

Explanatory Memorandum to the Climate Change (Wales) Regulations 2021

Explanatory Memorandum to:

- **The Environment (Wales) Act 2016 (Amendment of 2050 Emissions Target) Regulations 2021**
- **The Climate Change (Interim Emissions Targets) (Wales) (Amendment) Regulations 2021**
- **The Climate Change (Carbon Budgets) (Wales) (Amendment) Regulations 2021**
- **The Climate Change (Net Welsh Emissions Account Credit Limit) (Wales) Regulations 2021**

This Explanatory Memorandum has been prepared by the Economy, Skills and Natural Resources Group and is laid before Senedd Cymru in conjunction with the above subordinate legislation and in accordance with Standing Order 27.1.

Minister's Declaration

In my view, this Explanatory Memorandum gives a fair and reasonable view of the expected impact of the Climate Change (Wales) Regulations 2021:

- The Environment (Wales) Act 2016 (Amendment of 2050 Emissions Target) Regulations 2021
- The Climate Change (Interim Emissions Targets) (Wales) (Amendment) Regulations 2021
- The Climate Change (Carbon Budgets) (Wales) (Amendment) Regulations 2021
- The Climate Change (Net Welsh Emissions Account Credit Limit) (Wales) Regulations 2021

I am satisfied that the benefits justify the likely costs.

Lesley Griffiths MS
Minister for Environment, Energy and Rural Affairs

9 February 2021

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PART 1

1. Description

A suite of four regulations are covered within this Explanatory Memorandum and are referred to collectively as the Climate Change (Wales) Regulations 2021. Under Part 2 of the Environment (Wales) Act 2016 (“the Act”) Wales committed to reducing emissions of greenhouse gases from Wales by at least 80% in 2050. The Climate Change (Wales) Regulations 2018 established a system of interim emissions targets and carbon budgeting to create an emissions reduction trajectory towards the 2050 target. They also set out how the Welsh Ministers can utilise international carbon credits and set the credit (“offset”) limit for Carbon Budget 1 (CB1, 2016-20). Finally, they provided for how we will deal with emissions from international shipping and internal aviation in calculating our emissions.

The Climate Change (Wales) Regulations 2018, which supported the delivery of the Act, were namely:

- The Climate Change (Interim Emissions Targets) (Wales) Regulations 2018
- The Climate Change (Carbon Budgets) (Wales) Regulations 2018
- The Climate Change (International Aviation and International Shipping) (Wales) Regulations 2018
- The Climate Change (Net Welsh Emissions Account Credit Limit) (Wales) Regulations 2018
- The Carbon Accounting (Wales) Regulations 2018

The Climate Change (Wales) Regulations 2021 amend the 2050 target, the interim targets for 2040 and 2030, and CB2 (2021-25). They also set CB3 (2026-30) and the offset limit for CB2.

2. Matters of special interest to the Legislation, Justice and Constitution Committee

Section 31(4)(b) of the Environment (Wales) Act 2016 requires the Welsh Ministers to set CB3 in 2020, five years before the start of the budgetary period. In accordance with Section 49, before laying draft regulations the Welsh Ministers are required to request and take into account the advice of the advisory body. Under section 49(6) of the Act, if thereafter the Welsh Ministers propose making different provision from that recommended by the advisory body, they must also lay before the Senedd a statement setting out the reasons why. By virtue of no declaration being made by Welsh Ministers appointing an advisory body, Section 44 by default appoints the Climate Change Committee (CCC) to be our statutory advisory body.

In December 2019 the Minister for Environment, Energy and Rural Affairs requested advice from the CCC, including its recommendation for the level of CB3. The Minister requested the advice be published in September 2020 to allow for CB3 to be set by the end of that year. The CCC committed to this

timeline but subsequently, in June 2020, informed the Minister this would no longer be possible due to the challenges posed by the Covid-19 pandemic. The CCC moved publication of the advice to December 2020. The Minister decided it would not be manifestly unreasonable to choose to accommodate a small delay in setting CB3 in order to ensure legislation is brought forward on the basis of proper, thorough advice. The Welsh Ministers have obtained and taken into account the advice of the advisory body in relation to the Climate Change (Wales) Regulations 2021 now laid before the Senedd.

The Act does not establish a deadline for setting the offset limit for each carbon budget. The Welsh Ministers intend to set the CB3 offset limit no later than 2025.

The Carbon Accounting (Wales) Regulations 2018 utilise the UK Registry to host the Welsh credit account. Until the UK left the European Union, the UK Registry was governed by Commission Regulation (EU) 389/2013 establishing a union registry pursuant to Directive 2003/87/EC establishing a system for greenhouse gas emissions trading within the EU. Having left the EU, the UK no longer has access to the EU registries system. Officials are liaising with UK Government counterparts about a new, standalone UK Registry. Once this is established, the Welsh Ministers will need to amend the Carbon Accounting (Wales) Regulations 2018 to ensure provision for registering and keeping track of carbon units held by the Welsh Ministers. It is not expected Welsh Ministers will need to buy offsets in CB1 and it is expected the new UK Registry will be operational well in advance of the end of CB2.

3. Legislative background

The purpose of Part 2 of the Environment (Wales) Act 2016 is to require the Welsh Ministers to meet targets for reducing emissions of greenhouse gases in Wales. Part 2 puts in place a statutory emissions reduction target that requires the Welsh Ministers to ensure that net emissions of greenhouse gases in Wales, for the year 2050, are at least 80% lower than the baseline.

Part 2 also requires that the Welsh Ministers, by regulations approved by the Senedd, set interim emissions reduction targets for the years 2020, 2030 and 2040, and establish a system of 5-yearly carbon budgeting that together create an emissions reduction pathway to the 2050 target. The Climate Change (Wales) Regulations 2018 fulfilled this requirement.

The Environment (Wales) Act 2016 (Amendment of 2050 Emissions Target) Regulations 2021

- Section 29(3) allows the Welsh Ministers to amend the 2050 emissions target.
- Section 32 sets out the principles for amending the 2050 target.

The Climate Change (Interim Emissions Targets) (Wales) (Amendment) Regulations 2021

- Section 30(1) allows the Welsh Ministers to amend the interim emissions targets.

- Section 32 sets out the principles for amending the interim emissions targets.

The Climate Change (Carbon Budgets) (Wales) (Amendment) Regulations 2021

- Section 31 allows the Welsh Ministers to amend and set carbon budgets.
- Section 32 sets out the principles for amending and setting a carbon budget.

The Climate Change (Net Welsh Emissions Account Credit Limit) (Wales) Regulations 2021

- Section 33 provides that the Welsh Ministers must limit how many traded carbon units can be credited to the net Welsh emissions account in a given period. These regulations set the offset limit for Carbon Budget 2.

Section 32(2) of the Act prevents the Welsh Ministers from making regulations changing the 2050 emissions target, an interim emissions target or a carbon budget unless at least one of the following conditions is met:

- they are satisfied that it is appropriate to make the change as a result of significant developments in
 - scientific knowledge about climate change, or
 - EU or international law or policy relating to climate change;
- the change has been recommended by the advisory body;
- the change is in connection with provision made under section 35(1) or 37(2).¹

As required by the Act, the Welsh Ministers asked the CCC to provide advice to inform the development of the regulations. On 17 December 2020, following a Call for Evidence, the CCC provided their advice to the Welsh Ministers. The report, '[The path to a net zero Wales](#)', includes the CCC's recommendations on:

- The level of the 2050 target;
- The level of the 2030 and 2040 targets;
- The level of CB2 and CB3; and
- The limit for the use of offset credits in CB2.

In giving their advice on the level of the targets and budgets the CCC developed four different emissions scenarios across all sectors of the economy.² Drawing on these scenarios, the CCC then produced a fifth – the Balanced Net Zero Pathway that forms the basis of their recommendations.

¹ Section 35(1) relates to emissions from international aviation and international shipping. Section 37(2) relates to the definition of 'greenhouse gas'.

² Electricity supply, residential buildings, non-residential buildings, fuel supply, manufacturing and construction, surface transport, aviation, shipping, agriculture, land use, land use change and forestry, waste and F-gases.

The Climate Change (Wales) Regulations 2021 are brought forward in accordance with Section 32(2)(b) and follow the recommendations of the advisory body.

Section 32(3) of the Act requires the Welsh Ministers when making regulations changing the 2050 emissions target, or setting or changing an interim emissions target or a carbon budget, to have regard to the following:

- The most recent report under section 8 on the state of natural resources in relation to Wales
- The most recent future trends report under section 11 of the Well-being of Future Generations (Wales) Act 2015
- The most recent report (if any) under section 23 of that Act (Future Generations report)
- Scientific knowledge about climate change
- Technology relevant to climate change
- EU and international law and policy relating to climate change (including international agreements on measures designed to limit increases in global average temperatures)

The Climate Change (Wales) Regulations 2021 are brought forward in accordance with Section 32(3) of the Act.

Procedures for laying regulations

The regulations are subject to the approval of the Senedd via the draft affirmative procedure.

In accordance with Section 49, before laying draft regulations the Welsh Ministers are required to request and take into account the advice of the advisory body. By virtue of no declaration being made by Welsh Ministers appointing an advisory body, Section 44 by default appoints the Climate Change Committee (CCC) to be the statutory advisory body. Where regulations make different provision to the advice provided by the CCC, the Welsh Ministers must lay a statement before the Senedd setting out the reasons why.

The Climate Change (Wales) Regulations 2021 follow the advice of the advisory body.

4. Purpose and intended effect of the legislation

Environment (Wales) Act 2016 (Amendment of 2050 Emissions Target) (Wales) Regulations 2021

Current situation

Section 29 of the Act establishes a statutory emissions reduction target that requires the Welsh Ministers to ensure that net emissions of greenhouse gases in Wales, for the year 2050, are at least 80% lower than the baseline.

Purpose

The purpose of this regulation is to increase the 2050 target to at least 100% lower than the baseline ('net zero').

Intended effect

The intended effect of this regulation is to bring Wales's 2050 target in line with the CCC's recommendation, reflecting developments in scientific knowledge, public opinion and global ambition since the original target was set in 2016.

Climate Change (Interim Emissions Targets) (Wales) (Amendment) Regulations 2021

Current situation

The Climate Change (Interim Emissions Targets) (Wales) Regulations 2018 set the interim targets that represented a pathway to the 2050 target established in the Act as follows:

- a 2020 target for an emissions reduction of 27% against the baseline
- a 2030 target for an emissions reduction of 45% against the baseline
- a 2040 target for an emissions reduction of 67% against the baseline

Purpose

The purpose of this legislation is to set targets for 2030 and 2040 that represent a pathway to the new net zero target for 2050:

- a 2030 target for an emissions reduction of 63% against the baseline
- a 2040 target for an emissions reduction of 89% against the baseline

Intended effect

The intended effect of this regulation is to establish targets for 2030 and 2040 in line with the CCC's recommendations, frontloading action in the 2020s. Reducing emissions early matters as it is global cumulative emissions that drive climate outcomes. The Welsh Ministers must set each interim emissions target at a level they are satisfied is consistent with meeting the 2050 emissions target.³

Climate Change (Carbon Budgets) (Wales) (Amendment) Regulations 2021

Current situation

A carbon budget sets a maximum limit on the total amount of Welsh emissions permitted over a 5-year budget period. The Climate Change (Carbon Budgets) (Wales) Regulations 2018 set Carbon Budgets 1 and 2 as follows:

- CB1 (2016-2020): an average of 23% below the baseline

³ Section 32(1)(a) of the Act.

- CB2 (2021-2025): an average of 33% below the baseline

Purpose

The purpose of this legislation is to set CB2 and CB3 at levels that represent a pathway to the new targets for 2030, 2040 and 2050:

- CB2 (2021-2025): an average of 37% below the baseline
- CB3 (2026-2030): an average of 58% below the baseline

Intended effect

The intended effect of this regulation is to establish carbon budgets for the 2020s in line with the CCC's recommendations. The Welsh Ministers must set each carbon budget at a level they are satisfied is consistent with meeting:

- the 2050 emissions target; and
- the interim target for any interim target year that falls within or after that budgetary period.⁴

Climate Change (Net Welsh Emissions Account Credit Limit) (Wales) Regulations 2021

Current situation

The Climate Change (Net Welsh Emissions Account Credit Limit) (Wales) Regulations 2018 set the limit on the use of carbon units for CB1.

Purpose

The Act requires Welsh Ministers to set a limit on the total amount that the Net Welsh Emissions Account can be reduced through the use of carbon units. The Carbon Accounting (Wales) Regulations 2018 defines carbon units as the international offset credits generated through Certified Emission Reduction (CER). Offset credits provide a means by which Wales can invest in emission reduction activities overseas and use the emission reductions achieved to offset domestic emissions within the Welsh targets.

The purpose of this regulation is to set the limit on the use of carbon units for CB2 (2021-2025).

Intended effect

The intended effect of this regulation is to set the offset limit for CB2 in line with the CCC's recommendation and ensure that CB2 is met solely by reducing domestic emissions. As the CCC's recommendation is to outperform CB2 on the way to more ambitious CB3 and the 2030 targets, the CCC concludes that it is not appropriate to meet CB2 with any use of carbon units i.e. the offset limit for CB2 should be set at 0%.

⁴ Section 32(1)(b) of the Act.

PART 2 – REGULATORY IMPACT ASSESSMENT

Introduction

The four regulations that make up The Climate Change (Wales) Regulations 2021 all relate to Wales's emissions reduction pathway to 2050 and are highly interdependent. This RIA therefore considers options for the pathway as a whole, rather than each regulation in turn. The pathway set in regulations represents the strategic decarbonisation framework but many individual policy measures are required to achieve the pathway. There are multiple ways to deliver the pathway and so the actual costs and benefits can only be determined once the measures to meet the carbon budgets have been agreed; policy-level impact assessments are required to conduct this analysis.

Since the Senedd passed the Climate Change (Wales) Regulations in 2018, science, technology, markets and cost assumptions have changed, showing the inherent uncertainties in modelling emission pathways and estimating costs. The Welsh Government is focussed on developing and taking the actions needed to meet the carbon budgets and targets and so is reliant on the Climate Change Committee (CCC) advice. This means there are only two options presented in this RIA, both drawing on CCC expertise.

Options

Option 1: Retain current emissions pathway ('do minimum')⁵

Option 1 fulfils the statutory duty to set CB3 and does so at a level consistent with the existing 80% pathway and the CCC's 2017 advice. It also increases the average reduction required in CB2 from the existing 33% to 37% to take account of the early closure of Aberthaw Power Station. The Welsh Government endorsed this principle when accepting the CCC's 2017 advice. Finally, this option sets the CB2 offset limit at 0%, in line with the CCC's recommendation in their 2020 advice. It leaves all the decadal targets unchanged.

- Carbon Budget 2 (2021-25): 37% average reduction with a 0% offset limit
- Carbon Budget 3 (2026-30): 43% average reduction⁶
- 2030: 45% reduction
- 2040: 67% reduction
- 2050: at least 80% reduction against the baseline

⁵ These targets are all set against the 2017 CCC advice, which was in turn based upon scientific understanding of GHG emissions at that time (1990-2015 GHG emission data are used as the basis). However, understanding of emissions has progressed since then and the latest CCC analysis is considerably revised to take account of these changes. The Option 1 pathway does not take any of these adjustments into account.

⁶ There is no statutory deadline for setting each offset limit. We will set the CB3 offset limit no later than 2025.

Option 2: Accept the CCC’s recommendations in the December 2020 advice

- Carbon Budget 2 (2021-25): 37% average reduction with a 0% offset limit⁷
- Carbon Budget 3 (2026-30): 58% average reduction⁸
- 2030: 63% reduction
- 2040: 89% reduction
- 2050: at least 100% reduction against the baseline

Costs and benefits

Costs

We estimate the Present Value of resource costs of Option 2 will lead to additional resource costs of between £6bn and £10bn over the period to 2050.⁹ The best estimate, based on the Balanced Pathway that the CCC’s recommendations are drawn from, is that the cost is likely to be in the upper third of this range. Upper and lower bounds are drawn from analysis of all of the CCC’s scenarios in their December advice.¹⁰

Note: The resource costs of the net zero transition are not attributed as part of this analysis. Costs are likely to be shared between the Welsh and UK Governments, the private sector, investors and citizens.

	Best estimate	Lower bound	Upper bound
Option 1	£4.7bn	£3.3bn	£5.5bn
Option 2	£14.1bn	£10.1bn	£15.9bn
Additional cost of Option 2	£9.4bn	£5.9bn	£10.4bn

Table 1: Present Value of resource costs of Options 1 and 2¹¹

⁷ The CCC’s recommendation for CB2 was a 37% average reduction in law with a commitment to outperform it. This is the minimum required to meet the Balanced Pathway. Our costs analysis incorporates the CCC’s recommendation for CB2 with a view to meeting the 2030 recommendation and later targets.

⁸ There is no statutory deadline for setting each offset limit. We will set the CB3 offset limit no later than 2025.

⁹ Resource costs are discounted using the Social Time Preference Rate’ (STPR) (3.5%) to provide the Present Value of resource costs. Additional resource costs indicate the extra spend required to provide the same goods and services but in a low-carbon way. They are calculated by annualising the capital investment costs over their lifetimes using a suitable cost of capital and subtracting in-year operating cost savings.

¹⁰ Headwinds, Widespread Engagement, Widespread Innovation, and Tailwinds – in addition to the Balanced Pathway.

¹¹ Figures may not sum due to rounding and comparisons across multiple CCC scenarios.

Comparison with the CCC estimate

Figure 1 shows that the CCC forecast the resource cost of their Balanced Pathway to be approximately £25bn.¹²

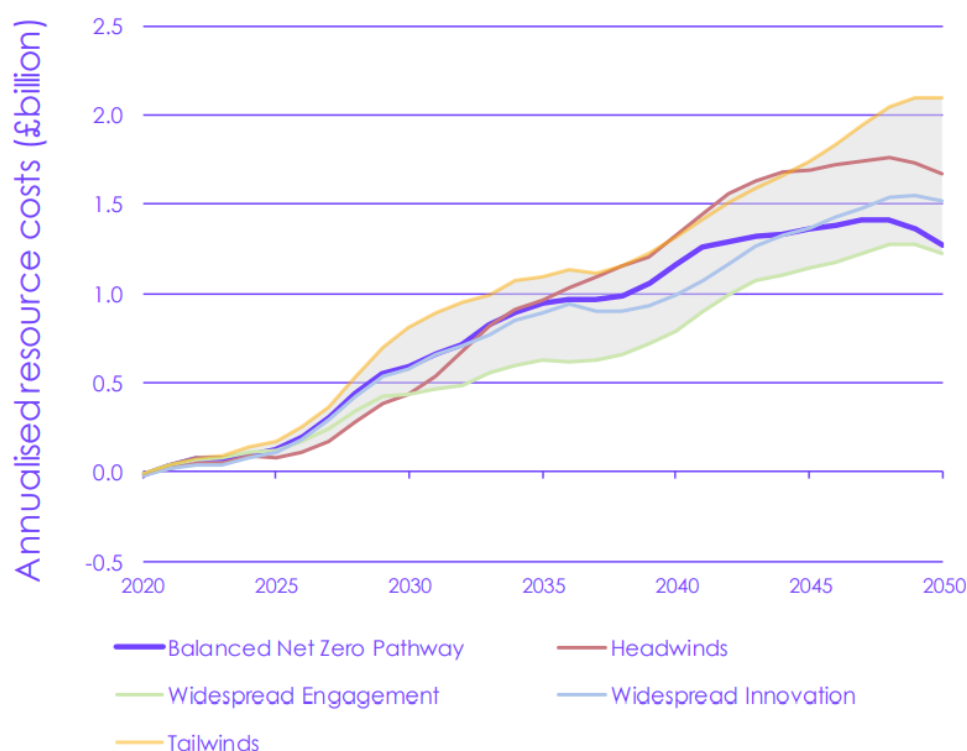


Figure 1: Annualised resource costs of the CCC’s scenarios; CCC analysis

The reasons for the difference between our estimate and the CCC’s estimate are twofold:

1. The CCC does not apply discounting to their estimates. The effect of discounting is the sole reason for the difference between their £25bn figure and the £14.1bn figure in Table 1.
2. The CCC compares the costs of achieving a net zero target with a hypothetical counterfactual¹³ of no-further climate-action from today. The counterfactual against which the costs in this RIA are compared is the existing statutory 80% target (Option 1).

Methodological approach

Note: Our cost estimates have been derived entirely from the CCC analysis and we have not undertaken our own modelling.

¹² The CCC report resource costs on an annual rather than cumulative basis. The £25 billion figure is the summation of the annual resource cost in each of the 30 years it takes to reach the net zero target. For detail on the CCC’s methodology, including assumptions, uncertainties and sensitivities, see Chapter 5 of [The Sixth Carbon Budget – The UK’s path to Net Zero](#).

¹³ The CCC’s counterfactual in the 2020 advice differs from all previous CCC publications. For more information see p.20 of [The Sixth Carbon Budget Methodology Report](#) (CCC, 2020).

The costs of both options are based on the scenarios produced by the CCC in their December advice. The costs of Option 1 are calculated by taking the annualised resource costs up to the point at which the particular scenario reaches the 80% target, whereas the costs of Option 2 take into account the whole pathway to net zero.

Figure 2 shows the cumulative annual resource costs for each scenario from 2020 onwards, up to the year where net zero emissions is reached. The point at which 80% is reached varies in the different scenarios (Table 2) and is indicated by the red dot in Figure 2. The additional costs of Option 2 are derived from the difference between the red dot and the end of the line.

The CCC’s scenarios rely to varying degrees on engineered greenhouse gas removals, such as Bioenergy with Carbon Capture and Storage (BECCS). The Balanced Pathway recommended by the CCC in their 2020 advice leads to a 96% reduction in Welsh emissions in 2050.¹⁴ The CCC advises that Wales can credibly meet net zero in the Balanced Pathway either with a 4% share (approximately 2MtCO₂e) of total UK engineered removals or through increased action in other areas, including land use and behavioural changes. However, the CCC’s analysis does not allocate a specific level of engineered removals to each UK nation. The analysis behind the figures in Table 1 includes Wales’s share of the UK costs of engineered removals in each CCC scenario up to 2050, in order to estimate the full cost of achieving net zero. Alternative ways of bridging the emissions gap would incur different costs.

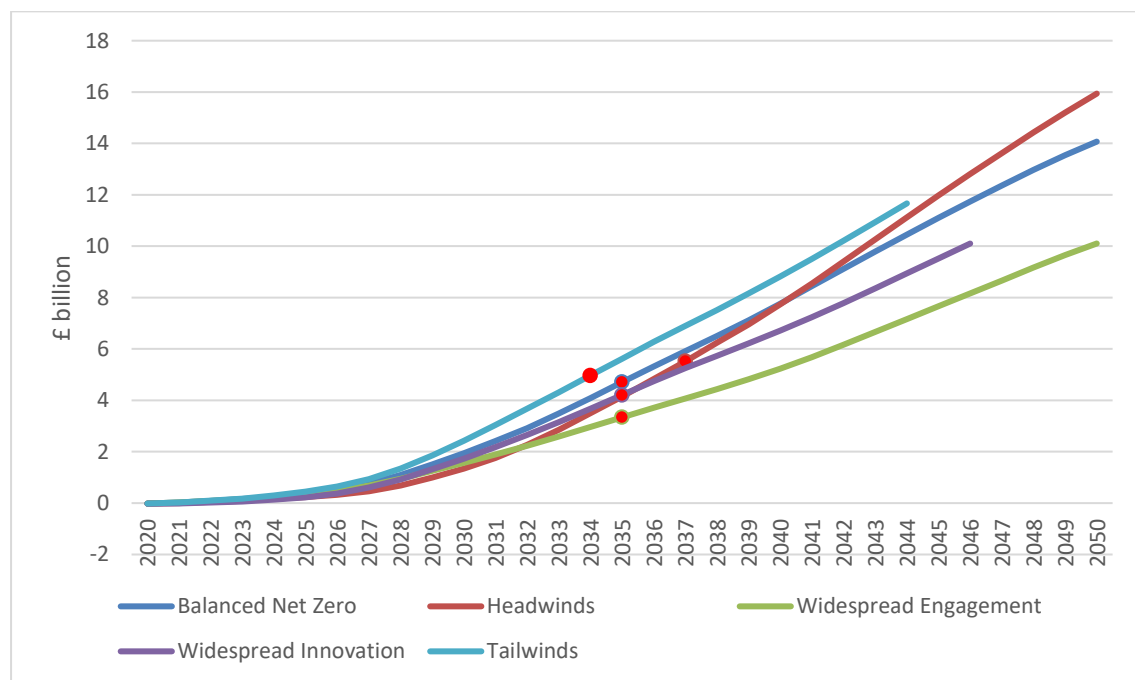


Figure 2: Cumulative Present Value of resource costs for each scenario; WG, using CCC analysis

	80%	Net zero
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¹⁴ The other CCC scenarios that do not reach net zero by 2050 are Headwinds (93%) and Widespread Engagement (99%).

Balanced Pathway	2035	2050
Headwinds	2037	2050
Widespread Engagement	2035	2050
Widespread Innovation	2035	2046
Tailwinds	2034	2044

Table 2: Years in which emission reduction targets are met under the CCC’s scenarios; WG, using CCC analysis¹⁵

We adopted this approach to estimate the costs of Option 1 because the CCC’s 2017 cost estimate of an 80% target can no longer be considered robust, due to significant falls in the costs of technology and methodological changes undertaken by the CCC.¹⁶ To illustrate the impact of these changes, Figure 3 shows the estimated resource cost of achieving an 80% target (produced in 2017) compared to the cost of achieving a net zero target (produced in 2020). This shows the uncertainty of estimating future resource costs, as they are highly sensitive to differences in behaviour change and the level of innovation in low carbon technologies.

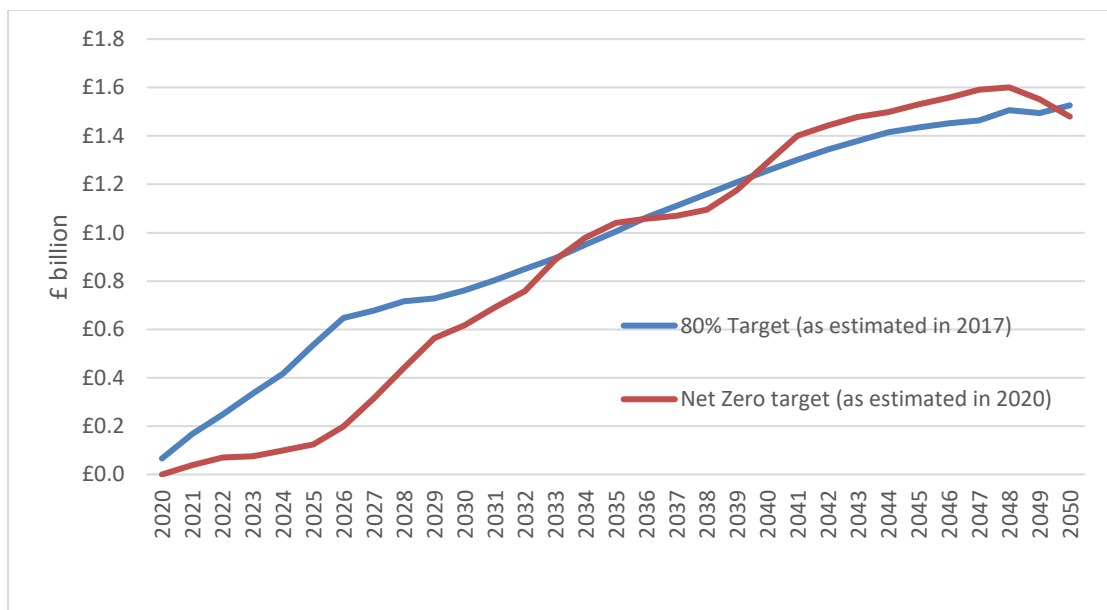


Figure 3: Annualised resource cost of Option 1 (2017) and Option 2 (2020) (£billion); WG, using CCC analysis¹⁷

¹⁵ Our analysis assumes a small amount of engineered greenhouse gas removals in the Balanced Pathway and Headwinds scenario before 2035 and 2037 respectively. This has been accounted for in the costs in Table 1. For the purposes of our analysis, the Balanced Pathway, Headwinds and Widespread Engagement Scenarios reach net zero in 2050 with varying amounts of engineered removals.

¹⁶ The changes and their implications are summarised in Box 1.2 on p.27 of [The Sixth Carbon Budget Methodology Report](#) (CCC, 2020).

¹⁷ Option 2 (Net Zero target) is based on our undiscounted cost analysis of the CCC’s Balanced Pathway and includes the costs of engineered removals required to reach net zero.

Where the costs are likely to fall

The CCC is clear that the costs should not be interpreted as being solely delivered through Welsh Government expenditure, nor as costs that only Welsh businesses and households have to bear. The extent to which costs and savings are shared across the UK – including the amount of expenditure through Welsh Government budgets – will be determined by policy at both UK and Welsh Government level. Many of the actions to reduce emissions will likely be paid for at UK level and/or socialised across the whole of the UK. The CCC provides the following examples:

- The costs associated with building new low-carbon generation will be shared across all consumers of electricity on the GB grid. The CCC has reflected this by allocating resource and investment costs for electricity supply to Wales in proportion to consumption, rather than make assumptions on where new zero-carbon generating capacity is located.¹⁸
- The costs of decarbonising industrial clusters could be met through a combination of direct financing from the UK Exchequer and/or be passed through to the end-users of low-carbon products.
- A market mechanism for greenhouse gas removals could see the UK aviation industry offsetting emissions by paying for removals, including planting trees, in all areas of the UK.

An expert advisory group convened by the CCC suggested that the private sector could deliver the majority of the investments in a transition to Net Zero.¹⁹ For this to happen, the Welsh and UK Governments will need to ensure appropriate regulatory and taxation regimes are in place. Given the CCC anticipates a small overall economic impact and assumes the private sector to finance most of the transition, the CCC expects the overall impact on public finances to 2050 to be limited.

Table 1 shows a larger total Present Value of resource costs for Option 2 than Option 1. This means that Option 2 may result in increased costs for households, at least in the short-term. However, in Option 2 households are likely to benefit from reduced operating costs over time. There is evidence to suggest that the benefits of Option 2 may outweigh the costs; the benefits are explored in further detail below.

In December 2020 HM Treasury published an interim report for its Net Zero Review.²⁰ The report recognises the implications for households arising from the structural changes required by the transition to a net zero economy but does not seek to calculate the impact of the transition on any particular group.

¹⁸ This assumption typically causes the estimate of Wales' share of UK costs to be lower than its share of UK abatement, because Wales is currently a significant net exporter of gas-fired power to the UK, but the costs of actions to decarbonise power will be shared by all electricity users in the UK.

¹⁹ For detail, see Chapter 5 of [The Sixth Carbon Budget – The UK's path to Net Zero](#).

²⁰ [Net Zero Review: Interim Report](#) (HM Treasury, December 2020)

The report acknowledges the inherent uncertainties in forecasting how the net zero transition will affect households by concluding that:

“The transition is a dynamic process that will take place over several decades, and its impact on individual households will ultimately depend on a range of factors including: the development of new low-carbon sectors in the UK; the pace of transition and policy levers chosen; the price of low-carbon alternatives to households and businesses’ current activities; and the dynamism of the labour and capital market.”

Households are exposed to the net zero transition through:

1. The goods and services they buy (household consumption). Different types of household will have different levels of exposure to the transition. For example, higher-income households consume more carbon in absolute terms, but lower-income households tend to consume more carbon relative to their income. HMT analysis suggests that the highest-income households emit around three times as much carbon as the lowest-income households, while on average their income is approximately eight times greater. Furthermore, regional analysis suggests that the average household greenhouse gas footprint in Wales is around the average, when compared to other parts of the UK.²¹
2. Labour market effects. There are likely to be large transitional labour market effects between sectors, with people in certain occupations (skilled trade, and process plant and machine workers) more likely to work in more carbon-intensive industries. People in these occupations are also disproportionately likely to have a lower level of education and to be lower income workers. HMT analysis suggests that people with lower and middle levels of education are employed in jobs with over 20% higher carbon intensity than highly educated employees, on average.
3. Changes to the value of assets. The interim report does not include analysis of this aspect. The net zero transition could affect household business profits, subsequently affecting households that own them (negatively or positively, depending on the household assets owned).

Benefits

The CCC’s December advice considers the benefits of net zero in the areas of prosperity, health and natural capital. The benefits discussed here follow the CCC’s approach of comparing a net zero pathway (Option 2) with a future of no further climate action, rather than comparing the benefits of Options 1 and 2 directly.

While it is not possible to quantitatively compare the macroeconomic, health and natural capital benefits under the options considered, it is reasonable to assume greater net benefits will accrue under Option 2 in relation to health and natural capital. This is because a net zero target will likely demand a greater policy response relevant to these areas, for example more tree planting, and this should increase the benefits flowing from these actions. Option 2 also

²¹ [Net Zero Review: Interim Report](#) (HM Treasury, December 2020, p.75)

frontloads climate action in the next 15 years, which would achieve the benefits earlier than Option 1 and result in greater cumulative benefit overall.

Prosperity and resilience

In the near term, the CCC report that GDP is likely to increase, especially as the economy rebuilds after the COVID-19 crisis. The negative economic impacts from COVID-19 mean the economy is not at full capacity and so present an opportunity for projects which are both ready to implement and which have a high fiscal multiplier effect. According to Hepburn et al (2020), green projects considered to have high multiplier values and strong climate benefits include building efficiency spending for renovations and retrofits, and natural capital investment for eco-system resilience and regeneration (such as restoration of carbon-rich habitats and climate friendly agriculture).²²

The CCC endorses this position, arguing that now is an ideal time to encourage investment, based on historically low interest rates and a potential demand shortage for cheap capital. Economic recovery from the COVID-19 pandemic necessitates stimulus, and many of the measures detailed in their advice have been shown to have high economic multipliers. However, it should be noted that other fiscal spending not linked to environmental policy may also have a high fiscal multiplier effect during periods of spare capacity. Furthermore, we cannot know for how long the economy will be at limited capacity as a result of COVID-19.

The CCC stresses that the estimates of annualised resource costs are not the same as macroeconomic impacts because resource costs are a microeconomic measure which do not account for wider dynamic interactions in the economy. For example, resource costs incorporate investment costs but do not account for the increase in GDP if that investment is made domestically. Furthermore, the shift away from fossil fuel imports is likely to have major benefits to the country's trade balance, which the resource costs also do not account for.

Macroeconomic analysis conducted in support of the CCC's advice demonstrates that despite the added resource costs involved, the net zero transition is expected to boost UK GDP by around 2% by 2030, levelling off at around a 3% increase by 2050.²³ The analysis estimates that UK net employment will be between 0.5-1% higher than the baseline of no further climate action between 2025-2050, with this employment growth largely resulting from the net zero investment programme.

The CCC reports that actions needed for the transition to net zero in Wales can stimulate economic growth, create jobs, and aid a recovery from the pandemic, as well as increasing resilience to future climate risks. Legislating the CCC's recommended targets would send a clear signal that Wales is open for low-carbon investment and take forward the commitment to "respond energetically to the climate emergency by pursuing a strong decarbonisation agenda", set

²² [Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change?](#) (Hepburn et al, May 2020)

²³ [Economic impact of the Sixth Carbon Budget](#) (Cambridge Econometrics, 2020)

out in the 'COVID-19 Reconstruction: Challenges and Priorities' paper, published in October 2020.²⁴ This will also help to encourage private investment at a time when it is needed to support Wales' economic recovery from the COVID-19 crisis. It could also help Wales secure competitive positions in growing global markets for low-carbon goods and services.

Health

There is clear evidence for the health benefits of the net zero transition. Some of these come directly from changes required to achieve net zero (e.g. more active travel and dietary changes) and some indirectly from the implications of those changes (e.g. better air quality from reduced burning of fossil fuels and more liveable buildings as insulation is improved). These benefits are difficult to quantify, but the CCC states that they "unquestionably offset some, if not all, of the overall resource costs of achieving emissions targets".

The CCC's Expert Advisory Group on Health concurred strongly with the CCC's previous assessment that climate action could bring significant benefits to health. The Group identified five key areas in which action would bring benefits to public health and reduction of health inequalities while contributing to the mitigation of – and adaptation to – climate change:

1. Improved air quality delivered by a move to a cleaner energy system and moving away from fossil fuel combustion in most sectors of the UK.
2. Healthier modes of transport, particularly due to the health benefits of walking and cycling and reducing air pollution from road vehicles.
3. More comfortable and efficient homes that are low-carbon, energy efficient and designed for a changing climate.
4. Better diets with a focus on healthy and sustainable alternatives to the highest carbon foods.
5. Sustainable economic and employment models that better support health and wellbeing.

While noting the potential benefits to public health, the Group noted that the biggest driver of health outcomes in the UK remains economic inequality. A just transition is therefore an essential part of a successful climate policy and health policy.

There are also some potential health risks associated with achieving net zero. One such risk is a greater risk of airborne infection where increased energy efficiency in buildings is not accompanied by adequate ventilation.²⁵

Natural capital and well-being

Each of the CCC's scenarios for Wales include measures to improve Wales' natural capital:

²⁴ [COVID-19 Reconstruction: Challenges and Priorities](#) (WG, 2020)

²⁵ University of Leeds study quoted in 'Could Energy Efficiency Actually Increase Hospital Infection Rates?' (2013): <http://www.buildings.com/articles/30879/could-energy-efficiency-actually-increase-hospital-infection-rates>

- Provisioning services. The scenarios include an increase in renewable energy generation – particularly wind – consistent with the Welsh Government's target to generate renewable electricity equivalent to 70% of Welsh consumption by 2030.
- Regulation services. The Balanced Pathway includes the planting of between 4,500 and 7,500 hectares of trees per year, from 2025 to 2050, which will also contribute to improved air quality. Trees filter rainwater before it reaches receiving waters, thus improving water quality. Strategic planting of trees on flood plains can also regulate flooding. Trees can also reduce storm water runoff and slow storm flow. Significant areas of peatland will also be restored which – in addition to carbon sequestration – provide other vital services, such as water regulation, flood protection and habitats for wildlife.
- Cultural services. The natural environment provides a range of cultural services, such as increased amenity benefits, improved mental health, educational benefits and spiritual well-being.
- Supporting Services. In agriculture, the scenarios include soil and crop measures that aim to increase the efficiency of fertiliser use. These have benefits to water and soil quality, and biodiversity.

*A just transition to Net Zero*²⁶

The CCC expects the transition to bring many benefits for UK households. By 2035, in the CCC's scenarios, people's homes will be better insulated, their cars will be cheaper to drive, they will have cleaner air, quieter streets, more access to green spaces and more opportunities to improve their health. Policy should aim to share these benefits broadly across the population.

The CCC also highlights the risk of uneven costs. In the long term, energy costs and energy bills are expected to fall significantly but electricity costs are likely to rise first. Although improvements to energy efficiency could largely offset these costs, the CCC says that the additional costs should not be automatically added to energy bills, which is a regressive approach. It notes that continuing to add climate policy costs primarily to electricity prices, but not gas prices, adversely affects particular groups (those with electric heating).

New job opportunities

The opportunities for jobs growth have, to date, largely been focused on deploying renewable electricity. Research conducted by the International Labour Organisation suggests that growth in renewable energy sources leads to greater job creation than growth in non-renewable energy sources.²⁷ The CCC anticipates that the next phase of decarbonisation will go beyond renewable electricity towards electric vehicles, low-carbon hydrogen, carbon capture usage and storage (CCUS) and buildings decarbonisation. Low-carbon industrial products will be in increasing demand across the world.

²⁶ For more detail, see Chapter 6 of [The Sixth Carbon Budget – The UK's path to Net Zero](#).

²⁷ ['The transition in play: Worldwide employment trends in the electricity sector'](#), (International Labour Organization, Research Department Working Paper No. 28, G. Montt, N. Maitre, S. Amo-Agyei, 2018)

The macroeconomic analysis published alongside the CCC's advice also provides some insights into potential employment effects.²⁸ It identifies boosts in employment in the utilities sector and in manufacturing and construction, while there will likely be job losses in oil and gas production and aviation. At a UK level, the analysis estimates net employment growth of between 0.5-1% compared with the baseline of no further climate action between 2025-2050, resulting from the economic stimulus effect of the major investment programme implied by the CCC's Balanced Pathway.

Pressure on existing jobs

A transition to Net Zero will also reduce demand for certain high-carbon services and technologies, such as fossil fuel extraction, processing and distribution, aviation, fossil fuel machinery and some livestock and dairy. This could see jobs in some key sectors significantly affected, though in each area there will also be new employment opportunities.

Regional considerations

The opportunities and challenges of the low-carbon transition will vary regionally. For example areas with older, energy inefficient housing could face higher energy bills. Rural areas off the gas grid, who typically pay more for heating fuel, could have more to gain from a switch to low-carbon heating. Current and future transport infrastructure can limit the ability of the local population to walk, cycle or use public transport, and may affect the opportunity for, and costs of, running an electric vehicle. However, a transition to electric vehicles alongside an increase in active travel will lead to a decrease in local air pollution, benefitting health. A shift to healthier diets, and improved quality of housing is expected to lead to lower costs for the health service. An increase in tree-planting and urban green spaces will provide more green recreational space. Relative wealth will be important, including the ability to fund changes locally.

CCC Expert Advisory Group on the costs and benefits of a UK net-zero emissions target

In 2019, the CCC set up the Advisory Group on the Costs and Benefits of Net Zero. The Advisory Group produced a Chair's Report based on the Group's deliberations and written submissions.²⁹

The thrust of the report was that the costs and benefits of deep decarbonisation are unknowable with any precision, as they are both very uncertain in themselves and depend both on the decarbonisation policies and the timescale over which they are pursued. However, that said, the Group drew the following conclusions:

²⁸ [Economic impact of the Sixth Carbon Budget](#) (Cambridge Econometrics, 2020)

²⁹ [Report to the CCC](#) (Advisory Group on the Costs and Benefits of Net Zero, May 2019)

- The climate science suggests that there are very large potential benefits of limiting the average global temperature rise to 1.5°C rather than 2°C, which provides a justification for a Net Zero as opposed to an 80% emission reduction target;
- The costs of reducing greenhouse gas (GHG) emissions have been grossly over-estimated in the past; recent modelling suggests that costs might be around 1% of GDP, but ongoing reductions in the costs of zero-carbon technologies suggest that in the future the costs might turn negative (i.e. zero-carbon electricity may turn out to be cheaper than fossil fuel generation, even if the climate benefits are not considered);
- The costs of reaching Net Zero by a certain date (e.g. 2050) will be lower the sooner the requisite policies are put in place to achieve it, to give investors certainty about the direction of travel and to fit in with investment cycles to minimise the stranding of long-lived high carbon infrastructure;
- The health co-benefits of reducing fossil fuel use and greenhouse gas emissions could be very substantial in terms of improved air quality, active travel and healthier lower-meat diets;
- However low (or negative) the costs of Net Zero turned out to be, the transition to Net Zero would involve deep structural changes that would affect people, communities and economic sectors in very different ways. There would be winners and losers. The political acceptability of the transition would depend on it being seen to be fair, as well as this being desirable on ethical grounds;
- Achieving Net Zero by 2050 will require wide-ranging policies that are credible, consistent across government, long-term and of a stringency to transform major techno-socioeconomic systems of society (including energy, food, transport, waste and resource use). The required policy approach “includes a stable long-term direction with clear governance, regular reviews for flexibility, use of markets to find the best solutions, support for large-scale deployment of new technologies as well as research and development, and approaches that are tailored to the needs of each sector, while maintaining consistency across the system.”

Their report emphasised that the benefits (including decreased climate risk) of net zero outweigh the costs, that good policy design is vital to keep costs low and maximise benefits and that clarity around the decarbonisation pathway is a key enabler of innovation.

In April 2020 the CCC asked the Advisory Group to reflect on whether the economic circumstances consequent on and subsequent to COVID-19 are likely to have affected the Group’s conclusions in its 2019 Report, as set out above. The Group concluded that, if anything, their recommendations from 2019 have been reinforced by events since.³⁰

³⁰ [Supplementary report to the CCC](#) (Advisory Group on the Costs and Benefits of Net Zero, December 2020)

“The climate science has not changed, justifying the pursuit of a 1.5°C target [and net zero]... There is now a much greater economic rationale for substantial public investment, and the right measures to crowd in private investment, than there was [in 2019].”

Administrative costs

The administrative cost burden on the Welsh Government arises from establishing and maintaining the legislative framework for emissions reduction, developing policy, and then monitoring and reporting progress against the targets and carbon budgets. These costs are expected to be broadly similar under each of the options presented above.

Environment Act factors

Section 32(3) of the Environment (Wales) Act 2016 lists a number of reports and factors that Welsh Ministers must have regard to when changing the 2050 emissions target, or setting or changing an interim emissions target or carbon budget. The reports and factors are:

- the most recent State of Natural Resources Report;
- the most recent Future Trends Report;
- the most recent Future Generations Report;
- scientific knowledge about climate change;
- technology relevant to climate change; and
- EU and international law and policy relating to climate change (including international agreements on measures designed to limit increases in global average temperatures).

State of Natural Resources Report

In December 2020 Natural Resources Wales (NRW) published the first documents as part of the second State of Natural Resources Report (SoNaRR 2020). Among these documents are NRW’s assessments of the four aims of the Sustainable Management of Natural Resources (SMNR). In its assessment of the achievement of SMNR Aim one (Stocks of natural resources are safeguarded and enhanced), NRW finds that climate change is having a “substantial effect on biodiversity and ecosystems” through:³¹

- shifting species ranges;
- localised extinctions;
- changes to life-cycle events;
- sea level rise;
- exacerbating the increase in invasive species including disease vectors; and
- altering the abundance and distribution of biodiversity.

³¹ [SoNaRR 2020: Assessment of the Achievement of SMNR Aim 1: Stocks of Natural Resources are Safeguarded and Enhanced](#) (NRW, 2020)

The projected increase in frequency and intensity of droughts, fluvial and coastal floods and heatwaves are all likely to further reduce overall ecosystem resilience.

NRW concludes that “Overall Wales’s natural resources are not safeguarded or enhanced to the degree that we can say we are achieving sustainable management.”³² It identifies decarbonisation as one of four opportunities for action to improve performance against Aim one. NRW has also published natural resource registers showing how climate change is causing pressures and impacts on the eight ecosystems within SoNaRR.³³

Ecosystem	Key pressures			
	Changing weather patterns	Sea level rise	Increased water temperature	Ocean acidification
Coastal margins				
Enclosed farmland				
Freshwater				
Marine				
Mountains, moorlands and heaths				
Semi-natural grasslands				
Urban				
Woodlands				

Table 3: Key pressures on ecosystems caused by climate change (NRW, SoNaRR 2020)

The full chapter on how climate change is threatening ecosystem resilience and ecosystem services will be published in March 2021.

Future Trends Report

The most recent Future Trends Report dates from 2017, with the next report due in summer 2021.³⁴ The report identifies key future social, economic, environmental and cultural trends for Wales, under six themes that impact all aspects of government and public administration. Climate change is one of the themes, along with population, health, economy and infrastructure, land use and natural resources, and society and culture. The report essentially asks two questions:

1. Where might Wales be going? (Trends)
2. What could this mean? (Influencing factors)

³² [SoNaRR 2020: Assessment of the Achievement of SMNR Aim 1: Stocks of Natural Resources are Safeguarded and Enhanced](#) (NRW, 2020, p.22)

³³ [SoNaRR2020: Natural resource registers](#) (NRW, 2020)

³⁴ [Future Trends Report](#) (Welsh Government, 2017)

Trends

Population

Wales' population is projected to increase over the next 20 years, possibly by around 5%. Around half of this growth could be due to natural change (births and deaths) and half due to in-migration from the rest of the UK or internationally. The UK's exit from the European Union could lead to more controlled migration in the future and a subsequently lower population growth rate.

Over the next 20 years, the percentage of over 65s in Wales is set to increase from around 20% to around 25% of the entire population. The population aged over 75 in Wales is also projected to increase from 9% of the population in 2014 to around 13% in 2030. The number of young people (aged under 16) is projected to increase up to 2023 and then fall slightly up to 2030.

The number of households in Wales is projected to grow faster than the overall population. This would lead to smaller household sizes.

Economy and infrastructure

The global shift of economic growth away from more mature economies has meant that the UK has, over the last 50 years, slipped down global GDP leagues in terms of the overall economy size as less mature economies catch up with those that developed earlier. However, this does not mean that growth will stop in developed countries. Importantly, the overall size of a country's economy is less important for wellbeing than the income per head, and by this measure the UK displays better resilience. However, since the recession in 2008, a productivity slowdown has sharply reduced growth rates. The UK and Wales have been particularly affected.

Wales has great untapped growth potential to generate energy, including from renewable sources. There is currently significant growth in the community level low carbon energy sector in Wales.³⁵

The provision of broadband infrastructure is developing rapidly after a slower start relative to the rest of the UK. This was in part due to Wales' demographics and the high level of rural households that are harder to connect to conventional wired broadband. The rapid increase in mobile internet infrastructure looks set to continue, which should help to reach those households that cannot currently access higher speed internet.

Current trends suggest that, despite growth in rail use, private vehicles are set to remain the dominant mode of transport in Wales in the short to medium term at least. The expected advent of autonomous or driverless vehicles in the next 10 to 15 years could in turn have implications for our transport systems.

³⁵ When the Future Trends Report was published in 2017, the total number of locally-owned projects was 63,071 with a capacity of 529MWe. The latest figures, from 2019, are 68,560 projects and a capacity of 549MWe. See <https://gov.wales/energy-generation> for more detail.

Climate change

Even in the best case scenario, there are likely to be significant national as well as global impacts beyond those already observed. Global temperature increases are likely to exceed the two degree threshold, unless significant and rapid action is taken globally.

There are potentially significant impacts to Wales from exceeding the global two degrees threshold. The latest UK Climate Change Risk Assessment identified the following areas for priority action:

- Flooding and coastal change risks to communities, businesses and infrastructure.
- Risks to health, wellbeing and productivity from high temperatures.
- Risk of shortages in the public water supply, and for agriculture, energy generation and industry, with impacts on freshwater ecology.
- Risks to natural capital including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity.

Infrastructure across Wales is already exposed to a range of climate hazards, which are projected to increase both in frequency and severity. Such infrastructure includes transport networks, underground infrastructure, energy and digital infrastructure and public water supplies. Impacts on some assets have the potential to cascade on to others as part of interdependent networks. Flooding poses the greatest long-term risk to infrastructure performance from climate change, but the growing risks from heat, water scarcity and slope instability caused by severe weather could also be significant.

Land use and natural resources

By 2050, average river flows in winter may rise by 10-15%. However, in the summer and early autumn they could reduce by over 50% and as much as 80% in some places. Droughts and flood events may become more common. Climate change may also affect the rates of groundwater recharge.

Soil carbon has been stable in improved land for 30 years. Recent increases in soil carbon in woodland until 2007 have now stabilised with no further increase detected. However, a significant decline in soil carbon in habitat land over the last 10 years has been detected and further work is needed to identify possible reasons for this.

Housing need in Wales is growing due to the number of households increasing faster than the number of available properties. In contrast, there is likely to be less suitable land available for development as flood plains and other lower lying land becomes increasingly prone to flooding.

Influencing factors

Political

The exit of the UK from the European Union may be the most immediate and potentially most disrupting factor to these identified trends. It is probable that this process will have a significant and wide ranging impact on Wales,

potentially impacting on economic growth and migration to Wales from both Europe and beyond.

There are also risks to the economic growth rate given the increasing potential for politically led 'de-globalisation'. Decreasing global trade patterns and the potential for increased protectionism could have a significant effect on both the mix and extent of various industries in Wales.

Economic

Economic growth rates could affect the amount of investment made in the research and development of new technologies, both globally and in Wales and the UK.

Social

Behavioural change among the Welsh population will be an unknown and potentially significant influence on how these trends unfold.

Technological

There is the potential for technological advances to dramatically improve the effectiveness and availability of low carbon energy. Mass production of current technologies such as solar power and energy storage may also help to dramatically increase the deployment of low carbon energy.

If the more pessimistic prediction for climate change occurs, there is a possibility that 'climate fixing' technology such as bioengineering may be employed to lower CO₂ levels in the atmosphere and levels of warming. The deployment of such technologies could have potentially significant effects and may not help to combat such effects as the acidification of the oceans.

Advances in household, transport and energy technologies could have a transformative effect on population behaviours, even over fairly short timescales.

Legislative

Ratification of the United Nations Paris Agreement has set the global legal context for climate change. The international context around climate change has now changed with a roadmap in place for global decarbonisation, setting a new long-term target for net zero global emissions in the second half of this century and key legislative requirements at all levels.

Environmental

There are a wide range of climate change scenarios and models. The next 20 years may be crucial in determining which of the various longer term warming scenarios will occur.

As the impacts from climate change become more prevalent, there may be an increasing risk of climate related disruption to global and regional economic networks. These could take the form of disruptions in crop production, or an increasing risk of flooding. The sensitivity of the climate to the rising levels of CO₂ in the atmosphere will be key to the extent to which infrastructure might be

disrupted. The more pessimistic scenarios also have the potential to impact significantly on population growth and migration levels, given the possibility of increased risk in terms of failures elsewhere in food production/ transportation and access to other resources, along with associated global conflicts.

There are some potential climate related risks that could impact negatively on health trends, not just in Wales but globally. One example is the greater risk of extreme hot weather events, the incidences of which are unpredictable. Climate change could also bring increasing risks of newly emerging infectious disease. Likewise, future air quality levels could be a major associated influencing factor. In contrast, there are also likely to be some opportunities presented by a warming trend. For example, the amount of energy required to maintain warm homes would reduce.

The level of sensitivity of Wales' biodiversity and habitats to climate change will be the key to how natural resources trends may evolve. There are risks from climate change in the frequency and the magnitude of extreme weather and wildfire events. Climate change is influencing the expansion or contraction of some species' ranges and populations, and the increasing frequency of extreme climatic events, predicted in many climate change scenarios, may have serious implications.

Future Generations Report

The most recent Future Generations Report was published in May 2020.³⁶ Chapter 5 specifically focuses on decarbonisation.

People's perception of decarbonisation

Concerns about climate change reached a record high in 2019 (85% in the UK). The Commissioner says that one of the things people have emphasised in conversations with her is the importance of having a more proactive government with stronger targets and regulation.

What future generations need

The report says we need to reduce our emissions in Wales by at least 95% by 2050, preferably sooner, to avoid catastrophic climate change. This means that in Wales we need to make an urgent transition to a low carbon economy and society.

Young people have had a significant impact on securing action on climate change in Wales. Public awareness, especially amongst the younger generation, has increased considerably in the last 12 months. Following the Fridays for Future protests, the Commissioner believes that 2019 was the year when children and young people showed politicians and decision makers across Wales and the world that they must do more to act on climate change. Young people are now demanding greater action and climate justice, calling on global leaders to take urgent action.

³⁶ [The Future Generations Report 2020](#) (Future Generations Commissioner for Wales)

The report argues that we need to address climate change because it is an equality and social justice issue and it will disproportionately affect the most vulnerable communities in Wales and across the world. Vulnerable communities are more likely to be exposed to the risks and impacts of climate change, without the ability to cope with or recover from those impacts.

Scientific knowledge about climate change

Two reports by the Intergovernmental Panel on Climate Change (IPCC) summarise the core of scientific knowledge about climate change: the Fifth Assessment Report (IPCC-AR5) and the Special Report on Global Warming of 1.5°C (IPCC-SR1.5).³⁷

Key conclusions from IPCC-AR5³⁸

- The climate is changing as a result of global greenhouse gas emissions; the IPCC concluded that it was unequivocal that humans were influencing the climate
- Many climate impacts are being detected across the world
- Further emissions will lead to further warming and change
- There is no simple threshold beyond which climate change moves from safe to dangerous
- The increase in global temperature is determined mainly by total carbon dioxide emissions over time, which must fall to near zero in order to limit warming

Summary of IPCC-SR1.5

At COP21 in Paris, the Intergovernmental Panel on Climate Change (IPCC) was invited to provide a Special Report in 2018 on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways. The report found that:³⁹

- Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C.
- Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate (high confidence).
- Climate-related risks for natural and human systems are higher for global warming of 1.5°C than at present, but lower than at 2°C (high confidence). These risks depend on the magnitude and rate of warming, geographic location, levels of development and vulnerability, and on the choices and implementation of adaptation and mitigation options (high confidence).
- Climate models project robust differences in regional climate characteristics between present-day and global warming of 1.5°C, and

³⁷ [Fifth Assessment Report](#) (IPCC, 2013) and [Special Report on Global Warming of 1.5°C](#) (IPCC, 2018)

³⁸ As quoted in [The Sixth Carbon Budget – The UK's path to Net Zero](#) (CCC, December 2020, p.355)

³⁹ https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Headline-statements.pdf

between 1.5°C and 2°C. These differences include increases in: mean temperature in most land and ocean regions (high confidence), hot extremes in most inhabited regions (high confidence), heavy precipitation in several regions (medium confidence), and the probability of drought and precipitation deficits in some regions (medium confidence).

The IPCC's projected differences between global warming of 1.5°C and 2°C include:

- Increased climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth.
- Global mean sea level rise of around 0.1 metre lower by 2100 (medium confidence). A slower rate of sea level rise enables greater opportunities for adaptation in the human and ecological systems of small islands, low-lying coastal areas and deltas (medium confidence).
- Lower impacts on biodiversity and ecosystems, including species loss and extinction, and lower impacts on terrestrial, freshwater and coastal ecosystems – enabling them to retain more of their services to humans (high confidence).
- Reduced increases in ocean temperature as well as associated increases in ocean acidity and decreases in ocean oxygen levels (high confidence).
- Consequently, reduced risks to marine biodiversity, fisheries, and ecosystems, and their functions and services to humans, as illustrated by recent changes to Arctic sea ice and warm-water coral reef ecosystems (high confidence).
- Most adaptation needs will be lower (high confidence).

New observations of climate

In its December advice to the UK Government, the CCC also listed new observations of climate since its last UK Carbon Budget 5 advice in 2015:⁴⁰

- The five years since 2015 have seen the five warmest years (globally) on record.
- The global average level of human-induced warming is now in excess of 1.1°C when defined consistent with practices used by the World Metrological Organisation and IPCC-SR1.5. Best estimates indicate that human activities are responsible for 100% of the warming observed since 1850-1900. The observed rate of increase in global temperature (~0.2°C per decade) has proceeded consistent with the near-term warming projection made by the IPCC-AR5 report (a 0.12-0.42°C per decade increase).
- Global sea levels have continued to rise, with the rate of increase over the last five years being the fastest observed to date. Global average sea levels are now estimated to be around 20 cm above levels in 1900.

⁴⁰ [The Sixth Carbon Budget – The UK's path to Net Zero](#) (CCC, December 2020, p.359)

- In the UK, the 2010–2019 decade was the second warmest cardinal decade on record after 2000–2009. In 2019, the highest ever temperature reached in the UK was recorded as well as the warmest ever recorded winter temperature. Considerably more high temperature records were set in the UK over than 2010s than low temperature records.
- Human-induced climate change has been clearly shown to increase the frequency and intensity of many (but not all) extreme weather events, with particularly clear signals in extreme heat and many heavy rainfall events.

Tipping points

While many impacts of climate change broadly reflect relatively gradual changes caused by steady increases in global average temperature, parts of Earth’s system have the potential to change abruptly. Once passed, these ‘tipping points’ cause a dramatic shift that can be irreversible. Examples of tipping points include loss of the Amazon rainforest or the West Antarctic ice sheet.

The IPCC introduced the idea of tipping points two decades ago. At that time, these ‘large-scale discontinuities’ in the climate system were considered likely only if global warming exceeded 5°C above pre-industrial levels. IPCC Special Reports in 2018 and 2019 now suggest that tipping points could be exceeded even between 1 and 2 °C of warming.⁴¹

In an article in Nature in November 2019, Professor Tim Lenton and others report that evidence is mounting that tipping points could be “more likely than was thought, have high impacts and are interconnected across different biophysical systems, potentially committing the world to long-term irreversible changes.”⁴² In their view, if tipping points are indeed looking more likely, then the costs associated with the resulting impacts mean warming must be limited to 1.5°C. They consider several cryosphere tipping points are dangerously close, but mitigating greenhouse gas emissions could still slow down the inevitable accumulation of impacts and help us to adapt. We might already have committed future generations to living with sea-level rises of around 10 m over thousands of years but that timescale is still under our control. The rate of melting depends on the magnitude of warming above the tipping point. At 1.5°C, it could take 10,000 years to unfold; above 2°C it could take less than 1,000 years. They conclude that “both the risk and urgency of the situation are acute...we might already have lost control of whether tipping happens”. We may still have some control over the level of damage arising from tipping and therefore “the consideration of tipping points helps to define that we are in a climate emergency and strengthens [2019’s] chorus of calls for urgent climate action.”

⁴¹ SR1.5°C (IPCC, 2018) and [Special Report on the Ocean and Cryosphere in a Changing Climate](#) (IPCC, 2019)

⁴² Climate tipping points – too risky to bet against, Professor Tim Lenton et al, Nature (November 2019), <https://www.nature.com/articles/d41586-019-03595-0>

Technology relevant to climate change

In discussing the role of technology and innovation in reaching net zero, the CCC advice considered both established and emerging technologies. It also explored the role of digitalisation.⁴³

Established technologies

In some sectors, such as power generation, technologies already exist to achieve “near-full decarbonisation”, and global trends are pushing efficiencies up and costs down. In other sectors, such as heating for buildings, technologies exist but the estimated costs are relatively high. The CCC advises that “where there is uncertainty around the costs or scale of competing low-carbon options a portfolio of options should be pursued.”

Emerging technologies

The CCC’s analysis includes several areas where solutions have been proposed but “innovation will be required to go beyond the reach of established technologies or methods”. These areas include hydrogen, heavy goods vehicles and carbon capture and storage.

Digitalisation

The CCC identifies digitalisation as “an important enabler” of the transition to net zero. It is seen as critical to the efficient production and use of energy across increasingly interconnected sectors, such as transport and buildings. The CCC anticipates that it will reduce the need for large amounts of back-up on the electricity grid by increasing the flexibility and dynamism of energy services e.g. vehicle-to-grid. It will also help reduce demands for energy, materials, food and water through predictive analysis, waste avoidance and video-conferencing.

Costs of technologies to achieve net-zero emissions

Ambitious mitigation targets in developed countries can help establish the new industries required and drive down the cost of currently more expensive technologies needed to reach net zero CO₂ emissions, including carbon capture and storage, hydrogen, low-carbon heating and technologies to remove CO₂ from the atmosphere.

EU and international law and policy relating to climate change

Paris Agreement

The Paris Agreement committed countries to keeping the increase in global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the increase to 1.5°C. In order to achieve this, countries agreed on the need for global emissions to peak as soon as possible and to achieve a balance between global emissions and removals (net zero) in the second half of the 21st Century, “on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty”.⁴⁴ Global average temperature is

⁴³ [The Sixth Carbon Budget – The UK’s path to Net Zero](#) (CCC, December 2020, p.402-405)

⁴⁴ [Paris Agreement](#) (United Nations, 2015)

already around 1.1°C above pre-industrial levels.⁴⁵ The UK ratified the Paris Agreement in November 2016.

The Paris Agreement requires countries to produce Nationally Determined Contributions (NDCs) every five years. NDCs must reflect each country's highest possible ambition towards the global temperature goal. The UK was part of the EU's NDC agreed in 2015, which requires an average reduction across Member States of at least 40% by 2030. On 12 December 2020, ahead of the end of the Brexit transition period, the UK published its own NDC. This included a 2030 emissions reduction target of at least 68%. This figure is based on a recommendation from the CCC, which uses the same scenario as that for the CCC's recommendations for Wales (the Balanced Pathway).

Wales's contribution to the Paris Agreement and UK NDC

Countries agreed to implement the Paris Agreement in a way that would “reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.”⁴⁶ Relative to many other countries, Wales is rich and has high historical emissions, going back centuries. Wales is now responsible for around 0.1% of global emissions each year, although since 1750 the UK has the 5th highest cumulative emissions in the world.⁴⁷

The global budget for limiting average global temperature rise to 1.5°C or 2°C can be informed by the latest climate science but the distribution of that budget between countries is a political and moral decision. There is no single agreed methodology or formula that can be used to define a country's fair contribution to mitigating climate change: it is a value judgment that must consider equality, capability and responsibility.

While there is no agreed methodology, the IPCC has summarised what the academic literature on ‘effort share’ approaches suggests regional targets should be, based on a review of 40 studies.⁴⁸ The approaches fall into three broad categories:

1. **Economically efficient:** These achieve the required abatement at least global cost (equal marginal abatement cost)
2. **Historical responsibility:** These assign emissions commitments on the basis of historic contribution to the climate emergency since 1990
3. **Forward-looking:** These assign emissions on the basis of a country's projected capability (income) or on the basis of convergence in global emissions per capita

⁴⁵ [WMO confirms 2019 as second hottest year on record](#), World Meteorological Organisation (15 January 2020)

⁴⁶ [Paris Agreement](#), Article 2.2

⁴⁷ Carbon Brief analysis: <https://twitter.com/CarbonBrief/status/1120715988532629506>

⁴⁸ [Regional GHG reduction targets based on effort sharing: a comparison of studies](#), Niklas Höhne, Michel Den Elzen & Donovan Escalante (Climate Policy, 2013)

International comparisons

Wales is a founding member of the Under2 Coalition, a global community of state and regional governments committed to ambitious climate action in line with the Paris Agreement.⁴⁹ The coalition includes more than 220 governments who represent over 1.3 billion people and 43% of the global economy.

121 states and regions disclosed their climate and environmental data as part of the Global States and Regions Annual Disclosure 2020.⁵⁰ Of these, 18 have set net zero targets, ranging from 2030 (Jämtland, Sweden) to 2045 (Scotland, California and Australian Capital Territory) to 2050 (including Catalonia and New York State). Hawaii aims to be net-negative by 2045.

Outside the Under2 Coalition, 7 countries have set net zero targets in law (for 2050, apart from Sweden for 2045). A further 7 countries have declared net zero targets in policy documents and 12 more have submitted net zero targets to the UN. Japan has recently declared its intent to achieve net zero by 2050, while China has done so for 2060. Joe Biden was elected president of the USA on a climate platform to aim for net zero emissions by 2050.⁵¹

Each government decides how to define the target, considering its formality (whether it is set in legislation or simply a policy target), scope (whether it covers all greenhouse gases or just CO₂ and whether it includes emissions from international aviation and shipping or not) and the approach to international offsetting (whether it is permitted or not).

European law and policy

In December 2019, the European Council agreed the objective of achieving a climate-neutral EU by 2050. This had previously been endorsed by the European Parliament in March 2019. The European Commission's (EC) proposed new European Climate Law would impose a legally binding target of net zero greenhouse gas emissions by 2050.⁵²

In December 2020, EU leaders agreed on a binding EU target for a net domestic reduction of at least 55% in greenhouse gas emissions by 2030, compared to 1990.⁵³ The previous target, set in 2014, was for at least a 40% reduction by 2030. The new target has been submitted to the UN as the EU's NDC.

EU climate legislation already in place includes the EU Emissions Trading System (ETS), the Effort Sharing Regulation (ESR), and the Land Use, and the Land Use Change and Forestry Regulation (LULUCF). The Renewable Energy Directive (RED II), the Energy Efficiency Directive and the Regulation on the Governance of the Energy and Climate Action also contribute in driving commitments to renewable energy. The EU acknowledges that without

⁴⁹ <https://www.under2coalition.org/>

⁵⁰ [Annual Disclosure Report](#) (Under2 Coalition, 2020)

⁵¹ [Which countries have a net zero carbon goal?](#) (Climate Change News)

⁵² https://ec.europa.eu/clima/policies/eu-climate-action/law_en

⁵³ <https://www.consilium.europa.eu/en/policies/climate-change>

enhancement these policies will fall short of the 55% target. It is therefore discussing potential policy changes, including strengthening carbon pricing in the EU through an extension of the ETS to new sectors, a carbon border adjustment mechanism to mitigate the risk of carbon leakage, and is reconsidering international aviation and shipping emissions with the ambition to include these within the EU ETS. The EC intends to make detailed legislative proposals by June 2021.⁵⁴

Integrated Impact Assessment

Having considered the regulations against our mandatory and non-mandatory impact assessments, we do not believe it is possible to quantify their impact as they simply provide the statutory framework for emissions reduction. The impact of taking action to meet the targets and carbon budgets depends on the measures and policies chosen. These policies will be set out in a report for each carbon budget period, the next being published in November 2021. Policies to deliver our carbon budgets are subject to an engagement process and impact assessments, including RIA where appropriate.

Additionally, the global nature of the climate emergency means it is not possible to determine the effect of more ambitious Welsh targets on climate-related risks in Wales, such as flooding, and the subsequent impact on the matters covered by the impact assessments, for example equality.

However, *if* Wales achieves the more ambitious targets *and* other countries make comparable effort, we increase the likelihood of limiting average global temperature rise to 1.5°C. If this temperature goal is met, we will limit Wales's exposure to climate change impacts. One such impact is heat-related mortality. We have worked with researchers at Bristol and East Anglia Universities to develop a short case study on heat-related mortality in Wales at 2°C and 1.5°C of global warming (see Annex A).

Summary

CCC advice

The CCC has concluded that a net zero target is now credible and the right target for Wales. Its December 2020 advice is a blueprint for achieving net zero and provides a detailed vision for realising this more ambitious goal.

The expected cost of achieving net zero has fallen since the CCC's 2019 advice. The estimated annualised resource cost has fallen from £3-5billion per year to significantly less than £2billion per year through to 2050. The CCC has also demonstrated that operational savings are expected to largely offset the investment costs for achieving net zero towards the middle of this century, and supporting research suggests a potential positive impact on GDP overall. The CCC's Advisory Group on the Costs and Benefits of Net Zero declared that the benefits (including decreased climate risk) of net zero outweigh the costs. In

⁵⁴ <http://europeanmemoranda.cabinetoffice.gov.uk/memorandum/communication-from-the-commission-to-the-european-parliament-the-council-the-european-economic-social-committee-1600418191>

addition to economic impacts, the CCC identified likely significant positive impacts for health and biodiversity in their Balanced Pathway.

Environment Act factors

SoNaRR highlights the substantial effect of climate change on biodiversity and ecosystems. It also identifies decarbonisation as a key opportunity to improve the sustainable management of natural resources and reduce several key pressures on all ecosystems.

The Future Trends Report considers several trends relevant to achieving climate change targets, notably an increasing, ageing population and more people living alone. Older people tend to have a higher carbon footprint than younger people and an increase in households suggests higher demand for heating and electricity. The Report also notes behaviour change as a key influencing factor on how the trends unfold; behaviour change is fundamental to achieving the CCC's Balanced Pathway. The Future Generations Report draws attention to the significant shift in public concern about climate change and increasing support for greater action, particularly among children and young people.

There is a very strong scientific basis for increased efforts to tackle climate change. IPCC-SR1.5 shows that keeping average global temperature increase to 1.5°C would reduce climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth, when compared to a 2°C rise. Option 2 is more aligned to achieving 1.5°C than Option 1, which relates more closely 2°C.

Technology to support the net zero transition is well-advanced and commercially deployed in many important areas, while further innovation is required in others. “The clarity of a net-zero goal could help stimulate innovation. Under a net zero target all sectors need to decarbonise or offset their emissions. This removes uncertainty and the temptation of sectors to lobby for a larger share of the remaining 20% of emissions [under the existing 80% target]. This clarity could cut the cost of capital as well as stimulating innovation, thereby bringing down the overall cost of mitigation.”⁵⁵

There are many ways of determining Wales's fair contribution to the Paris Agreement and the UK's NDC. However, the CCC's Balanced Pathway is the only 'bottom-up' scenario available that describes *how* the targets can be met. The CCC states that its December 2020 recommendations “reflect the goals and requirements of the Paris Agreement” for the following reasons:⁵⁶

1. The Balanced Pathway has been explicitly designed to reflect Wales's 'highest possible ambition' within Wales' particular capabilities
2. It would reduce Wales's annual per-capita emissions to under 3tCO₂e per person before 2040, in line with global pathways consistent with meeting the 1.5°C goal

⁵⁵ [Report to the CCC](#) (Advisory Group on Costs and Benefits of Net Zero, 2019, p.23)

⁵⁶ [The path to a Net Zero Wales](#) (CCC, December 2020, p.57)

In the last year there has been a notable shift in global ambition on climate change; many more countries have now adopted a net zero target or ambition, or are considering one. Joining the 'net zero club' would demonstrate Wales's support for new industries and provide the best opportunity for attracting green investment and jobs. It would also align with Wales's well-being goal to be a globally responsible nation.

Having considered both the CCC advice and the Environment Act factors, Option 2 is the preferred option.

Consultation

In preparing their advice the CCC ran a public Call for Evidence to capture input from organisations and individuals on matters relevant to the regulations, as well as UK Carbon Budget 6. The Call for Evidence ran from 5 December 2019 to 5 February 2020. The Welsh Government and CCC ran two stakeholder events during the period: one in Llandudno on 20 January 2020 and one in Cardiff on 21 January 2020, with around 60 delegates attending in total.

There were four questions in the Call for Evidence with a Wales focus. These each received between 11 and 37 responses.⁵⁷ A high-level overview of the responses and a list of respondents is available in the CCC's Summary of responses document.⁵⁸

We have published our Engagement Approach for Low Carbon Delivery Plan 2 that describes how we intend to involve and collaborate with people and stakeholders throughout 2021.⁵⁹ We also continue to consult on the policies required to meet the carbon budgets and targets, for example the Electric Vehicle Charging Strategy, Building Regulations Part L and F Review, and the Agriculture (Wales) Bill.⁶⁰

⁵⁷ <https://www.theccc.org.uk/publication/sixth-carbon-budget-and-welsh-emissions-targets-call-for-evidence-summary>

⁵⁸ [Welsh emissions targets: Summary of responses to Call for Evidence](#) (CCC, 2020)

⁵⁹ See <https://gov.wales/low-carbon-delivery-plan-2-engagement-plan>

⁶⁰ See <https://gov.wales/consultations>

Competition Assessment

This impact assessment does not include a Competition Assessment because the regulations do not provide for specific policies. It is not possible, therefore, to consider the specific impacts on competition within individual markets.

The competition filter test	
Question	Answer
Q1: In the market(s) affected by the new regulation, does any firm have more than 10% market share?	
Q2: In the market(s) affected by the new regulation, does any firm have more than 20% market share?	
Q3: In the market(s) affected by the new regulation, do the largest three firms together have at least 50% market share?	
Q4: Would the costs of the regulation affect some firms substantially more than others?	
Q5: Is the regulation likely to affect the market structure, changing the number or size of businesses/organisation?	
Q6: Would the regulation lead to higher set-up costs for new or potential suppliers that existing suppliers do not have to meet?	
Q7: Would the regulation lead to higher ongoing costs for new or potential suppliers that existing suppliers do not have to meet?	
Q8: Is the sector characterised by rapid technological change?	
Q9: Would the regulation restrict the ability of suppliers to choose the price, quality, range or location of their products?	

Post implementation review

Government progress review

The Environment (Wales) Act 2016 requires Welsh Ministers to prepare and lay a statement after each budgetary period setting out whether Wales has met the budget, whether they have debited or credited any carbon units and giving details on the type and number of units. The statement must explain what the Welsh Ministers consider to be the reasons why the carbon budget for the period has, or has not, been met. In particular, it must include the Welsh Ministers' assessment of the extent to which their proposals and policies for meeting the carbon budget for the period have been carried out and have contributed to the carbon budget for the period being met or not. This statement must be laid before the end of the second year after the budgetary period, allowing time for the emissions data to be compiled, which requires 18 months from the close of year.

With regards to each interim target and the 2050 target, Welsh Ministers must also prepare and lay a statement before the Senedd. This statement must be made before the end of the second year after the relevant interim target year. This statement will provide the Welsh Government's assessment of the total amount of emissions in that year, whether the interim emissions target has been met, and the total amount of carbon credits or debits for that year. The statement must also explain what the Welsh Ministers consider to be the reasons why the target has, or has not, been met.

Independent progress review

The Act provides for the CCC to monitor and report on progress. No later than six months after the Welsh Ministers lay the final progress statement for a budgetary period, the CCC must provide a report setting out their views on:

- the way in which the carbon budget for the period was or was not met; and
- the action taken by the Welsh Ministers to reduce net Welsh emissions of greenhouse gases during the period.

Following the Welsh Government's progress reports on the 2030 and 2040 interim targets, the CCC is required to advise whether the forthcoming interim target(s) and 2050 target represent the highest achievable targets for Wales. If not, they must state what the highest achievable target is.

Annex A: Heat-related mortality in Wales at 2°C and 1.5°C of global warming

Introduction

Officials worked with academic experts on climate impacts to explore one example of how Wales might benefit from adopting and achieving a more ambitious emissions reduction pathway, if matched by other countries.⁶¹ Heat-related mortality was chosen because it is the most direct way in which climate change is expected to affect public health and there is a strong, direct correlation between summer temperatures and increased mortality.

Temperature thresholds of 2°C and 1.5°C were selected because Wales's existing legislated emissions reduction pathway is broadly aligned to a 2°C rise in global average temperature, assuming similar effort from other countries, while the CCC's new recommended pathway is more closely aligned to a rise of 1.5°C. They are also the temperature goals in the Paris Agreement.

How is Wales's exposure to extreme summer temperatures projected to change?

Overall, Wales's summer mean temperature is projected to change around 20% faster than the global mean and by 30-45% faster than the global mean during the hottest 5% of summer days.⁶² This means Wales's hottest summer days are getting hotter and more extreme relative to mean temperatures.

How is this change expected to affect heat-related mortality?

Mortality increases as temperature increases above a regionally-specific threshold.⁶³ Mortality occurs throughout the summer months, even on days that are not extreme heatwaves. As well as increasing temperature extremes, climate change means Wales will experience more warmer days and, as a result, increased heat-related mortality.

Based on current baseline mortality rates, modelling of the recent past (1990-2019) suggests, on average, 25 heat-related deaths occur per year in Wales, increasing to 48, 67, and 137 heat-related deaths under 1.5°C, 2°C and 3°C warming scenarios respectively (see Figure 1 for error bars). **Limiting**

⁶¹ Setting and achieving tighter emissions targets in Wales alone will have a negligible impact on global temperature and on Wales's climate. We are therefore reliant on the collective effort of all countries to reduce the frequency and severity of negative climate change impacts in Wales, such as heatwaves.

⁶² UK Climate Projections 2018 data:

<https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index>

⁶³ By around 1.5% for every 1°C above ~17.2°C for Wales. [Climate change effects on human health: projections of temperature-related mortality for the UK during the 2020s, 2050s and 2080s](#), Hajat et al, Journal of Epidemiology & Community Health (2014, Volume 68, Issue 7).

warming to 1.5°C would therefore avoid 29% of the additional heat-related mortality at 2°C.⁶⁴

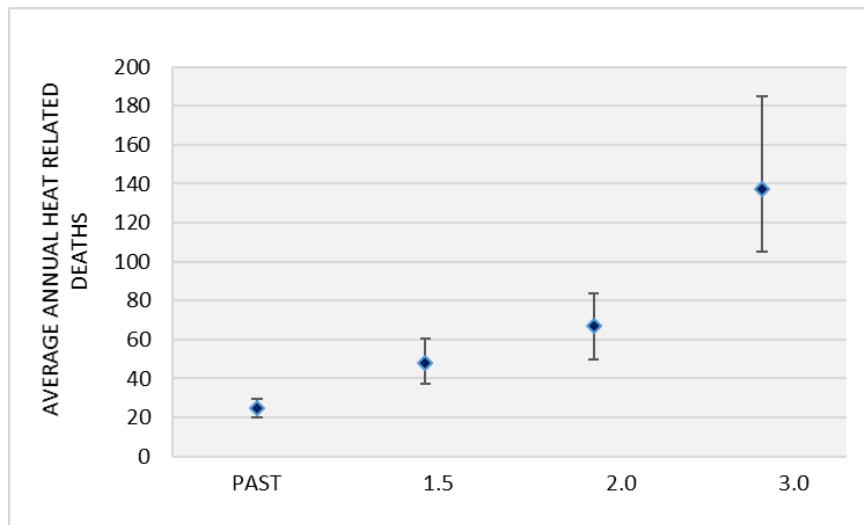


Fig. 1: Modelled average heat-related mortality per year in Wales for the past and 3 warming scenarios. Error bars signify 10-90% uncertainty in the projected climate.

Who is likely to be most affected?

Not everyone is equally vulnerable to heat-related illness. There are certain factors that increase an individual's risk during a heatwave, including:⁶⁵

- Older age: especially women over 75 years old, those living on their own, or in a care home;
- Chronic and severe illness: including heart conditions, diabetes, respiratory or renal insufficiency, Parkinson's disease or severe mental illness;
- Inability to adapt behaviour to keep cool: having Alzheimer's, a disability, being bed bound, too much alcohol, babies and the very young; and
- Environmental factors and overexposure: living in a top floor flat, being homeless, activities or jobs that are in hot places or outdoors and include high levels of physical exertion.

Which locations are likely to be most affected?

New research overlays heat-related climate hazard metrics with socio-economic factors.⁶⁶ The left-hand plot in Figure 2 shows that the locations with greatest absolute risk over the past 30 years (i.e. exposed to extreme heat hazards and at higher socio-economic levels of vulnerability and exposure) are

⁶⁴ Unpublished research (funded by the [UK Climate Resilience Program](#)) was carried out in support of this paper.

⁶⁵ [Caring for Patients Before and During a Heatwave: Advice for health and social care professionals](#), WG 2012

⁶⁶ Climate hazard metrics: Daily maximum and minimum temperature, vapour pressure (a measure of humidity), and degree days (variability of temperature extremes over a certain threshold). Socio-economic factors: population density, deprivation and proportion of population aged over 65.

in southeast and northeast Wales. The right-hand plot shows that when socio-economic factors are taken into account in combination with the projected change in climate hazards, locations at the greatest increase in risk are in Powys and across South Wales. Although these regions show the greatest increase in climate hazards, in absolute terms the southeast and northeast of Wales will still remain at the highest risk.

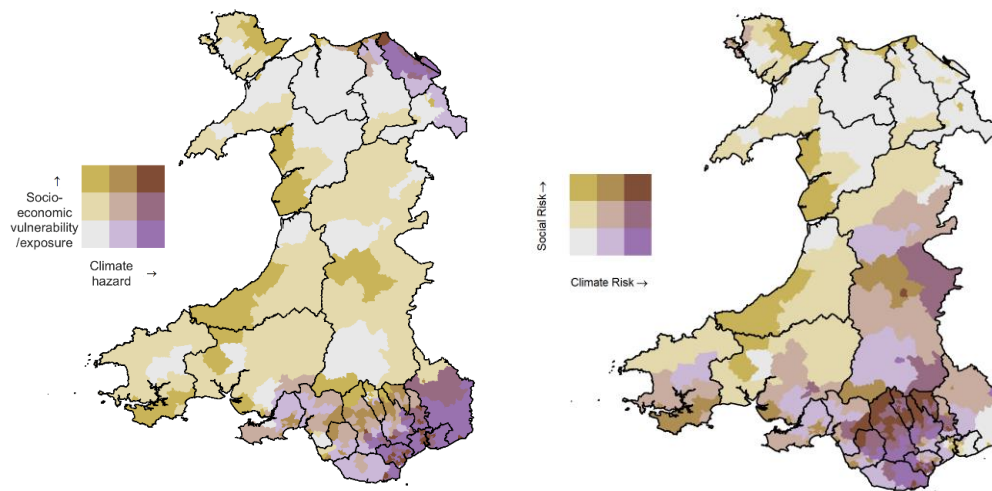


Fig.2: Left-hand plot shows current risk based on the past 30 years; right-hand plot shows the change in climate hazards between 1.5°C and 2°C of global warming – those places facing the greatest change in risk if we do not achieve 1.5°C (socio-economic factors remain stationary in time)

Can Wales expect fewer cold-related deaths?

This question has not been explored in the context of the higher targets and a comparison of 2°C and 1.5°C of global warming. However, research undertaken in 2014 suggests that by the 2080s the number of heat-related deaths may increase by around 340% and the number of cold-related deaths may reduce by around 40%. The number of heat-related deaths is not expected to surpass the numbers of cold-related deaths by the 2080s but the ratio of heat- to cold-related deaths is projected to increase from 1:35 to 1:5.⁶⁷

⁶⁷ [Climate change effects on human health: projections of temperature-related mortality for the UK during the 2020s, 2050s and 2080s](#), Hajat et al, Journal of Epidemiology & Community Health (2014, Volume 68, Issue 7). Figures quoted draw on the mean estimates.