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UK's turning point

Accelerating new growth on the path to net zero

November 2021

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Transformations are always complex. But the European continent can achieve new growth as it accelerates to net-zero.

Deloitte Economics Institute

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Contents

Foreword

We have known for a long time that our choices are harming the environment and the climate. Our experience of natural disasters – wildfires, droughts, floods and record-breaking heat waves – increasingly shows us the worsening impacts of our choices.

All these changes to our physical environment are taking place during a global pandemic when we have seen our systems tested and sometimes fail. We are now waking up to the consequences of our global connectedness, just as we are appreciating the depth of our mutual dependence. And we are taking stock of what we are personally willing to sacrifice to protect the shared assets on which we rely.

When world leaders meet at COP26 in Glasgow, they – and we – know that the world must choose between two paths: one of insufficient action, and one of bold, rapid investment in decarbonising the global economy, a monumental transformation that needs to be completed at an unprecedented pace.

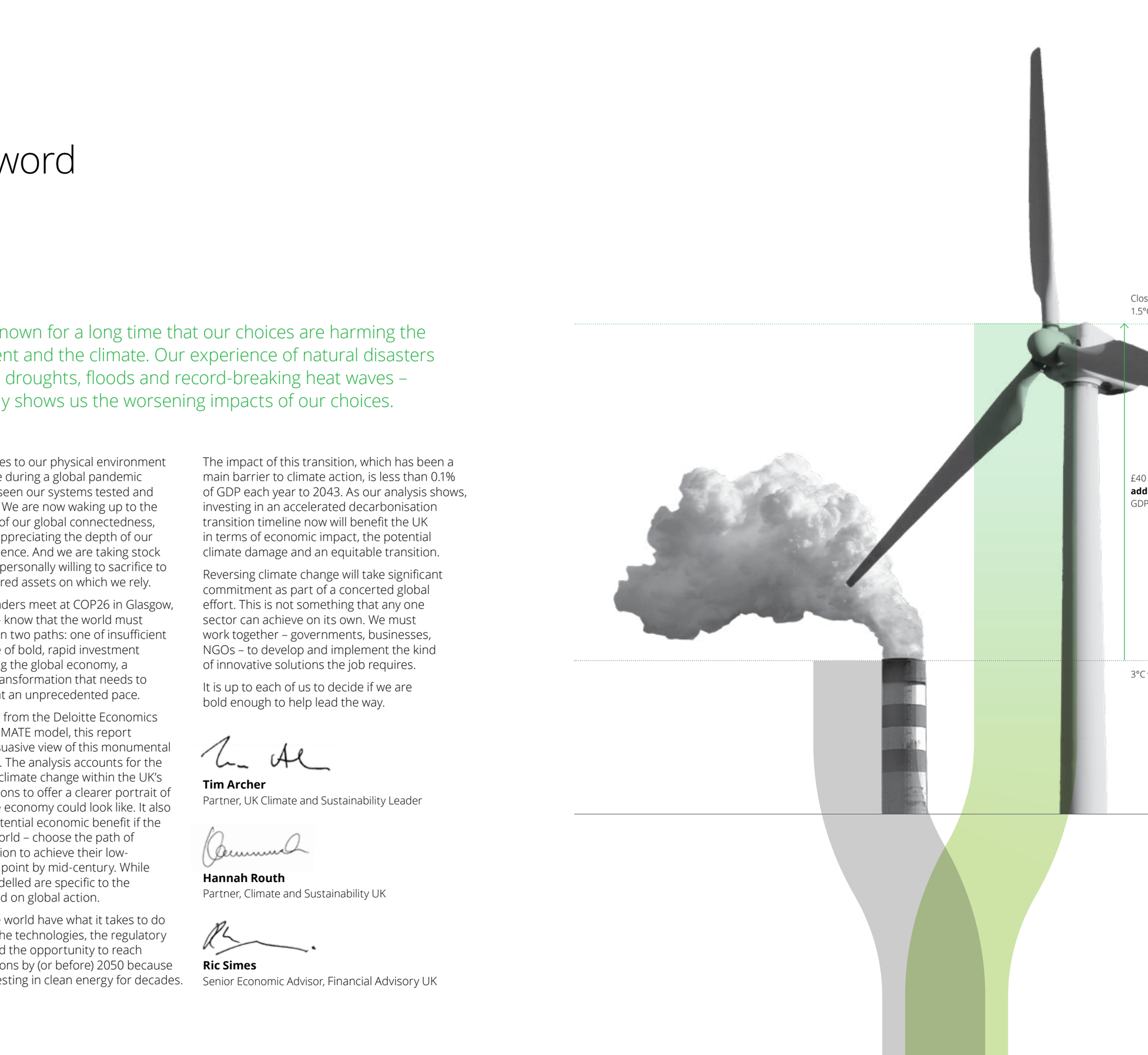
Using new data from the Deloitte Economics Institute's D.CLIMATE model, this report provides a persuasive view of this monumental transformation. The analysis accounts for the costs of global climate change within the UK's growth projections to offer a clearer portrait of what the future economy could look like. It also projects the potential economic benefit if the UK – and the world – choose the path of accelerated action to achieve their low-carbon turning point by mid-century. While the futures modelled are specific to the UK, they depend on global action.

The UK and the world have what it takes to do it. The UK has the technologies, the regulatory frameworks and the opportunity to reach net-zero emissions by (or before) 2050 because it has been investing in clean energy for decades.

The impact of this transition, which has been a main barrier to climate action, is less than 0.1% of GDP each year to 2043. As our analysis shows, investing in an accelerated decarbonisation transition timeline now will benefit the UK in terms of economic impact, the potential climate damage and an equitable transition.

Reversing climate change will take significant commitment as part of a concerted global effort. This is not something that any one sector can achieve on its own. We must work together – governments, businesses, NGOs – to develop and implement the kind of innovative solutions the job requires.

It is up to each of us to decide if we are bold enough to help lead the way.



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Key insights

The UK is a global leader in decarbonisation, but it needs to accelerate its progress to play its part to prevent the worst impacts of climate change.

In 2019 the UK was the first major economy to pass a net-zero emissions law. More recently, the UK government has released its Net Zero Strategy, which establishes and enhances funds for the decarbonisation of buildings, electric vehicle supply chains and as funding research into carbon capture, hydrogen and new nuclear projects.

Although the UK government's recent actions are welcome, it is clear that if the UK as a whole does not accelerate its efforts to curtail carbon emissions by mid-century, there will be a significant cost not only to the UK economy but to economies across Europe and the rest of the world. In addition, climate change puts human health, biodiversity and standards of living at risk. Not all of the economic and social consequences of these risks lend themselves to quantification, but even looking at those that can presents a powerful case for acting now.

Unchecked climate change, where temperatures rise by three degrees Celsius (3ºC) in the next century, could create approximately £115 trillion in global economic losses (in present value terms[a]) over the next 50 years. In 2070, global GDP could be 7.6% lower compared to a world without climate change.

The UK will not escape these effects, although it may be relatively less exposed compared to countries in southern Europe or parts of Asia Pacific. By 2070, it faces £220 billion in economic losses, according to Deloitte's analysis. In this smaller, climate-damaged future modelled by Deloitte, the UK economy could, on average, be smaller by 90,000 jobs *every year* until 2070. This is equivalent to the population of English towns such as Hartlepool or Grimsby. Therefore, achieving net-zero emissions by 2050 is not an aspirational goal, but an economic imperative.

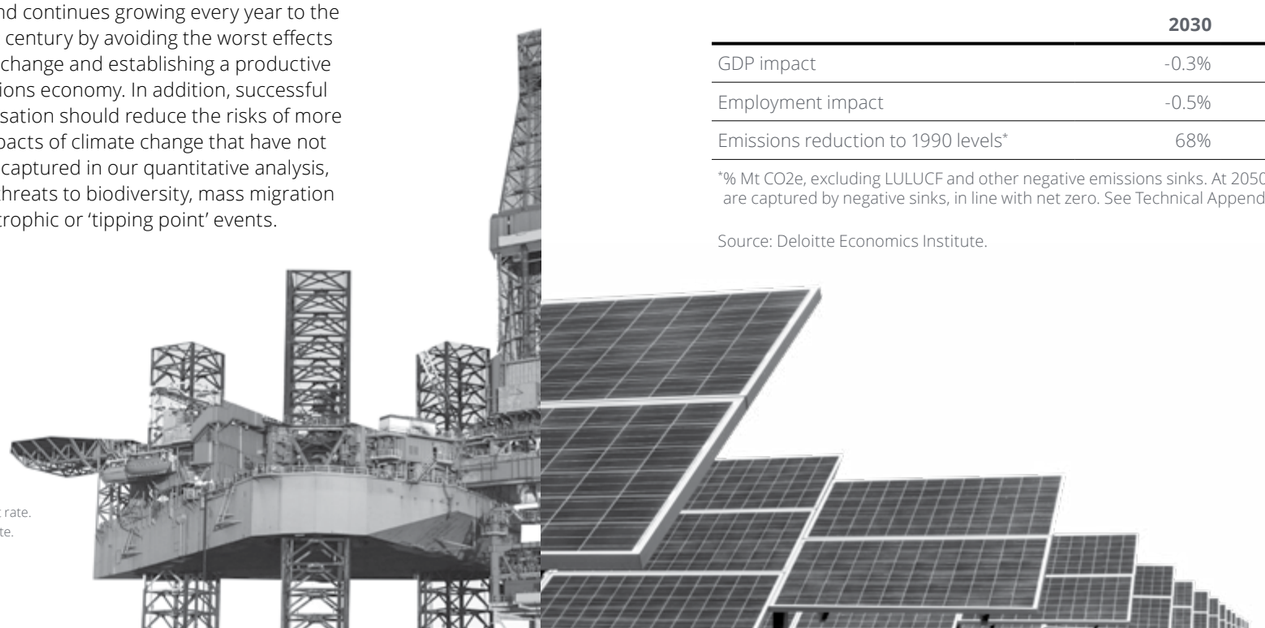
a. Total Net Present Value of deviation loss to global GDP over the period to 2070 at a 2% discount rate. Refer to Technical Appendix for a discussion on the selection and application of the discount rate.

The economic opportunities for the UK outweigh the costs.

Economy-wide decarbonisation to net-zero emissions by 2050 achieves the type of economic transformation that would typically occur over centuries, in just three decades. Decarbonisation would contribute to limiting global warming to close to one and a half degrees Celsius (1.5°C). It would be an extraordinary economic achievement and limit the environmental and social damage caused by climate change.

The rapid and large-scale deployment of wind generation in the UK has helped drive down the cost of renewables globally.[1] With continued investments in a low-carbon industrial revolution, the UK could achieve net-zero emissions by 2050. Doing so would cost 0.1% of UK GDP, or on average £6 billion every year until it reaches its turning point.

The turning point – when the economic gains of decarbonisation are greater than the costs – will come in 2043. After that the benefit of transition increases in every period, reaching 0.6% of UK GDP in 2070, and continues growing every year to the end of the century by avoiding the worst effects of climate change and establishing a productive low-emissions economy. In addition, successful decarbonisation should reduce the risks of more severe impacts of climate change that have not been fully captured in our quantitative analysis, including threats to biodiversity, mass migration and catastrophic or 'tipping point' events.



Decarbonising the UK could transform sectors and strengthen economic resilience.

Decarbonising the UK is an investment in emissions-free energy, mobility and industrial, manufacturing and agriculture systems. On its way to the turning point, the UK's production systems would need to rapidly scale up low-emissions technologies. What is produced and what is consumed will change. The lines between energy-producing and energy-consuming sectors will start to blur as the structure of energy markets evolves. Emerging industries will create new occupations for today's workers. A transformed UK economy would also be well-positioned to capitalise on new global markets for decarbonised exports.

By 2070, this transformation could add £160 billion to the UK economy over 50 years (in present value terms) as the world limits the losses caused by climate change.

In 2070 alone, the net benefit to the UK could be £40 billion. There is also evidence that countries that take early and rapid action to establish green and low-emission production capabilities will be rewarded with more sophisticated and competitive economies in a low-emission world.

This report outlines a model the UK can use to get the pace of reform, the scale of reform and the sequencing of reform right. The phases of decarbonisation we lay out represent the economic interaction of choices made about investments, technology and industrial systems, which together can create a new low-emission economy at the least cost.

Figure 1.1: Economic impact of the UK's decarbonisation pathway

	2030	2040	2050	2070
GDP impact	-0.3%	-0.1%	0.3%	0.6%
Employment impact	-0.5%	-0.4%	0%	0.5%
Emissions reduction to 1990 levels*	68%	80%	85%	92%

*% Mt CO2e, excluding LULUCF and other negative emissions sinks. At 2050, 15% of gross emissions are captured by negative sinks, in line with net zero. See Technical Appendix for further discussion.

Source: Deloitte Economics Institute.

Economics for a new climate

Since the Industrial Revolution, global economic growth has occurred in near lockstep with rising greenhouse gas (GHG) emissions. Even as the world burned fossil fuels and converted land to intensive agriculture, living standards and quality of life improved. While growth has not been constant or even – across countries or individuals – global GDP per person expanded at a rate of about 1.5% per year from 1750 to the present.[2]

This model of conventional economic growth is now running up against an overwhelming scientific consensus. Moreover, our own lived experiences increasingly indicate that the current system of economic production is rapidly generating untenable changes in the climate.[3]

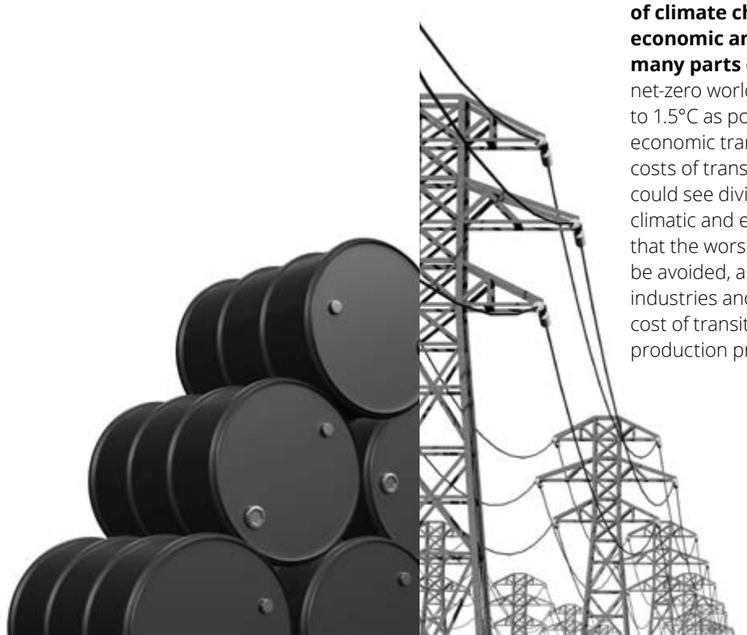
The D.CLIMATE model

This report analyses the D.CLIMATE framework that models the economic impacts of climate change if carbon emissions go largely unchecked, and what could happen when the UK transforms its systems to achieve net-zero emissions with the rest of the world by 2050. The model is based on significant research into region-specific climate and economic impacts across the UK and the world, which are used as inputs for Deloitte's D.CLIMATE model (refer to the Technical Appendix for more details).

Given the many uncertainties of modelling a 50-year time horizon, this exercise is not a forecast or a prediction, but rather scenario analysis to answer the question, 'What if?'.

Climate change impacts have not typically been included in economic analysis, so governments, business and the media alike have assumed a starting point where the economy will grow unaffected by the changes to our physical environment. If we do not include climate change in our modelling, though, it is hard to understand the economic impacts of different climate policy options, such as net zero. Despite the limitations that come with any model, D.CLIMATE provides a better starting point for comparing the costs of different responses to climate change by accounting for the inherent cost of global inaction. The results reveal the magnitude of the challenge, as well as the choices the world can still make to drive prosperity through a low-emission industrial revolution.

Throughout the report, we refer to several assumptions, scenarios and specialised terms which are described briefly on the right.



Our assumptions

- **Climate change is the new normal.** Unless the world takes rapid and coordinated action, an increasingly climate-damaged economy will become the new normal. When evaluating the costs and benefits of mitigation, business leaders and decision-makers should account for the consequences of climate change. Effective climate action requires reorienting our thinking to consider economic systems and natural systems as inextricably linked.[4]
- **Without action, global emissions and temperatures will continue to rise.** Without rapid, systemic change, global average warming would increase by around 3°C toward the end of the century. In this world, insufficient action on climate change would be the baseline path for the economies of the UK and the world. This baseline scenario would negatively impact economic growth, when compared to a world without climate change.
- **Rapid, coordinated global decarbonisation would not only limit the worst effects of climate change, it could also bring an economic and climate turning point for many parts of the world.** Transitioning to a net-zero world and limiting warming to as close to 1.5°C as possible requires an industrial and economic transformation. Despite the initial costs of transitioning, countries and industries could see dividends from their investment. It is a climatic and economic turning point in the sense that the worst effects of climate change could be avoided, and the economic benefits of new industries and technologies would offset the cost of transitioning from emissions-intensive production processes.
- **The net gain or the turning point is different for every economy.** The turning point is different because it reflects the combined impact of economic costs and benefits. The economic structure that creates growth today, and how that's modelled is impacted by decarbonisation. It also greatly depends on the exposure to 'locked-in' climate change impacts as the world warms by at least 1.5°C over the coming decades.

Costs:

- The inevitable costs to the economy as it moves away from emissions-intensive activity.
- The cost to the economy from global warming of at least 1.5°C, even with strong global action to reach net zero by 2050.

Benefits:

- The benefit of avoiding costs from limiting global warming to as close to 1.5°C as possible, instead of reaching around 3°C.
- The benefit of more a productive and modern economy, where demand is being met as consumer and industry preferences have changed.

Our two modelled climate futures

The two scenarios in this report compare what could happen if we allow the planet to warm on a path to 3°C by the end of the century with the economic opportunities of limiting global warming to as close to 1.5°C as possible by 2050.

1. **We do nothing further and global emissions rise ('around 3°C world'):** This economic path represents a future with a high rate of global GHG emissions, where current technologies and strategies reduce GHG emissions and stabilise the temperature increase at around 3°C by 2100. This scenario reflects a widely adopted set of emissions, economic and population assumptions referred to as SSP2-6.0. This scenario is specific to the UK economy and depends on global inaction. The results of this scenario are presented as a deviation, a comparison to a world that does not have climate change impacts modelled.
2. **We act decisively and hit global net zero by mid-century ('close to 1.5°C world'):** This scenario represents a sequencing of efforts by government, business and citizens to transform to net-zero emissions by 2050 and limit warming to as close to 1.5°C as possible - and well below 2°C. This scenario is specific to the UK economy and depends on global action. The results of this 'close to 1.5°C' scenario are presented as a deviation, a comparison to around '3°C world'.

Under each scenario, the rate of economic growth is impacted (deviates from trend) based on different climate and decarbonisation effects.

Glossary of terms

The following references and terms are defined for specific purposes in the context of this report.

Climate change: Changes in the regional and global climate brought about by increased greenhouse gas concentrations in the atmosphere.

Turning point: The economic point where the benefits of decarbonisation start to offset the combined costs of 'locked-in' climate change and the costs to transition the economy to net-zero.

Net zero emissions: A state in which GHG emissions from human activities are balanced by the emissions taken out of the atmosphere. The technical definition of this concept can be found in the technical appendix.

Close to 1.5°C world: This pathway describes a net-zero economy by 2050 in which global average warming is limited to well below 2°C and as close to 1.5°C as possible, compared with preindustrial levels.

Around 3°C world: An economic scenario that relates to a pathway of climate inaction, where the implied temperature change is 3°C above preindustrial levels towards the end of the century.

Representative Concentration Pathway (RCP): A greenhouse gas (GHC) concentration (not emissions) trajectory adopted by the Intergovernmental Panel on Climate Change (IPCC).

Shared Socioeconomic Pathway (SSP): A set of pathways adopted by the IPCC Sixth Assessment that explores how the global economy, society and demographics might change over the next century.

Clean energy and electricity: Clean electricity includes solar, wind, nuclear, hydropower and geothermal production technologies. Zero-emission hydrogen and bioenergy are combined with clean electricity to be described as clean energy.

Conventional energy and electricity: Includes coal, oil and gas as fuels and energy production as well as their use in electricity production. Carbon capture, use and storage are not separately modelled.

The economic impacts of two climate change futures

The economic impacts of two climate change futures

The UK has so far decarbonised faster than any other G7 country.[5] In 2019 the government legislated an interim target of reducing emissions by 68% by 2030, and 78% by 2035 compared to 1990 levels.

But more work needs to be done and the latest science suggests that we do not have much time to make this transition. According to the 2021 IPCC Sixth Assessment Report (AR6), the world's temperature will rise by at least 1.5°C during the 21st century unless deep reductions in emissions occur in the coming decade.[6]

A warming world and a changing climate are visible today. In the UK, flooding in particular has affected farming communities and exposed towns and cities. In the wider world, societies are facing even more dramatic hardships which drive a need for humanitarian intervention and contribute to disruptions in UK trade and migration flows.

Warmer air will increase its capacity to hold moisture, leading to heavier rainfall and increased flooding risk.[7] The devastation wrought by the floods of July 2021 across Germany, Belgium and the Netherlands can be attributed to climate change.[8] When simultaneous flooding struck the UK, India and China, and record-breaking heat affected the Pacific Northwest in the US and Canada, the world watched with a sense of foreboding.

Based on existing levels of warming, the next 30 years will bring similar extreme weather events that will put severe stress on all our systems – agricultural, healthcare, manufacturing, infrastructure and financial. Without significant change, the world is heading towards a climate-damaged global economy.

Accounting for climate inaction

Despite these climate events and scientific research, dominant economic projections tend to assume that economies will continue to grow as they traditionally have done, completely unaffected by the damages caused by climate change. When they do consider climate change damage and mitigation policy, it is often in scenario analyses that compare alternative future states against an erroneous 'business as usual' trend that assumes unconstrained economic growth via emissions-intensive economic production. This is the economic baseline that informs how most decisions and investments are made for governments and businesses alike.

If the economic impacts of a changing climate are left out of economic baselines, the result is likely to be poor forecasts, poor risk management and dangerously inadequate efforts to address the global climate crisis. A growing chorus of voices recognises the challenge and in 2020 the Network for Greening the Financial System (NGFS), made up of 92 central banks, released guidance on the need to solve this very issue.[9] If we are serious about shifting the global economy toward a low-carbon footing, it is critical to understand and account for the longer-term effects of climate change on productivity, output and economic growth.

To assess fully the costs of climate action, they need to be set against the costs of inaction that arise from climate change impacts. Deloitte has developed a framework that integrates the economic impacts of physical climate change into a baseline economic trajectory. Factoring in the costs of climate change reveals the tremendous damage the economies of the world could suffer if climate change goes largely, or wholly, unchecked. Equally important, the model highlights the significant opportunities that could arise if we transform our systems to achieve net-zero emissions by 2050. Our model also identifies the turning point, or the pivotal moment when the benefits from decarbonisation will outweigh the upfront investments.

Creating the UK's turning point

The UK government's new Net Zero Strategy sets out for the first time how the government intends to halve UK emissions in little over a decade, and to eliminate them by 2050. The success of the strategy will bring jobs, investment and wider benefits to the UK. The range of existing policy measures is being supplemented by new measures coming into force or under consideration to tackle the most challenging sectors. UK diplomatic efforts, during and after COP26 will seek to convince more countries to follow that lead.

While the UK rapidly accelerates its ambition for sustainable economic growth, there remains a need to get the economic framework right for the transition to net zero and limiting global average warming to as close to 1.5°C as possible by 2050.[b]

The transition from traditional manufacturing to modern, emissions-free production could create new value in the form of professional services, technology solutions and opportunities for industry diversification. These forms of value will make the UK's economy more resilient, an important metric of success in a low-carbon future.

Navigating the transition

But to reach this turning point of new economic growth, the next three decades will require significant investments, rapid decarbonisation and structural adjustments. The cost of these changes needs to be acceptable to local economies.

While some critics argue that decarbonisation would be too costly, we found that the cost of the transition is not catastrophic, but manageable: Our analysis reveals that the UK can achieve this structural adjustment with an impact of about 0.1% to the UK's GDP, or an average cost of £6 billion every year to 2043.

The UK can offset these costs by carefully coordinating the sequence of choices, investments, and technological and industrial changes that together will create a new low-emission economy. Ambitious action now offers the UK the opportunity to manage and mitigate these adjustment costs, which will be much higher if the country delays and is forced into more abrupt decarbonisation later.

b. In this analysis, net-zero is referred to a state where the UK economy has reduced GHG emissions by more than 90% below 1990 levels by 2050, excluding land use but including carbon removal (natural or human-made). This net-zero pathway for the UK is modelled to coincide with a net-zero global economy and global average warming limited to around 1.5°C by 2050. Further detail can be found in the Technical Appendix.

The scale of the UK's decarbonisation task

While the UK has been on a path of decoupling economic growth from emissions since the 1960s (as measured by emissions intensity of GDP), it still has some way to go.[10,11]

The UK accounts for about 1% of annual global carbon dioxide (CO_2) emissions today and 4.7% of all CO_2 emissions since 1751.[12] In 2019, oil and gas use was the source of over 85% of CO_2 emitted in the UK.[13] However, in the same year the UK generated 26 terawatt hours in renewable energy, which represented 2% of total global renewable energy production.[14]

The rapid and large-scale deployment of wind generation has helped drive down the cost of renewables globally.[15] Long associated with oil and gas production, the North Sea close to the UK shoreline has become a hub of offshore wind generation.

Despite the availability of proven substitutes, the UK has not yet fully transformed its energy systems. In 2020 the UK generated 43% of its electricity from renewable sources but burning natural gas continues to provide a significant proportion of electricity generation. Nevertheless, the UK government has outlined proposals to eliminate fossil fuels from electricity generation by 2035.[16]

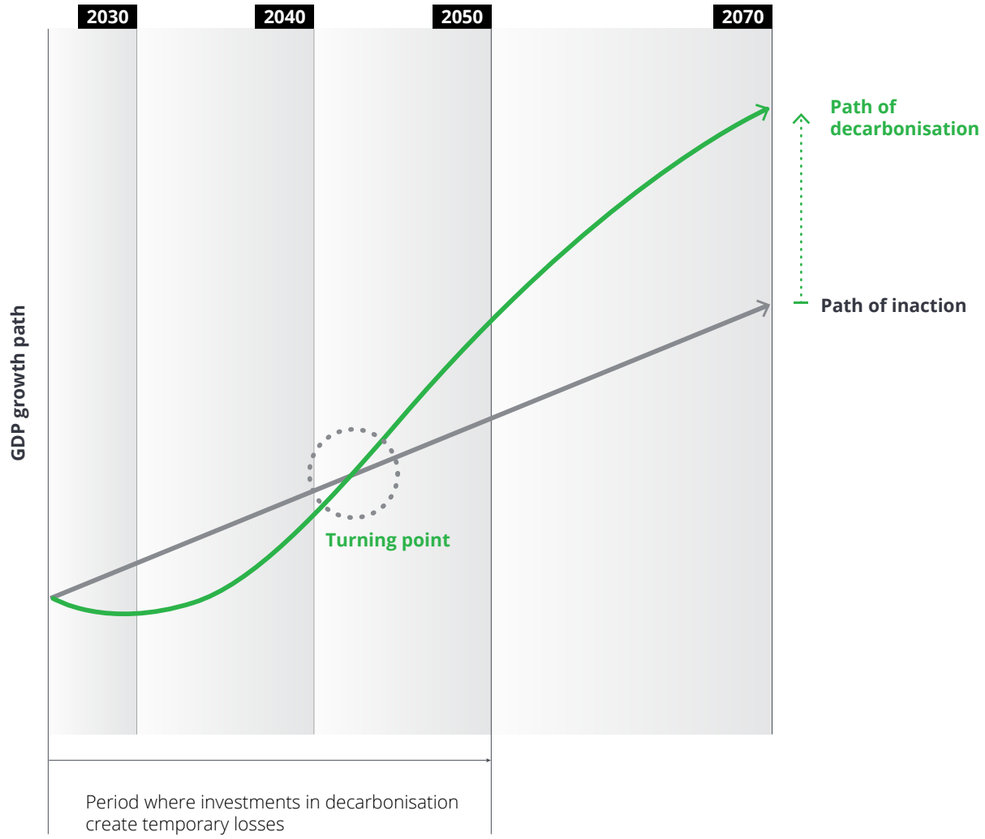
Figure 2.1: Europe's largest emitters have commitments to reduce emissions

	Europe	European Union (EU-27 + UK)	United Kingdom	Italy	France	Germany
Share of global carbon emissions	15%	9%	1%	0.9%	0.9%	1.9%
Target	Of European countries with interim 2030 and net-zero 2050 targets, the implied reduction in emissions on 1990 levels is **45%** at 2030 and **67%** of countries have a net-zero by 2050 target	Cut emissions by at least **55%** by 2030 All members must reduce emissions by at least **40%**	The United Kingdom has an interim target of reducing emissions by **68%** by 2030, and **78%** by 2035 compared to 1990 levels	Italy has an interim target of reducing carbon emissions by around **60%** by 2030	France has an interim target of reducing emissions by **40%** by 2030	Germany has an interim target of reducing emissions by **65%** by 2030

Note: Emission shares reflect carbon dioxide emissions only, attributed to the country in which they physically occur.

Source: Our World in Data and other government sources.[17]

Figure 2.2: Modelled economic growth to 2070 on the path to a 'close to 1.5°C world'



Source: Deloitte Economics Institute.

The cost of climate inaction for the UK

The cost of climate inaction for the UK

If the UK – and the world – do not take significant action to fight climate change and global emissions continue to rise with economic growth, it could result in global average warming of around 3°C by the end of the century (see Modelling climate change impacts in the UK). This is the baseline and trend outlook for the UK and the world.

The UK faces substantial direct impacts from climate change if global average warming is not limited to 1.5°C. Climate change will also affect the UK's trading partners, creating indirect impacts on the UK economy. The UK has a history of growth and engagement with the global economy, but in the face of unchecked climate change it becomes one of decline and retreat.[18] This is the baseline and trend outlook for the UK and the world, without significant change from today.

According to our model, global warming of 3°C would result in economic outcomes across six impact channels, namely: heat stress, capital damage, tourism expenditure flows, lost agricultural land due to sea level rise, agricultural yield changes, and the toll on human health.

In this climate-damaged world, the UK's economic potential would be reduced. Productive capital and knowledge are concentrated on repairing damage, instead of investing in new value-adding innovations and infrastructure. Just as COVID-19 focused efforts on mitigating the impact of the pandemic, climate change is already diverting efforts that otherwise would yield economic progress.

Source: Deloitte Economics Institute.

Figure 3.1: Economic impact associated with climate change

Heat stress
Lost labour productivity from extreme heat

Sea level rise
Lost productive land, both agricultural and urban

Damaged capital
Stalling productivity and investment

Human health
Increased incidence of disease and mortality

Tourism loss
Disrupted flow of global currency

Agriculture loss
Reduced agricultural yields from changing climate patterns

Source: Deloitte Economics Institute.

Rising temperatures, mounting losses

Over the next 50 years, our analysis shows that climate change-induced global economic losses could total approximately £115 trillion in present value terms.[c] In 2070, global GDP could be 7.6% lower than current projections that do not account for climate impacts.

The UK will not escape these effects, although our modelling suggests that it may be relatively less exposed than the rest of the world. By 2070, climate change-induced economic losses to the UK could total approximately £220 billion in present value terms.[d] This will result in the UK's labour force being 90,000 workers smaller every year to 2070.

For comparison, official estimates for the economic cost of flooding in the UK between November 2019 and February 2020, in which thousands of homes and businesses were damaged, appears small at £333 million.[19] By 2070, the GDP cost alone of unchecked climate change would be equivalent to the impact of 1,000 events of this scale.[20,21,22]

Over the next 50 years, the top five most impacted industries in the UK in terms of economic activity comprise 88% of the country's current output. The service sector and manufacturing would each lose around 15,000 jobs per year to 2070. These industries are economic powerhouses and major sources of employment in the UK.

Differing global impacts

While the UK does not face the most extreme direct physical climate risks relative to other countries and regions, if decarbonisation efforts do not accelerate, economic activity all over the world will be at risk. According to our analysis, the Asia Pacific region is estimated to face damages of up to £61 trillion over the next 50 years – putting the assets and operations of UK multinationals in these locations at risk.[23] Global trade and investment would also be impacted by climate damage in other parts of the world, compounding the impacts for the UK. Long-term migration flows driven by climate change could represent another significant risk to the UK and global economy, although they have not been included in this modelling.

Closer to home, our analysis shows there would be significant regional variations in the impacts of climate change in Europe, particularly along a North-South divide. Mediterranean countries could experience twice the GDP impacts as their northern counterparts. Spain, Italy and Portugal could encounter the largest negative effects, with potential economic losses topping 3% of GDP by 2070 due to lower labour productivity and greater exposure of their capital stocks to the physical impacts of climate change.

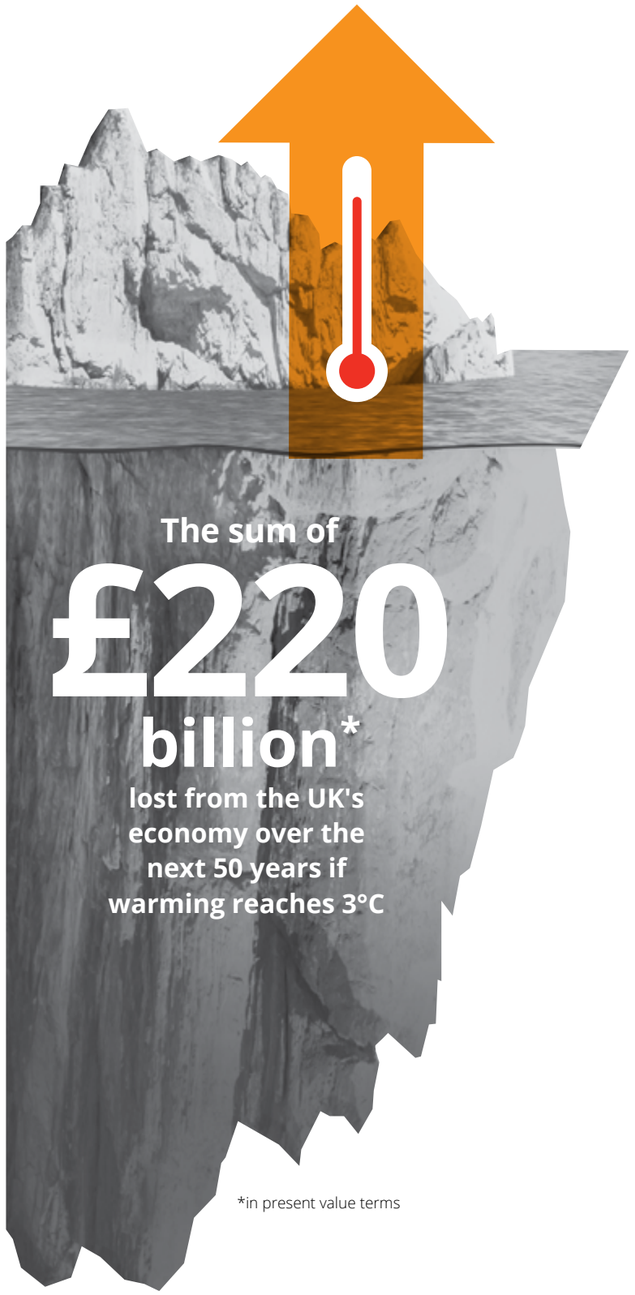


Figure 3.2: Economic impact by industry

Industry	GDP impact 2021-2070 (£ billion, net present value)
Public and private service sectors	**-130**
Manufacturing	**-60**
Transport	**-15**
Retail and tourism	**-10**
Construction	**-10**
Conventional energy	**-2**
Water and utilities	**-2**
Natural resources and mining	**-2**
Clean energy	**1**
Agriculture	**6**

Note: Within the modelling framework, it is possible for agriculture and forestry to experience positive increases to yields, due to warmer conditions, higher concentrations of CO_2 in the atmosphere and different regional patterns of precipitation increasing the geographical and product range of the industry. There is debate within the literature as to the long-term effect of climate change on agricultural and forestry output. With the inclusion of extreme events, greater downscaling of climate outcomes and a wider range of relevant variables (e.g. accounting for soil type), it is possible that climate change would drive net negative outcomes in this industry in the UK. However, in a globally consistent framework, this result is positive for the UK. See Technical Appendix for details on the methodology.

Note: Numbers may not add up due to rounding.

Source: Deloitte Economics Institute.

c. Total Net Present Value of deviation loss to global GDP over the period to 2070 at a 2% discount rate. Refer to Technical Appendix for a discussion on the selection and application of the discount rate.

d. As above for UK GDP. Refer to the Technical Appendix for a discussion on the selection and application of the discount rate.

Opportunities for the UK in a net-zero future

Opportunities for the UK in a net-zero future

If the UK chooses the path of decisive decarbonisation today, in less than 30 years it could achieve what has taken centuries of industrial evolution to accomplish. After reaching its turning point in 2043, the UK could start to enjoy the net positive economic gains of a modern, productive and emissions-free economy. This would be an incredible feat.

As the UK and the world reach the turning point, more severe climate change damage would be avoided and economies would start to yield returns from early and rapid decarbonisation.

This systematic economic and industrial transformation can be achieved at a modest cost – and in such a way where the UK's industries annually increase their size and productive capacity. From the turning point in in 2043, the UK economy is not only growing, it is growing more than it otherwise could.

The transformation of the UK sees increases to GDP in the first net-zero emission decade by 2050. Early and rapid investments in decarbonisation yield a dividend and reduce the costs of transition post-2035 until the turning point in 2043.

The small economic cost from today to 2035 reflects the value of the economic effort that the UK has chosen to adopt to lead the world. This decision ensures that UK industries transform to meet emerging global demand and supports the most emission-intensive industries in transition.

By 2070, this transformation could add £160 billion to the UK economy over 50 years (in present value terms) as the world limits the losses caused by climate change. In 2070 alone, the net benefit to the UK could be £40 billion.

There is also evidence that countries that take early and rapid action to establish green and low-emission production capabilities will be rewarded with more sophisticated and competitive economies in a low-emission world.

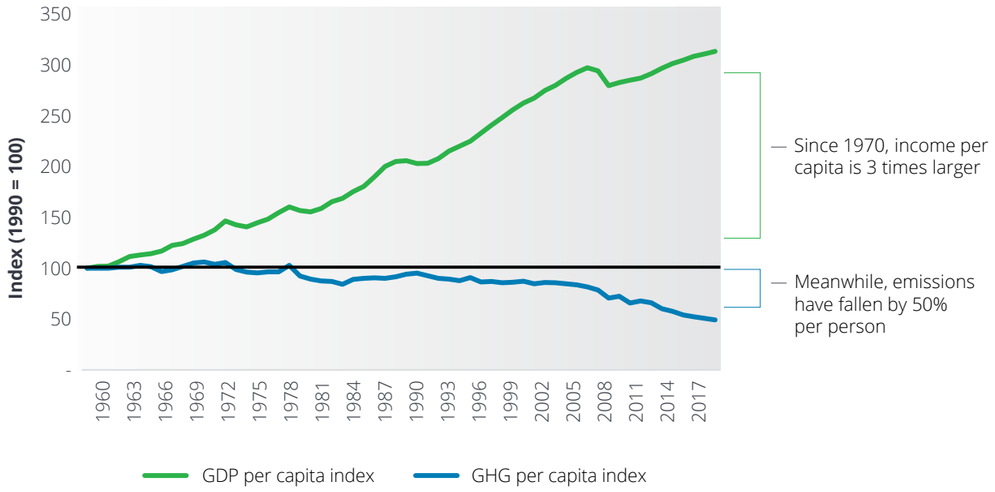
If the UK chooses the path of decisive decarbonisation today, in less than 30 years it could achieve what has taken centuries of industrial evolution to accomplish.

Decoupling emissions from growth

The UK has been on a path to decouple emissions from growth for many years (see Figure 4.1). This decoupling reflects a range of policy measures including the high-level framework provided by the emissions trading system and sector specific measures including renewables support in the energy sector (both large-scale generation and home installations; taxes on motor fuel, obligations to include renewables in transport fuel and support for electric vehicles; energy efficiency requirements for new homes and appliances; and specific interventions in priority manufacturing subsectors).

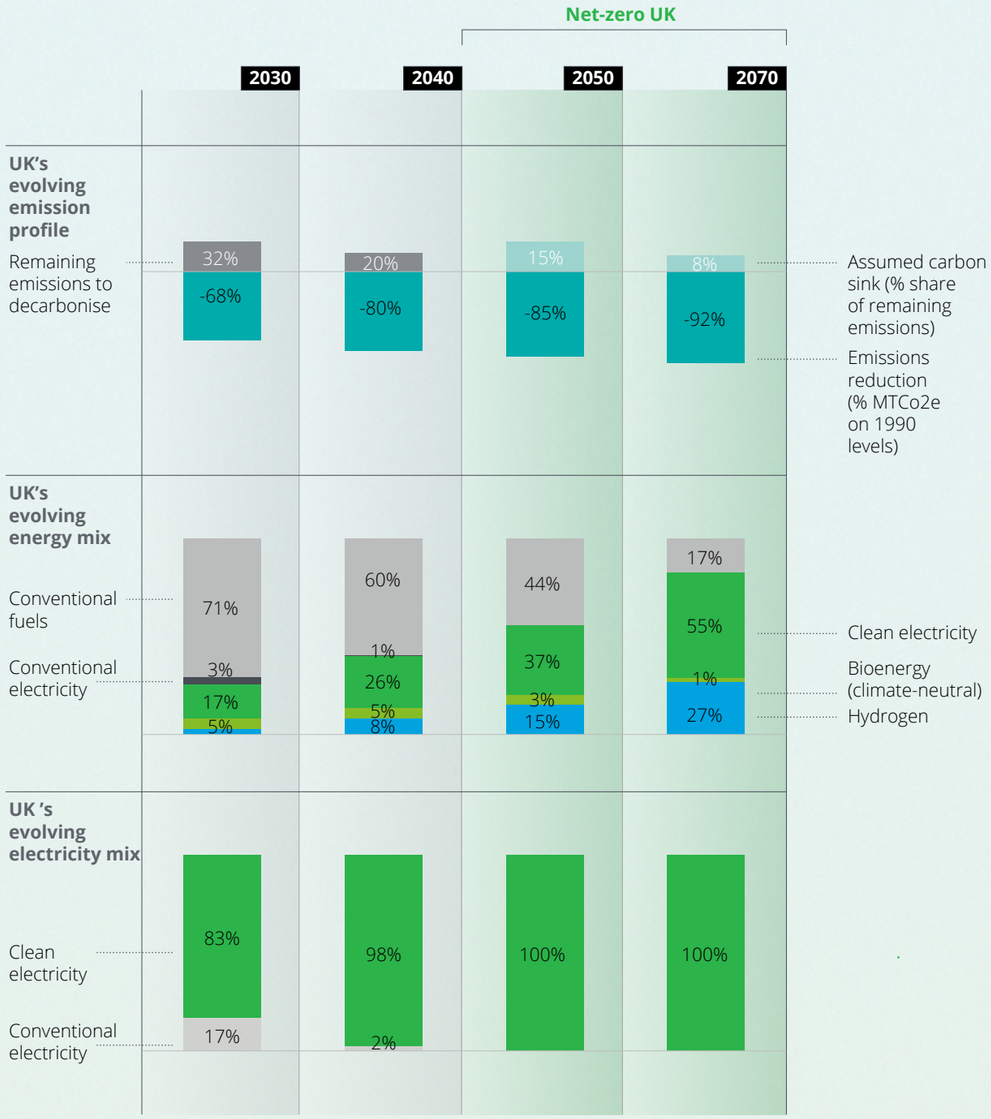
The use of renewables to replace the country's fossil-fuel based generation has driven the decoupling process in the past decade but a step change is required in the UK and elsewhere to meet ambitions. While the UK is committed to net zero, the policy framework needed to complete that process is still being put in place and is likely to include changes that are more challenging than those undertaken so far.

Figure 4.1: Trends in UK per capita GDP growth and carbon emissions



Source: Deloitte Economics Institute analysis of World Bank data
*Per capita GDP growth to 2019; per capita emissions to 2016

Figure 4.2: UK's net-zero transformation in three charts



Source: Deloitte Economics Institute.

Figure 4.3: The UK's step change transformation to a 1.5°C world

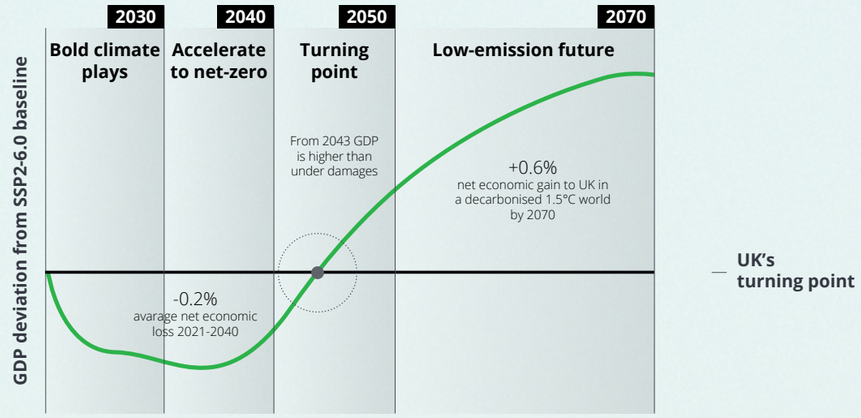


Figure 4.4: Industry opportunity

	Industries that are better off under transition at the end of each phase, in level terms	
Bold climate plays 2021 – 2030	Clean energy Construction	Agriculture and forestry
Accelerating to net-zero 2031 – 2040	Clean energy Construction	Agriculture and forestry Water and utilities
Turning point 2041 – 2050	Clean energy Manufacturing Construction	Retail and tourism Water and utilities Agriculture and forestry
Low emissions future 2051 – 2070	Clean energy Manufacturing Transport	Water and utilities Retail and tourism

Source: Deloitte Economics Institute.

Pathway to a net-zero UK

In the Deloitte modelled scenario, clean energy (primarily renewables like wind and solar) underpins the early and rapid transition, including the significant expansion of 'green' hydrogen using electrolysis to support harder to abate industries. This transition – from the renewable shift in electricity generation to the electrification of industrial and other processes – takes time but results in 100% clean electricity by 2050.[e] Alongside renewable shifts, additional technologies such as storage, firming and distribution services develop together with the generation component of the sector.

These early investments in clean electricity could provide a zero emission energy source to aid green hydrogen production. This will enable transition particularly in industry and support energy security. Early investment in Blue and then a move to Green Hydrogen could fulfil about 15% of the energy mix in the UK by 2050 (see the Technical Appendix).[f]

The D.CLIMATE model of a "close to 1.5°C world" incorporates a number of levers that could drive the transition. These are the underlying drivers of economic adjustment to decarbonisation in the modelled scenario.

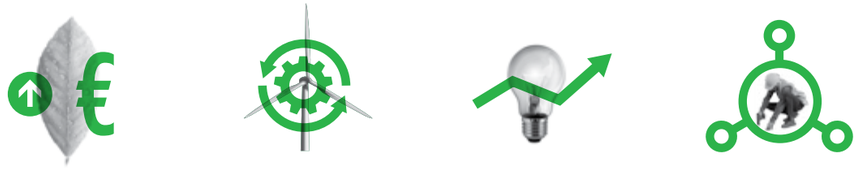
See the Technical Appendix for more details on the mechanisms that drive decarbonisation to reach the UK's turning point.

To aid the interpretation of the modelling results and to explain how the UK could achieve a low-carbon system transformation by 2050, we have outlined four phases of structural economic change: *bold climate plays, accelerate to zero, arriving at the turning point* and *a low-emission future.*

These four phases are narratives that synthesise the combined impacts of different actions and targets, taking place at different points in time.

They include several core features spanning production systems, policy, finance and consumer behaviour. The economic gains of decarbonisation occur in sectors and industries that will be the future of the UK's global comparative advantage.

Figure 4.4: Levers of economic change



Change is valued

- Decarbonisation policies and investments in new technologies accelerate
- The coverage and the value of explicit and implicit carbon prices rise
- Consumer behaviour changes

Energy transforms

- Renewable and clean electricity transform Europe's energy systems
- Renewables become cheaper compared to fossil fuels, increasing substitution in favour of renewables
- Overall energy use becomes more efficient

Fuels switch

- Electrification and the use of new sources of low-emission fuel power industry and households
- This transformation links energy-producing and energy-consuming sectors more closely
- Economies have cheaper and cleaner energy, and more productive economic output from it

Just transition

- No place or sector is left behind in transition
- Strategic economic policy meets the challenge and supports the workers

Source: Deloitte Economics Institute, D.CLIMATE model

e. Carbon capture, use and storage is not separately modelled.

f. The modelling only includes 'green' or zero-emission hydrogen. In practice, during transition, some low emission hydrogen (e.g. 'blue') will be necessary. The energy mix in this context is measured as total final energy consumption.

Bold climate plays: from 2021 to 2030

The UK's first phase of structural economic change begins now. Indeed, the next few years will be pivotal for accelerating technological innovation and creating the market conditions that can deliver decarbonisation at scale.

The next several years set the stage for rapid decarbonisation. The decisions by government, regulators, business and consumers reinforce initial progress and create the market conditions to deliver decarbonisation at pace and scale. Accelerating innovation, investment and R&D in the next decade will deploy the requisite technologies in sectors to achieve reductions after 2030. The coverage of the UK's Emissions Trading Scheme expands; carbon prices rise, making more of these projects attractive to private finance; supply chains transform; and the foundation for a structural shift to limit global average warming to 1.5°C is in place.

The impact of this first decade of global action on the UK's economy is marginal, with an average annual reduction in GDP of 0.2%. Due to the UK's relatively low fossil fuel dependency in its industrial structure, it has one of the least disruptive first ten years of transition, compared to some of its European peers.

The electricity generation sector undergoes a rapid transformation where clean generation technologies such as solar and wind and hydro become a larger share of the UK's production, while fossil fuel sources decline. Britain's four remaining coal-fired power plants have closed.[24]

By 2030, 83% of electricity is being generated by renewable and nuclear electricity sources. The construction sector benefits from this initial uptick in clean production across the economy. Clean electricity remains less than 20% of the broader energy consumption mix, but investments in this period set up the UK's harder to abate sectors to transition towards electrification or clean fuel sources in future phases.

Rapid growth in the clean electricity sector draws many new employees from elsewhere in the labour market, adding an average 20,000 workers per year. This absorbs a number of workers from more fossil fuel-reliant industries, such as conventional electricity generation.

Government policy can also use this transition as an opportunity to drive economic growth where it contributes to the wider objective of levelling up the UK regions. An existing example would be the Humber Renewable Energy Super Cluster and the incentives provided as part of the supporting Humber Enterprise Zone.[25] Siemens recently announced a doubling of the size of a large wind turbine blade factory in Hull.[26] Early investment in decarbonisation means an early, robust domestic market for industrial output of this kind.

Accelerate to zero: from 2030 to 2040

This decade centres on the meeting of interim targets agreed to in the early 2020s. The hardest shifts in industrial policy, energy systems and consumer behaviour are underway. This is a decade where economies, business and industries begin to see the consequences of bold climate plays, with different industries and regions transforming at different paces. The automotive industry across the UK and Europe has moved away from using the internal combustion engine. The recent announcement from Nissan and its industrial partners that a new electric model and batteries will be produced in Sunderland is an indication of the intent of the UK car industry.[27]

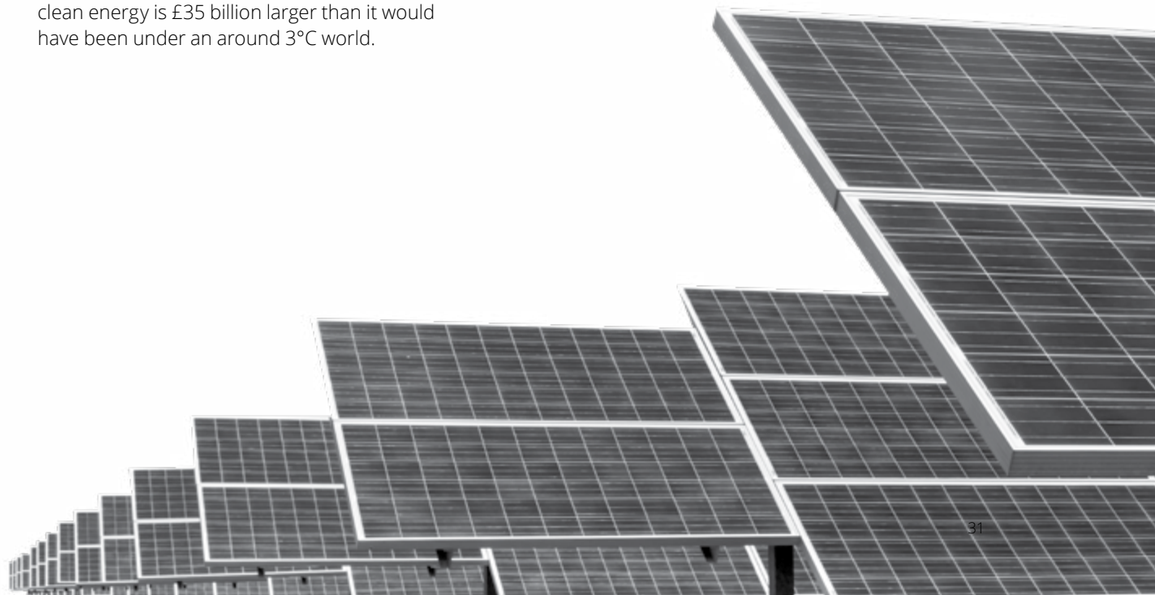
While the UK's aggregate economic output is lower in this period, this reflects a net effect. Sectors such as clean energy and electricity generation are surging ahead as early investments in the previous decade start to pay off. This is offset by sectors that face transition pressures from shifting demand patterns. All sectors are still growing through this period, while reallocating resources towards decarbonising processes.

Decarbonisation of electricity generation is practically complete by 2040. Combined with broader clean energy and fuel technologies like hydrogen and bioenergy, the output of clean energy is £35 billion larger than it would have been under an around 3°C world.

This more than offsets the £30 billion smaller conventional energy sector. The commercial deployment of low-carbon hydrogen production plants across the UK drives demand for water services, boosting output and employment in this sector.[28] The UK announced its first dedicated hydrogen strategy in 2021 including plans for 5GW of low carbon hydrogen production capacity by 2030.[29]

The construction sector benefits from this initial uptick in clean energy production. This occurs due to the infrastructure required to generate the required electricity output, as well as the electrification of the residential and commercial building stock, for example by retrofitting more than 25 million gas boiler-heated homes.[30] In addition to reducing emissions from heating, dedicated climate action enables the construction industry to decarbonise harder to abate parts of its supply chain. As such, employment in the construction industry steadily increases as output remains higher than under a damaged baseline.

Overall, output and employment are marginally lower in this period, but reflect the value that UK society is willing to place on its commitment to a net-zero and low-emissions future.



Arriving at the turning point: from 2040 to 2050

The decarbonisation adjustments in industry are almost made, the cost of new low-emission technologies is decreasing, and net economic gains are shared more widely. These efforts would also ensure that global warming remains on a path as close to 1.5°C – and well below 2°C.

In 2043 the UK reaches its turning point. Its economy is better off after a net-zero transition compared to a world without climate action, both in terms of GDP and employment. From this point on, the transition net benefits grow in every period.

This phase sees manufacturing jobs boom, adding 40,000 jobs relative to a climate damaged economy in 2050. Further, manufacturing output reaches its turning point by 2046, adding £9 billion to the economy by 2050. The industry is able to add value to the economy rapidly as it utilises the new opportunities presented by decarbonisation. For comparison, according to the Office for National Statistics (ONS) the gross value added (GVA) for agriculture, forestry and fishing in 2019 was £13 billion while the GVA for automotive manufacturing was £15 billion.[31]

After an initial shock of the decarbonisation phase during the 2020s, the UK's strengths in chemicals, medical and transport manufacturing are solidified and are further enhanced by the world's need for decarbonised manufacturing production. The UK's relatively sophisticated manufacturing sector means that it attracts a highly skilled workforce.

The acceleration in the wider economy between 2040 and 2050 drives output and jobs gains in the UK in retail and tourism. Disposable incomes in the wider economy are higher across a large portion of the economy relative to a climate damaged world, supporting outcomes in those industries.

Notably, this period also sees construction peak in terms of additional jobs, compared to a world without climate change action. As improvements occur in resource and energy efficiency, construction is able to operate more effectively whilst also decarbonising its processes, allowing it to rapidly grow its workforce. This boost in employment is also likely a result of the demand for decarbonising the existing stock of buildings, creating a short but high demand for construction workers which slows over time as existing buildings are retrofitted with new technologies and building standards to improve their energy efficiency.[32]

Overall, the net-zero transition is not as impactful on the UK economy as in other parts of the world. However, the region is able to leverage the benefits of transition, leaving GDP more than £13 billion higher than in a world without climate change action in 2050. Employment in services continues to grow and the UK develops a competitive advantage in low-emissions manufacturing. This will reflect the established strengths of the UK in a range of sectors including both the industrial sectors mentioned above and the supporting financial, business and other services that can enable the corporate effort needed to deliver decarbonisation globally.

A low-emission future: beyond 2050

Economies globally are at net-zero emissions and keep global average warming to around 1.5°C by the end of the century. Economic structures have been radically transformed, underpinned by a series of interconnected, low-emission systems spanning energy, mobility, manufacturing, and food and land use.

The energy mix is dominated by low- or zero-emission sources across every market, with green hydrogen and negative emissions solutions, both natural and technological, playing prominent roles. Over half of the UK economy's final energy consumption is provided by clean electricity.

Notably, the UK has turned a corner of decarbonisation and economic transition, and has started to see the full economic benefits heading towards 2070. The UK economy will see a significant expansion in its workforce due to the opportunities for new markets that a net-zero transition creates, with an additional net gain of 472,000 jobs as of 2070.[g] A low-emission future is benefitting trading partners globally and offers the world new sources of decarbonised and less resource-intensive economic growth.

In 2070, a decarbonised energy and manufacturing system is the largest beneficiaries of transition in the UK. These two high growth sectors make a significant contribution to the UK's employment net gains, providing a combined additional £250 billion to GDP and 600,000 jobs relative to a climate damaged world.

Not only has a net-zero transition allowed for the significant expansion of the clean energy industry, it has also revitalised the UK's manufacturing industry, creating new opportunities in decarbonisation and net-zero technologies. Further, the manufacturing industry benefits significantly from the avoided damages of climate change, allowing it to boom under a net-zero transition and avoid damages to labour productivity and capital caused by heat stress.

The UK's most emissions-intensive industries have now also reached their turning points. Emissions-free and electrified systems of transport and mobility add £7 billion to the economy, as well as an additional 13,000 jobs in 2070 alone. With coordination and rapid decarbonisation policy, the UK can revitalise and strengthen even its most emissions intensive industries.

While the specific makeup of the industries that are expected to prosper in this period is difficult to predict, if the UK can maintain its strong science base it should be able to maintain long-term clean growth. This could include new sources of low carbon energy. It could also include applying the knowledge gained through decarbonisation to other consumer and business needs. To the extent that decarbonisation requires ongoing improvements in a wide range of fields from battery technology to marine engineering, such improvements could also provide a range of other benefits.

g. This is a net figure taking into account sectors that are adding jobs and those that are losing them.

Concluding thoughts

Regional action for a global challenge

Climate change is taking place, and the changes in our physical environment will have an increasingly direct impact on our lives. The disruption that one powerful storm causes today could become the norm for storm damage in a climate-changed future where such events will be more intensive and occur more frequently. This damage will interrupt business operations, put a strain on local and regional governments, and harm human life - all of which comes at a significant cost.

Because uncontrolled climate change is dangerous for our economies and societies, we must work together to prevent it. Unfortunately, the discussions that governments, businesses and financiers are having to address decades of postponed action.

These first steps will be the hardest ones.

Around the world and across industries, there will be major changes to how people get around, what kinds of jobs they can do and how the businesses where they work create value. In some regions, entire industries are at risk. There may be times over the coming decades when some may question whether what we are doing is even working, while others may say that the price is just too high.

Yes, there is a real cost to change. Whether we are building clean energy sources, developing a carbon trading scheme, or funding the transformation of emissions-intensive industries, these economic investments will take time to yield measurable growth.

However, the benefits at a local level will likely accrue immediately. Construction workers would benefit from the new jobs building offshore wind farms. Public service workers would be actively managing the system change. Former fossil fuel workers will find use for their skills in new industries. Capital markets could support the transformation of the energy industry, driving the benefits throughout the economy.

Yet even if the UK takes bold and collective action, it needs to be responsive to what is going on in other parts of the world. That's because the built-in assumptions about the outcomes of the UK's decarbonisation depend on the efforts of all the regions of the world.

In its role post-COP26, the UK can have an outsized influence on global decarbonisation – and the world's turning point. The UK can act as an advocate, making the case that decarbonisation is in the best environmental, social and economic interests of countries everywhere. It can act as a policy example showing other countries how to decarbonise at the least cost and how to decouple emissions from economic growth. The UK can also provide expertise by developing underlying technologies and supporting practical measures to decarbonise in other economies through its traditional strengths in financial and business services. All of this depends upon, but will also complement, the UK's own commitment to net-zero emissions and drive global action on climate change.

Limitations of our work

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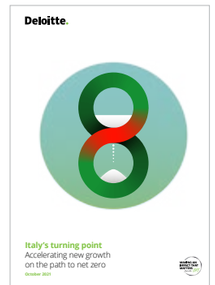

Appendix

Modelling climate change impacts in the UK

To quantify its conclusions, the Deloitte Economics Institute modelled the economic impacts of a changing climate on long-term economic growth using the following stepped process:

1

The model projects economic output (as measured by GDP) with emissions reflecting a combined Shared Socioeconomic Pathway (SSP)-Representative Concentration Pathway (RCP) scenario, SSP2-6.0, to the year 2100. The socioeconomic pathway, SSP2, is the 'Middle of the Road' among five broad narratives of future socioeconomic development which are used in conventional climate change modelling. The climate scenario, RCP 6.0, is an emissions pathway without significant additional mitigation efforts (a baseline scenario).[33] This results in a projected emissions-intensive global economy.

2

Increased atmospheric greenhouse gases cause average global surface temperatures to continue rising above pre-industrial levels. In the SSP2-6.0 baseline scenario, global average temperatures increase more than 3°C above pre-industrial levels by the end of the century, according to the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC). (Note that present-day temperatures have already risen more than 1.0°C above pre-industrial levels.)

3

Warming causes the climate to change and results in physical damage to the factors of production, for example, labour, capital and land). The Deloitte model includes six types of economic damage, regionalised to the climate, industry and workforce structure of each defined geography globally.

4

The damage to the factors of production is distributed across the economy, impacting GDP. Any change in emissions (and, correspondingly, temperatures) over time results in a change to these impacts and their interactions. The economy impacts the climate, and the climate impacts the economy.

5

The key variables of time, global average temperatures and the nature of economic output across industry structures combine to offer alternative baseline views of economic growth. Specific scenario analysis is then conducted, referencing a baseline that includes climate change damage. Scenarios can also include policy actions that either reduce or increase emissions and global average temperatures relative to the current SSP2-6.0 baseline view.

This modelling framework involves significant research on region-specific climate and economic impacts globally, which are used as inputs for Deloitte's D.CLIMATE model (refer to the Technical Appendix for more detail).

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