation step 6)**

The Industrial Strategy Council should be made a statutory body that can oversee and recommend policy to government and give longevity and consistency to the Industrial Strategy as a whole. **(Implementation step 11)**

The government should ensure that the remit of the Better Regulation Executive, and other relevant regulatory agencies recognises the important role of regulation in driving innovation through the Industrial Strategy. **(Implementation step 25)**

The development of Local Industrial Strategies should be taken as an opportunity to test and trial novel and strategically important Grand-Challenge-related technologies at a local level, giving them support on their route to national or international adoption. **(Implementation step 23)**



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## Drive the UK's international competitiveness

The Industrial Strategy should be used as a tool to make strategic interventions in the economy to drive UK competitiveness and, through market-opportunity creation, crowd-in different forms of finance (such as venture capital) into technology priority areas. **(Implementation step 21)**

## Solve grand challenges through cross-sectoral missions

The Industrial Strategy should aim to solve societal challenges by setting ambitious missions that work across sectors, actors and disciplines. Missions should have a greater level of granularity and specificity than the grand challenges. Missions should be designed to satisfy five key criteria – they should be: bold with societal relevance; measurable and time-bound; ambitious; cross-sector and cross-disciplinary; and generate bottom-up solutions among public, private and civil society organisations. **(Implementation step 1)**

Bold missions must not be watered down by siloed departmental thinking, and must work across departments. The existing missions should be further prioritised; more ambitious cross-sectoral missions, with firm measurable commitments should follow. **(Implementation step 2)**

## Systemically support the development of science, technology and the arts

Industrial Strategy Challenge Funds should be complemented by separate and parallel technology funding that is explicitly directed towards the support of emerging and early-stage technologies. Government must ensure that the pursuit of missions and Grand Challenges does not crowd-out technologies that are yet to link to missions. The government must have a clear strategy for both technology support and mission innovation. **(Implementation step 16)**

Innovation is not only about Science Technology Engineering and Maths (STEM) but also the Arts: STEAM. We recommend that the social sciences, humanities and creative arts are not only supported but central to ensuring that missions are framed as creatively and inspirationally as possible, helping citizens unleash their imagination of the future. **(Implementation step 3)**

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## Support sectoral capabilities and absorptive capacity

A mission-oriented approach works across sectors. This implies sector-specific capabilities and capacity to engage with technological opportunities (absorptive capacity). In light of experience with existing Sector Deals, the Industrial Strategy Council should undertake a review of policy measures and instruments to develop a granular approach to capacity development that is based on a detailed knowledge of business models, value chains and value capture in specific sectoral systems of innovation. **(Implementation step 4)**

We recommend much greater alignment of the UK's standards development with national policy to more effectively direct innovation in the Grand Challenge areas and extend the UK's influence internationally. Standards agencies should be equipped to undertake projects and trials of dynamic and agile standardisation and regulation to better drive innovation in rapidly developing technical areas. **(Implementation step 24)**

## Invest in public sector capabilities and work across government

To implement and deliver a mission-oriented industrial strategy, the Government should form multi-disciplinary, cross-departmentally-staffed, boundary-crossing Grand Challenge teams. These must be fully resourced, both in terms of funding but also in terms of leadership, staff, support and analytical capability, with operational autonomy to set their own goals and programmes, as well as senior reporting responsibility within government and the freedom to take initiative in a given challenge area. **(Implementation step 7)**

Missions require new dynamic public sector capabilities, such as the ability to experiment, explore and learn. We recommend the government consider the flexible and adaptable DARPA-style model. Not everything will work, nor should it be expected to. Risk aversion is the enemy of innovation. The DARPA portfolio approach welcomes risk-taking across the four Grand Challenge areas. **(Implementation step 8)**

Government should form advisory councils for each Grand Challenge recruited from senior levels of academia and industry, with the express purpose of communicating and inspiring politicians, policy-makers and the general public around the Challenges. **(Implementation step 9)**

Government should form technical teams based on each Grand Challenge to coordinate research and technical expertise to be drawn on by policy-makers, and to provide technology fore-sighting capabilities. Innovate UK needs to be properly resourced to act as a strategic driver of new technologies and promote the challenges and missions. **(Implementation step 10)**

Because missions are already framed in a time-bound and measurable manner, we recommend that the Industrial Strategy Council adopt the completion of missions as a key metric of success of the Grand Challenges Programme. Another metric should include the degree to which dynamic spill-overs to multiple sectors have occurred along the way. **(Implementation step 12)**

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## Connect with citizens, mobilising social and behavioural change

BEIS should, through external communications, explicitly demonstrate links between the bold top-level aspirations in the Grand Challenges and the missions, and the policy and spending commitments being announced from across government – including other departments and agencies such as Innovate UK and other funding bodies. **(Implementation step 17)**

Grand Challenges and missions must address society-wide issues and be accountable to citizen concerns. Models of co-creation, co-design, co-implementation, and co-evaluation should be developed upon international exemplars to ensure the legitimacy and longevity of missions. **(Implementation step 13)**

The government should clarify how the development of Local Industrial Strategies should speak to the aims of the Grand Challenges or aid the delivery of missions. **(Implementation step 22)**

## Leverage and crowd-in other forms of investment

Industrial Strategy Challenge Funds should be specifically targeted towards achieving missions and developing solutions to Grand Challenges. To this end, they should be designed such that they are outcomes-driven rather than technology-specific in order to aid the adoption of technological and behavioural change. **(Implementation step 15)**

The Industrial Strategy should align departmental innovation budgets with Industrial Strategy Challenge Funds and other funding streams to promote a challenge-based government-wide innovation budget. **(Implementation step 19)**

The Industrial Strategy can help align finance with the needs of investment-led growth. It is an opportunity to promote investment and innovation across the private sector. Innovation requires long-term, mission-oriented, patient finance. Lessons can be learned internationally, through the way in which public venture capital funds have operated, and/or lessons from public banks. The latter may require raising the capitalisation and reforming the remit of the British Business Bank. **(Implementation step 20)**



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## 2 Why a mission-oriented approach?

An Industrial Strategy that addresses bold challenges through missions can stimulate innovation, crowd-in private sector investment, and catalyse economy-wide, cross-sectoral transformation.

The Industrial Strategy not only deals with conventional horizontal economic foundations but also adopts a novel challenge-based approach. Four vertical 'Grand Challenges' were identified: Clean Growth, an Ageing Society, the Future of Mobility, and AI & Data Economy.



**We will set Grand Challenges to put the United Kingdom at the forefront of the industries of the future:**



**AI & Data Economy**

We will put the UK at the forefront of the artificial intelligence and data revolution



**Clean Growth**

We will maximise the advantages for UK industry from the global shift to clean growth



**Future of Mobility**

We will become a world leader in the way people, goods and services move



**Ageing Society**

We will harness the power of innovation to help meet the needs of an ageing society

The Industrial Strategy contains a vast range of policy proposals to strengthen the UK economy as well as develop the innovation system and coordinate various government actions around a cohesive set of goals. In May 2018 Theresa May announced the first mission in each Grand Challenge area. These were the first steps in driving the Grand Challenges into implementation in a range of areas. The announcement of these missions was crucial, demonstrating a willingness to attach concrete outcomes and targets to these broad aspirations.

What is a mission-oriented approach to industrial strategy?

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## 2.1 Mission-oriented innovation

Innovation has a rate but also a direction: the 21st century is increasingly being defined by the need to respond to major social, environmental and economic challenges.<sup>1</sup> Sometimes referred to as grand challenges, these include climate change, demographic challenges, and promotion of health and wellbeing. Behind them lie the difficulties of generating sustainable and inclusive growth. These problems are 'wicked' in the sense that they are complex, systemic, interconnected, and urgent; requiring insights from many perspectives. Poverty cannot be tackled without attention to the interconnections between nutrition, health, infrastructure, and education, as well as redistributive tax policy. Grand-challenge-thinking is being applied both in developed and developing countries, with some of the most interesting experiments around sustainability being driven by the needs of emerging economies.

### Recommendation 1

A challenge-oriented industrial strategy can help achieve an economy that is more inclusive, sustainable, and driven by innovation. By structuring policy to deliver economic spill-overs and harness technological advances, it can also help deliver ambitions in research and innovation, such as the government's target to increase R&D spending to 2.4 per cent of GDP by 2027. To do this, the approach and framework of the Industrial Strategy must be durable, forming a prominent part of the economic plan of this and any future government.

**The Industrial Strategy must receive a full and ambitious settlement in spending reviews to ensure its longevity and success.**

Examples of such direction-setting policies abound, including different technology policy initiatives in the United States,<sup>2</sup> France,<sup>3</sup> the United Kingdom<sup>2</sup> and Germany.<sup>4</sup> Mission-oriented policies are not just about throwing funds at problems but doing so in specific ways. It is for this reason that it is useful to study how specific mission-oriented agencies and organisations have worked, whether in military R&D programmes or in areas like health,<sup>5</sup> agriculture,<sup>6</sup> or energy.<sup>7</sup> In these examples, the relevant organisations made choices about what to fund, eschewing the dominant theory that the role of policy making is simply to level the playing field. Indeed, these agencies, and the wider programmes around them, have reshaped the playing field through missions aimed at a public objective, with other policies needing to be introduced to make it more profitable to move in that direction (for example, the U.S. land grant system, or tax reliefs for green investments).<sup>8</sup>

### Recommendation 2

In an environment in which the UK is likely leaving the EU and facing broad economic challenges, this opportunity to put the UK at the forefront of strategic technology areas and solutions to global problems must not be missed. **The Industrial Strategy must be used to capture political and social imagination around an economic vision of progress and to drive the UK's future international competitiveness.**

Turning these challenges into concrete problems that drive innovation across multiple sectors and actors requires learning from 'mission-oriented' policies that, in the past, have achieved specific objectives, whether landing a man on the Moon, or battling climate change. Britain has done this too, even whilst denying it had an Industrial Strategy: the promotion of the City of London as a global centre of finance; the efforts put into the revival of the automotive industry,

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especially in the North East; and playing a leading role in the mission of sequencing the human genome.<sup>9 10</sup> Such policies require different actors (both public and private) and different sectors to innovate (for example, travelling to the Moon required innovation in aeronautics, robotics, textiles, and nutrition). At the same time, for such policies to be successful, they must enable bottom-up experimentation and learning so that the innovation process itself is nurtured by discovery processes and dynamic feedback loops.<sup>11</sup>

Mission-oriented policies can be defined as systemic public policies that draw on frontier knowledge to attain specific goals, or 'big science deployed to meet big problems'. While the archetypal historical mission is NASA putting a man on the Moon, contemporary missions aim to address broader challenges that require long-term commitment to the development of challenges that are as much social as technological.<sup>12</sup> The active role being taken by governments and transnational organisations to develop strategies for a greener economy can be seen through a mission-oriented lens, as can those being developed to create greater wellbeing for an ageing population and better jobs for modern youth.<sup>13</sup> These challenges, which can be environmental, demographic, economic, or social, have entered innovation policy agendas as key justifications for action, providing strategic direction for funding policies and innovation efforts.

However, societal missions are much more complex because they are less clearly defined and must be co-defined by many stakeholders (how to frame a mission around social mobility is different to the Space Race).<sup>12</sup> One could add that these challenges also require big regulatory and behavioural changes at the societal/national systems level. Nelson's work *The Moon and the Ghetto* (1977) asked the demanding question of why innovation has resulted in such difficult feats as landing a man on the Moon, and yet continues to be so terribly disorganised and technologically unsavvy in dealing with the more earthly problems of poverty, illiteracy and the persistence of ghettos and slums. He argued that while politics was partly the culprit, the real problem was that a purely scientific and technological solution could not solve such problems. Even at the disciplinary level, there is a greater need to combine understandings of sociology, politics, economics, and technology to address the ills of society, as well as to make the conscious decision to point innovation towards them. This is exactly what a well-designed mission can achieve.

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## 2.2 A mission-oriented industrial strategy

Industrial strategy has historically involved both 'horizontal' policies that try to improve conditions across the national economy (for example, by improving skills and infrastructure) and 'vertical' policies that target interventions in specific areas, notably sectors (such as aerospace, automotive, or manufacturing) that have become the conventional understanding of industrial strategy. It ignores **the opportunity of a mission-oriented industrial strategy that reinvents the vertical dimension** to focus on problems that draw on many different sectors. It also ignores the importance of supporting general purpose technologies that have the potential to transform production distribution and consumption across an entire economy.

**Instead of using vertical policies to 'pick winners', the vertical aspect of missions picks the problem.** The solution is then reached by stimulating multiple sectors and multiple forms of cross-actor collaborations to address those problems using the entire research and innovation value chain, from fundamental research to applied research and cutting-edge innovation. Importantly, today's missions differ from NASA's original Apollo mission to the Moon because NASA's focus was on technological challenges. Today, with 'wicked' problems such as global warming, which require mass behavioural change alongside science and technology, the focus is on both technological *and social challenges*. This brings greater complexity to our solutions and means we have to recast the policy measures needed to make missions work in the 21st century.

Through well-defined missions to solve important challenges, policy makers can influence the direction of growth by making strategic investments and using suitable instruments across many different sectors. These create new industrial and innovation landscapes that build the confidence and growth expectations of the private sector that is crowded in. Here, governments act as market-shapers or market-creators rather than market-fixers. There is a compelling case for building a modern industrial strategy that addresses these challenges by stimulating investment across, rather than through, sectors.

### Recommendation 3

The framing of missions must provide a bold, targeted way to address challenges which bring together multiple sectors and stimulate bottom-up innovation. Formulating missions within the grand challenges is the best way to stimulate cross-sectoral innovation – technological, social, and creative – and to produce a definite roadmap for delivery. **Cross-sectoral missions must be developed and clearly prioritised with transparent delivery plans.**

Vertical and horizontal policies meet to support technologies and innovation on their road through development to the point of usage and application. At the same time, mission-driven innovation is also, by its nature, bottom-up. Achieving missions relies on the development of technologies to a level of maturity where they can be applied to real-world problems. The state can acknowledge its role as a market-shaper and creator to encourage, enable and provide a sense of direction for these challenges, but it must also recognise that it cannot decide in advance what the best remedies will look like. Any recommendations that rely on bottom-up solutions also rely on the UK having a well-funded, well-supported innovation ecosystem where scientific research *and* technology development are enabled. A rounded industrial strategy must balance these component parts. Fundamental research and general purpose technologies must be supported in and of themselves if we are to succeed.



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There is an inherent feedback loop between a mission-oriented strategy and the development of new technologies. Missions are not about prioritising applied research and innovation over basic fundamental research. Missions complement existing means of research and development (R&D) support. Achieving missions will require both the application of existing technologies and the development of new ones.

Missions can de-risk conditions for private investors, but they do more than this. They involve strategic thinking about the desired direction of travel, the technologies and industries that can help get there, and the policy frameworks required to promote it. Government must be realistic about the current capacity they have to think and act in a mission-oriented way and invest in the capabilities and resources needed. For example, evaluation tools (such as cost-benefit analysis) that are too linear and static will be problematic (see Section 4.1.1). The tools of industrial policy used to harness the power of the public and private sector together need to be married to a compelling purpose; one which meets society's needs.

In harnessing the direction of innovation to solve problems, a mission-oriented strategy is both top-down and bottom-up. Government's efforts should be directed at meeting shared social challenges and goals by supporting the development of new technologies and applying them to the most urgent problems. The articulation and framing of those goals and challenges must come through open public debate and communication initiated, organised and respected by government and public institutions.<sup>14</sup>

Whilst the broad 'payback' of missions is solving big societal challenges or problems, the economic case for supporting missions is the technological and intangible spill-overs that result from bottom-up innovation. The consequence is that whilst achieving the mission is important in terms of successful broad outcomes and citizen engagement, missions can still have positive effects on the economy and on innovation, even if the mission fails. Science and technology research can have positive economic benefits on other fields and sectors even if the original objective is not attained.

Mission-driven innovation needs to be a process of shared, public problem-solving that engages the private sector, consumers, citizens, universities, social entrepreneurs and public institutions. This topic, discussed in Section 4.1.4, means co-creation of the missions, co-implementation of the policy and co-evaluation of its success.

While the UK's Grand Challenges – and similar examples such as the United Nations' Sustainable Development Goals – are useful to stimulate problem-solving, they can be too broad to be actionable. Missions, on the other hand, define particular issues that different sectors can address in tackling a challenge, such as reducing carbon emissions by a given percentage over a specific period.

Figure 1 shows how a mission-oriented approach works: a broad challenge (such as tackling climate change) is broken down into a concrete mission (for example, a carbon-neutral city). It must be measurable: we must be able to answer whether or not it was achieved. It must be framed in a cross-sector manner, bringing in multiple actors and helping an economy become also differentiated. For example, a cancer mission that only involves the health sector is not a mission in the way described above; it is if it also involves all the preventative areas, such as the nutrition sector and lifestyle areas. Likewise, a Clean Growth mission may not just involve the

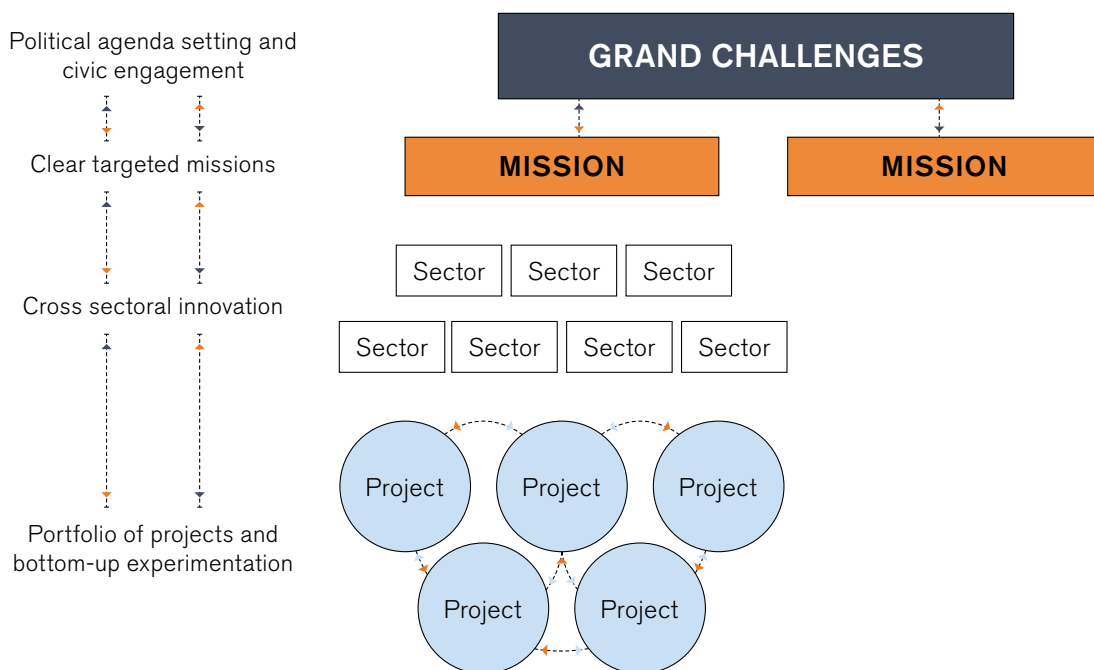
renewables sector, but also transport, construction, AI and agriculture. These sectors interact on different types of projects that are funded through instruments such as procurement or prizes. The experimentation and 'discovery' processes that project formation implies are key to making sure that missions fuel experimentation and not top-down processes that stifle innovation.

Sectors define the boundaries within which firms operate, such as transport, health or energy. Missions require different sectors to come together in new ways: the Future of Mobility will not be answered by the car manufacturing sector alone, for example.

Finally, solutions are specific projects undertaken by businesses, governments, universities or the third sector that can help support a mission. Solutions have clear objectives and should involve many different sectors, and can be supported through the use of policy interventions and financial instruments.

This framework will be used later in this report to map out how different diverse, cross-sectoral innovation projects can help achieve the missions set out by the Government in each Grand Challenge area.

**Figure 1: From challenges to missions and projects**



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## 2.3 Designing missions: a moonshot approach

The report for the European Commission titled *Mission-Oriented Innovation Policy: Challenges and Opportunities*,<sup>15</sup> sets out a framework for developing a series of cross-sectoral missions and the projects within those missions. This framework explores five criteria for setting missions:

- Be **bold**, inspirational with wide societal relevance
- Set a clear direction that is **targeted**, measurable and time-bound
- Be **ambitious** but not unrealistic
- Be **cross-disciplinary**, cross-sectoral and cross-actor innovation
- Involve multiple, **bottom-up** solutions

Such missions should be viewed as a portfolio of projects and bottom-up experimentations as shown in Figure 1. We refer to these diagrams as mission “roadmaps”.

### Implementation step 1

The Industrial Strategy should aim to solve societal challenges by setting ambitious missions that work across sectors, actors and disciplines. Missions should have a greater level of granularity and specificity than the grand challenges. Missions should be designed to satisfy five key criteria – they should be: bold with societal relevance; measurable and time-bound; ambitious; cross-sector and cross-disciplinary; and generate bottom-up solutions among public, private and civil society organisations.

### Implementation step 2

Bold missions must not be watered down by siloed departmental thinking, and must work across departments. The existing missions should be further prioritised; more ambitious cross-sectoral missions, with firm measurable commitments should follow.

A mission-oriented industrial strategy can help co-create markets of the future, not only fix them. For example, it should not be limited to responding to demand from existing customers but on the emerging needs of future users, citizens and businesses. Achieving this means not just looking at grand challenges through a technological lens, but also thinking about behavioural change and capturing the imaginations of citizens. Missions work by bringing diverse sectors together, and should therefore not only use science, technology, engineering and maths (STEM) but also the arts: STEAM.

### Implementation step 3

Innovation is not only about Science Technology Engineering and Maths (STEM) but also the Arts: STEAM. We recommend that the social sciences, humanities and creative arts are not only supported but central to ensuring that missions are framed as creatively and inspirationally as possible, helping citizens unleash their imagination of the future.

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Mission-oriented policies require an understanding of the difference between (1) broad challenges, (2) missions, (3) sectors and (4) specific solutions. A challenge is a broadly defined area that a government may identify as a priority (whether through political leadership or the outcome of a movement in civil society). These may include areas like climate change or the challenges of an ageing population. On a global level, the United Nations have identified 17 Sustainable Development Goals (SDGs). One hundred and ninety-three countries have signed up to these goals, so they provide inspiration to mission-oriented thinking.

Addressing these challenges, around health and the environment for example, must not be seen as a cost to, or a brake on, economic expansion. Rather, they present a means to focus on opportunities for investment-led growth that crowds in the knowledge and capabilities of various actors. Furthermore, successfully supporting technologies and addressing these challenges will result in world-leading innovation here in the UK, driving our international competitiveness.

In building the roadmaps (see Section 3), the MOIIS Commission reflected on the following issues. It is important that they are considered by anyone aspiring to formulate mission-oriented policies.

### **Who decides?**

Missions must be co-created; they cannot be handed down from above as a 'pet' project. In the same way that the SDGs were outcomes of a long consultation process, it is essential that UK-based challenges and missions also be outcomes of that process.

### **Positive goal**

The mission should be framed as a positive statement. A mission should not seek to remedy or remove a negative, but instead to create a positive. For example, a mission should not be framed as "reducing the burden of dementia", but as an optimistic vision of addressing it early on and improving quality of life for those with dementia. Similarly, the climate change threat should be framed as an opportunity to steer societies onto a new Clean Growth trajectory.

### **Stress the possible**

To successfully inspire citizens and innovators around the mission, the organisation setting the mission must envision and stress what the world may look like if the mission is achieved. Alternatively, it should describe the negative effects of not meeting the mission.

### **Granularity**

The mission should be a level of specificity below the challenge. The challenge should define the general area, whilst a mission should be an identifiable strand of the challenge, rather than a restating of the challenge itself. It must be clearly possible to say whether a mission has been achieved.

### **Timescale**

Timescales matter for missions. If they are set too long, they may not drive innovation or seem irrelevant to citizens. Conversely, if they are too short, they may not actually be ambitious enough and the spill-overs from innovation may not occur.

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## **Overlap between grand challenges**

Because grand challenge areas themselves are broad interdisciplinary aspirations, there will be some overlap. You cannot talk about the Future of Mobility without thinking about how the older and less mobile Ageing Society will travel around our built environment. There are dynamic connections between transport infrastructure, the built environment and achieving the sustainability challenge of Clean Growth. Data and artificial intelligence are technologies that are likely to contribute to solutions to all sorts of challenges. This overlap should not be ignored or avoided – it should be strengthened. Mission delivery and policy teams that intersect should communicate and share best practice as well as connect their networks of innovators. This should be viewed as an opportunity to develop mutually beneficial solutions to both challenges, rather than a zero-sum game.

## **Avoiding the “Christmas Tree” effect**

The MOIIS Commission has found that, when articulating a mission, it often starts as a clear statement. As this statement is shared with other policy makers, who make suggestions on the mission area, and to other government departments who add their view, the mission definition grows larger and larger. Like a Christmas Tree that starts bare, it ends up with lots of different things hanging off it. The definition has worsened from a succinct, bold statement to something bloated that tries to achieve many goals and many more sub-goals. This should be avoided in mission development. A mission should be understandable by a lay member of the public.

## **Timebound missions and deadlines**

In the criteria for a mission, it is clear that the mission statement itself must be time-bound and include a deadline. It is critical for policy makers to know whether the mission has been achieved or not. However for some of these grand challenge areas, the bold ambitions may necessitate a very long timescale. For example, two missions towards the Grand Challenges already announced by the Government have deadlines of 2040. Whilst these deadlines are far off, missions can provide a useful “anchor” for innovation policy that bestows longevity. Additionally, if the deadline is set too close, then it is highly unlikely that the technological or intangible spill-overs that are so important to a mission’s economic rationale will be developed. However, if there are only one-off opportunities for companies and research organisations to bid for funds, this may favour established and big incumbents over smaller and younger players. Predictable and repeated opportunities to apply for funding yield better results. Long-lasting well-recognised familiar funding schemes are especially important for innovative SMEs.

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## 2.4 Sectoral and technological systems of innovation

Industrial strategy does not occur in a vacuum. It is part of the institutional policy and regulatory framework of a national system of innovation that includes multiple types of organisations. The system itself is composed of an interlocking set of sectoral and technological systems with specific configurations of private and public sector firms, consumers, patterns of market and non-market interactions and regulatory and policy measures affecting those interactions.<sup>16 17 18 19 20</sup> In terms of research there is a spectrum of organisations, ranging from those that tend to specialise at the basic end (universities and research institutes) to those more at the application end (firms). This includes a range of intermediary organisations and public laboratories in between, such as Catapult centres. It also may include sectoral institutes like NIAB (the National Institute of Agricultural Botany) or TWI (formerly The Welding Institute), which have both research and sectoral capabilities. Britain's network of research capabilities, including those nurtured in public labs, has been thinned out over the decades.<sup>21</sup> We need to sustain and grow this infrastructure, be patient supporters of these institutes and recognise that the application of research is valuable alongside new scientific discoveries.

There is also a spectrum of funding for research that has direct public sector support at the more basic end, and also at the more applied end. The latter include organisations that provide patient strategic finance (such as public banks), private-sector firms with their sources of internal and external sources of finance, public procurement such as SBRI in the UK, and policy programmes to support collaborative R&D (including the Industrial Strategy Challenge Fund).

Organisations and funding streams that provide connections and interactions between the more basic and applied ends of the research spectrum are a key part of sectoral and technological systems. While this report is not intended to discuss the design of such organisations and support policies, their existence, design and appropriate level of funding are essential components of a successful industrial strategy.

The central point is that missions do not replace the need to build and enhance the strength of the UK's technological and sectoral systems of innovation, but they do depend on these systems. Achieving missions assumes that sectoral and technological capabilities are both in place. Without rocketry capabilities, the Apollo Moon programme would have not had much hope. Yet, it was that mission that developed that capability further and allowed it to interact with projects in other areas like computing, nutrition and even clothing.

Missions rely on sectoral systems and technological advances to meet challenges and may require structural changes in the nature and balance of activities and the business models of the firms within those systems. Therefore, policies must identify sector-specific system failures that inhibit these changes and support ways of addressing them; for example, through the creation of knowledge sharing and creating collaborative intermediary technology organisations such as the UK Catapult Centres.<sup>22 23 24</sup> While missions per se are separate to this, they can be also used to develop new capabilities and business organisations; for example, in the way that Germany's *Energiewende* mission helped the steel sector develop new processes to lower its material content (through repurpose, reuse and recycle).<sup>25</sup>

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#### Recommendation 4

Intersectoral collaboration on missions must be built upon sectors that have the capacity to be at the forefront of organisational and technological changes and whose firms can recognise, respond to and shape those changes and develop appropriate business models to capture value from them. **It is essential for industrial policy to understand and address specific sectoral system failures that inhibit the ability of existing firms and potential entrants from shaping and capturing value from emerging technological and market opportunities.**

How such sectoral investments interact with broader missions is key. For example, missions related to Clean Growth and the Future of Mobility should both be tapping into capabilities and capacity in the automotive industry. Such capabilities are an outcome of business investment (reinvestment of profits back into R&D, human capital, machinery, and managerial capability) and government investment, such as the High-Value Manufacturing Catapult, or the Faraday Institute for battery research.

#### Implementation step 4

A mission-oriented approach works across sectors. This implies sector-specific capabilities and capacity to engage with technological opportunities (absorptive capacity). In light of experience with existing Sector Deals, the Industrial Strategy Council should undertake a review of policy measures and instruments to develop a granular approach to capacity development that is based on a detailed knowledge of business models, value chains and value capture in specific sectoral systems of innovation.

Technological capability requires financing technological development independently of missions. Without AI competence, the AI sector will not be a good partner in any mission. But by allowing it to interact with ambitious missions, AI develops into new areas and improves in the process. General purpose technologies require special attention. *The Eight Great Technologies* were an example of this approach and more attention is needed on how those technologies are selected and nurtured. They have transformational potential but in the early stages of development are not easy to incorporate into a missions framework. Their final use may not be clear, as they themselves are often spill-overs, but these technologies still require support on their route to applications. Good examples of such technologies would include both “dry” technologies, such as quantum computing or robotics and the Internet-of-Things, and “wet” ones, such as cell therapies and synthetic biology.<sup>26</sup> Both general purpose technologies and “blue sky” laboratory research can only help solve our biggest challenges if they receive the necessary support. Moreover, mission-oriented policies can lead to the discovery of spill-over technologies and solutions; for example, Global Positioning System (GPS) technologies were developed because of a mission-type desire to develop more accurate ballistic missiles.<sup>27</sup> Thus, missions are not just about addressing problems but also are about creating new capabilities through new technologies and skills growth that can have much broader, typically unforeseen, benefits.

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Technological capabilities will require agencies that are committed to the following:

- *Scientific* breakthroughs required for missions (for example, in the field of artificial intelligence);
- *Technological* breakthroughs (for example, supporting general purpose technologies that may or may not aid a mission); and
- Innovative *service delivery* required for missions (for example, towards achieving the Ageing Society mission).

To truly lead on the global scale, as set out in the Industrial Strategy white paper, the UK needs increases in investment that go beyond even the ambitious target of 2.4 per cent of GDP. Any target R&D spending will be delivered by different types of institutions. Gross domestic expenditure on research and development (GERD) can be broken down into R&D spending by universities (HERD), by business (BERD) and by government institutions like public labs (GovERD). Evidence in the UK shows that while HERD has remained stable in the last decades, BERD and GovERD have fallen.<sup>28 29</sup> Indeed, this fall in the funding of government labs should be analysed and reversed.

Historically, it is precisely the GovERD type of R&D that has been the most mission-oriented. In the USA the equivalent is the R&D that occurs in institutions like DARPA, the Department of Defense or National Institutes of Health. The structure of such institutions is key, as indicated in Section 4.1.2. They must attract high levels of expertise, be flexible and adaptable, and accept risk; that is, be willing to accept the high failure rate of bold R&D projects.

### **Recommendation 5**

The Industrial Strategy must champion a dynamic innovation system, which includes support for strategic, applied and basic research, including institutions like Catapult centres that support technology development. It must also support general purpose technologies and capabilities needed for implementation and application of technology towards missions.

**There must be a programme of support for general purpose technologies that complements a separate ambitious programme focusing on grand challenges and missions.**







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### 3 Mission design and roadmapping

The MOIIS Commission considered the framing and direction of the missions, as announced by the Government, and how they could be improved to create a bold and clear roadmap, with a delivery plan. The Commission aimed to capture the ambitious nature of a grand challenge, while also implementing the mission framework to envision ways the missions can be delivered through multiple projects.

In this section, we present four worked examples showing how a mission-oriented approach can be applied. We consider the two levels of defining a mission:

- (1) Framing the mission in ambitious ways
- (2) Formulating a roadmap driven by cross-sectoral projects that stimulate innovation towards achieving the mission

The roadmaps are not a set of specific recommendations, but an illustration of the scope, methodology, and ambition of a mission framework. The proposed projects are simply meant to show the importance of multiple solutions and a range of potential policy drivers. While the MOIIS Commission also considered new missions that we felt were bolder in a moonshot way, our focus is on improving the existing missions announced by Government.

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## 3.1 Mission for Clean Growth

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### Mission framing

The Clean Growth mission was framed by Government to “*at least halve the energy use of new buildings by 2030*”. The mission can be significantly more ambitious and bolder in its wording. To reach the above-mentioned criteria of being bold with wide societal relevance while remaining realistic, the mission should be reframed to include *both* new-build and retrofit and resource efficiency, alongside energy efficiency. The mission is transformed from an incremental step to a rethink of how the buildings we occupy must adapt if we are to achieve clean growth. Therefore, the mission could be reframed as: “*At least halve the energy and resource use of new and existing buildings by 2030.*”

The UK Government’s own statutory advisors on climate change, the Committee on Climate Change, argued in a recent report<sup>30</sup> that housing needs to become an infrastructure priority, with bold action in construction skills, enforcement of performance standards, timber-built where possible, and with new forms of finance to decarbonise all housing to ensure UK carbon targets are met.

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## Mission roadmap

The Commission identified potential projects to realise bottom-up innovation towards the mission goal. There are two distinct aspirations included within this single mission: increasing the efficiency of new buildings and adapting existing buildings through retrofit, both to be low-carbon and to be fit for a future climate. Both will require much closer working between national government (for example, through the National Planning Policy Framework) and local government in their role as both public procurer and planning authority.

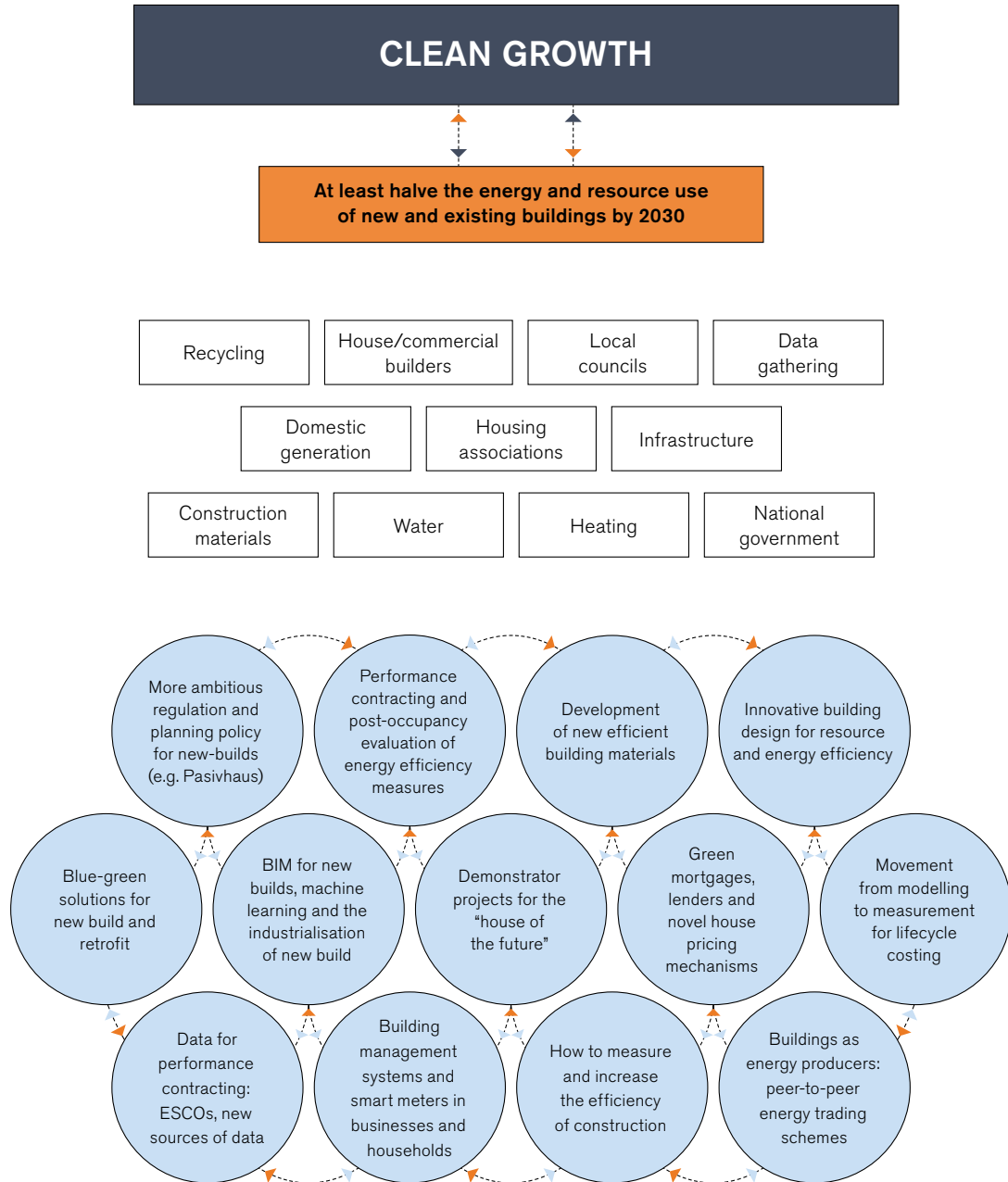
There are numerous routes forward that can be stimulated by bottom-up innovation. The key stakeholders are shown in the mission roadmap, such as the construction industry, home owners, private landlords, estate agents, housing associations, construction materials manufacturers, skills providers and national and local governments. These are **cross-disciplinary, cross-sectoral, and cross-actor alliances**. It is not an exhaustive list and the key is not to identify diverse sectors per se but to ensure the missions framing the projects are open and activate bottom-up, cross-sectoral innovation with real purpose and intent.

The mission roadmap sets out some **suggested project areas** that could be funded or delivered to spur innovation in areas towards the mission. We expand on some key areas here:

- **The building of the future.** How can we radically rethink not just the building materials but what functions buildings perform in our environment? Clean growth is not just about mitigating the way we live today, but about changing how we use buildings to reduce their environmental impacts and improve their liveability in future climates. This has significant overlap with the Future of Mobility Grand Challenge when thinking about how urban environments will change.
- **Connecting green investment to jobs.** Achieving this mission will be a 'new deal' in that it will require significant investment and create many new jobs. But how can we scale this? We should start with a cohort of cities that have influence, leadership and a willingness to push forward, with an eye to informing and changing national and local policies. Skills training should be part of the process from the beginning.
- **Performance contracting and data-enabled evaluation.** What sort of new rental agreements, smart architectural design contracts, and innovative procurement models do we need that set energy efficiency outcomes? How do we gather the live data we need to hold building designers and constructors to account? How would they change our built environment and our cities and how we redesign them?
- **Adopt smart policy frameworks.** This can support real-time governance and optimisation of the city. Reimagining how our urban governance adapts to the changes needed for clean growth will require our policy to be more agile. For example, new rental contracts or smart architectural design contracts may require the formation of new legal structures and legislation, and we must be able to do this at scale and with speed.

The mission as formulated is admirable but the restriction to new build fails to match the scale of the climate change challenge. Really innovative thinking must include the retro-fitting of existing houses as well.

Figure 2: Clean Growth mission roadmap



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## 3.2 Mission for AI and Data Economy

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### Mission framing

This Grand Challenge presents unique issues when formulating missions. Unlike the other Grand Challenges, artificial intelligence (AI) is a general purpose technology rather than a societal challenge and can therefore be applied in numerous areas. Indeed, it should be part of all missions. The result is that missions within this Challenge will vary widely in their sector and ambition. If the mission approach in the AI & Data Economy Grand Challenge is to succeed in a way that directs innovation towards societal goals, it must become more than just a list of sectors where the implementation of AI will drive technological change.

The Government's stated mission is to *"use data, Artificial Intelligence and innovation to transform the prevention, early diagnosis and treatment of chronic diseases by 2030"*. While satisfying the criteria to be bold, clear, and time-bound, societally relevant and ambitious, this mission can be enhanced by including additional drivers. This mission could be reframed as: *"Use data, artificial intelligence and innovation to transform the prevention, early diagnosis and treatment of chronic diseases by 2030, through the adoption of interoperable AI and data tools and standards"*.

The mission framework – focused on outcomes rather than outputs – can be used to make innovation in this field more understandable to the average citizen. Furthermore, missions could be articulated to drive the UK's international competitiveness as a basis for AI and data innovation. Missions must stimulate economic development and competitiveness whilst addressing the societal, behavioural and ethical questions raised by increasing use of big data and AI.

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## Mission roadmap

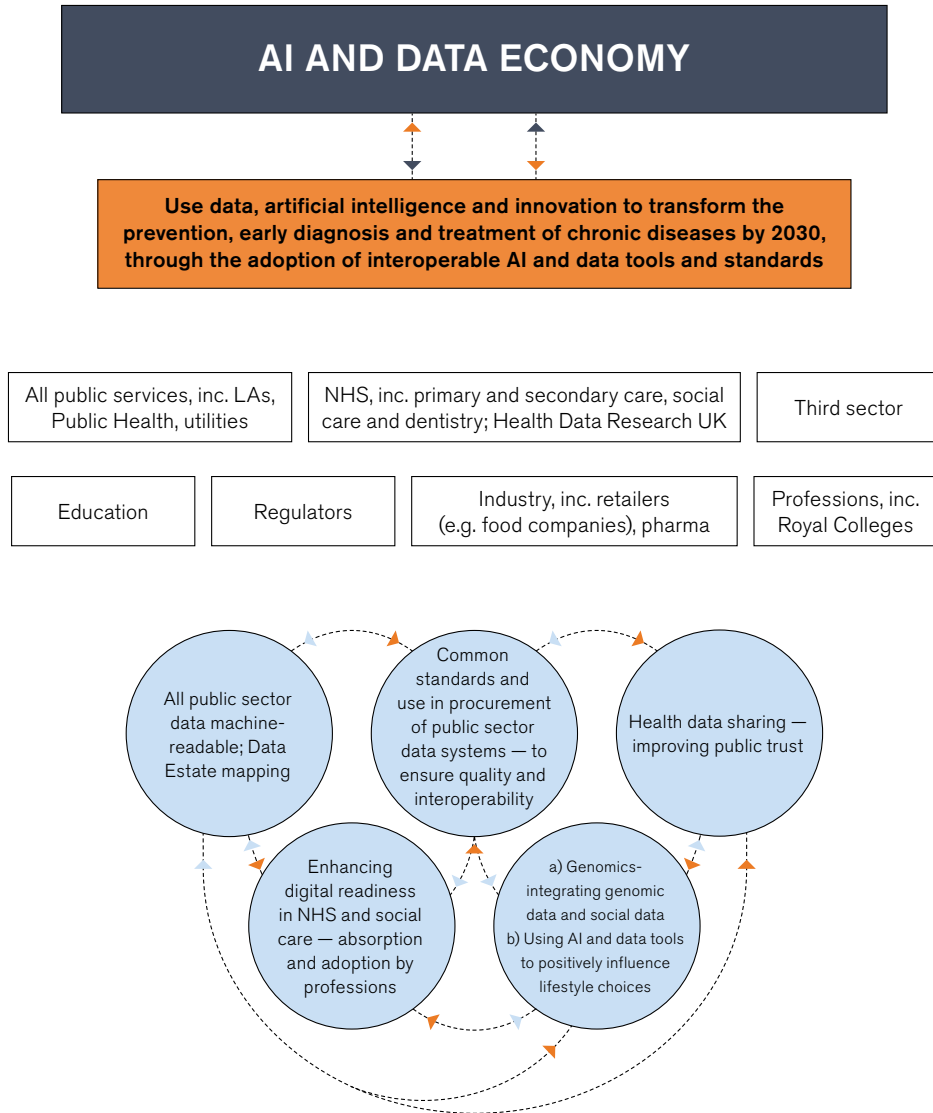
A society in which AI applications are rapidly becoming a widespread reality creates significant opportunities and threats. Industry is most at ease with developing and deploying software, but citizens are much less likely to be aware of the extent to which they interact with such technologies in their daily life. Therefore, a mission-oriented approach that brings together diverse sectors is particularly applicable in this Grand Challenge. Healthcare and medicine are regarded as being opportune areas for the adoption of AI solutions, so it is not surprising to select health as part of the first mission. The fact that the health services across the UK are esteemed by both politicians and the public makes it a logical focus for this Grand Challenge.<sup>31 32</sup>

Lessons learnt in this mission in the healthcare sector should be applied to other data/ AI missions.<sup>33</sup> The government's forthcoming Data Strategy should recognise the systemic challenges in 'fixing the plumbing' to ensure there is more coherence and less fragmentation in the way that public data is held, processed, shared and governed across public services. One way of ensuring this is to set projects on common, cross-cutting themes such as:

- **Making public-sector data machine-readable.** AI and machine-learning solutions need to be "trained" using large amounts of high-quality data. Making public-sector data accessible to machine-reading products (that is, computer programs can access, categorise, and process the data) will provide access to large amounts of training data to enable the testing and development of new AI technology. The UK's public-sector datasets are a national asset and should be used to support our competitive international advantage in this space.<sup>34</sup>
- **Improving public trust for data-sharing.** It is vital that the public are informed and educated on the use of public data. Public trust is a critical 'licence to operate' for AI technologies because the use of personal data can be perceived as invasive and risky. If we are going to open our datasets to researchers for R&D purposes, we need to make sure that people trust in these missions and that the benefit to the public and for social good are explicit. This will require broad debate and consultation alongside meaningful and relevant experimental innovations.
- **Common standards for the procurement of public-sector data systems.** Whilst the UK's large publicly-owned datasets could be precious basic materials for AI technologies, as adoption scales across the public sector, there is a risk of fragmentation should different solutions or systems be adopted in different sectors. The government should set clear standards for the procurement of AI data solutions and systems to avoid fragmentation and poor interoperability, as well as implementing agile regulation to ensure that standards remains fit for purpose as technologies evolve.



Figure 3: AI and Data Economy mission roadmap



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## 3.3 Mission for Ageing Society

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### Mission framing

The Government's mission to *“ensure that people can enjoy at least five extra healthy, independent years of life by 2035, while narrowing the gap between the experience of the richest and poorest”* is both clear and attractive as a starting point. However, there are problems in measuring the “healthiness” of these extra years, as a lot of the data is self-reported. A better measure of what constitutes healthy ageing would use objective criteria for what people are positively able to do, not only in terms of physical capacities (“independence”) but in the wider sense of whether society is organised to ensure that individuals are given the support and resources to lead lives they have reason to value, even if this requires help. The ultimate goal is to develop the Industrial Strategy in ways that will transform the UK economy to the benefit of citizens and society, and for as long as possible. This mission could be reframed as *“to enhance capabilities and quality of life through our increasingly longer lives”*.

To encapsulate the bold and inspirational nature of the overarching mission, the projects listed here are phrased in terms of the positive. The secondary text proposed for the broad mission is as follows: *“To reduce the number of years of life lived with age-related functional decline, while diminishing the loneliness, dependency, and an impaired sense of self-worth experienced in those years”*. Particular attention needs to be directed towards narrowing the gap between the experience of the richest and poorest.

Our increasingly ageing society is one of the most profound transitions of the 21st century, presenting a diverse range of needs of unprecedented scale. While it is easy to view the impacts of an ageing population as negatives, it should be remembered that this situation is born of success. The opportunities for UK industrial strategy are immense, spanning the whole economy and extending our international reach. After all, most of the world faces similar challenges, which makes it a potential market for exporting successful innovations and finding collaborators.

Quantifying this mission with targeted, time-bound and measurable objectives is awkward due to both the breadth of the Grand Challenge and the inherent difficulty of quantifying both capabilities and quality of life. Part of this mission should be to develop such metrics on a cross-government basis, taking inspiration from other frameworks such as the Scottish National Performance Framework, which connects directly to the UN SDGs. Nevertheless, the overall mission lends itself at once to a set of more specific projects for which it is much easier to see how targeted, time-bound, and measurable aims might be chosen.

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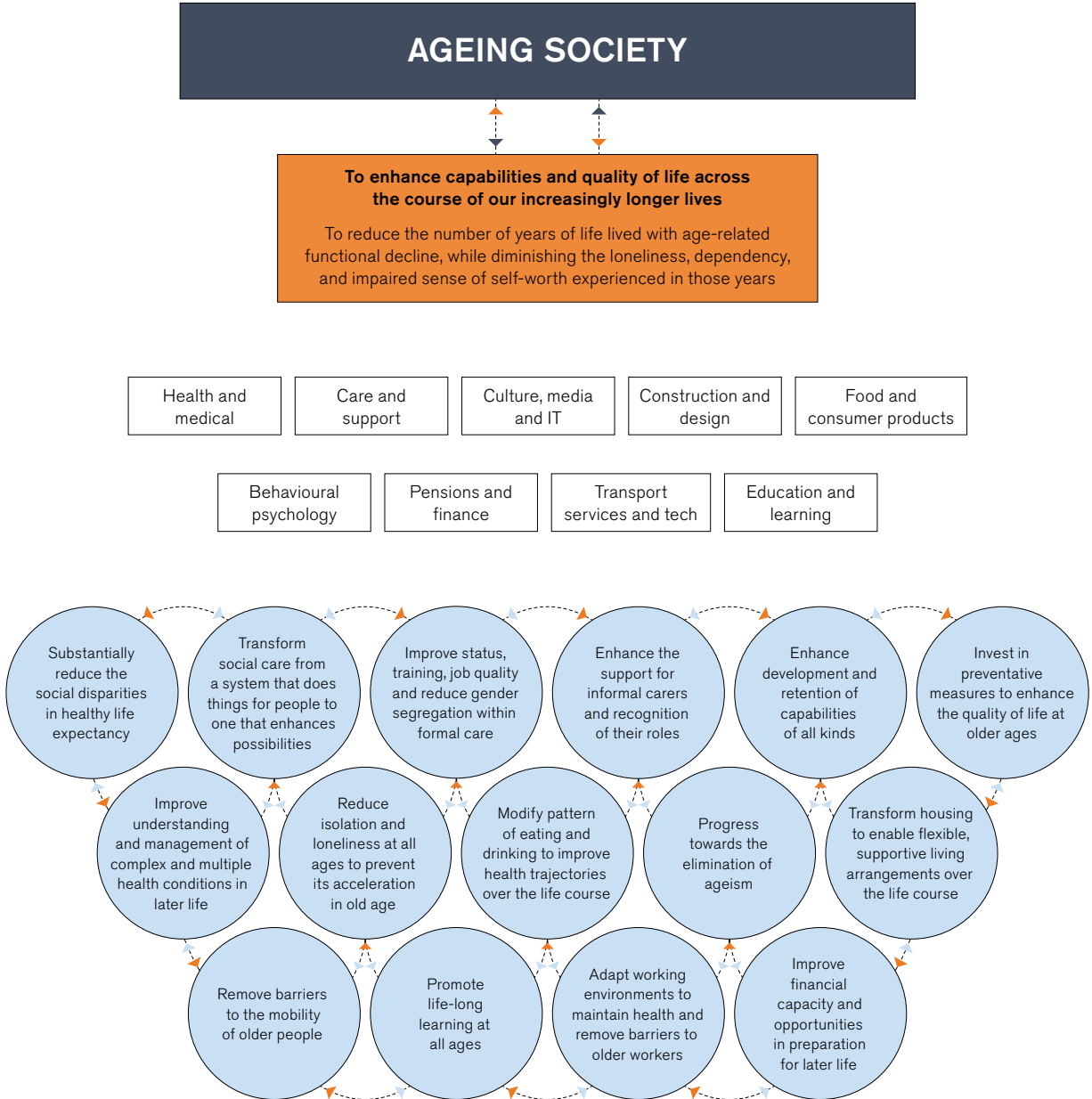
## Mission roadmap

Examples of key projects reaching towards this mission that will foster bottom-up innovation include:

- **Substantially reducing the social disparities in healthy life expectancy.** this addresses one of the unwelcome features of our ageing society; namely, the considerable difference in healthy life expectancy across the socio-economic spectrum.
- **Transforming the social care system from one that does things for people to one that enhances possibilities, and Improve status, training, job quality of formal care and reduce gender segregation within the sector.** these projects address shortcomings of current care management and attempt to confront the issues around human infrastructure required for a functioning care system. This requires rethinking what care services are for so they are enabling. This means enhancing capabilities in all directions. This will require reassessing the status and skills required of care professionals, and enhancing their training, career, and reward structure.
- **Enhance development and retention of capabilities of ageing people and Progress toward the elimination of ageism.** this recognises the need to view life as a trajectory during which capabilities are acquired but later need to be protected against a variety of age-related threats. These opportunities and threats result not only from individual development but also from what society makes possible, with ageism a real stumbling block to progress.

Missions and sub-missions addressing the Grand Challenge of an Ageing Society raise many cross-cutting issues that link with the other three pillars of the Industrial Strategy. How will a future mobility infrastructure be accessible to those people with age-related disabilities? How can we make housing and buildings that allow older people to live in their own homes for longer? What role will AI and other technologies play in an ageing society? How do we work with business to promote private investment and provision given the growing wealth of the older generation?

Figure 4: Ageing Society mission roadmap



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## 3.4 Mission for Future of Mobility

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### Mission framing

The Government's mission in this area is to *“put the UK at the forefront of the design and manufacturing of zero-emission vehicles, with all new cars and vans effectively zero-emission by 2040.”* From an innovation perspective, the MOIIS Commission considers this mission statement too narrow and insufficiently ambitious.

Existing policy statements elsewhere suggest that the target itself may well be met by existing market trajectories. Remember that missions are not meant to solve problems that will likely be solved under current conditions or trends.

We can assess the ambition of this mission by comparing it to what other countries have announced. The Scottish government has pledged<sup>35</sup> to phase out new petrol and diesel cars and vans across Scotland by 2032. India wants to only sell electric models by 2030, and Norway – the world leader in using battery-powered cars – has set a non-binding deadline that by 2025 all new cars sold will be zero-emission.<sup>36</sup>

The current UK mission statement is targeted and time-bound in terms of zero-emissions from certain classes of new vehicles by 2040, but not necessarily in terms of the industrial impact or wider socio-economic effect, with “at the forefront” being somewhat vague and lacking defined metrics.

The vehicles covered are too narrowly limited to “new cars and vans”. A more ambitious mission definition would allow for the inclusion of diverse solutions across the mobility sector, each of which could be the source of new areas of international competitiveness and technological spill-overs. Broadening the range of mobility innovations in play and the various methods required to pursue them would open more systemic change opportunities. The mission does not address more holistic, system-planning approaches to the built environment. Equally, the current mission does not address other innovation goals for mobility, such as safety, congestion, accessibility, health via active transport, or sustainability beyond emissions such as circular economy principles.

A more ambitious yet realistic mission framing would be: *“By 2040 to put the UK at the forefront of safe, sustainable, universally accessible travel, creating congestion- and emission-free, zero-accident systems.”* A more holistic mission design phase, involving industry and civic society as well as government and academia, and addressing systems design and transformation, should be the next step to clarify the targets and their associated activities.

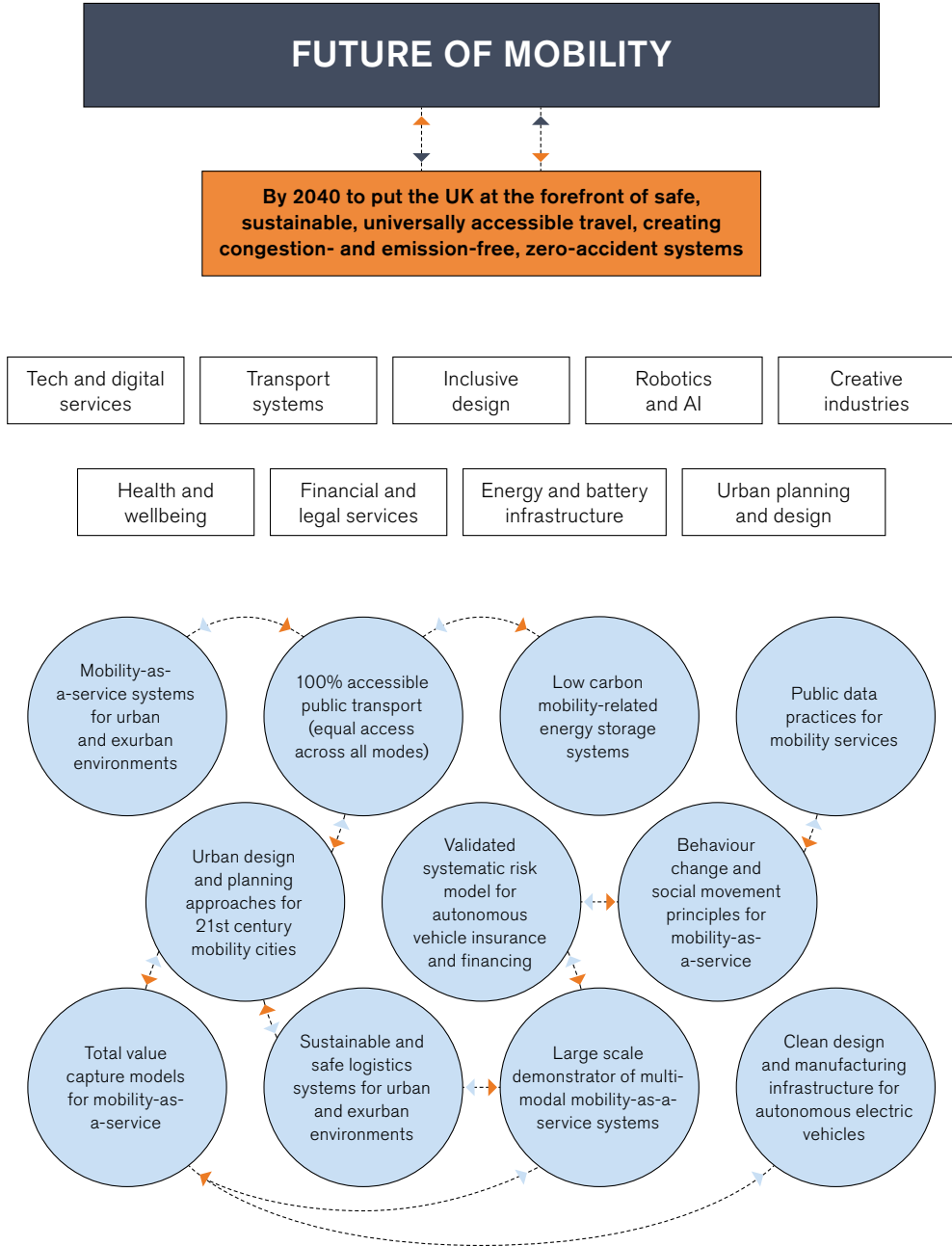
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## Mission roadmap

The projects should provide a vision of how such an expanded mission could be developed. Here we expand on a selection of the project suggestions made in the mission roadmap:

- **Urban design and planning approaches for 21st-century cities.** What does a street, neighbourhood, district or city look like with new patterns of mobility? How will autonomous vehicles or mobility-as-a-service require changes to the ways we design and move around cities? How will urban planning ensure accessibility of space and systemically optimise mobility demand within universal access to transport? This will involve creating new standards for road design, participation and iterative planning approaches, and extensive citizen consultation.
- **Large-scale demonstrator of mobility-as-a-service systems.** The transition from small-scale demonstrator to city-wide trials of mobility-as-a-service systems will require agile multi-party regulation and citizen participation to allow these technologies to scale up. This will include the ability to prototype and test connected systems, new urban design and governance models, systems procurement, Internet-of-Things and advanced connectivity infrastructure, citizen engagement and participation opportunities.
- **Shared data for shared mobility and shared outcomes, public data practices for mobility services.** New shared mobility services will require concomitant levels of trustworthy sharing of data, particularly if these services are to be agile, adaptive and responsive. Developing data practices and systems that citizens and companies can trust is critical for scaling up these technologies. This will include civic governance models, considerations of trust, identity and anonymity, and affordable open data for business, government and third sector.
- **Safe and sustainable logistics systems for urban and exurban environments.** In many modern cities, logistics and delivery vehicles make up a large proportion of urban traffic. To reduce the congestion and pollution of this essential transport function, we can also consider smarter movement of goods and materials. This will mean working with business, citizens and logistics companies to determine new models of transport, and novel 'last-mile' solutions.
- **Low-carbon mobility-related energy storage systems and services.** As petrol-powered vehicles are phased out and replaced by electric cars, energy usage patterns will change significantly. This, combined with new renewable but intermittent energy generation, will require us to confront how energy is generated, stored and distributed. Battery-powered vehicles present both a problem and an opportunity in terms of energy generation and storage, which necessitates systemic planning, combining short-term prototypes with long-term strategy, in a quest that starts today but extends to 2040 and beyond.

Figure 5: Future of Mobility mission roadmap







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## 4 Implementing a mission-oriented industrial strategy

Profound transformation demands that we do things differently. A mission-oriented industrial strategy provides a basis for steering research and innovation towards outcomes. However, missions are not ‘business as usual’ for innovation policy. Achieving missions will require new approaches to implementation. The rest of this report addresses a range of issues that must be tackled to alter the way Government operates in order to ensure the success of this strategy. In this section we focus on how the machinery of government and processes within government must adapt if a mission-oriented innovation strategy is to succeed. We also consider new institutions, organisations and frameworks that will need to be built if we are to direct innovation as desired.

**“Because Grand Challenges and missions are in their very nature dynamic and complex, new methods to model and capture their outputs and impact have to be formulated.”**

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## 4.1 Structures and agencies

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### 4.1.1 Policy evaluation and appraisal

#### **How can we go beyond conventional cost-benefit analysis and develop a dynamic framework for policy evaluation?**

Mission-oriented innovation and recognition of the state's role in shaping and indeed sometimes creating markets requires a new analytical framework and tools beyond static cost-benefit analysis. Conventional net present value calculations could stop any mission from the start.<sup>37</sup> Because Grand Challenges and missions are in their very nature dynamic and complex, new methods to model and capture their outputs and impact have to be formulated.

Market-shaping, mission-oriented approaches encourage us to think big, endorsing ambitious policies to transform ways of working rather than fix problems in existing ones. This raises questions about how to re-teach public-sector understanding of how to manage such ambition, and how to appraise and evaluate the market-shaping effect of the appropriate policies.

The HM Treasury Green Book<sup>38</sup> recognises that cost-benefit analysis (CBA) is not appropriate in all situations. It notes that:

“Social CBA and Social CEA are “marginal analysis” techniques. They are most appropriate where the broader environment (e.g. the price of goods and services in the economy) can be assumed to be unchanged by the intervention. These techniques work less well where there are potential non-marginal effects or changes in underlying relationships.”

This limitation is of crucial importance.<sup>39</sup>

Currently, policy interventions are assessed using budget-constrained, static, allocative efficiency measures, where it is assumed the intervention only affects a defined sphere of activity and does not diffuse into the wider economy. Mission-oriented policy focuses on dynamic efficiency and the creation of wider public and private value. This approach would engender spill-over effects in many sectors of the economy and alter the broader trajectory of economic growth. Evaluation could occur on three levels: enhancing user experience and engagement; expanding technological frontiers; and broader macroeconomic multiplier effects. To do this, governments need to experiment with new theory and methodologies. These include techniques from service design research that focuses on user experience and co-creation practice; and strands of evolutionary economics that focus on managing complex systems under conditions of uncertainty. Avoiding market failures is clearly not enough when a wider set of policy actions are required.

To enable a successful Industrial Strategy that can leverage the kinds of policy instruments discussed elsewhere in this report, a fundamental reappraisal of the role of public policy is required. This should go beyond the traditional ‘market failure’ framework to a ‘market co-creating’ and ‘market-shaping’ function. This new role would widen focus from marginal improvements in allocative efficiency driven by notions of ‘value for money’ to a broader notion of public value creation driven by public purpose<sup>40</sup> (see Table 1 below). Such a framework needs to be able to capture spill-over effects and structural changes to the economy that result from policy interventions.

**Table 1: Market-fixing vs market-shaping analytical frameworks (from Kattel et. al. 2018)**

	<b>Market-fixing</b>	<b>Market-shaping</b>
Justification for the role of government	Market or coordination failures: <ul style="list-style-type: none"> <li>▪ Public goods</li> <li>▪ Negative externalities</li> <li>▪ Imperfect competition/information</li> </ul>	Markets and institutions are co-created by public, private and third sectors. Role of government is to help markets support public purpose, also by involving users in co-creation of policy
Business case appraisal	<i>Ex-ante</i> CBA – allocative efficiency assuming static general relationships, prices etc.	Focused on systemic change to achieve mission – dynamic efficiency (including innovation, spill-over effects and systemic change)
Underlying assumptions	Possible to estimate reliable future value using discounting. System is characterised by equilibrium behaviour	Future is uncertain because of potential for novelty and structural change; system is characterised by complex behaviour
Evaluation	Focus on whether specific policy solves market failure and whether government failure avoided (Pareto-efficient)	Ongoing and reflexive evaluation of whether system is moving in direction of mission via achievement of intermediate milestones and user engagement. Focus on portfolio of policies and interventions, and their interaction
Approach to risk	Highly risk averse; optimism bias assumed	Failure is accepted as a learning device

Currently, influenced by the market failure framework, policy appraisal techniques are usually based upon a static form of **ex-ante cost-benefit analysis** (CBA). To enable market-type price comparison of interventions whose return will vary in terms of time, CBAs typically make use of a 'discount rate' that reflects the time preference of users of the service for having money now rather than in the future. After adjusting for inflation and discounting, costs and benefits can be added together to calculate the net present value (NPV).

The overall framework remains rooted in the idea that creating a 'market price' for interventions will enable the most accurate decision to maximise welfare and public value. CBA and NPV are mostly aimed at preventing costly government failures; by their very nature, they cannot tell us much about proactive market creating and shaping.

Theoretical and practical approaches to policy evaluation should be enriched and diversified to create the abilities needed to deliver challenge-driven policies. Governments should embrace

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new tools and techniques from service design research and from evolutionary economics and related disciplines that focus on shifting and shaping technology and innovation frontiers and managing complex systems in contexts of uncertainty.<sup>41</sup>

Further research, based on practical policy experience, is needed to flesh out mission-oriented policy evaluation frameworks at both the microeconomic and macroeconomic levels.

### **Implementation step 5**

BEIS and the HMT must develop alternative models of policy evaluation and appraisal that go beyond a cost-benefit approach. These methods must account for dynamic effects and go beyond conventional market-fixing methodology, allowing active market-shaping or market-creating through the Industrial Strategy to solve socio-economic Grand Challenges.

The government publishes additional guidance for evaluation processes in the Magenta Book,<sup>42</sup> which is important for innovation policy evaluation and builds in narratives and trajectory measures as evaluation tools. As part of the above implementation step, these tools should be expanded to include more dynamic quantitative evaluation tools as well as narrative analysis.<sup>43</sup>

When developing policy proposals for evaluation, it is important to understand the landscape within the area where the policy is to have effect. In a grand challenge this cause-and-effect relationship can be both dynamic and opaque.<sup>43</sup> Whilst missions aim to stimulate broad bottom-up innovation, in any environment where decisions have to be made within a constrained budget, this understanding of the blockages and drivers towards achieving a mission is important. Innovation is also a highly uncertain process with unexpected results that requires a more robust attitude to risk. To this end, it is worth exploring methods for understanding complex environments to devise a more flexible framework.<sup>44</sup> Systems modelling or mapping is a particularly useful technique with many tried and tested applications.<sup>45</sup>

### **Implementation step 6**

Systems modelling or systems mapping should be explored between BEIS and HMT as a framework for understanding, evaluating, and assessing policy interventions aimed at tackling Grand Challenges.

**“Organisations that have successfully tackled ambitious mission-oriented projects in the past have implemented structures that are flexible, adaptable, and able to foster bottom-up solutions.”**

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## 4.1.2 Public sector capabilities and structures

**What new capabilities will be needed in the public sector? How can the Industrial Strategy break silos within government to reach towards grand challenges? What kind of agencies and what type leadership are needed to manage missions?**

Missions are an end to 'business as usual' for public-private interactions and will require state agencies to be much more active in their role as co-shapers of markets. Civil servants themselves will need new skills to successfully manage this transition, such as complex systems analysis and innovation network management.<sup>46</sup> Missions require public actors to think outside of the box, both in helping to frame inspirational missions and in using government levers (from grants and loans to prizes and procurement) to crowd-in and galvanize new activity. The Mission-Oriented Innovation Network (MOIN), hosted by the UCL Institute for Innovation and Public Purpose (IIPP), which brings together global mission-oriented organisations, is creating a new public sector toolkit for mission-oriented policies.<sup>47</sup>

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### Cross-government working

To successfully deliver missions and meet the grand challenges, new governance structures within the public sector are needed. These structures must enable cross-sectoral and cross-institutional coordination, which means working across government silos and departments. Breaking silos means taking innovation outside of the ministries of business or innovation and putting it at the centre of economic growth strategies. This means coordinating mission strategy within the highest offices of executive power (such as the Cabinet Office and the Prime Minister's Office) and ensuring top talent lead such units. The Industrial Strategy should be at the heart of the UK's economic policy.

If we are to achieve the goals of a mission-oriented Industrial Strategy, these mission teams must operate across Whitehall, drawing on the expertise of all government departments and agencies. They must also be fully resourced, both in terms of financial means but also resources in terms of staff and analytical capability. The home for these grand challenge teams could be in BEIS, but the Office for AI is a good example of an independent, cross-department unit. These teams also need to work closely with the private sector to promote business investment and ensure these missions are not just public sector projects.

#### Recommendation 6

A mission-oriented industrial strategy works best when it is implemented across all departments. By being cross-sectoral and inter-departmental, it can effectively foster and influence the way in which tools – from grants, loans and procurement policy – can be used to crowd-in bottom-up experimentation. This should include dedicated autonomous grand challenge teams which require dynamic capabilities. **The machinery of government must become more agile and work across silos between departments to take a new and innovative approach to industrial and innovation policy spurred by missions and grand challenges.**

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## Implementation step 7

To implement and deliver a mission-oriented industrial strategy, the Government should form multi-disciplinary, cross-departmentally-staffed, boundary-crossing Grand Challenge teams. These must be fully resourced, both in terms of funding but also in terms of leadership, staff, support and analytical capability, with operational autonomy to set their own goals and programmes, as well as senior reporting responsibility within government and the freedom to take initiative in a given challenge area.

### Case Study: The Government Digital Service

The Government Digital Service (GDS) was launched in 2010 with the intention of breaking up the oligopolistic market of government IT procurement, decreasing the huge costs related to it and radically changing service delivery by creating an agile culture of service design that focused on user experience.<sup>48</sup> This entailed attracting top design and software talent to the government and rethinking what was measured and evaluated, and why. At the outset, GDS director Mike Bracken was asked to make savings targets the main KPI for the new agency. He refused to do this and instead implemented lower level, user-focused KPIs, aimed at creating a unified user experience through the gov.uk web domain (and its underlying infrastructure) and using agile service design processes (fast prototyping, constant user research). By doing so, the GDS saved the government £1.7 billion, diversified the IT supply chain (instead of a handful of large vendors, the UK Government now procures from approximately 3000 smaller companies) and created an award-winning domain. Importantly, GDS focused not only on creating something new, but also taking offline existing poor-quality online services and preventing cumbersome solutions from being deployed. While focusing on achieving a concrete outcome and not targeting static cost metrics, it achieved greater efficiency (and lower costs). For instance, the prototype for gov.uk was created in 12 weeks, costing only £261,000.

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## Capabilities and a portfolio-minded culture

Over the past decades, many public organisations have focused on increasing efficiency of the public sector. While efficiency is a crucial indicator of a successful public organisation, many of the reforms have outsourced key capabilities and thus hollowed out public organisations.<sup>49 50</sup> The capabilities to formulate strategic goals (within political and legal constraints) and align organisational resources to achieve these goals have been damaged.<sup>51</sup> Solving big problems does not necessarily equate with big organisations. Mission-oriented policies aimed at creating and shaping markets create a need for **new dynamic capabilities in the public sector**. Policy-makers must be more than simply project or programme managers. The complex network of interactions that stem from a bottom-up approach will require civil servants to manage a complex network of interacting innovation projects. This poses challenges such as how much civil servants should influence policy agendas, and whether civil servants need specialist engineering, design or science skills along with managerial capabilities. This might mean finding ways to bring in engineers and similar high-end skills on temporary basis (such as secondments).



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What can we learn from organisations like DARPA or ARPA-E in the USA or the German Fraunhofer Centres<sup>52</sup> to ensure we achieve missions? Organisational flexibility of mission-oriented investment and financing agencies is particularly important to enable rapid response to different conditions and to develop novel technologies. This agility can be enabled by granting the organisation operational autonomy from responsible government departments and giving them outcomes-based (rather than only outputs-based) reporting responsibilities to senior politicians or public servants (see Public Sector Capabilities section). As discussed here, public organisations such as DARPA have played a major part in the innovation chain by supporting the translation of research to viable businesses. This is a key push of the Industrial Strategy and all the Grand Challenges: various public agencies have to be given operational autonomy in achieving relevant outcomes, but these agencies must also be aligned in a ‘mission pipeline’ or ‘value chain’. It is important that Catapults remain funded by both the public sector and the private sector, in collaboration.

Organisations that have successfully tackled ambitious mission-oriented projects in the past have implemented structures that are flexible, adaptable, and able to foster bottom-up solutions. Again, typical cases include DARPA or ARPA-E in the USA<sup>47</sup> and other innovation and funding agencies across the world, such as Yozma in Israel and Sitra in Finland, or Government Digital Service in the UK. Management of a mission-oriented system of innovation will require specific types of leadership, and here one can learn from best-practice scenarios.

The DARPA model has been much studied and replicated. The European Commission is currently setting up a DARPA-like organisation called the European Innovation Council with a remit to boost innovation projects. The defining characteristics of the DARPA model,<sup>53</sup> are

1. Organisational flexibility
  - a. Independence from branches of government
  - b. Flat internal structure
  - c. Hiring outside government regulations
  - d. Fixed-term employment of directors and project managers
  - e. Flexible contracting mechanisms
2. Bottom-up programme design
3. Discretion in project choice
4. Active project management

DARPA-style mission agencies emphasise the need for discretion in project selection and active project management. This entails empowering teams to decide how to distribute funds and resources within a project, and to make decisions on milestones and technical goals throughout the project’s lifetime. Mission projects, by definition, require the creation of new knowledge or experience, and therefore pose challenges for conventional project evaluation frameworks. For instance, by empowering individuals within a horizontal (non-hierarchical) organisational structure, DARPA allows project managers to use their own expert judgement and discretion. These organisations also tackle the conundrum of when to carry on and push forward with a new technology and knowing when to change direction by entrusting individual project managers to make these decisions independently.

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In addition to the above characteristics, they come together to form a complementary package of organisational behaviours that contribute to the success of the mission organisations. This means caution about attempting to pick or choose single elements of the model while hoping for the same results.<sup>54</sup>

### **Implementation step 8**

Missions require new dynamic public sector capabilities, such as the ability to experiment, explore and learn. We recommend the government consider the flexible and adaptable DARPA-style model. Not everything will work, nor should it be expected to. Risk aversion is the enemy of innovation. The DARPA portfolio approach welcomes risk-taking across the four Grand Challenge areas.

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## **Leadership**

Leadership is an important determinant of success in a mission-oriented approach. If missions can be attached to an individual or individuals who can inspire the public and policy-makers around the importance of a mission as well as catalysing change, this can transform the likelihood of achieving the goal.

Leadership has political and managerial aspects. Missions require bold leaders willing to take on risk and create space for cross-departmental mission teams. Missions also require skilful managers to work with political and expert networks within government, and engage with the private and third sectors.

Such leadership also requires trustworthy networks, which can be provided by councils of passionate and inspirational champions from across relevant industries and academia. If such councils are formed around the remit of a grand challenge, this can be particularly successful, as in the case of the AI Council, which was formed to advise the Office for AI. As identified above, given the importance of breaking down government silos and departmental boundaries, these councils should report to the prime minister and senior ministers, as well as being assessed by the Industrial Strategy Council.

The success of a mission-oriented Industrial Strategy is communicating the above to the general public. By directly connecting innovation and industrial policy to citizens' concerns they can be involved in both setting the challenge and developing the solution (see Section 4.1.4). Given their senior positions, potential public recognition, and experience in the grand challenge areas, these advisory councils should have a major role in communicating the purpose of challenges and missions to the general public.

### **Implementation step 9**

Government should form advisory councils for each Grand Challenge recruited from senior levels of academia and industry, with the express purpose of communicating and inspiring politicians, policy-makers and the general public around the Challenges.

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## Technical and sectoral support and know-how

While the number of civil servants has grown, despite successive reforms aimed at slimming the public sector, public organisations lack high-end engineering and research skills. Some public research capacity has also shrunk or been privatised, such as the transformation of the Defence Evaluation & Research Agency (DERA) into the private company QinetiQ. Similarly, government nuclear power research capacity has shrunk. However, positive steps such as the founding of public-private initiatives such as Catapult centres on the model of the German Fraunhofer Institutes have been successful in overcoming some of these issues. These public and private research organisations are vital to the innovation process because they house absorptive capacity to deploy and apply technologies<sup>55</sup> and they bridge technology R&D to sectoral capacities. For example, the Catapult centres are part publicly funded and part privately funded and are directly focused on stimulating sectoral capacities and capabilities. They provide a template which can avoid time-consuming design of individual tailor-made institutes for a new technology or research area. They can also be a safe-haven, avoiding Britain's long term trend for research institutes to end up in universities or be privatised having begun within the public sector.

Policy making teams must be able to draw on technical know-how, not simply public policy experience, to be able to identify what policy levers can be used to drive innovation in each challenge area (see sections on Regulation and Procurement). In this report we recommend a parallel strand of Industrial Strategy focused on technology development, the reinforcing of government R&D structures and support for the innovation ecosystem. If these things are achieved then this innovation system should be able to provide the technical and technological expertise and know-how that the policy teams can draw on. We believe that this requires central coordination, which should be performed by technical grand challenge teams that complement the policy grand challenge teams. This technical capacity can co-ordinate ongoing research relevant to challenges and missions across UKRI, national labs and Catapult centres, as well as providing vital expertise on policy areas such as procurement and standards.

In Section 2.4 we argue new technologies will be essential to solving the grand challenges of today but at early stages of maturity these technologies can be hard to associate with a concrete mission. Therefore, technological fore-sighting capacity is needed in government to promote the Industrial Strategy. It is currently based in the Office of the Government Chief Science Adviser and does very useful work but should be complemented by an increase in the capacity within Innovate UK. Indeed Innovate UK has a crucial role to play as the nation's innovation agency and needs to have the capacity to do this. Specific technical teams could also be housed in existing organisations such as UKRI, Catapult centres, or bodies such as the Alan Turing Institute.

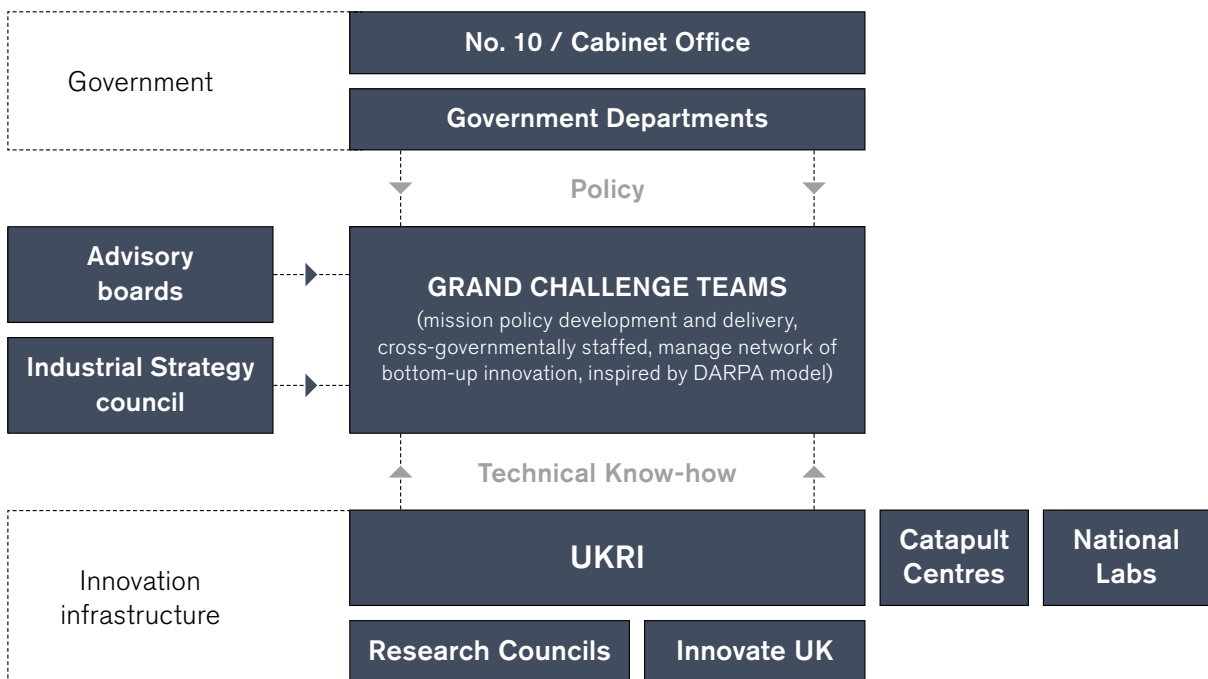
### Implementation step 10

Government should form technical teams based on each Grand Challenge to coordinate research and technical expertise to be drawn on by policy-makers, and to provide technology fore-sighting capabilities. Innovate UK needs to be properly resourced to act as a strategic driver of new technologies and promote the challenges and missions.

## Grand Challenge teams across government

The policy challenges of tomorrow will not necessarily accord with the structure of government today. The grand challenges within the Industrial Strategy are bold messages that allow inter-departmental conversations to happen. This must be valued and amplified. Breaking out of silos will be essential in order to make the most of the UK's talent for innovation and international competitiveness in building a better economy.

The structures proposed above are indivisible and will all need to collaborate to successfully harness technologies towards achieving the Grand Challenges. Figure 9 below shows how these cross-departmental teams can work across government, drawing policy expertise from across government departments and bringing technical know-how and expertise from a broad research and innovation infrastructure. These teams would oversee the delivery of grand challenge and mission policies and take leadership and guidance from advisory boards and the Industrial Strategy council.





**“Innovation and industrial policy needs longevity and consistency to succeed.”**

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### 4.1.3 Metrics and the Industrial Strategy Council

#### How can missions determine ‘what does good look like’? How can the Grand Challenges feed into metrics overseen by the Industrial Strategy Council?

In November 2018, the Government announced the formation of the Industrial Strategy Council (ISC) to be chaired by Bank of England Chief Economist Andy Haldane. The council has a remit to set the vision for the Industrial Strategy, to develop measurement metrics for its success, to evaluate the success of existing programmes and to imagine “what good looks like”. The ISC works across the three main strands of the strategy: sector deals, foundations of productivity, and – most importantly in this report – the Grand Challenges.

The ISC is a critical organisation in setting the vision for what broad strategic interventions in the economy can achieve. The Industrial Strategy Council is currently constituted as a non-statutory body that cannot make fiscal or public policy recommendations to government. Given the importance of the Industrial Strategy at the heart of the UK’s economic plan (see Recommendation 1), an empowered Council should work closely with central government to recommend policy activities. Innovation and industrial policy needs longevity and consistency to succeed. The sudden reduction in feed-in tariffs in the UK renewable energy sector is a notorious example of how unexpected change harms business. To ensure the longevity of the Industrial Strategy, we recommend placing the ISC on a statutory footing with a clear mandate, like other governmental oversight bodies such as the Committee on Climate Change or the Office for Budgetary Responsibility.

#### Implementation step 11

The Industrial Strategy Council should be made a statutory body that can oversee and recommend policy to government and give longevity and consistency to the Industrial Strategy as a whole.

#### Case Study: The Committee on Climate Change

In the UK, the 2008 Climate Change Act mandated the formation of a statutory Committee on Climate Change (CCC), which had the ability to advise government and to recommend specific targets to government and monitor progress towards them. The CCC is a statutory independent advisory body that does not have the ability to mandate policy, but instead relies on the risk of political embarrassment that might arise from ignoring an esteemed panel of experts. The CCC is broadly seen to have been a successful policy innovation.<sup>56</sup> A recent study of the CCC’s successes and failures, as well as its institutional characteristics, found that its ability to influence the government’s position and its long-term success were “because it has a clear statutory mandate, a high-profile chair, sufficient resources and skills, and a track record of rigorous, independent analysis”.<sup>50</sup>

A significant body of work for the ISC is the development of success metrics for the various component parts of the Industrial Strategy. The broad-based “foundations of productivity”, such as business environment or infrastructure, need attached measurements in order to evaluate their success in achieving the aspirations of the strategy as a whole. Similarly, the sector deals made between central government and different industrial sectors need to be assessed as to their quality and whether they offer additionality on top of what would have happened already.

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To successfully achieve the missions set by Government, all parts of the Industrial Strategy have to come together to form a functioning innovation system. Therefore, ambitious success measures across all parts of the Industrial Strategy are required. This will be vital to developing the new science and technology to meet today's challenges as well as those of the future.

The missions under each Grand Challenge carry inherent success metrics. If the missions are framed as time-bound, measurable targets that are clear in terms of whether they are achieved or not, these are metrics in their own right. The success of the mission-oriented approach relies on a long-term outlook, and the cross-sectoral, bottom-up development of solutions. Furthermore, missions stimulate dynamic, technological spill-overs that should be successfully captured. This is a further potential metric for the ISC.

### **Implementation step 12**

Because missions are already framed in a time-bound and measurable manner, we recommend that the Industrial Strategy Council adopt the completion of missions as a key metric of success of the Grand Challenges Programme. Another metric should include the degree to which dynamic spill-overs to multiple sectors have occurred along the way.





**“Missions supply a framework for collaboration. A sense of shared purpose should bring together coalitions and movements to share resources, across the public and private sectors for the sake of a common endeavour.”**

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## 4.1.4 Citizen and public engagement

### How can missions engage citizens in innovation policy? Who is innovation for?

While missions have the ability to solve society's challenges, it is vital that we ask who decides which challenges get chosen. The Government's Industrial Strategy sets ambitious targets for raising the UK's productivity and prosperity, but these metrics are more economic than social. For the Industrial Strategy to have effects that are recognised by the public, it must address problems that matter to the public. People must feel a difference. This is what we mean when we say that missions must tackle challenges that have broad societal relevance.

Missions present an opportunity to put citizen participation at the heart of innovation policy and to directly connect R&D spending and broader policy measures to issues that matter to people. For example, remedial climate change action is now being driven by citizen campaigns, not just focused on R&D but on habitual activities, ranging from flying to drinking through plastic straws. Parliament also has an important role in this regard.

#### Recommendation 7

Citizens must be engaged in the creation, selection, implementation, and assessment of missions to ensure that a mission-oriented industrial strategy solves problems that matter to them. An industrial strategy designed around grand challenges and support for general purpose technologies can capture the imagination of citizens and provide a framework to mobilise supporting social and behavioural change. **Government should use innovative technologies and the Grand Challenge programme to connect innovation to citizens and citizens to innovation.**

Missions supply a framework for collaboration. A sense of shared purpose should bring together coalitions and movements to share resources across the public and private sectors for the sake of a common endeavour. Missions to create new systems depend on alliances of investors, entrepreneurs, regulators, and consumers who bring about transformation.<sup>57</sup>

These “coalitions of transformation” are the agents of mission-driven innovation. Policy makers need to frame missions with the creation of these coalitions in mind. Whereas sectors and champions have been the agents of traditional industrial policy, coalitions and movements are the agents of mission-driven innovation. Mission-oriented innovation addresses the social impact of innovation on issues that matter to citizens, as expressed by the UN Sustainable Development Goals for healthy living (SDG-3), and for climate (SDG-13).

While solving challenges has always been key to UK industrial and innovation policy, missions are more concrete and defined in outcome, and broader in terms of policy instruments used. The critical questions are: Who should decide what the missions are, and what kind of accountable processes lead to decisions on missions? To galvanise private investment and inspire society at large to focus on long-term societal issues, missions need to have widespread legitimacy. There needs to be strong level of trust in the process of mission-setting.

Missions can be set by different actors. That is, missions work as a framework for innovation because they set a targeted goal which creates a space in which different actors can create new innovative solutions from the bottom up.

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How missions can be opened to a wide group of stakeholders, from individuals and civil society organisations to citizen movements, is critical to forming missions and to ensuring their longevity? This must involve looking at how this is articulated both within and without the democratic process. For example, Germany's *Energiewende* agenda was attributed to society's cumulative interest as much as the deliberative activities of the Green movement. Ultimately, in a parliamentary democracy these decisions must be made by elected politicians but these wider campaigns push out the boundaries of what is politically possible – the impact of Sir David Attenborough's *Blue Planet* television programme (BBC) on plastic waste in our oceans is a vivid example.

Furthermore, transition from a market-fixing to a market-shaping framework, which is critical to mission-oriented policies, involves rethinking and redefining the meaning of public value. This must include a consideration of public demand that is voiced through political parties, single-issue organisations, political movements, and individuals. In a digital age, this process can be facilitated in entirely new ways and citizen consultations can use modern technologies and social networks. However, public value is not just what citizens demand today, but what they may need or desire in the future. This tension between opening mission-oriented frameworks to citizens, whilst avoiding capture by passing trends, will be a difficult aspect of governing this framework.

We can identify defined stages of a mission-oriented approach that require citizen engagement:

- Development of missions from broad challenges
- Design of policy projects in each mission area
- Participation in implementation of mission and deployment of policy
- Evaluation and monitoring of overall missions

Each of these stages must be actively co-created with citizens, either individually, through modern technologies, by harnessing missions, or by working in collaboration with civil society organisations.

### **Implementation step 13**

Grand Challenges and missions must address society-wide issues and be accountable to citizen concerns. Models of co-creation, co-design, co-implementation, and co-evaluation should be developed upon international exemplars to ensure the legitimacy and longevity of missions.



**“A mission-oriented industrial strategy needs to understand what policy levers and incentives are available and when and how they need to be transformed to be used effectively.”**

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## 4.2 Instruments

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### 4.2.1 Policy levers and incentives

#### **To transform the government from a market-fixer to a market-creator or shaper, what broader levers are available to policy makers to drive innovation?**

The aim of a mission-oriented industrial strategy is to not only direct innovation towards solving broad challenges, but to also capture technological and economic spill-overs of the innovation towards these goals. Therefore, a mission-oriented industrial strategy needs to understand what policy levers and incentives are available and when and how they need to be transformed to be used effectively. The current strategy delivery is dominated by R&D funding through new Industrial Strategy Challenge Fund (ISCF) structures. Whilst these are a positive development, a wider range of government actions are needed to generate and shape activity to deliver the strategy. Potential supporting policies a government can offer include:

- 'Blue sky' science financing
- Support for technology development (bridging the so-called 'Valley of Death')
- Standards development
- Challenge prizes
- Public procurement
- Regulation and legislation
- Debt or equity investments
- Direct commissioning of relevant research by government departments, which might be separate from (and additional to) the UKRI budgeted funding

If this Industrial Strategy is to succeed on its own terms, both in the vision of creating a UK that is internationally competitive and on measures such as increasing R&D expenditure, it is vital that all of these levers are made available and used across government departments working in collaboration.

#### **Implementation step 14**

The government should undertake a review of policy measures and instruments, and their potential to align with each of the Grand Challenges and missions, and to support general technology development. Alignment across government should include a systems-wide approach to fiscal and tax environment, regulation and standards, business investment and procurement.

Changing innovation or industrial policy requires systemic change.<sup>58 59 60</sup> This requires both highly targeted funding calls for the development of key technologies (**directed funding**) and general subsidies for innovation across the economy, such as through tax incentives (**indirect funding**). Direct support should be the most important form of state action in the Industrial Strategy as it creates a real expectation of growth opportunities in challenge areas.<sup>61</sup> This anticipation of future growth means that direct supports have greater additionality than indirect supports such as R&D tax credits.<sup>62 63</sup> Companies invest in R&D not just because of

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profit margins, but also because of expectations about future growth and market opportunities. Direct funding structured through a mission-oriented framework of broad-based interdisciplinary innovation and support for emerging technology is the best way to deploy the Industrial Strategy.

To date, funding directed via Innovate UK through ISCFs has been towards a wide range of different programmes. Some of these have been highly directed towards the aim of developing specific technologies or economic sectors. Examples include the Faraday challenge for battery technology is firmly in the territory of applied technology development and the Transforming Construction challenge is linked to the construction sector deal. Whilst these are important, they are not *challenge* programmes. Part of the reason why these challenge funds have been devoted to non-challenge related work is that there are currently no other means available to support the development of general purpose technologies outside the remit of grand challenges. Arguably, these have only partially solved *challenges*. For example, there are many related, but less prominent non-technological barriers to the adoption of electric vehicles beyond batteries, such as provision of charging infrastructure and city planning requirements, the development of a 'smart' electricity grid to balance and smooth supply and demand, and novel business models for the shared ownership of vehicles. This is an example of the limits of looking through the lens of a single industrial sector or technology rather than a much broader socio-economic challenge. It happens because of the absence of a distinct and substantial programme of funding technologies.

#### **Implementation step 15**

Industrial Strategy Challenge Funds should be specifically targeted towards achieving missions and developing solutions to Grand Challenges. To this end, they should be designed such that they are outcomes-driven rather than technology-specific in order to aid the adoption of technological and behavioural change.

#### **Implementation step 16**

Industrial Strategy Challenge Funds should be complemented by separate and parallel technology funding that is explicitly directed towards the support of emerging and early-stage technologies. Government must ensure that the pursuit of missions and Grand Challenges does not crowd-out technologies that are yet to link to missions. The government must have a clear strategy for both technology support and mission innovation.

As ISCFs are currently the most used lever to effect policy, they have become the most visible component of new policy originating from the Industrial Strategy. However, despite being explicitly named to align with the Grand Challenges, other areas of the strategy, such as the foundations of productivity and the sector deals, also emerge publicly through ISCFs. The fact that the ISCF calls are often not attributed to the policy in the strategy they support can be confusing; it can appear that the grand challenges are not endorsed by major policies or spending but are simply aspirations or targets. Other policies have also been announced, such



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as the Future Homes Standard announced in the Spring Statement 2019, which clearly support the Government's first Clean Growth mission for energy-efficient buildings. However, these are not connected, either in the announcement or in supporting press or website communications, to the mission or the grand challenge. This is a missed opportunity for BEIS to show that missions are leading to concrete policy development.

### **Implementation step 17**

BEIS should, through external communications, explicitly demonstrate links between the bold top-level aspirations in the Grand Challenges and the missions, and the policy and spending commitments being announced from across government – including other departments and agencies such as Innovate UK and other funding bodies.

**“Using public procurement to incentivise innovation and alignment with strategic industrial aims can provide meaningful results with minimal added spend.”**

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## 4.2.2 Public procurement

### How can government instruments like procurement and prize schemes be used to stimulate experimentation to solve a mission?

A desirable outcome of any audit of policy instruments is a cross-government notion of an 'innovation budget', especially one that supports innovation based on cross-policy agendas and not just procurement. This is vital across the UK Government. Innovation is not just the purview of BEIS; it is spread between UK Research & Innovation (UKRI) as well as all government departments. Governments have buying power through their procurement budgets as well. Cross-departmental procurement should become part of the mission-oriented process.

Thus, innovation should not be viewed as just a small subset of spending but as a vital consideration for how *all* government budgets can be used to drive maximum return on investment. Using public procurement to incentivise innovation and alignment with strategic industrial aims can provide meaningful results with minimal added spend.

In 2011, the House of Lords Science & Technology Select Committee made broad recommendations to empower ministers for procurement.<sup>64</sup> The Royal Society of Arts, Manufacture and Commerce (RSA) published reports on the importance of systems thinking and policy design in the context of procurement,<sup>65</sup> and the Small Business Innovation Research Programme in the USA has been used as a model in various international contexts.<sup>66</sup> Given that procurement can drive both innovation and economic growth whilst also saving government and taxpayer money in the long term, it must be a major consideration of an industrial strategy.

#### Case Study: CivTech in NHS Scotland

A useful example of how agile procurement can stimulate innovation is the CivTech scheme being delivered by the Scottish Government, particularly its use in NHS Scotland. CivTech allows both public customers and private providers time for problem definition and for pre-commercial development.

This drives procurement and regulation together in a co-creation environment between purchaser and supplier. Procurement often has a bias towards low risk and high value, which excludes newer, innovative companies.

CivTech counters this through a staged selection process that allows providers to build 'increments of trust' to enable the public sector to work with a wide range of solution-providers, including start-ups and more established and mature SMEs. CivTech de-risks this approach by providing a suite of workshops on business, tech and personal development that prepares these innovative companies to work with the public sector.

Citizens are essential contributors to the formation of challenge solutions (for example, young people being the challenge sponsors and leading all aspects of selection and review of the solutions for an early mental health intervention app) and the scheme both creates and protects room to learn and fail fast.

The Industrial Strategy must **stimulate demand-side policies** to drive innovation.<sup>67</sup> To date, the Industrial Strategy could be seen to be very supply driven, as its primary tool has been increases in R&D funding. The aspiration to raise gross R&D spend to 2.4 per cent of GDP from the current level of approximately 1.8 per cent of GDP is welcomed; however, it will not, on its own, drive demand as well as supply. The much larger sums of money spent by the

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state through public procurement – currently approximately 13.7 per cent of UK GDP<sup>68</sup> – represent a significant demand-side stimulus. Therefore, aligning this entire procurement spend with the Industrial Strategy objectives is a vital step.

The internet, GPS technology, the semi-conductor industry and passenger jets are perhaps the most prominent examples of **government innovation-oriented procurement** resulting in major economic and social benefits. However, in many cases, procurement ends up simply picking the lowest-cost bid. This does not help to stimulate a broader innovation ecosystem and it rarely delivers value for money in the long run. To do so, procurement of new services or technologies should specify the criteria and characteristics needed, while allowing plenty of space for experimentation within those constraints. Public organisations on a national and local level should consciously develop capabilities for public procurement for innovation. Actively refining problem definitions with commercial providers has had positive additionality (see case study on CivTech below). However, public procurement processes often entail contradictory policy goals (cost savings, value-for-money, transparency). A mission-oriented policy framework offers a way to ‘structure’ these conflicting policy goals by specifying the desired result, not the solution. This specification helps to coordinate procurement processes across value-chains and agencies.

One example of this is how DARPA (see Section 4.1.2) works to crowd-in private-sector collaboration to satisfy public needs (in this case, defence). More recently, efforts have been made to take this same approach in sustainability development via Green Public Procurement.<sup>69</sup>

### **Implementation step 18**

To support the Industrial Strategy through demand-side stimulus, public procurement should be reformed across government to drive bottom-up innovation. This requires new dynamic metrics that go above and beyond short-term cost-effectiveness in procurement decisions.

### **Implementation step 19**

The Industrial Strategy should align departmental innovation budgets with Industrial Strategy Challenge Funds and other funding streams to promote a challenge-based government-wide innovation budget.



**“The effect of finance on the economy is not neutral. The structure of the financial system is key to the successful implementation of mission-oriented policy.”**

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### 4.2.3 Finance and crowding-in funds

#### Are new types of patient finance needed to support missions? How can mission-oriented finance crowd-in other forms of finance?<sup>70</sup>

The structure of the financial system is key to the successful implementation of mission-oriented policy. This is because finance and funding are not neutral. The type of finance available can affect both *where* investments are made and the *type* of activity that is funded.<sup>71 72</sup> The types of financial institutions and markets that exist have a material impact on activity in the real economy. This makes it necessary to rethink the UK's financial ecosystem to foster a greater emphasis on the provision of long-term, patient finance for investment in innovative firms.<sup>73 74</sup> There is an opportunity here to establish a closer dialogue between the Industrial Strategy and the Treasury's work on patient capital to ensure these parallel efforts are co-ordinated. This should be coupled with ongoing considerations of the UK's future access to finance as we leave the European Union, such as Sir Adrian Smith's review of funding structures.

Missions, by their nature, are designed to spur innovation towards addressing societal challenges. By providing a direction for economic growth, missions can also help to 'crowd-in' commercial investment by guiding business expectations about where future growth opportunities might lie.<sup>75 76</sup> However, because innovation is highly uncertain, has long lead times and is collective, innovation requires patient long-term finance. The private sector will often not invest in higher-risk areas until future returns become more certain. In countries that have achieved smart, innovation-led growth, the state has often supplied the long-term patient finance that the private sector was unwilling to provide. In these places, the state has not just sought to fix market failures but has acted boldly to invest in new technologies and create new innovation landscapes by acting as an investor of first resort rather than just as a lender of last resort.

#### Recommendation 8

An ambitious industrial strategy structured around solving grand challenges and stimulating technology development can increase business expectations of growth in new areas stimulating private sector investment, increasing wealth creation. **Catalytic public investments can leverage private-sector investments through a mission-oriented industrial strategy.**

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### **Case study: Scottish National Investment Bank**

In September 2017, First Minister of Scotland Nicola Sturgeon announced plans to establish a new Scottish National Investment Bank to support the Scottish Government's vision for delivering smart and inclusive growth. The announcement was informed in part by advice from IIPP Director Professor Mariana Mazzucato, who has been part of the Scottish Government's Council of Economic Advisors since 2016.

Following the announcement, IIPP was appointed to a small advisory group that was convened to lead the work developing an evidence-based implementation plan. The implementation plan was published in February 2018 and draws on IIPP's research to outline a roadmap for creating a new mission-oriented Scottish National Investment Bank. The proposed vision for the bank outlined in the plan is:

"The Scottish National Investment Bank will provide finance and act to catalyse private investment to achieve a step change in growth for the Scottish economy by powering innovation and accelerating the move to a low carbon, high-tech, connected, globally competitive and inclusive economy."

In March 2019, IIPP published a new report outlining a mission-oriented framework for the bank, which, if implemented successfully, will maximise its potential for promoting transformational change across Scotland's economy (Mazzucato and Macfarlane, 2019). Drawing on international evidence, as well as IIPP's own path-breaking research, we set out clear criteria for designing missions, as well as how a mission-based approach should be implemented in practice.

The bank is expected to become operational in 2020, and will aim to maximise additionality by providing access to the long-term patient finance necessary for ambitious firms to invest in innovation, and for large-scale projects that will help transform Scotland's economy in line with the bank's missions.

As described in the EU high-level report entitled *Accelerating Breakthrough Innovation*,<sup>77</sup> Europe suffers from a systemic failure in its ability to provide the large-scale venture capital needed to achieve market-creating innovation, particularly in areas such as deep tech. In China and the US there are large deep-tech growth funds that can write cheques of €50–100m; these are lacking in the UK and Europe more generally, both from private and public funds. Public-sector support for innovation, including from central government, is often perceived as slow and complex and overly focused on early-stage R&D rather than bridging the gap to private investment. The UK's withdrawal from the European Union and European Investment Fund will only worsen this situation. Efforts should be made to help innovators overcome regulatory barriers and partner with regional, national, and international innovation-related agencies. This is particularly true in deep-tech areas such as big data and artificial intelligence, synthetic biology and advanced materials. This should be coupled with market-shaping government policies setting the direction of innovation and crowding-in investment. It is important to do more to align flows of funding from Innovate UK and the British Business Bank and on to the Business Growth Fund.



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Understanding how this has been done well – what works, and what does not – requires learning from international experiences with financial institutions willing to provide strategic long-term finance. Examples include public venture capital funds, such as Yozma in Israel, state investment banks like the KfW in Germany, or the multilateral banks including the European Investment Bank. In each case, new forms of finance have often involved new forms of financial regulation.<sup>78</sup>

### **Implementation step 20**

The Industrial Strategy can help align finance with the needs of investment-led growth. It is an opportunity to promote investment and innovation across the private sector. Innovation requires long-term, mission-oriented, patient finance. Lessons can be learned internationally, through the way in which public venture capital funds have operated, and/or lessons from public banks. The latter may require raising the capitalisation and reforming the remit of the British Business Bank.

### **Implementation step 21**

The Industrial Strategy should be used as a tool to make strategic interventions in the economy to drive UK competitiveness and, through market-opportunity creation, crowd-in different forms of finance (such as venture capital) into technology priority areas.

**“Places and cities are key partners  
in driving missions forward.”**

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## 4.2.4 Local Industrial Strategies

### How can Industrial Strategy on a local or regional level amplify or accelerate the delivery of national challenges?

The Industrial Strategy rightly recognises the importance of *places* in delivering a national strategy. This is even more true for a strategy that has an explicit ambition to redress imbalances in productivity between the different regions of the UK, and in an environment in which some powers are devolved to a range of national, regional and district stakeholders. For example, adult social care budgets – a key concern when considering the Ageing Society grand challenge – are held at the local level. The development of Local Industrial Strategies (LIS) to complement the national strategy is welcome. However, it is not yet clear how each LIS must address the Grand Challenges component of the national Industrial Strategy: whether they have to demonstrate delivery of the specific national missions, or whether they just have to demonstrate activity loosely linked to the Grand Challenge areas. IIPP have worked with the Greater Manchester Combined Authority to imagine what a mission-oriented approach may look like in a city or regional context.<sup>79</sup>

From the perspective of a mission-oriented Industrial Strategy, places and cities are key partners in driving missions forward. Cities can more easily ‘converse’ with their citizens on missions and consult deeply with communities on where innovation should be directed (see section on citizen engagement). As innovation is a highly localised process that often occurs most intensely in a handful of locations, places can more easily connect with key innovation stakeholders. Finally, as so much of the delivery of the Grand Challenges concerns the built environment, attempts to achieve this without considering the unique local context for delivery will fail. For example, the first Clean Growth mission is on building energy efficiency, and considerations of our Ageing Society must consider the buildings people live in and how they get around.

#### Implementation step 22

The government should clarify how the development of Local Industrial Strategies should speak to the aims of the Grand Challenges or aid the delivery of missions.

Missions can also be used to bring together diverse policy-making tools in a certain place to either develop economic strategies for the location or in place-making. Consider the example of the Scottish National Investment Bank (SNIB), which has been founded with an explicitly mission-oriented remit. One mission area for SNIB is “promoting inclusive growth through place-making and local regeneration, including site preparation, infrastructure (transport and communication links) housing and related commercial, education and health investment”. The UK has some of the highest inter-regional inequality in the industrialised world.<sup>80</sup> Some of the suggested causes of this inequality are ‘wicked’ in that they are diverse and hard to differentiate. As highlighted by the SNIB place-making example, a range of factors from education to infrastructure, housing to local governance, all matter. Therefore, local Industrial Strategies should take the lead from the national Industrial Strategy and consider whether local missions or missions framed in place-making terms are appropriate.

Finally, the fact that location can play a unique role in the innovation process must be considered here. For an innovative technology to reach widespread adoption, it must go through a challenging scale-up process. This can involve gaining regulatory acceptance, cost-reduction, expansion of the means of production and implementation challenges. Regions or cities can play

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a significant role in this through becoming test-beds or sandboxes for certain technologies to aid their scaling-up. For example, a region could position itself at the forefront of the zero-carbon hydrogen vehicle sector by using all the regional policies of technology and business support, local tax breaks, regional government support and nimble regulation. This would not only draw in investment, but also play a part in the development of a technology that could then be further implemented nationwide.

### **Implementation step 23**

The development of Local Industrial Strategies should be taken as an opportunity to test and trial novel and strategically important Grand-Challenge-related technologies at a local level, giving them support on their route to national or international adoption.



**“Different forms of support are needed as technologies mature – standards and regulation are an important part of this innovation ecosystem.”**

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## 4.2.5 Standards and regulation

### What is the role of standards in the adoption of innovative technologies?

Technology development – to mission-oriented ends or otherwise – often means improving performance; for example, in home insulation or energy-efficient vehicles. Strong and progressive standards can drive positive behaviours in the private sector. This point has particularly emerged from such Grand Challenges as Future of Mobility and Clean Growth, where changes or improvements to buildings and cities will be needed, but there are no reasons standards cannot be used across the entire Industrial Strategy. Regulations that are poorly written or based on existing technologies rather than with an eye to new ones can hinder innovation. The Industrial Strategy must tread a fine line between harnessing regulations and standards to nurture disruption and avoiding capture by vested interests, protecting incumbent technologies or serving as a burden on innovators, thereby hindering their good work.

Different forms of support are needed as technologies mature – standards and regulation are an important part of this innovation ecosystem. A 2012 study for BEIS<sup>81</sup> showed the ways in which advanced economies like Germany and the USA use the standards in industrial policy to a much greater extent than the UK.

Innovation inherently involves a great degree of experimentation and trialling of innovative technologies and practices. Standards are an effective way of capturing and sharing knowledge and experience from these processes. In areas of rapid technological development where cycles of innovation occur at a quicker rate than relevant government regulation, collaborative industry-led standards can be a valuable tool. This is particularly true of critical areas highlighted in the Industrial Strategy white paper, such as autonomous vehicles and cyber-security. Methods of agile or rapid standardisation in a connected and digital world should be developed to ensure that standardisation brings benefits while also being flexible to new sectoral developments. This is relevant across the entire Industrial Strategy but particularly in the Grand Challenge areas where systemic change can be an issue.

Industrial and manufacturing standards, particularly those in advanced economies, can also serve as an important extension of national soft power on an international stage. When adopted nationally and subsequently internationally, these standards can attract business to the UK market. This is an important area of international competitiveness for the UK that has so far been neglected in Industrial Strategy.

#### Implementation step 24

We recommend much greater alignment of the UK's standards development with national policy to more effectively direct innovation in the Grand Challenge areas and extend the UK's influence internationally. Standards agencies should be equipped to undertake projects and trials of dynamic and agile standardisation and regulation to better drive innovation in rapidly developing technical areas.

Regulations must be viewed in the same way as standards, and the Industrial Strategy White Paper has committed to a £10m Regulators' Pioneer Fund, which is a welcome development. Whilst the Industrial Strategy is clear on the need for progressive rules to both protect citizens whilst stimulating and directing innovation, this goes against a long-term government aspiration to reduce the volume of 'red tape'. The UK government's focus around regulation is on reducing

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its burden and cost to business, with little regard for the important role it plays in an investment-led growth strategy. Clarity is needed from government about how these two aims can accord. Indeed, innovative regulation that allows disruption to established markets is currently UK government policy but this is not how innovators see it. This ambiguity must be resolved in order to align rules around innovation with the direction from a mission-oriented industrial strategy. The Better Regulation Executive has a statutory duty to monitor and reduce the burden of regulation but its stated remit does not connect this duty with innovation or growth. While the MOIS Commission views regulation as a critical policy tool at the Government's disposal in pursuing a mission-oriented Industrial Strategy, the interim Better Regulation Framework, published in August 2018,<sup>82</sup> makes no mention of innovation or Industrial Strategy.

### **Implementation step 25**

The government should ensure that the remit of the Better Regulation Executive, and other relevant regulatory agencies recognises the important role of regulation in driving innovation through the Industrial Strategy.







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## 5 Conclusion

The UK Government has an opportunity through the Industrial Strategy to look at industrial and innovation policy in a new way. A mission-oriented Industrial Strategy can harness the potential of technologies and sectors with a revived purpose, to influence the direction of innovation and to generate solutions to grand challenges. A strategy based around bold grand challenges and missions is a way of stimulating innovation, crowding-in investment across different actors (in public, private and civil society organisations), and catalysing new economy-wide cross-sectoral development. The Grand Challenges can position the UK as a leader in four globally relevant areas: Clean Growth, Future of Mobility, Ageing Society and the AI and Data Economy. For the past 14 months, the MOIIS Commission has been working to develop a model of how these Challenges can be translated into missions that are achievable, realistic, actionable and will lead to a step-change in innovation and industrial policy in the UK.

This means rethinking the vertical side of industrial strategy to be less about picking a list of top sectors, and more about considering the problems that multiple sectors can work together on. To do so, sectoral and technological capacity is key so we should not see challenge funding as an alternative to technological or sectoral support. Indeed, we argue for more support for general purpose technologies in parallel with a mission-oriented approach — as well as making economic sense in its own right it also enhances our capacity to tackle challenges in the long run.

The challenge-based approach is different from a conventional focus on particular industries because instead of picking the sectors you pick the problems — and make sure the capabilities to tackle them are invested in.

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In the report, the MOIIS Commission sets out a series of eight bold, top-level recommendations that demonstrate how the Industrial Strategy can:

- Steer the direction of innovation-led economic growth
- Drive the UK's international competitiveness
- Solve grand challenges through cross-sectoral missions
- Support systematically the development of science, technology and the arts
- Nurture sectoral capabilities and absorptive capacity
- Invest in public sector capabilities and work across government
- Connect with citizens, mobilising social and behavioural change
- Leverage and crowd-in other forms of investment

To do this, the Commission has formulated 25 implementation steps that set out how to adapt existing structures, agencies, and instruments to implement this new approach.

This report also describes how the mission-oriented framework of innovation works: it's not easy and we must engage in a learning by doing exercise. We have provided four worked examples of how cross-sector, cross-actor projects can stimulate bottom-up innovation in the direction of solving each of the four Grand Challenges. The examples illustrate the complexity of the process, so the cross-cutting themes that emerge are perhaps the most important lessons in the report. What does a mission-oriented approach imply for procurement policy? What does it imply for cross-departmental collaboration? What does it imply about the current mix of direct and indirect policy instruments used.

If adopted, our recommendations can position the UK as a world-leader in solving societal challenges such as climate change and the future of mobility. The market for such solutions is global. Through this new vision, the Industrial Strategy can deliver innovation-led economic growth that is inclusive, sustainable and globally relevant.

This report is only the beginning. The MOIIS Commission will continue to work with government to steer a mission-oriented approach to a challenge-led investment strategy. Our first phase has been focused on how to frame existing missions in a way that truly create a cross-sectoral, cross-actor and cross-disciplinary dynamic of investment. For example, giving accessibility priority in a Future of Mobility Grand Challenge will inspire innovation for disabilities.

In our next phase, we will ask what the future missions might be. But we as a Commission have also learned that the process of setting missions is just as important as creating them. Hence the need to bring new voices to the table from the private sector, the public sector and civil society. The capabilities required inside the public sector, to both set and manage missions is also key. This includes the capability to listen and engage with other voices. And to welcome the process of exploration and experimentation critical to mission thinking.

We hope this report inspires as a call to action. This is a living document. We will keep working.



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## 6 Appendices

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### 6.1 Appendix A – List of abbreviations and acronyms

AI	Artificial Intelligence
ARPA-E	Advanced Research Projects Agency for Energy
BEIS	Department for Business, Energy, and Industrial Strategy
BRE	Better Regulation Executive
CBA	Cost-benefit Analysis
CCC	Committee on Climate Change
DARPA	Defence Advanced Research Projects Agency (also known as ARPA)
DCMS	Department for Digital, Culture, Media & Sport
DfT	Department for Transport
DIT	Department for International Trade
EC	European Commission
EU	European Union
GDP	Gross Domestic Product
GDS	Government Digital Service
GovERD	Government Expenditure on Research and Development
GPS	Global Positioning System
HARPA	Health Advanced Research Projects Agency
HERD	Higher Education Research and Development
HMT	Her Majesty's Treasury
IIPP	UCL Institute for Innovation & Public Purpose
IPCC	Intergovernmental Panel on Climate Change
ISC	Industrial Strategy Council
ISCF	Industrial Strategy Challenge Fund
KfW	Kreditanstalt für Wiederaufbau
MOIIS	UCL Commission on Mission-Oriented Innovation & Industrial Strategy
MOIN	IIPP Mission-Oriented Innovation Network
NHS	National Health Service
NPV	Net present value

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OECD	Organisation for Economic Co-operation and Development
R&D	Research and development
SDG	UN Sustainable Development Goals
SME	Small or Medium Enterprise
SNIB	Scottish National Investment Bank
UCL	University College London
UKRI	United Kingdom Research & Innovation
UN	United Nations

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## 6.2 Appendix B – List of publications

List of related IIPP working papers and reports:

- Mazzucato, M. (2017). Mission-oriented innovation policy: Challenges and opportunities. UCL Institute for Innovation and Public Purpose, Working Paper Series (IIPP WP 2017-01). <https://www.ucl.ac.uk/bartlett/public-purpose/wp2017-01>
- Mazzucato, M. and Macfarlane, L., (2017). Patient strategic finance: opportunities for state investment banks in the UK. UCL Institute for Innovation and Public Purpose, Working Paper Series (IIPP WP 2017-05). <https://www.ucl.ac.uk/bartlett/public-purpose/wp2017-05>
- Semieniuk, G. and Mazzucato, M. (2018). Financing green growth. UCL Institute for Innovation and Public Purpose, Working Paper Series (IIPP WP 2018-04). <https://www.ucl.ac.uk/bartlett/public-purpose/wp2018-04>
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### 6.3 Appendix C – List of workshops and events

List of meetings, workshops and events co-ordinated by IIPP with government departments and policy-makers which have informed the MOIS commission:

- MOIS Commission meeting with BEIS Secretary of State Greg Clark MP, 6th March 2018, Department for BEIS
- Patient Capital and Industrial Strategy Workshop, 13th June 2018, House of Lords with speeches by Chi Onwurah MP, Vince Cable MP, Lord David Willetts
- BEIS and Treasury Workshop on mission-oriented policy evaluation, 20th June 2018, Department for BEIS
- Meeting with HMT Green Book team, 27th September 2018, UCL IIPP
- Meeting with Office for AI and DCMS team, 8th October 2018, UCL IIPP
- Meeting with HMT and Cabinet Office team on Intangible Assets and Intellectual Property, 12th October 2018, UCL IIPP
- Workshop between MOIS Ageing Society Working Group and the Labour Party Social Care team, 5th November 2018, House of Commons
- Meeting with the BEIS Grand Challenges Analysis team to discuss policy evaluation, 13th January 2018, UCL IIPP
- Meeting with BEIS Grand Challenges Analysis team and Better Regulation Executive to discuss policy evaluation, 30th January 2019, UCL IIPP
- Workshop at the European Commission on the remit and structure of the European Innovation Council (EIC), 22nd February 2019, European Commission, Brussels, Belgium
- Workshop at the Scottish National Investment Bank on mission-oriented finance, 25th February 2019, Waverley House, Edinburgh

The MOIS Commission meetings were held on:

- 6th March 2018
- 10th April 2018
- 21st May 2018
- 26th June 2018
- 27th June 2018
- 5th July 2018
- 17th July 2018
- 3rd September 2018
- 22nd October 2018
- 14th November 2018
- 3rd December 2018
- 14th January 2019
- 12th February 2019
- 18th March 2019
- 2nd May 2019

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## 6.4 Appendix D – How the MOIIS Commission worked

The UCL Commission on Mission-Oriented Innovation and Industrial Strategy (MOIIS) was formed in March 2018 in response to the need within the Government for external advice on how a grand-challenge-type policy programme could be deployed. This was prompted by the influence of Professor Mariana Mazzucato on the Government when it adopted the Grand Challenges as one of the three component parts of the UK Industrial Strategy, launched as a government white paper in November 2017. Commissioners were invited to join on invitation of the co-chairs Lord David Willetts and Professor Mazzucato. Secretary of State for BEIS Greg Clark attended and hosted the first meeting.

Between March 2018 and May 2018, the Commission met 12 times as a group, and six times in breakout groups per challenge area. A unique aspect of MOIIS was its active collaboration with BEIS: each meeting included two or three members of the BEIS Grand Challenges team. MOIIS also led the organisation of workshops in government departments, such as DfT and HMT, to present and discuss the missions concept (see Appendix C)

The Commission was supported administratively by the UCL Institute for Innovation & Public Purpose (IIPP). MOIIS drew heavily on the research expertise of IIPP, and relevant reports and policy briefs are documented in Appendix B. The Commission was directly supported by Dr George Dibb, Head of Industrial Strategy and Policy Engagement at IIPP and UCL Public Policy, who led the preparation of this report.

The MOIIS Commission draws on the broad experience of its members, including three sitting members of the House of Lords, former Chief Government Science Advisers (GSA) and departmental GSAs, practicing civil servants, academics of the innovation system and specialists in each of the grand challenge areas. These working groups developed the revised missions and the mission roadmaps shown in the worked examples in Section 3.

The MOIIS Commission did not engage in new primary research or evidence collection. The recommendations of the commission are drawn from the ongoing research of IIPP and from the experience of commissioners in the key grand challenges areas, as well as on the theory and practices of industrial and innovation policy.

The first months of the Commission were devoted to exploring how the mission's framework, set out by Professor Mariana Mazzucato in an EC report, prepared as Special Advisor for the EC Research Commissioner, on *Mission-oriented Research & Innovation in European Union*.

In May 2018, Theresa May made a speech at Jodrell Bank in which she announced the first mission within each Grand Challenge and thanked the MOIIS Commission for its work.

Through the discussions of Commissioners to formulate the mission roadmaps, several common themes emerged that were common across the implementation and delivery of all the grand challenges, which we call cross-cutting themes. These included government decision-making, widening the range of policy levers available to government, the interaction between public and private sectors, and cross-government working. The cross-cutting themes formed the basis of most of the Commission's meetings. The Commission formed recommendations on how these structures, tools and instruments should be used to deliver a mission-oriented Industrial Strategy.

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## 6.5 Appendix E – Acknowledgements

The MOIIS Commission is hosted and funded by the UCL Institute for Innovation and Public Purpose (IIPP).

This report is authored by the MOIIS Commission, co-chaired by Professor Mariana Mazzucato and Lord David Willetts. The MOIIS Commission is supported by Dr George Dibb (Head of Industrial Strategy & Policy Engagement, IIPP & UCL Public Policy) who co-ordinated the preparation of this report.

First and foremost, this report would not have been possible without time, dedication and work of the MOIIS Commissioners.

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# Endnotes

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