

DEMOS

THE CLIMATE CONSENSUS

THE PUBLIC'S VIEWS
ON HOW TO CUT
EMISSIONS: RESULTS
FROM THE CLIMATE
CALCULATOR

SEPTEMBER 2021

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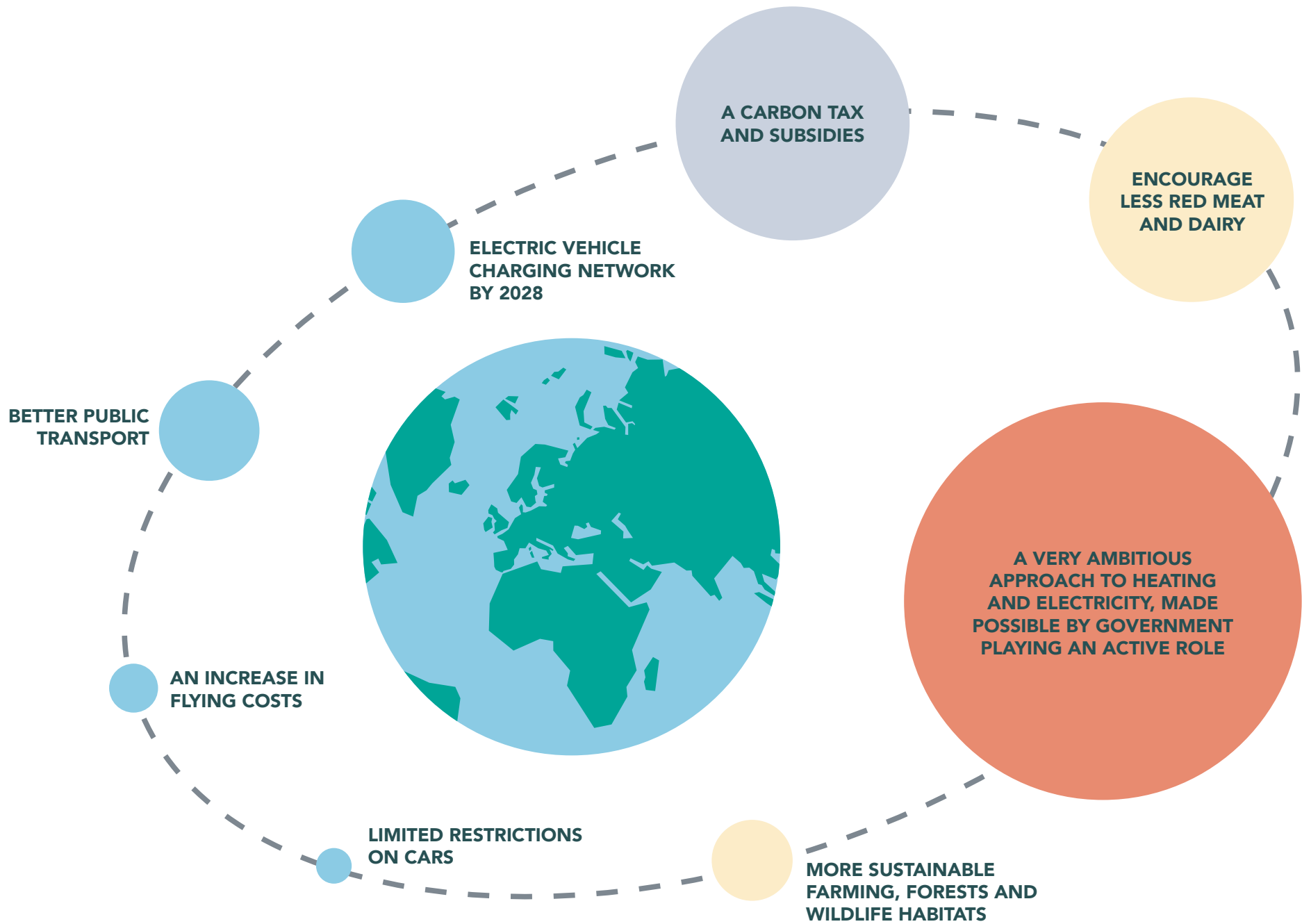
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Andrew Phillips and Charles Seaford



EXECUTIVE SUMMARY

The UK's 2030 climate target is within reach.

At a decisive point for climate action, this report marks a major intervention in the climate policy debate, presenting a viable path to meeting our 2030 target chosen by the UK public.

Made possible by innovative new technology, we report on a package of policies that represent the commitments and trade-offs we as a country are prepared to make, based on the input from a nationally representative group of nearly 20,000 people. We believe the Climate Calculator can be a vital part of stimulating a national conversation about how best the UK should address climate change.

THE POLICY PACKAGE

A carbon tax and subsidies for industry

Manufacturing and construction businesses pay a tax of £75 per tonne of CO₂ equivalent emitted. Those industries that find it difficult to decarbonise but put in place greener processes also receive a subsidy for CO₂ equivalent that they do not emit as a result. Manufacturers pass on their extra costs to consumers, so prices of some products increase. However, the proceeds of the tax are redistributed to households.

Better public transport

We continue with current levels of investment in improving buses and cycling (about £1bn a year), but also move to a system in which local government coordinates routes, improves services and sets fares. This will take some additional investment but will not be much more expensive than the current system in the long run.

Encourage less red meat and dairy

A strong campaign run by supermarkets, food companies and government makes plant-based foods and meat alternatives easier and more attractive to choose and cook, and increases

awareness of the health and climate benefits of a change in diet. This reduces red meat and dairy consumption per person by 10%.

Charging network for electric vehicles by 2028

A comprehensive network of public charge points for electric vehicles is in place by 2028: everyone without their own off-street parking will have access to a charge point in the street they live in, and for those on longer journeys, there will be rapid charge points at car parks and all petrol stations. For those with off-street parking, private charge points will be available for about £700. There will be a strengthened electricity grid to make this possible.

An increase in flying costs

A frequent flier levy is introduced which would involve no tax on the first return flight and at least 10% on the second, 20% on the third, 30% on the fourth and so on.

Limited restrictions on cars in city centres and on motorways

Major cities introduce limited restrictions on cars entering city centres. The motorway and dual carriageway speed limit is reduced to 60mph in order to reduce emissions and there is greater use of temporary 50mph limits to smooth speeds and reduce congestion.

More sustainable farming, forests and wildlife habitats

Some land is used for tree planting and to restore areas of peatland. Remaining agricultural land is also used to support less intensive, more sustainable and organic forms of farming. This reduces degradation of soil and protects biodiversity of insects, birds and other wildlife through reduced use of chemical fertilisers and pesticides and through paying farmers to create woodland, wildflower meadows and hedgerows.

A very ambitious approach to heating and electricity, made possible by government playing an active role

The government increases its 2030 target to 1.4m existing homes to have heat pumps installed each year, with 770,000 to be insulated. It takes an active role to ensure sufficient supply of heat pumps and insulation to households, that these create UK jobs, and that costs are minimised. It provides a grant to cover some of the additional costs and it introduces a government-backed loan scheme at low interest rates to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets more ambitious targets for wind and solar electricity generation.

A NEW WAY FORWARD

The Climate Calculator was built to create a step change in public engagement around climate policy, creating a new opportunity for people in the UK to determine a route to our 2030 climate target. The first of its kind, it allowed the public to weigh up the impact of individual policies on emissions as well as on household costs, jobs and health, enabling them to create a combination of measures to reach the target. It is still live, and we encourage readers who have not already used it to try it out (www.climatecalculator.co.uk).

Participants explored six policy areas: electric cars, public transport and cycling, heating, flights, food and land use, and other things we buy (covering manufacturing and construction). In each, people were presented with a series of policy options, from those maintaining the government's current approach to those requiring significant government intervention. This gave people the power to concentrate changes in a few sectors or to make smaller changes across more areas, but either way it required them to reach the UK government's 2030 climate target of a 39% emissions reduction from a 2019 baseline.¹ The package that emerged is therefore more than just a list of popular policies: it is a measured set of choices, compromises and investments the public are prepared to make to tackle climate change.

These measures, if taken together and taken soon, would result in a 42% reduction in emissions by 2030, exceeding the government's existing target and setting the country on a clear path to net zero.

They would cost households with an income of between £22,000 and £35,000 just £1.30 a week on average, and households with an income of between £35,000 and £53,000 just £3.75 a week on average. Those with an income of less than £22,000 would be 85p a week better off. We estimate the policies would create around 1,000,000 jobs as well as delivering improved health from better air quality and healthier diets, and improved biodiversity from more sustainable farming.

The most popular policies chosen by the public require government to take an active approach, leading a well-planned and orderly transition. Crucially, they are supported by public willingness to shoulder the required costs, provided those on lower incomes are protected. The policies in the package attracted between 77% and 94% support. All regions, income bands, supporters of different political parties and age groups converged on the same list and there was only limited variation in the levels of support for different policies from different demographic groups.

Further detailed policy development is needed of course, but this should be done with the public, using tools similar to the Climate Calculator. This has already shown how effective this form of engagement can be.

We urge the government to incorporate the public's priorities reported here into its imminent Net Zero Strategy: the public has spoken and it's time for the government to act.

¹ The 39% emissions reduction target by 2030 from a 2019 baseline is expressed in the UK's official climate target under the UNFCCC as a 68% reduction by 2030 from 1990 levels; if emissions from international aviation and shipping were included in this target, it would require a 64% reduction from 1990 levels in 2030.

INTRODUCTION

This report describes the Climate Calculator, the first public engagement tool that calculates the impacts of different climate policies chosen by users on greenhouse gas emissions and household budgets over the next decade. It is therefore the first such tool that gives the public the information they need when assessing alternatives. This report goes on to describe the policy choices that a nationally representative sample of just under 20,000 made when using the Calculator to choose their preferred policies to hit the government's 2030 emissions target.

THIS REPORT

In this introduction we set out the rationale for the Calculator and summarise how it works. In Chapter 2 we present what the Calculator shows about the costs to households of hitting the government's 2030 target. In Chapter 3 we report on the policy choices that the public made and Chapter 4 contains conclusions.

There are then six annexes. Annex 1 contains a link to the public's policy choices broken down by parliamentary constituency, using MRP analysis. Annex 2 sets out the public's policy choices broken down by different demographic categories and 2019 general election vote. Annex 3 contains the polling tables underlying the results in Chapter 3 and Annexes 1 and 2. Annex 4 sets out the analysis behind the descriptions of choices and impacts in the Calculator. Annex 5 contains details of the poll and MRP analysis, and Annex 6 contains a list of policy sources.

THE NEED FOR PUBLIC ENGAGEMENT

The UK has a good record on reducing greenhouse gas emissions: between 1990 and 2019 it achieved the largest reduction in the G20, down by 40%.² In

2019, it became the first major economy in the world to introduce a legal target for reducing emissions to net zero by 2050. And since then it has set several intermediate targets, the most immediate of which is for 2030: a reduction of 39% compared to 2019 levels.³

The UK government has already made some commitments that will contribute to meeting this target and work is underway on further policies. However, policies announced so far are not enough to meet the UK's 2030 target: according to the Climate Change Committee (CCC), current policy areas which are "on track" or "potentially on track" cover less than half of the required emission reductions by 2030.⁴ The CCC summarised the situation in its recent progress report to Parliament: "The path to net zero requires a rapid scale-up in low-carbon investment and low-carbon choices across the economy. Government must lead that change with more urgency than we have seen so far."⁵

The 40% reduction since 1990 was largely achieved by decarbonising electricity generation - in particular by reducing reliance on coal, and more recently by increasing solar and offshore and onshore wind capacity. This has required relatively little public engagement: citizens did not need to change their spending patterns, and indeed, with the exception of onshore windfarms and infrastructure close to the North Sea, they hardly needed to be aware of the effects of decarbonisation at all. However, citizens will be very aware of the changes needed to hit the 2030 target, and for some it will mean a change in how and where they spend money. For example, some people will change how they heat their homes, and some will switch to using electric cars. This is why Kwasi Kwarteng (Secretary of State for Business, Energy and Industrial Strategy) and Alok Sharma (President for COP 26) wrote in 2020 that "it is

² Climate Change Committee. Progress in reducing emissions: 2021 Report to Parliament. June 2021, p. 8. Available at www.theccc.org.uk/wp-content/uploads/2021/06/Progress-in-reducing-emissions-2021-Report-to-Parliament.pdf [accessed 13/09/2021]

³ Equivalent to a 64% reduction compared to 1990 levels, including international aviation and shipping.

⁴ Areas which are "fully on track" or "potentially on track" would reduce emissions by 16% in 2030, compared to 2019. Climate Change Committee. 2021 Progress Report to Parliament: Supporting information, charts and data - Progress in reducing emissions. June 2021, Figure 2. Available at www.theccc.org.uk/publication/2021-progress-report-to-parliament [accessed 13/09/2021]

⁵ Climate Change Committee. Progress in reducing emissions. 2021. p. 16.

important that we involve the public and bring them with us, so that the decisions we make align with society's concerns and values."⁶

In 2020 the UK Climate Assembly met - an innovative democratic engagement exercise, which brought together 108 people from across the UK to discuss how we should reach net zero by 2050. The Assembly members agreed that ongoing public engagement was vital, and "informing and educating everyone" was their most popular underlying principle for the path to net zero.⁷ Mr Kwarteng and Mr Sharma said that they "wholeheartedly agree with the spirit of [the Assembly's] recommendation on greater citizenship involvement around climate change."⁸ The CCC has also identified developing a public engagement strategy as a "priority recommendation" for the government in 2021-22, stating that the government should "develop... a public engagement strategy for net zero which builds on the findings of the UK Climate Assembly by involving people in decision-making, providing trusted information on decarbonisation choices and the need to reduce emissions and adapt to climate change. The strategy should also identify preferred policy options to empower people to contribute fully towards the path to net zero."⁹

HOW THE CLIMATE CALCULATOR HELPS

The economic case for acting is now clear - according to the Bank of England, not acting to reduce emissions would be five times more expensive for the economy as a whole by 2050, compared to taking action now.¹⁰ At an economy-wide level, the costs are manageable for the UK government.¹¹ But that does not mean that these costs should not be discussed in a detailed and thoughtful way by the public. If they are not, the transition risks losing public support.

It has been argued that a discussion is not taking place because the costs of climate policy for the typical household have not been made clear and because voters have not been consulted adequately. We agree that these costs should be made clear and that voters should have a choice. They need to be engaged in decision-making, and be given reliable

information about the changes required over the next decade and the implications that alternative approaches have for households.

That is what the Climate Calculator helps to provide. Building on the work of the Climate Assembly, the Climate Calculator is a way to engage a much wider audience. As already described, users of the website can select their preferred options for reducing emissions by 2030 across a range of areas, and can see the impacts of their decisions not just on emissions, but also on household budgets, jobs and health. There is also extensive explanation available about the changes in each area available for users to read.

HOW THE CLIMATE CALCULATOR WORKS

The best way to see how the Climate Calculator works is to use it – www.climatecalculator.co.uk – but we summarise its main features here.

Users are invited to select policies in six areas: electric cars, public transport and cycling, heating, flights, food and land use, and other things we buy (covering manufacturing and construction). Each of these topics is complex, but in each area we have simplified the choices to one or two questions - for example, by what date should an electric vehicle charging network be ready? Or, how high a carbon tax on industry should be in place by 2030? Importantly, our experience is that this exercise did not lead to superficiality – rather the contrary, it forced us to focus on the key decisions that will have to be made, and helped prevent those becoming obscured by extraneous detail. However, users can access details about what their choices mean, and as these choices are made, they are shown the implications for UK domestic emissions reductions by 2030 and for household budgets (users are asked to select which household income quintile they are in, so they can then see the impact on their household budget). All the policies are revenue neutral: where government spending is required, the costs to households through taxation, bills or a combination of the two are shown. The Calculator also shows the employment impacts of the various policy options presented to users. We provide detailed descriptions

6 HM Government. The Government Response to the Committee on Climate Change's 2020 Progress Report to Parliament. October 2020, p. 6. Available at www.gov.uk/government/publications/committee-on-climate-changes-2020-progress-report-government-response [accessed 13/09/2021]

7 Climate Assembly UK. The path to net zero. 2020, p. 12, 58. Available at www.climateassembly.uk/report/read/final-report.pdf [accessed 13/09/21]

8 HM Government. The Government Response to the Committee on Climate Change's 2020 Progress Report. 2020. p. 6.

9 Climate Change Committee. Progress in Reducing Emissions. 2021, p. 192. Available at www.theccc.org.uk/publication/2021-progress-report-to-parliament [accessed 14/09/21]

10 Bank of England. Key elements of the 2021 Biennial Exploratory Scenario: Financial risks from climate change. July 2021. Available at www.bankofengland.co.uk/stress-testing/2021/key-elements-2021-biennial-exploratory-scenario-financial-risks-climate-change [accessed 14/09/21]

11 Office for Budget Responsibility. Fiscal risks report. July 2021. Available at <https://obr.uk/frr/fiscal-risks-report-july-2021> [accessed 14/09/21]

of the topics and explanations of how we calculated the impacts of different choices in Annex 4. Some policy areas are not presented to users because they are technical or make only a limited difference before 2030: these include areas such as shipping, waste and greenhouse gas removals.

The impact of policies on emissions was calculated in two stages. First, we assessed the impact of policies on a set of 'policy outcomes' (for example reduction in car use, or expansion of wind-powered electricity generation). We then used the MacKay Carbon Calculator developed by the Department for Business, Energy and Industrial Strategy (BEIS) to project the impact of these outcomes on UK emissions in 2030.¹² At the same time, we modelled the impacts of these policies on tax, prices and jobs. The CCC's analysis, supporting reports and policy recommendations in the Sixth Carbon Budget were our primary source for this work but we also drew on an extensive range of other sources, including policy recommendations, in many recent research reports.¹³

Demos and WWF worked together to produce the Climate Calculator. The project was supported by National Grid and ScottishPower.

¹² Department for Business, Energy and Industrial Strategy. MacKay Carbon Calculator. Available at <https://mackaycarboncalculator.beis.gov.uk> [accessed 14/09/21]

¹³ Climate Change Committee. Sixth Carbon Budget. December 2020. Available at www.theccc.org.uk/publication/sixth-carbon-budget [accessed 14/09/21]

COSTS FOR HOUSEHOLDS

There is enormous uncertainty among the public and politicians about the costs of addressing climate change, and therefore there is potential resistance. The Climate Calculator shows that the costs to households of hitting the government's 2030 climate target need not be that great and changes to lifestyles can be reduced by effective government action.

WHAT THE CLIMATE CALCULATOR TELLS US ABOUT COSTS TO HOUSEHOLDS

The Climate Calculator shows that hitting the government's 2030 climate target will involve costs, but that with the right policies in place, these can be limited. It also shows that changes to lifestyles, at least in the next decade, can be reduced by early and well-planned government action.

In particular, the less well-off do not need to pay anything at all in the next 10 years, if policy is designed to protect lower income groups. In fact, our analysis found that if a carbon tax was redistributed to citizens, low-income households could actually be better off in 2030.

For example, one combination of policies¹⁴ to reach a 39% emissions reduction and involving a redistributed carbon tax has the following net impact on weekly household budgets, by household income quintile:

- Less than £22k: + £2.36
- £22k-£35k: + £0.32
- £35-£53k: - £2.27
- £53-£81k: - £5.60
- £81k+: - £14.82

14 The full combination of choices for this pathway is as follows: an electric vehicle charging network by 2027; better public transport; limited restrictions on cars; an ambitious approach to heating, with a target of 800,000 heat pumps per year by 2028, paid for through taxation; a moderate tax on frequent fliers; a strong information campaign to reduce red meat and dairy consumption by 10%; more intensive farming, with more forests and peatland restoration; a £100 carbon tax with £50 subsidies, with compensation payments to all households.

15 The full combination of choices for this pathway is as follows: an electric vehicle charging network by 2026; better public transport with limited restrictions on cars; a very ambitious approach to heating, with a target of 1.4m heat pumps per year by 2030, and more renewable electricity, paid for through taxation; no tax on flights; a strong information campaign to reduce red meat and dairy consumption by 10% per person; more sustainable farming, forests and wildlife habitats; and no change to current policy on industry (other things we buy).

But even if the government prefers not to redistribute the revenue from a carbon tax, it is still possible to keep the costs down for lower income households. With this constraint, reaching the 2030 target could cost the bottom quintile of households as little as 32p a week.¹⁵

The Climate Calculator does not address the implications of policies beyond 2030: there are too many uncertainties on the availability of technologies and how fast or slow societal change is to lower carbon lifestyles. In any case, what matters now is ensuring that the policies to get us to the government's 2030 climate target are affordable and that the public supports them.

THE POLICY IMPLEMENTATION CHALLENGE

Our analysis also shows that the public's preferred pathway to achieving the 2030 target requires the UK government to take action soon to plan and coordinate the transition effectively across the economy.

Seen this way, the analysis suggests the public's willingness to accept the limited disruption and cost involved in a low carbon transition depends on the government implementing it effectively: that is, managing supply chain issues, driving down costs and protecting low-income households. For example, we will need to replace millions of fossil fuel central heating systems with heat pumps over the next decade. If this is to be done economically, effective policy is required to build a resilient supply chain, reduce unit and installation costs, and subsidise heat pumps through grants

and low-interest loans. In a similar way, planning and coordination across government is required to ensure that a comprehensive charging network is rolled out for electric vehicles, and that the UK rapidly increases the amount of electricity generated by renewables. If the government takes an active approach to managing these issues, disruption and costs can be reduced.

Fortunately there are grounds for optimism. Over the last decade, the UK government has taken an active approach to increasing electricity generation from wind: in 2010, 3% of the UK's electricity came from wind, but this increased to 24% in 2020.¹⁶ This has been achieved because the government took an active role, establishing an overarching policy framework and using Contracts for Difference (CfDs) to maintain stable prices and reduce risk for renewable generators. This approach has given businesses certainty and, partly as a result, costs have fallen dramatically: prices for offshore wind generation in 2019 were two thirds lower than in 2015. While the exact details of the required policy framework will vary according to the sector, it is clear that this kind of active approach is perfectly possible.

16 Ritchie, H. and Roser, M. Electricity Mix. Our World in Data, (no date). Available at <https://ourworldindata.org/electricity-mix#wind-what-share-of-electricity-comes-from-wind> [accessed 14/09/21]

THE PUBLIC'S POLICY CHOICES

There is a set of eight policies which attracted between 77% and 94% support from users and which between them would deliver or exceed the government's 2030 target. Users tended to choose to limit the costs for households with incomes under £35,000, but did not always choose the most egalitarian options. Disparate demographic and political groups were united around these policies – there is consensus.

POLICIES TO REDUCE EMISSIONS

Participants explored six policy areas: electric cars, public transport and cycling, heating, flights, food and land use, and other things we buy (covering manufacturing and construction). In each, users were presented with a series of policy options, from those maintaining the government's current approach to those requiring significant government intervention. This gave people the power to concentrate changes in a few sectors or to make smaller changes across more areas, but required them to reach the target of 39% emissions reduction from a 2019 baseline. We estimated that the first 25% of this 39% will be achieved by existing and anticipated government policy.

Table 1 sets out the public's preferred policies to reduce emissions, ranked according to their popularity and showing their impacts on emissions reductions, individually and cumulatively. The most popular eight policies chosen by the public which would get us to the 2030 target are set out in Table 1, with the remaining policies in Table 2. Explanations of the numbers are given below the tables.

TABLE 1

THE PUBLIC'S PREFERRED POLICIES AND THEIR IMPACTS ON EMISSIONS

POLICY AREA	POLICY	OVERALL SUPPORT	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM EXISTING/ ANTICIPATED POLICIES
Other things we buy	A carbon tax and subsidies. Manufacturing and construction businesses pay a tax of £75 per tonne of CO2 equivalent emitted. Those industries that find it difficult to decarbonise also receive a subsidy of £50 per tonne of CO2 equivalent that they do not emit due to their investment in new processes. Manufacturers pass on their extra costs to consumers, so prices of some products increase.	94%	2.6%	28%
Public transport & cycling	Better public transport. We continue with current levels of investment in improving buses and cycling (about £1bn a year), but also move to a system in which local government coordinates routes, improves services and sets fares. This will take some additional investment but will not be much more expensive than the current system in the long run.	93%	1.1%	29%
Food and land use	Encourage less red meat and dairy. A strong campaign run by supermarkets, food companies and government reduces red meat and dairy consumption per person by 10%. It makes plant-based foods and meat alternatives easier to choose and cook, and increases awareness of the health and climate benefits of a change in diet.	93%	2.3%	31%
Electric cars and vans	Charging network by 2028. A comprehensive network of public charge points is in place by 2028: everyone without their own off-street parking will have access to a charge point in the street they live in, and for those on longer journeys, there will be rapid charge points at car parks and all petrol stations. For those with off-street parking, private charge points will be available for about £700. There will be a strengthened electricity grid to make this possible.	91%	1.2%	32%
Flights	An increase in flying costs. The 89% supporting this policy were made up of 62% who preferred higher costs for frequent fliers (no tax on the first return flight and at least 10% on the second, 20% on the third, 30% on the fourth and so on) and 27% who preferred a flat levy for all fliers of at least 10%.	89%	0.6%	33%

TABLE 1 (CONTINUED)

THE PUBLIC'S PREFERRED POLICIES AND THEIR IMPACTS ON EMISSIONS

POLICY AREA	POLICY	OVERALL SUPPORT	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM EXISTING/ ANTICIPATED POLICIES
Public transport & cycling	<p>Limited restrictions on cars. Major cities introduce limited restrictions on cars entering city centres. The motorway and dual carriageway speed limit is reduced to 60mph in order to reduce emissions and there is greater use of temporary 50mph limits to smooth speeds and reduce congestion.</p>	82%	0.4%	33%
Food and land use	<p>More sustainable farming, more forests and better wildlife habitats. Some land is used for tree planting and to restore areas of peatland. Some of the land is also used to support less intensive, more sustainable and organic forms of farming. This reduces degradation of soil and protects biodiversity of insects, birds and other wildlife through reduced use of chemical fertilisers and pesticides and through paying farmers to create woodland, wildflower meadows and hedgerows.</p>	79%	0.9%	34%
Heating & electricity	<p>A very ambitious approach to heating and electricity, made possible by government playing an active role. The government increases its 2030 target to 1.4m existing homes to have heat pumps installed each year, with 770,000 to be insulated. It takes an active role to ensure sufficient supply of heat pumps and insulation to households, that these create UK jobs, and that costs are minimised. It provides a grant to cover some of the additional costs and it introduces a government-backed loan scheme at low interest rates to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets more ambitious targets for wind and solar electricity generation.</p>	77%	7.8%	42%

TABLE 2
LESS POPULAR POLICIES AND THEIR IMPACT ON EMISSIONS

POLICY AREA	POLICY	OVERALL SUPPORT	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM EXISTING/ ANTICIPATED POLICIES
Electric cars and vans	The charging network (see above) is complete by 2027 rather than 2028.	67%	0.4%	42%
Other things we buy	A higher carbon tax (see above) with subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of CO2 equivalent emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise remains at £50 per tonne that is not emitted.	61%	2.4%	44%
Food and land use	The food campaign (see above) is supplemented by a tax of at least 8% on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 5% which, combined with the information campaign, results in a total reduction of 15% per person.	60%	0.7%	45%
Public transport & cycling	Investment in public transport and cycling. There is more investment in buses and cycling, in addition to moving to a system in which local government coordinates routes, improves services and sets fares (see above). Subsidy levels will increase in the long run. Cycling and e-cycling is encouraged and there is a major investment in the kind of cycle lane network that exists in some other countries: where feasible and useful, all major roads in towns and cities have cycle lanes.	55%	1.4%	47%
Flights	A sharp increase in flying costs. The 41% supporting this were made up of 28% supporting higher costs for frequent fliers (no tax on the first return flight, 20% on the second, 40% on the third, 60% on the fourth and so on) and 13% supporting a flat levy of 20%.	41%	0.6%	47%

TABLE 2 (CONTINUED)

LESS POPULAR POLICIES AND THEIR IMPACT ON EMISSIONS

POLICY AREA	POLICY	OVERALL SUPPORT	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM EXISTING/ ANTICIPATED POLICIES
Public transport & cycling	Restrictions on cars beyond those described above. In addition to the restrictions described above, major cities introduce more restrictions on cars entering city centres and put congestion charges in place, using the proceeds to further improve public transport.	40%	0.3%	47%
Electric cars and vans	The charging network (see above) is complete by 2026 rather than 2027 or 2028.	35%	0.7%	48%
Heating & electricity	The very ambitious approach to heating and electricity, made possible by government playing an active role (see above), plus subsidies for insulation. In addition to the measures described above, the government increases its 2030 target for insulation to 1.3m existing homes be insulated. The grant scheme covers insulation where this does not pay for itself through savings on bills.	33%	0.8%	49%
Food and land use	The food campaign (see above) is supplemented by a 25% tax on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 15% which, combined with the information campaign, results in a total reduction of 25% per person.	25%	0.9%	50%
Other things we buy	A higher carbon tax (see above) and higher subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of CO2 equivalent emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise rises to £100 rather than £50 per tonne that is not emitted.	24%	3.6%	53%

NOTES ON TABLES 1 AND 2

1. The cumulative figure in the right-hand column includes 25%, either already achieved by existing government policies assuming these progress as expected, or likely to be achieved by policies we expect the government to introduce in those areas where we did not offer users a choice (typically where the issues are purely technical). Thus for example, the 1.2% listed in the table as achieved by introducing a charging network by 2028 is the extra emissions reduction this would bring about, over and above the reductions achieved by existing policy on electric vehicles. This also means that the numbers tend to be higher in those areas (such as diet) where there are no existing policies.
2. In some cases, users were offered a choice of more or less ambitious policies (for example, a lower or higher carbon price, or ambitious or very ambitious policy on heating). In these cases the contribution to emissions reduction shown for the more ambitious policy is in addition to the contribution shown for the less ambitious policy.
3. In these cases we have assumed that those supporting a more ambitious policy would also support a less ambitious policy and have generally added their support to the support shown for the less ambitious policy, changing the wording from, for example 'a tax of 8%' to 'a tax of at least 8%.'
4. However because we are presenting the policies in Table 1 as the most popular set of policies needed to reach the 2030 target, and because a more ambitious policy on heating and electricity is needed in this set to reach the target, we have not included the less ambitious policy in this area in the table on the grounds that this would be superseded by the more ambitious policy and not actually implemented. This policy - for 800,000 heat pumps a year to be installed by 2028 - attracted an additional 20% support on top of the 77% supporting the more ambitious policy.
5. The popularity ranking is based on the choices made by a representative sample of 19,862 UK adults who used the Climate Calculator in July and August 2021, weighted to the profile of the population. As noted above, when making their choices, users were able to see what the policy was, what its implications for emissions reductions were, and what its implications for their household budgets would be, as well as for employment and other benefits. The objective of the exercise was to find out what policies the public preferred given the government's target for 2030 emissions and therefore users had to reach this target (39% reduction) before submitting their preferences.
6. In addition to the 19 policies presented here, users could choose the government's existing policies in each of the policy areas. Support for this option ranged from 3% (heating and electricity) to 21% (land use).
7. Two additional points are worth noting. First, even though people using the website only had to reach the UK's target (39%) for their choices to be counted, the median emissions reduction achieved was 44% - five percentage points higher than the UK's target and two percentage points higher than the reductions achieved by the package of policies presented in Table 1. 29% of users chose policies leading to reductions of between 39% and 41%, but 71% chose policies leading to higher levels of emissions reductions than this. These percentages do not show that there is 71% support for exceeding the target (given that a 39% level had to be achieved for the user's choices to be recorded), but they do show that for most of those who accepted the target it was relatively easy to find an acceptable mix of policies.
8. In addition, at least 89% of users expressed support for going further than current policy in all of the six policy areas included in the Calculator, even when 'going further' involved taxes (flights, other things we buy) or potentially unpopular messaging (reducing red meat and dairy consumption in food and land use). Again, this does not show that 89% of the public want the government to go further in all these areas, but given that it was not necessary to choose policies in every area to hit the target, it does suggest that most people actively support a wide range of measures.

THE DISTRIBUTION OF COSTS

There are three questions in the Climate Calculator which ask users to select their preferences about how costs and benefits are distributed - they do not affect the level of emissions reduction. These are:

- **Should a tax on flights be levied on all fliers, or only frequent fliers?** 62% of users supported a tax on frequent fliers, compared to 27% who supported a tax on all fliers. Excluding those who did not choose a tax on flights, 70% preferred a tax on frequent fliers compared to 30% who preferred a tax on all fliers. The majority in favour of a frequent flier levy is substantial but less overwhelming than the result from the UK Climate Assembly, where a tax on frequent fliers received 89% support.¹⁷
- **Who should pay for costs associated with changing how we heat our homes?** Users could select the options “through our tax bills”, “through our energy bills”, or an intermediate position where the costs were met through a mixture of tax and energy bills. There was a clear overall preference for the mixed option (54%), with energy bills alone the second preferred option (31%), and tax bills alone the least popular (12%).

- **Who should be compensated for price rises as a result of a carbon tax?** 9% of users chose to reduce tax bills and 85% chose some form of flat payment: 20% chose a flat payment to the 30% least well off households, 25% chose a flat payment to the 60% least well off households, and 39% chose a flat payment to all households.

VARIATIONS IN THE PREFERENCES OF DIFFERENT GROUPS

In Annex 2 we present a version of Tables 1 and 2, but with support broken down by age, household income, 2019 vote, residence area type (city centre, town centre, and so on) and region. Overall, the differences in the preferences of these groups are relatively small. While there were some slight differences in the ranking, the policies in Table 1 were the preferred policies for all groups.

Table 3 sets out the largest differences in support for Table 1 policies by specific groups where these differences were more than 2% lower than overall support (where there is an empty box it is because the lowest level of support in any group was within 2% of the overall level). What is striking is not the variation, but the lack of variation.

TABLE 3

LOWEST LEVELS OF SUPPORT FOR THE MOST POPULAR POLICIES AMONG DIFFERENT GROUPS

POLICY	OVERALL SUPPORT	AGE GROUP VARIATIONS	2019 VOTE VARIATIONS	HOUSEHOLD INCOME VARIATIONS	RESIDENCE AREA VARIATIONS	REGIONAL VARIATIONS
Limited restrictions on cars	82%	3%	3%			3%
More sustainable farming forests and wildlife habitat	79%		3%			3%
Very ambitious approach to heating and electricity	77%	3%	7%			3%

¹⁷ In full, the results from the UK Climate Assembly were “Taxes that increase as people fly more often and as they fly further” (68%), “Taxes that increase as people fly more often” (21%) and “A carbon tax on all flights” (12%). Climate Assembly UK. The path to net zero. 2020, p. 145. Available at www.climateassembly.uk/report/read/final-report.pdf [accessed 14/09/21]

There was more variation in the level of support for the less popular policies – for details see Annex 2. Some additional points – but note that all the variations described are small:

- Although the standard narrative is that younger people are more supportive of action on climate change, our results present a mixed picture. Older people were more likely to support a tax on flights (91% of those aged 65+ supported a tax, compared to 88% of those aged 18-24), and were much more likely to support the higher level of tax (45% of those aged 65+ supported this, compared to 32% of those aged 18-24). Similarly older age groups showed greater support for a quick rollout of an electric vehicle charging network - the option for rolling this out by 2026 was supported by 41% of those aged 55-64, but only 26% of those aged 18-24. On the other hand, younger age groups were more likely to support a tax on red meat and dairy (64% of those aged 25-34 supported this, compared to 54% of those aged 65+).
- People living in city centres are more likely to support higher ambition options, in comparison to those living in other areas - particularly on reducing red meat and dairy consumption, and implementing a higher carbon tax. 34% of those living in city centres supported the highest carbon tax option, compared to 21%-24% of those living in other areas.
- People with higher household incomes are more ambitious in certain policy areas, in comparison to people with lower household incomes: they are more likely to support a tax on red meat and dairy, a higher carbon tax, and a quicker rollout of the electric vehicle charging network. For example, 65% of people living in households earning £81,000 or more supported a tax on red meat and dairy, compared to 58% in households earning less than £22,000. Conversely, however, people with lower incomes are more likely to support a tax on flights, and more likely to support investment in cycling. 60% of people in households earning less than £22,000 supported investment in cycling, compared to 52% of people in households earning more than £81,000.
- People with a disability were slightly more likely to select more ambitious policy options, compared to people without a disability – this was true for heating and electricity, flights, food and land use, and other things we buy. For example, 39% of people with a disability supported the highest ambition option on heating and electricity, compared to 31% of those without a disability.
- People who did not own their own vehicle were more likely to support investment in cycling (63% compared to 54% of vehicle owners), and were more likely to support restrictions on cars and congestion charges (48% compared to 38%).

VARIATIONS IN THE PREFERENCES OF DIFFERENT GROUPS ON DISTRIBUTIONAL QUESTIONS

Preferences on how to fund changes to how we heat our homes varied a little by demographic characteristics. However, the 'mixed' tax and bills option was comfortably the most popular with every group.

- People in households earning £81,000 or more were slightly more likely to prefer to pay through bills (39%, compared to 30%-33% in other income brackets), but 48% still chose the 'mixed' option.
- Likewise, people in city centres were slightly more likely to prefer to pay through bills (38%, compared to 30%-32% in other areas).
- 53% of those in households earning less than £22,000 selected the 'mixed' option, even though meeting these costs through taxation would be better for them from a financial point of view.
- There was almost no difference between homeowners and non-owners.
- Older age groups were slightly more likely to prefer paying for changes to heating through tax (but it was still low at 14%-15%).

Preferences on the type of tax on flights varied, but again, a tax on frequent fliers as opposed to a flat rate on flights was the most popular option with every group. The margin between support for a frequent flier levy and a flat rate tax did vary slightly - note that the figures in this section exclude those who did not choose to implement a tax on flights:

- Among those that supported a tax on flights, support for a frequent flier levy was higher among younger age groups than older age groups (76% of people aged 35-44 preferred a frequent flier levy, compared to 64% of those aged 65+).
- Conservative voters were slightly less likely to prefer a frequent flier levy (68%) compared to others such as Brexit party voters (77%) or Liberal Democrat voters (73%).
- People in households earning higher incomes were more likely to prefer a frequent flier levy - 74% of those in households earning over £81,000 preferred a frequent flier levy, compared to 67% of those in households earning less than £22,000.
- People in city centres (79%) and town centres (75%) strongly preferred a frequent flier levy, while people living in rural areas (64%) were somewhat less likely to prefer this option.

The overall preference on the distribution of a carbon tax favoured flat payments to all households, although there were some differences between demographics. The option to reduce tax was clearly the least popular option with every group (including

among the best-off for whom it was the most financially attractive option), so here we focus on support for the other three options.

- Preferences varied by age. Older people were more likely to support flat payments to all households (45% of those aged 65+), while younger age groups were more evenly split between the three redistribution options (for example, among those aged 18-24, support for all three options - payments to all households, payments to the bottom 60% of households and payments to the bottom 30% of households - was almost identical).
- While the most popular option in every income bracket was payments to all households, this was more strongly favoured by low income households (selected by 42% of people in households earning less than £22,000, compared to 36% of those in households earning £81,000 or more). People in higher income households were more likely to pick the option for payments to 60% of households (30%, compared to 22% of people in households earning less than £22,000). In both cases this was not the most financially beneficial choice for those selecting it.

CONCLUSION

There is a set of eight policies that command very strong support – 77% or more – which will enable the government to hit its 2030 target. In addition, there is majority support for policies which keep the costs for the less well-off very low. However these policies require the government to adopt an active, planned approach to the transition. Failing that, it can still hit its target, but will have to rely on much less popular policies.

The overwhelming finding from this research is that the public prefers policies that require the government to take an active role in leading a well-planned and orderly approach to the net zero transition.

Many of the most popular eight policies chosen by the public require the government to take an active role in leading a well-planned and orderly transition in the ways described above. This in turn requires it to invest in the official capability – staff skills, organisation, networks and partnerships and so on - to do this. In particular, the most popular policies with the public which require government taking an active role are:

- Better public transport
- Encourage less red meat and dairy
- A comprehensive electric vehicle charging network by 2028
- A very ambitious approach to heating and electricity.

If this approach is adopted, the most popular package of policies, that is those set out in Table 1 or something similar, becomes possible.

Since this package would reduce emissions by 3% more than the current 2030 target, it would be possible to remove one or two policies that have relatively little impact on emissions and still hit the target.

The government could alternatively meet its 2030 target using an approach involving a less active role.

However, if it does, it may have to rely on types of policy that were found to be less popular with the public in this research.

DISTRIBUTIONAL CHOICES

The most popular distributional choices included a frequent flier levy, the costs of the changes to how we heat our homes being borne equally through bills and taxation, and the proceeds of the carbon tax distributed equally to all households.

Of course the government could adopt a less egalitarian approach than the popular choice, or it could adopt a more egalitarian approach, seeking to eliminate the impact on the bottom 20% or 40% of the income distribution.

Adopting a more egalitarian approach to distribution would involve paying for changes to how we heat our homes progressively through general taxation, and limiting payments from a carbon tax to the bottom 60% of households.

Adopting a less egalitarian approach to distribution would involve paying for changing the way we heat our homes entirely through bills (but carbon tax payments would still be made to all households).

The implications for weekly household budgets, assuming government adopted the popular set of policies set out in Table 1, are set out in Table 4.

ENGAGEMENT WITH THE PUBLIC

The Climate Calculator has shown how it is possible to engage with a wide audience, provide information about the implications of the choices we are facing and invite the public into a conversation about these choices. Once the government's Net Zero Strategy is published this autumn and COP 26 is concluded, we believe that tools similar to the Climate Calculator will be an important way of continuing the conversation about the details of policy.

TABLE 4

OPTION 1 IMPLICATIONS FOR WEEKLY HOUSEHOLD BUDGETS BY QUINTILE

	THE POPULAR OPTION	MORE EGALITARIAN	LESS EGALITARIAN
Less than £22k	+ £0.85	+ £1.66	+ £0.09
£22k-£35k	- £1.30	+ £0.02	- £2.36
£35k-£53k	- £3.75	- £2.09	- £4.65
£53k-£81k	- £6.79	- £9.06	- £7.21
£81k+	- £15.12	- £16.74	- £13.49

ANNEX 1

RESULTS BROKEN DOWN BY CONSTITUENCY

We used MRP analysis to estimate how individuals in each parliamentary constituency in England, Scotland and Wales would complete the Climate Calculator.

Individuals in every constituency would have chosen the same eight policies set out in Table 1 in the main report. The most popular policy of the eight (a carbon tax of £75 per tonne of CO2 equivalent emitted, with subsidies to industry) would have been the most popular in every constituency. The least popular of the eight (a very ambitious approach to heating and electricity) would have been the least popular of the eight in all but four constituencies. The table in the link shows support in every constituency for these two policies. The variation in support is very small – for carbon tax it is almost non-existent and varies from 93.76% in Bassetlaw to 94.57% in Dumfriesshire. For a very ambitious approach to heating, it varies from 75.60% in Ribble Valley to 79.37% in Tottenham. There would be slightly greater variations in support for some of the less popular policies, listed in Table 2 in the main report.

In four constituencies the least popular of the eight would be a shift to more sustainable farming, forests and wildlife habitats. The four constituencies and the support for this policy in each case are Bassetlaw (75.70%), Bexleyheath and Crayford (76.31%), Stone (76.0%), and Wolverhampton South East (76.16%).

The data is available to download at www.demos.co.uk/wp-content/uploads/2021/09/Climate-Calculator-Annex-1.pdf

ANNEX 2

TABLES OF CLIMATE CALCULATOR POLICIES

TABLE OF CLIMATE CALCULATOR POLICIES, WITH PUBLIC SUPPORT AND ASSOCIATED EMISSIONS REDUCTIONS: OVERALL

POLICY AREA	POLICY	OVERALL SUPPORT	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM EXISTING/ANTICIPATED POLICIES
Heating & electricity	A more ambitious approach to heating. The UK government increases its 2028 target to at least 800,000 heat pumps a year to be installed in existing homes, with at least 400,000 existing homes to be insulated. It provides grants to cover some of the additional costs and encourages low interest loans to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets targets for solar and onshore wind electricity generation.	97%	3.3%	28%
Other things we buy	A carbon tax and subsidies. Manufacturing and construction businesses pay a tax of £75 per tonne of carbon emitted. Those industries that find it difficult to decarbonise also receive a subsidy of £50 per tonne of carbon that they do not emit due to their investment in new processes. Manufacturers pass on their extra costs to consumers, so prices of some products increase.	94%	2.6%	31%
Public transport & cycling	Better public transport. We continue with current levels of investment in improving buses and cycling (about £1bn a year), but also move to a system in which local government coordinates routes, improves services and sets fares. This will take some additional investment but will not be much more expensive than the current system in the long run.	93%	1.1%	32%
Food and land use	Encourage less red meat and dairy. A strong campaign run by supermarkets, food companies and government reduces red meat and dairy consumption per person by 10%. It makes plant-based foods and meat alternatives easier to choose and cook, and increases awareness of the health and climate benefits of a change in diet.	93%	2.3%	34%

POLICY AREA	POLICY	OVERALL SUPPORT	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM EXISTING/ANTICIPATED POLICIES
Electric cars and vans	Charging network by 2028. A comprehensive network of public charging points is in place by 2028: everyone without their own off-street parking will have access to a charge point in the street they live in, and for those on longer journeys there will be rapid charge points at car parks and all petrol stations. For those with off-street parking, private charge points will be available for about £700. There will be a strengthened electricity grid to make this possible.	91%	1.2%	35%
Flights	An increase in flying costs. The 89% supporting this policy were made up of 62% who preferred higher costs for frequent fliers (no tax on the first return flight and at least 10% on the second, 20% on the third, 30% on the fourth and so on) and 27% who preferred a flat levy for all fliers of at least 10%.	89%	0.6%	36%
Public transport & cycling	Limited restrictions on cars. Major cities introduce limited restrictions on cars entering city centres. The motorway and dual carriageway speed limit is reduced to 60mph in order to reduce emissions and there is greater use of temporary 50mph limits to smooth speeds and reduce congestion.	82%	0.4%	36%
Food and land use	More sustainable farming, forests and wildlife habitats. Some land is used for tree planting and to restore areas of peatland. Some of the land is also used to support less intensive, more sustainable and organic forms of farming. This reduces degradation of soil and protects biodiversity of insects, birds and other wildlife through reduced use of chemical fertilisers and pesticides and through paying farmers to create woodland, wildflower meadows and hedgerows.	79%	0.9%	37%
Heating & electricity	A very ambitious approach to heating and electricity, made possible by government playing an active role. The government increases its 2030 target to 1.4m heat pumps a year to be installed in existing homes, with 770,000 existing homes to be insulated. It takes an active role to ensure sufficient supply of heat pumps and insulation to households, that these create UK jobs, and that costs are minimised. It provides a grant to cover some of the additional costs and it introduces a government-backed loan scheme at low interest rates to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets more ambitious targets for wind and solar electricity generation.	77%	4.5%	42%
Electric cars and vans	The charging network (see above) is complete by 2027 rather than 2028	67%	0.4%	42%
Other things we buy	A higher carbon tax (see above) with subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of carbon emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise remains at £50 per tonne that is not emitted.	61%	2.4%	44%
Food and land use	The food campaign (see above) is supplemented by a tax of at least 8% on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 5%, which combined with the information campaign results in a total reduction of 15% per person.	60%	0.7%	45%
Public transport & cycling	Investment in public transport and cycling. There is more investment in buses and cycling, in addition to moving to a system in which local government coordinates routes, improves services and sets fares (see above). Subsidy levels will increase in the long run. Cycling and e-cycling is encouraged and there is a major investment in the kind of cycle lane network that exists in some other countries: where feasible and useful, all major roads in towns and cities have cycle lanes.	55%	1.4%	47%

POLICY AREA	POLICY	OVERALL SUPPORT	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM EXISTING/ANTICIPATED POLICIES
Flights	A sharp increase in flying costs. The 41% supporting this were made up of 28% supporting higher costs for frequent fliers (no tax on the first return flight, 20% on the second, 40% on the third, 60% on the fourth and so on) and 13% supporting a flat levy of 20%.	41%	0.6%	47%
Public transport & cycling	Restrictions on cars beyond those described above. In addition to the restrictions described above, major cities introduce more restrictions on cars entering city centres and put congestion charges in place, using the proceeds to further improve public transport.	40%	0.3%	47%
Electric cars and vans	The charging network (see above) is complete by 2026 rather than 2027 or 2028	35%	0.7%	48%
Heating & electricity	The very ambitious approach to heating and electricity, made possible by government playing an active role (see above), plus subsidies for insulation. In addition to the measures described above, the government increases its 2030 target for insulation to 1.3m existing homes be insulated. The grant scheme covers insulation where this does not pay for itself through savings on bills.	33%	0.8%	49%
Food and land use	The food campaign (see above) is supplemented by a 25% tax on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 15%, which combined with the information campaign results in a total reduction of 25% per person.	25%	0.9%	50%
Other things we buy	A higher carbon tax (see above) and higher subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of carbon emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise rises to £100 rather than £50 per tonne that is not emitted.	24%	3.6%	53%

TABLE OF CLIMATE CALCULATOR POLICIES, WITH PUBLIC SUPPORT AND ASSOCIATED EMISSIONS REDUCTIONS: AGE

POLICY AREA	POLICY	OVERALL SUPPORT	18-24	25-34	35-44	45-54	55-64	65+	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Heating & electricity	A more ambitious approach to heating. The UK government increases its 2028 target to at least 800,000 heat pumps a year to be installed in existing homes, with at least 400,000 existing homes to be insulated. It provides grants to cover some of the additional costs and encourages low interest loans to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets targets for solar and onshore wind electricity generation.	97%	98%	98%	97%	97%	97%	97%	3.3%	28%
Other things we buy	A carbon tax and subsidies. Manufacturing and construction businesses pay a tax of £75 per tonne of carbon emitted. Those industries that find it difficult to decarbonise also receive a subsidy of £50 per tonne of carbon that they do not emit due to their investment in new processes. Manufacturers pass on their extra costs to consumers, so prices of some products increase.	94%	95%	95%	95%	94%	93%	93%	2.6%	31%
Public transport & cycling	Better public transport. We continue with current levels of investment in improving buses and cycling (about £1bn a year), but also move to a system in which local government coordinates routes, improves services and sets fares. This will take some additional investment but will not be much more expensive than the current system in the long run.	93%	94%	93%	94%	93%	91%	92%	1.1%	32%
Food and land use	Encourage less red meat and dairy. A strong campaign run by supermarkets, food companies and government reduces red meat and dairy consumption per person by 10%. It makes plant-based foods and meat alternatives easier to choose and cook, and increases awareness of the health and climate benefits of a change in diet.	93%	95%	94%	93%	94%	94%	92%	2.3%	34%

POLICY AREA	POLICY	OVERALL SUPPORT	18-24	25-34	35-44	45-54	55-64	65+	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Electric cars and vans	Charging network by 2028. A comprehensive network of public charging points is in place by 2028: everyone without their own off-street parking will have access to a charge point in the street they live in, and for those on longer journeys there will be rapid charge points at car parks and all petrol stations. For those with off-street parking, private charge points will be available for about £700. There will be a strengthened electricity grid to make this possible.	91%	92%	92%	91%	90%	90%	90%	1.2%	35%
Flights	An increase in flying costs. The 89% supporting this policy were made up of 62% who preferred higher costs for frequent fliers (no tax on the first return flight and at least 10% on the second, 20% on the third, 30% on the fourth and so on) and 27% who preferred a flat levy for all fliers of at least 10%.	89%	88%	88%	89%	89%	89%	91%	0.6%	36%
Public transport & cycling	Limited restrictions on cars. Major cities introduce limited restrictions on cars entering city centres. The motorway and dual carriageway speed limit is reduced to 60mph in order to reduce emissions and there is greater use of temporary 50mph limits to smooth speeds and reduce congestion.	82%	83%	83%	84%	82%	79%	81%	0.4%	36%
Food and land use	More sustainable farming, forests and wildlife habitats. Some land is used for tree planting and to restore areas of peatland. Some of the land is also used to support less intensive, more sustainable and organic forms of farming. This reduces degradation of soil and protects biodiversity of insects, birds and other wildlife through reduced use of chemical fertilisers and pesticides and through paying farmers to create woodland, wildflower meadows and hedgerows.	79%	82%	81%	79%	78%	78%	77%	0.9%	37%

POLICY AREA	POLICY	OVERALL SUPPORT	18-24	25-34	35-44	45-54	55-64	65+	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Heating & electricity	A very ambitious approach to heating and electricity, made possible by government playing an active role. The government increases its 2030 target to 1.4m heat pumps a year to be installed in existing homes, with 770,000 existing homes to be insulated. It takes an active role to ensure sufficient supply of heat pumps and insulation to households, that these create UK jobs, and that costs are minimised. It provides a grant to cover some of the additional costs and it introduces a government-backed loan scheme at low interest rates to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets more ambitious targets for wind and solar electricity generation.	77%	74%	79%	78%	76%	77%	76%	4.5%	42%
Electric cars and vans	The charging network (see above) is complete by 2027 rather than 2028	67%	62%	67%	69%	65%	68%	68%	0.4%	42%
Other things we buy	A higher carbon tax (see above) with subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of carbon emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise remains at £50 per tonne that is not emitted.	61%	61%	62%	65%	60%	58%	60%	2.4%	44%
Food and land use	The food campaign (see above) is supplemented by a tax of at least 8% on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 5%, which combined with the information campaign results in a total reduction of 15% per person.	60%	60%	64%	64%	61%	57%	54%	0.7%	45%

POLICY AREA	POLICY	OVERALL SUPPORT	18-24	25-34	35-44	45-54	55-64	65+	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Public transport & cycling	Investment in public transport and cycling. There is more investment in buses and cycling, in addition to moving to a system in which local government coordinates routes, improves services and sets fares (see above). Subsidy levels will increase in the long run. Cycling and e-cycling is encouraged and there is a major investment in the kind of cycle lane network that exists in some other countries: where feasible and useful, all major roads in towns and cities have cycle lanes.	55%	56%	52%	57%	57%	57%	55%	1.4%	47%
Flights	A sharp increase in flying costs. The 41% supporting this were made up of 28% supporting higher costs for frequent fliers (no tax on the first return flight, 20% on the second, 40% on the third, 60% on the fourth and so on) and 13% supporting a flat levy of 20%.	41%	32%	38%	41%	42%	44%	45%	0.6%	47%
Public transport & cycling	Restrictions on cars beyond those described above. In addition to the restrictions described above, major cities introduce more restrictions on cars entering city centres and put congestion charges in place, using the proceeds to further improve public transport.	40%	37%	40%	43%	41%	40%	39%	0.3%	47%
Electric cars and vans	The charging network (see above) is complete by 2026 rather than 2027 or 2028	35%	26%	32%	37%	34%	41%	38%	0.7%	48%
Heating & electricity	The very ambitious approach to heating and electricity, made possible by government playing an active role (see above), plus subsidies for insulation. In addition to the measures described above, the government increases its 2030 target for insulation to 1.3m existing homes be insulated. The grant scheme covers insulation where this does not pay for itself through savings on bills.	33%	31%	35%	35%	33%	34%	31%	0.8%	49%

POLICY AREA	POLICY	OVERALL SUPPORT	18-24	25-34	35-44	45-54	55-64	65+	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Food and land use	The food campaign (see above) is supplemented by a 25% tax on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 15%, which combined with the information campaign results in a total reduction of 25% per person.	25%	25%	26%	28%	26%	24%	21%	0.9%	50%
Other things we buy	A higher carbon tax (see above) and higher subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of carbon emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise rises to £100 rather than £50 per tonne that is not emitted.	24%	24%	26%	27%	24%	21%	20%	3.6%	53%

TABLE OF CLIMATE CALCULATOR POLICIES, WITH PUBLIC SUPPORT AND ASSOCIATED EMISSIONS REDUCTIONS: 2019 UK GENERAL ELECTION VOTE

POLICY AREA	POLICY	OVERALL SUPPORT	CONSERVATIVE	LABOUR	LIBERAL DEMOCRAT	BREXIT PARTY	GREEN PARTY	SCOTTISH NATIONAL PARTY	PLAID CYMRU	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Heating & electricity	A more ambitious approach to heating. The UK government increases its 2028 target to at least 800,000 heat pumps a year to be installed in existing homes, with at least 400,000 existing homes to be insulated. It provides grants to cover some of the additional costs and encourages low interest loans to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets targets for solar and onshore wind electricity generation.	97%	97%	97%	97%	98%	98%	96%	98%	3.3%	28%
Other things we buy	A carbon tax and subsidies. Manufacturing and construction businesses pay a tax of £75 per tonne of carbon emitted. Those industries that find it difficult to decarbonise also receive a subsidy of £50 per tonne of carbon that they do not emit due to their investment in new processes. Manufacturers pass on their extra costs to consumers, so prices of some products increase.	94%	95%	94%	95%	95%	94%	93%	95%	2.6%	31%
Public transport & cycling	Better public transport. We continue with current levels of investment in improving buses and cycling (about £1bn a year), but also move to a system in which local government coordinates routes, improves services and sets fares. This will take some additional investment but will not be much more expensive than the current system in the long run.	93%	92%	93%	93%	91%	93%	94%	97%	1.1%	32%
Food and land use	Encourage less red meat and dairy. A strong campaign run by supermarkets, food companies and government reduces red meat and dairy consumption per person by 10%. It makes plant-based foods and meat alternatives easier to choose and cook, and increases awareness of the health and climate benefits of a change in diet.	93%	92%	94%	94%	93%	93%	94%	90%	2.3%	34%

POLICY AREA	POLICY	OVERALL SUPPORT	CONSERVATIVE	LABOUR	LIBERAL DEMOCRAT	BREXIT PARTY	GREEN PARTY	SCOTTISH NATIONAL PARTY	PLAID CYMRU	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Electric cars and vans	Charging network by 2028. A comprehensive network of public charging points is in place by 2028: everyone without their own off-street parking will have access to a charge point in the street they live in, and for those on longer journeys there will be rapid charge points at car parks and all petrol stations. For those with off-street parking, private charge points will be available for about £700. There will be a strengthened electricity grid to make this possible.	91%	90%	92%	91%	92%	92%	93%	91%	1.2%	35%
Flights	An increase in flying costs. The 89% supporting this policy were made up of 62% who preferred higher costs for frequent fliers (no tax on the first return flight and at least 10% on the second, 20% on the third, 30% on the fourth and so on) and 27% who preferred a flat levy for all fliers of at least 10%.	89%	89%	90%	90%	90%	91%	93%	95%	0.6%	36%
Public transport & cycling	Limited restrictions on cars. Major cities introduce limited restrictions on cars entering city centres. The motorway and dual carriageway speed limit is reduced to 60mph in order to reduce emissions and there is greater use of temporary 50mph limits to smooth speeds and reduce congestion.	82%	79%	83%	85%	82%	86%	85%	91%	0.4%	36%
Food and land use	More sustainable farming, forests and wildlife habitats. Some land is used for tree planting and to restore areas of peatland. Some of the land is also used to support less intensive, more sustainable and organic forms of farming. This reduces degradation of soil and protects biodiversity of insects, birds and other wildlife through reduced use of chemical fertilisers and pesticides and through paying farmers to create woodland, wildflower meadows and hedgerows.	79%	76%	82%	83%	76%	84%	80%	82%	0.9%	37%

POLICY AREA	POLICY	OVERALL SUPPORT	CONSERVATIVE	LABOUR	LIBERAL DEMOCRAT	BREXIT PARTY	GREEN PARTY	SCOTTISH NATIONAL PARTY	PLAID CYMRU	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Heating & electricity	A very ambitious approach to heating and electricity, made possible by government playing an active role. The government increases its 2030 target to 1.4m heat pumps a year to be installed in existing homes, with 770,000 existing homes to be insulated. It takes an active role to ensure sufficient supply of heat pumps and insulation to households, that these create UK jobs, and that costs are minimised. It provides a grant to cover some of the additional costs and it introduces a government-backed loan scheme at low interest rates to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets more ambitious targets for wind and solar electricity generation.	77%	74%	79%	77%	70%	80%	80%	84%	4.5%	42%
Electric cars and vans	The charging network (see above) is complete by 2027 rather than 2028	67%	65%	70%	72%	60%	70%	74%	68%	0.4%	42%
Other things we buy	A higher carbon tax (see above) with subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of carbon emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise remains at £50 per tonne that is not emitted.	61%	59%	64%	70%	60%	71%	66%	71%	2.4%	44%
Food and land use	The food campaign (see above) is supplemented by a tax of at least 8% on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 5%, which combined with the information campaign results in a total reduction of 15% per person.	60%	55%	63%	64%	58%	69%	62%	64%	0.7%	45%

POLICY AREA	POLICY	OVERALL SUPPORT	CONSERVATIVE	LABOUR	LIBERAL DEMOCRAT	BREXIT PARTY	GREEN PARTY	SCOTTISH NATIONAL PARTY	PLAID CYMRU	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Public transport & cycling	Investment in public transport and cycling. There is more investment in buses and cycling, in addition to moving to a system in which local government coordinates routes, improves services and sets fares (see above). Subsidy levels will increase in the long run. Cycling and e-cycling is encouraged and there is a major investment in the kind of cycle lane network that exists in some other countries: where feasible and useful, all major roads in towns and cities have cycle lanes.	55%	50%	59%	56%	55%	60%	58%	53%	1.4%	47%
Flights	A sharp increase in flying costs. The 41% supporting this were made up of 28% supporting higher costs for frequent fliers (no tax on the first return flight, 20% on the second, 40% on the third, 60% on the fourth and so on) and 13% supporting a flat levy of 20%.	41%	40%	42%	41%	43%	49%	46%	40%	0.6%	47%
Public transport & cycling	Restrictions on cars beyond those described above. In addition to the restrictions described above, major cities introduce more restrictions on cars entering city centres and put congestion charges in place, using the proceeds to further improve public transport.	40%	37%	43%	41%	41%	48%	47%	54%	0.3%	47%
Electric cars and vans	The charging network (see above) is complete by 2026 rather than 2027 or 2028	35%	33%	37%	39%	32%	42%	39%	29%	0.7%	48%
Heating & electricity	The very ambitious approach to heating and electricity, made possible by government playing an active role (see above), plus subsidies for insulation. In addition to the measures described above, the government increases its 2030 target for insulation to 1.3m existing homes be insulated. The grant scheme covers insulation where this does not pay for itself through savings on bills.	33%	28%	36%	34%	28%	41%	42%	34%	0.8%	49%

POLICY AREA	POLICY	OVERALL SUPPORT	CONSERVATIVE	LABOUR	LIBERAL DEMOCRAT	BREXIT PARTY	GREEN PARTY	SCOTTISH NATIONAL PARTY	PLAID CYMRU	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Food and land use	The food campaign (see above) is supplemented by a 25% tax on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 15%, which combined with the information campaign results in a total reduction of 25% per person.	25%	21%	28%	25%	27%	31%	30%	28%	0.9%	50%
Other things we buy	A higher carbon tax (see above) and higher subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of carbon emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise rises to £100 rather than £50 per tonne that is not emitted.	24%	21%	25%	26%	22%	29%	31%	29%	3.6%	53%

TABLE OF CLIMATE CALCULATOR POLICIES, WITH PUBLIC SUPPORT AND ASSOCIATED EMISSIONS REDUCTIONS: HOUSEHOLD INCOME

POLICY AREA	POLICY	OVERALL SUPPORT	LESS THAN £22,000	£22,000 - £35,000	£35,001 - £53,000	£53,001-£81,000	MORE THAN £81,000	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Heating & electricity	A more ambitious approach to heating. The UK government increases its 2028 target to at least 800,000 heat pumps a year to be installed in existing homes, with at least 400,000 existing homes to be insulated. It provides grants to cover some of the additional costs and encourages low interest loans to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets targets for solar and onshore wind electricity generation.	97%	97%	97%	98%	97%	96%	3.3%	28%
Other things we buy	A carbon tax and subsidies. Manufacturing and construction businesses pay a tax of £75 per tonne of carbon emitted. Those industries that find it difficult to decarbonise also receive a subsidy of £50 per tonne of carbon that they do not emit due to their investment in new processes. Manufacturers pass on their extra costs to consumers, so prices of some products increase.	94%	93%	94%	95%	96%	95%	2.6%	31%
Public transport & cycling	Better public transport. We continue with current levels of investment in improving buses and cycling (about £1bn a year), but also move to a system in which local government coordinates routes, improves services and sets fares. This will take some additional investment but will not be much more expensive than the current system in the long run.	93%	93%	93%	93%	92%	92%	1.1%	32%
Food and land use	Encourage less red meat and dairy. A strong campaign run by supermarkets, food companies and government reduces red meat and dairy consumption per person by 10%. It makes plant-based foods and meat alternatives easier to choose and cook, and increases awareness of the health and climate benefits of a change in diet.	93%	93%	92%	93%	94%	94%	2.3%	34%
Electric cars and vans	Charging network by 2028. A comprehensive network of public charging points is in place by 2028: everyone without their own off-street parking will have access to a charge point in the street they live in, and for those on longer journeys there will be rapid charge points at car parks and all petrol stations. For those with off-street parking, private charge points will be available for about £700. There will be a strengthened electricity grid to make this possible.	91%	89%	91%	91%	92%	92%	1.2%	35%

POLICY AREA	POLICY	OVERALL SUPPORT	LESS THAN £22,000	£22,000 - £35,000	£35,001 - £53,000	£53,001-£81,000	MORE THAN £81,000	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Flights	An increase in flying costs. The 89% supporting this policy were made up of 62% who preferred higher costs for frequent fliers (no tax on the first return flight and at least 10% on the second, 20% on the third, 30% on the fourth and so on) and 27% who preferred a flat levy for all fliers of at least 10%.	89%	91%	89%	90%	88%	87%	0.6%	36%
Public transport & cycling	Limited restrictions on cars. Major cities introduce limited restrictions on cars entering city centres. The motorway and dual carriageway speed limit is reduced to 60mph in order to reduce emissions and there is greater use of temporary 50mph limits to smooth speeds and reduce congestion.	82%	82%	80%	82%	83%	83%	0.4%	36%
Food and land use	More sustainable farming, forests and wildlife habitats. Some land is used for tree planting and to restore areas of peatland. Some of the land is also used to support less intensive, more sustainable and organic forms of farming. This reduces degradation of soil and protects biodiversity of insects, birds and other wildlife through reduced use of chemical fertilisers and pesticides and through paying farmers to create woodland, wildflower meadows and hedgerows.	79%	79%	77%	80%	81%	81%	0.9%	37%
Heating & electricity	A very ambitious approach to heating and electricity, made possible by government playing an active role. The government increases its 2030 target to 1.4m heat pumps a year to be installed in existing homes, with 770,000 existing homes to be insulated. It takes an active role to ensure sufficient supply of heat pumps and insulation to households, that these create UK jobs, and that costs are minimised. It provides a grant to cover some of the additional costs and it introduces a government-backed loan scheme at low interest rates to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets more ambitious targets for wind and solar electricity generation.	77%	77%	76%	77%	77%	79%	4.5%	42%
Electric cars and vans	The charging network (see above) is complete by 2027 rather than 2028	67%	64%	68%	67%	69%	73%	0.4%	42%
Other things we buy	A higher carbon tax (see above) with subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of carbon emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise remains at £50 per tonne that is not emitted.	61%	59%	59%	63%	65%	70%	2.4%	44%

POLICY AREA	POLICY	OVERALL SUPPORT	LESS THAN £22,000	£22,000 - £35,000	£35,001 - £53,000	£53,001- £81,000	MORE THAN £81,000	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Food and land use	The food campaign (see above) is supplemented by a tax of at least 8% on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 5%, which combined with the information campaign results in a total reduction of 15% per person.	60%	58%	59%	59%	63%	65%	0.7%	45%
Public transport & cycling	Investment in public transport and cycling. There is more investment in buses and cycling, in addition to moving to a system in which local government coordinates routes, improves services and sets fares (see above). Subsidy levels will increase in the long run. Cycling and e-cycling is encouraged and there is a major investment in the kind of cycle lane network that exists in some other countries: where feasible and useful, all major roads in towns and cities have cycle lanes.	55%	60%	56%	54%	52%	52%	1.4%	47%
Flights	A sharp increase in flying costs. The 41% supporting this were made up of 28% supporting higher costs for frequent fliers (no tax on the first return flight, 20% on the second, 40% on the third, 60% on the fourth and so on) and 13% supporting a flat levy of 20%.	41%	46%	42%	37%	39%	39%	0.6%	47%
Public transport & cycling	Restrictions on cars beyond those described above. In addition to the restrictions described above, major cities introduce more restrictions on cars entering city centres and put congestion charges in place, using the proceeds to further improve public transport.	40%	43%	40%	39%	39%	44%	0.3%	47%
Electric cars and vans	The charging network (see above) is complete by 2026 rather than 2027 or 2028	35%	36%	35%	34%	35%	39%	0.7%	48%
Heating & electricity	The very ambitious approach to heating and electricity, made possible by government playing an active role (see above), plus subsidies for insulation. In addition to the measures described above, the government increases its 2030 target for insulation to 1.3m existing homes be insulated. The grant scheme covers insulation where this does not pay for itself through savings on bills.	33%	36%	33%	31%	32%	36%	0.8%	49%

POLICY AREA	POLICY	OVERALL SUPPORT	LESS THAN £22,000	£22,000 - £35,000	£35,001 - £53,000	£53,001-£81,000	MORE THAN £81,000	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Food and land use	The food campaign (see above) is supplemented by a 25% tax on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 15%, which combined with the information campaign results in a total reduction of 25% per person.	25%	27%	23%	22%	26%	29%	0.9%	50%
Other things we buy	A higher carbon tax (see above) and higher subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of carbon emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise rises to £100 rather than £50 per tonne that is not emitted.	24%	23%	23%	23%	26%	30%	3.6%	53%

TABLE OF CLIMATE CALCULATOR POLICIES, WITH PUBLIC SUPPORT AND ASSOCIATED EMISSIONS REDUCTIONS: AREA

POLICY AREA	POLICY	OVERALL SUPPORT	A CITY CENTRE	A TOWN CENTRE	IN A CITY BUT NOT IN THE CENTRE	IN A TOWN BUT NOT IN THE CENTRE	RURAL, OR IN A COUNTRYSIDE VILLAGE	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Heating & electricity	A more ambitious approach to heating. The UK government increases its 2028 target to at least 800,000 heat pumps a year to be installed in existing homes, with at least 400,000 existing homes to be insulated. It provides grants to cover some of the additional costs and encourages low interest loans to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets targets for solar and onshore wind electricity generation.	97%	97%	97%	97%	97%	97%	3.3%	28%
Other things we buy	A carbon tax and subsidies. Manufacturing and construction businesses pay a tax of £75 per tonne of carbon emitted. Those industries that find it difficult to decarbonise also receive a subsidy of £50 per tonne of carbon that they do not emit due to their investment in new processes. Manufacturers pass on their extra costs to consumers, so prices of some products increase.	94%	95%	94%	94%	94%	95%	2.6%	31%
Public transport & cycling	Better public transport. We continue with current levels of investment in improving buses and cycling (about £1bn a year), but also move to a system in which local government coordinates routes, improves services and sets fares. This will take some additional investment but will not be much more expensive than the current system in the long run.	93%	94%	94%	93%	92%	93%	1.1%	32%
Food and land use	Encourage less red meat and dairy. A strong campaign run by supermarkets, food companies and government reduces red meat and dairy consumption per person by 10%. It makes plant-based foods and meat alternatives easier to choose and cook, and increases awareness of the health and climate benefits of a change in diet.	93%	94%	93%	93%	93%	93%	2.3%	34%
Electric cars and vans	Charging network by 2028. A comprehensive network of public charging points is in place by 2028: everyone without their own off-street parking will have access to a charge point in the street they live in, and for those on longer journeys there will be rapid charge points at car parks and all petrol stations. For those with off-street parking, private charge points will be available for about £700. There will be a strengthened electricity grid to make this possible.	91%	92%	91%	92%	90%	89%	1.2%	35%

POLICY AREA	POLICY	OVERALL SUPPORT	A CITY CENTRE	A TOWN CENTRE	IN A CITY BUT NOT IN THE CENTRE	IN A TOWN BUT NOT IN THE CENTRE	RURAL, OR IN A COUNTRYSIDE VILLAGE	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Flights	An increase in flying costs. The 89% supporting this policy were made up of 62% who preferred higher costs for frequent fliers (no tax on the first return flight and at least 10% on the second, 20% on the third, 30% on the fourth and so on) and 27% who preferred a flat levy for all fliers of at least 10%.	89%	91%	90%	89%	89%	89%	0.6%	36%
Public transport & cycling	Limited restrictions on cars. Major cities introduce limited restrictions on cars entering city centres. The motorway and dual carriageway speed limit is reduced to 60mph in order to reduce emissions and there is greater use of temporary 50mph limits to smooth speeds and reduce congestion.	82%	85%	84%	81%	80%	81%	0.4%	36%
Food and land use	More sustainable farming, forests and wildlife habitats. Some land is used for tree planting and to restore areas of peatland. Some of the land is also used to support less intensive, more sustainable and organic forms of farming. This reduces degradation of soil and protects biodiversity of insects, birds and other wildlife through reduced use of chemical fertilisers and pesticides and through paying farmers to create woodland, wildflower meadows and hedgerows.	79%	82%	80%	79%	77%	78%	0.9%	37%
Heating & electricity	A very ambitious approach to heating and electricity, made possible by government playing an active role. The government increases its 2030 target to 1.4m heat pumps a year to be installed in existing homes, with 770,000 existing homes to be insulated. It takes an active role to ensure sufficient supply of heat pumps and insulation to households, that these create UK jobs, and that costs are minimised. It provides a grant to cover some of the additional costs and it introduces a government-backed loan scheme at low interest rates to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets more ambitious targets for wind and solar electricity generation.	77%	79%	76%	77%	76%	77%	4.5%	42%
Electric cars and vans	The charging network (see above) is complete by 2027 rather than 2028	67%	70%	65%	68%	66%	65%	0.4%	42%

POLICY AREA	POLICY	OVERALL SUPPORT	A CITY CENTRE	A TOWN CENTRE	IN A CITY BUT NOT IN THE CENTRE	IN A TOWN BUT NOT IN THE CENTRE	RURAL, OR IN A COUNTRYSIDE VILLAGE	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Other things we buy	A higher carbon tax (see above) with subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of carbon emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise remains at £50 per tonne that is not emitted.	61%	70%	59%	61%	58%	60%	2.4%	44%
Food and land use	The food campaign (see above) is supplemented by a tax of at least 8% on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 5%, which combined with the information campaign results in a total reduction of 15% per person.	60%	69%	64%	58%	56%	57%	0.7%	45%
Public transport & cycling	Investment in public transport and cycling. There is more investment in buses and cycling, in addition to moving to a system in which local government coordinates routes, improves services and sets fares (see above). Subsidy levels will increase in the long run. Cycling and e-cycling is encouraged and there is a major investment in the kind of cycle lane network that exists in some other countries: where feasible and useful, all major roads in towns and cities have cycle lanes.	55%	54%	52%	57%	57%	55%	1.4%	47%
Flights	A sharp increase in flying costs. The 41% supporting this were made up of 28% supporting higher costs for frequent fliers (no tax on the first return flight, 20% on the second, 40% on the third, 60% on the fourth and so on) and 13% supporting a flat levy of 20%.	41%	45%	40%	37%	41%	42%	0.6%	47%
Public transport & cycling	Restrictions on cars beyond those described above. In addition to the restrictions described above, major cities introduce more restrictions on cars entering city centres and put congestion charges in place, using the proceeds to further improve public transport.	40%	48%	39%	40%	39%	38%	0.3%	47%
Electric cars and vans	The charging network (see above) is complete by 2026 rather than 2027 or 2028	35%	36%	30%	36%	35%	37%	0.7%	48%

POLICY AREA	POLICY	OVERALL SUPPORT	A CITY CENTRE	A TOWN CENTRE	IN A CITY BUT NOT IN THE CENTRE	IN A TOWN BUT NOT IN THE CENTRE	RURAL, OR IN A COUNTRYSIDE VILLAGE	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Heating & electricity	The very ambitious approach to heating and electricity, made possible by government playing an active role (see above), plus subsidies for insulation. In addition to the measures described above, the government increases its 2030 target for insulation to 1.3m existing homes be insulated. The grant scheme covers insulation where this does not pay for itself through savings on bills.	33%	40%	30%	34%	32%	31%	0.8%	49%
Food and land use	The food campaign (see above) is supplemented by a 25% tax on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 15%, which combined with the information campaign results in a total reduction of 25% per person.	25%	34%	25%	25%	23%	22%	0.9%	50%
Other things we buy	A higher carbon tax (see above) and higher subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of carbon emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise rises to £100 rather than £50 per tonne that is not emitted.	24%	34%	24%	22%	21%	22%	3.6%	53%

TABLE OF CLIMATE CALCULATOR POLICIES, WITH PUBLIC SUPPORT AND ASSOCIATED EMISSIONS REDUCTIONS: REGION

POLICY AREA	POLICY	OVERALL SUPPORT	EAST MIDLANDS	EAST OF ENGLAND	LONDON	NORTH EAST ENGLAND	NORTH WEST ENGLAND	NORTHERN IRELAND	SCOTLAND	SOUTH EAST ENGLAND	SOUTH WEST ENGLAND	WALES	WEST MIDLANDS	YORKSHIRE AND THE HUMBER	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Heating & electricity	A more ambitious approach to heating. The UK government increases its 2028 target to at least 800,000 heat pumps a year to be installed in existing homes, with at least 400,000 existing homes to be insulated. It provides grants to cover some of the additional costs and encourages low interest loans to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets targets for solar and onshore wind electricity generation.	97%	97%	97%	97%	97%	97%	98%	97%	97%	97%	97%	97%	98%	3.3%	28%
Other things we buy	A carbon tax and subsidies. Manufacturing and construction businesses pay a tax of £75 per tonne of carbon emitted. Those industries that find it difficult to decarbonise also receive a subsidy of £50 per tonne of carbon that they do not emit due to their investment in new processes. Manufacturers pass on their extra costs to consumers, so prices of some products increase.	94%	93%	95%	94%	95%	94%	96%	94%	94%	95%	95%	94%	94%	2.6%	31%

POLICY AREA	POLICY	OVERALL SUPPORT	EAST MIDLANDS	EAST OF ENGLAND	LONDON	NORTH EAST ENGLAND	NORTH WEST ENGLAND	NORTHERN IRELAND	SCOTLAND	SOUTH EAST ENGLAND	SOUTH WEST ENGLAND	WALES	WEST MIDLANDS	YORKSHIRE AND THE HUMBER	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Public transport & cycling	Better public transport. We continue with current levels of investment in improving buses and cycling (about £1bn a year), but also move to a system in which local government coordinates routes, improves services and sets fares. This will take some additional investment but will not be much more expensive than the current system in the long run.	93%	94%	92%	92%	93%	92%	91%	92%	93%	93%	92%	93%	94%	1.1%	32%
Food and land use	Encourage less red meat and dairy. A strong campaign run by supermarkets, food companies and government reduces red meat and dairy consumption per person by 10%. It makes plant-based foods and meat alternatives easier to choose and cook, and increases awareness of the health and climate benefits of a change in diet.	93%	93%	92%	95%	92%	93%	93%	93%	93%	94%	94%	94%	93%	2.3%	34%
Electric cars and vans	Charging network by 2028. A comprehensive network of public charging points is in place by 2028: everyone without their own off-street parking will have access to a charge point in the street they live in, and for those on longer journeys there will be rapid charge points at car parks and all petrol stations. For those with off-street parking, private charge points will be available for about £700. There will be a strengthened electricity grid to make this possible.	91%	90%	91%	92%	91%	91%	92%	91%	90%	91%	90%	91%	89%	1.2%	35%

POLICY AREA	POLICY	OVERALL SUPPORT	EAST MIDLANDS	EAST OF ENGLAND	LONDON	NORTH EAST ENGLAND	NORTH WEST ENGLAND	NORTHERN IRELAND	SCOTLAND	SOUTH EAST ENGLAND	SOUTH WEST ENGLAND	WALES	WEST MIDLANDS	YORKSHIRE AND THE HUMBER	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Flights	An increase in flying costs. The 89% supporting this policy were made up of 62% who preferred higher costs for frequent fliers (no tax on the first return flight and at least 10% on the second, 20% on the third, 30% on the fourth and so on) and 27% who preferred a flat levy for all fliers of at least 10%.	89%	88%	90%	89%	91%	89%	90%	91%	88%	89%	92%	90%	89%	0.6%	36%
Public transport & cycling	Limited restrictions on cars. Major cities introduce limited restrictions on cars entering city centres. The motorway and dual carriageway speed limit is reduced to 60mph in order to reduce emissions and there is greater use of temporary 50mph limits to smooth speeds and reduce congestion.	82%	84%	84%	84%	83%	79%	81%	82%	81%	80%	82%	82%	82%	0.4%	36%
Food and land use	More sustainable farming, forests and wildlife habitats. Some land is used for tree planting and to restore areas of peatland. Some of the land is also used to support less intensive, more sustainable and organic forms of farming. This reduces degradation of soil and protects biodiversity of insects, birds and other wildlife through reduced use of chemical fertilisers and pesticides and through paying farmers to create woodland, wildflower meadows and hedgerows.	79%	78%	81%	82%	76%	78%	77%	79%	79%	80%	78%	78%	76%	0.9%	37%

POLICY AREA	POLICY	OVERALL SUPPORT	EAST MIDLANDS	EAST OF ENGLAND	LONDON	NORTH EAST ENGLAND	NORTH WEST ENGLAND	NORTHERN IRELAND	SCOTLAND	SOUTH EAST ENGLAND	SOUTH WEST ENGLAND	WALES	WEST MIDLANDS	YORKSHIRE AND THE HUMBER	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Heating & electricity	A very ambitious approach to heating and electricity, made possible by government playing an active role. The government increases its 2030 target to 1.4m heat pumps a year to be installed in existing homes, with 770,000 existing homes to be insulated. It takes an active role to ensure sufficient supply of heat pumps and insulation to households, that these create UK jobs, and that costs are minimised. It provides a grant to cover some of the additional costs and it introduces a government-backed loan scheme at low interest rates to cover the rest, with homeowners paying these back from their energy bill savings. Low-income households receive grants to cover the total cost. The government also sets more ambitious targets for wind and solar electricity generation.	77%	78%	76%	76%	74%	78%	80%	80%	77%	76%	79%	74%	77%	4.5%	42%
Electric cars and vans	The charging network (see above) is complete by 2027 rather than 2028	67%	64%	68%	68%	67%	67%	67%	70%	64%	67%	64%	66%	67%	0.4%	42%

POLICY AREA	POLICY	OVERALL SUPPORT	EAST MIDLANDS	EAST OF ENGLAND	LONDON	NORTH EAST ENGLAND	NORTH WEST ENGLAND	NORTHERN IRELAND	SCOTLAND	SOUTH EAST ENGLAND	SOUTH WEST ENGLAND	WALES	WEST MIDLANDS	YORKSHIRE AND THE HUMBER	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Other things we buy	A higher carbon tax (see above) with subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of carbon emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise remains at £50 per tonne that is not emitted.	61%	59%	65%	64%	65%	59%	63%	60%	60%	64%	59%	58%	60%	2.4%	44%
Food and land use	The food campaign (see above) is supplemented by a tax of at least 8% on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 5%, which combined with the information campaign results in a total reduction of 15% per person.	60%	61%	60%	66%	64%	59%	63%	59%	58%	56%	56%	58%	58%	0.7%	45%
Public transport & cycling	Investment in public transport and cycling. There is more investment in buses and cycling, in addition to moving to a system in which local government coordinates routes, improves services and sets fares (see above). Subsidy levels will increase in the long run. Cycling and e-cycling is encouraged and there is a major investment in the kind of cycle lane network that exists in some other countries: where feasible and useful, all major roads in towns and cities have cycle lanes.	55%	57%	55%	52%	57%	54%	57%	58%	56%	58%	54%	56%	56%	1.4%	47%

POLICY AREA	POLICY	OVERALL SUPPORT	EAST MIDLANDS	EAST OF ENGLAND	LONDON	NORTH EAST ENGLAND	NORTH WEST ENGLAND	NORTHERN IRELAND	SCOTLAND	SOUTH EAST ENGLAND	SOUTH WEST ENGLAND	WALES	WEST MIDLANDS	YORKSHIRE AND THE HUMBER	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Flights	A sharp increase in flying costs. The 41% supporting this were made up of 28% supporting higher costs for frequent fliers (no tax on the first return flight, 20% on the second, 40% on the third, 60% on the fourth and so on) and 13% supporting a flat levy of 20%.	41%	44%	43%	38%	39%	39%	41%	44%	39%	43%	41%	39%	41%	0.6%	47%
Public transport & cycling	Restrictions on cars beyond those described above. In addition to the restrictions described above, major cities introduce more restrictions on cars entering city centres and put congestion charges in place, using the proceeds to further improve public transport.	40%	40%	38%	41%	36%	42%	39%	42%	38%	38%	42%	44%	40%	0.3%	47%
Electric cars and vans	The charging network (see above) is complete by 2026 rather than 2027 or 2028	35%	35%	36%	35%	33%	34%	35%	38%	35%	35%	36%	34%	36%	0.7%	48%
Heating & electricity	The very ambitious approach to heating and electricity, made possible by government playing an active role (see above), plus subsidies for insulation. In addition to the measures described above, the government increases its 2030 target for insulation to 1.3m existing homes be insulated. The grant scheme covers insulation where this does not pay for itself through savings on bills.	33%	33%	34%	34%	32%	32%	35%	40%	31%	32%	35%	33%	31%	0.8%	49%

POLICY AREA	POLICY	OVERALL SUPPORT	EAST MIDLANDS	EAST OF ENGLAND	LONDON	NORTH EAST ENGLAND	NORTH WEST ENGLAND	NORTHERN IRELAND	SCOTLAND	SOUTH EAST ENGLAND	SOUTH WEST ENGLAND	WALES	WEST MIDLANDS	YORKSHIRE AND THE HUMBER	2030 EMISSIONS REDUCTION COMPARED TO 2019	CUMULATIVE EMISSIONS REDUCTION, INCLUDING 25% FROM OTHER POLICIES
Food and land use	The food campaign (see above) is supplemented by a 25% tax on red meat and dairy. The proceeds of the tax are used to make fruit, vegetables and other plant-based foods and meat alternatives cheaper. The tax reduces red meat and dairy consumption per person by 15%, which combined with the information campaign results in a total reduction of 25% per person.	25%	27%	25%	30%	28%	22%	22%	28%	23%	24%	22%	25%	22%	0.9%	50%
Other things we buy	A higher carbon tax (see above) and higher subsidies. Manufacturing and construction businesses pay a tax of £100 per tonne of carbon emitted rather than £75 per tonne. The subsidy for industries that find it difficult to decarbonise rises to £100 rather than £50 per tonne that is not emitted.	24%	25%	26%	27%	25%	22%	25%	26%	21%	25%	20%	21%	21%	3.6%	53%

ANNEX 3

POLLING TABLES

The full spreadsheet of polling tables can be found at <https://demos.co.uk/wp-content/uploads/2021/09/Climate-Calculator-Annex-3.xlsx>

ANNEX 4

CLIMATE CALCULATOR

EXPLANATORY

MATERIAL

This annex contains an edited version of the explanatory material that was published on the Climate Calculator website, with sections on each of the six policy areas plus two extra sections on electricity generation and other sectors not included in the Calculator. There is then a section which explores changes required to reduce emissions after 2030, and a further section explaining the details of how we calculated the results on the website.

Electric cars and vans

INTRODUCTION

Surface transport – cars, vans, lorries, buses and trains – produces about 25% of UK greenhouse gas emissions.¹⁸ We can reduce this by shifting from petrol and diesel to electric vehicles.

In this domain, users could choose between the government's existing policies, or alternatively a date for a comprehensive electric vehicle charging network in place across the UK - 2028, 2027 or 2026. Currently the government does not have a plan for a comprehensive charging network, although an electric vehicle infrastructure strategy is set to be published later this year.¹⁹

THE CURRENT SITUATION

At the moment there are around 32 million cars in the UK, of which around 200,000 are fully electric. About 2.3 million cars are sold each year, of which

approximately 108,000 are fully electric. There has been a sharp increase in electric car sales in recent years, but the current annual growth rate has settled down to 15%.

Electric cars' small market share – about 5% – is not surprising given that they are about a third more expensive than the petrol equivalent – though a government grant of £2,500 reduces this difference. So, for example, the electric equivalent of a petrol car costing £15,000 would cost £20,000 without the grant, but costs £17,500 with the grant.

In addition, we do not yet have a comprehensive charging network, and this creates difficulties for longer journeys. Range – how far a car can travel between charges – has much improved recently, although it is still perceived to be an issue by drivers. Range is likely to improve further.

SUMMARY OF OUR ASSUMPTIONS AND PREDICTIONS

Given this, and in line with what drivers say, we assume that there will be no major shift to electric cars beyond the current growth rate of 15% until (a) the price difference is eliminated and (b) there is a comprehensive public charging network. At that point, there will be a surge in electric car market share: petrol and diesel will quickly become positively unattractive given electric cars' lower

¹⁸ The percentages are based on CCC data for 2018, but with electricity supply and fuel supply reassigned to their end users, based on data from BEIS. On the Climate Calculator website, they sum to 91% as waste and shipping are not included. Using the CCC's sectoral categories, surface transport produced 21% of the UK's emissions in 2018.

¹⁹ Department for Transport. Transport Decarbonisation Plan. GOV.UK, July 2021, p. 99. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1009448/decarbonising-transport-a-better-greener-britain.pdf [accessed 14/09/2021]

maintenance and fuel costs, the prospect of a declining number of petrol stations, potentially low second-hand values, and the prospect of a government ban on new petrol and diesel cars (currently planned for 2030). Based on the above, we assume that electric cars' market share will jump to 40% in the first year that prices are equivalent and the full charging network exists, will rise to 80% in the following year, and to 100% in the year after that.

The difference in price between petrol/diesel and electric vehicles is predicted to be eliminated by around 2026.²⁰ At the moment there is no policy in place to create a comprehensive charging network, and the main policy question is what date we should aim for – 2026 or later. On the basis of the market share assumptions just set out, we predict that in 2030, only 9% of cars and vans on the road will be electric if the network is not ready by then. By contrast, we predict that around 30% of cars and vans on the road will be electric if the network is ready by 2026.

Note that cars last on average 11 years, so even once 100% of sales are electric, it will take another decade or so for all cars on the road to be electric.

SUPPLY CONSTRAINTS

Raw material supplies, especially minerals for batteries, represent a possible supply constraint.²¹ We assume that for the UK market – a small part of the global total – the impact of this would be higher prices rather than unavailability. However, according to the International Council on Clean Transportation, in the last decade “the near-term raw material price volatility has had minimal impact on electric vehicle battery prices.”²² In the absence of clear evidence to the contrary, we have assumed that raw material supply constraints do not seriously affect prices before 2030, although this is clearly uncertain.

NUMBER OF CHARGING POINTS

We assume that even the fastest charging points will be much slower than filling up a tank of petrol and

that therefore most charging will take place when the driver is doing something else. This means everyone should have convenient access to a charging point.

What constitutes ‘convenient access’ is a matter of judgement. Our judgement is that convenient means being able to recharge one’s car or van overnight close to home, whether or not one has off-street parking. This requires a larger number of public charging points than most other reports suggest is necessary. It would be possible to target those streets where the residents are more likely to buy a new car, i.e., more prosperous streets, but we have adopted a principle of universal access.

The data indicate that the drivers of 85% of vehicles will have access to a private charging point at their home.²³ These will cost around £700 to install and we assume that they will be paid for by drivers on purchase of their first electric car (an acceptable price given the £240 annual savings in fuel and maintenance). We then assume that the remaining 15% of vehicles (around 4.5 million) will need access to a point on 50% of evenings, and that the points have two heads, meaning one of these public points can be shared by four vehicles, that is around 1.125 million points. Our research suggests these will cost an average of £3,000 each to install, and we assume that these costs will be paid for through electricity charges, structured to make total costs for those with and without off-street parking the same.²⁴

It is possible that significantly fewer public points will be needed because workplace charging really takes off – the basis on which the modelling in several studies is done – generating a significantly lower requirement for public charging points (but with roughly the same total number of workplace and public charge points taken together).²⁵ The problem with this alternative approach is that we cannot know in advance which streets without off-street parking will be inhabited by drivers with access to workplace charging. We have therefore adopted universal access as a basic principle. In addition, encouraging workplace charging would create an incentive for commuting by car, contrary to the general direction

20 Transport for Environment and BloombergNEF. Hitting the EV Inflection Point. May 2021, p. 26. Available at www.transportenvironment.org/wp-content/uploads/2021/08/2021_05_05_Electric_vehicle_price_parity_and_adoption_in_Europe_Final.pdf [accessed 14/09/2021]

21 International Energy Agency. The Role of Critical Minerals in Clean Energy Transitions. May 2021. Available at www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions [accessed 14/09/2021]

22 Slowik, P., Lutsey, N. and Hsu, C. W. How technology, recycling, and policy can mitigate supply risks to the long-term transition to zero-emission vehicles. The International Council on Clean Transport, December 2020, p. 26. Available at <https://theicct.org/sites/default/files/publications/zew-supply-risks-dec2020.pdf> [accessed 14/09/2021]

23 Pirie, J. and others. The impact of a 2030 ICE phase-out in the UK. Cambridge Econometrics, November 2020, p. 30. Available at www.greenpeace.org.uk/wp-content/uploads/2020/11/The-impact-of-a-2030-ICE-phase-out-in-the-UK.pdf [accessed 14/09/2021]

24 Mathieu, L. Recharge EU: How many charge points will Europe and its Member States need in the 2020s. Transport and Environment, January 2020, p. 59. Available at www.transportenvironment.org/discover/recharge-eu-how-many-charge-points-will-eu-countries-need-2030 [accessed 14/09/2021]. The Cambridge Econometrics 2020 study cited has a c. 50% higher unit cost but for a much smaller volume.

25 Pirie, J. and others. The impact of a 2030 ICE phase-out. 2020. p. 15.

of policy. Our assumption – on- and off-street charging near the home – increases the total cost to the driver, but only by a few pennies a week.

We also assume 62,000 rapid and ultra-rapid public chargers at, and eventually replacing, petrol stations, at an average cost of £44,500 each (including a small number that cost significantly more).²⁶

BUILDING AND PAYING FOR THE CHARGING NETWORK

We assume that the public infrastructure will take a minimum of a year to plan and three years to build, and that therefore the earliest it could be built is 2026. The total cost, given the assumptions above, is c. £6.3bn, i.e., £2.1bn for each of the three years it is being built. We assume it lasts for 10 years, and that maintenance costs are £350m a year, creating an annualised cost of around £980m a year, assuming the Government pays zero real interest rates.²⁷ Total annual mileage of cars and vans is 300 billion, meaning the cost is a third of a penny per mile driven, whether in a petrol or electric car. The average weekly mileage for a car is 142 miles, meaning the average weekly cost of the network, if spread over all cars, is 47p (to be levied through petrol and electricity prices). This cost does not apply in the least ambitious option (no network in place by 2030) but the same cost applies to all of the other three options, all of which involve a network in place by 2030.

It would be possible for the taxpayer to bear the cost rather than drivers, but it is not clear why non-drivers should subsidise drivers. Equally, it would be possible for the total cost to be paid through electricity charges only and not petrol prices, but this would create high prices and a disincentive to the switch we are trying to encourage, at least initially. Given the overall cost to drivers is quite low (47p a week), we have not presented this option in detail.

We assume that private charge points are installed as and when drivers switch to electric. There are approximately 2.3 million car sales per year in the UK, which are likely to be slightly weighted towards those with off-street parking, so we assume 90% of these sales are to such drivers. On the other hand,

our estimate is that households with access to off-street charging own on average 1.5 cars, meaning the number of private points installed each year will rise to 1.4 million.²⁸ With costs at £700 per point, the total spend by drivers on new charge points will be £980 million a year.

WE HAVE FOCUSED ON BATTERY ELECTRIC CARS AND VANS, NOT HGVs OR HYBRIDS

We have focused on the shift to electric cars and vans, as the technology for both of these is already well developed. By contrast, the technology for electric HGVs is not so far advanced, and is unlikely to make a major impact before 2030.

In addition, we have focused on the shift to fully electric vehicles (Battery Electric Vehicles or BEVs), rather than Plug-in Hybrid Electric Vehicles (hybrids). This is because BEVs are forecast to reach price parity with petrol and diesel cars by 2026 and have significantly lower emissions than hybrids.²⁹ In other words, hybrids are a transitional technology which will offer no advantages in the long term.

OTHER ASSUMPTIONS ABOUT VEHICLE TECHNOLOGY

We have made the following additional assumptions:

- There are no hydrogen cars or vans by 2030. (In reality, there may be a few, but we assume the proportion will be small since hydrogen vehicles will remain too expensive.)
- There are no plug-in hybrid electric cars or vans. In reality there will be some, but we assume the numbers will be small as policy focuses on full BEVs. In any case, a small number of hybrids will make very little difference, as the emissions reduction compared to petrol and diesel vehicles is small: real-world use suggests emissions may even be similar to those of conventional petrol or diesel vehicles.³⁰
- BEVs account for 5% of rigid HGV distance in 2030, while plug-in hybrids and hydrogen HGVs account for 0% of distance (the CCC identified BEVs as the most likely technology for emissions reduction for this vehicle type).³¹

26 Pirie, J. and others. The impact of a 2030 ICE phase-out. 2020. p. 33.

27 £350m maintenance costs based on £250 maintenance per year for slow charge points, and £1,000 maintenance per year for rapid charge points (with the total rounded up slightly to £350m). Maintenance costs come from Weldon and Hilton (2019), with rapid charge point maintenance increased to £1,000 to reflect the inclusion of some ultra-rapid charge points in our model. Weldon, P. and Hilton, G. Derby EV Strategy and Electric Taxis. Ricardo Energy and Environment, March 2019, p. 14. Available at www.derby.gov.uk/media/derbycitycouncil/contentassets/documents/transport/airqualityplan/finalbusinesscase/Derby-EV-CAF--Report-March-2019.pdf [accessed 14/09/2021]

28 $2.3 \times 90\% \times 2/3$.

29 CCC. Sixth Carbon Budget Methodology. December 2020, p. 58. Available at www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-Methodology-Report.pdf [accessed 15/09/2021]

30 CCC. Sixth Carbon Budget Methodology. December 2020, p. 58.

31 CCC. Sixth Carbon Budget: Surface Transport sector summary. December 2020, p. 53. Available at www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Surface-transport.pdf [accessed 14/09/2021]

- There are no BEV or plug-in hybrid articulated HGVs in 2030: these are the least likely vehicle to adopt battery electric technology, given current price and range limitations.³² It is possible that hydrogen may be a viable technology for articulated HGVs by 2030. However, since the proportion is likely to be small in 2030, we assume 0%.
- BEVs account for 10% of bus distance, and hydrogen fuel-cell vehicles account for a further 10% by 2030. The CCC's Balanced Pathway uses a combination of BEVs and hydrogen vehicles to decarbonise buses.³³
- There is an increase in electric trains due to gradual electrification of the network over time. For passenger trains, the share of vehicle distance increases from 65% in 2015 to 80% in 2030, and for freight trains, the share increases from 8% in 2015 to 20% in 2030.
- There is a small increase in the use of biofuels in conventional vehicles:
 - For cars and vans, we follow the CCC's Balanced Pathway, in which biofuels make up about 7% of the conventional fuel used by cars and vans in 2030.³⁴ This is based on the assumption that the Department for Transport introduces E10 (petrol containing up to 10% renewable ethanol – a biofuel made from biomass – to reduce CO₂ emissions) as default petrol.³⁵
 - For HGVs and buses, we follow the CCC's Balanced Pathway, in which biofuels make up about 4% of fuel used by these vehicles in 2030.³⁶
 - For rail, we assume a marginal increase in biodiesel to 2% by 2030.
 - For non-road mobile machinery, we also assume a small increase to 2% biofuel by 2030.
 - For shipping, we assume 0% biofuel, based on the CCC's analysis that biofuel is not the optimal path for decarbonisation of shipping fuels.³⁷

Public transport and cycling

INTRODUCTION

Most cars and vans in the UK in 2030 will still be running on petrol or diesel, so shifting to public transport and cycling can help reduce emissions. Users could select three options in the Calculator: no change, better public transport, or better public transport and a comprehensive network of cycling lanes.

We can also reduce emissions by putting in place restrictions and speed limits for cars. Users could choose three options: no change, limited restrictions with reduced speed limits, or more restrictions with reduced speed limits and congestion charges for entering city centres.

PUBLIC TRANSPORT

The greatest potential for a shift from cars to public transport is in large cities outside London, where better public transport could reduce car use by 9% (this figure is based on comparisons between these cities and similar European cities).³⁸ Cities outside London account for around 18% of all UK car use so better public transport in these cities would reduce UK-wide car use by about 2%.^{39, 40} The study of these large cities that reported this figure also suggested (with less certainty) that the same reduction again could be achieved by improving public transport in other parts of the country. In other words, there could be a total reduction in car use across the whole UK as a result of improved public transport of around 4%.

This could be achieved at relatively low cost: re-organising bus services and adopting the well-established Transport for London franchise system across the country. This system allows the local authority to set fares, routes and timetables, to run integrated ticketing (for example tickets that are valid on more than one bus), and to ensure people can use buses to travel wherever they need to go. The local authority can also invest in additional and improved services. This involves some extra up-front

32 CCC. Surface Transport sector summary. 2020. p. 27.

33 CCC. Surface Transport sector summary. 2020.

34 CCC. Surface Transport sector summary. 2020. p. 34.

35 CCC. Surface Transport sector summary. 2020. p. 16.

36 CCC. Surface Transport sector summary. 2020. p. 34.

37 CCC. Sixth Carbon Budget: Shipping sector summary. December 2020. Available at www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Shipping.pdf [accessed 14/09/2021]

38 Sloman, L. and Hopkinson, L. Transforming public transport: Regulation, spending and free buses for the under 30s. Transport for Quality of Life, January 2019. Available at www.transportforqualityoflife.com/u/files/2%20Transforming%20public%20transport%20briefing.pdf [accessed 14/09/2021]

39 Taylor, I. and Hopkinson, L. Making transport fit for the Climate Emergency. Transport for Quality of Life, December 2020. Available at www.transportforqualityoflife.com/u/files/201203_FoE_Activists_Briefing-Making_transport_fit_for_the_Climate_Emergency_FINAL2.pdf [accessed 14/09/2021]

40 Department for Transport. Road traffic statistics: Traffic volume in miles. GOV.UK, April 2021. Available at www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra#traffic-volume-in-miles-tra01 [accessed 14/09/2021]

spending – plans to do this in Manchester have been costed at £122m over the first five years – but will not be much more expensive than the current system in the long run.^{41, 42}

Bus (and tram) services can be further improved by creating dedicated space for them on the roads so that they do not get held up in traffic. This can be done through a combination of bus lanes (which does take significant investment), and excluding cars from some streets. This can have additional health benefits by reducing pollution.

CONGESTION CHARGES

Congestion charges and road pricing have been introduced successfully in several cities around the world, and have reduced car usage in the areas covered (typically by between 20% and 40%).⁴³ For the most part, these measures cover relatively small areas, so the total reduction in car usage in a city may be quite small. We estimate that charges of this kind could reduce car use by up to 5% in major conurbations (or up to 1% in the UK as a whole). In London, distance travelled by car drivers fell 20% between 1999 and 2005.⁴⁴ This was not entirely because of the Congestion Charge (introduced in 2003): the Charge was brought in at the same time as improvements to public transport, and in particular to the bus network, which will also have had an effect.

CYCLING AND E-CYCLING

Cycling is mainly an alternative for short car journeys - under about five miles. In major cities where public transport is or could be the main mode for short journeys, the main impact of increasing cycling will be to reduce demand for public transport rather than car use. About 60% of new bike journeys in metropolitan areas result in reduced public transport

demand, while 25% result in less walking and only 15% in reduced car use.⁴⁵

However, in many other areas (representing up to 75% of car use) public transport is used for a small proportion of journeys. Across the country, of those urban journeys under 5 miles undertaken by public transport or car, only 14% are undertaken by public transport, and 86% are undertaken by car.⁴⁶ If the proportion of new bike journeys replacing walking is 25% as in the major cities, and if there are 1.45 passengers per car, then it would be reasonable to suppose that 100 extra bike journeys would replace 40 car journeys in these areas. This means that in the country as a whole, 100 bike journeys would replace about 34 car journeys.

The proportion of passenger miles travelled by bike in the UK is just 2%. This is under one fifth of the level in Germany and one twelfth of the level in the Netherlands.⁴⁷ If the UK was to get to German levels, it would reduce car use by around 3%, if we follow the assumptions set out in the previous paragraph.⁴⁸

In addition, if policies were adopted to get behind electric bicycles (e-cycles) and they caught on, including for journeys longer than 5 miles, then we could hope to achieve a larger reduction in car use, perhaps as much as 6%.

However, we assume this will only happen if cycling is as safe as it is in Germany, and perceived to be safe (a 2012 report revealed that the UK had a cycling death rate twice that of Germany).⁴⁹ This means a comprehensive network of separated cycle lanes.

These have been estimated to cost on average of £1.2m per mile.⁵⁰ Our estimate is that a 'comprehensive' network will consist of paths on about 7,500 miles of mainly urban and suburban main roads in addition to the existing network.⁵¹

41 Sloman and Hopkinson. Transforming public transport. 2019.

42 Royal Academy of Engineering. The transport congestion challenge: Getting the most out of the UK's road and rail networks. November 2015. Available at www.raeng.org.uk/RAE/media/Publications/Reports/The-Transport-Congestion-Challenge.pdf [accessed 14/09/2021]

43 Sloman, L. and Hopkinson L. An Eco Levy for driving: cut carbon, clean up toxic air, and make our towns and cities liveable. Transport for Quality of Life, November 2019. Available at www.transportforqualityoflife.com/u/files/6%20An%20Eco%20Levy%20for%20driving%20-%20cut%20carbon,%20clean%20up%20toxic%20air,%20and%20make%20our%20towns%20and%20cities%20liveable.pdf [accessed 14/09/2021]

44 Department for Transport. Carbon Pathways Analysis: Informing Development of a Carbon Reduction Strategy for the Transport Sector. The National Archives, July 2008, p. 88. Available at <https://webarchive.nationalarchives.gov.uk/ukgwa/+http://www.dft.gov.uk/pgr/sustainable/analysis.pdf> [accessed 14/09/2021]

45 Department for Transport. TAG data book. GOV.UK, November 2018. Available at www.gov.uk/government/publications/tag-data-book [accessed 14/09/2021]

46 Department for Transport. Proportion of urban trips under 5 miles taken by (i) walking or cycling (ii) public transport. GOV.UK, 13 December 2012. Available at www.gov.uk/government/publications/proportion-of-urban-trips-under-5-miles-taken-by-i-walking-or-cycling-ii-public-transport [accessed 14/09/2021]

47 European Cyclists' Federation. Cycling Data Map. (no date). Available at <https://ecf.com/cycling-data> [accessed 14/09/2021]

48 An additional 28% of total short journeys, meaning cars would travel 28% times 20% fewer miles – or around 5.6%.

49 Buehler, R. and Pucher, J. Walking and Cycling in Western Europe and the United States: Trends, Policies, and Lessons. TR News, June 2012. Available at <http://onlinepubs.trb.org/onlinepubs/trnews/trnews280/westerneurope.pdf> [accessed 14/09/2021]

50 Transport for Quality of Life. Cycling and Walking. 2019. Available at www.transportforqualityoflife.com/policyresearch/cyclingandwalking [accessed 14/09/2021]

51 There are 7,362 miles of urban A roads, 3,572 miles of B roads, and we might say about the same amount of C as B roads. This adds up to 14,500 miles. We are guessing about half the roads would be suitable for additional cycle paths, and that half plus what we have already would be sufficient to create a critical mass of paths.

That would require an investment of around £10bn.⁵² Allowing for maintenance and spreading the capital cost over ten years, this represents an annual cost of £2bn.

By comparison, the annual roads budget is around £11bn.⁵³

SPEED LIMITS

In addition to reducing the number of miles driven, we can reduce the amount of emissions per mile. These are already falling because of higher standards in new cars, and we assume the existing regulations will continue to drive this. However, the way people drive can also affect emissions levels: there is evidence that reducing the speed limit on motorways and dual carriageways to 60 mph, and increasing the number of temporary 50 mph restrictions to smooth speeds and reduce congestion, would lead to emissions reductions in the region of 1.5MtCO₂e (million tonnes carbon dioxide equivalent – the global standard measure of assessing greenhouse gas emissions).⁵⁴

PETROL PRICES

We have not offered raising petrol prices (or a universal road pricing scheme which amounts to much the same thing) as an option. The evidence is that high increases are needed to achieve a significant reduction in use, with the financial burden of these measures affecting the less well off in particular, and of course being widely unpopular. Academic studies suggest that prices may have to go up by as much as 100% to get a 10% reduction in demand,⁵⁵ and even advocates of road pricing assume a rise of almost 100% in per mile costs (fuel duty and tolls) to get a 30% reduction in car use.⁵⁶

OTHER ASSUMPTIONS ABOUT TRANSPORT DEMAND

We make the following additional assumptions about transport demand:

- Domestic distance travelled per person per year is 10,714km in 2030. This is slightly less than in 2015 (10,915km), based on the fact that distance travelled per person per year in England has fallen a little since 2007.⁵⁷ Distance travelled per person will also be affected by the proportion of workers who continue to work from home after the Covid-19 pandemic. Before the pandemic, 25% of car mileage was for commuting, for example.⁵⁸ However, given the uncertainty about long-term working patterns, our assumption is relatively conservative.
- Walking accounted for about 2.8% of domestic travel in 2015.⁵⁹ We assume this remains the same in 2030.
- Domestic aviation accounted for about 2% of domestic travel in 2015, and we assume this remains the same in 2030.
- We set the car occupancy rate at 1.55 passengers per vehicle. This is the rate recorded in England in 2019.⁶⁰ (This is a more conservative assumption than the Climate Change Committee model, where car occupancy increases to 1.7 by 2030).⁶¹
- The average annual mileage of cars in England in 2019 was about 11,900km and we assume this does not change.⁶² (The Department for Transport project a slightly downward trend whereas the Mackay Carbon Calculator models sharply rising numbers).

52 This is in line with the estimate in Taylor and Hopkinson. Making transport fit for the Climate Emergency. 2020.

53 Statista. Public sector expenditure on national and local roads in the United Kingdom (UK) from 2009/10 to 2020/21. July 2021. Available at www.statista.com/statistics/298667/united-kingdom-uk-public-sector-expenditure-national-roads [accessed 14/09/2021]

54 CCC. The Fourth Carbon Budget: Reducing emissions through the 2020s. December 2010, p. 155. Available at www.theccc.org.uk/wp-content/uploads/2010/09/CCC-4th-Budget-Book-with-hypers.pdf [accessed 14/09/2021]

55 Dunkerley, F., Rohr, C. and Daly, A. Road traffic demand elasticities: A rapid evidence assessment. RAND Europe, December 2014. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/395119/road-traffic-demand-elasticities.pdf [accessed 14/09/2021]

56 Sloman and Hopkinson. An Eco Levy for driving. 2019.

57 Department for Transport. National Travel Survey: 2019 data tables. GOV.UK, 5 August 2020, Table nts0101. Available at www.gov.uk/government/statistics/national-travel-survey-2019 [accessed 14/09/2021]

58 CCC. Sixth Carbon Budget Methodology. 2020. p. 48.

59 Department for Business, Energy and Industrial Strategy. MacKay carbon calculator (Excel version). GOV.UK, 3 December 2020. Available at www.gov.uk/guidance/carbon-calculator [accessed 14/09/2021]

60 Department for Transport. National Travel Survey: 2019 data tables. GOV.UK, 5 August 2020, Table nts0905. Available at www.gov.uk/government/statistics/national-travel-survey-2019 [accessed 14/09/2021]

61 CCC. Sixth Carbon Budget Methodology. 2020. p. 49.

62 Department for Transport. National Travel Survey: 2019 data tables. GOV.UK, 5 August 2020, Table nts0901. Available at www.gov.uk/government/statistics/national-travel-survey-2019 [accessed 14/09/2021]

Heating and insulation

INTRODUCTION

Buildings produce about 27% of UK greenhouse gas emissions.⁶³ We can reduce this by replacing worn out boilers with low-carbon alternatives such as electric heat pumps and installing insulation. We have focused on homes, but similar changes will be required for other buildings.

For buildings, the key policy choice over the next decade is how quickly the government should drive forward a programme of installing low-carbon heating systems (mainly heat pumps) and improving efficiency of existing buildings via insulation. Users could choose how ambitious they wanted to be:

1. Current policy: the government's target is to reach 600,000 heat pump installations per year by 2028.⁶⁴
2. Current approach but more ambitious: the government's target increases to 800,000 annual heat pump installations by 2028, with 400,000 existing homes to be insulated.
3. A planned approach: the target changes to 1.4m annual heat pump installations by 2030, with 770,000 existing homes to be insulated.
4. A planned approach with subsidies for insulation: 1.4m annual heat pump installations, with 1.3m existing homes to be insulated.

Users could also choose how to meet the costs of these changes – whether through general taxation, energy bills, or an equal mix of the two.

HEAT PUMPS – THE CURRENT SITUATION

Heat pumps will become the main low-carbon way of heating buildings. They work like reverse refrigerators, taking heat from the air and pumping it into the building. They are powered by electricity, but produce far more heat for a given amount of electricity than traditional electric heaters.

At the moment, there are about 265,000 heat pumps in the UK, providing heat to about 1% of homes. 25,000 heat pumps were installed last year, about 1.5% the number of gas boilers installed. This low

market share is hardly surprising, given that heat pumps are currently typically three times the price of a gas boiler.

It is likely that the cost of heat pumps will fall, however unlike electric cars and petrol cars, they will never be price competitive with gas boilers, although the running costs may be lower, especially if combined with insulation. If they are to replace boilers as the natural choice when an existing boiler wears out, the government will have to make grants and low-interest loans available.

Grants and loans for heat pumps

We assume that heat pumps will only be installed if the up-front costs to the consumer are no greater than those of a boiler. Our analysis suggests that government will have to provide a grant of between £3,600 and £4,800 per home to achieve this. It will also have to encourage or provide a system of low-interest loans.

To reach this conclusion, we made a series of assumptions: about how much more than a gas boiler a heat pump will cost, about how much electricity heat pumps will use, about electricity prices including tax, and about interest rates. Some of these will depend on government policy and so we have looked at the implications of two different policy approaches, one where the government takes an active approach and 'makes things happen', one where it takes a more passive approach, and relies more heavily on the market.

The cost of a heat pump

We assume that the additional up-front costs over and above those of replacing a boiler are £6,200 if the government takes a passive approach to supply chain and roll-out management, but that this falls to £5,400 if the government takes an active approach. This is calculated as follows. A heat pump currently costs £6,432,⁶⁵ and we can expect reductions over the next 9 years of between 23%⁶⁶ and 30%, the latter applying if government takes an active role to stimulate the market and create certainty of large-scale demand.⁶⁷ Other costs facing the household are between £3,412 and £3,791 (including decommissioning plus upgrading radiators

63 The percentages are based on CCC data for 2018, but with electricity supply and fuel supply reassigned to their end users, based on data from BEIS. On the Climate Calculator website, they sum to 91% as waste and shipping are not included. Using the CCC's sectoral categories, residential and non-residential buildings produced 17% of the UK's emissions in 2018.

64 We assume that the government will achieve this target, although it is not on track to do so at the moment: just 36,000 heat pumps were installed in 2020.

65 Element Energy. Development of trajectories for residential heat decarbonisation to inform the Sixth Carbon Budget. CCC, April 2021, p. 42. Available at www.theccc.org.uk/publication/development-of-trajectories-for-residential-heat-decarbonisation-to-inform-the-sixth-carbon-budget-element-energy [accessed 14/09/2021] The reductions are assumed for 2035 not 2030, but we assume the vast bulk is achieved by 2030.

66 Element Energy. Development of trajectories for residential heat decarbonisation. 2021. p. 42.

67 Department of Energy and Climate Change. Potential Cost Reductions for Air Source Heat Pumps. GOV.UK, January 2016. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/498962/150113_Delta-ee_Final_ASHP_report_DECC.pdf [accessed 14/09/2021]

and tanks).⁶⁸ We assume boilers cost £2,500 and that a heat pump lasts 5 years longer than a boiler (20 rather than 15 years).

Energy savings: how much electricity heat pumps will use and the cost of this electricity

There is a range of estimates for heat pump efficiency in the late 2020s. We assume an efficiency of 3.6 times boiler efficiency (towards the middle of the range).

We also assume an electricity price before tax of 2.9 times the gas price (the current difference) and that the tax on gas and electricity will be levied at the same level, i.e., 20%. This is less than the current tax on electricity (the cost of which is made up of 23% environmental and social levies and 5% VAT) and more than the tax on gas (currently around 6.6% of a gas bill) but if the change were to happen now, it would result in a very small reduction in cost for the average household.

On this basis, we assume heating a home with a heat pump results in savings equal to 16% of the current level of gas bills. In 2019 these were £610 according to BEIS,⁶⁹ and would have been £682 had gas and electricity been charged at the same 20% rate.

Low-cost loans

We assume that householders can take out low-cost loans paid off over the life of the heat pump. If the government takes a passive role in the roll out of heat pumps, we assume a real interest rate of 6%. If government takes an active role, for example by running a scheme itself or by facilitating energy service contracts or forms of secured loan, we assume a real interest rate of 3% (still significantly higher than the expected mortgage rate in the period). Either way, we assume that the interest and repayments are fully covered by energy savings and the benefit of heat pumps' longer life compared with boilers. This means we assume less is borrowed if the interest rate is 6% than if the interest rate is 3%, and that therefore the grants have to be higher if the government takes a passive role.

District schemes

In district schemes, heat is generated centrally and then supplied to buildings that are part of the scheme in the way that gas is currently supplied. This means there is no need for a heat pump in each home. District heat generation may use what is in effect a large central heat pump.

Homes that join a district scheme will incur costs about £3,000 per household lower than those where an individual heat pump is installed, but most householders will not be planning a boiler purchase at the time of conversion and therefore the £2,500 we assume for boiler costs cannot be used to offset these costs. We therefore assume that the grants per home for district schemes are just £500 less than for individual heat pumps.

GRANTS AND LOANS FOR INSULATION

We assume that the average cost of insulation in the 19% of homes where low-cost insulation is needed to make heat pumps efficient is £1,000.^{70, 71} We assume that the average cost of insulation in the 14% of homes where medium-cost insulation is needed is £4,000.^{72, 73} We assume that the energy savings resulting from low-cost insulation more than cover the costs of the insulation, even given the 6% interest rates associated with a more passive approach by government. Therefore, no additional subsidy is needed. However, any loan scheme will need to be extended to cover insulation.

We assume that the annual energy savings resulting from medium-cost insulation amount to £160 over and above those generated by the heat pump itself.⁷⁴ At the interest rates assumed, this means an additional grant per home of this type will be needed. This will be between £1,000 (3% interest rate) and £1,630 (6% interest rate).

68 Element Energy. Development of trajectories for residential heat decarbonisation. 2021. p. 42. The lower number reflects the scope for streamlining installation costs as reflected in Department of Energy and Climate Change. Potential Cost Reductions for Air Source Heat Pumps. 2016.

69 Department for Business, Energy and Industrial Strategy. UK Energy Statistics, 2019 and Q4 2019. GOV.UK, 26 March 2020. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/877047/Press_Note_March_2020.pdf [accessed 14/09/2021]

70 CCC. Sixth Carbon Budget - Dataset. December 2020. Available at www.theccc.org.uk/publication/sixth-carbon-budget [accessed 14/09/2021]

71 Element Energy. Development of trajectories for residential heat decarbonisation. 2021.

72 CCC. Sixth Carbon Budget - Dataset. 2020.

73 Element Energy. Development of trajectories for residential heat decarbonisation. 2021.

74 Element Energy. Development of trajectories for residential heat decarbonisation. 2021. p. 39.

HOW MANY HEAT PUMPS COULD BE INSTALLED EACH YEAR?

If there is an effective system of grants and low-interest loans in place, and heat pumps become the natural choice when replacing a boiler, then there are two limits on the number of installations: a demand limit, that is the number of boiler replacements in homes that are suitable for heat pumps multiplied by the take up rate, and a supply limit, that is the number of heat pumps that the industry can supply and install. The effective limit in any year is the lower of the two.

The demand limit is calculated as follows:

- Heat pumps can only be installed in 58% of UK's 28.5m homes without further insulation; a further 19% require low-cost insulation, and a final tranche of 14% require medium-cost insulation⁷⁵ (the base here including the 5.5m homes currently without central heating)⁷⁶
- Government measures, if it adopts an active approach, are sufficient to ensure a 100% take up in homes where no insulation is required, an 80% take up where low-cost insulation is required, and a 60% take up where medium-cost insulation is required.
- If it adopts a more passive approach, there will be a 60% take up in homes where no insulation is required, a 40% take up where low-cost insulation is required and a 30% take up where medium-cost insulation is required.
- There is no scrappage, and heat pumps are installed at the end of a boiler's useful life of 15 years.⁷⁷
- 17% of homes are part of district heating schemes (in line with the government's target) and therefore not part of the market for heat pumps.

If government adopts an active policy and heat pumps are confined to no or low-cost insulation homes, this generates the following demand limits: 1.4m homes a year, assuming all district heating is for other homes, or 1.15m homes a year if the insulation needs of district heating scheme homes are in the same proportion as homes in general.

A higher limit can be calculated if medium cost homes are included – but the supply limit means that this will not be reached. A lower limit applies if the government does not adopt an active approach.

The supply limit also depends on whether the government takes an active or passive approach to managing the supply chain and producer expectations. If the government takes an active approach, the limit is 620,000 in 2025 rising to 1.42m in 2030. If the government takes a passive approach, the limit is 220,000 in 2025, rising to 1.08m in 2030. The supply limit is always below the demand limit, except for the £1.42m in 2030, and therefore with this exception the supply limit is the limit we use in our modelling.

These numbers are based on two alternative limits set out by low-carbon energy consultants, Element Energy, for the Climate Change Committee: their "absolute limit", which we assume applies if the government takes an active approach, and their "achievable at a stretch" limit, based on industry feedback, which we assume applies if the government takes a passive approach.⁷⁸ In both cases we deduct the heat pump installations needed for new homes, which we assume to be 180,000 a year from 2025 (170,000 new homes were built in 2019, an eleven year high).⁷⁹

In 2028 the supply limit for existing homes is 1.12m installations. Our target figure of 1.4m in the 'very ambitious' policy for heating (options 3 or 4) also includes 280,000 homes in low carbon district heating schemes. This is on the assumption that we move towards the government's target of 17% at the same rate that individual heat pumps are installed (i.e. we reach the target over 15 years).

HOW MUCH INSULATION COULD BE INSTALLED EACH YEAR?

We assume that heat pumps are only installed as boilers are replaced, but there is potential to roll out insulation in the other properties where the boiler is not being replaced. We make the same assumptions as in the earlier sections about the proportion of properties suitable for low-cost and medium-cost insulation, the average cost of this insulation, the energy savings achieved, and the levels of take up associated with different policy approaches. We assume no supply-side constraint on the number of homes insulated each year. In our most ambitious scenario, constraints on demand mean there are 770,000 low-cost and 570,000 medium-cost insulations a year by 2030.

75 Element Energy and E4tech. Cost analysis of future heat infrastructure options. National Infrastructure Commission, March 2018. Available at <https://nic.org.uk/app/uploads/Element-Energy-and-E4techCost-analysis-of-future-heat-infrastructure-Final.pdf> [accessed 14/09/2021]

76 Piddington, J. and others. The Housing Stock of the United Kingdom. BRE Trust, February 2020. Available at https://files.bregroup.com/bretrust/The-Housing-Stock-of-the-United-Kingdom_Report_BRE-Trust.pdf [accessed 14/09/2021]

77 CCC. Sixth Carbon Budget: Buildings sector summary. December 2020. Available at www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Buildings.pdf [accessed 14/09/2021]

78 Element Energy. Development of trajectories for residential heat decarbonisation. 2021. p. 33.

79 Ministry of Housing, Communities and Local Government. Number of new homes built soars to an 11 year high. GOV.UK, 3 October 2019. Available at www.gov.uk/government/news/number-of-new-homes-built-soars-to-an-11-year-high [accessed 14/09/2021]

SUBSIDIES FOR FUEL-POOR OWNER-OCCUPIERS

We assume that the full costs of heat pump conversion and insulation are met for fuel-poor owner-occupiers (rather than just the costs minus new boiler costs and the amount of a low-cost loan). There are around 2m such households.

PAYING FOR LOW-CARBON HEATING AND INSULATION

We have offered three options for paying for the grants needed: taxpayers paying, consumers paying through their energy bills, and half through tax and half through energy bills.

If taxpayers pay, we assume the total cost is borne from income tax, NICs, capital gains tax, corporation tax and business rates (in proportion to the sums currently raised by these taxes).

If consumers pay, we assume the total cost is spread as an equal percentage of all household energy bills, excluding fuel-poor households.^{80, 81, 82}

ADDITIONAL ASSUMPTIONS

We have made the following additional assumptions:

- Non-domestic buildings: We assume that policy is designed to achieve the same level of take up in non-domestic buildings as in domestic buildings and that this is achieved through regulation rather than grants, and that ultimately the costs are borne by commercial landlords. This is a simplifying assumption rather than one which we expect or recommend, but it produces an adequate approximation for modelling purposes.
- Temperature of buildings, including hot water demand and cooling demand: We assume there is a small increase in demand for cooling but demand for space and water heating remain fairly constant (assuming any reduction in demand in 2030 from efficiency is cancelled out by the increase in numbers of homes).
- Hybrid heat share: We make a simplifying assumption that all heat pumps that are installed are full heat pumps, rather than hybrid, so hybrid heat pump share is assumed to be 0% in 2030.

- Energy demand from appliances and lighting: We assume that lighting and appliance demand remains constant in both the residential and non-residential sectors in 2030 and that there is an increase in efficiency in line with the assumptions in the CCC's Balanced Pathway.

Flights

INTRODUCTION

Before the pandemic, international flights produced about 7% of UK greenhouse gas emissions and had doubled since 1990, while domestic flights produced about 0.5%.⁸³ Once the pandemic is over, emissions from flights are likely to continue growing. No technology to significantly reduce emissions per mile flown will be available before 2030, so if we want to reduce emissions, we will have to reduce the number of miles flown.

Users could select three options for flights. The first option is the government's current policy: no tax would be introduced, and therefore emissions are likely to gradually rise in line with population and economic growth. The second and third options are two different levels of tax, which we estimate would reduce demand by 8.5% and 17% respectively.

Users could choose whether they preferred a tax on all fliers, or only frequent fliers. In the case of a simple tax on all fliers, the options available were a 10% tax or a 20% tax. Under a frequent flier system, the first return flight would be exempt from the tax, while the tax on subsequent flights would increase. In the moderate tax, this means 10% on the second return flight, 20% on the third return flight, 30% on the fourth return flight and so on. In the higher tax version, this means 20% on the second return flight, 40% on the third return flight, 60% on the fourth return flight and so on.

WAYS OF REDUCING MILES FLOWN

There are two main ways of reducing the number of miles flown: reduce airport capacity or increase prices with a tax.

80 Department for Business, Energy and Industrial Strategy. Annual Fuel Poverty Statistics in England, 2021. GOV.UK, 4 March 2021. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/966509/Annual_Fuel_Poverty_Statistics_LILEE_Report_2021_2019_data.pdf [accessed 14/09/2021]

81 Energy Action Scotland. Fuel Poverty Overview. (no date). Available at www.eas.org.uk/en/fuel-poverty-overview_50439 [accessed 14/09/2021]

82 Climate Change, Environment and Rural Affairs Committee. Fuel Poverty in Wales. National Assembly for Wales, April 2020. Available at <https://senedd.wales/laid%20documents/cr-ld13147/cr-ld13147-e.pdf> [accessed 14/09/2021]

83 The percentages are based on CCC data for 2018, but with electricity supply and fuel supply reassigned to their end users, based on data from BEIS. On the Climate Calculator website, they sum to 91% as waste and shipping are not included. Using the CCC's sectoral categories, aviation produced 7% of the UK's emissions in 2018.

We have not included reducing airport capacity in the options in the Climate Calculator because in practice it would lead to airlines increasing their prices. In other words, its effect on fliers would be similar to a price increase imposed by the government. The only difference would be that airlines or airports' profits would be higher and tax revenues lower. Limiting capacity could be a useful supplement to a tax but it is not an effective alternative. It is also worth noting that it now seems unlikely that a third Heathrow runway will be built by 2030.

We have assumed that there are two ways in which price increases could operate: an across-the-board tax (replacing or supplementing existing Air Passenger Duty), or a frequent flier levy. The frequent flier levy works by leaving the first (return) flight exempt, but then applying the levy at a rising rate: a base rate on the second return flight, twice that rate on the third return flight, three times that rate on the fourth return flight, and so on.

THE IMPACT OF PRICE INCREASES

Our estimates of the impact of price increases on the demand for flights are based on work done by Fouquet and O'Garra (2020).⁸⁴ We estimate that an across-the-board price rise of 10% will lead to a fall in demand of 8.5%, and a price rise of 20% will lead to a fall in demand of 17%. (We think these estimates are relatively conservative given other research on the effect of price changes on the demand for flights: a typical estimate is that a 10% increase leads to a 12.3% demand reduction for short haul flights, and an 8% reduction for long haul flights).⁸⁵ The same evidence suggests that a frequent flier levy structured in the way described above would require a price rise on the second return flight of as little as half these levels to generate the same overall demand reduction. However, we have more cautiously assumed that such a levy would require the second return flight to attract the same tax as

all flights in the other option, with the third flight attracting twice this level, the fourth three times this level and so on.

THE NUMBER OF FLIGHTS IN THE ABSENCE OF ACTION

We have applied the effect on demand of these different approaches to a baseline – the likely number of passenger miles in the absence of any action. To estimate this, we have used Department for Transport (DfT) projections: flights to and from the UK are estimated at 805 billion passenger kilometres in 2030 (this assumes no major UK airport expansion before 2030 – now considered the most likely scenario).⁸⁶ We then divide this by the projected population of 69.8 million (an approximate 4% increase on 2021),⁸⁷ and then divide the result by two (to estimate flights departing from the UK only as a rough estimate of the share of emissions attributable to UK citizens), which gives 5,772 km per passenger. This metric is used by the Mackay Carbon Calculator (MCC). This DfT baseline is significantly lower than that in the MCC partly because the MCC model assumes there is a new runway at Heathrow by 2030.

TECHNOLOGICAL CHANGES

We also make the following assumptions:

- International and domestic aircraft efficiency improves by 1.4% per year until 2030, following the CCC's Balanced Pathway.⁸⁸
- International and domestic aviation use 3.5% biofuel by 2030. We base this on the assumption that a Sustainable Aviation Fuel blending mandate is introduced in 2025.⁸⁹ However we assume the net impact on emissions of this measure is negligible.
- No hybrid electric international aircraft are in use before 2030.

84 Fouquet, R. and O'Garra, T. The behavioural, welfare and environmental impacts of air travel reductions during and beyond COVID-19. Grantham Research Institute on Climate Change and the Environment, July 2020. Available at www.lse.ac.uk/granthaminstitute/wp-content/uploads/2020/07/working-paper-342-Fouquet-OGarra.pdf [accessed 14/09/2021]

85 InterVISTAS Consulting. Estimating Air Travel Demand Elasticities. IATA, 28 December 2007. Available at www.iata.org/en/iata-repository/publications/economic-reports/estimating-air-travel-demand-elasticities---by-intervistas [accessed 14/09/2021]

86 Department for Transport. UK aviation forecasts 2017 data. GOV.UK, 24 October 2017, Table 73. Available at www.gov.uk/government/publications/uk-aviation-forecasts-2017 [accessed 14/09/2021]

87 Office for National Statistics. National population projections: 2018-based. 21 October 2019. Available at www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2018based [accessed 14/09/2021]

88 CCC. Sixth Carbon Budget Methodology. 2020. p. 261.

89 CCC. Policies for the Sixth Carbon Budget and Net Zero. December 2020, p. 171. Available at www.theccc.org.uk/wp-content/uploads/2020/12/Policies-for-the-Sixth-Carbon-Budget-and-Net-Zero.pdf [accessed 14/09/2021]

Food and land use

INTRODUCTION

Farming and other land use produces 13% of UK territorial greenhouse gas emissions, much of it from cows and sheep.⁹⁰ There are three main ways to cut emissions: reducing red meat and dairy consumption,⁹¹ encouraging sustainable and low-emission farming, and using land to plant trees and restore peatlands, saltmarshes and hedgerows.

The key policy question in this area is whether the government should seek to encourage a change in diet by reducing red meat and dairy consumption. Since the UK's population is projected to increase by 4% between now and 2030, emissions from farming and land use are likely to increase unless we change our diets. Users had four options to choose from:

1. Current government policy: no diet change
2. A strong campaign run by supermarkets, food companies and government which reduces red meat and dairy consumption per person by 10%.
3. A strong campaign combined with an 8% tax on red meat and dairy reduces consumption per person by 15%.
4. A strong campaign combined with a 25% tax on red meat and dairy reduces consumption per person by 25%.

We asked users a second key question in this area about the style of farming they would like to see in the future. Users could only make a selection if they changed diets first, since either approach requires at least some land to be released from livestock farming. Assuming they changed diets, users could then choose between two options:

1. More intensive farming, with some land released for tree planting and peatland restoration.
2. A less intensive, more 'agroecological' approach to farming. This means less land is released,

but more trees and hedgerows are planted on farmed land, and there is less and better use of synthetic fertilisers and pesticides. (This second option is more expensive because it requires greater subsidies from government.)

WAYS OF REDUCING MEAT AND DAIRY CONSUMPTION

Meat and dairy consumption per person have remained roughly the same for the last few years and people's diet does not tend to change quickly or easily. In addition, the population is expected to grow by 4% between now and 2030, so without action, emissions from farming are likely to increase by 2030.

Our review of the evidence suggests that a strong campaign run by supermarkets, food companies and government working together could reduce meat and dairy consumption per person by 10%. Any campaign would have to make plant-based foods and meat alternatives more attractive, and easier to choose and cook, as well as increase awareness of its health and climate benefits.

This is a best-guess estimate based on evidence that is generally inconclusive and weak. This evidence does suggest, however, that communications campaigns increase awareness and can have some, but limited, impact on behaviour.^{92, 93, 94, 95}

To go beyond this might require government to tax meat and dairy food. It could then use the proceeds to make other foods cheaper.

THE IMPACT OF PRICES ON DEMAND FOR MEAT AND DAIRY PRODUCTS

The evidence suggests that demand falls by 0.6% for every price increase of 1%. This means, for example, that if prices go up by 10%, people will buy 6% less.⁹⁶ We assume this would be in addition to the 10% reduction achieved through a campaign aimed at changing diets.

90 The percentages are based on CCC data for 2018, but with electricity supply and fuel supply reassigned to their end users, based on data from BEIS. On the Climate Calculator website, they sum to 91% as waste and shipping are not included. Using the CCC's sectoral categories, agriculture and land use produced 12% of the UK's emissions in 2018 (agriculture 10%, LULUCF sources 6%, and LULUCF sinks -4%).

91 This is also sometimes described as reducing all meat consumption. Analysis shows that red meat and dairy tend to have the highest GHG emissions, due to enteric fermentation in cows and sheep. Farming cows and sheep also requires more land than chickens or pigs. We have therefore assumed it is best to target red meat and dairy for diet change, although plant-based protein sources usually have lower GHG emissions than animal-based sources, regardless of the type of animal.

92 Ikonen, I. and others. Consumer effects of front-of-package nutrition labeling: an interdisciplinary meta-analysis. *Journal of the Academy of Marketing Science* Vol. 48, May 2020, pp. 360–383. Available at <https://doi.org/10.1007/s11747-019-00663-9> [accessed 14/09/2021]

93 Stead, M. and others. Mass media to communicate public health messages in six health topic areas: a systematic review and other reviews of the evidence. *Public Health Research* Vol. 7, Issue 8, May 2019. Available at <https://doi.org/10.3310/phr07080> [accessed 14/09/2021]

94 Crockett, R. and others. Nutritional labelling for healthier food or non-alcoholic drink purchasing and consumption. *Cochrane Database of Systematic Reviews*, 2018. Available at <https://doi.org/10.1002/14651858.CD009315.pub2> [accessed 14/09/2021]

95 Sparkman, G. and others. Cut back or give it up? The effectiveness of reduce and eliminate appeals and dynamic norm messaging to curb meat consumption. *Journal of Environmental Psychology*, Vol. 75, June 2021. Available at <https://doi.org/10.1016/j.jenvp.2021.101592> [accessed 14/09/2021]

96 Green, R. and others. The effect of rising food prices on food consumption: systematic review with meta-regression. *BMJ*, 17 June 2013. Available at <https://doi.org/10.1136/bmj.f3703> [accessed 14/09/2021]

Our modelling is based on the current average household spend on meat and dairy of £20.80 per week and the UK population rising by 4% by 2030.⁹⁷ We assume that the taxes raised would be spent entirely on making other food cheaper and that the demand for this other food would therefore rise.

IMPACT OF DIET CHANGES ON LAND USE

We assume for modelling purposes that meat and dairy exports remain a constant share of farm production and thus fall as UK demand falls. We also assume that there is a corresponding fall in imports of meat, dairy products, and animal feed. In other words, diet changes lead to corresponding levels of land use changes. On this basis, we assume that for every 1% reduction in UK meat consumption, approximately 150,000 hectares in the UK can be released for other purposes. We have looked at alternative scenarios, with the exact numbers for land used for different purposes in each scenario coming from data available from the UK Centre for Ecology and Hydrology.⁹⁸

TWO ALTERNATIVE APPROACHES

If land is released as a result of consumer diet changes, we have assumed that one of two alternative approaches will be adopted: one involves maintaining or increasing farming intensity, but releasing land for trees, peatland restoration and bio-energy crops; the other involves incentivising a less intensive, more 'agroecological' approach to farming including organic farming. This latter approach means that less land is released from farming, but more trees are planted on farmed land and there is improved hedgerow management and less and better use of synthetic fertilisers and pesticides. In this way it still delivers a high level of greenhouse gas reduction alongside better outcomes for nature.

We have then calculated the subsidy required for each of these to meet both conversion costs (spread over 20 years) and ongoing costs, to the extent that these are greater than the income generated

from selling crops or from other uses of land. We have drawn on a report for the Climate Change Committee Sixth Carbon Budget on the economic impacts of land use scenarios consistent with net zero emissions,⁹⁹ as well as modelling done for the Wildlife Trust, RSPB and the National Trust.^{100, 101}

OTHER FACTORS DRIVING EMISSIONS LEVELS

In the Mackay Carbon Calculator, low-carbon farming practices, such as improving soil and manure management, and reducing livestock enteric fermentation, are measured as indices of emissions intensity relative to the baseline year (2015). For our modelling, we assume that the emissions intensity (the amount of emissions for each unit of output) of farming associated with these indices decreases as the ambition level increases.

We assume there is relatively low uptake of biofuels in farm machinery in 2030 (2% of total share in 2030). We also assume that the number of poultry will increase slightly by 2030 (from 167m to 184m). This is in line with land use scenarios detailed by the CCC.

Other things we buy

INTRODUCTION

Manufacturing and construction produce 19% of UK greenhouse gas emissions.¹⁰² We can reduce this with a tax on carbon emissions to incentivise firms to change their processes. In some cases, these changes will be so expensive that this incentive won't work on its own, and subsidies will be needed as well. The tax will mean the price of some products increase.

We offered users four levels of ambition:

1. No change: the government has not yet confirmed what the emissions cap will be in the ETS in 2030.

97 Office for National Statistics. Family spending workbook 1: detailed expenditure and trends. 16 March 2021. Available at www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/expenditure/datasets/familyspendingworkbook1detailedexpenditureandtrends [accessed 14/09/2021]

98 UK Centre for Ecology and Hydrology. Updated quantification of the impact of future land use scenarios to 2050 and beyond - final report. CCC, 9 December 2020. Available at www.theccc.org.uk/publication/updated-quantification-of-the-impact-of-future-land-use-scenarios-to-2050-and-beyond-uk-centre-for-ecology-and-hydrology [accessed 14/09/2021]

99 Vivid Economics. Economic impacts of Net Zero land use scenarios. CCC, February 2020. Available at www.theccc.org.uk/wp-content/uploads/2020/01/Economic-impacts-of-Net-Zero-land-use-scenarios-Vivid-Economics.pdf [accessed 14/09/2021]

100 Rayment, M. Assessing the costs of Environmental Land Management in the UK. RSPB, National Trust and The Wildlife Trusts, October 2017. Available at www.wildlifetrusts.org/sites/default/files/2018-02/Assessing%20the%20costs%20of%20environmental%20land%20management%20in%20the%20UK%20Final%20Report%20November%202017.pdf [accessed 14/09/2021]

101 RSPB, National Trust and The Wildlife Trusts. Policy Briefing: Paying for Public Goods from environmental land management in England – an introduction. 2019. Available at www.wildlifetrusts.org/sites/default/files/2019-09/Making%20Public%20Goods%20Pay_England%20Policy%20Briefing%20September%202019.pdf [accessed 14/09/2021]

102 The percentages are based on CCC data for 2018, but with electricity supply and fuel supply reassigned to their end users, based on data from BEIS. On the Climate Calculator website, they sum to 91% as waste and shipping are not included. We include emissions from F-gases in the 'other things we buy' category. Using the CCC's sectoral categories, manufacturing and construction produced 12% of the UK's emissions in 2018, and F-gases produced a further 3%.

2. Carbon price of £75 per tonne of CO₂e, with a subsidy of £50 per tonne of carbon that businesses do not emit due to their investment in new processes.
3. Carbon price of £100 per tonne of CO₂e, with a subsidy of £50 per tonne of CO₂e that businesses do not emit due to their investment in new processes.
4. Carbon price of £100 per tonne of CO₂e, with a subsidy of £100 per tonne of CO₂e that businesses do not emit due to their investment in new processes.

We assume that the costs of a higher carbon tax would be passed on to consumers in the form of higher prices. A compensation scheme could be operated in response. We offered users four choices:

1. Reduce taxes
2. Compensate least well off 30% of households
3. Compensate least well off 60% of households
4. Compensate all households

HOW A CARBON TAX WORKS

The carbon tax works by making manufacturers pay according to how much carbon they produce. This gives them an incentive to make their processes more carbon efficient – the less carbon they produce the less tax they pay. New, carbon-efficient processes are often more expensive to operate than the old ones – if they weren't they would have been introduced already – but as long as the extra cost is less than the tax, the manufacturer will want to introduce them.

Sometimes the cost of new processes will be so high that even with a carbon tax the manufacturer won't introduce them. The government may then need to provide grants to cover part of these costs in order to reduce emissions.

It is important to bear in mind that these costs and the tax itself will not normally reduce manufacturers' profits but will be borne by consumers in the form of higher prices – and we have assumed that all the costs are passed on in this way. However, the government could compensate consumers by making regular flat payments to everyone out of the proceeds of the tax, or at least to the less well off.

BORDER ADJUSTMENTS

To stop foreign competitors who do not have to pay a carbon tax in their countries getting an unfair advantage, there needs to be an equivalent carbon tariff on imports. There also has to be a rebate of the tax to exporters, at least when exporting to countries that do not levy a carbon tax on their own manufacturers. That way they can compete with overseas firms that do not have to pay the tax.

CARBON TAX VS EMISSIONS TRADING SCHEMES

At the moment the UK government operates an Emissions Trading Scheme (ETS). This operates like a carbon tax, except that the rate is set at an auction where manufacturers bid for permits to emit a certain amount of carbon dioxide which they can then buy and sell. In this kind of scheme, the government sets the total emissions level, creating more certainty about the impact of emissions on climate change. However, because the rate is set by the market, there is some uncertainty about costs. We have assumed a carbon tax rather than a trading scheme, but there would be similar choices to be made were a trading scheme to continue: how many emissions to auction (which affects the rate), what level of subsidy to provide, and how to use the proceeds.

OUR MODELLING – ALTERNATIVE CARBON PRICES AND SUBSIDY LEVELS

We have modelled the impact on emissions and consumer prices of two rates of carbon tax – £75 and £100 per tonne of CO₂e in line with recommendations by the Zero Carbon Commission¹⁰³ and the International Energy Agency¹⁰⁴ respectively, and with annual grants of £50 and £100 per tonne of CO₂e for industries that face exceptionally high decarbonisation costs (the grant is paid when the firm introduces new processes and is for each tonne of carbon that is not produced but would have been in the absence of the new processes).

Estimates by Element Energy of the cost of emissions reduction (known as 'abatement') across industrial subsectors show that a carbon tax of £100, combined with a grant of £100 per tonne to cover high decarbonisation costs, should lead to a reduction of approximately 85% of industry emissions.¹⁰⁵

¹⁰³ The Zero Carbon Commission. How carbon pricing can help Britain achieve net zero by 2050. September 2020, p. 11. Available at <https://static1.squarespace.com/static/5e1ee218fbeca217fe06a421/t/5f75c51ffcf7968a6bc9fdf/1601553703192/White+Paper+-+How+carbon+pricing+can+help+Britain+reach+net+zero+by+2050.pdf> [accessed 14/09/2021]

¹⁰⁴ International Energy Agency. Net Zero by 2050: A Roadmap for the Global Energy Sector. July 2021, pp. 52-53. Available at https://iea.blob.core.windows.net/assets/beceb956-0dcf-4d73-89fe-1310e3046d68/NetZeroBy2050-ARoadmapfortheGlobalEnergySector_CORR.pdf [accessed 14/09/2021]

¹⁰⁵ Element Energy. Deep-Decarbonisation Pathways for UK Industry. CCC, November 2020. Available at www.theccc.org.uk/publication/deep-decarbonisation-pathways-for-uk-industry-element-energy [accessed 14/09/2021]

COMPENSATING CONSUMERS

The proceeds of a carbon tax can be used to help compensate consumers for the price increases it causes. However, because these increases are partly the result of introducing new, low-carbon processes that are more expensive than existing processes, paying out the proceeds of the carbon tax cannot completely compensate consumers. Indeed, the more effective the government's carbon tax is – the more low-carbon processes are introduced – the less carbon tax will be raised and so the less money there will be to pay out to consumers.

This means we have a choice. We can either compensate the least well off, and rely on the proceeds of the carbon tax to do this, or we can compensate everyone, and increase general taxation to do this, meaning the best off pay more. Or we can do something in between. We have presented these alternatives in the Climate Calculator.

Electricity generation

INTRODUCTION

Electricity generation produces greenhouse gas emissions, mostly from burning gas and coal.¹⁰⁶ These emissions can be reduced by switching to other sources of electricity, primarily wind and solar. In addition, the impact on emissions of the switch to electric cars and electric powered heat pumps in homes and other buildings depends on the electricity itself being low carbon. Because these switches involve a large increase in demand for electricity, there will have to be a large increase in wind and solar electricity generation, as well as electricity storage and grid capacity.

GOVERNMENT TARGETS

The government has set an ambitious 2030 target for offshore wind generation (40 GW). It has not set a comparable target for solar or onshore wind generation. For comparison, in National Grid ESO's high ambition "Leading the Way" scenario, by 2030 the UK would have 47 GW of offshore wind capacity, 40 GW of solar and 26 GW of onshore wind.¹⁰⁷

WIND AND SOLAR

We have assumed that in practice there is a range of

possible levels of offshore wind, onshore wind and solar, and that whether we end up at the bottom or top of the range will depend on how actively the government makes things happen. We have assumed that if the government plays an active role as described in the section on Heating, it will play an active role in electricity generation – and that if it plays a more passive role as described in the section on Heating, it will play a less active role in electricity generation. Therefore, renewable generation capacity increases in line with the user's selection on Heating:

	OPTION 1	OPTION 2	OPTION 3	OPTION 4
Offshore wind	36 GW	36 GW	44 GW	44 GW
Solar	21 GW	28 GW	35 GW	35 GW
Onshore wind	15 GW	18 GW	23 GW	23 GW

OTHER ASSUMPTIONS

Due to uncertainty about technological development, we have assumed that biomass with carbon capture and storage (BECCS), tidal stream and wave do not contribute to electricity generation in 2030. In reality there will probably be a small contribution from these or other sources.

In addition, we have assumed the following:

- There is no expansion of nuclear power by 2030 beyond Sizewell B and Hinkley point, resulting in about 4.5 GW capacity.
- There is no contribution from gas-powered electricity generation with carbon capture and storage (although this is likely to play a role after 2030).
- Seasonal storage of 3TWh¹⁰⁸ while short term storage capacity is 14GW and interconnection capacity is 21GW.¹⁰⁹

Other sectors

There are two sectors which are not presented to users in the Climate Calculator: waste and shipping. In both cases, we have made assumptions about changes in emissions before 2030.

Waste produces 6% of UK greenhouse gas

¹⁰⁶ CCC. Sixth Carbon Budget: Electricity Generation sector summary. December 2020, p. 6. Available at www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Electricity-generation.pdf [accessed 14/09/2021]

¹⁰⁷ National Grid ESO. Downloadable Future Energy Scenarios resources: Data workbook. July 2021, SV.22. Available at www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2021/documents [accessed 14/09/2021]

¹⁰⁸ CCC. Sixth Carbon Budget - Dataset. December 2020, scenario key metrics for the Balanced Pathway. Available at www.theccc.org.uk/publication/sixth-carbon-budget/ [accessed 14/09/2021]

¹⁰⁹ Figures supplied by National Grid, most closely aligned with the "Leading the Way" scenario in Future Energy Scenarios 2021 in National Grid ESO. Downloadable Future Energy Scenarios resources: Data workbook. July 2021, SV.22. Available at www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2021/documents [accessed 14/09/2021]

emissions.¹¹⁰ Tax and regulation can be used to reduce emissions from waste. We assume that some policies are introduced by 2030 to achieve this – for example, policies to increase recycling in England, and a ban on biodegradable waste going to landfill.¹¹¹ However, using the Mackay Carbon Calculator model, we only reduce emissions by around 2 MtCO₂e in this area. This compares to the CCC's Balanced Pathway, which reduces emissions from waste by around 14 MtCO₂e by 2030.

Shipping produces 3% of the UK's greenhouse gas emissions.¹¹² Due to uncertainty about technological development in this sector, combined with uncertainty regarding government policy, we do not assume any reduction in emissions in the shipping sector before 2030. This is in line with the CCC's Balanced Pathway.¹¹³

After 2030

The government's target is a 39% reduction by 2030 against 2019 levels – and a 100% reduction by 2050 – the year when the UK will reach 'net zero' emissions. This means we need to keep making progress from 2030 until 2050 to achieve this target.

There are a number of cross-economy technologies which may play an important role after 2030. In particular, there is uncertainty about the role of hydrogen, and the role of greenhouse gas removals (various kinds of carbon capture and storage). In both cases, we have assumed that neither will be operating at scale before 2030 for the purposes of the Climate Calculator. However, they may both become important after 2030.

Electric vehicles: under current policy, the government will ban sales of new petrol and diesel cars and vans in 2030. Therefore, new cars and vans will be electric after 2030. Cars and vans usually last on average 11 years, so almost all cars and vans in the UK will be electric by 2050. This means emissions from petrol and diesel vehicles will gradually reduce over time. Because Heavy Goods Vehicles (HGVs) are much larger than cars and vans, it is possible that electric batteries might not be able to power them. HGVs will probably use hydrogen instead in the future, as technology develops after 2030. (Hydrogen can be used to power vehicles in a way that does not produce any emissions from the vehicle.)

Heating: after 2030, we will need to continue to install electric heat pumps in people's homes to

replace their gas boilers. At some point - perhaps 2033 - the government will need to ban new gas boilers being installed in people's homes. Gas boilers last for around 15 years. As with petrol and diesel vehicles, this means that gradually all gas boilers will be phased out over time. In urban areas, district heating, via large heat pumps or other technologies, will be used. Hydrogen will also probably be used after 2030, replacing gas heating in some areas.

Flights: it will be possible in the future to reduce emissions from planes through technology - for example, using different fuels, or using hybrid electric planes. However, planes have a lifetime of about 30 years, so in 2050 planes will still be burning fossil fuels. The number of people flying has steadily grown over time. If this growth continues after 2030, that would increase emissions from flights. Therefore, it is likely that a tax on flights after 2030 will be necessary to constrain demand. If no tax is introduced, we would have to reduce emissions even further in other sectors.

Food and land use: most emissions from agriculture come from livestock (mainly cows and sheep). The main way to reduce emissions is to eat less red meat and dairy. If we have not changed our diets before 2030, that option will still be available to us after 2030. The government has committed to helping farmers reduce emissions, for example by adopting different farming methods. This will continue after 2030. Despite this, the Climate Change Committee predicts that agriculture will be the sector with the greatest remaining emissions in 2050. Greater change is possible with new technologies, such as lab-grown meat, but it is uncertain whether these will be successfully introduced in the future.

If we eat less red meat and dairy, we can plant more trees after 2030. However, without a change in diet, available land will be a constraint on tree planting. We can also continue restoring and protecting natural habitats such as peatland after 2030.

Other things we buy: reducing emissions from industrial production will be vital after 2030. The main way to achieve this will still be a carbon tax on businesses, combined with government investment in new technologies. After 2030, more technologies may become available to help reduce emissions. Electricity and hydrogen, used before 2030, will both be important after 2030 as well. Carbon Capture and Storage (CCS) is a technology which captures carbon produced during industrial processes and then stores it permanently instead of releasing it into

110 CCC. Sixth Carbon Budget: Waste sector summary. December 2020, p. 6. Available at www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Waste.pdf [accessed 14/09/2021]

111 CCC. Policies for the Sixth Carbon Budget. 2020. pp. 176-185.

112 CCC. Sixth Carbon Budget: Shipping sector summary. December 2020, p. 5. Available at www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Shipping.pdf [accessed 14/09/2021]

113 CCC. Sixth Carbon Budget: Shipping sector summary. 2020. pp. 20-21.

the atmosphere. This will be important for industries which may need to continue using fossil fuels in some processes (for example, producing very high heat). Currently CCS technologies are not used at scale, but they are predicted to become cheaper and more efficient over time, and should be ready to use at scale after 2030.

Electricity generation: after 2030, we will need to continue to install more renewable electricity - mainly wind and solar. This is particularly important because we will be using more electricity to power electric vehicles and electric heat pumps. We will also need other sources to cover times when it is not windy or sunny in the UK. We will probably need to use a variety of other sources, including nuclear, gas power stations fitted with Carbon Capture and Storage (CCS) technology, and hydrogen. According to the CCC, electricity generation will produce almost no emissions by around 2035-2040.¹¹⁴

Other sectors: decarbonising waste will probably involve a combination of measures including waste prevention, increased recycling, banning biodegradable waste from landfill, and preventing methane entering the atmosphere from landfill. In addition, after 2030 it may be possible to use Carbon Capture and Storage (CCS) technologies to reduce emissions from energy-from-waste facilities.¹¹⁵ The CCC's Balanced Pathway assumes that the main way of reducing emissions from shipping after 2030 is by using zero-carbon fuels, probably ammonia produced using low-carbon hydrogen.¹¹⁶

How we reach the results shown on the Climate Calculator

This note is divided into three sections: on emissions reductions, household budgets and employment. There is also an annex showing in detail the interaction between our work and the Mackay Carbon Calculator.

EMISSIONS REDUCTIONS

We have reviewed the evidence, much of it in reports commissioned or written by the Climate Change Committee (CCC), and on this basis have made predictions about the impact of alternative strategies on emissions. First, we have predicted the impact of the strategies on a range of outcomes relevant to the policy area in question – number of electric cars, amount of insulation, reduction in flight numbers and so on. Then we have used the UK government's MacKay Carbon Calculator to predict the impact of

these outcomes, and different combinations of these outcomes, on emissions. The data we have used and the assumptions we have made to generate our predictions on the outcomes relevant to each policy area are set out in the sections above.

STAGE TWO – PREDICTING EMISSIONS REDUCTIONS

The outcomes our analysis generates are input variables to the Mackay Carbon Calculator – that is things the user of that website can set to see what the implications for emissions are. Altogether, there are 162 of these input variables.

The strategies users of the Climate Calculator choose set the values of 58 of these, while we have pre-set the values for the other 104. For a list of these variables, how the values of the 58 change in response to different strategies, and the values of those we have pre-set, see the information available on the website.¹¹⁷

Household budgets

OVERALL APPROACH

The starting point for the modelling is the set of analyses described in the 'More details' pages (links in the previous section).

The impacts on household budgets are then modelled using two survey-based datasets: the Family Resources Survey (FRS) and Living Costs and Food Survey (LCF). The FRS contains detailed information on household incomes while the LCF contains household income and expenditure information. The measure of household income used is gross household income, which is divided into five quintiles (ranging from the poorest fifth of households in the bottom quintile to the richest fifth in the top quintile). Table 1 shows the distribution of gross household income in terms of the income brackets for each quintile. Results are presented in weekly terms at current prices.

TABLE 1
HOUSEHOLD GROSS INCOME BANDS FOR INCOME QUINTILES

QUINTILE	1ST	2ND	3RD	4TH	5TH
Annual gross household income bands	Below £22,000	£22,000 to £35,000	£35,000 to £53,000	£53,000 to £81,000	More than £81,000

114 CCC. Sixth Carbon Budget: Electricity Generation sector summary. 2020.

115 CCC. Sixth Carbon Budget: Waste sector summary. 2020. p. 23.

116 CCC. Sixth Carbon Budget: Shipping sector summary. 2020. p. 20.

117 Climate Calculator. How we reach the results shown on the Climate Calculator. 2021. Available at <https://climatecalculator.co.uk/results-shown> [accessed 14/09/2021]

ENERGY BILLS

For policy options where the cost of installing heat pumps and insulation, and decarbonising the electricity supply, are borne partially or wholly by billpayers, we assume that the costs are imposed as an additional flat rate payment across all UK households excluding the households in the UK that are defined as “fuel-poor” (around 14% of households). We use the information on fuel bill expenditure as a proportion of income to identify fuel-poor households in the LCF data. The most ambitious policy option for decarbonisation of buildings and electricity generation leads to an increase in bills of £8.71 per week for each non-fuel poor household.

DRIVING COSTS

There are two components to increased costs of driving in the model. One is the impact of increased investment in the public charging network for electric cars, which we estimate will increase costs by £0.47 per car per week. We model the distributional effects of this increase using data from the LCF on the number of cars in each household. Table 1 below shows the distributional effect of the increase by household income quintile.

The other component is the impact of congestion charges and other charges for drivers which are used to subsidise additional public transport investment when this option is chosen using the sliders in the public transport domain. We model the distributional effects of these charges by assuming that they are allocated in proportion to weekly road fuel (petrol plus diesel) costs, on the grounds that car users who drive more are more likely to incur these charges. The distributional impacts of this policy are shown in the second row of Table 2 below.

TABLE 2
DISTRIBUTIONAL EFFECT OF ADDITIONAL COSTS FOR DRIVERS: INCREASE IN COSTS PER WEEK

QUINTILE	1ST	2ND	3RD	4TH	5TH	AVERAGE
Average impact of increase in driving costs	£0.16	£0.31	£0.46	£0.63	£0.79	£0.47
Average impact of congestion charge (most ambitious policy option)	£0.09	£0.18	£0.27	£0.37	£0.46	£0.27

FOOD COSTS

Some of the policy options specified in the model use the tax system to incentivise a shift from meat and dairy products to fruit and vegetables by increasing the price of the former and subsidising the latter. The distributional impact of this shift is modelled using data from the Living Costs and Food Survey on household expenditure on meat and dairy and on fruit and vegetables in each quintile. Table 3 shows the weekly average impact on household incomes by income quintile under the most ambitious policy option for food and farming (which increases meat and dairy prices by approximately 25 per cent) while reducing fruit and vegetables prices by a similar amount. The overall effect of the policy is slightly regressive (i.e., poorer households pay slightly more per week) because poorer households consume more meat and dairy relative to fruit and veg than richer households do.

TABLE 3
WEEKLY IMPACT OF FOOD POLICIES ON COST OF LIVING BY INCOME QUINTILE

QUINTILE	1ST	2ND	3RD	4TH	5TH	AVERAGE
Net impact of taxing meat & dairy and subsidising fruit & veg on living costs (most ambitious policy option)	£0.20	£0.25	£0.08	-£0.63	-£0.40	£0.47

ADDITIONAL TAXES ON FLYING

We model two different options for additional taxes on flights. These are:

- Option 1: an across-the-board increase in air fares (of 10% or 20%, depending on the policy option chosen).
- Option 2: a levy which increases flight prices for frequent fliers. For the most ambitious policy option, people would face no additional tax on their first flight in any given year, but a price increase of 20% on the 2nd flight, 40% on their 3rd flight, 60% on their 4th flight and so on.

We have assumed that for the most ambitious policy choice, each of these options for flight taxes reduced demand for flying by the same amount: a predicted 17% reduction in air travel due to the increased cost of air fares. However, the tax yield from the two options is not the same; we estimate the flat rate 20% flight tax raises just under £4.2bn per year

compared to £3.1bn for the more ambitious version of the frequent flier levy. Table 4a shows the average weekly increase in expenditure on flights arising from the more ambitious policy choice (a 20% increase in air fares under option 1, and progressively higher increases for frequent flyers under option 2).

TABLE 4A
WEEKLY IMPACT OF FLIGHT TAXES (TWO DIFFERENT OPTIONS)

QUINTILE	1ST	2ND	3RD	4TH	5TH	AVERAGE
Option 1: Impact of 20% increase in all air fares	£0.33	£0.56	£0.93	£1.46	£2.44	£1.15
Option 2: Impact of tax on frequent flyers	£0.13	£0.25	£0.50	£1.88	£2.50	£0.85

The lower costs for the frequent flier option are largely because we are assuming the same price sensitivity as the number of flights rises. Thus, with the more ambitious option we expect to see no fall in the number of first flights, a 17% fall in the number of second flights following a 20% price rise, a 34% fall in the number of third flights following a 40% tax rise, a 51% fall in the number of fourth flights following a 60% tax rise, and so on. In short, the cost falls because we assume the tax works.

These costs are based on the distribution of number of flights per year by household income quintile, using data from Understanding Society, a survey of around 30,000 households per year in the UK (see Table 4b below). Adults in the poorest quintile are much less likely to fly than those in the richest quintile; 76% of the poorest quintile take no flights in a year compared to only 36% of the richest quintile. At the other end of the scale, 16% of adults in the richest quintile take four or more flights a year compared to only 3% of adults in the poorest quintile.

TABLE 4B
DISTRIBUTION OF FREQUENCY OF FLIGHTS PER YEAR BY INCOME QUINTILE

QUINTILE	1ST	2ND	3RD	4TH	5TH	AVERAGE
No flights	76.1%	71.3%	59.5%	52.6%	36.0%	55.2%
1 flight	12.3%	14.1%	17.6%	19.5%	22.0%	18.0%
2 flights	6.5%	7.3%	11.7%	15.2%	19.3%	13.3%
3 flights	1.9%	2.9%	4.1%	4.6%	6.7%	4.5%
4 or more flights	3.2%	4.4%	7.2%	8.2%	16.1%	9.0%

There is also an indirect impact on living costs of the flight taxes as the taxes increase the costs of business flights which are then passed through to consumers via increases in consumer prices. Table 4c shows the average impacts of the increase in costs arising from business flight taxes for households in each quintile under the two more ambitious policy options.

TABLE 4C
WEEKLY INDIRECT IMPACT OF BUSINESS FLIGHT TAXES ON LIVING COSTS (TWO DIFFERENT OPTIONS)

QUINTILE	1ST	2ND	3RD	4TH	5TH	AVERAGE
Option 1: Impact of 20% increase in all air fares	£0.38	£0.57	£0.78	£1.01	£1.54	£0.86
Option 2: Impact of tax on frequent flyers	£0.28	£0.43	£0.58	£0.76	£1.15	£0.64

The lower costs for the frequent flier option are largely because we are assuming the same price sensitivity as the number of flights rises. Thus with the more ambitious option we expect to see no fall in the number of first flights, a 17% fall in the number of second flights following a 20% price rise, a 34% fall in the number of third flights following a 40% tax rise, a 51% fall in the number of fourth flights following a 60% tax rise, and so on. In short, the cost falls because we assume the tax works.

THE IMPACT OF CARBON PRICES AND ABATEMENT OF CARBON EMISSIONS ON LIVING COSTS

As explained in the section on modelling the impact of a carbon price on other things we buy, we assume that the costs of abatement or the cost of a carbon price (if firms in a particular industry pay the carbon price rather than abating emissions) are fully passed through to consumers. Table 5 shows the impact of the most ambitious option for carbon price (£100/MtCO₂e, with a £100/MtCO₂e subsidy for hard-to-decarbonise industries).

TABLE 5
AVERAGE WEEKLY IMPACT OF INCREASES IN CONSUMER PRICES ON COST OF LIVING (MOST AMBITIOUS CARBON TAX OPTION)

QUINTILE	1ST	2ND	3RD	4TH	5TH	AVERAGE
Increase in weekly cost of living	£2.40	£3.63	£4.95	£6.41	£9.72	£5.42

COMPENSATION PAYMENTS TO HOUSEHOLDS AFFECTED BY INCREASED PRICES

When implementing a carbon tax, users can choose to make a payment to compensate some – or all – UK households for the cost of increases in consumer prices arising from the carbon tax. The payment is equal to the average increase in prices faced by households in the middle quintile of the income distribution (for the most ambitious carbon tax package, this is £4.95 per week). The following options are available:

1. A payment to all households
2. A payment to the poorest 60% of households (i.e., the 1st, 2nd and 3rd income quintiles)
3. A payment to the poorest 30% of households (i.e., the 1st quintile and the bottom half of the 2nd quintile).

If there is revenue from the carbon tax left over after making the payment to the relevant group of households as specified in the options above, the remaining revenue is used to reduce income tax and NICs payments. If no compensation package is chosen then the whole of the revenue from the carbon tax (net of subsidies to hard-to-decarbonise industries) is used to reduce income tax and NICs payments.

INCREASES IN INCOME TAX AND NATIONAL INSURANCE CONTRIBUTIONS

The model assumes that any increase in overall spending commitments is funded by taxation rises, i.e., the policy package taken as a whole is revenue neutral and does not increase government borrowing.

The model includes the following sources of additional spending (note that for any particular package of policies, some of these components may be zero, depending on what policy choices are made):

- Additional public transport investment (depending on user choices), taxation funds 90% or 100% of this additional investment, with the other 10% (if applicable) coming from user charging;
- Additional subsidy for installation of heat pumps and improved insulation for homes and other buildings (depending on user choices, this additional investment is paid for by taxpayers, billpayers or a mix of the two);
- Subsidy payments to industries which are hard to decarbonise;

- Compensation payments for price increases resulting from a carbon tax;
- Additional public spending to subsidise farmers to convert land from food production to woodland and to restore habitats like peatlands; and to incentivise organic and sustainable farming methods.

The model also includes the following sources of additional tax revenue:

- Revenue from the carbon tax;
- Revenue from additional taxes on flights.

The additional tax revenue required is calculated by summing the extra spending across each of these additional spending commitments, and then subtracting any additional revenue from the carbon tax or flight taxes.

The model assumes that additional tax revenue is raised from a combination of 5 taxes:

- Income Tax;
- National Insurance Contributions made by employees, employers and self-employed people (NICs)
- Corporation Tax;
- Business Rates;
- Capital Gains Tax.

Analysis of data from HMRC shows that in 2019/20, income tax and NICs accounted for just over 79 pence in every pound of revenue raised from these five taxes. Therefore, we assume that for every extra billion pounds that is raised from these taxes, income tax and NICs contribute around £790 million of the increased revenue.

We model the distributional impacts of increased income tax and NICs by assuming a flat percentage increase in tax liabilities for income above the relevant tax thresholds (the personal allowance for income tax, the primary threshold for employee NICs, the secondary threshold for employer NICs and the lower profits limit for self-employed NICs). For income tax, this is equivalent to the increased tax liability from increasing the basic rate, higher rate and additional rate by the same number of pence in the pound (e.g., from 20p to 21p for basic rate, 40p to 41p for higher rate and 45p to 46p for additional rate in England) while leaving the personal allowance unchanged. For NICs, similarly all rates above the relevant threshold are increased by the same amount.

Table 6 below shows the distributional impact of changes to income tax and NICs associated with raising an extra billion pounds from the five taxes shown above (and hence an additional £790m from

income tax and NICs). The impact of these tax increases is very progressive, with the lowest quintile of household income paying only an extra 2 pence per week, while the top quintile pays an extra £1.71 – over 80 times more. This discrepancy reflects the difference in average incomes in each gross income quintile (as shown in Table 6 below), but also the fact that the personal allowance is relatively high, at £12,570 per year in 2021/22. The lowest income quintile pays very little income tax or NICs, because average gross incomes are so low at the bottom of the distribution.

TABLE 6
AVERAGE INCREASE IN INCOME TAX AND NATIONAL INSURANCE CONTRIBUTION PAYMENTS BY INCOME QUINTILE PER £1BN RAISED IN ADDITIONAL TAXATION

QUINTILE	1ST	2ND	3RD	4TH	5TH	AVERAGE
Average increase in income tax and NICs, per week	£0.02	£0.11	£0.30	£0.63	£1.71	£0.56

Although we have modelled on the basis of income tax and NIC thresholds and rates, on the site we have presented the entire change in terms of income tax. In other words, we have assumed NICs are held constant and the extra cash that would have been paid is collected through income tax. This is to simplify the presentation – but makes no difference to the numbers.

EMPLOYMENT IMPACTS

Predicting employment patterns in nine years' time is by its nature rough and ready and the sources we have drawn on vary significantly in their assessments. However, they, and our own analysis, are adequate for our purpose, which is to identify the broad impact of a package of measures to reduce emissions, as opposed to advise between policy alternatives based on their precise employment impacts.

CARS

Based on an evidence review, we estimate the impacts on employment as follows:

- Reduction in maintenance workforce per car or van: 1,000 per 1% of the stock that is electric.^{118, 119, 120, 121, 122, 123}
- Reduction in vehicle assembly and supply chain workforce once electric cars have 100% market share: 7,000.^{124, 125, 126, 127}
- Impact of an industrial policy on vehicle assembly and supply chain jobs including battery production: 20,000^{128, 129, 130, 131} (some modelling gives up to 45,000).¹³²
- Installation of private charge points once electric cars have 100% market share: 6,000.
- Maintenance and operation of the complete public network and private points in 2030: c. 28,000 jobs.¹³³

118 CCC. Sixth Carbon Budget Methodology. 2020. p. 62.

119 NimbleFins. Average Cost to Run a Car UK 2021. 26 April 2021. Available at www.nimblefins.co.uk/cheap-car-insurance/average-cost-run-car-uk [accessed 14/09/2021]

120 RAC. Typical vehicle running costs - for a petrol engine car. 19 January 2016. Available at https://media.rac.co.uk/blog_posts/typical-vehicle-running-costs-for-petrol-engine-cars-42585 [accessed 14/09/2021]

121 Kwik Fit. Motorists' Costs Running At £162 Per Month - Excluding Cost Of The Car. 13 June 2018. www.kwik-fit.com/press/motorists-costs-running-at-one-hundred-and-sixty-two-pounds-per-month-excluding-cost-of-the-car [accessed 14/09/2021]

122 Harto, C. Electric Vehicle Ownership Costs: Chapter 2—Maintenance. Consumer Reports, September 2020. Available at <https://advocacy.consumerreports.org/wp-content/uploads/2020/09/Maintenance-Cost-White-Paper-9.24.20-1.pdf> [accessed 14/09/2021]

123 Office for National Statistics. Industry (2, 3 and 5 - digit SIC) - Business Register and Employment Survey (BRES): Table 2. 6 November 2020. Available at www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/industry235digsicbusinessregisterandemploymentsurveybrestable2 [accessed 14/09/2021]

124 The European Association of Electrical Contractors. Powering a new value chain in the automotive sector: The job potential of transport electrification. 2018, p. 6. Available at https://download.dalicloud.com/fis/download/66a8abe211271fa0ec3e2b07/c572c686-f52f-4c0d-88fc-51f9061126c5/Powering_a_new_value_chain_in_the_automotive_sector_-_the_job_potential_of_transport_electrification.pdf [accessed 14/09/2021]

125 Vivid Economics. Accelerating the EV transition: Part 1: environmental and economic impacts. WWF, March 2018. Available at www.wwf.org.uk/sites/default/files/2018-03/Final%20-%20WWF%20-%20accelerating%20the%20EV%20transition%20-%20part%201.pdf [accessed 14/09/2021]

126 Pirie, J. and others. The impact of a 2030 ICE phase-out. 2020. p. 23.

127 Unsworth, S. and others. Seizing sustainable growth opportunities from zero emission passenger vehicles in the UK. LSE Growth Commission, February 2020, p. 40. Available at www.lse.ac.uk/granthaminstitute/publication/seizing-sustainable-growth-opportunities-from-zero-emission-passenger-vehicles-in-the-uk [accessed 14/09/2021]

128 Vivid Economics. Accelerating the EV transition. 2018.

129 The Faraday Institution. UK electric vehicle and battery production potential to 2040. March 2020. Available at https://faraday.ac.uk/wp-content/uploads/2020/03/2040_Gigafactory_Report_FINAL.pdf [accessed 14/09/2021]

130 Unsworth and others. Seizing sustainable growth opportunities. 2020.

131 Pirie, J. and others. The impact of a 2030 ICE phase-out. 2020.

132 The Faraday Institution. UK electric vehicle and battery production. 2020.

133 The European Association of Electrical Contractors. Powering a new value chain in the automotive sector. 2018.

PUBLIC TRANSPORT AND CYCLING

Based on analysis of the relationship between capital investment and employment levels in the public transport industry, we estimate that each £1 bn invested per year in local public transport networks creates approximately 54,000 jobs.¹³⁴

HEATING AND ELECTRICITY

Based on an evidence review, we estimate the impacts on employment as follows:

- Installing a heat pump results in three times as many jobs as installing a boiler, including jobs in surveying, retrofit coordination and electrical maintenance and installation.^{135, 136}
- Making a heat pump results in twice as many jobs as making a boiler.¹³⁷
- An active industrial policy associated with a more active approach to heat pump roll out could increase the UK heat pump market share to c. 60%, as compared with the existing boiler market share of 30%.
- Low-cost insulation provides 0.03 of a job per home and medium cost insulation provides 0.12 of a job per home, including jobs in building envelope specialists, floorers, roofers, glaziers and plasterers.¹³⁸
- A net increase of between 70,000 and 140,000 jobs in electricity generation and installation depending on the level of ambition (these numbers are based on a very divergent range of estimates, and include supply chain jobs).^{139, 140, 141, 142, 143, 144}

FLIGHTS

In 2019 there were 160,500 jobs in the UK aviation industry¹⁴⁵ excluding manufacturing (some estimates are 30% higher but this is based on ONS numbers). To reach the projected fall in employment caused by a tax on flights, we have simply multiplied this number by the projected fall in passenger miles, and then by the industry multiplier (see section below on second round effects) which is c. 3. This is rough and ready of course, but adequate for our purposes.

FOOD AND FARMING

There will only be a small impact on food and farming employment.

OTHER THINGS WE BUY

There are two routes through which the introduction of a tax on carbon emissions leads to increased employment:

1. Changes in consumer spending patterns: we assume that consumers alter their purchasing behaviour in response to changes in consumer prices arising from the pass-through of the carbon price or the costs of abatement. This has consequences for the pattern of consumer expenditure across the economy (a shift from higher-carbon to lower-carbon products) which in turn affects employment levels in different industries, with knock-on effects on the distribution of income. On average, lower-carbon products tend to be more labour

134 Our analysis based on the ONS's data on the non-financial business economy: Office for National Statistics. Non-financial business economy, UK: Sections A to S. 24 June 2021. Available at www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinessconomyannualbusinesssurveysectionsas [accessed 14/09/2021]

135 Department for Business, Energy and Industrial Strategy. Heat pump manufacturing supply chain research project. GOV.UK, 14 December 2020. Available at www.gov.uk/government/publications/heat-pump-manufacturing-supply-chain-research-project [accessed 14/09/2021]

136 Loes, R. Heating engineers, skills and heat decarbonisation. UK Energy Research Centre, September 2019. Available at <https://ukerc.ac.uk/news/heating-engineers-skills-and-heat-decarbonisation> [accessed 14/09/2021]

137 Our analysis based on data from the EU Heat Pump Association and Department for Business, Energy and Industrial Strategy. Heat pump manufacturing supply chain research project. 2020.

138 Eunomia. Building Skills for Net Zero. CITB, March 2021. Available at www.citb.co.uk/media/kkpkwc42/building_skills_net_zero_full_report.pdf [accessed 14/09/2021]

139 Eunomia. Building Skills for Net Zero. 2021

140 Arvanitopoulos, T. and Agnolucci, P. The long-term effect of renewable electricity on UK employment. Renewable and Sustainable Energy Reviews, Vol. 134, December 2020. Available at <https://doi.org/10.1016/j.rser.2020.110322> [accessed 14/09/2021]

141 GOV.UK. New plans to make UK world leader in green energy. 6 October 2020. Available at www.gov.uk/government/news/new-plans-to-make-uk-world-leader-in-green-energy [accessed 14/09/2021]

142 Ecuity Consulting. Local green jobs – accelerating a sustainable economic recovery. Local Government Association, 2021. Available at https://gemserv.com/wp-content/uploads/2021/06/Local-green-jobs-accelerating-a-sustainable-economic-recovery_final-1.pdf [accessed 14/09/2021]

143 National Grid. Building the net zero energy workforce. January 2020. Available at www.nationalgrid.com/document/126256/download [accessed 14/09/2021]

144 Muttitt, G. and others. Sea Change: Climate emergency, jobs and managing the phase-out of UK oil and gas extraction. Platform, Oil Change International and Friends of the Earth Scotland, May 2019. Available at <http://priceoffoil.org/content/uploads/2019/05/SeaChange-final-r3.pdf> [accessed 14/09/2021]

145 Direct employment, excluding manufacturing, based on: Office for National Statistics. Industry (2, 3 and 5 - digit SIC) - Business Register and Employment Survey (BRES): Table 2. 6 November 2020. Available at www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/industry235digiticsicbusinessregisterandemploymentsurveybrestable2 [accessed 14/09/2021]

intensive than high-carbon products, which means that overall, the reallocation of consumer spending from higher-carbon to lower-carbon products are forecast to increase employment levels (by around 150,000 in the most ambitious scenario).

2. Additional capital investment: the introduction of a carbon tax for manufacturing and construction industries, combined with subsidies to incentivise decarbonisation in the industrial processes which are most difficult to decarbonise, will result in substantial capital investment across these industries as low-carbon technologies are rolled out. We use evidence from the Office for National Statistics¹⁴⁶ on the number of jobs presently created by capital expenditure across private sector industries to estimate the number of additional jobs created by this capital expenditure. In the most ambitious scenario, additional capital investment in low-carbon industrial processes is forecast to create around 270,000 jobs.

The additional employment created by changes in consumer patterns and capital investment in low-carbon industrial processes generates further second-round employment effects through employment multipliers as described below. In the most ambitious scenario, we estimate that the second-round employment impact increases employment by around half a million additional jobs, making a total of almost a million extra jobs generated by the shift to low-carbon processes in manufacturing and construction and associated changes in consumption patterns.

SECOND ROUND EFFECTS

Changes in employment in each industry lead to 'second round' effects because each industry uses inputs from other industries in the course of production, and so an increase in employment – and output – from one industry leads to knock-on 'multiplier' effects on other industries.¹⁴⁷ The Office for National Statistics produces multipliers¹⁴⁸ which enable us to estimate the size of these 'second round' employment effects. For example, the multiplier for the construction industry is estimated to be 1.783, meaning that an increase of 1,000 construction jobs leads to a further increase of 1,783 jobs throughout the UK economy. We do not include second-round employment impacts for the car industry or the electricity generation industry because our estimates for the employment changes in these industries are taken from existing research which already includes second round effects in the estimate. However, we have applied this multiplier in other industries.

This multiplier effect is known as 'Type I' (indirect effects) and does not include further induced effects arising from additional consumer expenditure by the additional workers employed as a result of the extra output of goods and services. The Office for National Statistics does not publish the latter ('Type II') and their size is inherently more uncertain than indirect effects, which is why we have excluded them from this analysis.

However, there is one effect similar to type 2 which we have included: the consequences of the switch to renewables and away from fossil fuels will reduce imports of the latter, and this will lead to an increase in domestic spending on goods and services which we estimate will generate around 60,000 extra jobs (we are grateful to advice from Cambridge Econometrics on this effect).

146 Office for National Statistics. Non-financial business economy UK: Sections A to S. 2021.

147 Howse, J. Input-output analytical tables: methods and application to UK National Accounts. Office for National Statistics, 27 October 2017. Available at www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/articles/inputoutputanalyticaltables/methodsandapplicationtouknationalaccounts [accessed 14/09/2021]

148 Office for National Statistics. UK input-output analytical tables - industry by industry. 9 April 2021. Available at www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/ukinputoutputanalyticaltablesindustrybyindustry [accessed 14/09/2021]

ANNEX 5

POLLING METHODOLOGY

A representative sample of 19,862 was recruited to use the Climate Calculator and submit their choices. When recruiting, quotas were established for gender, age group, region and socio-economic group and the results were then weighted to ensure they were representative of these categories, in addition to the following categories: disability status, 2019 general election vote, EU referendum vote, current voting intention, household income, education, ethnicity, number of adults in household, number of children in household, vehicle ownership, area of residence type (e.g. city centre), employment status, industry employed in (e.g. 'construction') and homeowner or not. Field work began on 16 July 2021 and was completed by 18 August. Respondents had to complete the Calculator and hit or beat the government's 39% target for their response to be counted.

This poll generated the results set out in the tables in Annex 3. Due to the very large sample size, these results are exceptionally robust, although we emphasise that in line with the objective of the exercise - to get the public's views on policy given the government's target - the sample is limited to those who completed the Calculator and submitted their choices.

In addition, we used Multilevel Regression with Post-stratification (MRP) to help generate constituency level results. We did this in three stages. We first identified clusters using Cluster Correspondence Analysis (CCA) with joint dimension reduction and clustering of categorical data. This approach simultaneously assigns individuals to unique clusters and optimal scaling values. As the different attributes are correlated, the dimension reduction will reduce the dimensionality of the data to as few dimensions as possible that can explain the most variation in the answers given by the respondents.

The cluster analysis identifies four distinct clusters of varying sizes (in descending order of their level of support for climate policies overall: 13%, 28%, 42%, and 17% of the respondents) which explain 75.6% of the total variance in the data. The four clusters map well in two dimensions with the within-cluster sum of squares being 0.099 (for the 42% cluster), 0.083 (for the 28% cluster), 0.124 (for the 17% cluster) and 0.050 (for the 13% cluster).

We then used these clusters as the basis for the MRP analysis itself to generate a report on the percentage in each cluster in each constituency. This was conducted by Focaldata, a specialist polling company. Their MRP model uses a range of individual and constituency level variables; these include (but are not limited to) age, gender, housing tenure, working status, education, votes at previous elections (2019 General and EU referendum), population density, % manufacturing, % commute to work by bicycle, % student and number of cars in household. All data is sourced from the Office for National Statistics (Annual Population Survey and Census) where possible, plus the Electoral Commission for election data, and estimated by Focaldata otherwise. They use a Bayesian exploded logit model, which is fit using Hamiltonian Monte Carlo with the open-source software Stan. The models are trained on the Google Cloud Platform.

There are sources of uncertainty throughout the MRP model, with uncertainty highest at the most granular predictions (e.g. constituency). A typical margin of error at a national level is $\pm 4\%$, and at constituency level is $\pm 7\%$.

Due to the way MRP works, there are higher levels of uncertainty where there are strong local factors, for example, if there is a strong local candidate standing for election. MRP draws inferences from similar voters and constituencies, but there are too few observations at individual constituencies to pick up these effects well.

The MRP analysis revealed real but not huge variation in cluster membership in different constituencies. This can be summarised as follows:

CLUSTER MEMBERSHIP – NATIONAL SAMPLE	LARGEST ESTIMATED CLUSTER MEMBERSHIP IN ANY CONSTITUENCY	SMALLEST ESTIMATED CLUSTER MEMBERSHIP IN ANY CONSTITUENCY
42%	49%	31%
28%	35%	22%
17%	24%	13%
13%	29%	6%

The poll itself and the cluster analysis told us the level of support for each policy by cluster membership. With the report on cluster membership for each constituency, we were able to create a weighted average support level for each policy in each constituency. These form the basis for the report in Annex 1.

ANNEX 6

POLICY SOURCES

On this page we provide links and in some cases page references to sources on actual and proposed policies designed to reduce greenhouse gas emissions. This is not intended to be a comprehensive guide, but simply references to some sources we found useful when building the Climate Calculator.

Within each area, we group references by the policy objective. We then list government links first, then those to the Climate Change Committee reports, and then those to other sources in alphabetical order.

Other references are provided in the footnotes to this report.

ELECTRIC CARS

Create a charging network

HM Government. The Energy White Paper: Powering our Net Zero Future. GOV.UK, December 2020, p. 92. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945899/201216_BEIS_EWP_Command_Paper_Accessible.pdf [accessed 17/09/2021]

CCC. Policies for the Sixth Carbon Budget and Net Zero. December 2020, p. 61. Available at www.theccc.org.uk/wp-content/uploads/2020/12/Policies-for-the-Sixth-Carbon-Budget-and-Net-Zero.pdf [accessed 17/09/2021]

Birkett, E. and Nicolle, W. Charging Up: Policies to deliver a comprehensive network of public EV chargepoints. Policy Exchange, February 2021, pp. 13, 59, 68, 74. Available at <https://policyexchange.org.uk/wp-content/uploads/Charging-Up.pdf> [accessed 17/09/2021]

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ELECTRICITY GENERATION

Stimulate wind and solar

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Stimulate nuclear power

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