



HM Government

Industrial Strategy

Building a Britain fit for the future



Contents

Foreword from the Prime Minister	04
Foreword from the Secretary of State	06
Introduction	08
Grand Challenges	30
Ideas	56
People	92
Infrastructure	126
Business Environment	162
Places	214
Conclusion: Britain and the world	240

Foreword from the Prime Minister



Over the last seven years, we have made huge progress in restoring our public finances and rescuing our economy from the brink of bankruptcy. Thanks to the sacrifices of the British people, the deficit is now down two-thirds since 2010, the unemployment rate is at its lowest in over 40 years and we have had 19 continuous quarters of economic growth.

We should take enormous pride in these achievements and the difference they are making for many families and businesses in our country. But at the same time, we must also recognise there are some communities which have struggled to keep pace with changes in the global economy and as a result not fully shared in the prosperity that growth has delivered.

For me it is not enough to see growth in the national economy if your local economy is shrinking. It is not ambitious enough to have record jobs growth, unless those jobs are secure and delivering real growth in wages. And we are not fulfilling Britain's potential if, despite having scientists and universities renowned the world over, we cannot turn their ideas into the products and services on which the industries of the future will be built.

That is why one of my first actions as Prime Minister was to begin the development of a modern Industrial Strategy that would help businesses to create high quality, well paid jobs right across the country. This document is a vital step in delivering that vision. More than just a set of announcements, it heralds a new approach to how government and business can work together to shape a stronger, fairer economy. At its heart it epitomises my belief in a strong and strategic state that intervenes decisively wherever it can make a difference. It is rooted in the conviction that a successful free-market economy must be built on firm foundations: the skills of its workers, the quality of the infrastructure, and a fair and predictable business environment. And where these are missing it takes energy and partnership between government and the private sector to address the problems.

That is exactly what this Industrial Strategy aims to do. It will help young people develop the skills they need to do the high-paid, high-skilled jobs of the future. It backs our country for the long-term: creating the conditions where successful businesses can emerge and grow, and helping them to invest in the future of our nation. And it identifies the industries that are of strategic value to our economy and works to create a partnership between government and industry to nurture them. In doing so, it will help propel Britain to global leadership of the industries of the future - from artificial intelligence and big data to clean energy and self-driving vehicles.

Two centuries ago it was our industrial revolution which led the world. Thirty years ago, it was our bold, pro-market reforms which set an example for others to follow. Today, our ambition is just as high. As we leave the European Union and forge a new path for ourselves, so we will build a Britain fit for the future and fulfil the mission that I set on my first day as Prime Minister: to make our United Kingdom a country that truly works for everyone.



The Prime Minister

A handwritten signature in blue ink, which appears to be 'T. May', written in a cursive style.

Foreword from the Secretary of State

We are at one of the most important, exciting and challenging times in the history of global enterprise.

Powered by new technologies, the way we live our lives as workers, citizens and consumers is being transformed across the world.

Britain is extraordinarily well-placed to benefit from this new industrial revolution. We are an open enterprising economy, built on invention, innovation and competition. Our universities and research institutions are among the best in the world. We have a deserved reputation for being a dependable and confident place to do business, with high standards, respected institutions, and the reliable rule of law. We have achieved near historic levels of employment. We are a crossing point for the world because of our geographic position, the English language, our strong ties, our openness to ideas and our vibrant culture. We have many industries - from financial services to advanced manufacturing, from the life sciences to the creative industries - which are world leading.

To benefit from the opportunities before us, we need to prepare to seize them. This would be needed at any time, and Britain's decision to leave the European Union makes it even more important.

More decisions about our economic future will be in our own hands, and it is vital that we take them.

In our Industrial Strategy we set out how we will build on our strengths, extend them into the future and capitalise on the opportunities before us.

A serious strategy must also address the weaknesses that keep us from achieving our full potential.

For all the excellence of our world-beating companies, the high calibre of our workforce and the prosperity of many areas, we have businesses, people and places whose level of productivity is well below what can be achieved.

By improving productivity while keeping employment high, we can earn more - raising living standards, providing funds to support our public services and improving the quality of life for all our citizens.

So this Industrial Strategy deliberately strengthens the five foundations of productivity: ideas, people, infrastructure, business environment and places.

As well as setting a path to improved productivity, our Industrial Strategy sets out four areas where Britain can lead the global technological revolution.

These four Grand Challenges - in artificial intelligence and big data; clean growth; the future of mobility; and meeting the needs of an ageing society - have been identified on the advice of the our leading scientists and technologists. They will be supported by investment from the Industrial Strategy Challenge Fund and matched by commercial investment.

Our Industrial Strategy will inform decisions now, and in the future. Other countries have benefited from establishing policies and institutions which endure. That is our aim. Through the consultation on our Green Paper, over 2,000 organisations from all parts of the United Kingdom have helped shape this strategy.

That partnership with innovators, inventors, job creators, local leaders, the devolved administrations, workers and consumers will continue as we work together to make our country fit for the future.



Rt Hon Greg Clark MP
Secretary of State for Business,
Energy and Industrial Strategy

A handwritten signature in white ink that reads "Greg Clark". The signature is written in a cursive, flowing style.

Introduction

The background features a dark blue field on the left, a red field at the bottom, and a dark blue field on the right containing abstract light streaks in red and white. The word "Introduction" is centered in the dark blue area.



Overview: We will create an economy that boosts productivity and earning power throughout the UK

Our five foundations align to our vision for a transformed 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

Key policies include:

Ideas

- ▶ Raise total research and development (R&D) investment to 2.4 per cent of GDP by 2027
- ▶ Increase the rate of R&D tax credit to 12 per cent
- ▶ Invest £725m in new Industrial Strategy Challenge Fund programmes to capture the value of innovation

People

- ▶ Establish a technical education system that rivals the best in the world to stand alongside our world-class higher education system
- ▶ Invest an additional £406m in maths, digital and technical education, helping to address the shortage of science, technology, engineering and maths (STEM) skills
- ▶ Create a new National Retraining Scheme that supports people to re-skill, beginning with a £64m investment for digital and construction training

Infrastructure

- ▶ Increase the National Productivity Investment Fund to £31bn, supporting investments in transport, housing and digital infrastructure
- ▶ Support electric vehicles through £400m charging infrastructure investment and an extra £100m to extend the plug-in car grant
- ▶ Boost our digital infrastructure with over £1bn of public investment, including £176m for 5G and £200m for local areas to encourage roll out of full-fibre networks

Business Environment

- ▶ Launch and roll-out Sector Deals - partnerships between government and industry aiming to increase sector productivity. The first Sector Deals are in life sciences, construction, artificial intelligence and the automotive sector
- ▶ Drive over £20bn of investment in innovative and high potential businesses, including through establishing a new £2.5bn Investment Fund, incubated in the British Business Bank
- ▶ Launch a review of the actions that could be most effective in improving the productivity and growth of small and medium-sized businesses, including how to address what has been called the 'long tail' of lower productivity firms

Places

- ▶ Agree Local Industrial Strategies that build on local strengths and deliver on economic opportunities
- ▶ Create a new Transforming Cities fund that will provide £1.7bn for intra-city transport. This will fund projects that drive productivity by improving connections within city regions
- ▶ Provide £42m to pilot a Teacher Development Premium. This will test the impact of a £1000 budget for high-quality professional development for teachers working in areas that have fallen behind

We will ensure our Industrial Strategy will endure by creating an independent Industrial Strategy Council that will assess our progress and make recommendations to the government.



Technological innovations are transforming how we live and work

The challenge for the future

The United Kingdom is a successful, competitive, open economy.

We have many strengths on which we can build, and some weaknesses we need to address. As we leave the European Union we need to raise our game at home and on the world stage. This can be done if we seize the opportunities of the years ahead - and it is essential if the British people are to enjoy prosperous lives with fulfilling work and high quality public services.

At the same time, the world is changing in fundamental ways. Technological innovations are transforming how we live and work. The proportion of older

people in our society is growing. The way we generate and use energy is changing rapidly.

The Industrial Strategy sets out how we are building a Britain fit for the future - how we will help businesses create better, higher-paying jobs in every part of the United Kingdom with investment in the skills, industries and infrastructure of the future. It ensures that our country and its citizens can embrace and benefit from the opportunity of technological change.

Our vision is for:

- ▶ the world's most innovative economy
- ▶ good jobs and greater earning power for all
- ▶ a major upgrade to the UK's infrastructure
- ▶ the best place to start and grow a business
- ▶ prosperous communities across the UK

To achieve this, we must ensure every part of our country realises its full potential. We are taking action now, including making the biggest ever increase in public investment in research and development, establishing a new fund to drive productivity by improving connections within city regions, and agreeing Sector Deals which will drive transformation in investment and productivity across the economy.

This Industrial Strategy is for the long term. It provides a policy framework against which major private and public sector investment decisions can be made with confidence. It is a strategy that is being implemented with, not just for, British enterprise - with the full involvement of innovators, investors, job creators, workers and consumers in England, Scotland, Wales and Northern Ireland.

It is also a strategy that recognises and respects the devolution settlements of Scotland, Wales and Northern Ireland. With many of the policies that can drive productivity being devolved, it is a strategy that necessarily brings our work together with that of the devolved administrations as we work in partnership to get the best possible outcome for every part of the UK.

The strategy set out in this paper is the work of many people, businesses, local leaders and institutions. It builds on nearly 2,000 formal responses to the public consultation on our Green Paper, *Building our Industrial Strategy*¹, from all types of organisation, sectors of the economy, groups of businesses and individuals - and many thousands of contributions through our programme of engagement throughout the UK over the last 10 months.

Our approach

Our consultation reinforced the importance of five foundations of productivity – the essential attributes of every successful economy.

These are **Ideas, People, Infrastructure, Business Environment** and **Places**. Our focus on them responds to the detailed feedback to the Green Paper.

Our five foundations align to our vision for a transformed economy – a transformation that is already taking place and will accelerate over the course of the coming decades:

Our five foundations



Ideas

the world's most innovative economy



People

good jobs and greater earning power for all



Infrastructure

a major upgrade to the UK's infrastructure



Business Environment

the best place to start and grow a business



Places

prosperous communities across the UK

Through this process we have also identified Grand Challenges which we will set for the UK government and wider economy. These are in response to global forces that will shape our rapidly changing future, and which the UK must embrace to ensure we harness all the opportunities they present. The Grand Challenges commit to:

- ▶ put the UK at the forefront of the artificial intelligence and data revolution;
- ▶ maximise the advantages for UK industry of the global shift to clean growth;
- ▶ become a world leader in shaping the future of mobility; and
- ▶ harness the power of innovation to help meet the needs of an ageing society.

Our foundations and Grand Challenges are set out in the sections that follow. This strategy also refers to a number of policies that will be added to over time to support the foundations and drive the UK's transformation.

We will:

Ideas

- ▶ raise total research and development (R&D) investment to 2.4 per cent of GDP by 2027;
- ▶ increase the rate of R&D tax credit to 12 per cent;
- ▶ invest £725m in new Industrial Strategy Challenge Fund programmes to capture the value of innovation;

People

- ▶ establish a technical education system that rivals the best in the world to stand alongside our world-class higher education system;
- ▶ invest an additional £406m in maths, digital and technical education, helping to address the shortage of science, technology, engineering and maths (STEM) skills;
- ▶ create a new National Retraining Scheme that supports people to re-skill, beginning with a £64m investment for digital and construction training;

Infrastructure

- ▶ increase the National Productivity Investment Fund to £31bn, supporting investments in transport, housing and digital infrastructure;

- ▶ support electric vehicles through £400m charging infrastructure investment and an extra £100m to extend the plug-in car grant;
- ▶ boost our digital infrastructure with over £1bn of public investment, including £176m for 5G and £200m for local areas to encourage roll out of full-fibre networks;

Business Environment

- ▶ launch and roll-out Sector Deals - partnerships between government and industry aiming to increase sector productivity. The first Sector Deals are in life sciences, construction, artificial intelligence and the automotive sector;
- ▶ drive over £20bn of investment in innovative and high potential businesses, including through establishing a new £2.5bn Investment Fund, incubated in the British Business Bank;
- ▶ launch a review of the actions that could be most effective in improving the productivity and growth of small and medium-sized businesses, including how to address what has been called the 'long tail' of lower productivity firms;

Places

- ▶ agree Local Industrial Strategies that build on local strengths and deliver on economic opportunities;
- ▶ create a new Transforming Cities fund that will provide £1.7bn for intra-city transport. This will fund projects that drive productivity by improving connections within city regions; and
- ▶ provide £42m to pilot a Teacher Development Premium. This will test the impact of a £1000 budget for high-quality professional development for teachers working in areas that have fallen behind.

These policies, alongside the many others set out in this document, are the first strategic actions of a long-term approach to transform our levels of productivity and our earning power as a nation, as businesses, as places, and as individuals. We are ready to be judged on our performance in implementing them.



We will agree Local Industrial Strategies that identify and build on strengths across the country

Building on our strengths

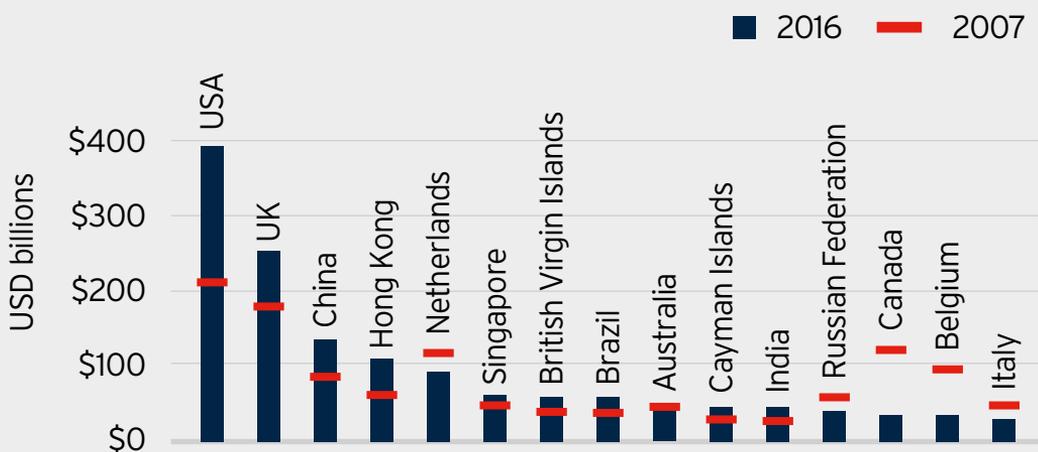
The UK is a fundamentally strong economy, with widely admired institutions and some of the world's leading businesses and universities.

We have some of the highest employment rates in Europe². We are a location of choice for businesses at the cutting edge of innovation and technology, attracting more overseas investment in R&D than many major countries, including Germany, France and China³.

Our flexible labour market, high levels of employment and competitive environment - with high standards and a dependable rule of law - make us a great place to do business.

UK inward investment compared to other countries

Inward foreign direct investment



Source: United Nations Conference on Trade and Development (2017) *World Investment Report 2017*

We are ranked seventh globally in the World Bank's Ease of Doing Business Index⁴. Our strengths are many and diverse: from our scientific and financial prowess to the vitality of our cultural and artistic life.

We have many creative and innovative businesses and we are strong in key sectors, from automotive and aerospace to food and drink and creative industries. We have millions of jobs in financial, professional and business services, which are also our country's biggest exporters⁵. We are at the cutting edge of technologies such as satellites and synthetic biology. Countries are keen to invest in our education and learn from our discoveries in health care. The UK ranks in the top five in the Global Innovation Index⁶. We need to make the most of these strengths so that we can be at the forefront of emerging technologies and industries in the years ahead.

The UK also contains some of the world's most attractive places to live, work, invest and be entertained. London is a world-leading hub for financial services, creative industries, tech businesses and more; a global city which continues to be a magnet for international businesses and talent. In recent years the UK's 'Core Cities', including Birmingham, Manchester and Glasgow⁷, have seen their economies transformed, while many smaller cities and towns such as Milton Keynes, Oxford and Cambridge have been hotspots for job creation. We must promote growth through fostering clusters and connectivity across cities, towns and surrounding areas.

Addressing our weaknesses

For all these strengths, we have an urgent need to improve. In recent decades we have not made the most of our export potential, invested too little, and have not nurtured some of the skills we need.

Too many of the UK's cities outside the capital underperform against the national average. We cannot tackle our problems unless we openly acknowledge them and accept we all share the responsibility for addressing them.

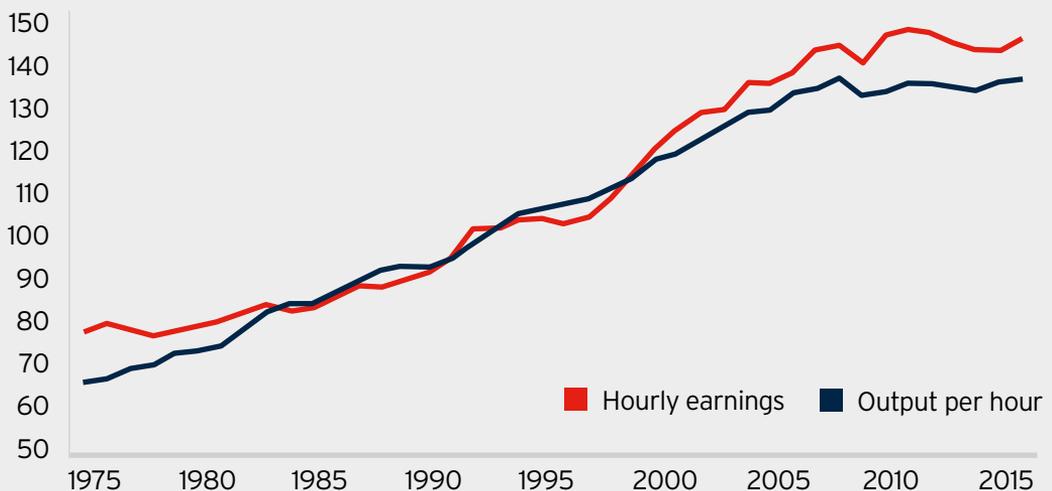
Our analysis and the responses to our Green Paper point to some important

weaknesses in the UK economy that we are determined, unflinchingly, to correct.

In particular, Britain's productivity has long lagged behind that of our competitors⁸. At a time of astonishing technological advance, output per hour worked in the British economy has been weak since the financial crisis⁹.

Rising wages depend on growing productivity

Hourly earnings and output per hour, index: 1993=100



Source: Data based on analysis of ONS national accounts and ASHE data (courtesy of Professor Paul Gregg, the University of Bath). *Hourly earnings is defined as mean compensation per employee hour.

We are proud of our flexible labour market that has delivered jobs for millions and we have achieved near record employment rates¹⁰, but this must now be accompanied by the sustained higher productivity that is the essential requirement for higher wages. Unless we improve productivity while holding on to high employment, we cannot raise living standards and quality of life for all our citizens.

Our relatively weak productivity performance is, to a significant degree, a problem of composition:

we have some of the most productive businesses, people and places in the world but also a 'long tail' of underperformance. Britain's top businesses are among the most admired in the world, but if the long tail of lower productivity persists, it will hold back UK growth, wages and living standards¹¹.

By addressing the disparities we can improve our overall productivity and earning power.

Taking action now

These are challenges that have been recognised by previous governments - we can learn from their successes as well as try to avoid their mistakes.

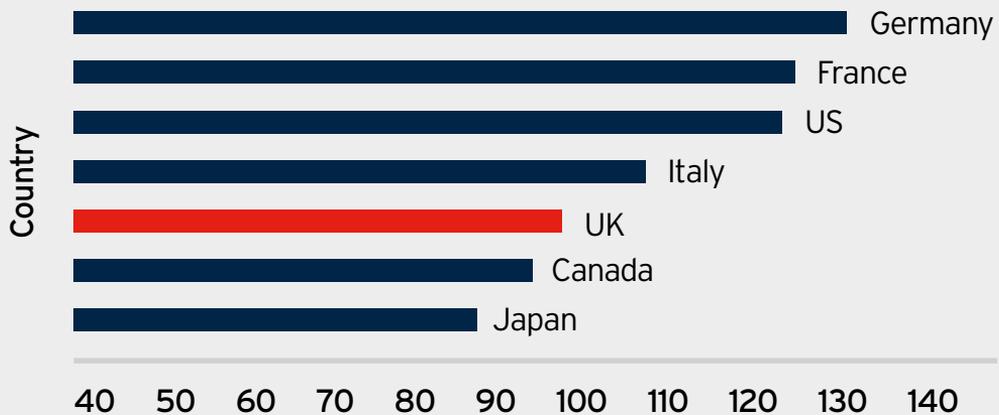
We successfully rebuilt our automotive industry by deliberately attracting investment from abroad, notably from Japan and more recently from India and continental Europe.

The initiatives of previous governments such as the advanced manufacturing strategies, the Eight Great Technologies, and the Catapult network have all contributed to our international reputation. These are strengths we can draw on and they present further opportunities to improve productivity and create good new jobs. The very

speed of technological change and the convergence of technologies present enormous opportunities. We are a nimble economy and we can move quickly to take advantage of innovations. We also have smart consumers who reward entrepreneurs developing new products and services. We know that the earliest adopters of new technologies are able to reap the greatest rewards in terms of additional jobs and increased revenue.

UK productivity relative to other G7 countries

GDP per hour worked, 2016, index: UK=100



Source: ONS (2017) International Comparisons of Labour Productivity.

The role of government

We have learned from previous attempts at industrial strategy – what has worked, and what has not.

It is important to have a clear understanding of what a government can and cannot do. We believe in the power of the competitive market - competition, open financial markets, and the profit motive are the foundations of the success of the UK. Indeed the best way to improve productivity is to increase exposure to competition.

But governments have a responsibility that extends beyond promoting competition. We have to work systematically through the factors responsible for higher productivity and earning power - the five foundations of Ideas, People, Infrastructure, Business Environment and Places that are central to this White Paper.

Governments in successful economies have recognised their strategic power and leadership role, allowing them to coordinate and convene efforts to develop and disseminate new technologies and industries. Individuals, businesses and researchers are motivated by ambitious missions - global and national challenges that need to be tackled by breaking down traditional barriers and finding new ways of doing things. From sequencing the human genome and tackling Aids to hosting the 2012 Olympics, we have seen successive governments identify ambitious missions that drive new endeavours.

Governments can make long-term investment that no single commercial

or academic player can take alone. The modern nation state is the most powerful means we have of pooling risk. We are willing to take these risks, which means accepting not all will work out successfully. An industrial strategy that avoids risk is no industrial strategy at all.

We have studied previous attempts at industrial strategy, which have had successes as well as failures. One lesson is that governments cannot do this on their own, instructing and planning but never listening or consulting. So our Industrial Strategy is a partnership with businesses, workers, universities and colleges, local government and the devolved administrations where we work together to achieve our goals.

From sequencing the human genome to hosting the London 2012 Olympic and Paralympic Games, we have seen successive governments identify ambitious missions that drive new endeavours



Grand Challenges

It is not enough just to look at the economy we have. We must make preparations for the economy we need to become.

We need to be acutely aware and take advantage of the world-changing trends which will shape Britain in the decades ahead. This is where the government must provide the strategic leadership set out above to support the development of new technologies and position the UK at the forefront of the industries of the future.

In this Industrial Strategy we propose a number of Grand Challenges. These are developments in technology that are set to transform industries and societies

around the world, and in which the UK - if we muster our forces across sectors - has the opportunity to play a leading global role.

These Grand Challenges are an invitation to business, academia and civil society to work together to innovate and develop new technologies and industries in areas of strategic importance to our country. We set them out in more detail in the next chapter.

Following extensive consultation during the consultation for our Green Paper, our four Grand Challenges will be:



putting the UK at the forefront of the artificial intelligence and data revolution;



maximising the advantages for UK industry from the global shift to clean growth;



being a world leader in shaping the future of mobility; and



harnessing the power of innovation to help meet the needs of an ageing society.

Global Britain

The decision to leave the European Union was not a decision to retreat from the world.

In fact we need to embrace it - to trade more not less. We must remain an open, liberal market economy. There are opportunities to be gained upon leaving the EU. The opportunity to become more protectionist is not one of them. Britain's future has to be one of free trade with the whole world, including with the rest of Europe.

The EU accounts for the largest proportion of UK trade¹². The size and proximity of the EU single market and our close connections with it mean the EU will always be a major trading partner.

The government believes it is overwhelmingly in our mutual interest to agree a comprehensive and ambitious UK-EU economic partnership that enables the most free and frictionless trade possible with minimal disruption to business. We should be optimistic and ambitious about what we can achieve, as we share the same beliefs in free trade, rigorous and fair competition, strong consumer rights and high standards.

There will, inevitably, be uncertainty while we determine the precise nature of our future trading arrangement with

Britain's future has to be one of free trade



the EU. To minimise this, we are seeking to agree an implementation period, of around two years, to allow business time to adapt to the new arrangements. This will ensure that no one has to go through two sets of changes, and will allow businesses to make decisions once there is greater certainty about the final outcome.

Our Industrial Strategy is designed to place us at the forefront in finding solutions to both UK and global emerging trends and challenges. As set out in our paper *Preparing for Our Future Trade Policy*¹³, we will reach out to old friends and new allies in expanding access to markets, supporting our businesses to export, and welcoming investment and collaboration from emerging and established partners from across the globe. The International Monetary Fund projects that above 80 per cent of world growth is likely to come from outside the EU in the near future¹⁴; we need to be ready for the opportunities such growth will bring. We are in discussions with a number of countries about future options, including full Free Trade Agreements. But Free Trade Agreements are not the only tools at our disposal.

We aim to put in place mechanisms to improve trading relations and remove barriers affecting UK businesses, and we will work closely with the devolved administrations as we forge new and deeper trade relationships around the world.

Our Industrial Strategy will be flexible to take account of developments in negotiations between the UK and the EU or changes in the global economy. While our Industrial Strategy will adapt, we will always be consistent in maintaining the principles of an open economy and fair competition that creates the conditions for businesses to thrive.



Wales's Sêr Cymru programme is designed to attract the highest calibre candidates to work in research groups in Welsh universities, such as Cardiff

Partnership with the devolved administrations

The truly generational challenges and opportunities to which our Industrial Strategy responds apply throughout the UK.

In addressing these issues we recognise and respect the devolution settlement and the empowerment it has offered the people of Scotland, Wales and Northern Ireland. There are important aspects of the five foundations of Ideas, People, Infrastructure, Business Environment, and Places that are associated with policies that are devolved, and we are committed to working in partnership across all four nations to reach the best possible outcome for every part of the UK.

Our Union offers a unique opportunity. The UK government and the devolved administrations can each learn from each other in areas of common interest. For example, Scotland has made great strides in energy efficiency and has one of the most effective systems for translating advances in life sciences into improved patient care. Wales's Sêr Cymru programme is attracting leading scientific talent matched to its innovation strengths. Northern Ireland is fostering a burgeoning cybersecurity business and research community.

Devolution has never meant that the UK government does not exist to serve the people and the economies of the devolved nations. This is exemplified in the funding we provide throughout the UK to support innovation excellence, and next generation digital infrastructure to connect urban and rural communities, and in the promotion of our national strengths as part of the GREAT campaign.

We also know that it is collaboration between our governments that results in some of the most powerful actions taken within the devolved nations. The six City Deals agreed in Scotland and Wales are testament to the impact that partnerships within the devolved nations can achieve. These deals have yielded ambitious investments driven by priorities identified by communities themselves, with a £1.6bn UK government investment bringing forward more than £3bn in funding from other partners. And we remain committed to further ambitious City and Growth Deals across Wales, Northern Ireland and Scotland.

The Scottish Government and the previous Northern Ireland Executive have also recently published industrial and economic strategies and the Welsh Government is to do the same in the coming weeks.

These publications reflect ambitious thinking for each economy and identify priorities that align fundamentally with the five foundations of this Industrial Strategy, whether in Scotland's focus on innovation and entrepreneurship or Northern Ireland's emphasis on inclusive growth.

In our Green Paper we committed to working with the devolved administrations as part of ministerial forums. This joint working has proven valuable, and as we implement our long-term strategy we will recommit to that partnership, seeking to tackle our shared opportunities with a focus on: addressing our shared Grand Challenges; making Sector Deals work for businesses across the UK; ensuring that our institutions collaborate for maximum impact; and working together on priorities for places.

A strategy for the long term, with benefits now

The responses to the consultation showed us that people and business want confidence that our Industrial Strategy will endure – that it is a framework they can use for decision making and that it can be expected to last.

The best way to secure this is for the strategy to command the widest possible support. We must earn this through the quality of the decisions we take and by sharing the evidence on which they are based. Yet commitment must not mean inflexibility - we need systems that adjust to new evidence and new challenges.

One key to this is data. Governments must practise what they preach about the opportunities of the data revolution. That means being innovative in how we collect and analyse economic data.

To support evaluation and further understanding of the economy, we aim to make the UK the best understood major economy. We will be developing a joint programme of work with the Office for National Statistics, academics and other stakeholders that will identify the gaps in our evidence base. The UK government also stands ready to work with the devolved administrations, where appropriate, to ensure the strongest possible data is held and used across the UK; in particular as we continue to transfer powers from the



UK to the Scottish Parliament in line with the Scotland Act 2016. We want to make more micro-level data available so people can study and understand our economy. This will enable us to improve significantly how we identify strengths and weaknesses in specific parts of the country. It will provide a shared evidence base on which we can build our Industrial Strategy.

We must have the right reporting mechanisms in place to ensure we achieve our ambitions. The Economy and Industrial Strategy Cabinet Committee, chaired by the Prime Minister, will remain responsible for our strategic vision and for driving delivery across government.

We will create an independent Industrial Strategy Council that will develop measures to assess and evaluate our Industrial Strategy and make recommendations to the government. The Council will have access to relevant government data and will be funded to commission specific evaluation projects as appropriate. It will be drawn from leading business men and women, investors, economists and academics from across the UK.

The real test of a successful strategy is the consequences it has for the lives of our fellow citizens. That must mean more good jobs and better pay. We are committed to high quality jobs for all UK citizens: that is why we will be responding to and building on the recommendations of the Matthew Taylor Review to ensure that employment rights are protected and workers can benefit from new technology.

By addressing these challenges we will be able to achieve the central objective of our Industrial Strategy - to improve living standards and economic growth across the country. This strategy is our long-term plan to ensure that people in all parts of the UK are able to lead fulfilling and prosperous lives, and that we can all make the most of the opportunities that lie ahead.

Grand Challenges

The background features a dark blue upper-left section, a black lower-right section, and a light blue bottom section, all separated by sharp diagonal lines.



Grand Challenges

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

The world is undergoing a technological revolution. Artificial intelligence (AI) will transform the way we live and work, from the way we diagnose and treat cancer to the security of online transactions. This fourth industrial revolution is of a scale, speed and complexity that is unprecedented. The first industrial revolution mechanised production using water and steam power; the second created mass production using electric power; the third automated production using electronics and information technology. This fourth revolution is characterised by a fusion of technologies that is blurring the lines between the physical, digital and biological worlds¹⁵. It will disrupt nearly every sector in every country, creating new opportunities and challenges for people, places and businesses to which we must respond.

This is not the only seismic global change to which the UK needs to respond. We owe it to ourselves and future generations to lower carbon emissions and move towards cleaner growth; we are facing a fundamental demographic shift as our population ages; and we are on the cusp of a profound shift in how we move people, goods and services around our towns, cities and countryside. We need to make the most of the global market opportunities these changes

present. We must also embrace the technological advances that improve productivity across many sectors, as well as the quality of our everyday lives.

A truly strategic government must do more than just fix the foundations: it must also plan for a rapidly changing future, look to shape new markets and industries, and build the UK's competitive advantage. The public and private sector must work with universities, researches and civil society to put the UK at the forefront of these revolutions, breaking down conventional barriers within and between business sectors and academic disciplines. This is what the Grand Challenges will achieve.

History shows governments around the world have taken advantage of global challenges. In the 1970s, the UK government was instrumental in developing the North Sea oil and gas industry. More recently, thanks to tailored public support, the UK has built the largest off-shore wind capacity of any country¹⁶ and developed world class gene sequencing technologies.

Overseas, Germany's Industrie 4.0¹⁷ is an example of a government helping prepare the country to take advantage of major trends, while in the United States the Defense Advanced Research Projects Agency (DARPA) and other

public research institutions have played a significant role in developing the technologies behind the internet and smartphone, spurring the growth of entire new markets. Other countries are already looking to capitalise upon the fourth industrial revolution. Japan, for example, has deliberate strategies to prepare for and to embrace these transformational changes in technology.

The ability to meet our Grand Challenges rests on broad capabilities. The DARPA programme has been effective because it is part of a much wider research and development (R&D) effort. Our capacity to act nimbly and effectively depends on maintaining capacities across a wide range of technologies and disciplines.

We can engage now with the challenge of AI because of previous investments in high performance computing. Similarly, we can rise to the challenge of an ageing society because we have already invested in resources such as the UK Biobank, which tracks the health information of 500,000 volunteers¹⁸, and we have a lead in understanding the interaction between genes and environment.

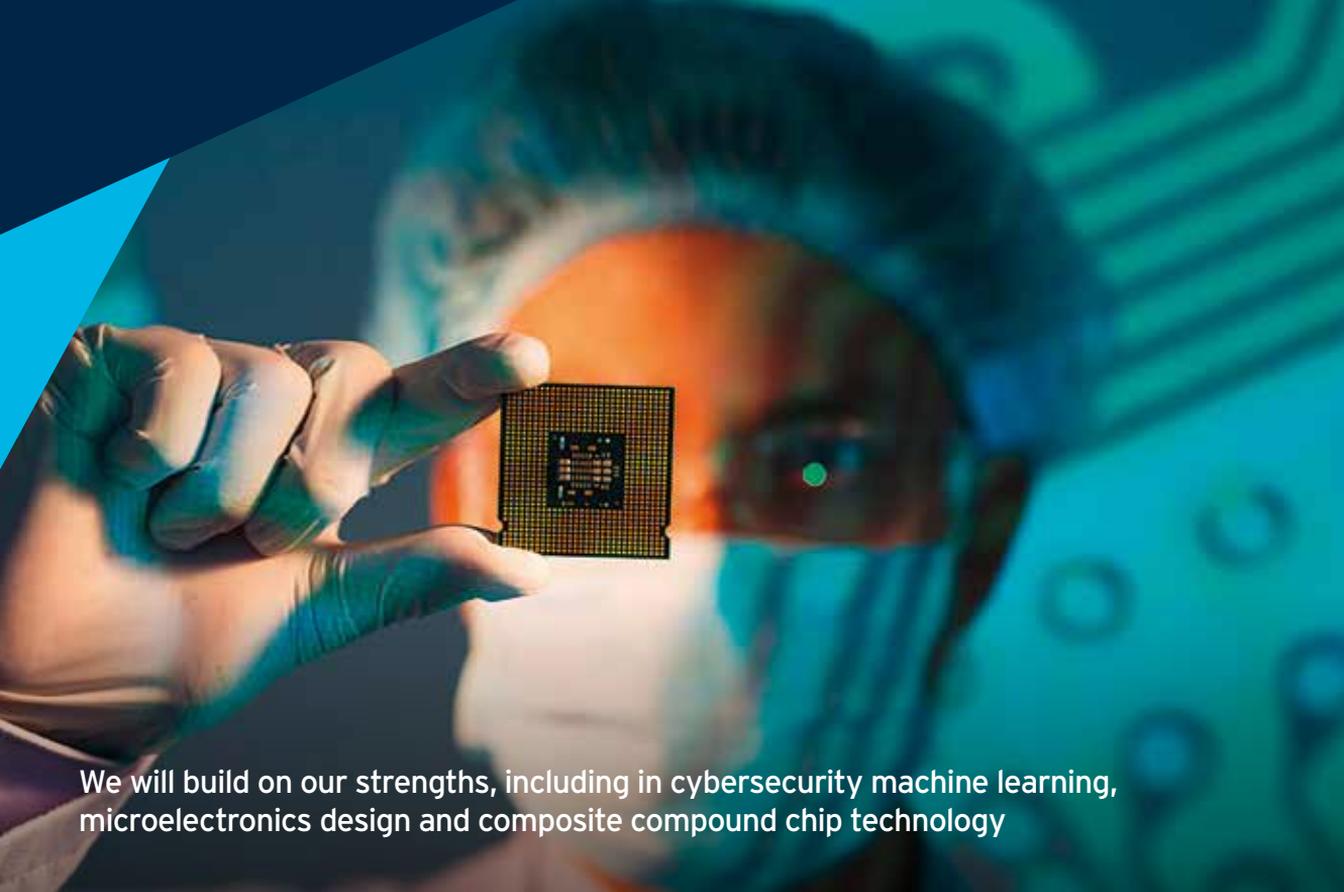
We must continue to support a broad range of key capabilities and emerging technologies.

We also need to be clear where our distinctive advantages lie. We will build on our existing strengths, from cybersecurity, machine learning, microelectronics design and composite compound chip technology to biotechnologies and life sciences such as genetics and cell therapies. At the same time we must develop new strengths in emerging sectors. We must do this as a partnership between businesses, scientists, investors, educators and policy makers to take full advantage of the transformational potential of these trends to improve people's lives, their work and the nation's productivity.

This partnership must be UK-wide, embracing our four nations. The UK government needs to work in collaboration with the governments and businesses of Scotland, Wales and Northern Ireland. Just as we committed in the Green Paper to holding ministerial forums with each devolved administration, we will work together to rise to each of the Grand Challenges.



'A truly strategic government must do more than just fix the foundations: it must also plan for a rapidly changing future.'



We will build on our strengths, including in cybersecurity machine learning, microelectronics design and composite compound chip technology

What are the Grand Challenges?

We have taken evidence from our Green Paper consultation, and worked with scientific leaders - the Government Office for Science, UK Research and Innovation (the Research Councils and Innovate UK), the Council for Science and Technology and the national academies - to identify four Grand Challenges. We will:

- ▶ put the UK at the forefront of the artificial intelligence and data revolution;
- ▶ maximise the advantages for UK industry from the global shift to clean growth;
- ▶ become a world leader in shaping the future of mobility; and

- ▶ harness the power of innovation to help meet the needs of an ageing society.

We must not expect that every individual action will bring guaranteed or immediate success. Through inviting competing proposals and ideas, the government will identify, support and fund a range of promising projects. We must not let a fear of failure make us unimaginative or risk averse. The government must be willing to back a broad portfolio of risky initiatives rather than be constrained by the possibility of individual failures.

To respond to the Grand Challenges, business, academia, civil society and



'Business, academia, civil society and the government must engage together, bringing their expertise and entrepreneurial spirit, to drive us all towards success.'

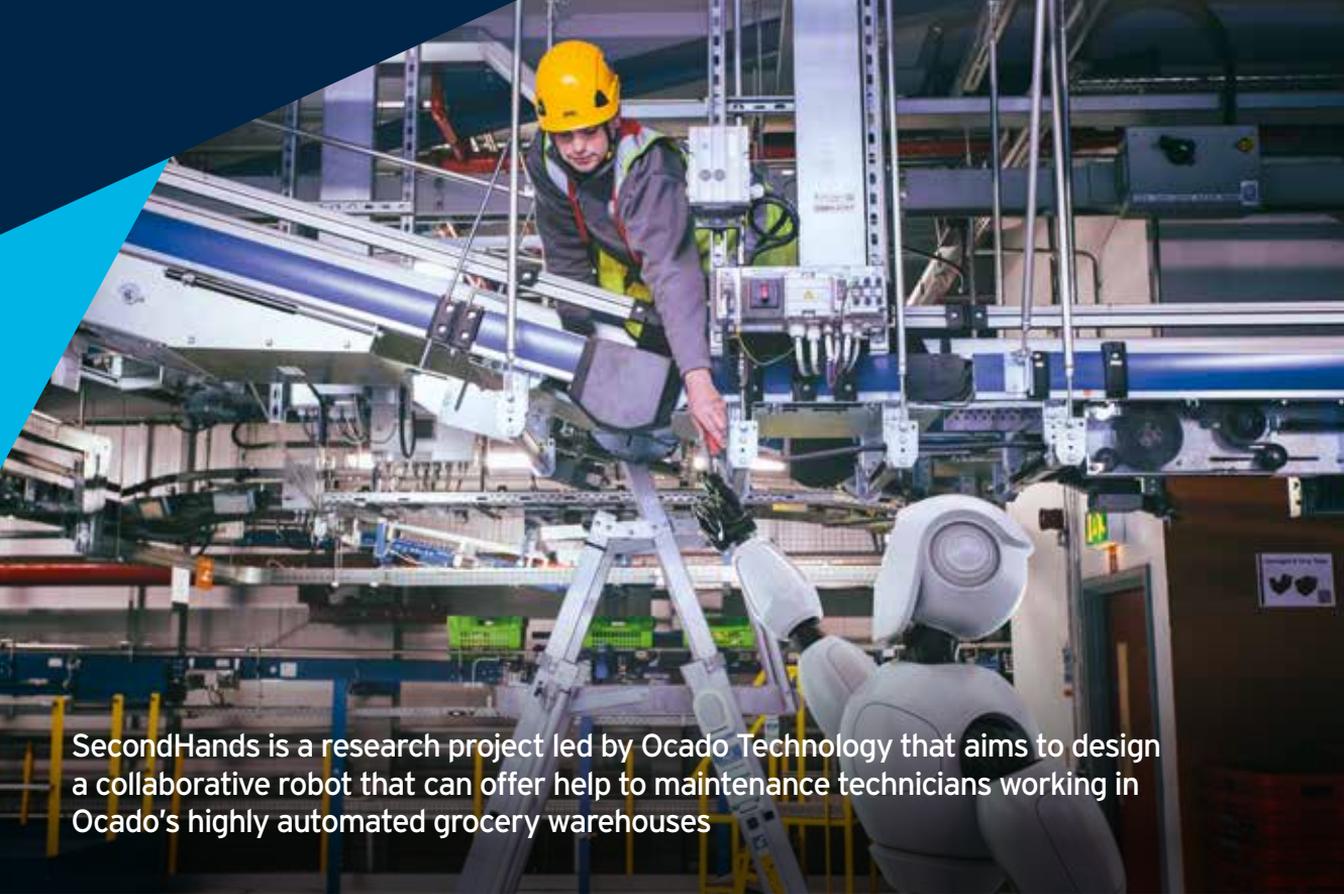
the government must work together, bringing their expertise and entrepreneurial spirit, to drive us all towards success. By setting out strategic visions and a positive role for government we hope to attract the engagement of some of the brightest minds from across the private and public sectors. For each Grand Challenge, we will ask leading figures from industry and academia to act as expert advisors, led by a 'Business Champion'. Working alongside ministers, these figures will be responsible for engaging a diverse range of industry voices and raising the profile of the challenge. They will advise on how to make the most of the global opportunity it presents and review how we can work together to respond to it – such as improving supply and increasing demand in nascent markets, and ensuring that innovations can diffuse and scale. We will look to appoint Business Champions and external advisers in early 2018.

We will ensure that the government makes the most of all its policy levers to achieve success. Levers include regulations, funding and Sector Deals.

We will also direct the government's convening power, promote exports and inward investments, and build consumer trust in new technologies. Where appropriate, teams will develop 'missions' to tackle the Grand Challenges. They involve tackling specific problems, such as reducing carbon emissions by a given percentage over a specific year period¹⁹, using well defined and concrete goals to allow progress to be monitored and assessed, and the option to change course when appropriate.

Progress on each Grand Challenge will be regularly reviewed to ensure that policies are having the desired impact, we are focusing on the correct issues, and we are aware of any changes in the UK's advantage over other countries.

In the next section we set out some early priorities for each of the four Grand Challenges. These will be developed in more detail with the Grand Challenge teams over the coming months including setting missions where appropriate.



SecondHands is a research project led by Ocado Technology that aims to design a collaborative robot that can offer help to maintenance technicians working in Ocado's highly automated grocery warehouses

Growing the AI & Data-Driven Economy

We will put the UK at the forefront of the AI and data revolution.

Artificial intelligence and machine learning are general purpose technologies already starting to transform the global economy. They can be seen as new industries in their own right, but they are also transforming business models across many sectors as they deploy vast datasets to identify better ways of doing complex tasks - from helping doctors diagnose medical conditions more effectively to allowing people to communicate across the globe using instantaneous speech recognition and translation software.

Embedding AI across the UK will create thousands of good quality jobs and drive economic growth. A recent study found digital technologies including AI created a net total of 80,000 new jobs annually across a population similar to the UK²⁰. By one estimate, AI could add £232bn to the UK economy by 2030²¹.

We start from a position of strength. The UK is already a world leader in AI, with the building blocks to make significant advances. We have some of the best research institutions in the world and

globally-recognised capability in AI-related disciplines, including maths, computer science, ethics and linguistics. We have substantial datasets in public institutions where AI can be explored safely and securely. We have great strengths in the underpinning technologies, from ARM's microchips to the microcomputers of Raspberry Pi. UK innovators push boundaries in robotics and the internet of things. These strengths are the result of academic excellence, research ingenuity, smart business decisions, and investment by previous governments of different political persuasions.

As with previous revolutionary technologies, these changes cannot be resisted and it would be irresponsible to fail to prepare. Meeting our Grand Challenge means maximising the opportunities created by AI and advanced data technologies, and responding to the potential impacts on society. It is a call for businesses, research institutions and the government to work together throughout the UK to invest in these technologies, encourage their adoption and set standards in secure, trusted use of data.



'Embedding AI across the UK will create thousands of good quality jobs and drive economic growth. AI could add £232bn to the economy by 2030.'

The AI and data-driven economy

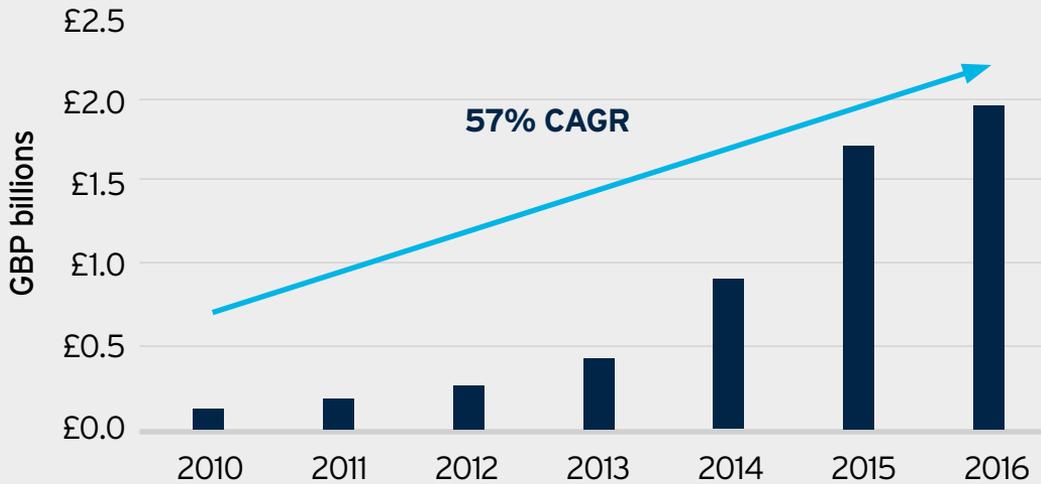
Artificial intelligence: technologies with the ability to perform tasks that would otherwise require human intelligence, such as visual perception, speech recognition, and language translation

Machine learning: a type of AI that allows computers to learn rapidly from large datasets without being explicitly programmed

Data-driven economy: a digitally connected economy that realises significant value from connected, large-scale data that can be rapidly analysed by technology to generate insights and innovation

Global venture capital investment in artificial intelligence

Cumulative average growth rate (CAGR), 2010-2016



Source: Hall, W. and Pesenti, J. (2017) *Growing the Artificial Intelligence Industry in the UK*. Growth is cumulative average growth rate 2010 to 2016

We must ensure that Britain is among the first countries to ensure that everyone benefits from this revolution.

An early response to this challenge is the Artificial Intelligence Sector Deal, responding to the review by Professor Dame Wendy Hall and Jérôme Pesenti, *Growing the AI Industry in the UK*²².

In consultation with a range of people with expertise in this area, we have identified four priorities for this Grand Challenge:

We will make the UK a global centre for artificial intelligence and data-driven innovation

We will build on our world-class research by working with industry

to develop innovative uses of AI and advanced analytic technologies through the Industrial Strategy Challenge Fund*. For example, through the Industrial Strategy ‘Next generation of services’ project we will invest in developing applications of AI and data-driven innovation for service sectors; and, through the ‘Data to early diagnostics and precision medicine’ programme we will invest to enhance the power of health data to diagnose life-changing diseases at the earliest possible stage and develop precision treatments to cure them.

*All wave 2 programmes are subject to final business case, when further details on funding will be made available

We will also support businesses with regulation that stimulates and facilitates innovation. Building on the 'sandbox' approaches that the Financial Conduct Authority and Ofgem, the energy regulator, have successfully implemented, we are establishing a £10m Regulators' Pioneer Fund to support UK regulators to develop innovative approaches to emerging technologies.

We will foster, attract and retain the best and brightest research talent. The Alan Turing Institute will become the national research centre for AI, supporting new Turing Fellowships. We will invest £45m to support additional PhDs in AI and related disciplines, increasing numbers by at least 200 extra places a year by 2020-21, aiming to expand the numbers in UK universities year-on-year into the next decade.

We will also develop people's skills to keep up with the speed of technological change by supporting universities and businesses to develop an industry-funded masters programme, with an initial scale of over 200 places. We will also work

with industry to explore how best to train cross-discipline professionals to apply AI in their specialist areas, for example through conversion courses and continuing professional development.

We will support sectors to boost their productivity through artificial intelligence and data analytic technologies

A major source of productivity improvements comes from making the most of AI and machine learning across the economy. We are working with industry to establish an industry-led AI Council that can take a leadership role across sectors. The AI Council will be supported by a new government Office for AI. In partnership with industry and academia, these bodies will champion research and innovation, stimulate demand and accelerate uptake across all sectors of the economy. The office, working with the AI Council, will lead work to increase awareness of the advantages of advanced data analytic technologies and promote greater diversity in the AI workforce.



'We will build on our world-class research by working with industry to develop innovative uses of AI and advanced analytic technologies through the Industrial Strategy Challenge Fund.'

To support rapid adoption of AI technologies at scale, the Office for AI will work initially with six priority business sectors: cybersecurity; life sciences; construction; manufacturing; energy; and agricultural technology. The office will work in partnership with the new GovTech Catalyst to ensure the public sector can benefit from these technologies. It will also collaborate with partners to promote adoption, for example through the Digital Catapult's 'Machine Learning Garage' programme launching in January. This programme will provide low-cost access to high quality machine learning computation power for start-ups, and support businesses of all sizes with expertise on cost-effective machine learning computation.

As the global market expands, we will increase our export support for AI and data businesses. The Global Entrepreneur Programme will look to increase its focus on attracting AI and data-led businesses to establish headquarters in the UK.

We will lead the world in safe and ethical use of data and artificial intelligence giving confidence and clarity to citizens and business

AI and data are already creating enormous opportunities for us to understand more about everything, from our health to what we like to buy. But it is vital that we remove barriers to innovation and ensure that data is used in a way that is both safe and fair to individuals.

The UK will take an international leadership role by investing £9m in a new Centre for Data Ethics and Innovation. This world-first advisory body will review the existing governance landscape and advise the government on how we can enable and ensure ethical, safe and innovative uses of data, including AI. This will include engaging with industry to explore establishing data trusts to facilitate easy and secure sharing of data. We will consult widely in due course on the detailed remit for this new centre.

We will also strengthen overall data security, reinforcing the UK's position as a global centre for cybersecurity. We will develop detailed recommendations over the next six months.

We will help people develop the skills needed for jobs of the future

AI and data analytics will change jobs and businesses, and we want people to be able to capitalise on these opportunities. Our Industrial Strategy builds on our work to develop people's skills, investing an additional £406m in maths, digital and technical skills in England. This includes investing £84m over the next five years to deliver a comprehensive programme to improve the teaching of computing and drive up participation in computer science. We will up-skill 8,000 computer science teachers and work with industry to set up a new National Centre for Computing Education.

We will also promote a new adult digital skills entitlement to support basic training and our new National Retraining Scheme will help people re-skill and up-skill as the economy changes, including as a result of automation. This scheme will be informed by career learning pilots, which are testing barriers to adults engaging in learning, and the National Retraining Partnership. Initially it will focus on priority skills, including digital. As a first step, we will invest £30m to test the use of AI and innovative education technology (edtech) in online digital skills courses.

We also need to build an evidence base about how technological change may affect different sectors, groups and places. Building on the work of Skills Advisory Panels and local Digital Skills Partnerships in England, the government and industry will explore how data analytics can be used to improve our understanding of employer demand for skills.



'AI and data are already creating enormous opportunities for us to understand more about everything, from our health to what we like to buy.'

One of the many applications of AI and data analytics technologies is to enable more efficient use of energy and resources. For example, intelligent algorithms applied to data on atmospheric conditions and soil moisture could dramatically reduce the amount of water needed for agriculture. Actions to support our first Grand Challenge will complement the second challenge we have identified - maximising the advantages to UK industry of the global shift to clean growth.

Clean Growth

We will maximise the advantages for UK industry from the global shift to clean growth – through leading the world in the development, manufacture and use of low carbon technologies, systems and services that cost less than high carbon alternatives.

The move to cleaner economic growth – through low carbon technologies and the efficient use of resources – is one of the greatest industrial opportunities of our time. By one estimate, the UK’s clean economy could grow at four times the rate of GDP²³. Whole new industries will be created and existing industries transformed as we move towards a low carbon, more resource-efficient

economy. The Paris Agreement of 2015 commits countries to revolutionising power, transport, heating and cooling, industrial processes and agriculture. The effect of these changes will be felt by businesses throughout the economy, and will involve the reallocation of trillions of pounds of public and private finance towards the pursuit of cleaner growth.

Shift of global investment towards the clean economy

Stowe Global Coal Index and global green bonds issuance



Source: Climate Bonds Initiative (2017); Stowe Global Indexes. *2017 green bond issuance is estimated. The Coal Index takes the last data of each month from Jan 11 to Oct 17



The UK has been at the forefront of encouraging the world to move towards clean growth. We are determined to play a leading role in providing the technologies, innovations, goods and services of this future. We want to support our strong automotive, aerospace and construction industries to increase their share of global markets as they shift to clean energy sources and efficient new materials. We want UK businesses to lead the development of new markets in areas such as smart energy systems and the 'bio-economy' - the use of renewable biological resources from land and sea to produce food, materials and energy.

We also want everyone to feel the benefits of clean growth, so we will work to create a future where our cities benefit from cleaner air, our businesses from enhanced resource security and our countryside from regenerated natural capital.

The UK is already one of the most successful countries at growing our economy while reducing emissions. We have cut emissions by more

than 40 per cent²⁴ since 1990, while our economy has grown by two thirds²⁵. Our recently-published Clean Growth Strategy²⁶ sets out our ambitious proposals for continuing this progress through the 2020s. We have world-leading capabilities in areas including electric vehicle manufacture, offshore wind, smart energy systems, sustainable construction, precision agriculture and green finance. With business, academia, the government and civil society working together, we can do more.

We will aim to maximise UK businesses' share of the global markets as they are transformed by the shift to clean growth, and make our country one of the best places in the world to develop and sell clean technologies.

We will increase our support for innovation so that the costs of clean technologies, systems and services are reduced across all sectors, and we will collaborate on international initiatives such as Mission Innovation - a global partnership for clean energy research and development - to bring

'The move to cleaner economic growth - through low carbon technologies and the efficient use of resources - is one of the greatest industrial opportunities of our time.'

The UK has been at the forefront of the global move towards clean growth, with projects such as the Blyth wind farm in the north east of England



the best minds together to accelerate progress. We will align our policies, regulations, taxes and investments to grow the markets for these new innovations so that they are successfully commercialised in the UK. Our long-term goals are to make clean technologies cost less than high carbon alternatives, and for UK businesses to take the lead in supplying them to global markets.

We will take action to establish and extend UK leadership in the following early priority areas:

We will develop smart systems for cheap and clean energy across power, heating and transport

Smart systems transform our ability to use clean energy cost-effectively, and so will be in high demand globally. We are good at designing such systems. A national electricity grid was a great British technical achievement. Now we are setting ourselves the challenge of remodelling it so it can handle many different sources of clean energy, and use new technologies to store energy and manage

demand. We will launch a new Industrial Strategy 'Prospering from the energy revolution' programme to develop world-leading local smart energy systems that deliver cheaper and cleaner energy across power, heating and transport, while creating high value jobs and export capabilities. Our world-leading *Smart Systems and Flexibility Plan*²⁷ will build on the rollout of smart meters to grow the markets for these systems and technologies in the UK. We will continue to work closely with the nuclear and offshore wind industries to further drive down the costs of clean power, while building UK supply chains. We will also continue to explore the long-term options for clean heating and the many potential uses of low carbon hydrogen.

We will transform construction techniques to dramatically improve efficiency

A rapidly urbanising world needs buildings that can be constructed and operated more efficiently. Our new Industrial Strategy 'Transforming Construction' programme will take full



'Our long-term goals are to make clean technologies cost less than high carbon alternatives, and for UK businesses to take the lead in supplying them to global markets.'



We will grow the markets for innovative farming technologies and techniques such as the use of drones

advantage of new technologies to provide safer, healthier and more affordable places to live and work that use dramatically less energy to build and run. It will ensure UK businesses develop world-leading capabilities in integrating construction, digital energy and efficiency technologies - the kind of system integration at which the UK excels. We have launched a call for evidence on additional measures to build a market for energy efficiency among homeowners. This will incentivise greater private investment in household and commercial building energy efficiency, to grow the markets for these types of buildings and technologies.

We will make our energy-intensive industries competitive in the clean economy

Global markets for clean and efficient industrial fuels, processes and materials are growing rapidly. We are investing £162m in innovation for low carbon industry, and developing a new strategy for the bio-economy. We will work with industry to stimulate further market investment in clean and efficient technologies and process, including through all manufacturing Sector Deals, and through developing a new scheme to support investment in industrial energy efficiency. This scheme will help large businesses install measures that will cut their energy use and bills, as well as improve their productivity. This will build on the 2050 Decarbonisation Action Plans that we have agreed with seven of the most energy-intensive sectors.

We will put the UK at the forefront of the global move to high-efficiency agriculture

Rising global demand for food and water is increasing the need for agriculture that produces more from less. Our new 'Transforming food production: from farm to fork' programme will put the UK at the forefront of advanced sustainable agriculture. Over the coming years, as we replace the Common Agricultural Policy, we will increase the incentives for investment in sustainable agriculture, helping to grow the markets for innovative technologies and techniques. With powers set to return from the EU, the UK government is in discussions with the

devolved administrations over future arrangements. Our work will develop in line with the outcome of those discussions.

We will make the UK the global standard-setter for finance that supports clean growth

We will extend the UK's global leadership in green finance - building on our world-leading financial sector - working with industry through our new Green Finance Taskforce. We are now working with the British Standards Institution and the City of London's Green Finance Initiative to develop the world's first green financial management standards.



'We are investing £162m in innovation for low-carbon industry, and also developing a new strategy for the bio-economy.'

We use an enormous amount of energy to move people and goods from place to place: around 40 per cent of the UK's total final energy use²⁸. Developing UK leadership in low carbon transport is therefore a shared priority with our Future of Mobility Grand Challenge. We will invest in innovation to develop clean technologies across road, rail, aviation and maritime transport.

The Future of Mobility

We will become a world leader in shaping the future of mobility.

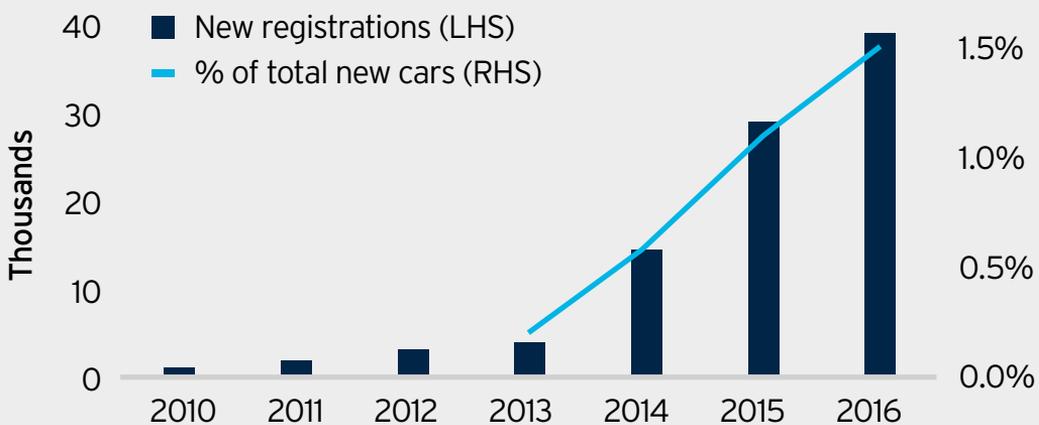
We are on the cusp of a profound change in how we move people, goods and services around our towns, cities and countryside. This is driven by extraordinary innovation in engineering, technology and business models. Significant investments are being made in the electrification and automation of road vehicles, in the modernisation of rail services to deliver higher capacity, speed and connectivity, and in the development of autonomous aerial and marine transport. New market entrants and new business models, such as ride-hailing services, ride sharing and

'mobility as a service', are challenging our assumptions about how we travel.

These technologies can transform public transport. The UK's road and rail network could dramatically reduce carbon emissions and other pollutants, congestion could be reduced through higher-density use of road space enabled by automated vehicles, and mobility could be available when we want it, where we want it and how we want it.

UK electric car ownership has increased rapidly since 2010

New electric car registrations



Source: Department for Transport (2017) Vehicles statistics. *Electric car includes plug-in hybrids, 100% electric, range extended electric and fuel cell electric cars

The government wants to see fully self-driving cars on the UK roads by 2021



'New market entrants and new business models, such as ride-hailing services, ride sharing and mobility as a service, are challenging our assumptions about how we travel.'

We have significant strengths in many of the most relevant areas of research and development, including artificial intelligence and complex vehicle engineering. We have dynamic businesses developing new mobility solutions, and innovative, strong and diverse automotive, rail, maritime and aviation sectors. We have a long history of bringing transport innovation to the world. We also have strengthening leadership at a local level, with mayors in English cities and City Deal Boards in Scotland and Wales actively pursuing new ways to address the complex transport needs of our cities.

As the UK has the highest percentage of the population living in urban areas in the OECD we are well placed to contribute to these challenges of urbanisation²⁹.

We will build on the innovative work of the Office for Low Emission Vehicles, the Centre for Connected and Autonomous Vehicles and the Transport Catapult to look across the road transport system for opportunities to improve customers' experience, drive efficiency and enable people to move around more freely. We will work with a full range of stakeholders across the UK to deliver this challenge.

We have identified four early priorities:

We will establish a flexible regulatory framework to encourage new modes of transport and new business models

Mobility has always depended on standards. Our regulatory environment must evolve with the times to support the emergence of new technologies and new business models. We will ensure we continue to have one of the most open environments in the world for transport innovation and new services by undertaking a thorough regulatory review of all relevant legislation.

The government wants to see fully self-driving cars, without a human operator, on UK roads by 2021. We will therefore make world-leading changes to the regulatory framework, including updating our code of practice for testing automated vehicles to allow developers to apply to test their vehicles nationwide without a human safety operator and carrying out a project with the Law Commission to set out proposals for a long-term regulatory framework for self-driving vehicles.

We will seize the opportunities and address the challenges of moving from hydrocarbon to zero emission vehicles

For zero emission vehicles to become universal the right framework is needed. Building on the work of the Faraday Battery Institute and the Office for Low Emission Vehicles programme, we have announced a package to support the transition to zero emission vehicles.

This includes a new £400m Charging Infrastructure Investment Fund (£200m from the government to be matched by private investors); £100m new funding for the plug-in car grant; £40m R&D funding (matched by industry) for new charging technologies including on-street and wireless projects; and a commitment that the government will lead the way, making 25 per cent of all cars in the central government department fleet ultra-low emission by 2022.

Building on these commitments, in the coming months we will publish a strategy on government support for the transition to zero emission road transport, ensuring the UK continues to be a world leader in the development, manufacture and use of these vehicles.

We will prepare for a future of new mobility services, increased autonomy, journey-sharing and a blurring of the distinctions between private and public transport

The future mobility marketplace is likely to operate differently to the transport system of today. We will consult with industry and others on the government's role to support this, and publish a Future of Urban Mobility strategy within the next 12 months. The National Infrastructure Commission (NIC) will also launch a new innovation prize to determine how future roadbuilding should adapt to supporting self-driving cars, with the West Midlands, a UK centre of expertise on connected and autonomous vehicles, being a key testing location for the best entries. We will also be investing £5m from

the 5G Testbeds and Trials programme for an initial trial, starting in 2018, of 5G applications and deployment on roads, including helping to test how we can maximise future productivity benefits from self-driving cars.

We will explore ways to use data to accelerate development of new mobility services and enable the more effective operation of our transport system

We will continue to invest in R&D and testbed infrastructure for connected and autonomous vehicles. We will explore how simulated digital environments can support and accelerate development of self-driving technology through an R&D competition to be launched by the Centre for Connected and Autonomous Vehicles, the first R&D competition of its kind in Europe.



'We will ensure we continue to have one of the most open environments in the world for transport innovation and new services by undertaking a thorough regulatory review.'

One of the main groups benefiting from this revolution is older people who may no longer be able to drive or have other difficulties with mobility. Our fourth challenge is focused on meeting the particular needs of an ageing society.

Ageing Society

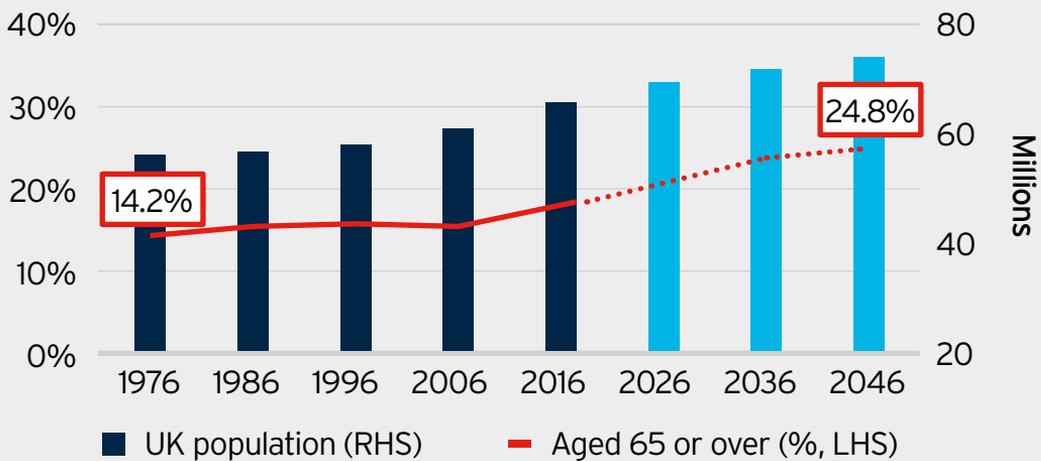
We will harness the power of innovation to help meet the needs of an ageing society.

The UK population is ageing, as it is across the industrialised world. We are living longer than ever before; we have historically lower birth rates; a large cohort of people - the so-called 'baby boomers' born after the Second World War - are reaching retirement³⁰. One in three children born in the UK today can expect to live to 100³¹.

The prospect of longer lives will require people to plan their careers and retirement differently. Ageing populations will create new demands for technologies, products and services, including new care technologies, new housing models and innovative savings products for retirement. We have an obligation to help our older citizens lead independent, fulfilled lives, continuing to contribute to society.

By 2046 almost 1 in 4 people will be 65 years old and over

UK population and proportion of population aged 65 and over



Source: ONS (2017) "Population estimates"

*2016-based population projections are used

Ageing populations will create new demands for technologies, products and services



'One in three children born in the UK today can expect to live to 100. The prospect of longer lives will require people to plan their careers and retirement differently.'

Innovation in age-related products and services can make a significant difference to UK productivity and individuals' wellbeing, and will find a growing global market. Ageing also presents significant challenges to the economy, including greater caring demands on those of working age and increased health and social care costs. Without action, an ageing population could reduce the size of our workforce and lead to lower productivity.

If we succeed, we will create an economy which works for everyone, regardless of age. A new generation of British businesses will be thriving in the growing global market

for age-related products and services. Older people will be able to lead fuller, more independent lives, increasingly supported by smart home technologies, wearable devices and tech-enabled health and care services. British businesses will have redesigned jobs and workplaces to better use their older workers' experience, enabling individuals to keep active and stay in work. Workers will have more flexibility to help balance their work with caring responsibilities. Younger generations will be able to plan for their longer careers with confidence.

Many countries are grappling with this challenge, most notably Japan. There are some distinctive British opportunities which build on our strengths. These include powerful health datasets in the NHS, world-leading design institutes, the artificial intelligence research community, a strong life sciences sector and the financial services industry. Making the most of these advantages could turn the ageing challenge into a global opportunity.

We will take action to and extend UK leadership in four early priority areas:

We will support new products and services for the growing global population of older people, meeting important social needs and realising the business opportunity for the UK

Globally, there are likely to be two billion people over the age of 60 by 2050³². UK businesses must take advantage of markets created by this rise in older consumers. Doing this could also improve people's quality of life. Through a forthcoming Industrial Strategy 'Healthy Ageing' programme we will invest in innovation to help older people maintain their chosen lifestyle, and stay independent for longer. We will explore opportunities to work with UK businesses to encourage emerging consumer markets, and the development of innovative products and services that support people throughout their working life and into retirement. This could include new finance products or partnering with the retail tech sector

to identify barriers to the development and diffusion of new products.

We will support sectors to adapt to a changing and ageing workforce

As people lead longer, healthier lives, they will need to save and work for longer to ensure they have a secure retirement. With an ageing workforce and fewer people entering the labour market from education and training, employers will need a more flexible labour market that can accommodate older workers. The government will continue to build on the Fuller Working Lives Strategy and has already appointed a Business Champion specifically for older workers. This signals our commitment to work with employers to promote the benefits of older workers to employers across England - in terms of their strategic approach and practical advice. We will also encourage industries to lead in adapting their workplaces to the requirements of an ageing workforce. To help realise the potential in the labour market, including amongst women, older workers, carers and disabled people, we will work with business to make flexible working a reality for all employees across Britain and to inform the evaluation of the Right to Request Flexible Working regulations.

We will leverage our health data to improve health outcomes and UK leadership in life sciences

The NHS generates powerful datasets that could be harnessed in a safe, fair and secure manner to develop

new tools to diagnose and treat illness earlier. In response to Professor Sir John Bell's life sciences review³³, the government will be working to develop a number of regional Digital Innovation Hubs. These hubs will support the use of data for research purposes within the strict parameters set by the National Data Guardian. Health and social care are devolved but the technological challenges and benefits can be supported and seized across the UK. Through the Industrial Strategy 'Data to early diagnostics and precision medicine' programme, we will invest to continue to explore the application of data for better, more innovative health and care.

We will support care providers to adapt their business models to changing demands, encouraging new models of care to develop and flourish

The government's forthcoming Green Paper on care and support in England will respond to the wide challenges facing the social care sector, setting out proposals for long-term, sustainable reform. The Industrial Strategy can play a role in supporting the care sector to adapt for the future. We will support the care sector to innovate and develop new business models, including by making better use of emerging technology through the Industrial Strategy Challenge Fund. We will also encourage care businesses to access the opportunities provided by the strengthened Growth Hub network.



'There are some distinctive British opportunities which build on our strengths... Making the most of these advantages could turn the ageing challenge into a global opportunity.'

Next Steps

What we have outlined here is just the start. Over the months ahead we want to work in partnership with businesses, universities, researchers and civil society on these Grand Challenges. All four are ambitious - and they are difficult. Success is

not guaranteed. But trying to tackle them is not just worthwhile, it is essential. If we can rise to these challenges we will have equipped our country for a future that is not just prosperous but also socially and environmentally responsible.

Ideas





Ideas

To be the world's most innovative economy

Our ability to innovate - to develop new ideas and deploy them - is one of Britain's great historic strengths, from the jet engine and the bagless vacuum to MRI scanners and the World Wide Web.

We are a global leader in science and research: top in measures of research excellence and home to four of the top 10 universities in the world.

We need to do more to ensure our excellence in discovery translates into its application in industrial and commercial practices, and so into increased productivity. The government and the private sector need to invest more in research and development (R&D). We need to be better at turning exciting ideas into strong commercial products and services. And we must do more to grow innovation strengths in every part of the UK, as well as maintaining our position as a global leader in science and innovation.

Through our Industrial Strategy, Britain will take a leading role in a new industrial revolution as significant as the last. We will drive change through the biggest increase in public investment in R&D in our history. We will ensure the UK is the best place for innovators, and through our Grand Challenges we will drive partnerships between the best minds in science and business throughout Britain.

Key policies include:

- ▶ Raising total R&D investment to 2.4 per cent of GDP by 2027
- ▶ Increasing the rate of R&D tax credit to 12 per cent
- ▶ Investing £725m in new Industrial Strategy Challenge Fund programmes to capture the value of innovation

Innovation is about new ideas, new ways of doing things, new products and services, new technologies and new business models. It can come from radical transformation or incremental improvements; from within a business or from a new insurgent; from a major scientific advance or the application of a known technology in a new process. Our ideas are crucial to the productivity improvements that boost our earning power.

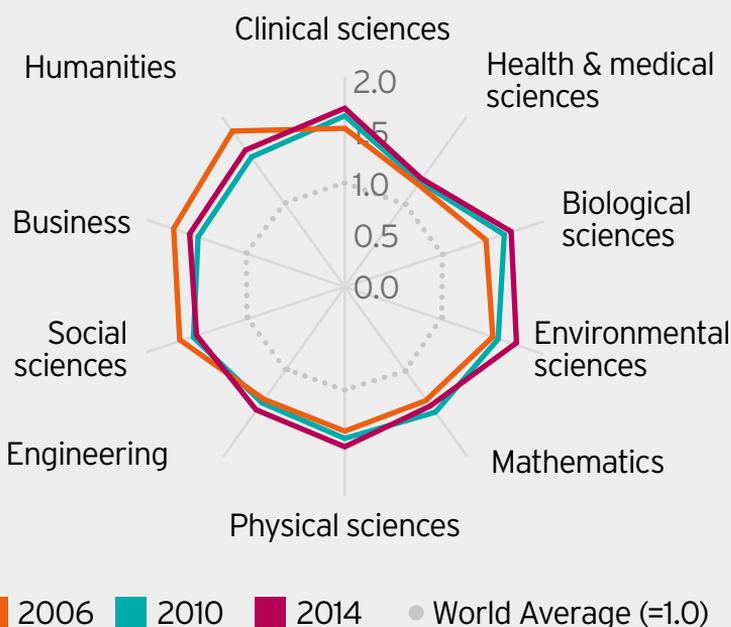
Our ability to innovate - to develop new ideas and deploy them - is one of Britain's historic strengths. We are a nation of innovators: from Sir Frank Whittle's jet engine to Sir Tim Berners-Lee's World Wide Web; from Sir James Dyson's bagless vacuum cleaner to the automatic kettle of Russell Hobbs. The UK is rated one of the most innovative countries in the world - an 'innovation leader' in the 2017 European



'We will drive change through the biggest increase in public investment in research and development in our history.'

The UK research base across research fields

UK field-weighted citation impact across research fields



Source: Elsevier (2017) "International comparative performance of the UK Research Base 2016". A field-weighted citation impact of 1.0 represents world average

Over half of UK firms are innovating.

Of those firms:

51% used new business practices.

36% introduced new products.



25% innovated in their processes.



38% used new methods of organising their work.



30% changed their marketing concepts or strategies.



Based on UK Innovation Survey Data 2015. Survey only includes enterprises with 10+ employees

Innovation Scoreboard and 23 per cent above the EU average performance³⁴. We are recognised as a global leader in science and research, top in measures of research excellence³⁵ and home to four of the top ten universities in the world³⁶. We punch above our weight in delivering high-quality, impactful and diverse research work.

We have leading-edge research and development (R&D) in many sectors and industries, including but not limited to life sciences, aerospace, automotive, technology, energy and the creative industries. We also have world-class service sectors including in law, accounting, financial services,

advertising, architecture and insurance. We have a lively and thriving start-up environment. We produce and attract some of the most talented people in the world and draw in proportionally more internationally mobile R&D than other large countries³⁷.

While we score well on measures of research and innovation, we need to do more to ensure this translates into improvements in earning power. According to the UK Innovation Survey, just over half of our businesses are classed as innovative³⁸, meaning there is significant potential to raise our game. There are four key challenges that this Industrial Strategy will address.

Our first challenge is that neither the government nor the private sector is investing enough in R&D. This holds back the productivity of both public services and business. It means the UK risks losing out in the race to develop the technologies and innovations that will shape the businesses and markets of the future. We invest less in R&D than most of our competitors - 1.7 per cent of GDP compared to 2.8 per cent in the United States and 2.9 per cent in Germany³⁹.

Even after allowing for the structure of our economy - which is dominated by services rather than the traditionally R&D-intensive sectors like manufacturing - we still invest comparatively little⁴⁰. Business investment in R&D in the UK is relatively low⁴¹. R&D performed in businesses is concentrated in a small number of big businesses and in a small number of sectors such as pharmaceuticals, motor vehicles and technology⁴². Indeed, just over three quarters of private R&D investment in the UK is driven by 400 businesses⁴³. Fewer of our small and medium-sized enterprises (SMEs) introduce new products and processes than their European competitors⁴⁴. Furthermore,

the latest data shows that the UK's strength in research is being challenged by emerging economies⁴⁵.

R&D is an example of public spending stimulating rather than displacing private spending: economies with high levels of public investment in R&D also typically have high levels of private investment⁴⁶. In the UK every £1 of public investment on R&D attracts around £1.40 of private investment⁴⁷.

Our second challenge is improving our ability to turn exciting ideas into commercial products and services and capture their maximum value. Our world-class science and research does not always feed through to world-leading home-grown businesses. There have been major breakthroughs made in UK universities and research labs bought up by global businesses - from magnetic resonance imaging in the 1970s, lithium-ion batteries in the 1980s, monoclonal antibodies in the 1990s and genetic sequencing in the last decade. All of these are pioneering UK ideas being developed elsewhere or bought by businesses from overseas. Within R&D, the 'D' for development needs a particular boost.



'R&D is an example of public spending stimulating rather than displacing private spending... In the UK every £1 of public investment on R&D attracts around £1.40 in private investment.'

Much of our innovation tends to be in areas such as software and branding, including marketing and advertising⁴⁸, which often require less patient capital to fund them. We are good at low-cost innovation and flexible start-ups but the long and patient process of getting a new technology to market is difficult. As a result many of our innovative businesses are nimble, flexible and imaginative but do not grow to be substantial, big or strong. There are exceptions, but in general British businesses' R&D tends to favour quick routes to market, rather than long development times, and selling businesses to growing them.

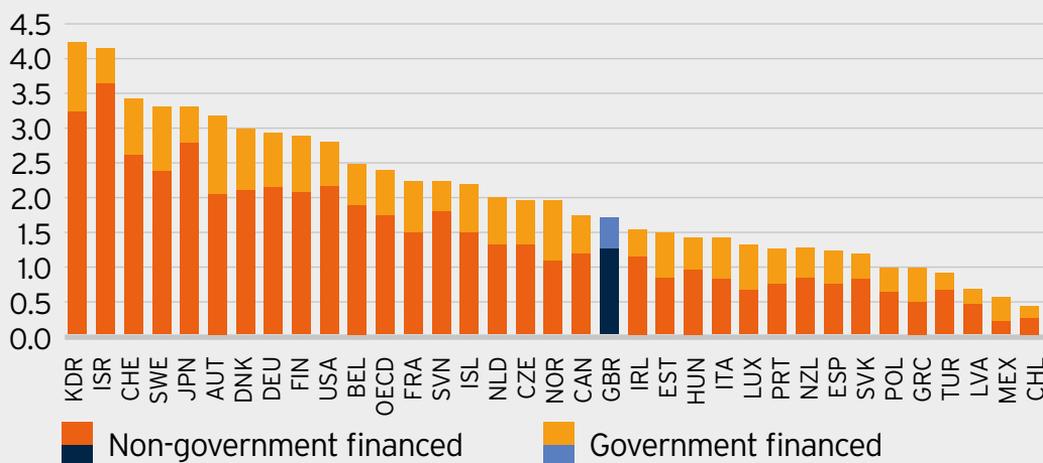
Our third challenge is to build research and innovation excellence across the UK. There is world class R&D and innovation across the UK, from excellent research

in university departments and public research organisations to investments from leading businesses. We need to capitalise on these strengths and foster the local ecosystems that can support innovation and sustained growth.

The Science and Innovation Audits⁴⁹ – led by consortia of business, universities and Local Enterprise Partnerships in England and relevant agencies in the devolved nations – are revealing distinct local and regional strengths and opportunities for collaboration across the UK. But they are also exposing the barriers an area can face in building its strengths into an ecosystem that attracts investment and talent – such as access to skills or knowledge and the capacity of businesses to innovate.

UK's spending on research and development compared to other countries

Gross domestic expenditure on R&D by source of financing as a proportion of GDP, 2015



Source: OECD (2017) "OECD Economic Surveys: United Kingdom 2017". *2014 data for France, Ireland, Italy, Portugal and OECD aggregate. 2013 data for Belgium, Israel, Luxembourg and Sweden. Non-government financed includes finance from higher education, which may be partly government-financed; and from the rest of the world, which may include foreign and supranational government finance

Our fourth challenge is to ensure the UK remains a world leader in global science and innovation collaboration. A total of 17 per cent of UK R&D investment is financed from abroad⁵⁰ and half of UK R&D performed in business was by overseas-owned businesses⁵¹.

17% of total **UK R&D investment** is financed from abroad

Half of all UK research publications in 2014 were internationally co-authored - a share that has increased every year since 2010 - with these articles tending to score more highly on excellence and impact⁵². This demonstrates that international collaboration is vital to our continued success. But UK leadership is being challenged by emerging economies and competition grows for research talent and private investment. For us to remain a leading R&D nation, we will need to capitalise on our strong reputation and continue to attract the top talent from around the world, including from EU member states.

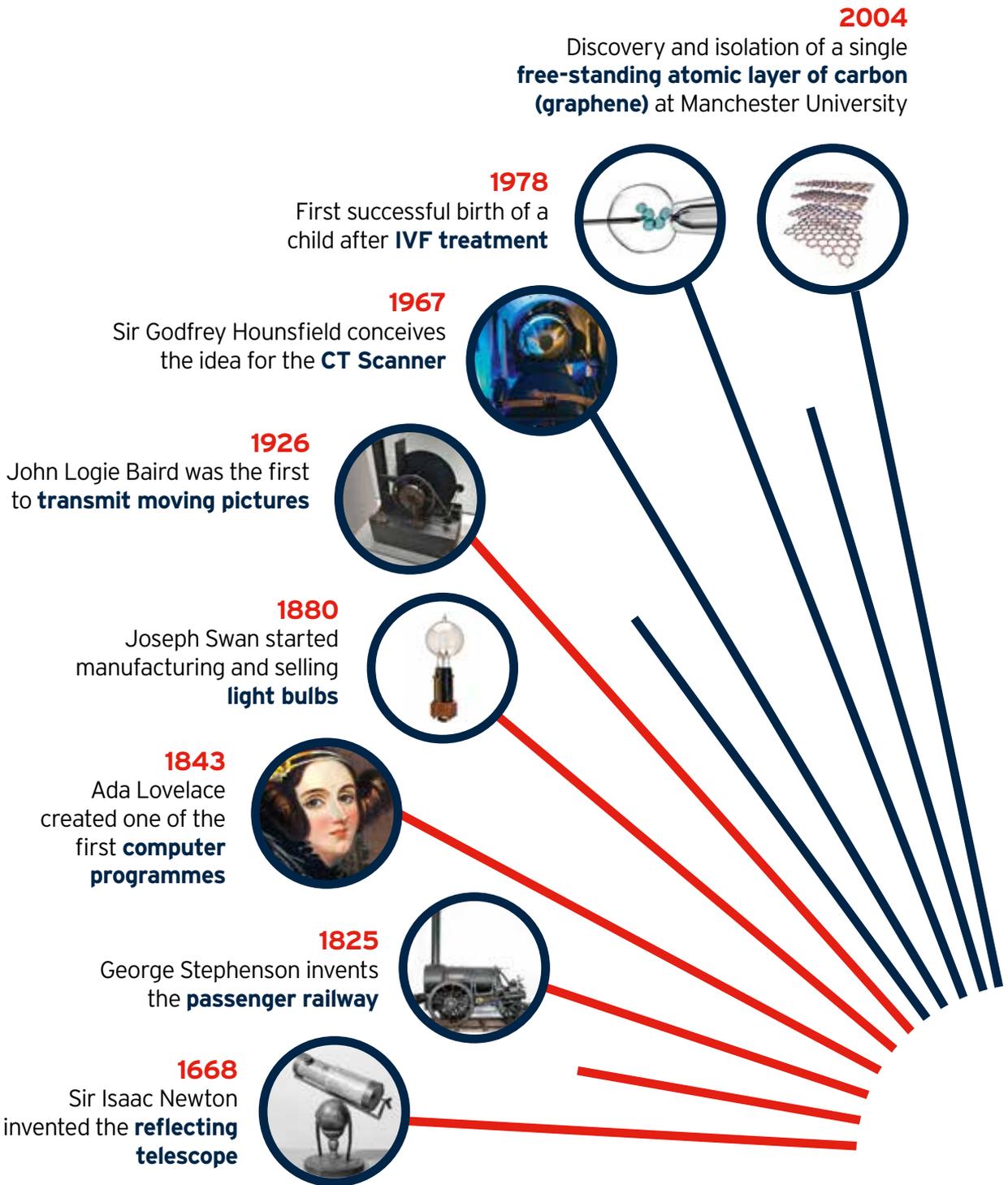
We must ensure we remain connected to other leading international sources of ideas and have the capacity to absorb the advances they are making, working closely with the devolved nations to make the most of strengths and opportunities across the UK. We need to make strategic choices to maximise our international collaborations to support UK priorities and the Grand Challenges.

If we address all this together we will be stronger not just in R&D and wider innovation, but in maximising the productivity and earning power benefits for businesses and people throughout the country. By 2030 we want the UK to be the most innovative country in the world: a home to the most dynamic businesses at the cutting edge of new technologies and processes, and which supports all businesses to adopt new ways of working to help them prosper. This means investing in R&D and the skills needed in a changing work environment to maximise the rewards and benefits innovation can bring to everyone in the UK.



'By 2030 we want the UK to be the most innovative country in the world: a home to the most dynamic businesses at the cutting edge of new technologies and processes.'

A nation of innovators



2011

Saturn Bioponics develop the world's first **three-dimensional crop growing system**



2012

Susannah Clarke revolutionised joint replacements by using **3D printed technology** allowing personalised joint replacement with fewer complications



2013

Surrey Satellite Technology's **S-band radar system, NovaSAR**, which revolutionises navigation and surveillance communications wins an Innovation award from the Institution of Engineering and Technology (IET)



2015

Oxford Nanopore launch MinION a **portable DNA sequencing USB device** for on-the-go RNA/DNA sequencing which can be used to monitor viruses like Ebola or trace antibiotic resistance without the need for large scale computing infrastructure



2015

DeepMind's AlphaGo defeats the reigning Go European Champion becoming the **first programme to defeat a professional player**, giving us deeper understanding of the power and flexibility of machine learning



2016

Double Negative wins its third Academy Award for its **pioneering visual effects work** on sci-fi psychological thriller *Ex Machina*



2017

Richard Henderson awarded the Nobel Chemistry Prize for developing **cryo-electron microscopy** for the high-resolution structure determination of biomolecules in solution



Our Grand Challenges will be driven by R&D in artificial intelligence and data-driven technology, clean growth, adapting to an ageing society and future mobility

Our approach

Investing in R&D to transform our economy.

For the UK to become the most innovative country in the world we need a generational increase in public and private R&D investment. **In this strategy we commit to reach 2.4 per cent of GDP investment in R&D by 2027 and to reach 3 per cent of GDP in the longer term, placing us in the top quartile of OECD countries.**

If we meet this target we will transform our economy. It could increase public and private R&D investment by as much as £80bn over the next 10 years, with much wider benefits across the UK economy.

We could see a dramatic change in the use of R&D by industry, with our businesses creating the next generation of technologies to revolutionise productivity in all sectors from construction and agriculture to manufacturing and the creative industries. This will raise the standard of living and establish UK leadership in global markets. The UK will lead the way in the R&D driving our Grand Challenges: in artificial intelligence and data-driven technology, clean growth, the ageing society and mobility.

Our vision for a knowledge-led economy is underpinned by world-leading research, world-class facilities and international collaborations that push scientific frontiers and attract the brightest talents, from Nobel Prize winners to ambitious graduate students.

'Innovation clusters' will form and grow around our universities and research organisations, bringing together world-class research, business expertise and entrepreneurial drive. These clusters can create thousands of skilled jobs in R&D, innovation and wider sectors, driven by the growth in science, technology, engineering and maths (STEM) skills led by new teachers and more doctorates. These skilled people and businesses must be located throughout the UK, growing research and innovation strengths throughout England, as well as in Scotland, Wales and Northern Ireland.

Increasing investment in R&D to 2.4 per cent of GDP in a decade is ambitious and will require concerted effort by the government and business. **As a first step we will invest an additional £2.3bn over what was previously planned in**

2021/22, raising total public investment in R&D to approximately £12.5bn in that year alone. This investment will see public R&D spending increase as a share of GDP every year. It means that we will have raised public investment in R&D from around £9.5bn last year (2016/17) to around £12.5bn in 2021/22.

£12.5bn

public investment in R&D in 2021/22 alone

This is an extra £7bn over five years - the biggest ever increase in public funding of R&D. We will invest strategically in technologies and ideas closer to market to drive UK competitiveness, while also continuing to fund the curiosity-driven research that is fundamental to the quality of our work and ensures our place as a world-leading knowledge economy.

We will work with industry in the coming months to develop a roadmap for meeting this target. This will provide a framework to drive business investment in R&D and focus on key sectors, technologies



'Our vision for a knowledge-led economy is underpinned by world-leading research, world-class facilities and international collaborations that push scientific frontiers and attract the brightest talents.'

and clusters, including by optimising government investment to drive private investment in R&D and considering further opportunities to improve the business environment, including access to finance, regulatory frameworks, and intellectual property. This will maximise the impact of public investment in science and innovation to support businesses to invest more and drive outputs to realise our commitment to invest 2.4 per cent of GDP in R&D.

There are measures we can take now to help achieve this target:

- ▶ **We will invest a further £725m in a second wave of the Industrial Strategy Challenge programme** across the UK to respond to some of the greatest global challenges and opportunities - from climate change to automation. This will bring together world-class UK research with business investment to develop the technologies and industries of the future and ensure we capture the value of these innovations to our economy. Further details of this investment are outlined in the next section.
- ▶ **We will invest £300m over the next three years in world-class talent** including in priority areas aligned with the Industrial Strategy, such as artificial intelligence, to enhance our skilled workforce and attract private sector R&D investment. This investment will focus on collaboration and the flow of people between industry and academia and interdisciplinary and cutting-edge

research and innovation to support the Industrial Strategy programme and the Grand Challenges. Support will range from Knowledge Transfer Partnerships and PhD programmes, with strong and flexible links to industry, to prestigious awards that support rising stars and the top talent from both the UK and overseas.

- ▶ **We will work with our leading universities, research institutes and UK Research and Innovation to increase global investors' R&D activities taking place in the UK.**

Of the world's 2,500 top R&D investors, just 50 businesses are responsible for 40 per cent of private sector investment globally⁵³. If we could attract an additional five per cent of R&D from these top 50, UK-based R&D would increase by around a third⁵⁴.

- ▶ We will work with UKRI to develop a **new competitive Strategic Priorities Fund**, which builds on the vision of a 'common fund' set out in Sir Paul Nurse's review⁵⁵. This will support high quality R&D priorities which would otherwise be missed - multi-disciplinary and inter-disciplinary programmes identified by researchers and businesses at the cutting edge of research and innovation. We will set out further details in due course. UK Research and Innovation strategy will deliver a real-terms increase in council budgets of approximately 20 per cent between 2015/16 and 2019/20. We will also increase support for Quality-Related research

through Research England. This recognises the vital importance of providing underpinning funding for our world-leading universities to invest in the excellence and impact of their research and ensure the sustainability of our research infrastructure.

▶ We will improve the UK tax system to support innovation. The government will increase the rate of the R&D expenditure credit for large businesses from 11 per cent to 12 per cent from 1 January 2018. To provide businesses with the confidence to make R&D investment decisions, the government will also introduce a new Advanced Clearance Service for R&D expenditure credit claims. More widely, the government will work with small and medium sized businesses, and those developing new and emerging technologies, to ensure that they can access the maximum amount of support from R&D tax credits, and will launch a campaign to raise awareness in these sectors.

▶ **We will make it easier to finance innovation** by increasing the resources for government agencies that promote and fund innovation like Innovate UK - our world leading innovation agency that supports businesses across the UK to collaborate and innovate - and the British Business Bank. As detailed in the Business Environment chapter, we will increase the funding of the British Business Bank and create a new investment fund to ensure the best knowledge-intensive, high-growth businesses get access to the venture capital they need to scale up and become world-beating businesses.

▶ We are also allocating a further £44m of grant funding to enable Innovate UK to fund £150m of responsive grant competitions in 2017/18. This will allow it to support hundreds more high-growth businesses, collaborations and industries to innovate and compete in future global markets.



'If we could attract an additional five per cent of research and development from these top 50 research and development investors, UK-based R&D would increase by around a third.'

In addition, Innovate UK will pilot new ways of financing innovation:

- **£50m Innovation Loans pilot** over the next two years to target the most promising projects in viable businesses on the cusp of commercialisation, but not yet ready to access loans from commercial lenders; and
- **an Investment Accelerator pilot** to bring in seed equity alongside grant funding by matching the most innovative early stage businesses with investors. This will attract and bring forward private capital alongside public funding.

Both pilots will be evaluated to assess their success and determine if they can be scaled up in future.

- ▶ **We will develop an agile approach to regulation** that promotes innovation, the growth of new sectors, and innovative market entrants while ensuring effective protections for citizens and the environment. An example is establishing a clear framework for autonomous vehicles and, through our Digital Charter, building agreement on the ethical and effective use of new technologies and data. This will build on successful, innovative approaches to regulation (like regulatory sandboxes) trialled by the Financial Conduct Authority and Ofgem.

- ▶ **We will improve public procurement as an important source of finance for innovative businesses** that does not dilute their equity and gives an endorsement for others to invest. The United States is particularly effective at promoting innovation in this way through its Small Business Innovation Research programme. David Connell, an expert on technology exploitation programmes, has reviewed the UK's Small Business Research Initiative (SBRI) programme. Informed by this review, and recognising the value of the programme, we will refocus the SBRI to increase its impact for innovative businesses, aligning it with Grand Challenges and building capability in the public sector to drive productivity by adopting SBRI solutions. As a first step, this month we announced a new GovTech Catalyst with a GovTech Fund of up to £20m over three years, which will use SBRI to support tech firms to provide the government with innovative solutions for more efficient public services.

The Trusted Data Exchange used by Belfast City Council.



Case Study: the growth of 'nquiringminds'

Innovative start-up **'nquiringminds'** took an idea from concept to product with SBRI support, and tested it with Belfast City Council.

The Trusted Data Exchange (TDX) provides analytics and secure data-sharing, powered by artificial intelligence, that allows users to share data sets, maximising the ability to analyse and generate insight. 'nquiringminds' and Belfast City Council used the TDX with internal

and open datasets to optimise the collection of business rates. SBRI played a pivotal role in the company's growth from a start-up with a novel idea to a 12-person business with plans for continued growth.

Stable SBRI funding over several years enabled the company to build a skilled team, create intellectual assets and, importantly, to test a new product in a real-world environment and enter a new market.



'We will develop an agile approach to regulation that promotes innovation, the growth of new sectors, and innovative market entrants.'



UK Research and Innovation (UKRI) will join up the funding landscape for science, research and innovation and help to translate excellent research into better business outcomes

Capturing the value of ideas

If the UK is to be the most innovative country in the world, we need to be able to capture the value from our science, research and creativity and support innovations that drive our productivity.

There is no single path to innovation. Successful products and services come from a range of sources - from businesses developing new products and universities creating businesses to the lone inventor commercialising an idea. The government will do more to address some of the frictions in the system to support

collaboration and the flow of knowledge between research and industry, accelerating the path to market.

In order to capture more value from our ideas and innovations, we are creating UK Research and Innovation, which will invest around £8bn per annum by 2020 in the highest-quality research and innovation across the UK.

This new organisation will ensure the UK maintains its world-leading position in research and innovation. Bringing together the seven research councils, Innovate UK and the funding element of the Higher Education Funding Council for England (HEFCE), UK Research and Innovation will join up the funding landscape for science, research and innovation and help translate excellent research into better business outcomes.

We are investing in strategic innovation challenges through the ambitious new **Industrial Strategy Challenge Fund**, which will help deliver the Grand Challenges and support sector productivity including through Sector Deals. The Industrial Strategy Challenge Fund brings together world-class UK research with business investment to develop the technologies that will transform existing industries and create entirely new ones. We announced £1bn of investment in Wave 1 across the UK - focused on areas of strategic importance to the UK, including: the Faraday Battery Challenge to design, develop and

manufacture batteries for the electrification of vehicles and efficient use of renewable energy; artificial intelligence and robotic systems for extreme environments like nuclear and space; future satellites; and technologies for medicine manufacture. By bringing together key players, and focusing on the big innovation challenges facing the UK, the Industrial Strategy Challenge Fund will maximise the value of the new ideas being developed.

To support UK priorities in key areas of innovation we will invest a further £725m in the Industrial Strategy Challenge Fund over the next four years. We are announcing six Industrial Strategy Challenges in Wave 2 aligned with our Grand Challenges and Sector Deals and two Pioneer Challenges to build industry engagement and readiness for future funding.



'We are creating UK Research and Innovation, which will invest around £8bn per annum by 2020 in the highest-quality research and innovation across the UK.'

The next Industrial Strategy Challenge Fund programmes are:

Clean Growth



► **Transforming construction, up to £170m*** - The way we create our buildings has not changed substantially in 40 years and needs a drastic overhaul if it is to deliver the buildings that the UK needs. Construction is currently expensive and too many buildings waste energy. We need to transform construction so that we can create affordable places to live and work that are, safer, healthier and use less energy. By taking a lead in the UK, we can increase our ability to export. Global demand for efficient buildings is rising rapidly, driven by the pressures of urbanisation, affordability, and the need to cut emissions.

► **Prospering from the energy revolution*** - Around 80 per cent of global energy use still comes from fossil fuels⁵⁶. To preserve a safe and stable climate, this has to change fast. Countries all over the world are moving to renewable energy, with investment more than doubling over the last decade⁵⁷. But for the majority of our energy to be clean and affordable, we need much more intelligent systems. Smart systems can link energy supply, storage and use, and join up power, heating and transport to increase efficiency dramatically. By developing these world-leading systems in the UK, we can cut bills while creating high value jobs for the future.

* All wave 2 programmes are subject to final business case when further details on funding will be made available.

Clean Growth



- ▶ **Transforming food production*** - The world will need 60 per cent more food by 2050 to allow us to feed 9 billion people, while demand for water is expected to rise by 20 per cent in the agriculture sector alone⁵⁸. For this to be possible, the way we produce our food needs to be significantly more efficient and sustainable.
- ▶ By using precision technologies we can make that a reality: transform food production whilst reducing emissions, pollution, waste and soil erosion. By putting the UK at the forefront of this global revolution in farming, we will deliver benefits to farmers, the environment and consumers whilst driving growth, jobs and exports.



'Smart systems can link energy supply, storage and use, and join up power, heating and transport to increase efficiency dramatically.'

AI and data



▶ **Audience of the future, up to £33m***- Immersive technologies such as virtual, augmented and mixed reality are changing how we experience the world around us - from entertainment and art to shops and classrooms. The challenge is to bring creative businesses, researchers and technologists together to create striking new experiences that are accessible to the general public. This can create the next generation of products, services and experiences that will capture the world's attention and position the UK as the global leader in immersive technologies.



▶ **Next generation services, up to £20m***- Services account for almost 80 per cent of the UK economy⁶⁰. As technologies like artificial intelligence and data analytics become ubiquitous, we need to ensure UK service sectors are primed. Pioneer funding will help service industries to identify how the application of these technologies can transform their operations. This will help to set UK service industries at the forefront of developing and using innovation.

Ageing Society



▶ **Data to early diagnosis and precision medicine, up to £210m*** - There are fatal diseases that take years to develop before they present symptoms. Developing effective treatments - such as for pancreatic cancer which develops on average 14 years before symptoms present - becomes progressively harder. The challenge is to combine the wealth of data created by UK researchers with real world evidence from our health service. That will allow industry to create new products and services that will diagnose diseases earlier and help clinicians choose the best treatment for individual patients. This will save lives and set the UK at the forefront of a growing global market in diagnostics.

▶ **Healthy ageing*** - By 2040, one in eight people in the UK will be aged over 75 - an increase from one in 12 today⁵⁹. Staying active, productive and independent is important to our increasing numbers of older people. The challenge is to innovate, so older people's aspirations are met and so better, more effective care supports an independent lifestyle as they age. By working together, the government and industry can address the challenges of ageing whilst capturing a growing global market.



'Services account for almost 80 per cent of the UK economy. As technologies like artificial intelligence and data analytics become ubiquitous, we need to ensure service sectors are primed.'



UK Space Agency is studying how machines can support humans to make the exploration of the universe more efficient

We will invest in pioneer funding for **quantum technologies, up to £20m***, recognising the impact this could have across a number of challenge areas. A new set of products from medical devices to sensors and safer communication systems may be possible using the emerging physical science known as quantum technology. The potential is huge but still largely in the lab environment. Pioneer funding will bring new disruptive businesses together with existing businesses to understand how this emerging technology can be turned into products that will underpin industry in the future.

We will run a third wave of Industrial Strategy Challenge Fund programmes, with UK Research and Innovation launching an expression of interest for potential challenges next year.

Alongside the Industrial Strategy Challenge Fund, we are also improving the incentives, processes and skills that support the flow of knowledge and ideas around society and, building on the Dowling Review⁶¹, increase opportunities for research commercialisation. Universities work with businesses in many different ways to exchange ideas - from licensing

intellectual property and creating spin-outs to collaborative R&D, contract research and consultancy. To capture this diversity fully we are asking UK Research and Innovation to **develop a new Knowledge Exchange Framework**. This framework will benchmark how well universities are doing at fostering knowledge sharing and research commercialisation. It will sit alongside the Research Excellence Framework and the Teaching Excellence and Student Outcomes Framework, providing a holistic view of how universities are delivering their threefold mission of generating knowledge through research, transmitting knowledge through teaching, and translating knowledge into practical uses through knowledge exchange. The development of the Knowledge Exchange Framework will build on the work of the *McMillan Review*⁶², and will capture the rich network of collaborations between universities and businesses. In parallel the higher education funding bodies are changing the incentives and rewards for capturing

the value of research by **increasing significantly the importance of 'impact' in the Research Excellence Framework (REF)**, raising it from 20 per cent to 25 per cent in the next assessment round.

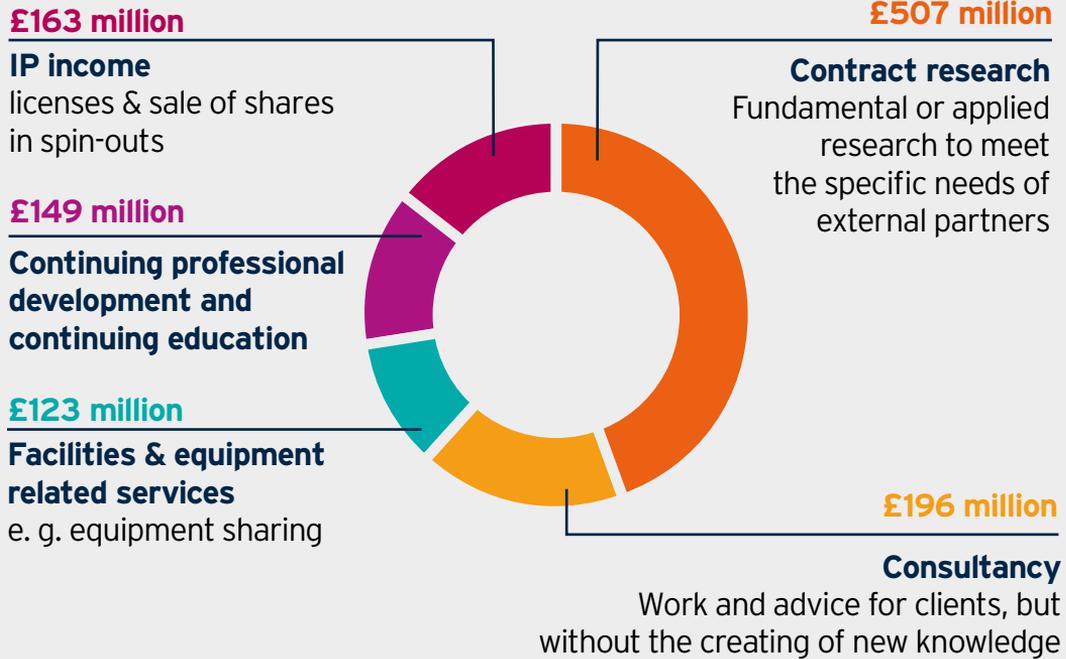
Emerging findings from independent research into commercialisation of university intellectual property highlight the improvements in university practices and commercialisation outcomes in recent years. The research also suggests that university technology transfer offices sometimes lack the resources and skills to fully develop commercialisation opportunities, particularly in institutions that have historically undertaken less of this activity. **We will increase funding that supports universities and businesses working together to innovate and commercialise research.** Key to this is the Higher Education Innovation Funding (HEIF) in England, which enables universities to engage with businesses and improve the commercial skills of their staff. HEIF has deepened universities' relationships with business.⁶³



'We are also improving the incentives, processes and skills that support the flow of knowledge and ideas around society.'

Universities earn £1.1bn from their collaborations with business

Income of higher education institutions from knowledge exchange activities with businesses



Source: HESA (2017) "Higher Education Business and Community Interaction Survey 2015/16".

*Includes both publicly and non-publicly funded higher education institutions

University patents, licence income and industrial collaboration are increasing⁶⁴, and there is scope - and demand from business - to do more. We have announced an increase of £40m a year to HEIF **and will now commit to reaching a total of £250m a year by 2020-21, as recommended in the Witty Review⁶⁵**. The increased support will align with the needs of the Industrial Strategy and will result in consequential funding for the devolved administrations. We expect universities to continue to use HEIF to help

address the needs of local innovative businesses and contribute to regional development, including collaboration with their Local Enterprise Partnership.

The UK has a range of public research organisations that bridge the gap between business, academia and the public sector, bringing together the best people in their fields to work side-by-side on later-stage research and development and transform high potential ideas into new products and services.

Higher Education Innovation Funding

Higher Education Innovation Funding (HEIF) supports knowledge-based interactions between universities and colleges and the wider world. Universities use HEIF to respond to business needs and to local opportunities. Recent examples include:

- ▶ HEIF is supporting the University of Central Lancashire's **Centre for Small and Medium Enterprises Development**, which is delivering almost £10m worth of business support projects and is set to reach almost 1,000 SMEs in the region;
- ▶ The Royal College of Art is using HEIF to support its **InnovationRCA programme**, which has incubated and spun-out 39 start-ups, employing over 500 people, over the last nine years;
- ▶ The University of Huddersfield is working with partners, including the Leeds City Region Local Enterprise Partnership,

to increase productivity and economic growth - including by using HEIF to establish a **business engagement and support facility** at the University's 3M Buckley Innovation Centre;

- ▶ Imperial College will be forming **stakeholder groups for SMEs** around specific topics - making it easier to access Imperial's expertise. It will run a proof of concept fund to help researchers advance projects with clear translation potential; and
- ▶ The **Connecting Capability Fund** is supporting groups of universities to work together to meet a range of business needs. The first round of funding has supported: productivity-building in the east of England; helping SMEs to scale up in the south of England; developing an investment fund for university spin-outs in the north of England; and developing new therapies for age-related diseases.



'The UK has a range of public research organisations that [bring] together the best people in their fields to work side-by-side on later-stage research.'

Through the work of Innovate UK, the government has expanded this part of the innovation ecosystem, establishing a network of 'Catapult centres' to commercialise new and emerging technologies.

An independent review of the Catapult network⁶⁶ has recently concluded. It sets out that Catapults are an important and successful part of the UK's innovation ecosystem, and that they can drive innovation and economic benefit in the UK. As well as highlighting the success of the best-performers, the review has also found that improvements should be made to the network to increase its performance and economic impact. The High-Value Manufacturing Catapult is a particular success story. Since inception in 2012 it has tripled the impact of government spending - generating £655m of additional income from industry by working with over 3,000 businesses every year to bring new technology to market.

It has established a strong track record of helping UK manufacturing businesses of all sizes connect better with their customers and supply chains and boost their competitiveness by applying new technologies that enable faster and cheaper production of products and components. Its work is not only anchoring production in the UK, it is also helping to re-shore manufacturing lost to other countries and winning the high value inward investment projects that create jobs and local growth.

We want Catapults to play a growing role in UK innovation. We will use this review to improve the strategies, governance and performance management of Catapults, and to agree long-term funding for them to ensure they can deliver better outcomes for the Industrial Strategy.

We will be putting in place £178m of interim funding to allow them to continue their work and will agree long-term funding for the network early next year. For those Catapults where most improvement is needed, we will ask UK Research and Innovation to run a 12-week process to develop their plans.

A technician trialling a new access system for offshore wind turbines on the 7MW Offshore Renewable Energy Catapult Levenmouth Demonstration Turbine, Scotland



'Our High Value Manufacturing Catapult has established a strong track record of helping UK businesses of all sizes connect better with their customers and supply chains.'

Case Study: Offshore Renewable Energy Catapult supporting innovation in offshore wind energy

The **Offshore Renewable Energy Catapult** is supporting Edinburgh-based small business ACT Blade to develop an entirely new form of offshore wind blade, based around its highly advanced and proven sail-rig technology.

Using UK expertise in composites and high-tech textiles, ACT Blade's innovative lighter and

longer design is currently being tested at the Offshore Renewable Energy Catapult's test centre at Blyth.

The design has the potential to not only reduce the cost of energy and extend the lifetime of the UK's onshore wind fleet, but also establish novel manufacturing processes in the UK.



The iconic Rocket Tower at the National Space Centre in Leicester is home to Blue Streak and Thor Able rockets

Building innovation excellence across the country

As evidenced above, innovation is a highly collaborative activity. It flourishes in clusters and through networks.

Our universities and colleges are central to world-class innovation clusters. Research clusters from Cambridge to Glasgow attract inward investment from businesses looking to access knowledge and talent, bringing a positive impact to the wider local economy in terms of jobs and infrastructure investment. We are fortunate that our leading research-intensive universities are spread across the country. There are substantial established and emerging research clusters across the UK - such as life sciences in the north west and Cambridge's Laboratory of Molecular Biology⁶⁷, environmental sciences in

Exeter with the combined research strengths of the university and the Met Office, and Loughborough University's science and enterprise park⁶⁸. There are other universities with distinctive research strengths - Leicester for space, the University of East Anglia for agri-science, Abertay for video games, and precision optics at Glyndwr. There is potential for these and other excellent universities to develop and scale up local innovation clusters which will deliver local growth.

Evidence shows that innovation drives productivity and that interventions work

best where they support existing strengths and collaborations⁶⁹. Building on the Science and Innovation Audits⁷⁰, **we are launching a new competitive £115m Strength in Places Fund** to support areas to build on their science and innovation strengths and develop stronger local networks. The fund will support collaborative programmes based on research and innovation excellence in places right across the UK which can demonstrate a strong impact on local productivity and enhance collaboration between universities, research organisations, businesses, local government and Local Enterprise Partnerships in England and relevant agencies in the devolved nations.

The fund will identify and support areas of emerging R&D strength that are driving business clusters and it will build on the regional economic impact of existing institutions including universities, research institutes, Innovation and Knowledge Centres and Catapults and will link to Local Industrial Strategies. This will be delivered

through UK Research and Innovation as a competitive fund for collaborative bids. The government and UK Research and Innovation will evaluate these in 2021 to see how they are working and consider further scaling up.

The UK also has some of the best research laboratories in the world - from the National Physical Laboratory, which helps to set global measurement standards that support trade and innovation, to the UK Met Office with its world-renowned climate and weather modelling examining climate change and our resilience to extreme weather events. In our Green paper we committed to reviewing whether there is more that can be done to leverage such laboratories to drive local productivity. Following the review, led by Professor Dame Julia Goodfellow, **we are setting an expectation of all labs in receipt of significant public funding to support local economic growth.**

The review identified several gaps to building sustained partnerships between labs and local businesses and we will explore mechanisms to overcome these.



'We are launching a new competitive £115m Strength in Places Fund to support areas to build on their science and innovation strengths and develop stronger local networks.'

Science & Innovation Audit Themes

- 1 Edinburgh and South East Scotland City Region**
Digital technology and Data-Driven Innovation
- 2 Sheffield City Region and Lancashire**
High value manufacturing
- 3 Greater Manchester and East Cheshire**
Health Innovation and Advanced Materials
- 4 Midlands Engine**
Advanced Manufacturing; Digital Technologies and Data; and Systems Integration
- 5 South West England and South East Wales**
Advanced Engineering and Digital Innovation
- 6 Enabling Technologies in Scotland's Central Belt**
High value manufacturing
- 7 Bioeconomy of the North of England**
Agri-tech and industrial biotechnology
- 8 East of England**
Life sciences and agri-tech
- 9 Innovation South**
Digital enabling technologies
- 10 Leeds City Region**
Medical technology
- 11 Liverpool City Region+**
Infection; Materials Chemistry; and High Performance Computing
- 12 OffShore Renewable Energy**
Offshore energy and sustainable ocean technologies
- 13 Oxfordshire Transformative Technologies**
Quantum computers; autonomous vehicles; digital health; and space and satellites
- 14 Cyber Resilience Alliance**
Cybersecurity
- 15 Maximising the Marine Economy of the Highlands & Islands**
Aquaculture, wave and tidal energy and marine biotechnology
- 16 North West Nuclear Arc Consortium**
New nuclear technology
- 17 North West Coastal Arc Eco-Innovation Partnership**
Low carbon energy and eco-innovation
- 18 Northern Powerhouse Chemicals and Processing Science**
Chemicals
- 19 Northern Powerhouse in Health Research**
Medical
- 20 The South Wales Crucible**
Steel innovation; smart manufacturing; health informatics; and agri-tech
- 21 Upstream Space**
Space infrastructure and technology
- 22 Precision Medicine Innovation in Scotland**
Precision medicine
- 23 Applied Digital Technologies**
Digital capability
- 24 Sustainable Airports**
- 25 The Knowledge Quarter**
Biomedical; heritage; digital publishing; and data science



'Science and Innovation Audits help local organisations map their research and innovation strengths, and identify areas of potential global competitive advantage.'





The first major project of the UK-US Science and Technology Agreement is UK investment in the Long Baseline Neutrino Facility and Deep Underground Neutrino Experiment

International Collaboration

Research and innovation are global endeavours and talented and experienced people in these fields are internationally mobile.

Businesses have talent scouts around the world to spot opportunities in the most creative clusters, and investment tends to follow talent. The UK has the second largest bilateral flow of scientists⁷¹ and we want the UK to be a magnet for world-class talent. We will increase the number of scientists working in the UK and enable leading scientists from around the world to work here. We will continue to recruit and retain the best talent and ensure the UK remains a world-leader in science and innovation through our Rutherford Fund. The Fund is investing £118m over four years (from 2017/18) in fellowships for early-career to senior researchers.

We have doubled the number of available visas in the Tier 1 (Exceptional Talent) route available to those who are already recognised as global leaders or who show considerable promise in their fields. This recognises the importance of supporting those working in the digital technology, science, arts and creative sectors, and ensures that the UK can continue to welcome international talent to work in these key emerging and innovative industries. The government is also changing immigration rules to enable world-leading scientists and researchers endorsed under the Tier 1 route to apply for settlement after three years

and to make it quicker for highly-skilled students to apply to work in the UK after finishing their degrees. We are relaxing the labour market test to allow UK Research and Innovation and other select organisations to sponsor researchers, making it easier to hire international researchers and members of established research teams. The National Academies are considering how they can encourage top global research talent to come to the UK through the Research and Innovation Talent scheme within Tier 1 of the visa system.

We also want the UK to be the partner of choice for science and innovation. Approximately one in five businesses are engaged in collaboration⁷². Global collaborations are crucial in meeting the Grand Challenges. We will launch a new International Research and Innovation Strategy in early 2018 in partnership with UK Research and Innovation and a £110m fund for International Collaborations to enhance the UK's excellence in research and innovation through global engagement.

This will be complementary to the existing Official Development Assistance budget, which supports projects that benefit developing countries. We have already strengthened key partnerships with pioneering new collaborations through:

- ▶ **the first formal science and technology agreement with the United States**, signed in September, with a UK contribution worth £65m to collaborate on projects exploring some of the most important questions in science and advance our understanding of the origin and structure of the universe; and
- ▶ replicating this model with other countries - for example, we are developing a **joint Science, Technology and Innovation Strategy with China** to expand and deepen our collaboration. Through programmes like the Newton-Bhabha Funds, and the UK India Education Research Initiative, we continue to build and sustain the UK's science, research and innovation partnership with India.



'The UK has the second largest bilateral flow of scientists and we want the UK to be a magnet for world-class talent.'



The Square Kilometre Array links Jodrell Bank in Cheshire with a network of radio telescopes in South Africa and Australia

The UK will also take on the annual chairmanship of the EUREKA intergovernmental organisation in July 2018, which will enable us to guide the strategic direction of the organisation to enhance further our global presence. EUREKA helps SMEs across Europe and globally to collaborate on bringing innovative ideas to market.

Our research collaboration is supported by our substantial commitment to developing countries, and by our leadership of wider global initiatives. We can develop shared research programmes around a global challenge and also use shared

infrastructure. This is exemplified by our leading role in the Square Kilometre Array, linking Jodrell Bank in Cheshire with a network of radio telescopes in South Africa and Australia. It will handle a flow of data greater than the current flow of all data across the internet and provides important opportunities for commercial development. Similarly, our leading position in Mission Innovation - a 23-country partnership to accelerate clean energy innovation by doubling investment in targeted research and development - brings together our commitments to clean growth, raising investment in research and development, and global engagement.

Some of our closest relationships and collaborations are with EU member states. The UK has already worked collaboratively with our partners to shape the EU Research and Innovation Framework programmes, which are based on excellence and global impact and aim to accelerate the exchange of ideas, talent and getting innovation to market. EU and UK businesses and universities have collaborated on a range of projects, from faster Ebola testing and cleaning up industrial processes to the use of solar power. The UK is a leader in attracting and retaining the best global researchers.

Through the EU Horizon 2020 we have received 20 per cent of all awarded European Research Council (ERC) grants⁷³; we are a 'top five' collaboration partner for all member states in the Horizon 2020 programme⁷⁴; and we have attracted €3.6bn to date for our innovative businesses and universities.⁷⁵ The UK has signalled its desire to seek a far-reaching science and innovation agreement with the EU that establishes a framework for future

cooperation. We would welcome the chance to discuss possible options for our future involvement in the EU framework programmes as part of this agreement. The UK wants to continue to take part in those specific policies and programmes which are greatly to the UK and the EU's joint advantage, such as those that promote science, education and culture.

Higher education is devolved to Scotland, Wales and Northern Ireland. The devolved administrations and their agencies have a close relationship with the institutions in each nation and deep knowledge of the many opportunities for international collaboration within them. We want to work with the devolved nations - governments and institutions both - in seizing opportunities to collaborate internationally.



'Our leading position in Mission Innovation... brings together our commitments to clean growth, raising investment in research and development and global engagement.'

People





People

To generate good jobs and greater earning power for all.

The United Kingdom has one of the most successful labour markets in the world. Our employment rate is at a near historic high - one of the fastest post-recession rates relative to other major economies⁷⁶. It is underpinned by a world-class higher education system, the first choice of students and researchers around the world. Employers are ever more closely involved in the system, and we are committed to delivering three million apprenticeship starts by 2020.

But we still face challenges in meeting our business needs for talent, skills and labour. In the past, we have given insufficient attention to technical education. We do not have enough people skilled in science, technology, engineering and maths. We need to narrow disparities between communities in skills and education and remove barriers faced by workers from under-represented groups in realising their potential.

We will ensure that everyone can improve their skills throughout their lives, increasing their earning power and opportunities for better jobs. We will equip citizens for jobs shaped by next generation technology. As the economy adapts, we want everyone to access and enjoy good work.

We will put technical education on the same footing as our academic system, with apprenticeships and qualifications such as T levels. We will continue to support teaching in our schools, flexible career learning and other measures to transform people's life chances.

Key policies include:

- ▶ Establish a technical education system that rivals the best in the world, to stand alongside our world-class higher education system;
- ▶ Invest an additional £406m in maths, digital and technical education, helping to address the shortage of science, technology, engineering and maths (STEM) skills
- ▶ Create a new National Retraining Scheme that supports people to re-skill, beginning with a £64m investment for digital and construction training

We recognise that people, and the skills they have, are a key driver of productivity. Having the right skills increases people's earning power. Investing in our people across their lifetimes is fundamental to our shared success, from strong foundations for children and young people in schools and relevant, high quality education and training in our further and higher education systems to career-long learning and enabling employers to invest in their workforce.

As our Industrial Strategy Green Paper set out, we are building on significant strengths and improvements in our education system in England. We have an additional 1.8 million children in good and outstanding schools compared to 2010⁷⁷. It has been estimated that half of all UK 17 year olds will participate in higher education by the age of 30⁷⁸. We are involving employers ever more closely in the education system, and we are committed to delivering three million apprenticeship starts by 2020.

We have a world-class higher education system that remains the second most popular destination for study by overseas students after the United States⁷⁹.

3 million

apprenticeship starts
by 2020

We have an effective labour market too. British businesses are good at creating jobs - our flexible labour market makes it easy for people to participate in the workforce in a way that fits with their preferences and circumstances and meet the needs of our businesses and the economy. We are increasing the rates of labour market participation among under-represented groups⁸⁰ and the gender pay gap is now at a record low for people working full-time⁸¹. Partly as a result of its flexibility, Britain's labour market has performed well in the decade since the financial crash, and our employment is at a near historic high rate of 75 per cent⁸².



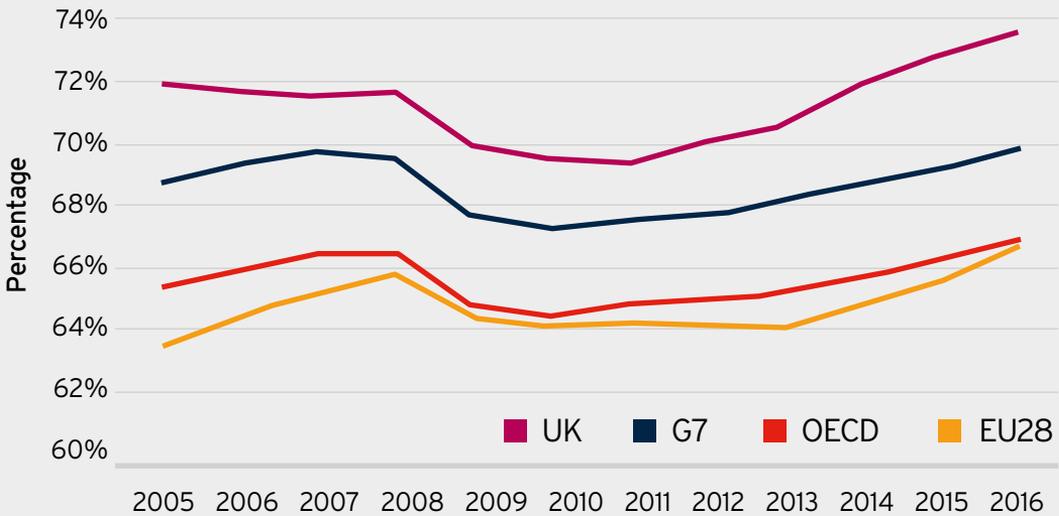
'We will create a country where everyone can improve their skills at all stages of their lives, to boost their earning power and the opportunity for better jobs.'



We are reforming functional skills qualifications to improve their quality and levels of employer recognition. Image: Automotive manufacturing at the Advanced Propulsion Centre in Coventry

The UK's employment performance compared to other countries

Employment rate 2005-2016



Source: OECD (2017) "Employment Outlook 2017". *Employment rate is as a per cent of working-age population working (aged 15-64)

Time and again, businesses choose to locate in the UK rather than elsewhere because of the flexible labour market and the fact that we have many well educated and trained workers.

► **As well as strengths, we have important challenges. Firstly, we need to improve the quality and reputation of our technical education.**

For too long, technical education has not had the prestige that it has enjoyed in other countries. The system can be complex and confusing, not always meeting the needs of individuals or those of employers and the wider economy. The existence of domestic skills shortages has meant that migrant labour has been required to help plug the gap⁸³.

► **Secondly, we need to tackle particular shortages of STEM skills.**

These skills are important for a range of industries from manufacturing to the arts. The number of STEM undergraduates has been increasing over the last few years⁸⁴, but there remains unmet demand from employers⁸⁵. 40 per cent of employers

reported a shortage of STEM graduates as being a key barrier in recruiting appropriate staff⁸⁶. Jobs in science, research, engineering and technology are expected to rise at double the rate of other occupations between now and 2023⁸⁷ and the majority of jobs on the Home Office Shortage Occupation List are in either STEM-related roles or industries⁸⁸.

We know, too, that the pipeline of students studying STEM-related courses narrows as it reaches higher levels. Of the 16 year olds who have achieved an A*-C grade in GCSE maths, fewer than a quarter continue to study maths after age 16⁸⁹. Although there has been a 20 per cent increase in entries to maths A levels since 2010⁹⁰, less than a third of students studying STEM related A levels go on to gain a STEM degree, and a significant proportion of STEM graduates do not go into STEM occupations⁹¹.



'Time and again, businesses choose to locate in the UK rather than elsewhere because of the flexible labour market and the fact that we have many well educated and trained workers.'



Will we create a country where everyone can improve their skills at all stages of their lives

There is also significant regional variation in uptake of STEM subjects, including maths. In Reading in 2016, 57 per cent of students who achieved A*-C at 15 went on to study maths at level 3; in Barnsley it was 10 per cent⁹². And we know girls are less likely to choose STEM subjects than their male counterparts⁹³.

► **Thirdly, we need to tackle entrenched regional disparities in education and skill levels.** According to research by the Confederation of British Industry, disparities in education and skills are the biggest drivers of regional variation in productivity⁹⁴. Regional education

outcomes vary at every phase. For example, 73 per cent of children in early years learning in the south east of England meet the expected standard across early learning goals, compared to only 66 per cent in the West Midlands and north west of England⁹⁵. Almost 90 per cent of London's secondary schools are good or outstanding, compared to just 67 per cent of schools in the north east of England⁹⁶. The entry rates to higher education for 18 year olds are 40 per cent in London, but only 29 per cent in the north east of England⁹⁷.

► **Fourthly, we need to ensure that everyone, no matter what their background or level of skill, has an opportunity to enter into and progress at work and through the education and training system.** Barriers that prevent under-represented groups from realising their full potential need to be broken down. For example, women, who account for just under half of all employees in the UK, are more likely to be in 'low-paid, low-skilled' work⁹⁸. And as technological change transforms the jobs and the skills that our businesses require, we need to make sure that people have the opportunity to learn and train throughout their working lives. At the moment, our problem is not unemployment caused by technology, it is low earning power caused by, among other reasons, a failure to use technology. Through our Industrial Strategy, we are determined to ensure that we have both the

skills to take advantage of new technologies and the means to help those who are affected by technological change.

20%

increase in entries to maths A levels since 2010

► **Employers, individuals and the government all have a role to play to help people develop the right skills so they are able to work with, and alongside, new technologies.**

These groups will need to work together to create opportunities for people to pursue higher earnings over the longer term and support the growth of a high-wage, high-skilled economy.



'We are determined to ensure that we have both the skills to take advantage of new technologies and the means to help people who are affected by technological change.'

Our approach

We start by building on our strengths. The UK has one of the most accomplished higher education systems in the world.

Higher education plays a significant role in bringing benefits for the UK economy, particularly in the provision of higher-level skills that are needed by employers both nationally and within local areas. There are many examples of higher education institutions and local employers collaborating to target specific skills needs⁹⁹. These businesses are involved in co-development of curricula and providing

real-life projects and resources to help students understand the practical relevance of their courses. Employers value the skills of graduates¹⁰⁰ and data continues to show the benefit of a higher education qualification (equating to more than £100,000 on average over the course of a person's working life, up to £170,000 for a man and £250,000 for a woman¹⁰¹).

We will create 15 new technical education routes designed through rigorous labour market analysis and in partnership with employers



In the run-up to the financial crisis, the up-skilling of the UK's workforce accounted for around 20 per cent of total labour productivity growth¹⁰². Research predicts around 1.8 million new jobs will be created between 2014 and 2024, and 70 per cent of them will be in the occupations most likely to employ graduates¹⁰³.

To ensure that higher education is responsive to employer and industry needs - and to students' employment expectations - the Higher Education and Research Act, passed earlier this year, will put in place a modern regulatory framework through the creation of a new regulator, the Office for Students (OfS). The OfS, which will be established in January 2018, will address employer and student needs and expectations in the short, medium and long term - considering the skills gaps that exist today, and anticipating the demands of the future economy. It will make the sector more dynamic and make it

easier for new, high quality providers to offer higher education. By encouraging innovation and a focus on student outcomes, the OfS will drive improvements in productivity and support the wider economic needs of the country. This will increase the number of work-ready graduates, including in STEM, and promote innovative ways of learning, such as that being delivered by New Model in Technology and Engineering (NMiTE) in Herefordshire and the Dyson Institute of Engineering and Technology in Wiltshire.

Furthermore, our commitment to conducting a major review of funding across tertiary education will ensure a joined-up system that works for everyone.

Education and training are devolved to Scotland, Wales and Northern Ireland. While our approach on these issues applies to England, this is a shared priority among all nations of the United Kingdom.



'Around 1.8 million new jobs will be created between 2014 and 2024, and 70 per cent of them will be in the occupations most likely to employ graduates.'

Delivering a world-class technical education system

Technical excellence has historically not been valued as highly as academic success and standards have been lower.

We want our technical education system to be as prestigious as higher education in this country, and for it to rival the best systems in the world. We are undertaking a major programme of reform based on the findings of the independent panel led by Lord Sainsbury¹⁰⁴. In the Skills Plan¹⁰⁵ we committed to creating 15 new technical education routes, designed through rigorous labour market analysis and in partnership with employers. Apprenticeships and new T levels will be based on the same set of high standards for occupational competency, designed by employers, and students will have opportunities to move between academic and technical routes.

New T levels will be backed by over £500m annually by the time the programme is rolled out fully. This will ensure we can increase by over 50 per cent the number of hours training for 16-19 year-old T level students, including a high-quality work placement – putting our technical education system on a par with the best in the world. **We will also update school and college performance measures to ensure that students can make an informed choice between technical or academic education in time for the introduction of the first T levels, recognising them as equally valued routes.**

Over £500m

annual backing for new T levels

Training hours for 16-19 year-old T level students to

increase by over

50%

We have recently published our T level action plan, setting out the implementation timetable and announcing the first T levels to be taught from 2020 (digital, construction and education and childcare)¹⁰⁶. The plan also sets out the vital role that employers will play in the reforms: we have convened T level Panels (made up of employers, industry professionals and education experts) across the six routes for delivery in 2020 and 2021, and further panels will be convened across the remaining five T level routes for delivery in 2022.

We will also invest up to £20m between 2018/19 and 2019/20 to help further education colleges develop the skills of their staff to deliver the new technical qualifications. We will also host a major Skills Summit with leading employers and publish a public consultation on the detailed design and delivery of T levels before the end of the year.

We have already announced government support for the creation of new Institutes of Technology. These institutes will increase the provision of higher-level technical education across the country and we will launch a call for proposals to establish the first of these shortly. The institutes will sit alongside our four flagship employer-led National Colleges, which are delivering high-quality skills training for the digital, creative, nuclear and high speed rail sectors.

To ensure there is excellent quality provision for those progressing from the new T levels and other full-time education, and for those in the workforce looking to up-skill or retrain, we want to address the needs of students and employers more effectively, and we will undertake a review into higher level technical education at levels 4 and 5.

This review will consider the supply of, and demand for, quality higher-level classroom-based technical education, responding to the recommendations of Lord Sainsbury's review.



'We want our technical education system to be as prestigious as higher education in this country, and for it to rival the best systems in the world.'

Driving up the study of maths

Sir Adrian Smith's review of maths education for 16-18 year olds in England, published in July, found a strong demand for mathematical and quantitative skills in the labour market at all levels¹⁰⁷.

It also identified a consistent under-supply reflecting the low take up of maths among 16-18 year olds in England, and low achievement relative to other developed countries. It set out a strong case for raising participation and improving both basic and advanced maths skills: adults with basic numeracy skills earn higher wages and are more likely to be employed than those who fail to master basic quantitative skills. Higher levels of achievement in maths are associated with higher earnings for individuals and higher productivity. Strong quantitative skills are increasingly important as an underpinning for all forms of STEM study, but also for highly-skilled employment outside core STEM disciplines. As the Smith review points out, learned societies argue that students across the sciences, social sciences and humanities need significant quantitative skills, and these should be a central component of their education.

Maths should not be perceived as an exceptional talent; it is a basic skill that can be mastered with the right teaching and approach, as shown by OECD evidence from successful models such as Singapore, Switzerland and Denmark¹⁰⁸.

Improving the take up of maths qualifications and the quality of maths teaching across the education system is one of the most significant interventions that government can make to tackle STEM skills shortages and secure wider benefits for the economy¹⁰⁹.

Demand is clearly growing. For example, the UK's world-class creative industries, which cover film, TV and video games, are growing at twice the rate of the economy as a whole and are heavily reliant on STEM skills¹¹⁰.

We have already taken some early actions in response to the Smith Review. This includes a level 3 Maths Support Programme, which will build on the momentum created by the Further Maths and Core Maths Support Programmes, and work with schools and colleges to improve maths education by sharing best practice and working to increase participation and attainment in maths among 16-18 year olds. The programme will work to deliver focused intervention targeted to those who need it most.

We are also focused on expanding the capacity for maths teaching. We offer generous financial incentives for those training to teach priority subjects such as maths, and last year we trained more maths teachers than in any of the previous four years. To incentivise recruitment to initial teacher training and ensure we retain as many teachers as possible, we are piloting new style bursaries in maths.

Around 30 per cent of young people do not currently achieve a GCSE standard pass aged 16, and of these, only around 17.5 per cent achieve a good standard of maths by the age of 19¹¹. In these crucial years, the basic maths gap widens compared to high performing countries¹². England remains unusual among advanced countries in that the study of maths is not universal for all students beyond 16¹³.

To tackle this, we will test innovative approaches to improve outcomes in basic maths for those aged 16 and over, through a £8.5m pilot.

We will also invest £40m to establish Further Education Centres of Excellence across the country to build teaching capacity and spread best practice.

We are also reforming functional skills qualifications to improve their quality and levels of employer recognition, and will continue to monitor and review the current policy which requires students without a GCSE standard pass in maths and English at 16 to continue to study towards this aim.

We are seeing growth in the new core maths qualifications introduced in 2014, which are designed to prepare students for the mathematical demands of university study, employment and life. These have been endorsed by a large number of universities, including many in the Russell Group¹⁴. We have funded 145 early adopter schools and colleges to begin teaching the new qualifications.



'Adults with basic numeracy skills earn higher wages and are more likely to be employed than those who fail to master basic quantitative skills.'



We offer generous financial incentives for those training to teach priority subjects such as maths, and last year we trained more maths teachers than in any of the previous four years

There were almost 3,000 entries in the first year (2016)¹¹⁵, and this grew to 5,361 entries in 2017¹¹⁶. To deepen the understanding of the gender disparity in STEM subject choices at ages 16 to 19, we will explore how to improve the accessibility and transparency of data published on STEM, by institution and subject.

We need to go further on maths. Building on Sir Adrian Smith's recommendation to make core maths available to all students on level 3 pathways, **we will incentivise education institutions to offer maths by providing a £600 premium to existing per pupil funding rates for each additional student who takes**

maths or further maths at AS/A level or core maths. This will help education providers to support more students aged 16 and over to study maths.

We also recognise that universities are an important influence on students' choices. In response to Sir Adrian Smith's recommendations, we are working with institutions such as the Royal Society and the British Academy to encourage universities and employers to signal the value of level 3 maths qualifications for entry to undergraduate courses that have a significant quantitative element, and the value for a wide range of job roles. These investments will begin to meet

the demand for coveted STEM skills, as well as close the advanced maths gap that exists between our education system and the best in other developed countries.

This ambition must also be built on a foundation of good basic maths skills. A good level of numeracy supports the achievement of further qualifications, contributing to better employment, higher wages and further opportunities to up-skill¹¹⁷. Getting more young people to this level also widens the pool of students capable of studying advanced maths and other STEM subjects. However, our basic maths performance is middling¹¹⁸; and regional variations mean that some parts of the country have fallen behind¹¹⁹, contributing to lower productivity. We need to boost the number of people reaching a good standard by the end of compulsory education to strengthen our economy, widen prosperity, and compete with the top international education systems.

We will take action to ensure that more students leave education at age 18 with a basic level of numeracy - both to build the pipeline of

students who are able to go on to higher levels of STEM study, and because basic maths skills have a proven value in their own right. The £42m Teaching for Mastery maths programme is being received positively¹²⁰ and will reach half of all primary schools by 2020. We are delivering this through a network of 35 maths hubs, outstanding and inspirational schools and colleges, and backed by an additional £6m to put maths hubs in areas of need. **We will now invest £27m in the further expansion of Teaching for Mastery maths programme to reach 11,000 primary and secondary schools in total by 2023.**

We will work with top maths universities to expand the specialist maths school model pioneered by Exeter University and King's College London. **We are providing £350,000 annual funding for every maths school to deliver the specialist maths school model**, including extensive outreach work with schools and teachers to ensure all students have the chance to achieve their mathematical potential.



'We need to boost the number of people reaching a good standard by the end of compulsory education to strengthen our economy, widen prosperity and compete with the top international education systems.'



The New Model in Technology & Engineering in Hereford aims to become the first new 'greenfield' university in the UK for 30 years

Case Study: The New Model in Technology & Engineering

In October, the government announced up to £15m in funding for a new engineering university in Hereford. The New Model in Technology & Engineering (NMiTE) aims to become the first new 'greenfield' university in the UK for 30 years, addressing the growing need for engineering talent in sectors such as advanced manufacturing, artificial intelligence and cybersecurity.

NMiTE is taking a radical approach to training the next generation of

engineers, including the target of a 50/50 gender split and recruiting graduates from non-traditional backgrounds. It will also offer accelerated degrees, meaning students can graduate in two years. Courses will be co-created with employers, with mandatory work placements of 6-12 months before graduation.

NMiTE will take its first cohort of students in September 2020, with development cohorts in 2018 and 2019.

Driving up digital skills

Alongside this comprehensive programme to support the study of maths, the government will work to boost the supply of digital skills across the economy.

Digital skills are vital for both STEM and non-STEM specific jobs, with demand growing. This is evidenced by Tech City UK research, which shows that highly skilled and highly paid digital jobs grew at twice the rate of non-digital jobs between 2011 and 2015¹²¹. We will introduce a new entitlement for adults who lack core digital skills to access specified basic digital skills training free of charge. This will mirror the approach taken for adult literacy and numeracy training. As set out in our Digital Strategy¹²², we intend that everyone has the opportunity to increase their digital capability.

We are already taking action on a number of fronts, from the introduction of the first digital T level (as one of the first of the technical education pathways in September 2020) to the development of digital apprenticeships, including degree apprenticeships.

The new standards across all 15 routes are designed by industry, enabling businesses to reflect the knowledge and skills they need, such as digital skills. We are taking forward the recommendations from the Shadbolt Review of Computer Science Degree Accreditation and Graduate Employability¹²³ with stakeholders. We are focusing on ways to increase the number of students who undertake work experience to develop their professional skills and ways of accrediting work experience in degrees. To bring together real-world cyber expertise and educational experience we have announced the launch of a new £20m Cyber Discovery programme - a four-year study programme for the next generation of cybersecurity professionals. We expect the programme to reach nearly 6,000 participants by 2021.



'Highly skilled and highly paid digital jobs grew at twice the rate of non-digital jobs between 2011 and 2015.'

But we need to go further. In 2014 we broke new ground by introducing a new, more rigorous computing curriculum in England for pupils aged 5-16, including coding and the basics of programming. However, some teachers find it challenging to deliver this new curriculum, and that this is limiting the number of students taking computer science qualifications and the quality of teaching they receive¹²⁴.

The government will invest £84m over the next five years to deliver a comprehensive programme to improve the teaching of computing and drive up participation in computer science, with a particular focus on girls. Measures include up-skilling 8,000 computer science teachers - enough for one in every

secondary school - and working with industry to set up a new National Centre for Computing Education to produce training material and support schools.

We are also investing £20m in a new Institute of Coding, which will be formed through a consortium of universities and employers. The new institute will sit alongside Ada, the National College for Digital Skills, and work with employers and businesses to deliver higher level digital skills. New digital platforms will expand the reach of STEM Ambassador and CREST Awards programmes to increase young people's engagement with STEM subjects. A new digital platform for the CREST Awards will help double the number of students taking part in CREST Awards across the UK

We have recently announced a new £20 million Cyber Discovery programme - a four-year study programme for the next generation of cybersecurity professionals



from 30,000 to 60,000 by March 2019, with a particular focus on reaching groups that are currently under-represented in STEM.

We will target immediate shortages in digital skills, giving individuals the skills they need to progress in work through the new National Retraining Scheme, set out later in this chapter.

This range of interventions - spanning primary, secondary and tertiary education, and addressing basic, intermediate and higher levels of study - will achieve a big expansion in the depth and breadth of our workforce's STEM skills.



'We will target immediate shortages in digital skills, giving individuals the skills they need to progress in work through the new National Retraining Scheme.'

Case Study: 2018 Year of Engineering

The Year of Engineering is a government-led campaign that will bring the world of engineering directly to children and young people. It will celebrate the UK's proud engineering heritage and seek to ensure we have the skilled engineering workforce we need for tomorrow. It will raise the profile of engineering and alter perceptions of what it is to be an engineer today, working across a range of key areas in construction, transport, chemicals, biomedical and the software industry.

We are working with hundreds of organisations from the industry, who have signed up to lead exciting events and activities to inspire young people from all backgrounds, showing them, their parents and teachers the opportunities that a career in engineering can bring.

Investing in skills to support growth and opportunity across the country

Tackling regional differences in skills and educational attainment is vital if we are to boost earning power across the whole country.

In England, the government has three roles to play.

Firstly, to ensure that the national system works across the country, making a real difference in areas of most need. Our investment in technical education and T levels, for example, will have the greatest impact in areas where more students go on to technical than academic education.

Secondly, to address the specific needs of local areas through additional action, such as our Opportunity

Areas programme and our targeted establishment of new maths hubs in under-achieving areas. These recognise that different areas and regions often face particular challenges, as well as opportunities, and that these need tailored approaches to meet them.

Thirdly, to help ensure that the necessary connections and capacity are in place at local level to link skills provision with economic need.

We are growing our successful maths hubs and setting up a new network of English hubs



There are a variety of institutions at local level with valuable contributions to make to skills development, as set out in the Places chapter. We need to ensure they work together to deliver the best possible outcomes for their community and for the local economy, as part of Local Industrial Strategies.

Recent reforms in education and skills have improved educational outcomes for many children. But the government recognises that it needs to act to ensure the benefits of these reforms reach every part of the country. The first stage is to design system-wide policies to effectively support the weakest areas. That is why the new national funding formula ensures that schools with the most challenging intakes attract the most funding. The £280m Strategic School Improvement Fund will provide high quality, evidence-based support to schools across England. We also need to extend our school improvement infrastructure to the places that need it most. We are

growing our successful maths hubs and setting up a new network of English hubs in areas of weak early development in language and literacy.

There are some parts of the country that suffer from even more acute disadvantage and have even greater need. We will support these places through our £72m Opportunity Areas programme, which will target intensive support through discrete interventions in 12 areas. As well as being priority areas for our national programmes, the areas will benefit from support from national businesses, the Education Endowment Foundation and the Careers Enterprise Company, co-ordinated by local Partnership Boards. This concentration of resources will allow us to trial innovative new approaches, which can in turn be scaled up to improve performance in the wider system.

We also know that improving the quality of teaching and leadership in a school is a significant driver of school



'The £280m Strategic School Improvement Fund will provide high quality, evidence-based support to schools across England.'

performance, so we want to focus particular effort on addressing this vital engine of educational attainment at a crucial stage in young people's development. We are already providing over £30m in tailored support to secure more great teachers in the schools that struggle the most with recruitment and retention and will pilot a student loan reimbursement programme to help attract and retain teachers in the subjects and areas of the country that need them most.

However, we believe a significant further intervention is needed to achieve the level of change required on this vital issue. That is why **we will invest £42m to pilot a Teacher Development Premium**, as described in more detail in the 'Places' chapter. This will test the impact of a £1,000 budget for high quality professional development for teachers in areas of the country that have fallen behind.

Finally, the government has a role to play in ensuring that the connections and capacity exist in local areas and regions to link educational institutions with labour markets. Devolution of budgets and control within England plays its part, **and we will devolve the adult education budget to mayoral areas in 2019**. This will help mayors to ensure learners can gain the skills that local businesses need. But devolution is only a part of the solution in England, with productive partnership working and meaningful local influence equally important in ensuring the supply of skills to an area.

Key to this local influence will be the introduction of Skills Advisory Panels, which will be rolled out shortly, and integrated into Mayoral Combined Authorities and Local Enterprise Partnerships to inform the analysis that feeds into Local Industrial Strategies. As set out in the Places chapter, these strategies will bring together local actors including businesses and education providers to determine local growth priorities. Skills Advisory Panels will produce rigorous analysis of the current and future supply and demand for skills and help areas form a clearer understanding of their skills requirements. They will have real, meaningful influence over the provision of education and training for those over the age of 16, and work with Mayoral Combined Authorities and Local Enterprise Partnerships to establish the best way to ensure that influence is effective, and to inform careers advice and guidance. Skills Advisory Panel analysis will be structured around the 15 new technical education routes; education and training providers will need to take account of this analysis when planning T level offers. As well as supporting the creation of new Institutes of Technology across all regions to deliver higher level technical education, we will also promote local Digital Skills Partnerships that will increase collaboration between public, private and charity sector organisations and help address local digital skills needs in more targeted and innovative ways.

Creating opportunities for all throughout life

As automation and digitalisation change the nature of jobs and the skills required to do them, and as working lives become longer, it is vital our education system allows people to learn and train throughout their lives.

That is why the government committed to building the best programme of learning and training for people in work and returning to work. For some, this will mean keeping their skills current in fast-moving sectors. For others, it will mean refreshing their skills after a period out of the labour market. And for others still, it will mean training in order to transition or develop their skills as their sector changes in response to technological shifts.

Key parts of this programme are in place already. We are implementing a range of measures in England to make it as easy as possible to undertake higher-level study, including the introduction of post-graduate masters and doctoral loans from 2016/17 and 2018/19 respectively. Financial barriers to the provision of accelerated degrees are being reduced for higher education providers that wish to offer a three-year

degree programme in two years, by introducing new tuition fee arrangements to widen student choice for these degree programmes. The OfS also has powers to monitor and report on arrangements for students transferring from one course or institution to another - increasing students' ability to transfer or return to study should a change in circumstance have required them to take a break from their original course. We are improving funding for part-time students, with maintenance loan support available from 2018/19 for all first degrees and graduates undertaking a second degree in a STEM subject.

We want all young people to realise their potential, and we have made progress in boosting the number of disadvantaged young people who go to university.



'We will pilot a student loan reimbursement programme to help attract and retain teachers in the subjects and areas of the country that need them most.'



We recently launched the first Career Learning Pilot - the £10m Flexible Learning Fund - to test accessible ways of delivering learning to adults

Young people from disadvantaged backgrounds were 43 per cent more likely to go to university in 2016 than in 2009, and applications from those from such backgrounds are at record levels¹²⁵. But we need to do even more to widen participation for those from disadvantaged and under-represented groups looking to re-skill and up-skill. The Higher Education and Research Act 2017 has introduced a number of measures aimed at supporting more students from all backgrounds to participate in higher education and to support their success. The primary aim of the OfS will be to ensure that the higher education system in England is delivering positive outcomes for students.

This includes requiring universities to publish student participation and progression data broken down by gender, ethnicity and socio-economic background. This greater transparency will prompt further action and build on what has already been achieved.

The government is committed to conducting a major review of funding across tertiary education to ensure a joined-up system that works for everyone. As current and significant reforms move into implementation, this review will look at how we can ensure that the education system for those aged 18 years and over is accessible to all and is supported by a funding system that provides value for money and

works for both students and taxpayers, incentivises choice and competition across the sector, and encourages the development of the skills that we need as a country.

The government is committed to supporting adults to secure meaningful and productive employment, and equipping them with the skills they need to maximise their earning potential. This is core to our Industrial Strategy as we seek to take advantage of the opportunities from longer working lives, automation of low skilled labour and changes to the labour market.

To drive up adult learning and retraining, we will introduce an ambitious National Retraining Scheme in England by the end of this Parliament. It will give individuals - particularly those hardest to reach - the skills they need to thrive and support employers to adapt as the economy changes. A high level advisory group - the National Retraining Partnership - will bring together the government, businesses and workers, through the Confederation of British Industry and the Trades Union Congress, to set the strategic direction

and oversee implementation of the scheme.

The National Retraining Scheme will be informed by £40m announced in the Spring Budget to test innovative approaches to helping adults up-skill and re-skill. The pilots will help us learn more about how to support and incentivise adults to learn skills that will help them, their local economies and national productivity. We have already launched a Flexible Learning Fund, making available up to £10m to support projects that design and test flexible, accessible ways of delivering learning to working adults with low or intermediate skills. Further pilots testing other barriers to adults' learning will be announced in due course.

Starting next year, the National Retraining Scheme will initially target skills shortages in key sectors, ensuring that we can develop much-needed digital and construction skills. A total of £30m will be invested to test the use of artificial intelligence and innovative education technology (edtech) in online digital skills courses so that students can benefit from this emerging technology.



'Young people from disadvantaged backgrounds were 43 per cent more likely to go to university in 2016 than in 2009, and applications from such backgrounds are at record levels.'

Matthew Taylor Review

The world of work is changing rapidly. It is becoming more flexible and more connected. Advances such as remote access technology mean people unable to be in an office eight hours a day can still participate in work. This year we have seen more women active in the labour market than ever before, and more people with disabilities are able to use their talents in the workplace, supporting and sharing in the economic prosperity of the country¹²⁶.

We are determined that the UK should be among the first countries to identify the best way to ensure everyone benefits from this technological revolution. That is why Matthew Taylor, Chief Executive of the Royal Society of Arts, was commissioned by the Prime Minister to undertake a review of modern employment. His report, published in July 2017¹²⁷, outlined an ambition for all work in the UK economy to be fair and decent, and for employers to offer opportunities that give individuals realistic scope to develop and progress. The government shares that ambition for 'good work'. The Business Secretary will take on the role of promoting the delivery of better quality jobs in the British economy.

The changing world of work means that what represents 'good work' to one person might be different for someone else.

We accept Matthew Taylor's recommendation that the government should identify a set of measures against which to assess job quality and success. We are starting a dialogue with experts - including worker representative bodies such as the Trades Union Congress, organisations like the Chartered Institute for Personnel and Development and business bodies such as the Confederation of British Industry - to develop a common set of principles and measures. This conversation will begin with the aspects that we believe are foundational: **overall worker satisfaction; good pay; participation and progression; wellbeing, safety and security; and voice and autonomy.**

Sector Deals provide a further opportunity for employers to promote good work and boost productivity. The right approach will vary from sector to sector. Delivering better quality jobs could involve a commitment to better employment relations and contracts that fosters both flexibility and security. It could mean on-the-job training or the provision of high quality apprenticeships to help people progress in work.

We will provide £34m to expand innovative construction training programmes across the country, including a programme in the West Midlands, focused on supporting the country's housing needs and building upon existing good practice.

Action on construction and digital is just the first step. Further ahead, and supported by the National Retraining Partnership, we will be engaging with sectors and Skills Advisory Panels in England to develop future policy. We will also continue to support Unionlearn, an organisation of the Trades Union Congress, to help embed a culture of learning throughout working lives.

The government must also do more to help people of all ages navigate our labour market. People need access to the information, advice and guidance that will help them make choices as they progress through the education system and their careers.

We will publish a comprehensive careers strategy shortly that will set out plans to improve the quality and coverage of careers advice for people of all ages. The strategy will build on the current work of the Careers Enterprise Company and employers to increase encounters between businesses and young people and the National Careers Service, to improve the quality and coverage of careers advice in schools and colleges, and give people the information they need to access training throughout their working lives. It will be based on evidence, both in this country and internationally, which identifies the most effective practices to support people of all ages and in all areas, including those who are hardest to reach.



'We will provide £34m to expand innovative construction training programmes across the country, including a programme in the West Midlands, focused on supporting the country's housing needs and building upon existing good practice.'



Apprenticeships are a vital UK-wide vehicle for employer investment in their workforce, enabling employers to develop the skills and behaviours that they need, as well as offering opportunities for those already in work and those entering it for the first time. We introduced a new Apprenticeship Levy in April 2017 to reverse the established trend in the UK of low employer investment in skills. In 2020 levy contributions in England are expected to take apprenticeship investment to double what was spent in 2010¹²⁸. Apprenticeships funding, raised through the levy, is managed by the Scottish government, Welsh government and Northern Ireland Executive as skills is a devolved matter.

From April 2018, we plan to allow levy-paying employers in England to transfer up to 10 per cent of their funds to another employer, including within their supply chain. The government will continue to work with employers on how the apprenticeship levy can be spent, so that the levy works effectively and flexibly for industry, and supports productivity across the country.

We want everyone to have an opportunity to realise the lifetime benefits that come from undertaking an apprenticeship. We are delivering the recommendations of the Maynard Taskforce¹²⁹ to improve access to apprenticeships for people with learning difficulties and/or disabilities.

We are making over £60m available to support apprenticeship take up by young people and poorer families from disadvantaged areas and setting ambitious goals to increase the proportion of apprenticeships started by people of black and minority ethnic backgrounds or with a learning difficulty and/or disability by 20 per cent by 2020.

We also need to do more to address the under-representation of other groups in our labour market and support employees to stay in work. Our economy is missing out on the untapped potential this represents for employers. Work keeps people healthy, mentally and physically. It enables people to be economically independent, and gives more choices and opportunities to fulfil other ambitions in life. The McGregor-Smith Review put the potential benefit to the UK economy from full representation of black and minority ethnic workers, through improved participation and progression, at £24bn a year¹³⁰. Organisations with the highest levels of gender diversity are 15 per cent

more likely to outperform their rivals¹³¹, yet female employment continues to be below that of men and the difference in the amount of years women and men spend in full time work is the biggest driver of the 18 per cent gender pay gap¹³². In mid-2017, just under half of working-age disabled people were in employment, compared with 81 per cent of working-age non-disabled people¹³³. OECD projections show that by 2030, if the share of women working reached the same level as for men, annual growth rates in GDP per capita would rise by 0.5 percentage points in the UK. The boost to economic growth would be even higher if women's working hours increased too¹³⁴.

Businesses that have diverse, inclusive workplaces recognise this brings improved productivity. For example, offering flexible working can enable employers to reach a wider talent pool, both male and female, including returners, older workers and people with disabilities. Creating a workplace which is truly flexible can improve productivity.



'Businesses that have diverse, inclusive workplaces recognise this brings improved productivity. For example, offering flexible working can enable employers to reach a wider talent pool.'

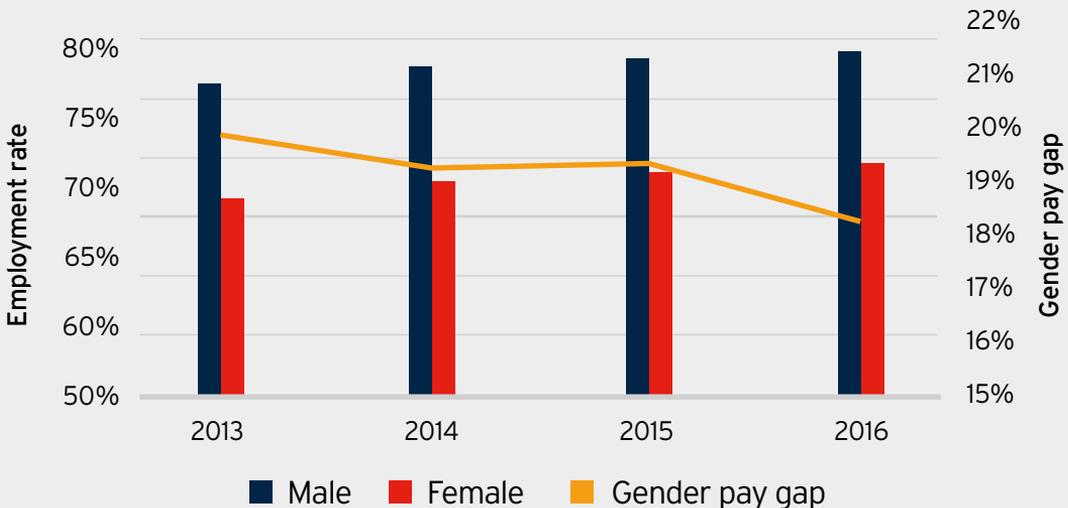
Our Industrial Strategy Grand Challenges on Ageing and growing the Artificial Intelligence & Data-driven Economy set out early actions.

We are already taking steps to encourage wider participation in the labour market. For working parents of three and four year olds in England, we have doubled free childcare from September 2017¹³⁵. Emerging evidence shows that parents are able to work more hours, with some indication of

higher retention of mothers in work¹³⁶. To tackle some of the barriers women face at work we introduced landmark legislation in April 2017, which requires all large employers in Britain to report on their gender pay gap. Although black and minority ethnic employment is at a record high¹³⁷, we know there is more we can do. We are taking action through the Race Disparity Audit¹³⁸ in hotspots that require extra work to help those from black and minority ethnic backgrounds into the workplace.

United Kingdom employment for men and women and the gender pay gap

Employment rate by gender and gender pay gap



Source: ONS (2017) "Labour Market Statistics time series dataset and ONS (2017) Annual Survey of Hours and Earnings: 2017 provisional results". *Gender pay gap is defined as the difference between men's and women's hourly earnings as a percentage of men's earnings. Full-time workers only

We will also publish shortly a plan for improving social mobility in England, which will set out how the education system will expand equality of opportunity. Further steps include:

- ▶ **working with business** to develop an action plan to make flexible working a reality for all employees across Britain and to inform the evaluation of the Right to Request Flexible Working Regulations. More than twenty million employees now have the right to request flexible working, which is helping parents and others to balance work with other responsibilities. The government will work with employers to help understand and promote practices that enable employees to realise the potential of those who can benefit from more flexible working;
- ▶ **supporting people to return to work after time out for caring**, with £5m funding announced in the spring 2017 Budget. Four new public sector programmes are refreshing the skills and experience of returning teachers, social

workers and allied health professionals in England, and those who wish to become civil servants in England and Scotland. We are also working with employers and other business groups to increase opportunities within the private sector across the UK. This includes commissioning Women Returners and Timewise to produce best practice guidance and working with the Women's Business Council to develop a toolkit for employers; and

- ▶ **publishing plans shortly to achieve our ambition to see one million more disabled people in employment in the UK by 2027.** We will also help those with mental health conditions in England to enter, progress and remain in work as part of our response to the recently published Stevenson-Farmer review¹³⁹.



'More than twenty million employees now have the right to request flexible working, which is helping parents and others to balance work with other responsibilities.'



Case study: PwC - reporting on black and minority ethnic pay and bonus gaps

PwC has become one of the first organisations to publicly report its black and minority ethnic pay and bonus gaps. Kevin Ellis, chairman and senior partner at PwC, has set out the ambition: 'We are hoping that by reporting our black and minority ethnic pay and bonus gaps we can shine the spotlight on ethnicity in the workplace and encourage organisations to take action. In our experience, publishing pay data adds a level of public accountability that starts conversations and drives change'.

Analysis of the data showed that, while PwC pays its employees equally for doing equivalent jobs, the pay gap in PwC was driven by a greater proportion of black and minority ethnic staff in junior administrative roles and fewer in senior management. Through taking steps to understand its workforce, PwC has been able to implement new approaches that aim to retain its junior black and minority ethnic talent and improve rates of progression to senior management levels.

Global skills and talent

The actions and approaches that we have set out in this chapter will be more critical as we exit the European Union and look to improve the levels of skills of our workforce to meet the opportunities and challenges ahead.

We want to continue to be an attractive destination for the world's most talented and innovative people and the UK will continue to remain a global, outward looking nation and home to the brightest and best. Our thriving and flexible labour market continues to attract international businesses and investment, enabling businesses to respond and adapt to economic change.

To ensure that our labour market remains competitive, the Migration Advisory Committee has recently undertaken a wide-ranging consultation to form a UK-wide view of our skills needs¹⁴⁰, ensuring our future migration system supports our Industrial Strategy. We will consider the Migration Advisory Committee's forthcoming conclusions carefully.



'We want to continue to be an attractive destination for the world's most talented and innovative people and the UK... will remain a home to the brightest and the best.'

Infrastructure

The background features a dark blue field with a diagonal split. A purple triangular shape is on the right side, and a bright green triangular shape is at the bottom left.



Infrastructure

A major upgrade to the UK's infrastructure.

Infrastructure is the essential underpinning of our lives and work, and having modern and accessible infrastructure throughout the country is essential to our future growth and prosperity.

Much of this investment is, by its nature, large scale and long term, and one of the most significant ways the government can influence the economy - from our transport and housing through to the roll-out of digital networks. Our National Infrastructure and Construction Pipeline is worth around £600bn and public infrastructure investment will have doubled in a decade by 2022/23.

We must make sure our infrastructure choices not only provide the basics for the economy, they must actively support our long-term productivity, providing greater certainty and clear strategic direction. Our investment decisions need to be more geographically balanced and include more local voices. We can improve how we link up people and markets to attract investment, and we must be more forward-looking in respect of significant global economic trends.

Through our Industrial Strategy, the country's economic geography will be transformed by a surge of infrastructure investment heralding a new technological era.

We will build a Britain that lives on the digital frontier, with full-fibre broadband, new 5G networks and smart technologies. We will create a new high speed rail network that connects people to jobs and opportunities, regenerate our stations and airports, and progressively upgrade our road network. And we will improve people's lives where they live and work, with high quality housing and clean, affordable energy. Providing the right infrastructure in the right places boosts the earning power of people, communities and our businesses.

Key policies include:

- ▶ Increase the National Productivity Investment Fund to £31bn, supporting investments in transport, housing and digital infrastructure
- ▶ Support electric vehicles through £400m charging infrastructure investment and an extra £100m to extend the plug-in car grant
- ▶ Boost our digital infrastructure with over £1bn of public investment, including £176m for 5G and £200m for local areas to encourage roll out of full-fibre networks

The availability of high quality infrastructure is essential for our lives and work, and our future growth and prosperity. Efficient transport systems bring a wide range of work within people's reach, and bring goods from suppliers to markets. Clean and affordable energy holds down the cost of living and the cost of doing business. Digital infrastructure allows us to lead modern lives and to do business in the technologies and industries of the future. Providing the right infrastructure in the right places boosts the earning power of our businesses, people and places.

Our investments in infrastructure, and our decisions on procurement, are among the government's most significant interventions in the economy. They are large-scale - our National Infrastructure and Construction Pipeline is worth around £600bn of public and private investment, and we spend 14 per cent of GDP on public sector procurement each year¹⁴¹ - and they are long-term, shaping the evolution of the economy over decades.

The way we make these investments influences the pattern of industrial development across the country, and the speed of emergence and adoption of new technologies and business models. Just as our market structures can be designed to favour innovation or incumbents, so can our choice of investments. Similarly, decisions on physical infrastructure can widen or narrow geographic divisions in wealth and productivity, and determine whether we lead or lag with respect to technological developments. Our Industrial Strategy is an important opportunity to consider these decisions strategically, ensuring that our approach to infrastructure not only provides the basics for the economy, but also actively supports our long-term national interests.

In many important respects we have a strong track record and we will continue to promote the UK's strengths as a destination for capital investment. In 2016, the UK had the most attractive environment for infrastructure investment when compared to 25 international competitors¹⁴².



'Our National Infrastructure and Construction Pipeline is worth around £600bn and public infrastructure investment will have doubled in a decade by 2022/23.'

At least 95 per cent of UK premises will have access to superfast broadband by the end of 2017

National Productivity Investment Fund: £31bn until 2022/23

Allocations to date:



Transport
£4.9bn



Housing
£11.5bn



Digital
£0.7bn



**Research and
Development**
£7.1bn

Costs are presented on a UK basis. Further allocations will be made at future fiscal events.

We have established the National Infrastructure Commission to advise us on investment.

The government has improved coverage for digital infrastructure. 95 per cent of premises will have access to superfast broadband by the end of 2017; 99 per cent have indoor voice coverage; and 96 per cent have indoor 4G data coverage¹⁴³. Our cities are embracing new technology, illustrated by Swansea exploring the potential for 5G technology as part of its City Deal.

Meanwhile, investments in clean energy infrastructure have helped to cut carbon emissions by 42 per cent since 1990¹⁴⁴, while the economy has grown by two thirds¹⁴⁵.

However, there are opportunities for improvement, and specific challenges that an Industrial Strategy allows us to address. Throughout our Green Paper consultation, stakeholders have emphasised the importance of considering a broad range of objectives when designing major investment

programmes, as too narrow an assessment of costs and benefits can preclude important opportunities.

We have also heard calls for our investments to be more geographically balanced, and more forward-looking in respect of significant global economic trends.

The devolved administrations in Scotland, Wales and Northern Ireland have responsibility for aspects of their own regional development and physical infrastructure. Each has responsibility for water, waste, flood defences and road transport. With narrow exceptions Northern Ireland also has responsibility for energy and all other forms of transport infrastructure, and Scotland their internal rail infrastructure. The UK government is responsible for digital infrastructure and telecommunications throughout the country. The devolution settlement has never been a barrier to shared best practice and where appropriate we will continue to collaborate with our partners in each nation.



'Our cities are embracing new technology, illustrated by Swansea exploring the potential for 5G technology as part of its City Deal.'

A photograph of an offshore wind farm with several wind turbines stretching across the horizon over a body of water under a cloudy sky. A dark blue and green geometric shape is in the top-left corner.

We will invest to increase UK competitiveness in relation to long-term global economic changes, such as the shift to clean growth

Our approach

We are committed to increasing our investment in infrastructure, while providing greater certainty and a clear long-term direction.

The National Productivity Investment Fund will be extended to 2022/23 and increased from £23bn to £31bn, with investment targeted at areas that can have the biggest impact on productivity. This includes £4.9bn for transport, £11.6bn for housing and £740m for digital infrastructure. Public investment in economic infrastructure will have doubled in a decade by 2022/23. This investment will be delivered through a strengthened institutional framework, with longer-term budgets, the advice of the National Infrastructure Commission, an increased focus on effective delivery of projects in departments, and five-year capital investment programmes for road, rail, water and flooding.

We will take a more strategic approach to our investment and design of relevant markets, focusing on three principles.

We will:

- ▶ invest in ways that support all the objectives of the Industrial Strategy: increasing innovation, developing skills, growing business, and driving productivity and earning power in urban and rural places across the UK;
- ▶ take greater account of disparities in productivity and economic opportunity between different places, ensuring our investments drive growth across all regions of the UK; and
- ▶ invest to increase UK competitiveness in relation to long-term global economic changes, such as the shift to clean growth. These will be positive choices that enable the UK economy to flourish in the context of these transformational changes.

Investing to support the objectives of the Industrial Strategy

The essential role played by infrastructure means our investment decisions can have transformational effects on places, businesses and society.

We will maximise the contribution that such investments can make to growth and productivity by strengthening consideration of broad strategic outcomes at the earliest stage of policy and programme design, and then carrying them through all subsequent parts of the design and procurement process.

To deliver this, we will embed Industrial Strategy objectives in the strategic design stage of major investments. We will review different methodologies and promote the adoption of best practice. We will develop this approach, including through the forthcoming Transforming Infrastructure Performance programme, to consider how our investment programmes can be designed to support our Industrial Strategy objectives, such as:

- ▶ **Grand Challenges** - to what extent the investment can support the success of our Grand Challenges on artificial intelligence and data, clean growth, the future of mobility and the needs of an ageing society;
- ▶ **Ideas** - how the investment can support the development and commercialisation of new smart technologies, infrastructure and ideas;
- ▶ **People** - whether the investment can support the development of skills within the UK workforce;
- ▶ **Business environment** - how investments can best support supply chains, and the exporting of goods and services; and
- ▶ **Places** - how the investment can act to reduce regional productivity differences, and boost earning power across the UK.



'We will embed Industrial Strategy objectives in the strategic design stage of major investments. We will review different methodologies and promote the adoption of best practice.'

An early example is the *National Shipbuilding Strategy*¹⁴⁶, where we have begun work to understand how UK shipbuilding can maximise prosperity for the UK and its constituent nations and regions. The forthcoming *Transforming Infrastructure Performance* programme and *Transport Infrastructure Efficiency Strategy*, along with the *Transport Infrastructure Skills Strategy* will support the increase in innovation, skills, businesses growth and earning power, and ensure these interests inform decision-making. They will help the government and its agencies in building long-term collaborations with industry, reducing procurement transaction costs, maximising innovation, and exploiting digital technologies such as the adoption of off-site construction techniques and smart infrastructure.

We have already improved our approach to procurement through the 'balanced scorecard', which requires procurers to consider relevant social and economic objectives, such as skills development, diverse supply chains and sustainability, alongside cost-effectiveness. We will embed this approach on all major construction and capital investment projects. We are boosting procurement standards by extending the Commercial Capability Development Programme to arm's-length bodies and will improve our procurement tools to make public sector contracts more accessible for small and medium-sized enterprises (SMEs) and to further incentivise

innovation. We will improve our digital procurement platforms to make it easier for suppliers to do business with the government, for example through implementation of the Crown Marketplace purchasing platform. We will explore how to build on our pilot to collect feedback from purchasers - which may help highlight the quality on offer from smaller, less well-known businesses in addition to larger, more established brands. We will align the Small Business Research Initiative (SBRI) with the Industrial Strategy Grand Challenges, and introduce a GovTech Catalyst with a GovTech Fund of up to £20m over three years, which will use SBRI to help government departments procure innovative solutions.

As a general principle, we will aim for resilience as well as efficiency - the resilience of our infrastructure systems and the wider environments within which they operate. This is important both for avoiding disruptions caused by shocks, such as flooding and drought, and for supporting sustainable growth in our economy and population over the long term.

- ▶ We are setting high standards in cyber and climate change resilience for our projects across the UK, which will give us greater security and protection from natural risks, and can be the basis for a successful industry exporting these services. Resilience is proposed as a key performance measure within the

National Infrastructure Commission's assessments.

- ▶ We will work not just to preserve, but to enhance our natural capital - the air, water, soil and ecosystems that support all forms of life - since this is an essential basis for economic growth and productivity over the long term. In England, our 25-year Environment Plan will set out an ambitious approach to ensure that all aspects of natural capital are taken into account in our approach to infrastructure and other major investment decisions, while each of the devolved administrations take forward their own work to secure and support the UK's natural capital.
- ▶ We are investing £2.6bn to better protect the nation from flooding, including more than 1,500 flood defence schemes, which will protect 7,500 households and provide £30bn in economic benefits¹⁴⁷. These projects, such as the River Hull waterfront, act as a catalyst for regeneration. A £4.3m flood alleviation scheme in Selly Park North in Birmingham

enabled new, flood-resilient student nurse accommodation to be built.

- ▶ We are developing a National Policy Statement for water resources to ensure that businesses and households in England can continue to rely on high quality water supplies in the future. This will be complemented by more ambitious demand and environmental management.



'We are setting high standards in cyber and climate change resilience for our projects across the UK, which will give us greater security and protection from natural risks.'



Case Study: Heathrow Logistics Hubs

Heathrow Airport has invested more than £11bn in the last decade including building the new Terminal 2 and Terminal 5. It is one of Britain's biggest infrastructure clients spending more than £1.5bn annually with 1,200 suppliers from around the UK.

Heathrow has recently set out the procurement strategy that it intends to follow. It has long-listed 65 sites across the UK in the running to be selected as a Logistics Hub for the potential expansion of the airport. Four locations will eventually be selected to pre-assemble components of the expanded airport before transporting them in consolidated loads to Heathrow.

The proposed logistics hubs will ensure that people from across the UK benefit from the expansion of the airport. By inviting other major infrastructure clients into the process there is the potential for them to benefit, and together offer long-term custom through a succession of projects, supporting investment in offsite manufacturing facilities and employment around the country.

By considering its procurement strategy at the earliest stage, Heathrow has shown how it can both affordably and sustainably spread the potential benefits of expansion across the UK whilst securing the capacity required to deliver the programme.

Invest in infrastructure to drive growth across the UK

In our more strategic approach to infrastructure investment, a priority will be to strengthen growth and accelerate the creation of economic opportunities throughout the UK.

Well-targeted investment can drive economic development, particularly when implemented as part of a wider programme of interventions to address the unique circumstances of each area. However, an approach based solely on static analysis can favour investment in places where development has already happened, and overlook long-term benefits that infrastructure can bring to a place. Cost-benefit analysis will remain central to decision making, complemented by our approach to strategic programme design, referenced previously, which will make use of broad-based and dynamic assessment techniques that reflect the full potential for infrastructure to support local economies.

Transport is particularly important to supporting local growth, in both urban and rural communities. Our Rebalancing Toolkit will provide a framework to support high value transport

investments in less productive parts of the UK. The toolkit will ensure that the dynamic benefits of investment are considered more strategically by improving the focus, quality and transparency of 'rebalancing' evidence in strategic business cases - and applying it more consistently. We would like to consider with the devolved administrations how this approach might in turn work across the UK.

More broadly, as set out in the *Transport Investment Strategy*¹⁴⁸, transport investment must seek to create a more reliable, less congested and better connected transport network; to build a stronger, more balanced economy by enhancing productivity and responding to local growth priorities; to enhance our global competitiveness by making the UK a more attractive place to trade and invest; and to support the creation of new housing. In addition, we will fund a new Major



'Transport investment must seek to create a more reliable, less congested and better connected transport network to build a stronger, more balanced economy.'

Road Network to improve connectivity by targeting funding at strategically important local authority 'A' roads.

The Transforming Cities Fund will provide £1.7bn for projects that improve connectivity, reduce congestion and utilise new mobility services and technology. It will transform local productivity in city regions, for example, by linking the towns around our cities to city centres, and to each other. Half of this funding will be allocated through a competition for transport projects in cities, with the remainder allocated to the six combined authorities with elected metro mayors.

We will continue to strengthen local decision making on infrastructure. We will make the most of places' strengths through our Local Industrial Strategies and City Deals, and we will lend local authorities in England up to £1bn at a discounted interest rate to support local, high-value infrastructure projects through the Public Works Loan Board, with corresponding shares available to local authorities in Scotland and Wales. As respondents to our Green Paper consultation proposed, the establishment of Sub-National Transport Bodies, the development of Combined Authorities, enhancement of Local Enterprise Partnerships and the introduction of Local Industrial Strategies will further strengthen the capabilities of communities to identify their infrastructure needs and to work with central government to deliver them. Transport for the North will become a statutory body in April 2018, and the government will continue to work with Midlands Connect and

England's Economic Heartland to improve prioritisation of local projects as they work towards statutory status. This includes by providing £6m to support the development and delivery of rail and motorway projects in the Midlands Connect strategy.

Our transformational projects, such as High Speed 2, will offer opportunities for local development across their routes. £300m will be invested to ensure High Speed 2 infrastructure can accommodate future Northern Powerhouse and Midlands rail services. This will enable faster services between cities in the north, including Liverpool and Manchester, Sheffield, Leeds and York, and from these cities to the East Midlands and London. This will realise benefits across the UK for decades to come.

Respondents to our Green Paper consultation highlighted the importance of housing to the economic success of our cities and regions. As detailed in the Places chapter, we have announced a comprehensive policy package that will raise housing supply by the end of this Parliament to its highest level since the 1970s, on track to reach 300,000 per year. This will be achieved through £15.3bn of new financial support for housing over the next five years, taking total support to £44bn over the period, as well as planning reforms to make more land available for housing, and better use of underused land in our cities and towns. Housing developments require appropriate infrastructure so we are increasing the Housing Infrastructure Fund to £5bn to provide the right conditions for more house-building to take place.

To improve the productivity of construction, the *Transforming Infrastructure Performance* programme will use the power of government spending to help drive the adoption of modern methods of construction. This will build on the commitment made by five government departments to adopt a presumption in favour of offsite construction by 2019 across suitable capital programmes where this represents best value for money. This will bring together government and industry to facilitate implementation of the Construction Sector Deal, including £170m of investment through the Industrial Strategy programme, *Transforming Construction*, which will support innovation and skills in the sector.

Our international gateways connect people and markets and attract inward investment, keeping the UK globally competitive. Our ports handle 95 per cent of UK freight¹⁴⁹, and we have asked the National Infrastructure Commission to undertake a study on the future of freight infrastructure. The

study will be published in spring 2019 and will look at urban congestion, decarbonisation and how to harness the potential of new technologies.

We have the third largest aviation network in the world¹⁵⁰ and are developing a new Aviation Strategy to build on our strengths to create a safe, secure and sustainable aviation sector for a global, outward-looking Britain. We are also making progress towards delivering much-needed new airport capacity in the south east. We have announced that a new Northwest Runway at Heathrow is our preferred scheme for increasing airport capacity. We will consider all responses to the public consultations before deciding on the next steps.

As technology evolves, low cost access to space offers an exciting opportunity for the UK to thrive in the commercial space age. We are working with industry to grow our share of the global space market from 6.5 per cent to 10 per cent by 2030. To achieve this, businesses must be able to pursue new commercial opportunities from the UK.



'The Transforming Cities Fund will provide £1.7bn for projects that improve connectivity, reduce congestion and utilise new mobility services and technology.'

Case Study: How HS2 will help to deliver our Industrial Strategy



High Speed 2 is an example of an infrastructure project that can deliver the wider ambitions of our Industrial Strategy. The project will establish a High Speed Rail network from London to Leeds and Manchester, with construction continuing until 2033. This provides a long-term opportunity to contribute to growth and productivity throughout the UK, and to support each foundation of our Industrial Strategy:

Ideas

- ▶ HS2 is working with i3P to enable collaboration between clients, government and the supply chain on strategic collaborative innovation opportunities¹⁵².
- ▶ The UK Rail Research and Innovation Network will enable collaboration between the rail industry, universities, small and medium-sized business (SMEs), and infrastructure owners to deliver innovations for both HS2 and the existing network.

People

- ▶ 25,000 jobs will be supported in the construction of HS2, including up to 2,000 new apprenticeships. 70 per cent of these jobs will be outside London.
- ▶ More than 3,000 permanent jobs will be created by the operation and maintenance of HS2.

- ▶ Those shortlisted to bid for the £2.75bn rolling stock contract should illustrate how they will support the HS2 strategic goals and objectives, including the creation of employment opportunities and investment in workforce education and skills.
- ▶ HS2 has supported the development and opening of the National College for High Speed Rail. 1,000 people will train at the college each year.

Business Environment

- ▶ Around 60 per cent of contracts within the supply chain are expected to be awarded to SMEs, with suppliers required to advertise subcontract opportunities to further boost SME accessibility.
- ▶ It will increase the ability for start-up businesses outside London to connect with international investors, venture capitalists and mentors in the capital, giving them the reliability and accessibility they need to develop long-term relationships.

- ▶ It will make it easier for businesses throughout Britain to access international markets by bringing our city regions closer to airports.

Places

- ▶ The government has provided funding for communities to maximise the wider economic benefits of HS2 in their areas. Work between local authorities, Local Enterprise Partnerships and other local stakeholders, Network Rail and the government has been key to developing these plans.
- ▶ For example, the Greater Manchester Combined Authority recognises the opportunity HS2 brings in making Manchester a more attractive business location. It estimates that up to 180,000 new jobs will be created by 2040¹⁵³, adding £1.3bn to the region's economy¹⁵⁴.



'25,000 jobs will be supported in the construction of HS2, including up to 2,000 new apprenticeships. 70 per cent of these jobs will be outside London.'

We will support this, subject to business case through a £50m programme to enable new satellite launch services and low gravity spaceflights from UK spaceports, building on £99m that we are already investing to build the National Satellite Test Facility. These investments will give the UK end-to-end capability in the building, testing and launch of small satellites, boosting our economy and inspiring the next generation of scientists and engineers. We are already legislating to enable a safe

and supportive regulatory environment for these activities, and several sites in England, Wales and Scotland have so far come forward with spaceport plans. UK spaceports could access a global market for launching small satellites worth £10bn over 10 years¹⁵¹, and offer low gravity flights to advance cutting-edge science. The UK Space Agency will help industry to develop new technologies, infrastructure and services, establishing the UK as a world leading destination for space launch.

Increasing competitiveness in the face of major global economic forces

We will invest to increase the UK's competitiveness in transformative parts of the global economy.

The shift to clean growth and the spread of digital technology are particularly significant, as our infrastructure decisions in these areas are already shaping the evolution of markets and encouraging the emergence of new technologies. These trends will affect the way we live, work and travel, and will disrupt business models and markets across multiple sectors over coming decades. We will invest in infrastructure that enables the country to flourish and maximises economic opportunities, supporting our Industrial Strategy Grand Challenges.

Clean Growth

As our Clean Growth Grand Challenge outlines, we want to maximise the advantages for UK industry of the global shift to clean growth. We will position the UK as a world leader,

deploying the major interventions of the Industrial Strategy - in innovation, skills, business and local growth, trade and investment - in support of this goal.

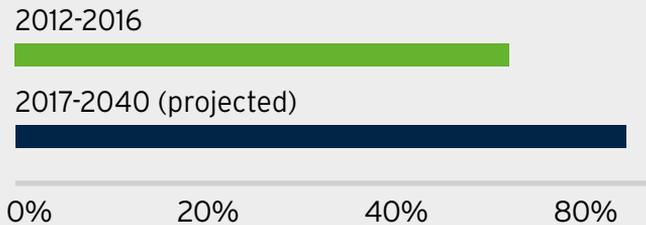
4x

The UK's clean economy could **grow at four times the rate of GDP**

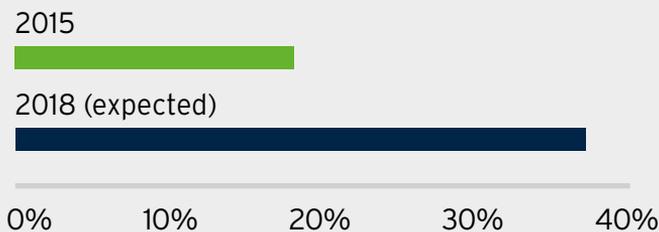
Innovation in clean growth will be important for low cost, low carbon infrastructure systems, as well as for realising industrial opportunities. We will increase support for clean growth innovation by making this a strategic priority for the Industrial Strategy Challenge Fund.

The clean economy's growing share of global markets

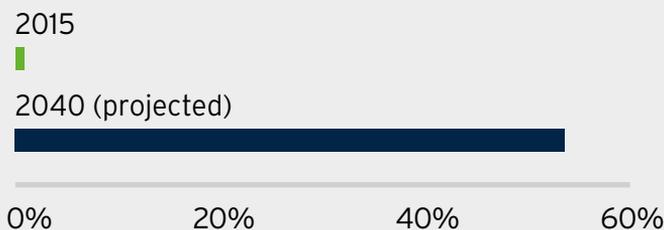
A. Clean power investment as share of global power investment



B. Share of global construction with more than 60% green projects



C. Global market share of electric vehicles



Sources:

A: Frankfurt School - UNEP Collaborating Centre (2017) Global Trends in Renewable Energy Investment 2017, Bloomberg New Energy Finance (2017), New Energy Outlook 2017

B: Dodge Data & Analytics (2016) "World green building trends 2016: developing markets accelerate global green growth"

C: Bloomberg New Energy Finance (2017) "New Energy Outlook 2017"



'UK spaceports could access a global market for launching small satellites worth £10bn over 10 years, and offer low gravity flights to advance cutting edge science.'



This will build on the more than £2.5bn of government investment in low carbon innovation by 2021 set out in the Clean Growth Strategy. In addition to the Faraday Challenge for battery technology, we are now announcing three new Industrial Strategy programmes in Clean Growth across energy, construction and agriculture. We will continue to build our international partnerships in clean growth research and innovation: the UK is a proud member of Mission Innovation - a global initiative that aims to reinvigorate and accelerate the global clean energy revolution. And we will strengthen support to commercialise new clean technologies through our investments in patient capital, beginning with a new equity fund for which we will provide up to £20m.

We will use all the government tools available to support innovation in a low carbon economy including

market design, taxation and regulation. We will also aim to accelerate private investment and promote market growth.

£100bn

of annual exports could be supported by the UK's clean economy by 2030

Our approach is to undertake a comprehensive package of measures to promote the uptake of zero emission vehicles. We have announced a further £100m for the plug-in car grant to incentivise the purchase of battery electric vehicles, and we are committing to 25 per cent of the cars in central government department fleets being electric by 2022. We are announcing an additional £200m of public investment, to be matched by private investment to create a new £400m

Charging Infrastructure Investment Fund, and we will regulate to support further expansion of the charging infrastructure network. After the Grenfell Review, we will update building regulations to mandate that all new residential developments must contain the enabling cabling for charge-points in the homes. We will also provide £40m to support new technologies for on-street and wireless charging. By acting in this way to strengthen the growth of markets for clean technologies in the UK, we will support the development of the UK supply chains that will create jobs and drive future exports.

We will promote overseas investment in the UK's clean economy and strengthen our support for UK exporters through better identification of overseas opportunities, industry briefings, overseas missions, pavilions at key international events and campaigns for sectors and industries that are delivering clean growth. We will also promote the UK's exceptional expertise through the Green is GREAT campaign to amplify the UK's global reputation for excellence in this area.

Many of our stakeholders have called on us to take a 'whole systems approach' to the decarbonisation of energy infrastructure systems. We agree with this principle, and will position the UK as a leader in clean and efficient power, transport and heat through an integrated approach to decarbonising these increasingly connected systems. We aim to implement our *Smart Systems and Flexibility Plan* in full by 2022, enabling the electricity system to work more flexibly and efficiently. The zero emission road transport strategy, to be published in the coming months, and work on the options for the long-term decarbonisation of heating will build on this. They will support the growth of markets for technologies that create synergies between systems, such as energy storage, smart meters, vehicle-to-grid charging and heat networks.



'We are announcing an additional £200m of public investment, to be matched by private investment, to create a new £400m Charging Infrastructure Investment Fund.'

An important benefit of a cleaner economy is cleaner air. We are determined to tackle air pollution and support affected areas, given the significant negative impact it has on public health, the economy and the environment. We will provide £220m for a new Clean Air Fund that will allow local authorities in England

with the most challenging pollution problems to help individuals and businesses adapt as measures to improve air quality are implemented. This new fund is in addition to the £255m provided to implement the Air Quality plan earlier this year, and takes the total amount invested in cleaner air since 2010 to £3.2bn.

Case Study: Smart Islands programme on the Isles of Scilly

Located in the Atlantic Ocean, 28 miles from the mainland, the Isles of Scilly face challenges in installing new infrastructure, with high costs shared among a population of only 2,500 people. Taking on these challenges, a new Smart Islands programme will use smart grid technology to improve energy provision, reduce costs and support local growth.

The Smart Islands programme will aim to transform the islands' infrastructure, with its goals to provide 40 per cent of electricity using renewables, to cut electricity bills by 40 per cent, and for 40 per cent of vehicles on the islands to be electric or low carbon - all by 2025.

The programme will pilot an integrated smart energy system to improve energy efficiency and manage energy demand, incorporating new low carbon and smart technologies, such as electric vehicles. It will be operated by a local community energy services

company and monitored through an 'internet of things' platform. Energy audits, monitoring and training will be provided for free, young people will have the opportunity to undertake internships and develop STEM skills, and support will be provided to 10 supply chain businesses in the region to develop new products and services for the programme. As one of the first of its kind, and a model that will be scalable to other rural communities and cities across the world, the programme offers the potential to build and export UK expertise.

The programme is a partnership between the public and private sectors, including the council, Hitachi, Moixa, PassivSystems, and other local partners. The Cornwall and Isles of Scilly Local Enterprise Partnership has agreed in principle to provide up to £2.95m to support the programme, funded through our Local Growth Fund.



Funding will start from 2018, and will be allocated competitively to local authorities in England with the worst pollution problems. More generally, we will expect local areas in England to consider clean energy and the economy-wide shift to clean growth as important elements in the development and implementation of Local Industrial Strategies.

As these transformational changes in our energy systems take place, we will remain committed to minimising energy costs for households and businesses.

Innovation and system efficiency will be central to this over the long term. The dramatic reduction in the cost of offshore wind is an example of how business innovation can be supported through effective market design. We will carefully consider the findings of Professor Dieter Helm's review into the cost of energy¹⁵⁵, and act on further opportunities for cost reduction in the power sector.



'A new Smart Islands programme will use smart grid technology to improve energy provision, reduce costs and support local growth.'

Moving towards a regenerative circular economy

The economy exists within the natural world, and cannot be separated from it. Energy and materials are essential contributions to the production of goods and services, and a healthy society depends on a healthy environment. The Natural Capital Committee has advised that carefully planned and targeted investments in natural capital – such as woodland planting, peatland restoration and wetland creation – can deliver significant economic growth, and generate returns of up to nine times the costs.

A linear ‘take, make, dispose’ economy risks eroding the natural capital central to its long-term growth through resource depletion and environmental pollution.

We are committed to moving towards a more circular economy – to raising productivity by using resources more efficiently, to increasing resilience by contributing to a healthier environment, and to supporting long-term growth by regenerating our natural capital. Our measures to achieve this will include:

- ▶ an approach to infrastructure investment that aims to regenerate natural capital, as set out in this chapter;
- ▶ raising the resource productivity of businesses, including through the promotion of recycling and strong secondary materials markets where products are designed with efficiency and recyclability in mind;
- ▶ working in partnership with food businesses ‘from farm to fork’, through the Courtauld Commitment to deliver a 20 per cent per capita reduction in food waste by 2025;
- ▶ supporting innovative and highly-efficient precision agriculture through the Industrial Strategy programme: ‘Transforming food production, from farm to fork’;
- ▶ a new Bioeconomy Strategy that will set out a framework for growth in the sector to develop new low carbon bio-based products and processes; and
- ▶ continually strengthening our policies in line with our national ambitions of zero avoidable waste and a doubling of resource productivity by 2050, including through our 25-year Environment Plan and a new strategy for resources and waste.

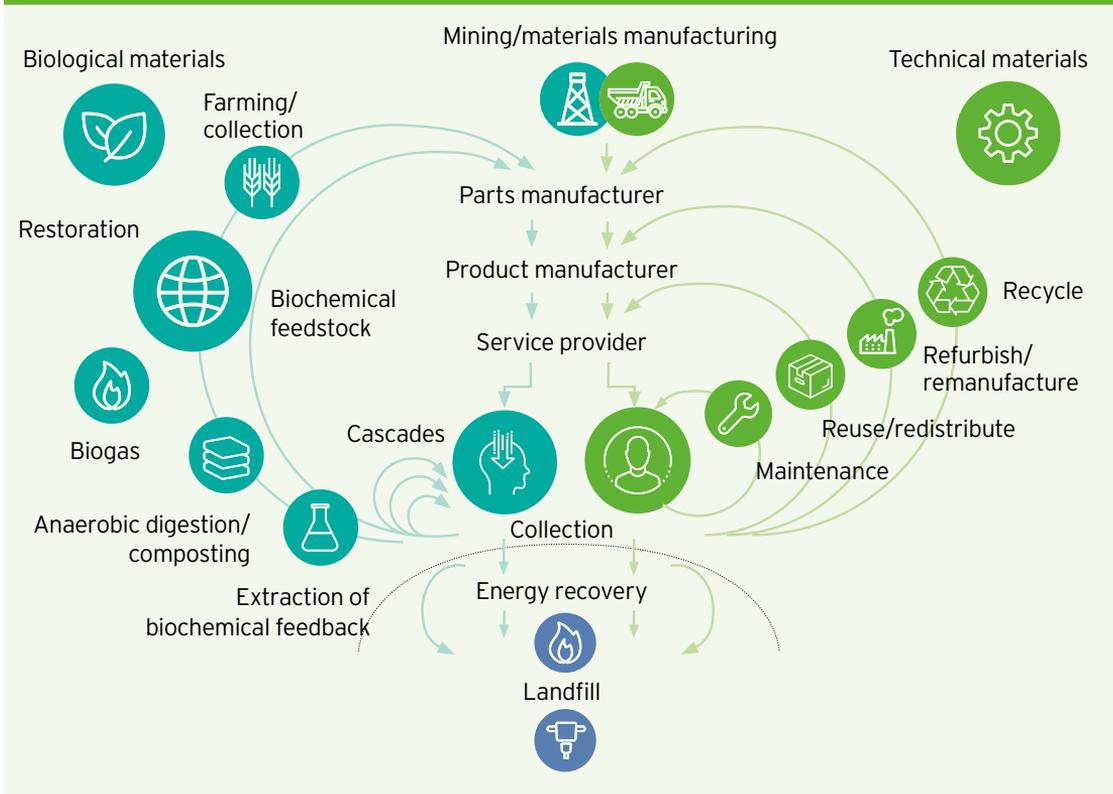
In the more immediate term, energy efficiency and reforms to the retail energy market will provide the opportunity to lower bills. Up to £6bn could be saved in 2030 through investment in cost effective energy saving technologies in the industrial and commercial sector¹⁵⁶. We will encourage greater investment in energy efficiency measures and technologies, including by developing a new scheme to support investment in industrial energy efficiency, to help large businesses install measures that will cut their energy use and bills, as we improve their productivity. We are developing a wider package of measures to support businesses to improve their energy productivity and increase their energy efficiency by at least 20 per cent by 2030, and will consult on this in 2018. We have also launched calls for evidence on additional measures to build a market for energy efficiency among homeowners, and in ensuring the public sector leads by example in encouraging wider markets for energy efficiency.

We can also reduce costs for the UK as a whole by making intelligent use of our oil and gas assets and expertise. While the move towards clean growth is clear, oil and gas remains one of the most productive sectors of the UK economy, supporting 200,000 jobs directly and in the supply chain¹⁵⁷, and generating £24bn in annual exports¹⁵⁸. The emerging shale gas industry offers the prospect of creating jobs, enhancing the competitiveness of downstream sectors and building up supply chains. We are considering how to implement our proposal for a Shale Environmental Regulator. We will support the development of these industries while recognising the devolved nature of planning in the devolved nations, and will work with the sector to explore its potential contribution to clean growth through technologies such as carbon capture, use and storage, and the hydrogen economy.



'We are committed to... raising productivity by using resources more efficiently, to increasing resilience by contributing to a healthier environment and to supporting long-term growth by regenerating our natural capital.'

The circular economy replaces extraction and waste with restoration and regeneration. Products, components and materials are reused in ways that maintain their utility and value as they move through biological and technical cycles¹⁵⁹.



We will become a world leader in 5G, and provide reliable, high-speed connectivity to our towns, cities and rural areas

Digital

The world is becoming increasingly digitalised, and digital connectivity has rapidly become an essential requirement for the way people live and do business.

As well as providing improved connectivity we have an opportunity to develop digital technologies that we can export to the world.

As we have set out in the *Digital Strategy*¹⁶⁰, we are already taking action to improve connectivity for UK businesses and consumers and we are working with industry and Ofcom, the communications regulator,

to ensure there is connectivity where people live, work, and travel. We are building on the success of our Superfast Broadband Programme, which will provide 95 per cent of UK premises with access to superfast broadband by the end of this year¹⁶¹.

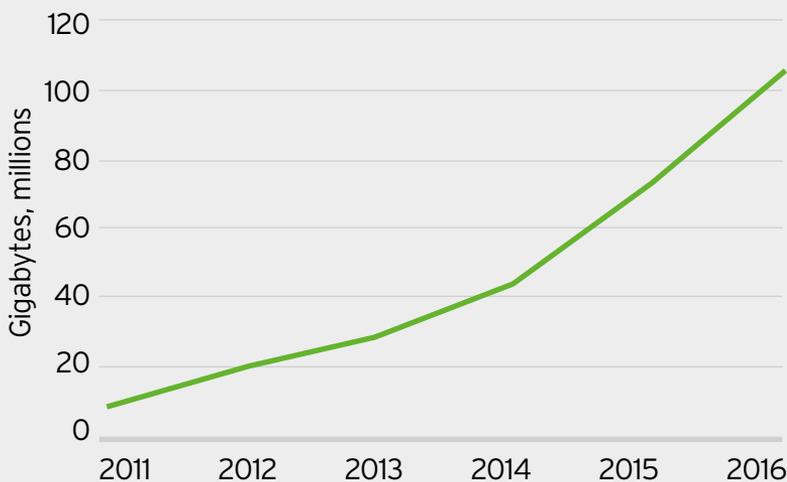
We are also taking steps to facilitate the delivery of the next generation of digital connectivity, to bring about faster and more reliable connections throughout the UK. We have announced an additional £385m for investments in digital



'We are... taking steps to facilitate the delivery of the next generation of digital connectivity, to bring about faster and more reliable connections throughout the UK.'

United Kingdom mobile data traffic

Total UK mobile data traffic



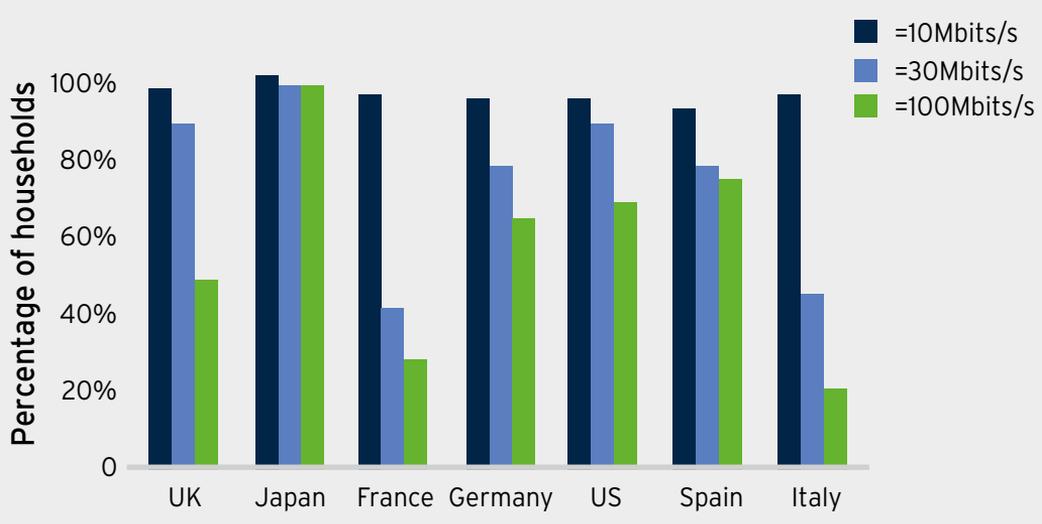
Source: Ofcom (2016) *"Connected Nations Report 2016"*



GATEway (Greenwich Automated Transport Environment) is an £8m research project, led by TRL, to understand how to overcome the technical, legal and societal challenges of implementing automated vehicles in an urban environment

Roll-out of super-fast and ultra-fast broadband in the UK compared to the rest of the G7

Availability of fixed broadband networks by advertised speeds, 2015



Source: Ofcom (2016) "The Communications Market Report: International"

infrastructure, taking total investment from the National Productivity Investment Fund to £740m, and total public investment to over £1bn.

Our ambitious *5G Strategy* outlines the policies that will put the UK at the forefront of the next generation of mobile technology by creating the conditions for the market to develop and to deploy 5G in a timely and efficient manner. An upgrade to our *5G Strategy* will be published before the end of year.

Fundamental to this success is the 5G Testbeds and Trials Programme. The programme will harness areas where the UK has a competitive advantage - such as in scientific research, engineering talent and our rich variety of technology businesses. It will help deliver projects in phases, starting with an initial £25m competition for projects in different industry sectors. This builds on £16m of existing investment in the 5GUK test network facility - a world-leading project being delivered by three universities to develop a 5G test network facility.

We will invest a further £160m in new 5G infrastructure. One of the first projects to benefit will

see £10m invested to create facilities where the security of 5G networks can be tested and proven. A £5m trial to test 5G applications and deployment on roads in 2018, will help to test how we can maximise future productivity benefits from self-driving cars, building on the work already progressing on connected and autonomous vehicle trials in the West Midlands. The National Infrastructure Commission will also launch a new innovation prize to determine how future roadbuilding should adapt to support self-driving cars.

To support the path to 5G, we will provide additional government investment of up to £35m to fund a trial of technical and commercial solutions to high-speed, reliable connectivity on the train via trackside infrastructure. This will be used to upgrade the Network Rail test track in Melton Mowbray, install trackside infrastructure along the Trans-Pennine route between Manchester, Leeds and York, and support the rollout of full-fibre and 5G networks. It will build on existing projects, such as Project SWIFT (Superfast Wi-Fi In-carriage-for Future Travel), a joint venture



'The 5G Testbeds and Trials Programme... will harness areas where the UK has a competitive advantage - such as in scientific research, engineering talent and our rich variety of technology businesses.'

between CISCO, Network Rail and Innovate UK that will facilitate a rail Wi-Fi trial between Glasgow and Edinburgh.

5G deployment will require a boost in infrastructure investment and we will work with Ofcom to facilitate this. In future, infrastructure sharing and neutral host models, where service providers pay for access to networks owned and maintained by third-parties, could become more widespread to support dense networks in connectivity hotspots and to provide wide area coverage in hard to reach areas.

In addition to becoming a world leader in 5G, we need to provide reliable full-fibre connectivity to our towns, cities and rural areas. Only three per cent of the UK has full-fibre coverage - where full-fibre can connect directly to the premises with significantly enhanced data capacity - compared with 70 per cent or higher in Spain, Portugal, Japan and South Korea.

Our ambition is for ten million premises to be connected to the 'full-fibre' network, with a clear path to national coverage over the next decade. More investment in fibre and ultrafast services is being supported by the Digital Infrastructure Investment Fund. This has accelerated roll-out by increasing access to private finance for businesses involved - encouraging new entrants to the market and unlocking over £1bn in investment.

We have made significant progress in helping to create the conditions for investment in full-fibre connectivity, through our investments programmes, the introduction of a five year business rates relief for fibre infrastructure deployed from April 2017, and the establishment of a Barrier Removal Task Force. To build on this, we will undertake a review of telecoms market, to understand businesses' incentives for investment in new digital infrastructure,



Digital rail technology will transform the railways, enabling trains to run more frequently, at lower cost and greater resilience

establishing a clear evidence base to determine what, if any, additional policy interventions may be needed to deliver our objectives whilst promoting a stable environment for investment. It will take into account the expected developments in the regulation of the telecoms market and will assess:

- ▶ the barriers to investment in digital infrastructure and next-generation digital connectivity, now and over the coming decades including cost, levels of demand, and market structures;
- ▶ how investment incentives vary between different areas of the UK and across different parts of the telecoms market; and
- ▶ what policy changes the government should consider to encourage greater investment in new digital infrastructure. These may include encouraging greater competition, other measures that can increase the attractiveness of investment through changes in the relative risks and returns, or direct government intervention.

A report, to be published in summer 2018, will identify options for incentivising

investment in the UK's future digital infrastructure. We will also publish a Statement of Strategic Priorities next year setting out our objectives in relation to the widespread availability of fixed and mobile connectivity.

Full-fibre is the gold standard for fast and reliable broadband. We are investing £200m in the Local Full-fibre Networks Challenge Fund to stimulate commercial telecoms network providers to build more full-fibre connections to homes and businesses across the UK. £10m of this has been allocated to pilots, including a £2m pilot voucher scheme in Aberdeenshire, Bristol, Bath and north-east Somerset, Coventry and Warwickshire, and West Yorkshire. The remaining £190m will be competitively allocated through a Challenge Fund, open to local areas, with funding awarded to those areas that can best leverage private sector investment in building and extending local fibre networks.

Digital technology will transform our railways, allowing more frequent, more reliable services, and we want Britain to be at the forefront of developing this technology.



'Our ambition is for ten million premises to be connected to the full-fibre network, with a clear path to national coverage over the next decade.'

We have announced £5m to embed Digital Railway technology between Manchester and York. In addition, we will provide £84m for best-in-class, state-of-the-art in-cab digital signalling across a range of trains, and £5m to develop a Digital Railway upgrade on the south

east and east London lines, alongside funding to develop a Digital Railway upgrade on the Moorgate branch. Network Rail will work with stakeholders to develop a strategy to grow our skills and expertise in Digital Rail.

Case study: Vodafone and CityFibre

The government's ambition to provide ten million premises with 'full-fibre' will require new ways of funding and delivering network infrastructure. A long-term strategic partnership between Vodafone and CityFibre is the market's response to this challenge. It will bring gigabit-capable full-fibre broadband to up to five million homes and businesses by 2025, comprising 50 per cent of the government's target.

Construction of the first phase of deployment to one million premises is due to start in the first half of 2018 and will be largely complete in 2021. The first towns and cities to benefit from the roll out will be announced over the coming months and the first customers connected towards the end of 2018.

Data

Our country has world-class data, from the highest quality geospatial and climatic analysis to company information.

We are committed to making this data available to innovators and businesses throughout the UK to create products and services that will transform our economy and society. We want the UK to be the best place to start and run a digital business. Strengthening public confidence in data, and giving greater clarity to business, will support measures to help the tech industry to flourish, reinforcing the UK's position as one of the world's leading digital economies.

We are working to improve collaboration on data sharing between agencies, for example, between HM Revenue and Customs, the Department for Business, Energy and Industrial Strategy, Local Enterprise Partnerships and Growth Hubs to support the objectives of the industrial strategy.

For example, we will explore means of identifying businesses with scale up potential, and encouraging them to access the support available to help them reach their potential. We are working to harness data from across the government to identify those businesses with greater propensity to successfully export, and to provide them with appropriate support. We will report on progress next year.

The UK has some of the best geospatial data in the world, much of it held by public bodies. To make the most of the value of this data, support the growth of the digital economy and consolidate the UK's position as the best place to start and grow a digital business, the government will establish a new Geospatial Commission to provide strategic oversight of the various public bodies that hold this data.



'We are committed to making our world-class data available to innovators and businesses throughout the UK to create products and services that will transform our economy and society.'

Case study: Transport for London - Turning Data into Knowledge

For almost 10 years, Transport for London (TfL) has been releasing open and free data on timetables, service status and disruption. This has created a market for developers to deliver more than 600 apps that have revolutionised users' journeys. Deloitte estimates that the release of open data by TfL is generating annual economic benefits and savings of up to £130m for travellers, London and TfL itself¹⁶³. Use of TfL's open data provides the following benefits:

- ▶ **Saved time for passengers** - Greater certainty of when the next bus or Tube will arrive is saving time equivalent to £70m to £90m per year;
- ▶ **Creating commercial opportunities for third party developers** - Access to data has increased the contribution of developers to the London economy of between £12m and £15m per year;

- ▶ **Two-way data** - TfL receives significant data from those it shares with, gaining a better understanding of journeys in London to improve operations; and
- ▶ **High-value job creation** - It directly supports around 500 jobs, with a further 230 indirect jobs in the supply chain and wider economy that have also been created.

The benefits are illustrated by Citymapper, which provides its users across 40 cities with a smart view of how to travel to their destination. Based on data generated by the app, Citymapper have sought to route public transport in a way which optimises user need and has been granted a six-month license to operate a weekend night bus route between London stations.

To further boost the digital economy, the government will work with Ordnance Survey (OS) and the new Commission, by May 2018, to establish how to open up freely OS MasterMap data to UK-based small businesses in particular, under an Open Government Licence or through an alternative mechanism, while maintaining the OS's strategic strengths. We are providing £80m over the next two years to support this work.

£80m

over the next two years to **support our work** in data

We are exploring how the government can best facilitate conditions for secure, trusted, personal identity assurance in the private sector. The digital economy relies on trust to work effectively - transactions can be approved and paid for with a digital signature; property and goods can be transferred; entrance and access to resources or premises can be permitted or prevented. Getting this

right will remove friction and allow businesses and government to run more quickly, simply and securely - helping realise the potential of the UK's digital economy and increasing productivity.

In support of our Grand Challenge on data and artificial intelligence (AI), we are establishing a new Centre for Data Ethics and Innovation to enable and ensure safe, ethical and ground-breaking innovation in AI and data-driven technologies. The centre will work with government, regulators and industry, as well as across sectors and applications, to ensure that our regulatory regime fully supports - and removes barriers to - the ethical and innovative use of data and AI. This will lay the foundations for AI adoption which could benefit households across the UK by up to £2,300 per year by 2030¹⁶⁴, and ensure that we maximise the positive impact of these technologies on our economy and society. Now is the right time to harness the growing momentum around data-driven technologies, placing the UK at the cutting edge of trusted and innovative deployment of data.



'Now is the right time to harness the growing momentum around data-driven technologies, placing the UK at the cutting edge of trusted and innovative deployment of data.'

Minimising business energy costs and raising resource productivity

Minimising business energy costs

The framework for achieving clean growth and affordable energy was set out in the recent Clean Growth Strategy and sits at the heart of this Industrial Strategy. The government is committed to minimising energy costs for businesses, to ensure our economy remains strong and competitive. We recognise that our industrial electricity costs are currently higher than those of our competitors. We will act to address this by taking steps to reduce costs both now and in the future.

Minimising costs in the short term

We already provide substantial compensation to eligible energy intensive industries for the cumulative costs of energy and climate policies, reducing the impact of these policies on their electricity bills by up to around 80 per cent. We are moving from a system of compensation to one of exemption for some of these costs, to make the cost saving more direct and easier for industry to access.

We will consult on widening eligibility for the exemption schemes for energy intensive industries to address potential intra-sectoral competitive distortions, taking into consideration the impact on consumer bills. As state aid considerations for the Feed-in-Tariff scheme will take longer to

resolve, current compensation will remain in place in the meantime.

We will encourage greater investment in energy efficiency measures and technologies, including by developing a new scheme to support investment in industrial energy efficiency, to help large businesses install measures that will cut their energy use and bills, as well as improving their productivity. We will develop a package of measures to support businesses to further improve their energy productivity and will consult on this in 2018. Our goal is to enable business and industry to improve energy efficiency by at least 20 per cent by 2030.

We are consulting on the design of a new £18m programme to support investment in the recovery and re-use of heat from industrial processes, leading to lower bills, and potentially new revenue streams for industry.

Medium term

Competition in contracts for clean power generation is already driving down costs: the costs of offshore wind have fallen by half since 2015¹⁶⁵. We will carefully consider the findings of Professor Dieter Helm's independent review into energy costs in the power sector, and take further action to reduce costs where appropriate.

The Smart Systems and Flexibility Plan launched this year aims to save consumers and businesses up to £40bn cumulatively over coming decades. We will continue to update this to keep pace with developing technology.

Longer term

Innovation is crucial to reducing costs over the long-term. We will invest over £2.5bn in low carbon innovation by 2021 as set out in the Clean Growth Strategy.

We are investing up to £100m to support innovation in low carbon industrial processes and technologies such as carbon capture, use and storage, and electrification, and we will develop a framework to support the long-term development of these processes.

We will explore further opportunities to support innovation and cost reduction through the Industrial Strategy Challenge Fund, through the negotiation of Sector Deals, and through the implementation together with industry of the 2050 Decarbonisation Action Plans that we have agreed with seven of the most energy intensive industrial sectors.

Raising resource productivity

We will support businesses' long-term productivity through innovative approaches to resource efficiency. We will position the UK as a world leader in sustainably maximising the value we extract from our resources, while minimising the negative impacts of their extraction, use and disposal.

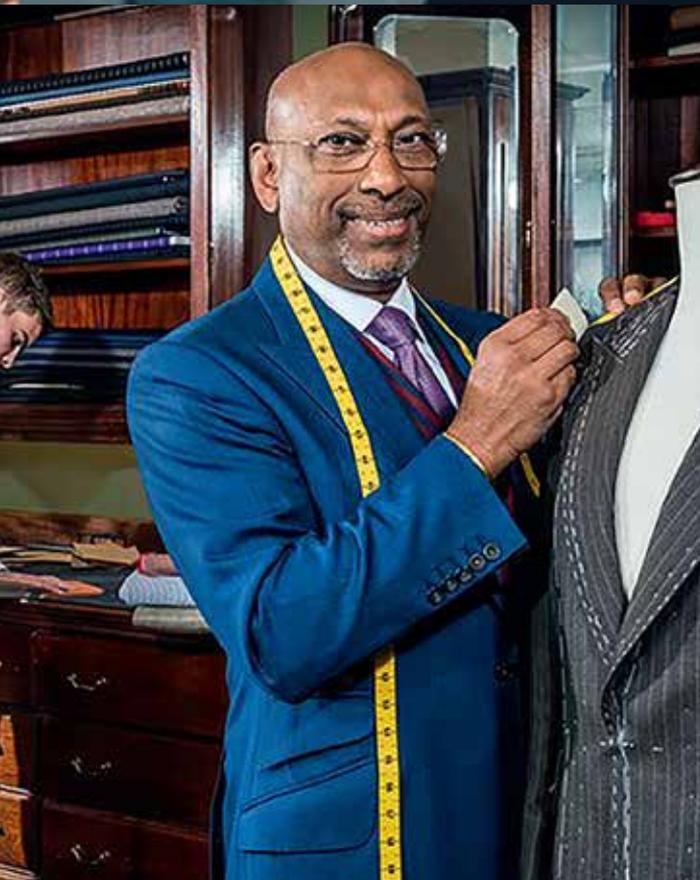
We will take further measures to strengthen the markets for secondary materials, and in 2018 we will publish a new resources and waste strategy to support businesses in maximising the economic benefits from greater resource productivity.

The OECD ranks the UK as one of the best places to start and grow a business.

As part of this work, we will work with industry to explore options to introduce electronic tracking of waste. This will support the development of new markets for waste materials and improve the efficiency of enforcement, creating a level playing field for the waste and resources sector. This will build on the foundations set out in our 25 Year Environment Plan.

Business Environment





Business Environment

To be the best place to start and grow a business.

The United Kingdom has a global reputation as a good place to do business. A new business starts up every 75 seconds, and we are home to five of the top 10 fastest-growing businesses in Europe. People looking to grow or relocate a business come to Britain confident in our high corporate standards. The OECD ranks us as one of the best places to start and grow a business; we have the most competitive tax rates and we are welcoming to global talent and disruptive start-ups.

Our challenge is to improve how we spread the best practice of our most productive businesses. We are one of the world's great financial centres, yet growing businesses sometimes face difficulty in accessing finance.

Our managers are, on average, less proficient than many competitors, and we should make better connections between high-performing businesses and their supply chains.

Our Industrial Strategy aims to make Britain the best place to start and grow a business, and a global draw for innovators. We will drive productivity in businesses of all sizes by increasing collaboration, building skills and ensuring everyone has the opportunity of good work and high-paying jobs. We will ensure the financial sector is better connected to the rest of the economy, driving impactful investments. We will create a business environment equipped for the challenges and opportunities of new technologies and ways of doing business.

Key policies include:

- ▶ launch and roll-out Sector Deals – partnerships between government and industry aiming to increase sector productivity. The first Sector Deals are in life sciences, construction, artificial intelligence and the automotive sector
- ▶ drive over £20bn of investment in innovative and high potential businesses, including through establishing a new £2.5bn Investment Fund, incubated in the British Business Bank.
- ▶ a review of what actions could be most effective in improving productivity of SMEs, including how to address the 'long tail' of less productive businesses.

Britain's prosperity is founded on being an open, liberal free-trading economy in which new businesses can be created easily; existing businesses can attract investment from our world-class financial system and investors can act with confidence in the quality of our corporate standards.

The British business environment is one of the most admired globally as one of the best places to start, locate and grow a business¹⁶⁶. A new business starts in Britain every 75 seconds. We are home to some of the biggest, most respected businesses, including half of the top 10 fastest-growing businesses in Europe¹⁶⁷. The first foundation of our Industrial Strategy is to maintain and enhance the business environment that is so essential to the UK's success.

In the past, industrial strategy came to be associated with attempts by the government to control business through

nationalising, subsidising, protecting and directing large parts of the economy. This modern Industrial Strategy, learning the lessons of the past and drawing on the detailed, wide-ranging response to our Green Paper, charts a different approach.

The role of the government is not to pick favourites and subsidise or protect them; rather, it is to ensure that the British business environment is shaped by competition and contestability in which the best businesses of all sizes can thrive. No incumbent - however large and longstanding - should feel immune from this challenge. Anyone with a good idea and the entrepreneurial ambition to make it a reality should see the UK as the best place to do business.

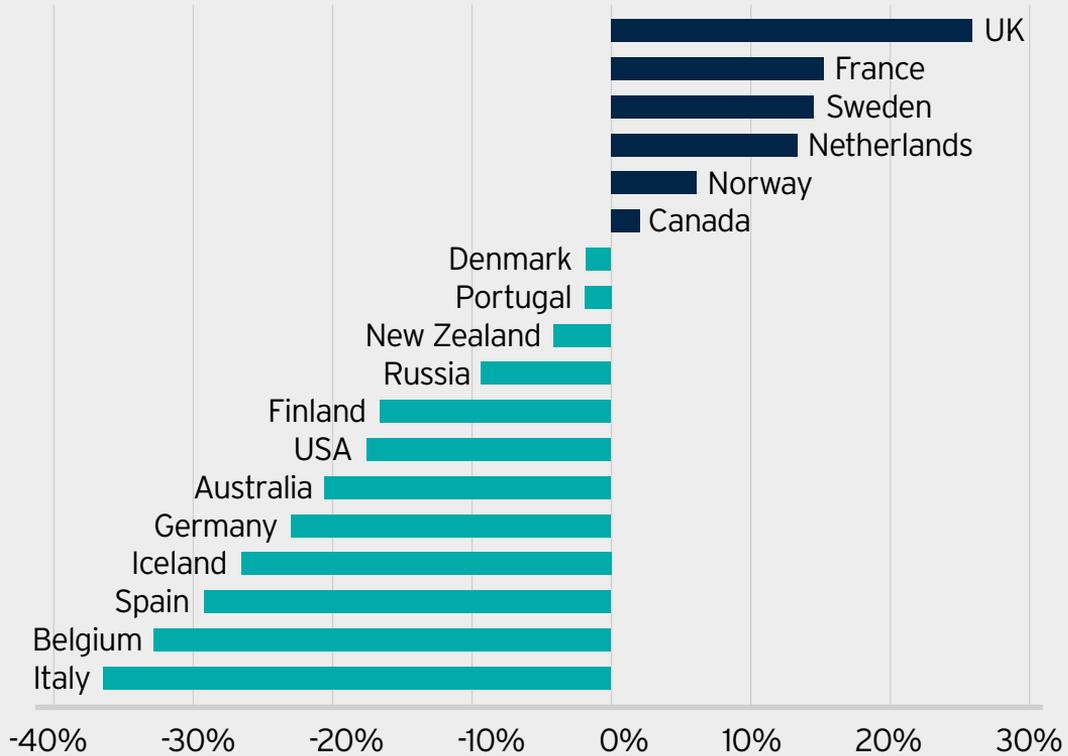
Most of the interventions set out in this paper apply across the whole economy, and to a wide range of businesses.



'A new business starts up in Britain every 75 seconds, and we are home to... half of the top 10 fastest-growing businesses in Europe.'

The UK's record in creating new businesses compared to other countries

Percentage change in the number of new businesses created between 2007 and 2015



Source: OECD (2016) "Entrepreneurship at a Glance 2016"

A significant improvement in our level of technical skills, the upgrading of our infrastructure, investing in research and development (R&D) and realising the full potential of communities are long-term commitments to all businesses, current and future. Some sectors that will shape our lives in the years ahead have not yet been created; they will come with future technologies and entrepreneurial endeavours.

We must build on our strengths, as exemplified by sectors such as automotive, aerospace, financial and professional services, creative industries and life sciences. Their success has often been enhanced through collaboration - by businesses, the government, research institutions, universities and colleges - to align policies, enhance investments and create sector-wide institutions.

Building on our strengths



We are ranked as **one of the best places in the world** to start and grow a business¹⁶⁸



Over **1,100** businesses start every day in Britain - or one every 75 seconds¹⁶⁹



We are now home to **half of the top 10 fastest growing companies** in Europe¹⁷⁰



The number one destination in Europe for **inward investment**¹⁷¹



The UK ranks **fifth** in the Global Innovation Index¹⁷²



'Britain's prosperity is founded on being an open, liberal free-trading economy in which new businesses can be created easily.'

Over the last decade successive governments have developed a partnership approach to working with sectors. This is exemplified by the Office of Life Sciences, and the creation of the jointly-funded Advanced Propulsion Centre and Aerospace Technology Institute. We want to build on past successes and to ensure we are working effectively with existing and emerging sectors; helping to identify where specific interventions can help raise productivity.

19% is the **UK** **corporation tax rate**

We will ensure that this approach is available to other sectors. No sectoral initiatives should be a strategy for incumbency, and we will openly encourage future businesses as well as existing players. Our City Deals, which give powers to help a region support economic growth, create jobs or invest in local projects, have done much to bring people together - from Aberdeen and the Tees Valley to the West Midlands and Cambridge - over the last six years.

Our proposal in the Green Paper for Sector Deals met with an extraordinary and positive response.

Our national approach to the business environment must be mirrored at local level so that our cities, towns and counties can attract and cultivate successful businesses.

For most of the last century, Britain experienced a shift in power from our cities, towns and counties towards the capital. The tide has started to turn through City Deals, Growth Deals, Devolution Deals and creating Mayoral Combined Authorities. Power is beginning to shift from Whitehall. Local Enterprise Partnerships in England have provided a platform for local leaders and businesses to shape policies for their area. Our Green Paper consultation made clear the enthusiasm for increased local decision making. The role for communities throughout the country in driving productivity is a major component of our Industrial Strategy. Enhancing the business environment locally is a key objective in our push for further devolution.

In enhancing our business environment nationally and locally, there are a number of components that the consultation on the Green Paper revealed to be of particular importance.

Access to finance

Britain is well-placed as one of the world's great financial centres, with access to a deep pool of capital and domestic and overseas investors attracted to our reputation as a rigorous jurisdiction.

However, we have not made the most of this advantage in providing access to finance for growing businesses.

The government's Patient Capital Review consultation estimated that if the UK had the same level of investment as the US, total venture capital investment in UK businesses would be £4bn more per year¹⁷³. There is also evidence of extreme regional disparities, with over 70 per cent of investment in 2016 made in the south east¹⁷⁴.

Diffusion of good practice

Britain's relatively poor recent record in productivity is not uniform. We have some of the world's most productive businesses, but research shows that we have an unusually 'long tail' of underperforming businesses, pulling the average down.

We are not as good as other countries at spreading the best practice of our top performers.

The Bank of England has carried out extensive work¹⁷⁶ to understand the key factors for improvement.

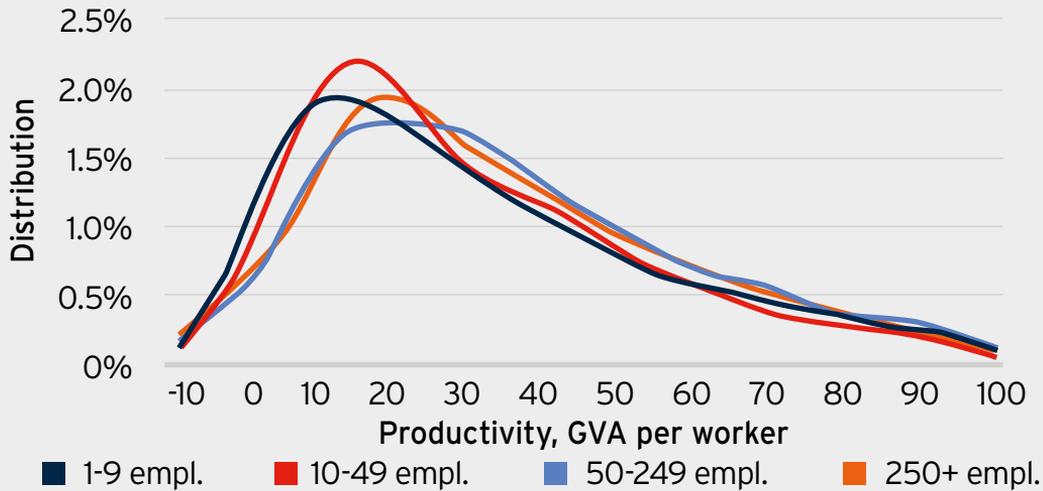
One is greater access to management skills. Studies suggest that the average UK manager is less proficient than many overseas competitors¹⁷⁷, while management skills could account for a quarter of the productivity gap between the UK and the US¹⁷⁸. Another is the availability of advice and mentoring for growing businesses, such as closer relationships between high performers and their supply chains to drive more effective practice.



'Our City Deals, which give powers to help a region support economic growth, create jobs or invest in local projects, have done much to bring people together.'

Productivity distribution by business size

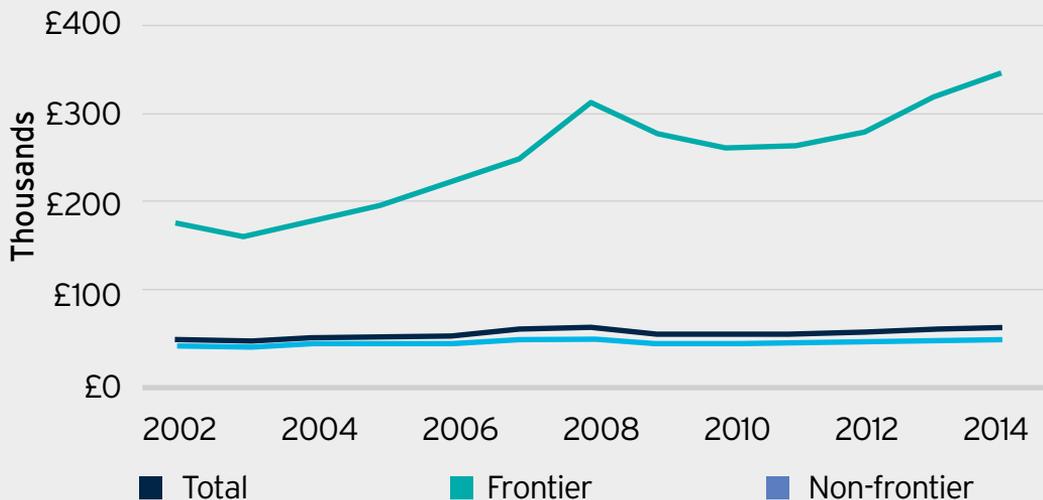
Distribution of real business-level GVA per worker by business size bands



Source: ONS (2017) *Understanding firms in the bottom 10% of the labour productivity distribution in Great Britain* *Businesses can have negative levels of value added per worker in specific periods when they report larger values of purchases than their total turnover. Includes all firms covered by the Annual Business Survey and excludes financial and insurance activities and real estate activities

Productivity gap between the UK's frontier and non-frontier businesses

Productivity gap between the UK's frontier and non-frontier businesses



Source: Haldane, A (2017) *"Productivity puzzles"* speech, London School of Economics, 20 March. *Frontier defined as top 5% of businesses by GVA per worker in a given year

Tackling our productivity challenge

'Imagine [if] productivity growth in the second, third and fourth quartiles of the distribution of UK firms' productivity could be boosted to match the productivity of the quartile above. That sounds ambitious but achievable. Arithmetically, that would deliver a boost to aggregate UK productivity of around 13 per cent, taking the UK to within 90-95 per cent of German and French levels of productivity respectively¹⁷⁵.

Andrew Haldane, chief economist at the Bank of England.

Some of the biggest opportunities for raising productivity come in sectors of the economy that have lower average productivity levels, but where many people work and which are vital to our economy.

We will work closely with sectors such as hospitality, retail and tourism on each of the foundations of productivity in order to be able to progressively drive up the earning power of people employed in these industries and enhancing our national productivity.

Parts of the UK economy are unusual in having underdeveloped domestic supply chains.

Fixed capital investment is another factor important to productivity growth. The UK's investment rate

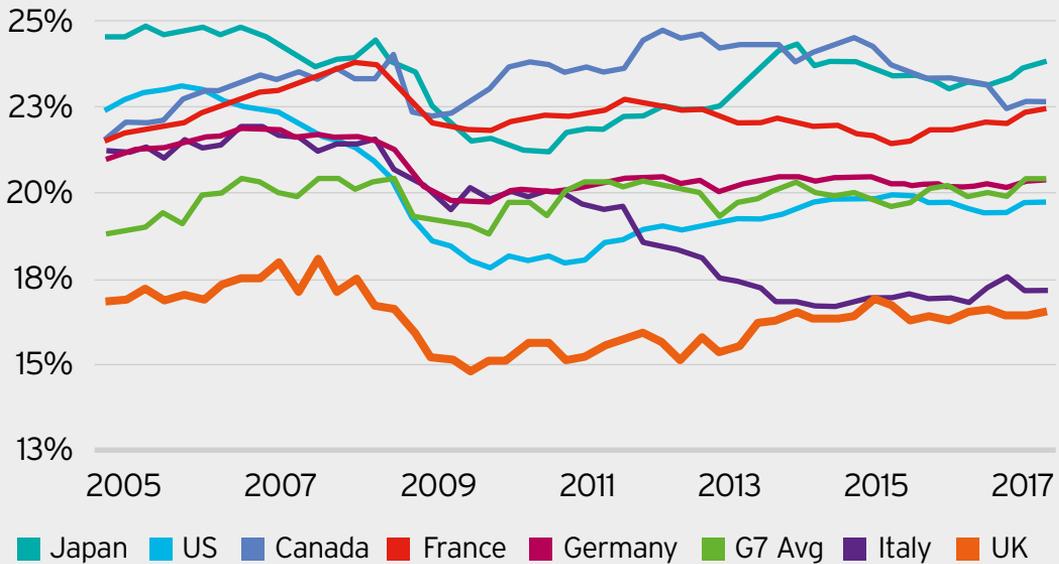
is lowest in the G7¹⁷⁹. Many UK businesses, including large listed businesses, are not investing as much as our competitors' businesses in skills, technology and equipment.



'We are not as good as other countries at spreading the best practice of our top performers. One [factor] is greater access to management skills.'

Fixed capital investment in the UK compared to other G7 countries

Fixed Capital Investment as a percentage of GDP for G7 countries



Source: OECD (2017) "Quarterly National Accounts 2017". Fixed Capital Investment is gross fixed capital formation

Entrepreneurship and scale-ups

Whilst some small businesses are happy to stay small, and are a valued part of the economy, many have the opportunity to improve their productivity. Entrepreneurs are adding to the millions of small and medium sized businesses throughout Britain that make a very significant contribution to our country through taxes, employing people and through the value of the goods and services they provide.

However, it is right to give attention to the ambitious, high potential small and medium sized businesses that are so critical to jobs and productivity¹⁸⁰.

We have a great record on start-ups: over 40 businesses are created in Britain every hour and research found that the UK ranks third amongst OECD countries for start-ups¹⁸¹. This is supported by a tax environment that rewards entrepreneurship. But as the Patient Capital Review identified, we could do better in the longer-term process of building up successful businesses to reach large-scale and as the Scale-Up Taskforce has highlighted, more can be done to increase the number of businesses that achieve their full potential.

Case study: Scale-Up Champion and Scale-Up Taskforce

In the Industrial Strategy Green Paper we announced the Business Minister Margot James MP as the Scale-Up Champion and established the Scale-Up Taskforce, co-chaired by entrepreneur Sahar Hashemi. The taskforce was set up to explore what more the government, working alongside the private sector, can do to help businesses scale up.

Supporting the development of the Industrial Strategy, the Scale-Up Taskforce prioritised four areas:

- ▶ better use of government and privately held business data to identify and target growing businesses when they need additional support;
- ▶ enhanced leadership and management capability and access to talent;
- ▶ greater awareness, and more take up, of equity finance and capital to help founders invest in business growth; and
- ▶ improved access to markets; through international trade, opportunities for government procurement and better supply chain support.

We need to make it easier for businesses of any size, in any location, to access finance. More opportunities to operate in an environment with advice and challenge, especially from other entrepreneurial business people, can help businesses succeed initially and through their stages of development. And we know that universities and colleges have more scope to be both the originators and propagators

of new businesses. As discussed in the Ideas chapter, there is potential for universities to generate even greater economic value from research, for example through intellectual property licensing and spin out businesses. We need to make sure universities have the resources and skills to commercialise opportunities and attract the investment required.



'Entrepreneurs are adding to the millions of small and medium sized businesses throughout Britain that make a very significant contribution to our country.'

Exports

Being an open, outward-facing economy can drive up competition. Exports and imports amounted to 58 per cent of GDP in 2016, with UK exports valued at nearly £550bn¹⁸². As we leave the European Union and negotiate new trade deals, we should build on our strong record and ensure

our businesses can access markets and bring in the returns. Businesses that export account for 60 per cent of the UK's annual productivity growth¹⁸³, deliver stronger employment growth and pay higher wages than those that don't.

Case Study: DigitalGenius - A cutting-edge AI company on an export journey

DigitalGenius brings practical applications of artificial intelligence (AI) into the customer service operations of some major global businesses. Its customer service platform combines the best of human and machine intelligence, enabling businesses to live up to and exceed rising consumer expectations. The platform automates and increases the quality and efficiency of customer support across communication channels like email, chat, social media and mobile messaging.

One of DigitalGenius's main clients is a major airline company, who has used the platform to help customer service agents to cope with the

huge increase in messaging volume from social media channels. Agents are supported by the AI to provide more efficient, better service for the customer, while the AI learns from every interaction.

A focus on exports has been a key part of the company's business plan from the start - and with the support of government, has enabled DigitalGenius to grow from 20 to 60 employees in one year, building software that is currently powering over 30 contact centres around the world.

The competitive and regulatory environment

Government policy and the regulatory environment can be pivotal to a good business environment. According to the World Bank, the UK is the seventh best country in the world to do business, and a leader among major economies in the EU¹⁸⁴.

Our tax rates are competitive. Since 2010, the UK corporation tax rate has been reduced from 28 per cent to 19 per cent, the lowest overall rate among G20 countries. It is easy to start a new business, and our competition policy is geared to ensuring that almost all sectors are subject to positive competitive forces. Where competition is inadequate, economic regulators promote entry and simulate competitive pressure.

The integrity of UK law and the impartiality of our professional bodies are prime reasons why businesses throughout the world choose to locate or conduct their business in this country. We continue to review and refresh our standards to lead and reflect social change,

such as our proposals for corporate governance and mergers. This is done with respected institutions such as the Bank of England and the Takeover Panel.

New technologies, new ways of doing business and new industries often require an agile but dependable regulatory system to support them. Autonomous vehicles, for example, raise important questions of the insurance liabilities and road traffic regulations needed if the technology is to be deployed properly. Investors in peer-to-peer lending and many fintech applications are more likely to trust large sums of money to jurisdictions with up-to-date and effective anti-fraud regimes.

The right business environment demands a regulatory system responsive to not only today's economy but to the future economy as well. We are committed to this aim.



'Businesses that export account for 60 per cent of the UK's annual productivity growth, deliver stronger employment growth and pay higher wages than those that do not.'

We are determined to have the right support for small businesses. Smaller businesses, without the clout of scale, can suffer disproportionately from heavy-handed regulation and bureaucratic excess. They can also find themselves exposed to detrimental behaviours - intentional or otherwise - by larger businesses that are their suppliers and customers.

In recognition of this, the government has worked with small business representative organisations, including the Federation of Small Businesses,

the British Chambers of Commerce and the Institute of Directors, to set up the first Small Business Commissioner. The Commissioner's remit includes helping small businesses on payment issues, dispute resolution and sourcing advice. Alongside sector-specific support, such as the Groceries Code Adjudicator and the Pubs Code Adjudicator, we are committed to providing assistance for smaller businesses in asserting themselves amid the larger players in the economy.

Good work

High standards in the business environment also apply to people's working conditions. Workers in Britain should expect to be treated well: highly productive employers not only pay their workforce well, but also invest in their staff through training and development, good terms and conditions and opportunities to participate in the way the business is run.

We should be proud of the way our flexible labour market has created more jobs than ever before, and that the experience of work for most people is positive and empowering. The National Minimum Wage and National Living Wage have provided help to people on lower wages. When tax levels and tax credits are taken into account, average take home pay for families with a member in full-time employment is higher in the UK than the rest of the G7 nations¹⁸⁵.

If we are to embrace the new ways of working that technological advances offer, it is essential that our workforce should be confident that they will not be mistreated. That is why the Prime Minister asked Matthew Taylor, the Chief Executive of the Royal Society of Arts, to examine the opportunities and risks around modern working practices.

The commissioning of the Matthew Taylor review - and our intention to act on its recommendations - makes the UK one of the first countries in the world to examine how to ensure everyone benefits from the technological revolution. We should look to take up the opportunity this change brings to our working lives - for work that is fair and decent, with realistic scope for development and fulfilment. We start by setting out our ambition for good work in the 'People' section of this paper.

The role of government

The business environment we seek - to be the best place for businesses to start and grow, that encourages better productivity and supports higher wages and good work for all - involves an active role for the government.

Alongside its responsibility for regulation and taxation, the public sector provides or funds many of the foundations of productivity - including education, vocational training, transport and other infrastructure, and some scientific research. Its procurement of around £270bn a year of goods, works and services, from pharmaceuticals to IT, has a major impact on the private sector¹⁸⁶.

£270bn

of **public sector procured goods, works and services** has a major impact on the private sector

The government must use its powers and make its decisions recognising

the commitments of our Industrial Strategy. This means businesses should expect consistent, strategic action from government to secure clear long-term objectives and ensure policies in different areas are not at odds, but align properly to give mutual support.

An active government will also be alert to new opportunities to advance our Industrial Strategy, and agile enough to seize them when they appear. An example is in attracting investments from multinational and foreign businesses - where major decisions require strong government engagement, as illustrated in bringing Japanese car makers to the UK in the 1980s to the great benefit of our economy. We have no qualms about seeking to establish and maintain positive relationships with interested investors, be they UK or overseas businesses, and continually promoting, reviewing and refreshing our offer as a place to do business.



'Highly productive employers not only pay their workforce well, but also invest in their staff through training and development, good terms and conditions and opportunities to participate in the way the business is run.'



Ensuring that firms can access finance is essential to their investment, growth and success

A strong theme to responses to our Green Paper was that businesses should be able to deal with the government without having to navigate different approaches by different government departments. Every part of government should be encouraging and offering partnership. Businesses should feel they have a positive relationship with officials and ministers who listen to, understand and assist them.

We are determined to create in the government the most effective champion and partner of business in the developed world - an ambition which demands changes in organisation and practice.

Our approach

Our ambition to make the UK the best place to start and grow a business requires us to safeguard the things we do that already contribute to our success, and to act where necessary to make us even more attractive.

We will drive up productivity; provide more opportunities for better, higher paying jobs; and shape our business environment to take on the challenges and opportunities of new technologies and new ways of doing business, especially as we leave the EU.

Our Industrial Strategy is for the long term, and not all

our future reforms can be captured in this paper. We are committed to continuous improvement on the path set out in this strategy, and as befits its emphasis on innovation, we will pilot some reforms locally. This allows a wide range of innovation to be tested, and the lessons to be learned and applied.

Acting on our commitments

To support high-growth innovative businesses to achieve their potential, we have launched an action plan to drive over £20bn of investment into these businesses over the next 10 years by:

▶ establishing a new £2.5bn investment fund incubated in the British Business Bank to be floated or sold once it has established a sufficient track record. The fund, through co-investment with the private sector, will

unlock a total of £7.5bn investment, ensuring businesses can get access to the capital they need to scale up and become world leaders;

▶ significantly expanding the support that innovative knowledge-intensive businesses can receive through the Enterprise Investment Scheme (EIS) and Venture Capital Trusts (VCTs) while introducing a test to reduce the scope for and redirect low risk



'We are determined to create in the government the most effective champion and partner of business in the world - an ambition which demands changes in organisation and practice.'

- ▶ investments, together unlocking over £7bn of new investment;
- ▶ seeding a series of private sector fund of funds of scale, with a first wave of investment of up to £500m, delivered through the British Business Bank, unlocking double this investment in private capital. Up to two further waves will be launched, attracting a total of up to £4bn of investment;
- ▶ backing first-time and emerging fund managers through the British Business Bank's established Enterprise Capital Fund programme, supporting at least £1.5bn of new investment; and
- ▶ backing overseas investment in UK venture capital, expected to drive £1bn of investment.

We will also support long-term investment by:

- ▶ giving pension funds confidence that they can invest in assets supporting innovative businesses as part of a diverse portfolio. With over £2tn in UK pension funds, small changes in investment have the potential to transform the supply of capital to innovative businesses;
- ▶ changing the qualifying rules in Entrepreneurs' Relief to remove the disincentive to accept external investment and consulting on the detailed implementation of that change;
- ▶ launching a National Security Strategic Investment Fund of up to £85m to invest in advanced technologies that contribute to our

national security missions; and

- ▶ continuing to work with industry and regulators to introduce better and more transparent reporting by listed businesses on how their capital allocation decisions affect their productivity and by promoting more long-term investor stewardship. We will also take forward commitments announced recently following our Corporate Governance Reform Green Paper, including measures to better align executive pay with long-term company performance

And we will promote investment in all parts of the country by:

- ▶ launching a commercial investment programme run by the British Business Bank to support developing clusters of business angels outside London;
- ▶ identifying ways to tackle barriers faced by female-led businesses in accessing venture capital through new behavioural research commissioned by the British Business Bank; and
- ▶ rolling out a network of British Business Bank regional managers by autumn 2018 to ensure businesses across the UK know how to access sources of investment. The network will cover England, Scotland, Wales and Northern Ireland, with managers responding to a region's particular needs and acting as convenors to improve collaboration, sharing of expertise and the creation of networks of private and public partners.

We will also support businesses to get access to debt finance by extending the British Business Bank's Enterprise Finance Guarantee to March 2022 and expanding the programme to support up to £500m of loans a year. We will also work with businesses, lenders, insurers, the British Business Bank and the Intellectual Property Office to overcome the barriers facing high growth, intellectual property-rich businesses.

£20bn

investment into high growth, innovative businesses over ten years

£2.5bn

investment fund to be incubated in the British Business Bank

To increase the diffusion of best practice so that small and medium-sized enterprises (SMEs) have the tools to become more productive, we will:

- ▶ trial innovative approaches to driving up the adoption of modern business practices. Through the new Business Basics Programme, we will work closely with Innovate UK, Be the Business, and local areas, including mayors, leading businesses and trade associations, to test and encourage SMEs to adopt technologies and practices such as new accountancy software or performance management systems. We will work with Be the Business to explore improving productivity through enhancing management practices and improving skills. This will build on their research capability and dissemination of evidence.



'We will promote investment in all parts of the country by launching a commercial investment programme run by the British Business Bank to support developing clusters outside London.'

Case Study: The Productivity Leadership Group and Be the Business

In July 2015 some of Britain's most senior business leaders came together to form the Productivity Leadership Group (PLG). Their aim was to identify practical steps to raise productivity among British businesses. At Autumn Statement 2016, the government announced up to £13m funding over three years to support the group's work, which focuses on improving productivity through the diffusion of best practice - including management practices and technology.

In July 2017, PLG launched the 'Be the Business' campaign. This aims to help businesses across the UK benchmark their current level of productivity, access best practice advice and improve through structured management training.

Alongside this, the PLG has also developed a pioneering programme, Productivity through People. Through this, large businesses (such as BAE Systems, GlaxoSmithKline, John Lewis Partnership, Rolls-Royce and Siemens) reach out to SMEs in their supply chain, inviting them to a 12-month co-funded development programme. This is driven by business schools in the region and aims to improve SME skills to boost their productivity. Productivity through People will be scaled across a number of regions over the next year.

To learn more about Be the Business, see: www.bethebusiness.com

► ensure all businesses have access to a local Growth Hub. Over the last three years, we have established and tested Growth Hubs in every Local Enterprise Partnership area in England. We will build on this programme, providing continued funding to enable Growth Hubs to bring public and private sector partners together, such as UK Research and Innovation, the British Business Bank, Tech Nation, investors and universities. We want Growth Hubs to carry on building their reach, developing peer-to-peer networks,

connecting businesses to the best support available from the private and public sectors. We will also work with Local Enterprise Partnerships, Growth Hubs, universities and the private sector to support high potential businesses to scale up.

We will launch a review of what actions could be most effective in improving productivity and growth of SMEs, including how to address what has been called 'long tail' of lower productivity firms. This will include reviewing the

evidence and evaluating the role of digital services, data and information in the take up of effective business advice and support services. We will announce the policies we intend to take forward following this review in Autumn 2018.

We will also work with partners to pilot and evaluate the role that customer feedback and online ratings marketplaces could play in making it easier for SMEs to assess the quality of advice. This will start in the first half of 2018.

Manufacturing is crucial to the economy, providing 10 per cent of the UK's GVA¹⁸⁷, generating around 50 per cent of our exports¹⁸⁸ and accounting for 70 per cent of business-led R&D¹⁸⁹. However, advanced manufacturing supply chains are highly complex, with components sometimes crossing borders several times. Our departure from the EU, and any resulting trade arrangements, will create challenges and opportunities for the supply chain and many firms are recognising the benefits of local supply chains.

To boost our supply chains, secure internationally mobile investment and anchor high

value manufacturing in the UK we will:

- ▶ launch a new Supply Chain Competitiveness programme that will target areas where key businesses need to improve to match the best in Europe and beyond, supporting training and enhanced business processes.
- ▶ encourage industry leaders and the best performing sectors to improve further by adopting best practice as exemplified by the automotive sector. The automotive sector intends to commit to increasing local content to 50 per cent by 2022, from 44 per cent, as part of their proposed Automotive Sector Deal.

We will support businesses to access international markets, driving up exports by:

- ▶ working with business to undertake a review of export strategy, reporting in spring 2018. The review, as well as the GREAT Britain campaign, will ensure the government has the right financial, practical and promotional support in place for new and existing exporters to sell overseas. The review will convene expertise from across



'The automotive sector intends to commit to increasing local content from 44 per cent to 50 per cent by 2022, as part of their proposed Automotive Sector Deal.'

- ▶ government and the private sector, including:
 - better support for medium and larger businesses to access new markets and export more;
 - identifying smaller businesses with the potential to succeed and grow as exporters;
 - better signposting to online and local sources of information, and access to finance;
 - working with the private sector to ensure all businesses receive high quality export advice; and
 - strengthening government-to-government relationships to realise new export opportunities.
- ▶ establishing a network of nine UK Trade Commissioners, each developing a regional trade plan covering export promotion, investment and trade policy;
- ▶ building on the new UK Export Finance (UKEF) initiatives, which work with partner banks to help businesses fulfil overseas contracts. UKEF will introduce a new guarantee to banks designed to increase liquidity in the supply chain. This will improve exporters' access to capital and enable their suppliers to fulfil new orders. UKEF will also launch a targeted campaign to promote the support they offer to exporters and overseas buyers, as part of the wider GREAT campaign;
- ▶ bringing together businesses of all sizes to bid for global infrastructure contracts as a single 'Team UK' consortium, with the potential for support from UK Export Finance and through supply chain fairs. We are considering other ways to support British consortia, including expanding the approach to other sectors;

The Impact of Greater Manchester Business Growth Hub

Since 2011,
Business Growth Hub has...



Built a network of over
34,000 businesses



Offered intensive, face-
to-face support to over
8,600 businesses

...and since 2013 it has achieved
the following outcomes across its
ten Local Authorities:



17,052 jobs



**1,254 start-up
loans**



**£267m boost to
the local economy**

Case Study: Monster Group (UK) - A High Growth business and graduate of Goldman Sachs 10,000 Small Businesses UK programme

Established in 2007, Monster Group (UK) is an online retailer based in York, selling a wide range of products from popcorn makers to shelving units. Through Goldman Sachs 10,000 Small Businesses UK, CEO Rana Harvey re-evaluated the business' processes and strategy. By applying tools learned on the programme, she reduced her order processing time from 29 minutes to less than two minutes. As part of the revitalised strategy, Rana rebranded her business from 'Dazzling Dummies' to 'Monster Group (UK)', embracing a more diverse product range.

Since Rana graduated from Goldman Sachs 10,000 Small Businesses UK in 2012, the businesses' revenues increased by over 330 per cent. In

November 2015, Rana purchased a 90,000 square foot warehouse in North Lincolnshire to run alongside her premises in York, allowing her to drastically increase the business' product offerings. She also set up a research and R&D centre in York, resulting in more efficient product development and increasing the company's competitiveness in the market.

Reflecting on her experience, Rana said, "I had never dreamed of developing an R&D site before I started on the 10,000 Small Businesses programme - I was focused on driving international sales. The strategy and operations management modules changed all of that".



'[We will establish] a network of nine UK Trade Commissioners, each developing a regional trade plan covering export promotion, investment and trade policy.'



We will support businesses to access international markets, drive up exports and improve productivity Image: Port of Felixstowe

▶ piloting intensive export growth support for potential scale-ups and particularly ambitious medium sized businesses. This includes co-investment to access commercial export support services, with each eligible business offered a grant on a 50:50 match funded basis. We will work with Local Enterprise Partnership Growth Hubs to ensure joined up and easily accessible export and business growth advice;

▶ continuing to develop the [great.gov.uk](https://www.great.gov.uk) platform ensuring it meets the needs of more UK businesses. The platform already provides export opportunities, connections and overseas buyers, onboarding onto e-commerce websites and attracts inward investors.

And we will help UK businesses to grow internationally through investing overseas. The government is evaluating through pilots a suite of products and services to support businesses investing internationally, both through market entry and expansions.

Already, UKEF has launched an updated Overseas Investment Insurance product which can help to manage risk for UK businesses.

As discussed above, **our competition, legal and regulatory frameworks are fundamental to our economic success.** We have a reputation for a world-leading competition regime and our consumer protection framework encourages engaged, active consumers who drive high standards. We will build on this reputation, including by:

- ▶ providing the Competition and Markets Authority (CMA) with an extra £2.8m a year, so it can take on more cases against businesses that are acting unfairly, and will allow the CMA to use more of the fines it collects to meet the legal costs of defending its decisions. The government will ensure the UK has the effective competition system it needs after the UK has left the EU;
- ▶ encouraging the CMA to identify, prioritise and tackle inadequate competition in low-productivity sectors that have an important impact on growth;
- ▶ publishing a review of the existing competition regime by April 2019, to make sure it is working as effectively as it can to support an enterprise economy; and;
- ▶ publishing a Consumer Green Paper that tackles areas where markets are not working for consumers and businesses



'We will pilot intensive export growth support for potential scale-ups and particularly ambitious medium sized businesses.'

Strengthening partnerships with industry: The Food and Drink Sector

The UK has a thriving, world-renowned food and drink sector, with products in demand across the globe, from Scotch Whisky to cheese, confectionery and premium seafood. The sector plays a key part in all local economies and devolved nations. It is the largest manufacturing sector in the UK and the wider food chain contributes £112bn GVA and employs one in eight people across the UK. The enduring strength of the sector is built on strong agricultural and manufacturing foundations. The sector is at the cutting edge of innovation and world class science from new technologies that raise agricultural productivity and resilience while reducing environmental impact, to innovation that prolongs shelf life, helping to reduce food waste.

The opportunities - and challenges for food and drink raised by exiting the EU are significant. To address this, we are committing to establishing a new partnership between government and the whole food chain, working with industry leaders from agriculture, food and drink manufacturing, retail, hospitality and logistics. This new Food and Drink Sector Council will lead the work to secure the UK's position as a global leader in sustainable, affordable, safe and high-quality food and drink. An early task for this sector council will be to build on emerging proposals for a sector deal in food and drink manufacturing, including support to transform exports and capitalise on its unique innovation opportunities in sustainable agriculture and food manufacturing.

We must also make sure that regulation is as simple as possible for businesses. In England, we will continue to support businesses to comply with regulation at a local level. All businesses choosing to set up a Primary Authority partnership will have access to assured advice, with support from Growth Hubs. We will support Local Enterprise Partnerships in translating and co-ordinating regulatory frameworks that focus on local business needs, simplifying the way regulation is delivered.

To ensure a fair landscape for business, we will go further on reforming business rates. On top of the major reforms to business rates announced at Budget 2016, worth approximately £9bn by the end of this Parliament, we will improve the fairness of the system and provide a further £2.3bn of support to businesses over the next five years.



The UK has a thriving, world-renowned food and drink sector with products such as Scotch Whisky, in demand around the globe

This additional support includes bringing forward to 1 April 2018 the planned switch in indexation from RPI to CPI and legislating retrospectively to address the so-called 'staircase tax'.

Recognising the importance many consumers and workers place on the social contribution of businesses, we have also established the Inclusive Economy Partnership to address some of the biggest challenges that face our society, encouraging collaborations between business and civil society, enhancing the UK's reputation as a global hub for social investment.

We will also **take significant steps to advance the role of government** and address the points raised in the Green Paper consultation.

We will:

- ▶ make it easier for businesses to get the information they need online by improving the way the government provides key information and support to business, alongside continued investment in the national Business Support Helpline; and
- ▶ make the government more streamlined, responsive and focused on delivering the highest value deals. To assist this, we will expand our existing account management approach, including the Strategic Relationship Management programme to offer a single point of contact, coordinating HMG support, to a broader range of companies.

We will **attract investments from multinational and foreign businesses** and make the most of the opportunity this presents not only to create thousands of well paid jobs across the UK, but to drive up skills, increase investment in R&D and stimulate new technologies and ways of working. These companies drive up both their own productivity and wider domestic supply chains. We will:

- ▶ build on our recent successes and learn from international peers. We will work to target and support businesses to base high value investments and operations in the UK, particularly as we leave the European Union;
- ▶ work with local partners to target investments with the greatest economic potential. We will identify what support is needed to attract these companies, improving the ease, cost, speed and ultimately the value of bringing investment to the UK. We will change our primary measure of performance from the total number of projects coming to the UK, commonly used in international indices, to focus on delivering projects that offer the UK the greatest economic impact;

- ▶ look to increase the level of R&D and innovation projects and high paid jobs coming to the UK. Of the world's 2,500 top R&D investors, just 50 companies are responsible for 40 per cent of private sector investment globally¹⁹⁰. We will work with our leading universities, research institutes and UK Research and Innovation to increase the proportion of R&D activity in these leading companies that takes place in the UK. UK-based R&D would increase by around a third if we attracted an additional five per cent of funding from the world's top 50 R&D investors;
- ▶ we will also increase the rate of R&D tax credits for large firms (R&D Expenditure Credit) from 11 per cent to 12 per cent from 1 January 2018 and provide businesses with the confidence to make R&D investment decisions through a new Advanced Clearance Service for R&D credit claims; and
- ▶ we will explore how best to support multinational firms in locating their global and European headquarters in the UK, if it can be demonstrated that locating their headquarters here would create the positive economic impact we would look for in all investments.



'We will attract investments [from abroad] and make the most of the opportunity this presents... to drive up skills, increase investment in R&D and stimulate new technologies and ways of working.'



Rolls Royce Trent XWB engine production in Derby

Sector Deals

Partnerships between the government and industry on sector-specific issues can create significant opportunities to boost productivity, employment, innovation and skills.

We know that these partnerships can work - from our experience of decade-long partnerships such as the Auto Council and the Office for Life Sciences to more recent collaborations including tourism, creative industries, space and professional and business services.

In our Green Paper we suggested that we could build on this successful model of collaborative working, where specific sectors could come together under clear leadership and make a compelling case to negotiate a Sector Deal with the government to boost the earning power and productivity of that sector.

The response to our suggestion of Sector Deals has been emphatic, not only in endorsing the concept but in generating a wide range of proposals. Of course there is no requirement for any sector to have a deal and no deadline for concluding one but in recent months we have begun negotiations with some sectors about potential deals. These discussions have reinforced the enormous potential of

the model, with some already showing tangible results.

Four of these discussions have concluded successfully with transformative Sector Deals. We are announcing Sector Deals with life sciences, construction, artificial intelligence and the automotive sector, with the creative industries, industrial digitalisation and a number of other sectors in advanced discussions.

Building on success: our partnership with the aerospace sector

The UK government is backing the aerospace sector and its strengths in productivity and innovation to secure a share of the growing global market. The Aerospace Growth Partnership (AGP), a strategic partnership between the government and industry, is focused on helping shape and influence a business environment that tackles barriers to growth, boosts exports and grows high value jobs for the UK aerospace sector.

In 2016, the government extended a funding

commitment to aerospace research and development and the Aerospace Technology Institute, providing a decade of certainty. This gives industry confidence to invest for the long term, bringing the total commitment to nearly £4bn by 2026¹⁹¹. Such government-sector partnership supports technological innovation, promotes competitiveness, and anchors key manufacturers such as Airbus, Rolls-Royce and GKN in the UK.



'The response to our suggestion of Sector Deals has been emphatic, not only in endorsing the concept but in generating a wide range of proposals.'

Life Sciences Sector Deal

The government and the life sciences sector have agreed to a transformative, multi-billion pound Sector Deal, ensuring that the UK remains at the forefront of innovation in this sector.

The Sector Deal will help ensure new pioneering treatments and medical technologies are produced in the UK, improving patient lives and driving economic growth. The deal involves substantial investment from private and charitable sectors and significant commitments in research and development from the government.

The life sciences sector is highly productive and export focused, generating £64bn of turnover and employing more than 233,000 scientists and staff¹⁹². The UK is home to world-leading businesses such as GSK and AstraZeneca, a strong small

and medium-sized business sector, major health charities such as the Wellcome Trust and Cancer Research UK, and the globally-admired NHS.

The Sector Deal builds on the Life Sciences Industrial Strategy, which Professor Sir John Bell led on behalf of the sector. Published in August 2017, it provided a vision where industry, the government, the NHS and charities can all contribute to make the UK an attractive location for businesses to invest and for patients to benefit. It is the first in a series of deals we intend to agree with the sector to realise this vision.



What is in the deal?

Reinforcing the UK Science offer

Following a long-term collaboration, Novo Nordisk this year has invested £115m in a diabetes research innovation centre in Oxford. Other new investments will be announced as a result of this deal, including:

MSD is announcing its commitment to establish a state of the art life sciences discovery research facility in the UK, focused on early bioscience discovery and entrepreneurial innovation. The new UK Discovery Centre is anticipated to accommodate 950 staff.

QIAGEN, a leading provider of molecular testing solutions that enable valuable insights to be gained from any biological sample, will partner with Health Innovation Manchester to develop a genomics and diagnostics campus. This will attract companies from across the world to the north west of England. QIAGEN also plans to expand its existing operations in Manchester and this, alongside the genomics campus, has the potential to create 800 skilled jobs.

Health Advanced Research Programme

The Health Advanced Research Programme (HARP) is an ambitious shared endeavour, with the aim of finding solutions to the major healthcare challenges of the next 20 years while also creating new UK industries; it is one that all parties, in particular charities, are committed to developing further in the coming months and years to realise fully its potential. This deal contains significant concrete commitments that will lay the foundations of the Life Sciences Industrial Strategy's vision for HARP, including investment from the Industrial Strategy Challenge fund into an early diagnostics challenge.

Manufacturing

The deal is committed to growing life sciences manufacturing which, as a major source of exports, makes a significant contribution to the UK economy.



'The Life Sciences sector is highly productive and export focused, generating £64 billion of turnover and employing more than 223,000 scientists and staff.'

Data

In response to the Life Sciences Industrial Strategy, the government will be working to develop a number of regional Digital Innovation Hubs that support the use of data for research purposes within the legal framework and meet the strict parameters for sharing data and the security standards set out by the National Data Guardian. They will create controlled environments for real-world clinical studies, the application of novel clinical trial methodology, and the comprehensive evaluation of new innovations so that patients can benefit from scientific breakthroughs much faster. NHS England, NHS Digital and Health Data Research UK will lead the delivery of this programme, drawing

on input from multiple stakeholders including the academic sector, the life sciences industry, the charity sector and patients.

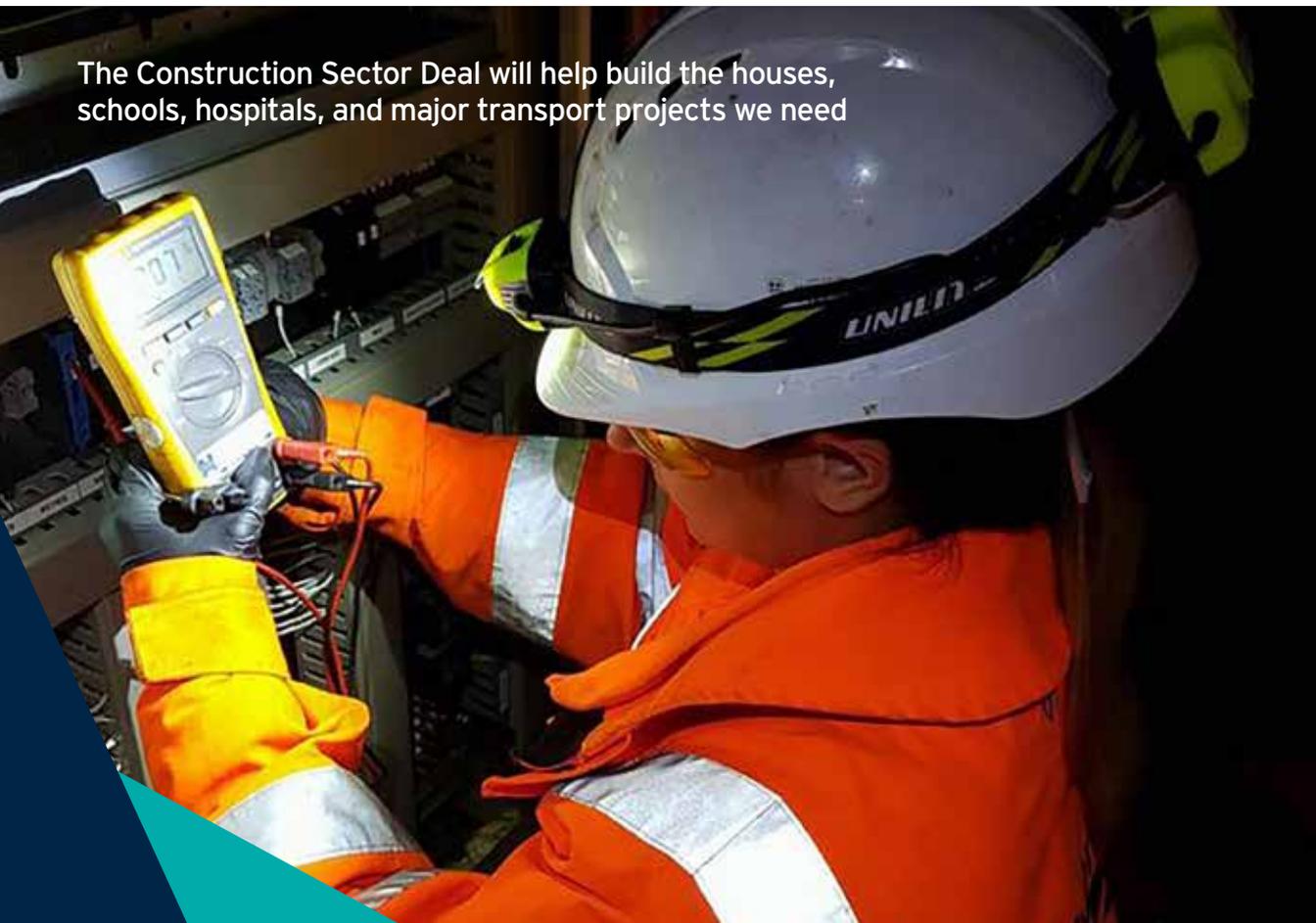
NHS Collaboration

This deal restates the commitment by the government for the NHS and industry to collaborate closely, an invaluable feature of the UK life sciences landscape.

Skills

The government is committed to giving UK businesses the workforce they need to flourish while reinforcing the employer-led principles of the recent reforms to technical education.

The Construction Sector Deal will help build the houses, schools, hospitals, and major transport projects we need



Infrastructure and Clusters

This deal is committed to helping life sciences clusters flourish, such as the Oxford-Milton Keynes-Cambridge corridor where the government is investing in housing and infrastructure

projects. Further regional approaches, including in the north of England via the Northern Health Science Alliance, are expected for further phases of the deal.

Construction Sector Deal

The government and the construction sector, through the Construction Leadership Council and with the leadership of Andrew Wolstenholme, have agreed a Sector Deal to transform the productivity of the sector benefiting the wider economy.

Construction is one of the largest sectors in the UK economy - with a turnover of £370bn¹⁹⁴, contributing £138bn in value added to the UK economy¹⁹⁵ and employing 3.1 million people (9 per cent of the total UK workforce)¹⁹⁶. The deal will substantially boost the sector's productivity, through greater investment in innovation and skills, creating new and well-paid jobs and maximising its export potential. This will also reduce the environmental impact, improve the efficiency and reduce whole life cost of new projects and buildings to help build the houses, schools, hospitals and major transport projects we need.

What is in the deal?

The deal, the first of a series we intend to negotiate with the construction sector, contains commitments to work collaboratively in three key areas:

Procuring for Value

In the months ahead the sector and the government will work to ensure construction projects across the public and private sectors are procured and built based on their whole life value, rather than just initial capital cost. The sector will aim to develop a procurement standard and work with the Infrastructure and Projects Authority to develop cost and



'Construction is one of the largest sectors in the economy - with a turnover of £370bn, and employing 3.1 million people.'

performance benchmarks for assets and contractors and monitor outcomes including increased housing capacity, productivity and pre-manufactured value among other initiatives.

Industry-led Innovation

A joint commitment to invest in a transformative programme which brings together the construction, digital technology, manufacturing, materials and energy sectors to develop and commercialise digital and offsite manufacturing technologies. This will accelerate change in the infrastructure and construction sector, ensuring new technologies that can help deliver the government's planned investments in infrastructure and our 2015 commitment to deliver a million homes by the end of 2020 and half a

million more by the end of 2022 are commercialised as quickly as possible.

Skills for the Future

The construction sector, with support from the government, will work closely in the coming months to drive increased investment in skills development, whilst adopting a more strategic and co-ordinated approach to recruitment, and equipping workers with the skills that they will need for the future. This will be achieved through a joint commitment to implement reforms to the Construction Industry Training Board to make it more strategic and industry led, and to enable the sector to make best use of funding from the Apprenticeship Levy.



Artificial Intelligence Sector Deal

The government and the artificial intelligence (AI) sector have agreed a Sector Deal to boost the UK's global position as a leader in developing AI technologies.

Taking immediate, tangible actions to advance our AI and Data-Driven Economy Grand Challenge, this deal will anchor the UK as the go-to destination for AI innovation and investment.

AI's extraordinary potential is already well known: by one estimate it could add £232bn to the UK economy by 2030¹⁹⁷. The UK is a recognised world leader in developing AI: Deepmind, Babylon and Swiftkey - which was backed by Innovate UK - are all globally renowned companies founded here.

The Sector Deal builds on the review by Professor Dame Wendy Hall and Jérôme Pesenti, *Growing the artificial intelligence industry in the UK*, which involved an extensive range of business leaders, academics and research councils. The review made recommendations for both the government and industry, recognising the role that the government can play in creating the conditions to support emerging sectors to grow.

The deal will establish an enduring partnership between industry, academia and the government through the UK Artificial Intelligence Council, where all partners will work together to promote the safe, fair application of this technology. The deal contains mutual commitments to encourage the responsible sharing of data to develop new value, and to ensure that the UK produces and retains the best global talent.

What is in the deal?

Realising the Potential of Data

The deal recognises the critical importance of data availability, and its responsible use, to businesses at the forefront of the development of AI applications. The government and industry will work together to establish data trusts, an innovative approach to stimulating fair, safe and equitable data sharing between parties.



'[The AI Sector Deal] will anchor the UK as the go-to destination for AI innovation and investment.'

A Skilled and Diverse Workforce

To be global leaders in the application of AI, companies must attract the talent they need. We are committed to working together to build and maintain the best AI workforce in Europe, focusing on post graduate level skills and above. We will invest £45m to support additional PhDs in AI and related disciplines, create a prestigious artificial intelligence fellowship programme and work together to develop an industry-funded masters programme.

Coordination and Uptake

For the economy to realise the benefits of AI, the sector and the government will coordinate action on solutions to shared challenges and opportunities through an AI Council, a new government Office for Artificial Intelligence, an expansion of Tech City UK to become Tech Nation and a new GovTech Fund.

Nissan Juke production line in Sunderland



Automotive Sector Deal

This Sector Deal builds on the government's long-standing partnership with the UK automotive sector.

It ensures that the UK continues to reap the benefits from the transition to ultra-low and zero emission vehicles by continuing to build the agile, innovative and cost competitive supply chain needed to secure internationally mobile investment and anchor high value manufacturing in the UK.

The UK automotive sector is a great success story. We are the third largest European car producer and have the highest productivity in Europe among major automotive producing nations¹⁹⁸. The sector employs 159,000 people directly in vehicle manufacturing, with an additional 238,000 in the supply chain¹⁹⁹, providing highly skilled, well paid jobs and increasing prosperity across the country.

Tighter environmental regulation and shifts in consumer demand are changing how cars are powered, while technology is changing how they are

driven. The result is cleaner, safer and less congested journeys. This Sector Deal ensures the UK is at the cutting edge of these innovations through the Faraday Battery Challenge and accelerating the development of a world-leading connected and autonomous vehicle facilities. Increasing the productivity and competitiveness of UK suppliers, especially as new value chains emerge, is central to the deal and an industry-led productivity improvement programme will be rolled out to target areas where UK suppliers need to improve to match the best in Europe.

What is in the deal?

The Sector Deal represents the next step in the partnership between the government and industry, building on what we have already achieved together and agreeing priorities to maximise opportunities in the transition to electric, connected and autonomous vehicles.



'We are the third largest European car producer and have the highest productivity in Europe amongst the major automotive producing nations.'

Electrification

The automotive sector is an area of genuine competitive advantage to the UK and the sector is perfectly placed to take advantage of emerging markets in ultra-low emission vehicles.

The government, through the Advanced Propulsion Centre, is already supporting the development of low carbon technologies that will form the basis of future vehicle supply chains. In order to maintain our position as a global leader, the government and the industry have set out specific actions to build on this work.

Connected & autonomous vehicles (CAV)

The UK has an opportunity to assert global leadership in the demonstration and deployment of CAV technologies, capitalising on our position as a global leader in research and development, and our competitive advantage of being able to test anywhere in the UK today.

Our support for CAV will be co-ordinated under the MERIDIAN hub, which will seek to convene UK industry around a set of long-term strategic priorities that require long-term investment to ensure we remain at the cutting edge of the industry.

Supply Chain

The transition to ultra-low emission and CAV presents an opportunity to maximise the economic benefits to the UK supply chain. The close partnership of the government and the industry has already led to significant improvements in the competitiveness of the UK supply chain in recent years, increasing the level of UK content in nationally produced vehicles from 36 per cent in 2011 to 44 per cent in 2016²⁰⁰.

Building on this, we are committing to rolling out an industry-led supplier improvement programme that will target areas where businesses need to improve to match the best in Europe. The programme will provide bespoke training and enhanced business processes to help build the vertically-integrated supply chain we need in the UK to manufacture the future generation of vehicles at volume. This will support the sectoral ambition to increase the level of UK content in nationally produced vehicles to 50 per cent by 2022.

Sector Deals in advanced discussions

The success of the Sector Deal approach is not just limited to the sectors where we have agreed deals; some of the most exciting business-led proposals have come from sectors where we are continuing our negotiations to meet their ambitions.

Creative Industries

The creative industries sector, which makes up over five per cent of the UK economy and employs more than two million people, is one of the fastest growing and contributes £87bn of GVA²⁰¹. Deal discussions are ongoing, building on the comprehensive review led by Sir Peter Bazalgette²⁰² which considered the needs of this diverse sector. The deal is subject to final agreement between the government and the sector, led in discussions by the Creative Industries Council with critical input from the Creative Industries Federation and others from across the sector, but significant progress has been made already across a wide range of potential areas for agreement in the coming weeks.

Innovation

Creative businesses are, by their very nature, innovators. In recognition of this, we have committed to transformative investment into pioneering immersive technologies like virtual reality and augmented reality through £33m government investment from the Industrial Strategy Challenge Fund. We are also aligning our support for the innovative strengths of the sector behind the Bazalgette Review's recommendations to build creative clusters across the UK - by funding eight research partnerships between universities and business clusters, match funded by investment from universities, regions and the businesses involved.



'The creative industries sector, which makes up over five per cent of the UK economy and employs more than two million people is one of the fastest growing, contributing £87bn.'

Creative Industries sector commitments

- ▶ Align private sector investment behind the Industrial Strategy Challenge Fund (ISCF) Immersive technologies programme.
- ▶ Collaborate in the Arts and Humanities Research Council

Creative Clusters competition, with significant private sector investment coming from the universities, regions and businesses involved.

Government commitments

- ▶ Invest in immersive technologies, such as virtual and augmented reality from the Industrial Strategy Challenge Fund, allowing creative businesses to develop the products, services and experiences of the future.
- ▶ Support eight research partnerships between creative businesses of all sizes and universities with significant commercial potential through the Arts and Humanities

Research Council Creative Clusters competition and investment.

- ▶ Establish a new national Creative Industries Policy and Evidence Centre to produce independent evidence to boost understanding of the creative industries, including how they are working together in clusters and across the wider economy.

Alongside the commitments to enhancing innovation in creative industries, the government is also making a number of other significant commitments to the sector to support our ongoing negotiations. These include committing to extend support to the UK Games Fund to 2020, a proven approach to mentoring and developing the games developers of the future and our recent commitment to increase the number of available Tier

1 (Exceptional Talent) visas for non-EEA migrants, which will also support the creative industries to continue to attract the best and brightest talent.

Ongoing areas for negotiation

Ongoing discussions with a view to agreeing a deal are focusing on how the government and sector can lift productivity and the growth of creative clusters further, such as by linking high-growth potential creative

businesses with investment opportunities in businesses with intellectual property. A further priority is exploring action to address access to the right finance so creative businesses can scale up where demand is not always met by supply, because of well-recognised market failures, reflecting that creative businesses deal in intangibles. Given the sector's reliance on intellectual property, the government and industry are discussing further joint action to strengthen the copyright framework.

Other areas featuring strongly in negotiations are how the government and industry can work together to shape a creative industries-focused trade strategy to significantly

increase exports and to ensure the talent pipeline creative businesses require is in place. We are currently in consultation with the industry to define a three-year target for export growth plus we are discussing a range of measures to attract, develop, and retain the talent it needs, including an industry-led careers strategy. We will also explore opportunities to work with the Institute for Apprenticeships to prioritise apprenticeship standards development for the creative industries in areas where they are experiencing skills gaps and shortages. We expect the Institute for Apprenticeships to prioritise the development of standards in sectors which are priorities for the Industrial Strategy.

Industrial Digitalisation and the Made Smarter Review

The UK manufacturing sector makes a significant contribution to the UK economy (£177bn GVA in 2016)²⁰³. Manufacturing accounts for over 50 per cent of UK exports²⁰⁴ and over 70 per cent of R&D²⁰⁵. The productivity of the sector has increased four times

faster than the rest of the economy²⁰⁶. But with the potential for growth and to build on the strength of our exports, the UK must not be complacent; digital technology presents the sector with a huge opportunity to increase productivity and growth as well as create new markets.



'Manufacturing accounts for around 50 per cent of UK exports and 70 per cent of R&D. The productivity of the sector has increased four times faster than the rest of the economy.'

The application of digital technologies, such as artificial intelligence and robotics, data analytics and additive manufacturing have already made transformational improvements to productivity where businesses have exploited their potential, but the opportunity exists to go further.

The visionary and ambitious industry-led *Made Smarter* review²⁰⁷ into industrial digitalisation, led by Professor Juergen Maier, Chief Executive of Siemens UK, sets out the significant opportunities to be gained by the development and adoption of these technologies across all UK manufacturing sectors. The Review projects a substantial increase in growth over the next decade complemented by a reduction of CO2 emissions and an increase in skilled jobs throughout the economy by capitalising on industrial digitalisation.

The recommendations in the review emphasise how a strong partnership between manufacturing businesses and the government and a focus on

leadership, adoption and innovation of digital technologies, can make the UK a global leader in driving forward the fourth industrial revolution. The Review describes how existing business support systems can be effectively co-ordinated and how people across the country can access the training they need to take advantage of the skilled jobs that this transformation will generate.

On-going discussions between industry and the government on a Sector Deal are focused on how the ambitions set out in *Made Smarter* can be realised. We are discussing how we can build on existing pilot activities, align programmes in areas such as skills and R&D and coordinate of institutions, such as Catapults and research bodies to help realise the opportunities *Made Smarter* highlights for manufacturing across the UK.

Nuclear

The nuclear sector is integral to increasing productivity and driving growth across the country. Nuclear is a vital part of our energy mix, providing low carbon power now and into the future. The safe and efficient decommissioning of our nuclear legacy is an area of world-leading expertise. The nuclear sector, under the leadership of Lord Hutton, is in advanced discussions with the government on a range

of ambitious proposals to increase competitiveness and achieve greater value at both national and regional levels.

Industry-led proposals for a Nuclear Sector Deal focus on how, working with the government, substantial cost reductions can be achieved across the UK's new build and decommissioning programmes. There are shared interests in improving productivity and the

opportunities to improve the UK's competitiveness, domestic capability and export growth. The sector's proposals cover the supply chain, nuclear R&D and skills, where the aim of the deal is to help deliver the diverse

workforce needed for the future, supporting a potential 100,000 jobs from Cumbria, north Wales, Somerset, Essex and Suffolk²⁰⁸.

Further details of our ongoing discussions will be announced in the coming weeks.

Working with other sectors

Since the publication of our Green Paper, a large number of industries have signalled their interest in a Sector Deal and we have been working with many of them in recent months. Some of these have been particularly impressive in their level of ambition and innovation, but Sector Deals are not required for every sector. To aid the development of any further proposals, sectors should articulate how they meet the criteria set out on the next page.

A key expectation of these criteria is that any proposals align with our Industrial Strategy, including how they might demonstrate the commitment from certain sectors of the economy to meeting the Grand Challenges we have set out in this document. We will be speaking to all those sectors who have submitted expressions of interest over the months ahead and will be announcing that we intend to proceed with some further Sector Deal discussions in the New Year.



'Nuclear is a vital part of our energy mix, providing low carbon power now and into the future. The safe and efficient decommissioning of our nuclear legacy is an area of world-leading expertise.'

Questions sectors should ask themselves as they develop their deal proposals

Is there clear leadership from the sector?

We have asked for deals to be proposed by an identifiable leader who can bring together an appropriately broad representation of the sector. A key part of that leadership will be in ensuring appropriate and proportionate arrangements to implement the

commitments in the deal. The sector's leader or deal champion should generally be a single individual with sufficient authority in the industry to negotiate a deal's content directly with government ministers with the full backing of the sector they represent.

Does the Sector Deal represent the breadth of the sector?

A Sector Deal cannot be restricted to incumbents; it must show how it will bring in new entrants and challengers. Not every business and relevant stakeholder needs to be represented in the deal, and the most ambitious businesses should not be held back by a lack of engagement from the less ambitious, but proposals should evidence how a broad range of businesses have been involved. This is likely to mean involving more businesses than are necessarily members of a relevant trade body.

We would also expect, where relevant, local authorities, Local Enterprise Partnerships, Prosperity Boards, development agencies (such as Scottish Enterprise), other local business membership organisations and universities to be involved where they have an interest in furthering the success of a particular sector.

Does the proposal include a rigorous analysis of the comparative strengths and weaknesses of the sector?

Any proposals from a sector should clearly set out a sector's comparative strengths and weaknesses and its importance to the UK economy, drawing on a broad and rigorous evidence base. Sectors should make reference to any overarching analysis that help make the case for a sector-specific initiative, for example:

- ▶ quantitative studies of the sector including its contribution to UK GDP, productivity per head, earnings per worker, jobs, exports, or level of investment;
- ▶ qualitative evidence of the strengths and weaknesses of the sector including its reputation domestically and globally;
- ▶ key international competitor markets and how the UK differentiates itself; and
- ▶ the position and importance of the sector alongside other industries in its supply chain



'A Sector Deal cannot be restricted to incumbents: it must show how it will bring in new entrants and challengers.'

Will the specific proposals have an impact on productivity, earning power or the availability of good work?

Deal proposals should have a demonstrable and analytically rigorous impact on the productivity and earning power of the sector.

- ▶ We expect credible analysis of the impact of any proposals to accompany each specific proposal showing expected increase in GVA, employment or increases in skilled workers, exports or specific investments (including foreign direct investment) resulting from the deal. Tangible commitments are likely to be the most convincing.
- ▶ Where proposals have a strong link to local economies in particular parts of the UK, we would expect any analysis about their impact to be backed

and informed by the areas themselves and consistent with any local economic development strategies (engagement with local government, local economic development bodies and local membership organisations may help to provide the analysis to demonstrate the impact on particular places).

- ▶ We would expect that any proposals clearly demonstrate how a potential deal might positively impact on small- and medium-sized enterprises.
- ▶ We would expect proposals to demonstrate where they will lead to specific investments from industry.

Can the specific proposals be delivered?

Sector Deal proposals need to be realistic and achievable. We are looking for evidence that industry commitments can be delivered and that clear governance arrangements will be set up. Any arrangements should be proportionate to the scale of ambition of the deal itself and designed to ensure commitments will endure. To be credible, deal proposals should include specific delivery plans covering each component of the proposal.

On the government's side we are committed to having an honest conversation with sectors about what we can deliver. While avoiding prescription, there are some guiding principles:

- ▶ Parliamentary time is at a premium so proposals that require legislation are likely to prove more challenging than those that do not;

- ▶ we will consider reprioritising existing sources of government funding if there is a solid evidence base but there is no new government funding available for Sector Deals; and
- ▶ proposals that advocate making changes to government policy where substantial reform is underway will need to be particularly compelling in their impact.

Is there a clear offer from the sector?

We will expect Sector Deals to include detailed proposals on how they can contribute to the success of the sector, the objectives of the Industrial Strategy (boosting earning power, productivity and investment), the Grand Challenges we set out in this strategy and other national objectives.

These are deals - just as each sector will have views about what they can offer and what

would be most valuable from policymakers, the government will, naturally, have a collective view on what we can offer and expect in return. There will be other government expectations of the commitments industry should be making in a deal which might include evidence on how the sector will help deliver against other stated national objectives.



'We will expect Sector Deals to include detailed proposals on how they can contribute to the success of the sector, the objectives of the Industrial Strategy, the Grand Challenges and other national objectives.'

(creating new ways for citizens to engage with public services, as identified in the Digital Strategy, and including the use of Blockchain and AI technologies) and quantum technologies. There will be an evidence-based long-term pipeline, subject to consultation with the Prime Minister's Council on Science and Technology;

- ▶ undertake Sector Deals with emerging and disruptive industries where there is a compelling case to do so, beginning with artificial intelligence. The collaboration with government will drive growth in new sectors such as robotics and autonomous systems (including drones) and educational technologies (edtech) - where we are investing £30m to test the use of innovative edtech and artificial intelligence in online digital skills courses. The government will use its convening power to bring together entrepreneurs and experts to explore Sector Deals with other future sectors following the outcome of the future sectors reviews (above);
- ▶ launch the Industrial Strategy Challenges using emerging technologies to promote future sectors. This includes our £93m commitment to fund challenges for the use of robotics in hazardous environments, £20m for AI to create next generation services, and £20m to invest in the industrialisation of quantum technologies;
- ▶ work with businesses to inform development of an agile approach to regulation that promotes and supports innovation, growth of new sectors and the requirements of innovative market entrants - while ensuring effective protections for citizens and the environment. We will also strengthen our horizon scanning, including through a new Ministerial Working Group on Future Regulation and support the new £10m Regulators' Pioneer Fund, this will help regulators to develop innovative approaches aimed at getting new products and services to market; and
- ▶ work with the British Business Bank to ensure businesses in future sectors are given every chance to access finance, grow and thrive.



'New and innovative businesses drive earning power across the economy... We will establish a new Future Sectors team that will lead work across sectors that are developing and using the technologies and business models of the future.'

Places





Places

To have prosperous communities throughout the UK.

The United Kingdom has a rich heritage with world-leading businesses located around the country. Our cities, towns and rural areas have competitive advantages that will be essential to shaping our economic future.

Yet many places are not realising their full potential. The UK has greater disparities in regional productivity than other European countries²⁰⁹. This affects people in their pay, their work opportunities and their life chances.

Every region in the UK has a role to play in boosting the national economy. We will build on the strong foundations of our city, growth and devolution deals and continue to work in partnership with local leaders to drive productivity. We will introduce Local Industrial Strategies and further strengthen local leadership through Local Enterprise Partnerships and Mayoral Combined Authorities.

We will also introduce new policies to improve skills in all parts of the country, create more connected infrastructure, back innovation strengths, ensure land is available for housing growth, and strengthen our cultural assets.

We are working with our partners in the devolved administrations to deliver ambitious plans for communities across Scotland, Wales and Northern Ireland.

We will also continue to build the Northern Powerhouse and Midlands Engine to help create prosperous communities throughout the UK.

Key policies include:

- ▶ Agree Local Industrial Strategies that build on local strengths and deliver on economic opportunities
- ▶ Create a new Transforming Cities fund that will provide £1.7bn for intra-city transport. This will fund projects that drive productivity by improving connections within city regions
- ▶ Provide £42m to pilot a Teacher Development Premium. This will test the impact of a £1000 budget for high-quality professional development for teachers working in areas that have fallen behind

The Industrial Strategy provides a national policy framework against which major public and private investments can be made with confidence. It is grounded in sound fiscal policy alongside our future approach to ideas, people, infrastructure and the business environment.

Yet economic growth does not exist in the abstract. It happens in particular places. Cities, towns and rural areas have distinctive comparative advantages. Our national framework will only be effective if it reflects and makes the most of these economic opportunities and challenges.

Strong local economies around the world tend to have some key attributes. They have a good supply of skilled labour; they are well connected and have land available for homes, offices and factories; and they have rich innovation ecosystems, often built around a university. They have an attractive cultural environment²¹⁰.

We recognise that different policies will be needed for different places. In some areas the constraining issue may be housing or land supply; in other parts of the country it may be poor transport connections or skills shortages. Policies should therefore match local needs.

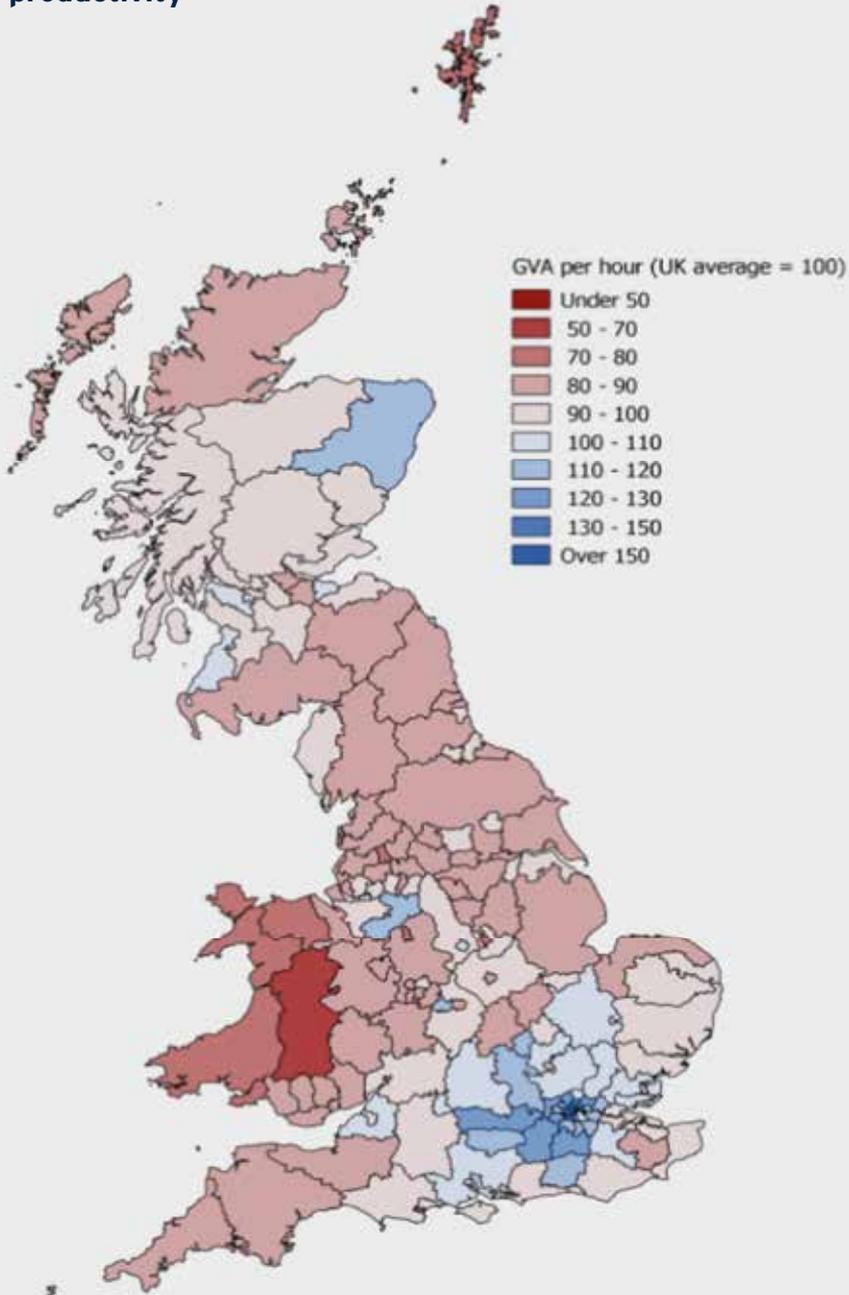
Such an approach is essential because the United Kingdom has greater disparities in regional productivity than in other European countries²¹¹. However we are confident that all our cities, towns and rural areas in the UK can increase their prosperity if they have the right policies and approach.



'Our cities, towns and rural areas have competitive advantages that will be essential to shaping our economic future.'

Variation in performance across regions

Regional productivity



Source: ONS (2017) "Subregional Productivity: Labour Productivity."
Ordnance Survey Data © Crown Copyright 2017*NUTS3 statistical region classification

Large regional cities in many other European countries tend to be motors of growth of the regional and national economy. Economists identify this as a consequence of agglomeration - bringing together labour, suppliers and consumers into bigger markets - and a major driver of productivity. Yet most English cities outside London have not enjoyed the higher productivity seen in similar communities across Europe. This presents an opportunity to make better use of local assets.

Places across the country have strong and distinctive commercial and industrial legacies. These economic successes were forged not by order of central government but by the ambition and ingenuity of local business and civic leaders. As we enter a new period of technological revolution, our approach must be guided by the same spirit.

Yet during much of the last century the UK came to be one of the most centralised states in Europe²¹². Local businesses and civic leaders lacked the means to set their

own economic destinies and national government too often took a one size fits all approach. In recent years the tide has started to turn.

Since 2010, City, Growth and Devolution Deals have shifted power and funding to local areas to enable them to take strategic decisions about local priorities. Collectively these bespoke deals have enabled places to develop long-term plans; strengthen local leadership through directly elected city-region mayors and Local Enterprise Partnerships; and have more powers to create the right conditions for prosperity.

The Industrial Strategy builds on these foundations and goes further to strengthen the performance of our cities, towns and rural areas. It will allow national and local leaders to focus their efforts where they will have the greatest economic impact. Through addressing national and local barriers to growth we can help create prosperous communities throughout the UK.



'Since 2010, the City, Growth and Devolution Deals have shifted power and funding to local areas to enable them to take strategic decisions about local priorities.'



Leeds city centre

Our approach

The people best placed to drive forward local economies are those who live, work and do business in them.

We need to harness this local insights to develop clear, long-term strategies for future growth - this approach is vital to successful local economies.

We will work in partnership with places to develop Local Industrial Strategies, which will be developed locally and agreed with the government. These strategies will help identify priorities to improve skills, increase innovation and enhance infrastructure and business growth. This will guide the use of local funding streams and any

spending from national schemes.

Local Industrial Strategies will be long-term, based on clear evidence, and aligned to the national Industrial Strategy. They will identify local strengths and challenges, future opportunities and the action needed to boost productivity, earning power and competitiveness. This might include addressing skills issues, improving infrastructure, harnessing the potential of world-class science and innovation, supporting new high-value

businesses, or identifying leading sectors to inform the development of deals.

These strategies will establish new ways of working between national and local leaders in both the public and private sectors. Universities, colleges and other local institutions will be key, as will an approach that is responsive to both local and global market conditions to provide greater long-term certainty.

We will agree the first Local Industrial Strategies by March 2019.

We will prioritise areas with the potential to drive wider regional growth, focusing on clusters of expertise and centres of economic activity.

Places in England with a Mayoral Combined Authority will have a single strategy led by the mayor and supported by Local Enterprise Partnerships. For parts of the country without a mayor, the development of the strategy will be led by the Local Enterprise Partnership. We will also discuss the suitability of this approach with the devolved administrations.

Local leadership

Successful strategies require strong public and private leadership. We will continue to work with the new city region mayors, combined authorities, local authorities and Local Enterprise Partnerships to drive growth in England. We will continue to support locally-driven partnerships, proposals and reforms, with the aim of ensuring that economic powers are exercised at the most appropriate level and that decision-making is effective and clear.

We recognise that there are different arrangements for local government and business leadership at a regional level in each of the devolved nations. City and Growth Deals will continue to support growth and create opportunities across Scotland, Wales and Northern Ireland, and we will discuss further collaboration with each of the devolved administrations.

We now have directly elected mayors in place for a number of our English city regions, covering a third of the English population.



'Local Industrial Strategies will be long-term, based on clear evidence, and aligned to the national Industrial Strategy.'

The government will make available to Mayoral Combined Authorities a £12m fund for 2018/19 and 2019/20 to boost the new mayors' capacity and resources.

We have announced a deepening of the devolution deal with the West Midlands Combined Authority, which includes £6m for a housing delivery taskforce, £5m for a construction skills training scheme and a £250m allocation from the Transforming Cities Fund to be spent on local intra-city transport priorities. In addition, Greater Manchester and the government will work in partnership to develop a Local

Industrial Strategy. The government will provide a £243m allocation from the fund and will continue to work with Transport for Greater Manchester to explore future options.

We have agreed a 'minded to' devolution deal with the North of Tyne authorities, which will be subject to the consent of local partners. This will see £600m of investment in the region over a 30-year period and create a new mayor to be elected in 2019 with control over economic levers including planning and skills.

Case Study: Local leadership of industrial regeneration in the Tees Valley

The government is working with the Tees Valley mayor to support the regeneration of an extensive industrial area at Redcar by the South Tees Development Corporation. This is the first Mayoral Development Corporation outside London and is promoting local economic development and inward investment on the south bank of the River Tees. The government announced £118m at the Autumn Budget 2017 to ensure the ongoing safe and secure management of the former SSI steelworks, an integral part of the wider 4,500 acre development site. This includes removing dangerous

substances left over from the SSI steel production processes and making the site attractive to private sector investment. A further £5m was announced at the same time for the South Tees Development Corporation to take forward its plan.

The South Tees Development Corporation estimates the project could create 20,000 new jobs in skilled sectors and contribute an additional £1bn per annum to the local economy. This sustained economic growth will benefit the entire Tees Valley and demonstrates the importance of the powers devolved to its mayor.

We remain firmly committed to Local Enterprise Partnerships. From next year, the Prime Minister will chair a biannual 'Council of Local Enterprise Partnership Chairs'. This will provide an opportunity for Local Enterprise Partnership leaders to inform national policy decisions.

While Local Enterprise Partnerships across the country have played an important role in supporting local growth, feedback suggests that their performance has varied²¹³. We are reviewing the roles and responsibilities of Local Enterprise Partnerships and will bring forward reforms to leadership, governance, accountability, financial reporting and geographical boundaries. We will work with Local Enterprise Partnerships to set out a more clearly defined set of activities and objectives in early 2018.

These will be driven by influential local leaders, acting as figureheads for their area's economic success, and a clear strategy for local and national partnership.

We will agree and implement appropriate structures for holding Local Enterprise Partnerships to account. We will work with Local Enterprise Partnerships to review overlapping geographies and ensure people are clear as to who is responsible for driving growth in their area.

We recognise that in order to deliver their role effectively, Local Enterprise Partnerships need financial support. We will make additional financial resources available to Local Enterprise Partnerships that demonstrate ambitious levels of reform following the review.



'We have announced a deepening of the devolution deal with the West Midlands Combined Authority, which includes £6m for a housing delivery taskforce, £5m for a construction skills training scheme and £250m from the Transforming Cities Fund.'



Ceramics production in Stoke-on-Trent

Case Study: The ceramics cluster in Stoke-on-Trent

Businesses in Stoke-on-Trent have a fresh vision for the ceramics industry that has started to reverse a long-term trend of factory closures and job losses.

Traditional ceramics, such as table and giftware, have enjoyed significant growth since 2009²¹⁴. Partners from industry, education and local government are now targeting a greater share of the global market for innovative ceramics in industries ranging from digital to healthcare.

There is significant potential for growth: ceramics use ranges from electrical insulation for microchips and circuit boards to hip replacements and heart valves.

This partnership has developed an ambitious proposal for an Advanced Ceramics Campus that combines technical innovation, creativity and commercialisation with the skills needed for the next generation of engineers in the Midlands Engine and beyond. This demonstrates the potential to reimagine and reinvent local industries.

The right economic geography

We have already encouraged collaboration to address shared challenges over regional corridors in the Northern Powerhouse and Midlands Engine.

Such regional approaches can help to deepen pools of skilled labour, drive competition, and increase market access. There are also policy benefits to working at scale, including logistics and the promotion of the UK on the world stage.

We are expanding this approach across the country. In the Cambridge-Milton Keynes-Oxford corridor we have agreed an ambitious programme of infrastructure, housing, business investment and development. We are also working with the Thames Estuary 2050 Growth Commission to develop a future vision and will explore options for ambitious housing deals with local authorities in the Thames Estuary region.

Others are realising the benefits. Four Local Enterprise Partnerships - Swindon and Wiltshire, Cornwall and the Isles of Scilly, Heart of the South West and Dorset - have come together through the South

West Rural Productivity Commission to develop proposals for rural growth. This collaboration also exists across sectors. The Heart of the South West Local Enterprise Partnership is working with Cumbria to develop proposals for the nuclear industry.

We also recognise the need to have policy flexibility below the regional or Local Enterprise Partnership level. That could be to support innovation in economic clusters or to ensure that inner city boroughs, or small towns and their rural hinterlands, are able to contribute to, and benefit from, wider economic growth.

Some towns face particular challenges. We will consider agreeing approaches with towns on how the government, local councils, Local Enterprise Partnerships and businesses can work together to deliver growth in that area.



'Regional approaches can help to deepen pools of skilled labour, drive competition, and increase market access.'

Towns should be able to demonstrate that they can work collaboratively with local business and civic leaders to develop innovative solutions and attract private investment.

We are working with a range of local partners to explore new approaches, including on a pilot Town Deal with Grimsby.



Local Industrial Strategies will set out how local leaders and businesses will work together to deliver growth across the country (image: Grimsby)

Case Study: Driving growth in towns across the country

There are significant productivity differences within our regions as well as between them. High growth city centres and clusters are often found in close proximity to areas of lower productivity. To support local leaders in addressing the challenges for their area, an in-depth understanding of the barriers to growth is required, which can only come from local partnership.

Grimsby

Grimsby is looking to a new economic future as it adapts to industrial change. There are strong prospects in the energy industry - the Port of Grimsby is increasingly seen as a destination of choice for offshore wind and operations maintenance - and in port-related logistics and manufacturing, chemicals/petrochemicals and food processing. The Greater Grimsby Partnership Board is developing a new approach to regeneration that will be taken forward by public and

private sector partners to revitalise the town centre, increase skill levels and create new jobs and housing.

Harlow

Designated a New Town in 1947, Harlow is undergoing a period of renewal. It is home to a new Enterprise Zone; located at the heart of the London-Stansted-Cambridge corridor, benefits from excellent transport links to these major centres; and has been selected by the government as the location for Public Health England's new science hub. The government has also worked with Harlow College to open a new Advanced Manufacturing Centre and a base at Stansted Airport to train local workers in the skills required. Community leaders are working with the government to improve the business prospects of the town and the earning power of residents.

The most knowledge-intensive jobs, industries and research are increasingly concentrated in particular economic clusters²¹⁵. This 'clustering effect' gives rise to additional benefits to other associated sectors through higher employment and inward investment, such as in Sheffield's Advanced Manufacturing Innovation District. We will identify and work with a number of emerging clusters to deepen their foundations, identify and remove barriers to growth and strengthen supply chains.

We will work with local partners to develop a portfolio of High Potential Opportunities around strategic supply chain gaps, places and clusters that are attractive to investors and have economic potential, but which are not widely understood by businesses as they do not have sufficient market information. We will provide targeted promotion and support for investors to increase investment into the UK.

Case Study: Advanced manufacturing in Sheffield City Region

The Sheffield City Region is home to an advanced manufacturing cluster with the University of Sheffield's Advanced Manufacturing Research Centre (AMRC) as its core. The AMRC is located on the Sheffield-Rotherham border, benefiting from government backing as part of the Sheffield City Region Enterprise Zone and as a centre for the High Value

Manufacturing Catapult. The park is undergoing rapid expansion, including high-profile investments such as McLaren's £50m manufacturing facility and a £110m Rolls-Royce Advanced Blade Casting Facility. The recent Science and Innovation Audit made clear the wider opportunities for an innovation corridor that can maximise the benefits of industry 4.0.



'We will identify and work with a number of emerging clusters to deepen their foundations, identify and remove barriers to growth and strengthen supply chains.'



East Devon

We will ensure that local areas continue to receive flexible funding for their local needs. Following the UK's departure from the European Union, we will launch the UK Shared Prosperity Fund. We intend to consult next year on the precise design and priorities for the fund.

We have committed to guarantee funding for any project signed while we are in the EU, even if it continues after we have left, so long as the project provides good value for money and aligns with domestic priorities.

The government remains committed to further business rates retention in England and is working collaboratively with local government on further reforms: 100 per cent business rate retention has been piloted in five parts of the country since April 2017, including Liverpool City Region, Greater Manchester, the West Midlands, the West of England and Cornwall. Additional pilots will begin in April 2018.

Foundations of productivity

The success of our Industrial Strategy relies on credible Local Industrial Strategies and strengthened local leadership, supported by effective, locally-targeted national policies.

People

Education and skills are among the biggest determinants of local productivity²¹⁶. Since 2010 we have made important strides in improving our education and skills system. Employers are more involved in shaping our skills system, including in our ambition for three million apprentices to have started in the five years to 2020²¹⁷. This is set out in more detail in the People chapter of this paper.

Our challenge now is to ensure that these improvements are felt across the country, with opportunities available for everyone wherever they live. There remain significant regional disparities in education and skills, such as the disparities in educational achievements among young people²¹⁸.

Education and skills training are devolved to Scotland, Wales and Northern Ireland.

We recognise that there are similar initiatives in areas of England and the devolved administrations, including the development of Regional Skills Assessments in Scotland and the implementation of Regional Skills Partnerships in Wales. Given the cross-border nature of many employers, we will seek to use our continuing dialogue with the devolved nations to consider how we tackle skills issues impacting these businesses and communities

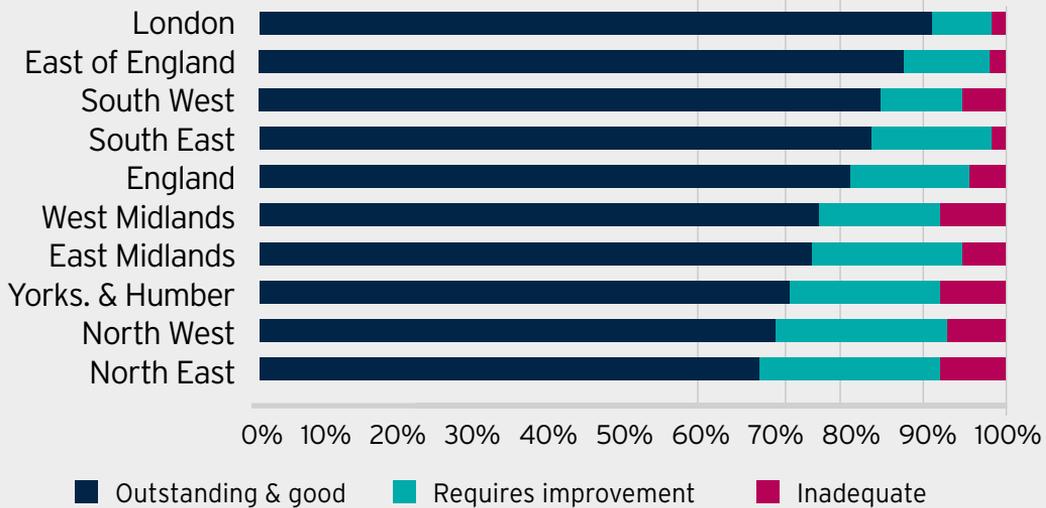
Our approach to addressing challenges facing our education and skills system will focus on school improvement across the country. In London, 90 per cent of secondary schools are good or outstanding, compared to just 67 per cent of schools in the north east²¹⁹.



'Since 2010 we have made important strides in improving our education and skills system. Employers are more involved in shaping our skills system, including in our ambition for three million apprentices.'

Secondary school performance across England

Secondary School Ofsted rating, March 2017



Source: Ofsted inspection data 2017

Building on existing support, we will invest £42m to pilot a Teacher Development Premium. This will test the impact of a £1,000 budget for high quality professional development for teachers in areas of the country that face the greatest challenge in driving pupil outcomes.

We will also deliver reforms to technical education to help places drive productivity across the country. These reforms, set out in the People section of this paper, will have positive and pronounced effect on places outside the south east, where uptake is considerably higher. But we will also need to do more to make sure local skills systems respond effectively to local needs.

We will work with Mayoral Combined Authorities and Local Enterprise Partnerships across all areas of England to establish Skills Advisory Panels. These will enable mayors and Local Enterprise Partnerships to support employers, education providers and local government in identifying current and future local skills needs shaping the provision and funding of post-age 16 education and training and careers guidance.

Infrastructure

High quality infrastructure between and within cities is vital to local productivity. Commitments to projects like High Speed 2 will better connect our great cities. As set out in the infrastructure chapter, we will continue to enhance connections across regional corridors of economic growth

This includes £300m funding to ensure High Speed 2 infrastructure can accommodate Northern Powerhouse and Midlands rail services. Transport for the North and Midlands Connect are working up the case for these services. This will enable faster links between cities in the north, including Liverpool and Manchester, Sheffield, Leeds and York, and from these cities to the East Midlands and London. To support the delivery of the Midlands Connect Strategy, the government will provide £2m to develop options to address key constraints on the Coventry-Leamington rail corridor, and £4m for congestion measures.

We will invest more in improving transport connections within city regions. We will make £1.7bn available through the Transforming Cities Fund to support projects that drive productivity by improving connections within city regions. This will target projects that drive productivity by improving connections within city regions. Half will be allocated on a per capita basis to the six combined authorities with elected metro mayors, and half will be allocated via competition.



'We will make £1.7bn available through the Transforming Cities Fund to support projects that drive productivity by improving connections within city regions.'

Case Study: Cambridge-Milton Keynes-Oxford corridor

The corridor containing Cambridge, Milton Keynes and Oxford has the potential to be the UK's Silicon Valley.

Two of its universities are consistently ranked in the world's top four²²⁰, it competes for international high-tech and science investment, and it contains nationally significant industry concentrations such as information technology, life sciences, automotive engineering and professional services. Estimates by the National Infrastructure Commission (NIC) suggest that, with the right actions, annual output of the corridor could increase by £163bn per annum by 2050 - approximately doubling the growth expected to happen without government intervention²²¹.

In the Autumn Budget, the government announced a vision for the corridor to stimulate economic growth. This includes an ambition for one million homes by 2050, starting with a housing deal with Oxfordshire comprising a government investment of up to £215m to fund local infrastructure in return for up to 100,000 homes in the area by 2031. And the government is investing in the rail and road infrastructure needed to boost productivity across the corridor and support the homes the area needs. In order to further stimulate economic growth:

- ▶ Local Enterprise Partnerships across the corridor, and the Cambridgeshire and Peterborough Combined Authority, are working to back the area's world-class science and innovation assets, as well as identifying and growing new sectors and business.
- ▶ The government is working on a series of sector deals in life sciences, artificial intelligence and construction with potential benefits for the corridor.
- ▶ The government will work with local partners to build on the strong international profile of the corridor to boost inward investment and exports.
- ▶ Building on the corridor's expertise in driverless vehicle technologies, the government recently announced a £6.9m investment in a driverless vehicle testing infrastructure scheme involving the Culham Science Park in Oxfordshire and the Millbrook proving ground in Bedfordshire.
- ▶ Cambridge has been announced as one of eleven Tech Nation regional hubs that will be established outside London.

As detailed in the Infrastructure chapter, we will adopt a more strategic approach to new infrastructure investment in order to drive growth across the country. Our 'Rebalancing Toolkit' will mean that no decisions on significant investments are taken without due consideration being given to the impact of investments on local growth.

We will ensure that investments in infrastructure are consistent with our goals for cutting carbon emissions while growing the economy, as set out in the Clean Growth Strategy. Our new Local Energy Programme will support areas to develop their capability and capacity to realise energy opportunities - such as the Teesside Collective, a grouping of multi-national industrial companies, which are developing proposals for a cluster using carbon capture, usage and storage.

Housing is vital to the economic success of our cities and regions. The government has made available £15.3bn of new financial support for housing over the next five years, bringing total support for housing to at least £44bn

over this period. This includes introducing planning reforms that will ensure more land is available for housing, and that better use is made of underused land in our cities and towns.

Being more responsive to local needs is an important part of the government's housing strategy. We will deliver bespoke housing deals with places where housing demand is high. The government wants to support places with ambitious and innovative plans to build additional homes where they are needed, and which will support wider economic growth. We want to support greater collaboration between councils, a more strategic approach to planning housing and infrastructure, more innovation and high quality design in new homes and creating the right conditions for new private investment.

We have announced a housing deal with Oxfordshire to deliver 100,000 homes by 2031 and a joint statutory spatial plan, supported by government investment of up to £215m for infrastructure, affordable housing and local capacity.



'Housing is vital to the economic success of our cities and regions. The government has made available £15.3bn of new financial support for housing over the next five years.'

The deal also seeks to secure and create jobs across Oxfordshire. This ambitious rate of housing delivery is consistent with the National Infrastructure Commission's target of one million new homes in the Cambridge-Milton Keynes-

Oxford corridor by 2050. We are in discussions with a number of other places around the country about housing deals, including Greater Manchester, Leeds, the West Midlands and the west of England.

Ideas

As demonstrated by Science and Innovation Audits, there are world-class science and innovation assets across the UK²²². These range from agricultural technology in the east of England and advanced manufacturing in the Sheffield City Region to offshore renewable energy in north east England and neuroscience in Cardiff. There are research and institutional strengths across the country on which we can build in order to foster strong innovation ecosystems.

We will work with areas to identify measures that can help to grow innovation ecosystems, using the evidence from the Science and Innovation Audits. To support this, we will create a new £115m per annum Strength in Places Fund. This will build on existing areas of excellence across the country, funding collaborative programmes proposed by universities, local employers, Local Enterprise Partnerships and their counterparts in the devolved nations.

Investment in culture, sport and heritage can contribute to positive economic and social outcomes²²³. An

exemplar is the success of Hull City of Culture this year. Next year we will see local economies across the Northern Powerhouse benefit from the Great Exhibition of the North - a two-month showcase of the great innovation, design, and arts hosted in Newcastle and Gateshead. Building on the success of the Northern Cultural Regeneration Fund and the recommendations of the Bazalgette Review, we are investing £2m in place-based cultural development to continue to support the role culture can play in regeneration.

Cultural bodies can enhance the attractiveness of places. Building on the legacy of the 2012 Olympics, part of the Queen Elizabeth Olympic Park is being developed to locate the British Council. The government has consulted on how Channel 4 could increase its regional impact, including moving some or all of its staff outside London. The government is in discussions with Channel 4, and will set out next steps shortly.

We will also use the relocation of arms' length bodies and departmental functions to support growth across

the UK. We will move jobs, including senior roles, out of London and the surrounding area to new hubs and specialist clusters across the UK between now and 2025. For example, we are building on the digital health cluster in

Leeds by moving NHS Digital, alongside HM Revenue and Customs, into a new hub of 6,000 civil servants. We will be looking to move further health functions to the city to build on this success.



Case Study: Research laboratories and agri-tech innovation in Norwich

Norwich Research Park is a world-renowned centre of agri-tech research and innovation with an annual research expenditure of over £230m. It brings together 3,000 scientists, researchers and clinicians in a range of leading research institutions. These include the John Innes Centre, Quadram Institute, Earlham Institute, Sainsbury Laboratory, University of East Anglia and Norfolk and Norwich University Hospital. There are also over 70 research-based business

companies on the site in the agricultural heartland of Norfolk. Research is focused on the full range of agricultural innovation from ‘farm to fork’. The region’s credentials in relation to translational research are also continuing to grow. The Quadram Institute is due to open fully in 2018 and will offer outstanding genetic research on the role microbiomes play in human health and disease. This is already attracting the attention of major food businesses worldwide.



‘We will create a new £115m per annum Strength in Places Fund. This will build on existing areas of excellence across the country.’



Belfast, Northern Ireland

Working across the UK

We are working with our partners in the devolved administrations to deliver ambitious plans for communities across Scotland, Wales and Northern Ireland.

Since 2014 we have announced six City Deals across Scotland and Wales that will involve up to £1.6bn of UK government investment. We are committed to taking forward further deals in each nation.

In Scotland, we are making good progress towards City Deals for Stirling and Clackmannanshire and the Tay Cities, and have announced that we will begin negotiations on a growth deal for the Scottish borderlands. In each of these, we will continue to work alongside local partners and the Scottish government.

We intend to begin formal negotiations towards a Growth Deal with north Wales and will consider proposals for a mid-Wales deal, working alongside the Welsh government and local partners. With ambitious deals we have already agreed with the Cardiff and Swansea regions this means that all regions of Wales have the potential to benefit from deal investment.

In Northern Ireland, we will open negotiations for a Belfast City Deal as part of our commitment to a comprehensive and ambitious set of city deals across Northern Ireland.

Our backing for economic growth corridors extends across the devolved nations. It includes support for further cross-border working between North Wales and Cheshire and Warrington, and an interest in how proposals for a mid-Wales growth deal could take account of the same. This is in addition to the benefits for the Bristol-Cardiff-Newport area that will arise from the abolition of tolls across the Severn Bridge by the end of 2018.

Our support for economic clusters, culture and innovation applies throughout the UK. We want to build on the innovative approaches secured through City and Growth Deals, supported by their respective boards, and work with places within Scotland, Wales and Northern Ireland - and with our partners in each devolved administration - to explore Local Industrial Strategies that align with regional, national and UK priorities.

We are committed to ensuring that the UK government and the devolved administrations work effectively together. We therefore propose to work with the devolved

administrations to review inter-agency cooperation, to identify opportunities for improving both the coherence and impact of government interventions and to improve awareness of, and access to, opportunities throughout the UK supply chain.

The reforms set out throughout this chapter, with their unwavering focus on communities, regions and networks, are a new approach to economic growth in the UK. They will ensure we lay the foundations for strong, sustainable growth in incomes that is better shared across the country. This is a critical moment for our cities and regions. As we make choices for our economy in the coming years, our Industrial Strategy will create new opportunities for communities throughout the UK to shape their dynamic, prosperous futures.



'Since 2014 we have announced six City Deals across Scotland and Wales that will involve up to £1.6bn in UK government investment.'



The Oil and Gas Technology Centre in Aberdeen is an industry-led research organisation funding projects to help realise the full potential of the North Sea as a global centre for oil and gas innovation.

Case study: Deal investment across the UK

Six City Deals have already been agreed across Scotland and Wales since 2014. These deals - which leverage billions of pounds of additional investment from partners in the public and private sector - demonstrate that our partnership with the devolved administrations and our collaboration with local partners can yield ambitious, large-scale plans driven by the priorities that places identify for themselves. They show that the devolution settlement can be a major catalyst for economic growth.

The Aberdeen City Region Deal agreed in November 2016 is worth more than £250m to the regional economy in north east Scotland. That deal is supporting regional innovation in north east Scotland's food and drink sector,

its growing biopharmaceutical sector, improvements in digital infrastructure, local transport and the **expansion of Aberdeen harbour.** It is also building on the work done by both the government and industry to support the oil and gas industry by promoting innovation and collaboration between industry players.

An excellent example of this is the £180m investment in the **Oil and Gas Technology Centre that opened in Aberdeen** in February 2017. The new centre is an industry-led research organisation, backed by both the UK and Scottish governments which will fund projects to help unlock the full potential of the UK North Sea and which aims to become the global centre for oil and gas innovation.



Tata Steel, Port Talbot

Case Study: Innovation in steel across the UK

The UK has a good track record in steel innovation based on both strong industrial heritage and outstanding research and development. Our research strengths are spread as widely as Cardiff, Huddersfield, Cambridge and Warwick, while a Steel Science Centre forms part of the £1.3bn Swansea Bay City Region Deal. The government has been working closely with the steel industry to map the current capability of the

sector and discuss a series of proposals developed since the publication of *Building our Industrial Strategy*. We will aim to identify opportunities for steel markets and build on these innovation assets across the UK. We will continue to engage with industry, as well as with the unions, the devolved administrations and other partners to develop a commercially sustainable proposition in a competitive global market.



'Our research strengths are spread as widely as Cardiff, Huddersfield, Cambridge and Warwick, while a Steel Science Centre forms part of the £1.3bn Swansea Bay City Region Deal.'

Conclusion



Britain and the world

We face a time of unprecedented economic change, powered by new technology. Now is the time for the United Kingdom to ensure we are well prepared to prosper.

Our Industrial Strategy sets out our vision for the future economy and our strategy to boost the productivity, earning power and quality of life of the British people. Our aim is that by 2030 we will have transformed productivity and earning power across the UK to become the world's most innovative economy and the best place to start and grow a business, with upgraded infrastructure and prosperous communities across the country.

Our strategy commits the government to working with business, universities, researchers and civic society over the years ahead to take advantage of the opportunities we have and address those aspects we need to improve. We build on Britain's many strengths. We will focus on reinforcing the foundations of productivity: ideas, people, infrastructure, our business environment and places.

We know that reinforcing the foundations of productivity is necessary but not sufficient; we need to do more to embrace the opportunities of the future. As an open and agile economy, built on innovation and enterprise, change can play to our strengths.

Our Grand Challenges will place us in the vanguard of changes transforming the world - which will shape our lives - and which must work for us all. Our Sector Deals will drive up productivity through partnerships between the government and industry to boost investment and skills. Built on the five foundations, our strategy will ensure that Britain is one of the most attractive places in the world to live, work and invest.

Our Industrial Strategy is taking action now. We have committed to the biggest ever increase in public and private investment in research and development. Public infrastructure funding will have doubled in a decade by 2022/23 and through Local Industrial Strategies we will work with local leaders to build the most dynamic economies. We are reforming our technical education system to make it as prestigious as our higher education system, and we are supporting businesses across the country to boost their exports and productivity.

Partnership is at the heart of our approach. We are in discussions with businesses, devolved administrations, city regions and Local Enterprise Partnerships about how we support communities to thrive. The Grand Challenges and Sector Deals will only succeed with the active engagement of the best and brightest across the UK. We will continue to identify new challenges and technologies as our public spending on research and development grows substantially.

Yet the world is changing fast. A successful Industrial Strategy needs to combine agility with patience. We need a clear and consistent direction, policies and institutions that are trusted by business, investors, local leaders, universities and researchers, which allow them to invest in a shared vision of the future. But we also need to be flexible to change. This is why it is so important that this Industrial Strategy will be continuously updated, informed by evidence about how our economy is changing and what it means for productivity, and the effectiveness of current policies. Our Industrial Strategy Council will ensure we have the right approach to measuring success.

What will not change is our commitment to an open, liberal, modern economy, built on the core principles of competition, free trade and high regulatory standards.

Our strategy is also one that is avowedly international. We will stay true to our tradition of being one of the world's most open economies - welcoming investment from overseas, participating in global supply chains, and buying and selling goods and services from all over the world - and to our obligations as part of the international community. Clean energy, for example, is not just an economic opportunity; it is also a moral duty in addressing climate change.

The process of leaving the European Union inevitably entails some uncertainty as negotiations take place to determine our future economic relationship. We want to have a continuing deep partnership with the EU that will not disrupt supply chains or impose barriers to our largest trading partner. We will not just respect the rights of European citizens living here; we will develop an approach through which European citizens can continue to come here to work and contribute to our economy. The UK and all of Europe benefit from our partnerships in research. We want that collaboration to continue on major science, research and technology initiatives. We are leaving the EU, but we are not leaving Europe.



We can also do more to embrace the opportunities, and so much emerging innovation, in the wider world. We must do more to export and promote what we do to the world's fastest-growing economies, where there is a strong appetite not only for our goods but our world-class services, from tourism and healthcare to professional and financial services, and for cultural collaboration too. We will be active participants in the international bodies setting standards and regulations especially in the emerging industries of the future such as artificial intelligence and data protection.

The United Kingdom is, and will be, a leading global economy. The ambition of our Industrial Strategy is to build a Britain fit for the future, a country confident and outward-looking, as we work together to increase productivity and earning power for everyone.

References

1. BEIS (2017), 'Building our Industrial Strategy' Green Paper <https://www.gov.uk/government/consultations/building-our-industrial-strategy>
2. Eurostat (2017), 'Employment and activity by sex and age', (For workers aged 15-64 years old), <http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do>.
3. Eurostat Science and Technology database (2017), 'Research and Development', <http://ec.europa.eu/eurostat/web/science-technology-innovation/data/database>
4. The World Bank (2017), 'Ease of doing business index'; <http://data.worldbank.org/indicator/IC.BUS.EASE.XQ>
5. UNCTAD (2017), 'International Trade in Goods and Services' <http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx>
6. Global Innovation Index (2017), 'Global Innovation Index 2017 Report', <https://www.globalinnovationindex.org/analysis-indicator>
7. The Core Cities is a group of cities including: Birmingham, Bristol, Cardiff, Glasgow, Leeds, Liverpool, Manchester, Newcastle, Nottingham and Sheffield.
8. ONS (2017), 'International comparisons of productivity', (Based on output per hour worked, current prices), <https://www.ons.gov.uk/economy/economicoutputandproductivity/productivitymeasures/datasets/international-comparisons-of-productivity-first-estimates>
9. ONS, (2017), 'Labour Productivity: April to June 2017', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/bulletins/labourproductivity/apriltojune2017>
10. ONS (2017), 'Employment rate (aged 16 to 64, seasonally adjusted)', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/timeseries/lf24>
11. Haldane, A (2017), 'Productivity puzzles' Speech given at the London School of Economics, 20 March. <http://www.bankofengland.co.uk/publications/Pages/speeches/2017/968.aspx>
12. ONS (2017), 'UK Balance of Payments, The Pink Book: 2017', Table 9.4 <https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/bulletins/unitedkingdombalanceofpaymentsthepinkbook/2017>
13. DIT (2017), 'Preparing for our future UK trade policy', <https://www.gov.uk/government/publications/preparing-for-our-future-uk-trade-policy>
14. IMF (2017), 'World Economic Outlook, October 2017', <https://www.imf.org/external/pubs/ft/weo/2017/02/weodata/index.aspx>
15. WEF (2017), 'The Fourth Industrial Revolution: what it means, how to respond' <https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/>
16. BEIS (2017), 'The Clean Growth Strategy (2017)', <https://www.gov.uk/government/publications/clean-growth-strategy>
17. Innovations for Germany (2014), 'The new High-Tech Strategy', <https://www.hightech-strategie.de/de/The-new-High-Tech-Strategy-390.php>
18. UK Biobank (2017), 'About UK Biobank' <http://www.ukbiobank.ac.uk/about-biobank-uk/>
19. Mazzucato, M (2017), 'Mission Oriented Innovation Policy: Challenges and Opportunities', <https://www.ucl.ac.uk/bartlett/public-purpose/publications/2017/oct/mission-oriented-innovation-policy-challenges-and-opportunities>
20. McKinsey (2017), 'Shaping the future of work in Europe's 9 digital front-runner countries' <https://www.mckinsey.com/global-themes/europe/shaping-the-future-of-work-in-europes-nine-digital-front-runner-countries>
21. PwC (2017), 'Sizing the prize, PwC's Global Artificial Intelligence Study: Exploiting the AI Revolution' <https://www.pwc.com/gx/en/issues/data-and-analytics/publications/artificial-intelligence-study.html>
22. Hall, W and Pesenti, J. (2017), 'Growing the Artificial Intelligence Industry in the UK: The independent review' <https://www.gov.uk/government/publications/growing-the-artificial-intelligence-industry-in-the-uk>
23. Ricardo Energy and Environment for the Committee on Climate Change (2017) 'UK business opportunities of moving to a low carbon economy' <https://www.theccc.org.uk/wp-content/uploads/2017/03/ED10039-CCC-UK-Bus-Opportunities-Draft-Final-Report-V7.pdf>
24. BEIS (2017), 'Provisional Greenhouse Gas Emissions Inventory Statistics 2016' <https://www.gov.uk/government/statistics/provisional-uk-green>

- house-gas-emissions-national-statistics-2016
25. ONS (2016), 'Quarterly National Accounts Statistical bulletins' <https://www.ons.gov.uk/economy/grossdomesticproductgdp/timeseries/abmi>
 26. BEIS (2017), 'The Clean Growth Strategy (2017)', <https://www.gov.uk/government/publications/clean-growth-strategy>
 27. BEIS (2017), 'Upgrading our energy system: smart systems and flexibility plan (2017)', <https://www.gov.uk/government/publications/upgrading-our-energy-system-smart-systems-and-flexibility-plan>
 28. BEIS (2017), 'Energy consumption in the UK 2017' <https://www.gov.uk/government/statistics/energy-consumption-in-the-uk>, Table 1.01
 29. OECD (2017), 'OECD Economic Survey of the UK, 2017' <http://www.oecd.org/eco/surveys/United-Kingdom-2017-OECD-economic-survey-overview.pdf>
 30. Government Office for Science (2016), 'Future of an ageing population' <https://www.gov.uk/government/publications/future-of-an-ageing-population>
 31. ONS (2016), 'What are your chances of living to 100?', <https://visual.ons.gov.uk/what-are-your-chances-of-living-to-100/>
 32. United Nations (2015), 'World population ageing 2015', http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Highlights.pdf
 33. Office for Life Sciences (2017), 'Life Sciences: industrial strategy' <https://www.gov.uk/government/publications/life-sciences-industrial-strategy>
 34. European Commission (2017), 'European Innovation Scoreboard', http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en
 35. Elsevier (2017), 'International comparative performance of the UK Research Base 2016', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/651174/uk-research-base-international-comparison-2016.pdf
 36. QS Top Universities (2017), 'QS World University Rankings 2018', <https://www.topuniversities.com/>
 37. Full Fact (2017), 'How many Nobel Prizes has the UK won?', <https://fullfact.org/news/how-many-nobel-prizes-has-uk-won/>, and, OECD (2017), 'Main Science and technology indicators (MSTI)', (2015 data point used, Percentage of GERD funded by rest of the world), <http://www.oecd.org/sti/msti.htm>
 38. BIS (2016), 'UK innovation survey 2015' https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/506953/bis-16-134-uk-innovation-survey-2015.pdf
 39. OECD (2017), 'Main Science and Technology Indicators', (2015 data points used), <http://www.oecd.org/sti/msti.htm>
 40. OECD (2017), 'Science Technology and Industry Scoreboard', (BERD adjusted for industrial structure), http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-scoreboard-2017_9789264268821-en
 41. OECD (2017), 'Main Science and technology indicators' <http://www.oecd.org/sti/msti.htm>
 42. ONS (2017), 'Business enterprise research and development, UK: 2016' <https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/bulletins/businessenterpriseresearchanddevelopment/2016>
 43. ONS (2017), 'Business enterprise research and development, UK: 2016' <https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/bulletins/businessenterpriseresearchanddevelopment/2016>
 44. European Commission (2017), 'European innovation scoreboard 2017' http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en
 45. Elsevier (2017), 'International comparative performance of the UK Research Base 2016', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/651174/uk-research-base-international-comparison-2016.pdf
 46. OECD (2017), 'Main Science and Technology Indicators', (2015 data points used), <http://www.oecd.org/sti/msti.htm>
 47. Economic Insights (2015), 'What is the relationship between public and private investment in science, research and innovation?', <https://www.gov.uk/government/publications/research-and-development-relationship-between-public-and-private-investment>
 48. Intellectual Property Office (2016), 'UK intangible investment and growth', <https://www.gov.uk/government/publications/uk-intangible-investment-and-growth>

49. BEIS (2017), 'Science and innovation audits: second reports published', <https://www.gov.uk/government/publications/science-and-innovation-audits-second-reports-published>
50. ONS (2015), 'UK Gross domestic expenditure on research and development', <https://www.ons.gov.uk/economy/governmentpublic-sectorandtaxes/researchanddevelopmentexpenditure/bulletins/ukgrossdomesticexpenditureonresearchanddevelopment/2015>
51. ONS (2017), 'Business enterprise research and development, UK: 2016' <https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/bulletins/businessenterpriseanddevelopment/2016>
52. Elsevier (2017), 'International comparative performance of the UK Research Base 2016', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/651174/uk-research-base-international-comparison-2016.pdf
53. European Commission (2017), 'The 2016 EU Industrial R&D Investment Scoreboard', <http://iri.jrc.ec.europa.eu/scoreboard16.html>
54. BEIS analysis based on ONS GERD and European Commission data. ONS (2015), 'UK Gross domestic expenditure on research and development', <https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/bulletins/ukgrossdomesticexpenditureonresearchanddevelopment/2015>, and, European Commission (2016), 'The 2016 EU Industrial R&D Investment Scoreboard', <http://iri.jrc.ec.europa.eu/scoreboard16.html>
55. BIS (2015), 'Nurse review of research councils: recommendations', <https://www.gov.uk/government/publications/nurse-review-of-research-councils-recommendations>
56. IEA (2016), 'World Energy Outlook 2016', <https://www.iea.org/newsroom/news/2016/november/world-energy-outlook-2016.html>
57. Frankfurt School UNEP Collaborating Centre (2017), 'Global Trends in Renewable Energy Investment 2017' http://fs-unesp-centre.org/sites/default/files/attachments/17083blnef_unep_gtr_data_file.pdf
58. UN-Water (2016), 'The United Nations World Water Development Report 2016' <http://unesdoc.unesco.org/images/0024/002440/244041e.pdf>
59. ONS (2014), 'ONS National Population Projections' <https://www.ons.gov.uk/people-populationandcommunity/populationand-migration/populationprojections/bulletins/nationalpopulationprojections/2015-10-29>
60. ONS (2017), 'National Accounts Low Level Aggregates', <https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/ukgdpolowlevelaggregates>
61. Royal Academy of Engineering (2015), 'The Dowling Review of Business University Research Collaborations', <http://www.raeng.org.uk/policy/dowling-review/the-dowling-review-of-business-university-research>
62. HEFCE (2016), 'University KE framework: Good practice in technology transfer', <http://www.hefce.ac.uk/pubs/rereports/Year/2016/ketech/>
63. Royal Academy of Engineering (2015), 'The Dowling Review of Business University Research Collaborations', <http://www.raeng.org.uk/policy/dowling-review/the-dowling-review-of-business-university-research>
64. HEBCI (2015/16), 'HE-BCI record 2015/16 (Part B)', <https://www.hesa.ac.uk/data-and-analysis/publications/hebci-2015-16>
65. BIS (2013), 'Encouraging a British Invention Revolution: Sir Andrew Witty's Review of Universities and Growth', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/249720/bis-13-1241-encouraging-a-british-invention-revolution-andrew-witty-review-R1.pdf
66. Ernst and Young (2017), 'Catalapult Network Review'
67. MRC (2017), 'Economic impact report 2015/16', <https://www.mrc.ac.uk/publications/browse/economic-impact-report-2015-16/>
68. Loughborough University Science and Research Park, <http://www.lusep.co.uk/>
69. Brenner, T; Emmrich, C; Schlump, CI (2013), 'Regional Effects of a Cluster-oriented policy measure - The Case of the InnoRegio program in Germany', <https://wpis.files.wordpress.com/2013/04/wp-30.pdf>
70. BEIS (2017), 'Science and innovation audits: second reports published', <https://www.gov.uk/government/publications/science-and-innovation-audits-second-reports-published>
71. Elsevier (2017), 'International comparative performance of the UK Research Base 2016', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/651174/uk-research-base-international-comparison-2016.pdf

72. BIS (2016), 'UK innovation survey 2015', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/506953/bis-16-134-uk-innovation-survey-2015.pdf
73. BEIS (2017), 'UK's participation in horizon 2020: May 2017', <https://www.gov.uk/government/statistics/uks-participation-in-horizon-2020-may-2017>
74. European Commission (2017), 'Research and Innovation performance and Horizon 2020 country participation', http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=country-profiles
75. BEIS (2017), 'UK's participation in horizon 2020: May 2017', <https://www.gov.uk/government/statistics/uks-participation-in-horizon-2020-may-2017>
76. OECD (2017) 'OECD Employment Outlook', <https://data.oecd.org/emp/employment-rate.htm>
77. Ofsted (2016), 'Ofsted Annual Report of Her Majesty's Chief Inspector of Education, Children's Services and Skills 2015/16', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/574186/Ofsted_annual_report_education_and_skills_201516_web-ready.pdf
78. DfE (2016), 'Participation rates in higher education: 2006 to 2016', <https://www.gov.uk/government/statistics/participation-rates-in-higher-education-2006-to-2016>
79. UNESCO (2017), 'Student flow', <http://uis.unesco.org/en/uis-student-flow>
80. ONS (2017), 'Dataset A08: Labour market status of disabled people', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/labourmarketstatusofdisabledpeoplea08>
81. ONS (2017), 'Annual Survey of Hours and Earnings: 2017 provisional and 2016 revised results', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworking-hours/bulletins/annualsurveyofhoursandearnings/2017provisionaland2016revisedresults>
82. ONS (2017), 'Labour Market Statistics', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/bulletins/uklabourmarket/september2017>
83. Bank of England working paper (2015), 'The impact of immigration on occupational wages: evidence from Britain', <http://www.bankofengland.co.uk/research/Documents/workingpapers/2015/swp574.pdf>
84. UCAS (2017), 'UCAS 2016 Application Cycle: End of Cycle Report', <https://www.ucas.com/corporate/data-and-analysis/ucas-undergraduate-releases/ucas-undergraduate-analysis-reports/ucas-undergraduate-end-cycle-reports>
85. UKCES (2015), 'STEM: Employer Skills Survey 2015: UK Results. 2016.', <https://www.gov.uk/government/publications/ukces-employer-skills-survey-2015-uk-report>
86. CBI (2015), 'Inspiring growth: CBI/Pearson education and skills survey 2015', http://www.cbi.org.uk/index.cfm/_api/render/file/?method=inline&fileID=92095A98-3A90-4FBD-9AF-891997B103F50
87. Social Market Foundation for EDF Energy (2017), 'Jobs of the Future', <https://www.edfenergy.com/sites/default/files/jobs-of-the-future.pdf>
88. Home Office (2016), 'Immigration Rules Appendix K: shortage occupation list', <https://www.gov.uk/guidance/immigration-rules/immigration-rules-appendix-k-shortage-occupation-list>
89. DfE (2017), 'Report of Professor Sir Adrian Smith's review of post-16 mathematics', <https://www.gov.uk/government/publications/smith-review-of-post-16-maths-report-and-government-response>
90. DfE (2017) 'Statistics: 16 to 19 attainment', (October KS5 SFR provisional data), <https://www.gov.uk/government/collections/statistics-attainment-at-19-years>
91. UKCES (2013), 'The supply of and demand for high-level STEM skills', <https://www.gov.uk/government/publications/high-level-stem-skills-supply-and-demand>
92. DfE (2017), 'Report of Professor Sir Adrian Smith's review of post-16 mathematics', <https://www.gov.uk/government/publications/smith-review-of-post-16-maths-report-and-government-response>
93. OECD (2015) 'The ABC of Gender Equality in Education Aptitude, Behaviour, Confidence' <http://www.oecd.org/pisa/keyfindings/pisa-2012-results-gender-eng.pdf>
94. CBI (2016), 'Unlocking regional growth', http://www.cbi.org.uk/index.cfm/_api/render/file/?method=inline&fileID=9AF06

- 398-223D-4214-B96F1AD8A2FE4CC8
95. DfE (2017), 'Early years foundation stage profile results: 2016 to 2017', <https://www.gov.uk/government/statistics/early-years-foundation-stage-profile-results-2016-to-2017>
 96. Ofsted (2017), 'Maintained schools and academies inspections and outcomes as at 31 March 2017', <https://www.gov.uk/government/statistics/maintained-schools-and-academies-inspections-and-outcomes-as-at-31-march-2017>
 97. UCAS (2017), 'UCAS 2016 Application Cycle: End of Cycle' Report', <https://www.ucas.com/corporate/data-and-analysis/ucas-undergraduate-releases/ucas-undergraduate-analysis-reports/ucas-undergraduate-end-cycle-reports>.
 98. ONS (2017), 'Labour Market Statistics time series dataset', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/labourmarketstatistics>; ONS(2017), 'Annual Survey of Hours and Earnings: 2017 provisional and 2016 revised results', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2017provisionaland2016revisedresults>. Resolution Foundation (2016), 'Low Pay Britain 2016', <http://www.resolutionfoundation.org/publications/low-pay-britain-2016/>
 99. CBI (2017), 'The right combination: CBI/Pearson education and skills survey 2016', <http://www.cbi.org.uk/cbi-prod/assets/File/pdf/cbi-education-and-skills-survey2016.pdf>
 100. CBI (2017), 'Helping the UK thrive: CBI/Pearson Employment and Skills Survey 2017', <http://www.cbi.org.uk/insight-and-analysis/helping-the-uk-thrive/>
 101. BIS (2013), 'Impact of university degrees on the lifecycle of earnings: some further analysis', <https://www.gov.uk/government/publications/university-degrees-impact-on-lifecycle-of-earnings>
 102. BIS (2015), 'UK skills and productivity in an international context', <https://www.gov.uk/government/publications/uk-skills-and-productivity-in-an-international-context>
 103. UKCES (2016) 'UK labour market projections: 2014 to 2024', www.gov.uk/government/publications/uk-labour-market-projections-2014-to-2024
 104. BEIS and DfE (2016), 'Post-16 skills plan and independent report on technical education', <https://www.gov.uk/government/publications/post-16-skills-plan-and-independent-report-on-technical-education>
 105. BEIS and DfE (2016), 'Post-16 skills plan and independent report on technical education', <https://www.gov.uk/government/publications/post-16-skills-plan-and-independent-report-on-technical-education>
 106. BEIS and DfE (2016), 'Post-16 skills plan and independent report on technical education', <https://www.gov.uk/government/publications/post-16-skills-plan-and-independent-report-on-technical-education>
 107. DfE (2017), 'Report of Professor Sir Adrian Smith's review of post-16 mathematics', <https://www.gov.uk/government/publications/smith-review-of-post-16-maths-report-and-government-response>
 108. DfE (2016), 'Achievement of 15-Year-Olds in England: PISA 2015 National Report', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/574925/PISA-2015_England_Report.pdf
 109. DfE (2017), 'Report of Professor Sir Adrian Smith's review of post-16 mathematics', <https://www.gov.uk/government/publications/smith-review-of-post-16-maths-report-and-government-response>
 110. DCMS (2015), 'Sectors Economic Estimates', <https://www.gov.uk/government/statistics/dcms-sectors-economic-estimates-2016>
 111. DfE (2017), 'Level 2 and 3 attainment in England: Attainment by age 19 in 2016', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/603921/Tables_6_-_15_2017SFR_V2.xlsx
 112. IEA (2016), 'Trends in International Mathematics and Science Study (TIMSS) 2015 International Results in Maths', <http://timss2015.org/timss-2015/mathematics/student-achievement/>; OECD (2016), 'Programme of International Student Assessment (PISA) 2015 Results (Volume I): Excellence and Equity in Education', <http://dx.doi.org/10.1787/9789264266490-en>
 113. DfE (2017), 'Level 2 and 3 attainment in England: Attainment by age 19 in 2016', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/603921/Tables_6_-_15_2017SFR_V2.xlsx
 114. Core maths qualifications are: City & Guilds Level 3 Certificates in Using and Applying Mathematics; OCR Level 3 Certificate in

- Quantitative Reasoning; OCR Level 3 Certificate in Quantitative Problem Solving; Pearson Edexcel Level 3 Certificate in Mathematics in Context; WJEC Eduqas Level 3 Certificate in Mathematics for Work and Life; AQA Level 3 Certificate in Mathematical Studies
115. DfE (2017), 'Report of Professor Sir Adrian Smith's review of post-16 mathematics', <https://www.gov.uk/government/publications/smith-review-of-post-16-maths-report-and-government-response>
 116. Data collected from individual exam boards: Pearson <http://qualifications.pearson.com/content/demo/en/support/support-topics/resultscertification/grade-statistics.html?Qualification-Family=mathematics-in-context>, AQA <http://www.aqa.org.uk/exams-administration/results-days/results-statistics>, OCR <http://www.ocr.org.uk/ocr-for/exams-officers/stage-4-results/results-statistics/results-statisticsarchive/>
 117. BIS (2016), 'Returns to Maths and English Learning (at level 2 and below) in Further Education', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/522300/bis-16-180-maths-english-learning.pdf
 118. CIPD (2017), 'From 'inadequate' to 'outstanding': making the UK's skills system world class', <https://www.cipd.co.uk/about/media/press/170419-uk-skills-crisis#>
 119. DfE (2017), 'Level 2 and 3 attainment in England: Attainment by age 19 in 2016', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/603776/Tables_16_-_24_2017SFR.xlsx
 120. DfE (2016), 'Evaluation of the maths teacher exchange: China and England', <https://www.gov.uk/government/publications/evaluation-of-the-maths-teacher-exchange-china-and-england>
 121. Tech Nation 2017 Tech City (2017), 'Digital tech jobs are being created twice as fast as non-digital jobs', <https://technation.techcityuk.com/digital-skills-jobs/jobs-salaries-data/>
 122. DCMS (2017), 'UK Digital Strategy 2017', <https://www.gov.uk/government/publications/uk-digital-strategy/uk-digital-strategy>
 123. BEIS (2016), 'Computer science degree accreditation: Shadbolt review', <https://www.gov.uk/government/publications/computer-science-degree-accreditation-and-graduate-employability-shadbolt-review>
 124. The Royal Society (2017), 'After the Reboot: computing education in UK schools', <https://royalsociety.org/~media/policy/projects/computing-education/computing-education-report.pdf>
 125. Parliament (2017), 'Higher Education: Disadvantaged: Written question - 4520', <http://www.parliament.uk/business/publications/written-questions-answers-statements/written-question/Commons/2017-07-12/4520/>
 126. ONS (2017), 'Labour market status of disabled people', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/labourmarketstatusofdisabledpeoplea08>; ONS (2017), 'Number of Women in Employment' (aged 16 and over, seasonally adjusted), <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/timeseries/mgsb/lms>;
 127. BEIS (2017), 'Good work: the Taylor review of modern working practices', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/627671/good-work-taylor-review-modern-working-practices-rg.pdf
 128. DfE (2017), 'New levy to double annual investment in home-grown skills', <https://www.gov.uk/government/news/new-levy-to-double-annual-investment-in-home-grown-skills>
 129. BIS, DfE, DWP (2016), 'Paul Maynard taskforce recommendations', <https://www.gov.uk/government/publications/apprenticeships-improving-access-for-people-with-learning-disabilities/paul-maynard-taskforce-recommendations>
 130. BEIS (2017) 'Race in the workplace: The McGregor-Smith Review' <https://www.gov.uk/government/publications/race-in-the-workplace-the-mcgregor-smith-review>
 131. 'McKinsey (2015), 'Diversity matters', <https://www.mckinsey.com/business-functions/organization/our-insights/why-diversity-matters>
 132. ONS (2017), 'Employment rate (aged 16 to 64, seasonally adjusted)', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/timeseries/lf24/lms>; Olsen et al. (2010), 'The Gender Pay Gap in the UK 1995-2007'; http://openaccess.city.ac.uk/15912/1/genderpaygap2010_olsen-etal.pdf; McKinsey (2015), 'Diversity matters', <https://www.mckinsey.com/business-functions/organization/our-insights/why-diversity-matters>
 133. ONS (2017), 'Labour market status of disabled people', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/>

- employmentandemployeetypes/datasets/labourmarketstatusofdisabledpeoplea08
134. OECD (2012), 'Closing the Gender Gap, Act Now: United Kingdom, Organisation for Economic Cooperation and Development', <http://www.oecd.org/gender/Closing%20the%20Gender%20Gap%20-%20UK%20FINAL.pdf>
 135. DfE (2017), 'Evaluation of Early Implementation of 30 Hours Free Childcare', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/629460/Evaluation_of_early_implementation_of_30_hours_free_childcare_.pdf
 136. DfE (2017), 'Evaluation of Early Rollout of 30 Hours Free Childcare', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/642007/Evaluation_of_early_rollout_of_30-hours_free_childcare.pdf
 137. ONS (2017), 'Labour Market Status by Ethnic Group', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/labourmarketstatusbyethnicgroupa09>
 138. Cabinet Office (2017), 'Race Disparity Audit', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/650723/RDAweb.pdf
 139. DWP and DH (2017), 'Thriving at Work: a review of mental health and employers', <https://www.gov.uk/government/publications/thriving-at-work-a-review-of-mental-health-and-employers>
 140. MAC (2017), 'Call for evidence and briefing note: EEA-workers in the UK labour market', <https://www.gov.uk/government/consultations/call-for-evidence-and-briefing-note-eea-workers-in-the-uk-labour-market>
 141. HMT (2017), 'Public Expenditure Statistical Analyses 2017', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/629926/PESA_2017_print.pdf; ONS (2017), 'Input-output supply and use tables', <https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/inputoutputsupplyandusetables>
 142. CMS (2016), 'Infrastructure Index: Bridging the gap', <https://cms.law/en/GBR/Publication/Infrastructure-index-bridging-the-gap>
 143. DCMS (2017), 'UK Digital Strategy 2017', <https://www.gov.uk/government/publications/uk-digital-strategy/uk-digital-strategy>
 144. BEIS (2017), 'Provisional Greenhouse Gas Emissions Inventory Statistics 2016', <https://www.gov.uk/government/statistics/provisional-uk-greenhouse-gas-emissions-national-statistics-2016>
 145. ONS (2016), 'Quarterly National Accounts Statistical bulletins', (Series ABMI. Seasonally adjusted chained volume measures), <https://www.ons.gov.uk/economy/>
 146. MoD (2016), 'National Shipbuilding Strategy: an independent report', <https://www.gov.uk/government/publications/uk-national-shipbuilding-strategy-an-independent-report>
 147. DEFRA (2014), 'Reducing the risks of flooding and coastal erosion: An investment plan, December 2014', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/389789/fcerm-investment-plan-201412.pdf
 148. DfT (2017), 'Transport Investment Strategy: Moving Britain Ahead', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/624990/transport-investment-strategy-web.pdf
 149. DfT (2017), 'Transport Investment Strategy: Moving Britain Ahead', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/624990/transport-investment-strategy-web.pdf
 150. DfT (2017), 'Transport Investment Strategy: Moving Britain Ahead', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/624990/transport-investment-strategy-web.pdf
 151. Frost & Sullivan (2017), 'UK Space Launch Services Market - A review of market potential and UK industry competitiveness', <https://www.i3p.org.uk>
 152. <https://www.i3p.org.uk>
 153. High Speed Two (HS2) Limited (2016), 'How HS2 will generate growth: 'Changing Britain: HS2 Taking Root'', <http://www.wiganworks.com/Docs/Economic/Changing-Britain-HS2-Taking-Root.pdf>
 154. High Speed Two (HS2) Limited (2016), 'How HS2 will generate growth: 'Changing Britain: HS2 Taking Root'', <http://www.wiganworks.com/Docs/Economic/Changing-Britain-HS2-Taking-Root.pdf>
 155. Cost of Energy: Independent Review (2017) <https://www.gov.uk/government/publications/cost-of-energy-independent-review>
 156. BEIS (2017), 'The Clean Growth Strategy (2017)', [https://www.gov.uk/government/publications/clean-growth-strategy/The Clean Growth Strategy \(2017\)](https://www.gov.uk/government/publications/clean-growth-strategy/The%20Clean%20Growth%20Strategy%20(2017))

157. Oil and Gas UK (2017), 'Oil and Gas UK Economic Report 2017', <http://oilandgasuk.co.uk/wp-content/uploads/2017/09/Economic-Report-2017-Oil-Gas-UK.pdf>
158. ONS (2015), 'UK trade data', <https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/bulletins/uktrade/previousReleases>
159. Ellen MacArthur Foundation (2013), 'Towards the Circular Economy', www.ellenmacarthurfoundation.org/business/reports/ce2012
160. DCMS (2017), 'UK Digital Strategy 2017', <https://www.gov.uk/government/publications/uk-digital-strategy/uk-digital-strategy>
161. DCMS (2017), 'Guidance - Broadband Delivery UK', <https://www.gov.uk/guidance/broadband-delivery-uk#-superfast-broadband-programme>
162. Think Broadband (2017), 'UK Superfast and Fibre Coverage' <https://labs.thinkbroadband.com/local/>; Ofcom (2016), 'Connected Nations 2016', https://www.ofcom.org.uk/__data/assets/pdf_file/0035/95876/CN-Report-2016.pdf
163. Deloitte (2017) 'Assessing the value of TfL's open data and digital partnerships', <http://content.tfl.gov.uk/deloitte-report-tfl-open-data.pdf>
164. PWC (2017), 'How will artificial intelligence affect the UK economy?', <http://www.pwc.co.uk/services/economics-policy/insights/the-impact-of-artificial-intelligence-on-the-uk-economy.html>
165. <https://www.gov.uk/government/news/new-clean-energy-projects-set-to-power-36-million-homes>
166. World Bank (2018). 'Ease of Doing Business Index 2018'. <http://www.doingbusiness.org/~media/WBG/DoingBusiness/Documents/Profiles/Regional/DB2018/EU.pdf>
167. Financial Times (2017), 'The FT 1000: The complete list of Europe's fastest-growing companies', <https://ig.ft.com/ft-1000/?mhq5j=e5>
168. World Bank (2018). 'Ease of Doing Business Index 2018'. <http://www.doingbusiness.org/~media/WBG/DoingBusiness/Documents/Profiles/Regional/DB2018/EU.pdf>
169. BEIS analysis of 2016 Banksearch Data
170. Financial Times (2018). '1000 Europe's Fastest Growing Companies.' <https://ig.ft.com/ft-1000/>
171. EY (2017). 'UK Attractiveness Survey 2017: Time to act.' [http://www.ey.com/Publication/vwLUAssets/2017-UK-Attractiveness-Survey/\\$-FILE/EY-UK-Attractiveness-Survey-2017.pdf](http://www.ey.com/Publication/vwLUAssets/2017-UK-Attractiveness-Survey/$-FILE/EY-UK-Attractiveness-Survey-2017.pdf)
172. The Global Innovation Index (2017). 'The Global Innovation Index 2017: Innovating Feeding the World.' <https://www.globalinnovationindex.org/gii-2017-report#>
173. HMT (2017). 'Financing growth in innovative firms: consultation.' https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/642456/financing_growth_in_innovative_firms_consultation_web.pdf
174. British Business Bank (2017). 'Small Business Equity Tracker Report 2017.' https://british-business-bank.co.uk/wp-content/uploads/2017/07/239-Small-Business-Equity-Tracker-Report_2017WEB.pdf
175. Haldane, A (2017), 'Productivity puzzles' Speech given at the London School of Economics, 20 March. www.bankofengland.co.uk/publications/Documents/speeches/2017/speech968.pdf
176. ONS (2017) 'Understanding firms in the bottom 10% of the labour productivity distribution in Great Britain.' <https://www.ons.gov.uk/economy/economicoutputandproductivity/productivitymeasures/articles/understandingfirmsinthebottom10ofthelabourproductivitydistributioningreatbritain/jantomar2017>
177. Centre for Economic Performance (2007) 'Management Practice & Productivity: Why they matter' http://cep.lse.ac.uk/management/Management_Practice_and_Productivity.pdf
178. Bloom, Van Reenen(2016), 'Measuring and explaining management practices across firms and countries', <http://www.nber.org/papers/w12216>
179. ONS (2017) 'An international comparison of gross fixed capital formation.' <https://www.ons.gov.uk/economy/grossdomesticproductgdp/articles/aninternationalcomparisonof-grossfixedcapitalformation/2017-11-02>.
180. BEIS (2016), 'Business population estimates 2016', <https://www.gov.uk/government/statistics/business-population-estimates-2016>
181. HM Treasury (2015), 'Fixing the foundation: creating a more prosperous nation', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/443898/Productivity_Plan_web.pdf
182. ONS (2017), 'National Accounts Aggregates' <https://www.ons.gov.uk/file?uri=/economy/grossdomesticproductgdp/compendium/unit-edkingdomnationalaccountsthebluebook/2017/uknationalaccountsthebluebook2017/bbchapter01nationalaccountsataglancev3.xls>
183. BIS (2011), 'International Trade and Investment

- the Economic Rationale for Government Support', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32106/11-805-international-trade-investment-rationale-for-support.pdf
184. World Bank, (2017). 'Doing Business 2018: Reforming to Create Jobs.' <http://www.doing-business.org/~media/WBG/DoingBusiness/Documents/Profiles/Regional/DB2018/EU.pdf>
185. BEIS (2017) 'Good Work: The Taylor Review of Modern Working Practices'. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/627671/good-work-taylor-review-modern-working-practices-rg.pdf
186. HMT (2017). 'Public Expenditure.' https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/629926/PESA_2017_print.pdf
187. ONS (2016), 'UK National Accounts, The Blue Book: 2016', <https://www.ons.gov.uk/releases/uknationalaccountsbluebook2016>
188. ONS (2017), 'UK Trade in goods by classification of product by activity time series dataset' <https://www.ons.gov.uk/businessindustryandtrade/internationaltrade/datasets/uktradeingoodsbyclassificationofproductbyactivity>
189. ONS (2017), 'Business enterprise research and development, UK: 2016' <https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/bulletins/businessenterpriseanddevelopment/2016>
190. European Commission (2017), 'The 2016 EU Industrial R&D Investment Scoreboard', <http://iri.jrc.ec.europa.eu/scoreboard16.html>
191. BEIS (2016), 'New aerospace technologies to get £365 million funding', <https://www.gov.uk/government/news/new-aerospace-technologies-to-get-365-million-funding>
192. OLS (2016), 'Strength and Opportunity 2016 - The landscape of the medical technology and biopharmaceutical sectors in the UK', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/635714/strength-and-opportunity-2016-bioscience-technology-accessible-revised.pdf
193. Known as Merck and Co Inc. in the US and Canada
194. ONS (2017), 'Annual Business Survey, UK non-financial business economy: 2016 provisional results', (Figures include construction contracting, construction services and construction products), <https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/bulletins/uknonfinancial-businesseconomy/2016provisionalresults>
195. ONS (2017), 'Annual Business Survey, UK non-financial business economy: 2016 provisional results', (Figures include construction contracting, construction services and construction products), <https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/bulletins/uknonfinancial-businesseconomy/2016provisionalresults>
196. ONS (2017), 'Annual Business Survey, UK non-financial business economy: 2016 provisional results', (Contracting defined as SIC 41, 42 and 43 and Self-employed construction contractors), <https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/bulletins/uknonfinancial-businesseconomy/2016provisionalresults>
197. PWC (2017), 'How will artificial intelligence affect the UK economy?', <http://www.pwc.co.uk/services/economics-policy/insights/the-impact-of-artificial-intelligence-on-the-uk-economy.html>
198. Eurostat (2017), 'Structural Business Statistics', <http://ec.europa.eu/eurostat/web/structural-business-statistics/data/database>
199. ONS (2017), 'Employee jobs', 'Self-employed jobs', 'Employment multipliers', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/employeejobsbyindustryjobs03>; <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/selfemploymentjobsbyindustryjobs04>; <https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/adhocs/007234provisionalestimatesoftypeiukemploymentmultipliersandeffectsby-su14industrygroupandsectormarketgovernmentnpsishreferenceyear2013>
200. SMMT (2017), 'Automotive Sustainability Report', <https://www.smmt.co.uk/industry-topics/sustainability/uk-supply-chain/>
201. DCMS (2015), 'Sectors Economic Estimates', <https://www.gov.uk/government/statistics/dcms-sectors-economic-estimates-2016>
202. DCMS (2017), 'Independent Review of the Creative Industries', <https://www.gov.uk/government/news/bazalgette-review-sets-recommendations-for-continued-growth-of-uks-creative-industries>

203. ONS (2017), 'GDP Low Level Aggregates', <https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/ukgdpolowlevelaggregates>
204. ONS (2017), 'UK Trade in Goods by Classification of Product by Activity and UK Trade', <https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/datasets/publicationtablesuktradedcpa08>; <https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/datasets/publicationtablesuktrade>
205. ONS (2017), 'BERD, UK 2016', <https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/datasets/ukbusinessenterprisereasearchanddevelopment>
206. ONS (2017), 'Labour Productivity', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/datasets/labourproductivitytables110andr1>
207. BEIS (2017), 'Made Smarter Review', <https://www.gov.uk/government/publications/made-smarter-review>
208. Nuclear Skills Strategy Group (2017), 'Nuclear Workforce Assessment 2017', http://www.cogentskills.com/media/76523/nwa2017_public.pdf
209. Martin et al. (2015), 'Spatially rebalancing the UK economy: The need for a new policy model', http://www.regionalstudies.org/uploads/documents/SRTUKE_v16_PRINT.pdf
210. Magnani M. (2014), 'Creating Economic Growth. Lessons for Europe', <http://www.palgrave.com/us/book/9781137427045>
211. Martin et al. (2015), 'Spatially rebalancing the UK economy: The need for a new policy model', http://www.regionalstudies.org/uploads/documents/SRTUKE_v16_PRINT.pdf
212. Martin et al. (2015), 'Spatially rebalancing the UK economy: The need for a new policy model', http://www.regionalstudies.org/uploads/documents/SRTUKE_v16_PRINT.pdf
213. NAO (2016), 'Local Enterprise Partnerships', <https://www.nao.org.uk/wp-content/uploads/2016/03/Local-Enterprise-Partnerships.pdf>
214. ONS (2017), 'UK Non-Financial Business Economy (Annual Business Survey): Sections A-S', <https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinesseconomyannualbusinesssurveysectionsas>
215. Centre for Cities, McKinsey & Co. (2014), 'Industrial Revolutions: Capturing the Growth Potential', http://www.centreforcities.org/wp-content/uploads/2014/07/FINAL_Centre-for-cities-report2014.pdf
216. CBI (2016), 'Unlocking regional growth', http://www.cbi.org.uk/index.cfm/_api/render/file/?method=inline&fileID=9AF06398-223D-4214-B96F1AD8A2FE4CC8
217. DfE, 'FE data library apprenticeships' <https://www.gov.uk/government/statistical-data-sets/fe-data-library-apprenticeships#history>
218. Ofsted (2017), 'Maintained schools and academies inspections and outcomes as at 31 March 2017', <https://www.gov.uk/government/statistics/maintained-schools-and-academies-inspections-and-outcomes-as-at-31-march-2017>
219. Ofsted (2017), 'Maintained schools and academies inspections and outcomes as at 31 March 2017', <https://www.gov.uk/government/statistics/maintained-schools-and-academies-inspections-and-outcomes-as-at-31-march-2017>
220. National Infrastructure Commission (2017), 'Cambridge - Milton Keynes - Oxford corridor: Interim Report', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/569867/Cambridge-Milton_Keynes-Oxford_interim_report.pdf
221. National Infrastructure Commission (2017), 'Cambridge - Milton Keynes - Oxford corridor: Interim Report', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/569867/Cambridge-Milton_Keynes-Oxford_interim_report.pdf
222. BEIS (2017), 'Science and innovation audits: second reports published', <https://www.gov.uk/government/publications/science-and-innovation-audits-second-reports-published>
223. DCMS (2017), 'The role of culture, sport and heritage in place shaping', <https://www.gov.uk/government/publications/the-role-of-culture-sport-and-heritage-in-place-shaping>

Image references

- Cover Department for International Trade
- Pg16 The University of Liverpool
- Pg22 Jessica Ennis, Mo Farah and Greg Rutherford at the London 2012 Olympic and Paralympic Games, image credit: London 2012
- Pg24 Flight path map, image credit: Department for International Trade
- Pg34 A scientist at the Compound Semiconductor Applications Catapult, Cardiff
- Pg36 SecondHands, a research project led by Ocado Technology, image credit: Ocado
- Pg44 EDF Energy Renewables proposed Blyth Offshore Demonstrator wind farm off the North East of England coast, image credit: EDF
- Pg49 Driverless car, image credit: The Centre for Connected & Autonomous Vehicles
- Pg64 Sir Isaac Newton's reflecting telescope. Image credit: The Board of Trustees of the Science Museum.
George Stephenson's Rocket. Image credit: The Board of Trustees of the Science Museum.
Joseph Swan's lamp. Image credit: The Board of Trustees of the Science Museum.
Sir Godfrey Hounsfield's CT scanner. Image credit: The Board of Trustees of the Science Museum.
- Pg71 Nquiringminds Trusted Data Exchange - used by Belfast City Council, image credit: nquiringminds
- Pg78 Airbus Defence & Space / Mars Rover / Meteron, image credit: UK Space Agency
- Pg83 A technician from Limpet Technology trialling a new access system for offshore wind turbines on the Offshore Renewable Energy Catapult's 7MW Levenmouth Demonstration Turbine. Image credit: Offshore Renewable Energy Catapult
- Pg84 The 42m high iconic Rocket Tower at the National Space Centre in Leicester, image credit: The National Space Centre, Leicester
- Pg88 The first major project of the UK-US Science and Technology Agreement is UK investment in the Long Baseline Neutrino Facility (LBNF) and Deep Underground Neutrino Experiment (DUNE)
- Pg90 Square Kilometre Array, Jodrell Bank, Cheshire
- Pg96 An engineer at The Advanced Propulsion Centre, Coventry, image credit: Advanced Propulsion Centre
- Pg92-93 Future Engineers Hub at the National Railway, York, image credit: National Railway Museum
- Pg106 Secondary school maths pupils, image credit: National Centre for Excellence in the Teaching of Mathematics (NCETM)
- Pg108 New Model in Technology & Engineering, Hereford, image credit: New Model in Technology & Engineering
- Pg112 Students at a maths hub, image credit: National Centre for Excellence in the Teaching of Mathematics (NCEM)
- Pg120 A technician operating machinery, image credit: Department for Work and Pensions
- Pg136 Heathrow Airport, image credit: Heathrow Airports Ltd
- Pg139 High Speed 2, image credit: HS2 Ltd
- Pg147 An engineer working on a wind turbine
- Pg154 Digital rail technology, image credit: Digital Railway
- Pg162-163 Bolton-based manufacturer Pure Fabs, image credit: Business Growth Hub
Savile Row, bespoke tailors Maurice Sedwell, image credit: The GREAT Campaign
Cheadle-based business The Urban Botanist, image credit: Business Growth Hub
- Pg186 Port of Felixstowe
- Pg189 Whisky bottling, image credit: Scotch Whisky Association
- Pg192 Trent XWB-97 production line in Derby, image credit Rolls-Royce plc
- Pg196 A Network Rail engineer, image credit: Unilite
- Pg200 Nissan Juke production line, Sunderland, image credit: Nissan Europe
- Pg212 Citymapper Smartbus, image credit: Gilbert Wedam (Citymapper Limited)
- Pg220 Leeds
- Pg224 Ceramics manufacturing, Stoke on Trent, image credit: British Ceramic Confederation
- Pg226 Alexandra Docks, Grimsby, image credit: Invest North East Lincolnshire
- Pg228 East Devon
- Pg235 Image credit: Norwich Research Park
- Pg236 Titanic Belfast
- Pg238 image credit: The Oil and Gas Technology Centre Aberdeen
- Pg239 Tata Steel





© Crown copyright 2017

This publication is licensed under the terms of the Open Government Licence v3.0 except where otherwise stated. To view this licence, visit nationalarchives.gov.uk/doc/open-government-licence/version/3 or write to the Information Policy Team, The National Archives, Kew, London TW9 4DU, or email: psi@nationalarchives.gsi.gov.uk. Where we have identified any third party copyright information you will need to obtain permission from the copyright holders concerned.

This publication is available from: www.gov.uk/beis

Contact us if you have any enquiries about this publication, including requests for alternative formats, at: enquiries@beis.gov.uk