

[My2050](#) is an online tool developed by the Department for Business, Energy & Industrial Strategy (BEIS) to help the public understand what the UK target of net zero greenhouse gas emissions in 2050 means, and the different ways it could potentially be achieved. It is designed to be used with desktop or laptop computers, and isn't suitable for mobile phones at this stage, but may be in future.

How to use this toolkit? Who is this resource aimed at?

This teaching resource created by the Royal Geographical Society (with IBG) is primarily for teachers delivering either geography, mathematics or science at Key Stage 3 or Key Stage 4. However, it can be modified for use by younger or older students.

This resource uses the My2050 calculator at <https://my2050.beis.gov.uk>

What is this resource?

The Department for Business, Energy & Industrial Strategy have created a whole-energy-system model involving thousands of data sources and assumptions on greenhouse gas emissions in the United Kingdom (UK) which are mostly carbon dioxide, to create this interactive resource. The intended aim is to raise awareness about current climate change and to draw attention to the UK net zero greenhouse gas emissions target in 2050 enshrined in law under the Climate Change Act.

What is climate change?

The Earth's climate is ever-changing. In the past it has changed many times in response to a variety of natural causes. However, the 2007 [Fourth Assessment Report of the Intergovernmental Panel on Climate Change](#) (IPCC) concluded it is very likely (more than 90% probability) that most of the observed global warming since the mid-20th century is linked to human activity. The main human influence on global climate is the emission of greenhouse gases, particularly carbon dioxide (CO₂) from the burning of fossil fuels, but also methane (CH₄), F-gases and nitrous oxide (N₂O). As these gases build up in the atmosphere, they strengthen what is known as the greenhouse effect, which leads to global warming.

What is the greenhouse effect?

The greenhouse effect was a phrase first coined by French mathematician Joseph Fourier, with the Swedish scientist Svante Arrhenius being the first scientist to explore the phenomenon. Svante Arrhenius investigated to see if the earth's average surface temperature was influenced by 'the presence of heat absorbing gases in the atmosphere' in 1896 (<https://www.theguardian.com/science/2005/feb/03/lastword.environment>). The greenhouse effect is a literal analogy of a greenhouse (greenhouses, by definition, are glass garden buildings which have high temperatures for growing produce). The earth's atmosphere is currently acting like a greenhouse due to some atmospheric gases trapping the sun's heat. CO₂ is one of five primary greenhouse gases; it is a particular problem because it is emitted in far larger quantities and persists for much longer than other greenhouse gases. Some of these impacts are already being realised with record-breaking temperatures and unusual seasonal patterns.

Examples are:

- Rising temperatures – the average temperature of the Earth's surface has risen by about 0.75°C since around 1900. Global sea levels could rise by up to 1 metre (above 1990 levels) by the end of this century.
- Extreme weather – more frequent heat waves and heavy precipitation are already more likely in the coming decades in regions all over the world.
- Water availability for drinking or farming may be less predictable as rain is likely to be more variable and higher temperatures may lead to an increased frequency of droughts.



- Increased risk of extinction for 20% to 30% of species and loss of biodiversity. Damage to marine ecosystems because of ocean acidification.
- The social, environmental, and economic costs of climate change could be huge if no global action is taken to reduce carbon emissions. You can find out more about the costs of climate change in the [Stern report](#). Further information is available in government [guidance](#).

Understanding ‘net zero’

The prefix ‘net’ means the final value after accounting for the difference between production and removal of greenhouse gases in our atmosphere, which can be measured as ‘carbon dioxide equivalent’ emissions since CO₂ is the largest greenhouse gas emission (and is referred to as ‘carbon emissions’ in this Toolkit). A net zero emission target means an overall balance between the emissions produced by the country and the emissions taken out of the atmosphere. This is not to say that the UK will not emit carbon in the future but rather that emissions will be balanced with action to remove carbon from the atmosphere. This is effectively matching output levels to input levels to produce a net zero effect.

The best visualisation of this target is to imagine a bath with the taps running and the plug out. The bath taps represent carbon emission into the atmosphere – these taps have been running furiously since the industrial revolution. The level of the bath water represents the concentration of greenhouse gases in the atmosphere and the bath plug represents drainage and carbon removal. This is not the same as a gross zero target which would reduce all emissions to zero. For a continuation of modern twenty-first Century life, this is unrealistic.

If the UK surpasses the target of net zero emissions for 2050 this would mean the country has achieved ‘net negative emissions’ either by utilising nature or, more likely, through engineering and mitigation (<http://www.lse.ac.uk/GranthamInstitute/news/what-is-net-zero/>).

How to use the interactive resource

Open the [My2050](#) online tool. Read the opening instructions which briefly explain how to use the tool. Then click on the screen to close the instructions and start the interactive animation.

CO₂e Meter

There is a CO₂e meter on the right-hand side of the screen, which shows the UK greenhouse gas emissions in 2050 relative to 1990 emissions, as a percentage reduction. On this meter, net zero is -100%, whilst the -80% marker is what the UK emissions target used to be before 2019. When My2050 is first opened, the percentage reduction shown in the meter is -35%, which is what we will achieve by 2050 if all levers (see below) remain at ambition level 1 (minimum effort to decarbonize). If you increase your decarbonization ambition for a lever above level 1, to level 2, 3 or 4 using the lever slider, you can immediately see the change in the animation and the effect on UK greenhouse gas emissions in the meter.

The Levers and ‘Levels of Ambition’

At the bottom of the screen are 15 sliders or ‘levers’ which represent the most important ways to decarbonize the UK energy system, grouped under 5 headings:

Transport:	Travel Demand, Light Vehicles, Heavy Vehicles
Buildings:	Behaviour, Efficiency, Heating System
Industry:	Carbon intensity, Carbon capture, Hydrogen
Low Carbon Electricity:	Nuclear, Wind, Solar, Wave & Tidal
Land, Bioenergy & Waste:	Forestry and Bio-energy

Each lever can be given a ‘level of ambition’ ranging from Level 1 (minimum effort to decarbonize) to Level 4 (extreme effort to decarbonize). When My2050 is first opened, all the levers are set at the bottom of each range (Level 1). You can move the blue dot up to one of three higher ambition levels

represented by white dashes, namely Level 2 (ambitious effort), Level 3 (highly ambitious effort) and Level 4 (extreme effort, at the top of the slider).

The levels were chosen by a panel of over 100 energy experts. Level 1 roughly represents doing nothing more than what we have achieved to date, and if all levers remain at level 1, the meter shows that we will only achieve a 35% reduction in emissions by 2050, well short of our net zero target.

The lever levels have 'popups' which describe the change involved. For example, Light Vehicles level 4 represents all light vehicles on the road being electric by 2050. To see more information about each lever, click on the lever icon symbol, which will open an information page about that lever.

Aim to be realistic when choosing your Ambition levels. Level 4 is extreme effort to decarbonise effort, so should only be used for a few levers that you think are most important.

Go to the results

Beneath the CO₂e meter you will see a 'Go to results' button for when you finished, where you can see graphs of:

- a) CO₂e emissions (and emission reduction popups) for your pathway, relative to level 1
- b) Energy demand and supply by sector for your pathway, relative to 2015

Specification links

This is directly relevant to the Geography GCSE curriculum for all four Awarding Organisations.

AQA

3.1.1.4. Climate change

Climate change is the result of natural and human factors and has a range of effects. Evidence for climate change from the beginning of the Quaternary period to the present day. Possible causes of climate change: • natural factors – orbital changes, volcanic activity and solar output • human factors – use of fossil fuels, agriculture and deforestation. Overview of the effects of climate change on people and the environment.

Managing climate change involves both mitigation (reducing causes) and adaptation (responding to change). Mitigation – alternative energy production, carbon capture, planting trees, international agreements. Adaptation – change in agricultural systems, managing water supply, reducing risk from rising sea levels.

Edexcel

Topic 2: Weather hazards and climate change

2.3 Global climate is now changing as a result of human activity a. How human activities (industry, transport, energy, farming) produce greenhouse gases (carbon dioxide, methane) that cause the enhanced greenhouse effect.

Topic 8: Geographical investigations – UK challenges

8.4 The UK's climate change challenges c. Range of responses to climate change in the UK at a local and national scale.

OCR

Environmental threats to our planet

2.3.2 There are a number of possible causes of climate change. How human activity is responsible for the enhanced greenhouse effect which contributes to global warming.

Eduqas

Core Theme 5: weather, climate, and ecosystems

5.1.2 What are the causes of climate change? Flows and stores in the carbon cycle and the processes that link these stores. The greenhouse effect. How human activity affects the carbon cycle. Global cooling due to volcanic activity as one natural cause of climate change during the Quaternary period.

Exploration of content

Tip: *Whenever you begin an activity make sure you start with all the blue dots positioned at the bottom of the 15 lever sliders (corresponding to all levers at Level 1 representing minimum effort to decarbonise) by clicking the 'Reset Levers' button.*

This is the first teaching resource for students. Use this tick list of questions to explore the My2050 calculator.

1. Understanding the different levers of decarbonisation

The students should preferably run through all the levers with the support of the teacher, and move the lever slider to see what happens to the landscape, and then click the lever icon to read through the contents of the information page.

By the end of the exercise, students should be able to give an answer to the following questions for each lever:

- Why is this lever important for decarbonization?
- What changes does this lever cause in the landscape?
- What do the lever levels 1 to 4 represent?
- What else have you learnt from the information page about this lever?
- Are there things you can do to help?

2. Wind energy is now the cheapest form of electricity generation (<https://www.independent.co.uk/environment/wind-power-now-the-cheapest-source-of-electricity-but-the-government-continues-to-resist-onshore-a6685326.html>) and it accounts for circa.18% of UK electricity generation.

Increase the Wind slider up to Ambition level 3. What percentage drop in emissions that you have achieved? How many gigawatts (GW) of wind electricity generating capacity does Level 3 represent? How much electrical energy can this capacity generate?

Answer: emissions fall from -35% to -52%. Level 3 represents 160 GW of wind generating capacity. This could generate 600 TWh of electrical energy per year.

Return the slider to the bottom.

3. Solar energy: An argument often heard against solar energy is 'but it isn't sunny enough in the UK!' Did you know that whilst the sunlight hours do drop to less than 8 hours a day in winter, the sun intensity in the UK in summer is strong?

Germany has a similar level of sunlight to the UK, yet it has surged ahead in solar technology with a pioneering new transformation called the '[energiewende](#)'. Increase Solar slider up to Ambition level 3. What percentage drop in emissions that you have achieved? Pause for a moment and consider why this is a different result to question 2?

Answer: emissions fall from -35% to -42%. This is less of a fall than for wind, because energy experts who set the levels of ambition thought there was more potential for wind energy than for solar energy in the UK.

Return the slider to the bottom.

4. Electric vehicles: There has been a shift towards electric vehicles (EVs) in 2020, and the Prime Minister announced in November 2020 that sale of new petrol and diesel cars won't be allowed after 2030.

Increase the Light Vehicles slider right up to Ambition level 4, which corresponds to all light vehicles on the road being electric by 2050. What percentage drop in carbon emissions that you have achieved? What could emissions drop to, if these electric vehicles were powered by low carbon electricity, such as using Wind Level 3?

Answer: emissions fall from -35% to -42%. If electric vehicles used low carbon electricity from Wind Level 3, emissions would fall to -62%.

Lesson activities

This is designed to be completed after the Exploration of content. The activities below assume a certain level of proficiency with the My2050 calculator tool.

A key command word in the following set of lesson activities is to: **Justify**. To justify means:

Give reasons for the validity of a view or idea why some action should be undertaken. This might reasonably involve discussing and discounting alternative views or actions. Each of the views present or options available will have positives and negatives. For the outcome(s) chosen, the positives outweigh the negatives. Students should be able to explain all of this review process.

Activity and key question	Description	Intention
<p>1 Say what you see</p> <p><i>A new nuclear future</i></p>	<p>Tip: <i>always start an activity with the blue dots at the bottom of all of the sliders, on the lowest setting, Ambition level 1 by clicking the Reset Levers button.</i></p> <p>Open up the My2050 calculator and describe what you see. Let us oversimplify and assume this is the current situation in the UK. Write out a paragraph to describe the scene.</p> <ol style="list-style-type: none"> 1. From the starting screen can you identify what opportunities and challenges there are for a UK urban area in the 21st Century? What forms of energy production could you enhance? Is there space to make changes to transport in the image? 2. Hinkley Point C in Somerset will be the first new nuclear power station built in the UK for 30 years. The first reactor is estimated to be operational by 2025. Since Hinkley Point is already under construction, it is included in Nuclear level 1. How many more nuclear power stations would be built if the Nuclear lever is level 2? By how much would emission fall? 3. Click the 'Go to results' button. You will now see your emissions results in a bar graph. Assess which sector has dropped, and which have not dropped back below the 1990 emission level. 4. Justify this mock scenario for a new nuclear future. Complete the recommended exam question: Assess the reasons why the UK and other countries use a mix of different energy resources. You will find a mark scheme for this Edexcel 2018 paper 2 Q4 (f) at https://qualifications.pearson.com/en/support/support-topics/exams/past-papers.html 	<p>Students to initially move a lever</p> <p>Linked to topical debate on nuclear</p> <p>First use of Go to results button</p>



<p>2 Alternative energy</p> <p><i>Is wind windy enough?</i></p>	<p>Tip: <i>always start an activity with the blue dots at the bottom of all of the sliders, on the lowest setting, Ambition level 1 by clicking the Reset Levers button.</i></p> <p>The UK is the best country in Europe for wind power. The strongest winds are recorded at sea with dominant winds throughout the year coming from a westerly direction, and most UK wind farms are located offshore where the sea is shallow.</p> <ol style="list-style-type: none"> 1. Write down a list of things required for expanding the wind power industry? Look carefully at the screen and consider size, access and cabling. 2. Wind power contributed 18% of the UK electricity generation in 2018 and this is set rise further. Increase the wind lever to Ambition level 2. Will this deliver a greater carbon emissions reduction than your answer for nuclear? 3. The government has announced that the UK will build 40 GW of wind power by 2030. If we carried on building at this rate until 2050, how many GW would we have in 2050? What ambition level does this correspond to? Some critics accuse the technology of being 'unsightly', and hence why most UK wind farms are built offshore. With this in mind what other levers can you increase which will not drastically alter the look of this urban area? 4. Click the 'Go to results' button. This time select the Energy supply and demand tab at the top of the page. Compare your levers to the 2015 data by working out the percentage change for Renewables in TWh. To calculate percentage change: <ol style="list-style-type: none"> a. Work out the difference between the two numbers (hover over the graph bars to see the exact values) b. Divide the increase by the original number c. Multiply the answer by 100 to give you a percent d. If this number is negative, then it is a percentage decrease 5. Justify this mock scenario for a new wind powered future. Complete the recommended exam question: Explain one way a named developed country has attempted to manage its energy resources in a sustainable way. You will find a mark scheme for this Edexcel 2018 paper 2 Q4 (e) at https://qualifications.pearson.com/en/support/support-topics/exams/past-papers.html 	<p>Utilise topical news on wind power</p> <p>Instruct students to use more levers</p> <p>Go to results button</p> <p>First use of the Energy demand and supply button</p> <p>Incorporate mathematics into the activity: percentage change</p>
<p>3 Role play</p> <p><i>Different opinions</i></p>	<p>Tip: <i>always start an activity with the blue dots at the bottom of all of the sliders, on the lowest setting, Ambition level 1 by clicking the Reset Levers button.</i></p> <p>You will have noticed there are multiple figures dotted around this urban area. Naturally, people have different</p>	<p>Move to group work: debate with representation from the some of the 15 levers:</p>



	<p>opinions about large-scale projects such as Hinkley Point C and offshore wind farms. In groups of 5 assume the role and opinion of someone working in one of the 5 different lever sections. These overall categories are:</p> <ol style="list-style-type: none">1. Transport2. Buildings3. Industry, CCS & Hydrogen4. Low Carbon Electricity5. Land, Bioenergy & Waste. <p>Make sure all are represented.</p> <p>For the following list of people consider: what are their priorities? What balance of levers would they want across the board? Move each lever according to the possible mindset of:</p> <ul style="list-style-type: none">• Travel demand – city mayor• Light vehicles – new first-time drivers• Heavy vehicles – haulage owner• Behaviour – individual adult• Efficiency – double glazing salesperson• Heating System – a heat pump supplier• Carbon intensity – the government minister for industry• Carbon capture – an oil company executive• Hydrogen – a gas supplier• Nuclear – a local resident• Wind – environmental advocate• Solar – energy consultant• Wave & Tidal – marine biologist• Forestry – a farmer• Bio-energy – eco-leader <p>Prepare to debate and argue your case for your levers to have high ambition. Use some of the characters listed above in your argument for the maximum level of emissions reduction. Now work out what <i>other</i> levers you need to adjust. You want to lower as much emissions as possible!</p> <p>Now, as a group, you are now going to outline an argumentative piece of writing from one of three viewpoints:</p> <ol style="list-style-type: none">1. A car plant factory worker2. A building sector architect3. A vocal environmental organisation <p>Ultimately you need to agree on your levers and future carbon emissions reduction decisions. Justify your group's future scenario. Complete the recommended exam question: State how energy supply issues can lead to conflict. You will find a mark scheme for this AQA 2019 paper 2 Q6.4 at https://www.aqa.org.uk/find-past-papers-and-mark-schemes</p>	<p>Encourage consideration of other viewpoints and touch upon NIMBYISM</p> <p>Argumentative writing</p>
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<p>4 Chart the change</p> <p><i>What has changed in Electricity generation between 1990 and 2018?</i></p>	<p>Tip: <i>always start an activity with the blue dots at the bottom of all of the sliders, on the lowest setting, Ambition level 1 by clicking the Reset Levers button.</i></p> <p>This activity is solely for the low carbon Electricity section of the My2050 calculator. Electricity is important, but it currently represents only about one sixth of the energy we use. However, it is important that we decarbonize electricity generation by using low carbon electricity sources like nuclear and renewables.</p> <p>Pie charts are an excellent way to show relative sizes. Use page 27 from the UK energy in brief 2019 (link also page 17) to draw 2 pie charts for the UK energy [Electricity] mix in 1990 and 2018. To make a pie chart:</p> <ol style="list-style-type: none"> a. Divide each value by the total (319.7 TWh) and multiply by 100 to get a percent. b. Now to figure out how many degrees for each 'pie slice' divide the original value by the percentage and multiply by 360° <ol style="list-style-type: none"> 2. What has changed between 1990 and 2018? 3. Read around this topic on the UK energy mix. Assess which fuel types will continue to increase for electricity production? 4. Now turn your attention to the other sections. What other levers need to change to hit net zero by 2050? Create your own scenario to try to accomplish net zero for 2050. Which levers need to have the most ambition? <p>Justify this mock scenario with your changes to future electricity production. Complete the recommended exam question: Outline one reason why some countries have a limited energy supply. You will find a mark for this AQA 2018 paper 2 Q6.4 at https://www.aqa.org.uk/find-past-papers-and-mark-schemes</p>	<p>Incorporate mathematics into the activity: pic chart</p> <p>Link to energy brief 2019</p> <p>Encourage students to create their own scenario balance for 2050</p> <p>Electricity section</p>
<p>5 Future scenarios</p>	<p>Tip: <i>always start an activity with the blue dots at the bottom of all of the sliders, on the lowest setting, Ambition level 1 by clicking the Reset Levers button.</i></p> <p>Screenshot the My2050 interface and save the image in a Word doc. Based on what you have now learnt; move the Ambition levers you believe need to change for 2050. Try to limit the number of Level 4s you need since Level 4 represents extreme effort. Again, screenshot this My2050 'future scenario' and save.</p> <ol style="list-style-type: none"> 1. Print off the Word doc and stick in the two image scenarios. 2. Annotate around each image in two different colours of pen. In one colour identify the industries and behaviour that produce carbon emissions, in the other colour identify the industries and behaviour that limit emissions. On your 'future scenario' image now 	<p>Challenge students to create their own future</p> <p>Go to results button</p> <p>Energy demand and supply button</p> <p>First use of the Details of my scenario button</p> <p>Buildings section</p>



	<p>write on the Ambition levels you selected to improve. This is what the UK needs to achieve!</p> <ol style="list-style-type: none">3. Click on the 'Go to results' button, select the Energy supply and demand button, screenshot the graph and print off. Now also click 'Details of my scenario', screenshot or copy the information and print off. Stick in these additional images and you now have a plan of how the country will achieve net zero!4. Buildings and their construction account for 39% of energy-related carbon dioxide emitted annually. In the future, behaviour change, better insulation and heat pumps or hydrogen may tackle this problem. For the Buildings section what will change? Set the Ambition levels according to how successful you think future buildings will be at reducing carbon emissions. <p>Justify this mock scenario for a new low carbon future. Complete the recommended exam question: Explain how different strategies can be used to make energy supplies more sustainable. You will find a mark scheme for this AQA 2018 paper 2 Q6.5 at https://www.aqa.org.uk/find-past-papers-and-mark-schemes</p>	
6 Future difficulties	<p>Tip: <i>always start an activity with the blue dots at the bottom of all of the sliders, on the lowest setting, Ambition level 1 by clicking the Reset Levers button.</i></p> <p>Since 1990, emissions from international aviation in the UK have steadily increased. Aviation comes in under the Heavy Vehicles lever.</p> <ol style="list-style-type: none">1. Split into 4 groups. Each group will research, argue and present a future scenario for each of the 4 Ambition levels for Heavy Vehicles. Use the Ambition pop-up text boxes to kick-start your assignment.2. Present a short presentation to the whole class including answers to:<ol style="list-style-type: none">a. Why is this lever important for overall transition to net zero?b. What are the consequences of level 4 effort for each of the types of transport?c. What are the challenges of the societal choice to keep flying?d. Amend the other levers to reach net zero. Click Go to results. <p>Justify this mock scenario for a new low carbon future. Complete the recommended exam question: 'Extraction of fossil fuels can bring both advantages and disadvantages.' Explain this statement using an example you have studied. You will find a mark scheme for this AQA 2019 paper 2 Q6.5 at https://www.aqa.org.uk/find-past-papers-and-mark-schemes</p>	Group work Aviation Go to results

<p>7 Creative writing</p> <p><i>Articulate what needs to be</i></p>	<p>Tip: <i>always start an activity with the blue dots at the bottom of all of the sliders, on the lowest setting, Ambition level 1 by clicking the Reset Levers button.</i></p> <p>There is no such thing as a perfect scenario or ‘the best’ route – there are lots of different ways to reach the end goal of net zero by 2050.</p> <ol style="list-style-type: none"> 1. Your final task is to return all levers to their original setting and to create whichever scenario you want to. Experiment and have fun! 2. Click ‘Go to results’ and this time, read the ‘Share your Scenario’ button to see how to share your work with others. 3. Complete this activity with some creative writing – can you bring this data to life? Outline the scenario you have chosen explaining how a journey to school might be different in 2050. Alternatively, you could write a diary extract from 6AM to 6PM in the year 2050. <p>Make sure you justify this mock scenario for a new low carbon future. Complete the recommended exam question: Examine the impacts of the development of one or more renewable energy sources on people and the environment in the UK. You will find a mark scheme for this OCR 2018 paper 3 (d) at https://www.ocr.org.uk/qualifications/past-paper-finder/</p>	<p>Creative task</p> <p>Encourage class to experiment</p> <p>Share your scenario</p>
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Nuclear EDF Hinkley Point C

<https://www.edfenergy.com/energy/nuclear-new-build-projects/hinkley-point-c/about>

Wind BBC ‘record’ offshore wind

<https://www.bbc.co.uk/news/uk-49769259>

UK energy in brief 2019

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/857027/UK_Energy_in_Brief_2019.pdf

Fossil fuels fall to record low

<https://www.theguardian.com/environment/2019/dec/19/fossil-fuels-fall-to-record-low-in-britains-energy-mix-data-shows>