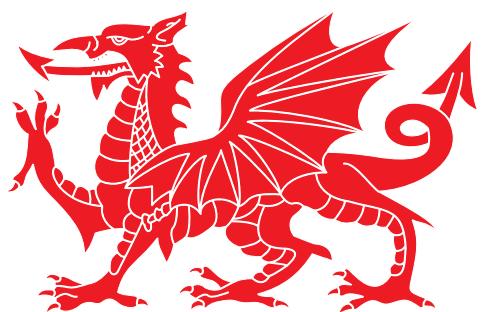




Building a low-carbon economy in Wales

Setting Welsh carbon targets

Committee on Climate Change
December 2017



Acknowledgements

The Committee would like to thank:

The team that prepared the analysis for this report: This was led by Adrian Gault, David Joffe and Tanja Wettingfeld.

Other members of the Secretariat who contributed to this report: Sasha Abraham, Jo Barrett, Owen Bellamy, Ellie Davies, Aaron Goater, Mike Hemsley, Jenny Hill, Ewa Kmietowicz, Alexandra Scudo, Indra Thillainathan, Steve Westlake and Nathan Wyatt.

A number of organisations and stakeholders for their support, including the Welsh Government.

A wide range of stakeholders who attended our committee meeting in Cardiff and responded to our call for evidence, engaged with us, including through public dialogue, or met with the Committee bilaterally. In particular we thank those who presented at our committee meeting in Cardiff: David Clubb, Prys Davies, Mike Edge, Gill Kelleher, Martyn Kenny, Mike Palmer, Martyn Popham, Eurgain Powell, Peter Quinn, Steve Waygood.

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The Committee



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Jim Skea is Professor of Sustainable Energy at Imperial College, with research interests in energy, climate change and technological innovation. He is also Research Councils UK Energy Strategy Fellow and President of the Energy Institute. Jim was Research Director of the UK Energy Research Centre (2004 to 2012) and Director of the Policy Studies Institute (1998 to 2004). He was awarded a CBE for services to sustainable energy in 2013 and an OBE for services to sustainable transport in 2004.

Executive Summary



In March 2016, the Environment (Wales) Act received Royal Assent. It sets a 2050 target to reduce emissions by at least 80% from 1990 levels and provides the legislative framework for establishing a carbon budgeting approach in Wales.

The Act requires that before the end of 2018, Welsh Ministers must set in regulation interim emissions targets for 2020, 2030 and 2040, together with 5-year carbon budgets for the periods 2016-2020 and 2021-2025.

The Committee on Climate Change (“Committee”) was asked by the Welsh Government to provide independent advice on these emissions targets. This advice is in two parts: in April 2017 we advised on carbon accounting and design of Welsh carbon budgets and other targets. The Welsh Government stated in July that it accepted our recommendations on the design of the targets, including that they should be on the basis of the full set of actual Welsh emissions. In this report, we provide advice on the level of emissions targets and carbon budgets.

The Environment Act is part of wider framework in Wales, including the Well-Being of Future Generations Act, which places tackling climate change within the context of wider changes to how Welsh society works. We take this into account in our analysis and recommendations.

In 2015 greenhouse gas emissions in Wales were 19% below the level in 1990. Many of those emissions in Wales are from large point-sources: around 55% of Welsh emissions are covered by the EU emissions trading system, compared to around 40% for the UK as a whole. These include important Welsh industrial installations, together with a number of power stations including the very large coal plant at Aberthaw (which alone accounted for 14% of total Welsh greenhouse gas emissions and 51% of Welsh power generation emissions in 2015). The Aberthaw plant will cease emitting by 2025 under the UK Government's commitment to phase out unabated coal-fired generation by that date.

Our assessment of the challenges and opportunities to reduce emissions in Wales suggests that achieving an 80% reduction by 2050 will be more challenging than the equivalent reduction for the UK as a whole. Our existing scenarios to meet an overall UK reduction of 80% imply a fall in Welsh emissions by 76% on 1990 levels.

In this report we identify ways that Wales can go beyond this to achieve the legislated minimum reduction of 80%, in a manner consistent with the wider framework in Wales. We also identify potential to go slightly beyond this minimum 80%, to a reduction of 85% by 2050.

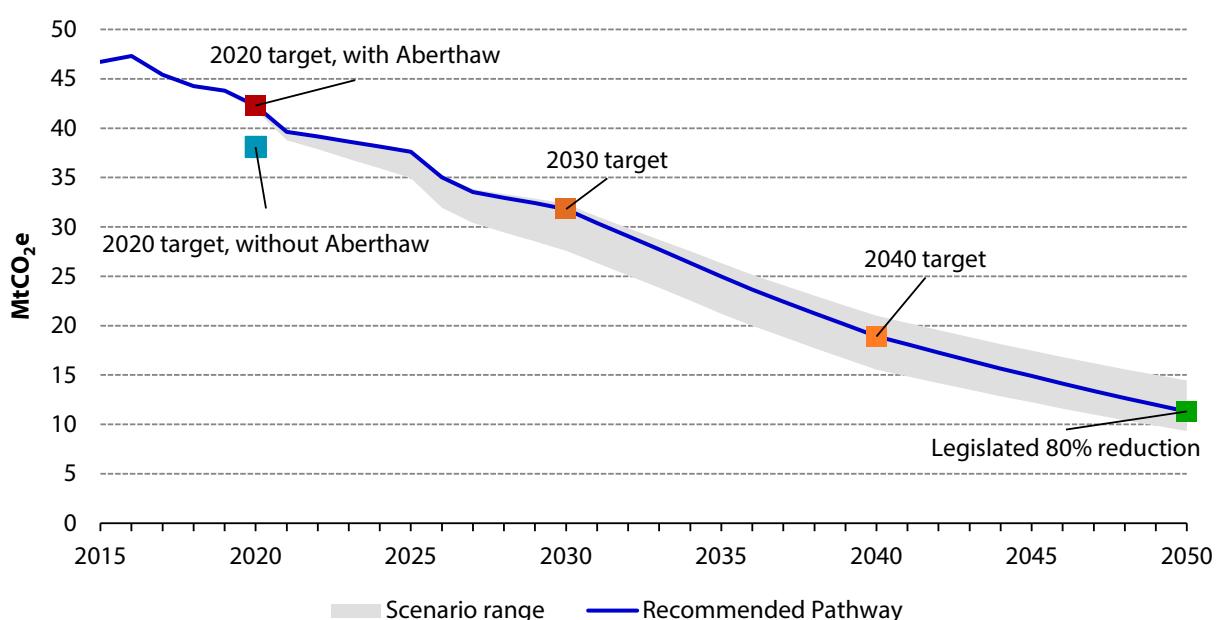
Our recommendations on the levels of the targets are:

- **Interim targets.** The targets that we recommend for 2020, 2030 and 2040 are on a path to an 80% reduction in Welsh emissions by 2050 (Figure 1). Of these, the key targets are those from 2030 onwards, as there is relatively little that the Welsh Government can do in policy terms to meet the 2020 target. The target for 2020 reflects anticipated reductions in emissions from fossil fuel power generation, especially coal.
 - **We recommend a 2020 target for an emissions reduction of 27% on 1990 levels.**
 - **We recommend a 2030 target for an emissions reduction of 45% on 1990 levels.**
 - **We recommend a 2040 target for an emissions reduction of 67% on 1990 levels.**
- **Carbon budgets.** The Environment Act sets the requirement for carbon budgets, which are limits on the allowed emissions over five-year periods (aligned to Welsh Parliamentary terms). The first two of these budgets, for the periods 2016-20 and 2021-25, need to be set in 2018. As is the case for the 2020 target, there is little scope for new policies to meet the first

carbon budget, with much of the anticipated reduction due to reduced fossil power generation.

- **First carbon budget (2016-20).** We recommend that emissions over the first carbon budget period are limited to an average of 23% below 1990 emissions.
- **Second carbon budget (2021-25).** We recommend that emissions over the second carbon budget period are limited to an average of 33% below 1990 emissions.
- **Adjustment in case of the Aberthaw coal plant closing before 2025.** The recommended levels of the 2020 target and the first two carbon budgets allow for continued generation, though declining, from the large Aberthaw coal-fired power station in South Wales. If emissions from this station cease prior to 2025, these targets should be tightened in order to maintain the ambition embodied in the recommended 2020 target and carbon budgets across the rest of the Welsh economy. Our recommendations in Chapter 5 set out the appropriate adjustments. For example, closure of the station before 2020 should lead to the 2020 interim target being tightened to a reduction of 32% on 1990 levels.

Figure 1. Emissions scenarios and recommended targets for Wales over the period to 2050



Source: CCC analysis.

Notes: The scenario range presented is from Wales's contribution to meeting UK carbon budgets and the UK 2050 target (at the lower end) to the maximum reductions identified for Wales.

In order to provide a stable, long-term framework to drive the required steady reductions in emissions, it is necessary for policies to act on time horizons longer than the five-year Welsh Parliamentary terms and the individual carbon budgets aligned to them. A longer-term view is required, in keeping with the intent of the Well-Being of Future Generations Act. Development of policies in the rest of this Welsh Parliament term should be with the aim of meeting the 2030 target and preparing to meet the 2050 target, as well as meeting the carbon budgets to 2025.

The legislated target under the Environment (Wales) Act for an 80% reduction from 1990 to 2050 means reducing emissions by at least 75% on 2015 levels. Meeting the targets will be highly challenging, and will require sustained policy effort across all sectors. Some policy areas are fully devolved to the Welsh Government, while others are reserved or only partially devolved.

Our recommendations on policy include areas where powers are devolved, together with actions that the Welsh Government can take indirectly in areas such as planning, procurement and the possibility to act as a convenor to facilitate action. There is also potential for Wales to access a greater share of UK-wide funding opportunities.

Our key policy recommendations are:

- **Building standards.** The Welsh Government has devolved powers on building standards for new-build properties. These should be used to ensure new buildings have a high standard of energy efficiency and are designed for low-carbon heating systems. This will avoid costly retrofit in future and ensure household energy bills are no higher than needed. This is an area in which Wales can play a leading role in UK action to reduce emissions.
- **Retrofit energy efficiency and low-carbon heat.** Improvements to the energy efficiency of the existing building stock is of major importance, in order to reduce emissions, energy bills and levels of fuel poverty, as well as to enable deployment of low-carbon heating systems. This should be a high priority for the Welsh Government. Heating and regulations around retrofit of energy efficiency are both reserved areas of policy, although the Welsh Government is able to provide funding to retrofit programmes. Despite limited policy levers, under existing powers there are important actions that can be taken to drive and facilitate emissions reductions from buildings:
 - **Funding and 'soft' support for building energy efficiency and low-carbon heat.** There is a lot that the Welsh Government can do to join up and support the chain of decision-makers (e.g. householders, social landlords, installers and suppliers) for energy efficiency and low-carbon heating systems. This should focus on what has worked elsewhere: local area-based schemes, zoning of incentives well supported by advice, a local list of trusted installers and 'one-stop shop' communication. The public can be engaged through face-to-face contact, Street Champions and engaging parents through schools.
 - **A strategy for heat decarbonisation in Wales.** Consideration of the local context is important in considering the long-term decarbonisation of heat. The Welsh Government should develop a heat decarbonisation strategy that includes engagement with the public, which can help to secure a local mandate for infrastructure and can help avoid costs and delay.
 - **Use of waste heat from industry.** Wales has a large amount of heavy industry, and where heat is recoverable it represents an important opportunity for decarbonisation via heat networks. Welsh Government has a key potential role to use its ability to bring community and industry stakeholders together to find mutually beneficial solutions.
- **Transport** policy is devolved only on the demand side. We therefore focus on ways that Wales can cut emissions by using these levers, which also have wider benefits, together with actions that can facilitate uptake of ultra-low-emissions vehicles:
 - **Public transport and especially active travel** can reduce emissions from road transport, especially in the nearer term. Walking and cycling can have considerable health benefits,

whilst reduced car use should improve air quality. There is potential to recycle revenue from clean-air zones into cycling infrastructure and public transport, including procurement of ultra-low-emissions buses.

- **Supporting uptake of ultra-low-emission vehicles.** Uptake of electric vehicles has been slow in Wales to date. It is important to develop a better network of charging points, especially in mid-Wales, and tackle other non-financial barriers (e.g. through parking, use of priority lanes, raising awareness and public procurement).
- **Agriculture** policy is fully devolved to the Welsh Government, which should now take the opportunity to put in place farming policies to reduce emissions that move beyond the current voluntary approach and replace the Common Agricultural Policy with a framework that links support to measures aimed at emissions reduction and removals, and to improving the resilience of the natural environment to the impacts of climate change.
- **Forestry** is also devolved to Wales. Whilst the Welsh Government has previously announced highly ambitious tree-planting targets, current rates are far below the level needed to reach these. The Welsh Government should simplify and streamline the process for supporting tree planting, in order to reduce the barriers to action.
- **Electricity generation.** The recently announced target for electricity equivalent to 70% of Welsh consumption to be generated from renewables in Wales by 2030 is consistent with our scenarios and complements the emissions reduction targets under the Environment Act. Renewable generation in Wales can contribute to decarbonisation of the GB system and provide local economic benefits. The Welsh Government can help to encourage low-carbon electricity through use of public procurement and use of planning powers. The Welsh Government, together with many Welsh energy and environmental organisations, has called on the UK Government to do more to support onshore wind and solar development in Wales.¹ It is important that a way is found to deploy these technologies where they meet local planning criteria.
- **Procurement.** The Welsh Government's consultation on a target for the public sector to reach carbon neutrality is a positive step, although the details of this are yet to be determined. The public sector in Wales can use procurement rules positively to help drive emissions reductions in a number of areas (e.g. uptake of ultra-low-emission vehicles, low-carbon products). The Welsh Government should develop a strategy to ensure that climate change is fully reflected in public procurement.
- **Planning.** The planning framework is another useful lever that needs to be well aligned to objectives for emissions reduction in Wales, for example through encouraging walking, cycling and use of public transport, and ensuring readiness for or installation of electric vehicle charging points in new developments.

The framework in Wales provides particular opportunities to reduce greenhouse gas emissions whilst providing wider benefits to Welsh society. We look forward to seeing how this works in practice, and hope that Wales can provide an example to the rest of the UK in moving to a low-carbon society.

¹ <http://gov.wales/newsroom/environmentandcountryside/2017/171129-wales-calls-on-uk-government-to-do-more-to-support-onshore-wind-and-solar-development/?lang=en>

Chapter 1: Overview



In the Environment (Wales) Act 2016, the Welsh Government legislated to introduce carbon budgets to reduce greenhouse gas emissions. The Act requires that before the end of 2018, Welsh Ministers must set in regulation interim emission targets for 2020, 2030 and 2040 and carbon budgets for the periods 2016 to 2020 and 2021 to 2025.

The Environment Act was designed alongside complementary legislation in the form of the Well-Being of Future Generations Act (WFGA) 2015. The WFGA sets in place seven well-being goals and a sustainable development principle, which public bodies in Wales must take account of in decision making.

The Committee on Climate Change (Committee) was asked by the Welsh Government to provide advice on aspects of the Environment (Wales) Act. In April 2017, the Committee provided advice on the appropriate carbon accounting approach for targets under the Act, including Wales's share of international aviation and shipping emissions.

This report provides the second of part of the requested advice. It assesses the appropriate decarbonisation pathway for Wales, including specific recommendations on interim targets for 2020, 2030 and 2040, together with carbon budgets running to 2025.

This chapter is set out in five sections:

1. The Committee's previous recommendations on target design
2. Required advice on the level of interim targets and carbon budgets
3. The wider framework in Wales
4. Powers devolved to Wales
5. Stakeholder engagement for this advice

Chapter 2 presents our assessment of climate science and international circumstances. Chapter 3 sets out our analysis on the challenges and opportunities for reducing emissions in Wales, together with our scenarios for doing so. Chapter 4 presents the economic costs and wider benefits of action. Chapter 5 sets out our recommendations on the levels of the targets and budgets, on the role of emissions credits and carbon trading and key policy recommendations.

The Welsh Government has previously (in 2011² and 2013³) asked the Committee to report on progress reducing emissions and preparing for climate change. The Committee also reports on Wales's emissions and progress towards meeting targets in the annual report on progress to the UK Parliament each year.⁴ As part of the Environment (Wales) Act the Committee will provide the Welsh Government a report on progress at the end of every carbon budget period.

² CCC (2011) *Reducing emissions and preparing for climate change in Wales – 2011 progress report*.

³ CCC (2013) *Progress on reducing emissions and preparing for climate change in Wales*.

⁴ The 2017 UK progress report, *Meeting Carbon Budgets: Closing the policy gap - 2017 Report to Parliament*, includes an assessment on Welsh action to reduce emissions up to 2015, the latest year for which data are available.

1. The Committee's previous recommendations on target design

In April 2017, the Committee provided the first part of its advice, on carbon accounting and design of Welsh carbon budgets and other targets. Our key recommendations were:

- The overall accounting framework should be based on actual emissions in Wales, rather than adjusting for activity in the EU Emissions Trading System as under UK carbon budgets. Using actual emissions is the most transparent way of accounting for emissions and will encourage decarbonisation in all sectors of the Welsh economy. However, consideration should be given to particular provisions for some industrial sectors:
 - It is important that where there is a risk of displacement of industrial activity to other countries with less stringent climate policies (i.e. 'carbon leakage') policy does not encourage a reduction in Welsh industrial output. Climate policies should be designed carefully to avoid this risk.
 - The level of industrial activity in Wales could turn out to be higher or lower than that anticipated when setting emissions targets. In the case that this difference in output is large, this could constitute a significant change in circumstances that warrants reviewing the level of carbon budgets so as to maintain the level of ambition for emissions reduction across the rest of the Welsh economy.
 - Should competitive companies based in Wales win more business, causing actual industrial emissions to be higher than those allowed for under the carbon budgets, it could be reasonable for international emissions credits to be used to offset these additional emissions.
- Beyond the role for purchase of credits in the case of significantly increased industrial output outlined above, the option for the Welsh Government to purchase credible, international emissions credits should be retained to provide flexibility for unforeseen circumstances:
 - The role of these credits should be as a back-up option rather than their use being planned for and should require prior advice from the Committee on Climate Change.
 - Credible international credits include those linked to international agreements (i.e. Kyoto and the Paris Agreement) or allowances that are part of meeting EU emissions targets.
- Wales's share of international aviation and international shipping should be included within Welsh emissions targets. Given our recommendation that emissions accounting be based on actual emissions, rather than 'net' emissions used for UK carbon budgets, inclusion of these sectors on the basis of fuel sales presents no practical challenges. Wales should still pursue international policy action (rather than unilateral action) to reduce emissions in these sectors.
- All targets under the new Bill should be expressed relative to 1990 emission levels (i.e. as percentage reductions), rather than on an absolute (i.e. megatonne) basis. For the five-year carbon budgets, this would most simply be represented as the average reduction on 1990 emissions across the budget period:
 - This will ensure the targets are less sensitive to changes in the emissions inventory than the use of absolute targets and will therefore be a more stable basis to drive policy action.
 - Using a single basis for targets avoids the potential for targets on different bases to become misaligned, as a result of changes to the emissions inventory.

In July 2017, the Welsh Government announced the acceptance of all of the Committee's recommendations.⁵

This report provides the second of two parts of the requested advice, to assess the appropriate decarbonisation pathway for Wales and to advise on the levels of the interim targets and carbon budgets.

2. Required advice on the level of interim targets and carbon budgets

The Environment (Wales) Act sets in legislation a target to reduce Welsh emissions by at least 80% on 1990 levels⁶ by 2050. The Act requires interim targets and the first two carbon budgets to be legislated by the end of 2018:

- Interim targets should be set for the years 2020, 2030 and 2040.
- The first two five-year carbon budgets, covering the years 2016 to 2020 and 2021 to 2025, must also be set.

The Welsh Government has requested the Committee's advice on the levels of the interim targets and carbon budgets. The Act specifies that in setting the targets, the Committee must advise whether the target proposed is the highest achievable target, and if not, what the level is of the highest achievable target.

The Act also specifies that the advice should include the extent to which emissions credits ('carbon units') and emissions trading should be used to meet the carbon budgets, and the Committee's view on the sectors of the Welsh economy in which there are particular opportunities to reduce emissions.

The Act specifies that in advising on these levels, the Committee must have regard to:

- 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, and
- EU and international law and policy relating to climate change (including international agreements on measures designed to limit increases in global average temperatures).

We consider climate science and circumstances at EU and international level in Chapter 2. Chapter 3 sets out our scenarios, including consideration of relevant technologies. It presents the scenario on which the proposed targets and budgets are based, and identifies the highest achievable targets.

⁵ <http://gov.wales/about/cabinet/cabinetstatements/2017/carbonbudgetingframework/?lang=en>

⁶ Formally, the reduction under the Environment (Wales) Act is against 'baseline' emissions, calculated from 1990 emissions for all greenhouse gases except for HFCs, for which the earliest available data (1995) is used. Throughout this report, unless otherwise specified, references to 1990 emissions should be taken to mean 'baseline' emissions for the purposes of putting the targets into legislation.

We consider the implications of the wider framework within Wales in the section below. This then affects the development of our scenarios (Chapter 3), and consideration of the wider benefits of action to reduce greenhouse gas emissions (Chapter 4). An assessment of the economic costs to society of meeting the targets and budgets is also set out in Chapter 4.

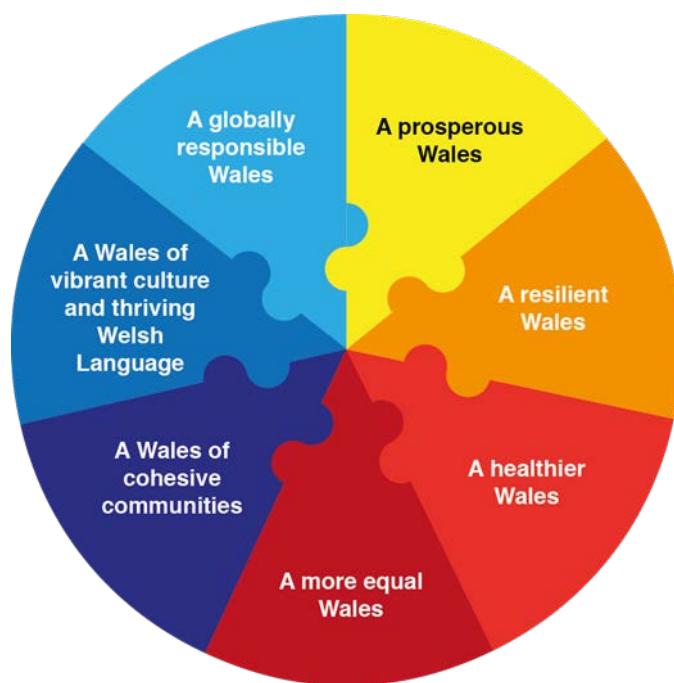
Recommendations on the levels of the targets and budgets are set out in Chapter 5, together with recommendations on the roles carbon units and emissions trading. In that Chapter, we also make policy recommendations, taking into account the opportunities we have identified in our scenarios, the wider framework in Wales and the powers devolved to the Welsh Government.

3. The wider framework in Wales

In addition to the Environment (Wales) Act 2016, Wales has also legislated the Well-Being of Future Generations (Wales) Act 2015 (WFGA). The Act puts a well-being and sustainable development duty on public bodies.

The WFGA sets out seven well-being goals, which should guide public sector bodies in their decision making (Figure 1.1). They are not to be taken individually but as a holistic set of goals: public sector bodies should work towards achieving all of them. We have considered these well-being goals in identifying the wider benefits of actions to reduce greenhouse gas emissions in Wales (Chapter 4).

Figure 1.1. Well-being goals of the Well-Being of Future Generations Act



Source: <http://gov.wales/topics/people-and-communities/people/future-generations-act/?lang=en>

The Act also commits the Welsh Government to set national indicators, so that progress towards achieving the well-being goals can be measured. The 46 published indicators include emissions of greenhouse gases within Wales, which is the primary focus of this advice.⁷

The Act also sets out a sustainable development principle, which is based on five 'ways of working': Long term, Prevention, Integration, Collaboration and Involvement. In developing our scenarios for carbon budgets for Wales, we have applied these ways of working to our analysis:

- We have developed a long-term decarbonisation pathway for Wales, which balances the short-term challenges of decarbonisation with the long-term requirements of the Environment (Wales) Act (i.e. reaching the 2050 target for an emissions reduction of at least 80%), taking into account the trends identified in the future trends report (Box 1.1).
- As part of the process to develop our advice, we issued a Call for Evidence, to which we received over 30 responses. The feedback provided by Welsh stakeholders in those responses, and at various events to discuss our advice, has been valuable in considering pathways for Welsh decarbonisation.

Box 1.1. Future Trends Report 2017

The Future Trends Report identifies key future social, economic, environmental and cultural trends that may affect Wales and provides initial analysis of the factors that could influence the future trends identified.

Future trends are identified in six themes: Population, Health, Economy and Infrastructure, Climate Change, Land Use and Natural Resources, and Society and Culture. All of these trends overlap and interact to some extent, and all are relevant for the future of the Welsh society. This box summarises trends that were most relevant to the purpose of this report: developing a credible path to decarbonisation in Wales whilst realising the well-being benefits of decarbonisation:

- **Population.** Wales's population is projected to increase over the next 20 years, by around 5%. At the same time, household size is expected to decrease. The number of single-person households is predicted to rise by over 30% in the next 20 years.
- **Health.** Obesity levels are expected to increase slightly.
- **Economy and Infrastructure.** There has been a global trend from manufacturing towards a service-based economy. It is unclear whether this trend will continue and how this will affect Wales in the next 30 years. Despite growing rail use, there is currently no general trend to switch from private to public mode of transport in Wales.
- **Climate Change.** Infrastructure across Wales is already exposed to a range of climate hazards. Flooding is a high risk to infrastructure, but risks from heat, water scarcity and slope instability are also identified in the report.
- **Land Use and Natural Resources.** It is likely that ecosystems across Wales have insufficient resilience to the challenges that they face.

Source: <http://gov.wales/docs/statistics/2017/170505-future-trends-report-2017-en.pdf>

⁷ There is an additional indicator of emissions of greenhouse gases attributed to the consumption of global goods and services in Wales, but we have not included this indicator in our analysis. The Welsh Government is in the process of producing estimates of Welsh emissions on a consumption basis.

4. Powers devolved to Wales

The Welsh Government does not have full powers over all sectors that are relevant for decarbonisation (Box 1.2). In considering how the targets could be met, and especially the potential to go beyond a contribution to meeting an overall 80% reduction in emissions for the UK as a whole, we have prioritised areas in which powers are devolved to Wales.

Where powers are reserved (i.e. not devolved), the Welsh Government will also have an important role in ensuring that the emissions reductions take place. In particular, the Welsh government should focus on the following areas:

- **Working with the UK Government** to ensure that UK-wide policies work for Wales.
- **Planning.** The planning framework is another useful lever that needs to be well aligned to objectives for emissions reduction in Wales (e.g. through encouraging walking, cycling and use of public transport, and ensuring readiness for or installation of electric vehicle charging points in new developments).
- **Procurement.** The public sector in Wales can use procurement rules positively to help drive emissions reductions in a number of areas (e.g. uptake of ultra-low-emission vehicles, low-carbon products).
- **Convening role.** It is important the Welsh Government maximises its potential to bring stakeholders together and facilitate dialogue and strengthen relationships, to enable the development of mutually beneficial projects that contribute to decarbonisation.
- **Access to UK-wide funding.** The Welsh Government should seek to ensure that households and businesses in Wales have good access to UK-wide funding opportunities where possible and appropriate.

Box 1.2. Devolved and reserved powers

The balance of powers that are devolved and reserved in Wales changed in 2017, when the Wales Act amended the Government of Wales Act 2006. Wales moved from a 'conferred matters' model to a 'reserved matters' model.

The following powers are relevant for decarbonisation policies:

- **Economic and fiscal:** Mostly reserved.
- **Energy supply:** The Welsh Government will have the power to grant or refuse planning permission for power plants up to 350 MW, for licensing of new oil and gas exploration in Wales and for licensing of new coal developments.
- **Planning** is mostly devolved, with the exception of nationally significant infrastructure in Wales.
- **Energy efficiency and low-carbon heat for buildings** are mostly reserved, except for regulations for new-build properties and the encouragement or funding of energy efficiency improvements.
- **Fuel poverty** is devolved.
- **Industry:** Mostly reserved.
- **Transport:** Demand-side measures (e.g. public transport, walking and cycling) are devolved.
- **Agriculture and land use:** Fully devolved.
- **Waste:** Fully devolved.

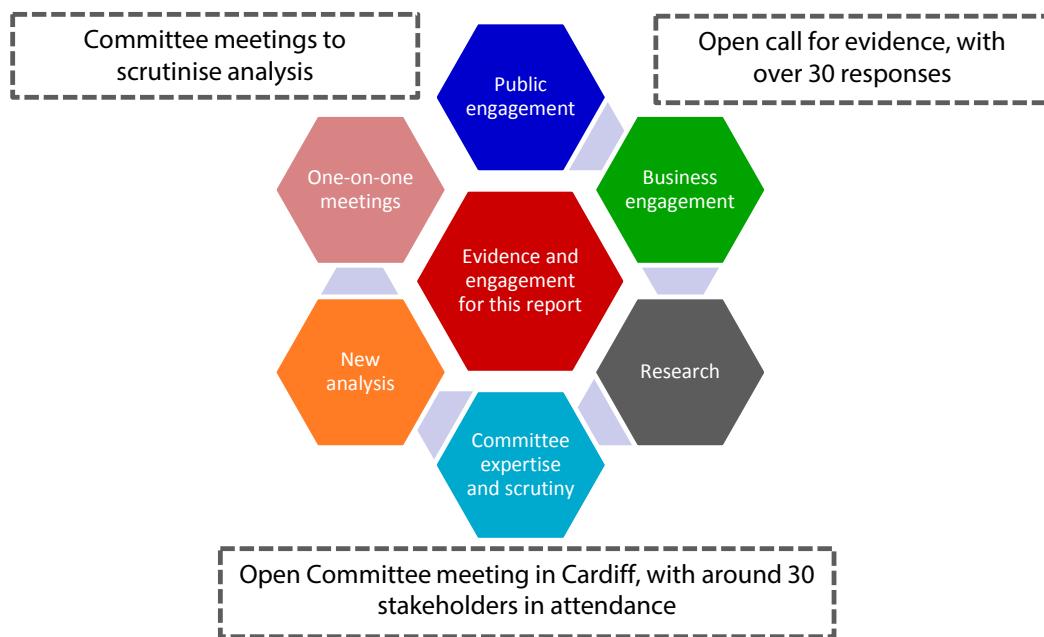
5. Stakeholder engagement for this advice

The Committee engages widely with businesses, governments, researchers, non-government organisations, representative bodies and other relevant parties throughout its work. The Committee has gathered evidence specifically for this advice (Figure 1.2):

- On 6 July 2017 we published a Call for Evidence, containing ten questions on climate science and international circumstances, the path to 2050, emission targets and action and the wider considerations.
- Two public meetings, one in South Wales and one in North Wales, gave stakeholders the opportunity to engage in person and to clarify any questions regarding the Call for Evidence.
- We received over 30 responses to the Call for Evidence. Responses are published on our website.⁸
- To provide further input we held a public Committee session on 7 July 2017, attended by around 30 people.⁹
- We have also held meetings with individual stakeholders from a range of sectors, and with Welsh Government departments.
- We have drawn on research we have commissioned on how emissions can be reduced in each sector for previous advice on UK carbon budgets.¹⁰

Our engagement has been valuable in gathering views on the design of carbon targets and evidence about the existing policy framework and possible paths for Welsh emissions.

Figure 1.2. Evidence and engagement for this report

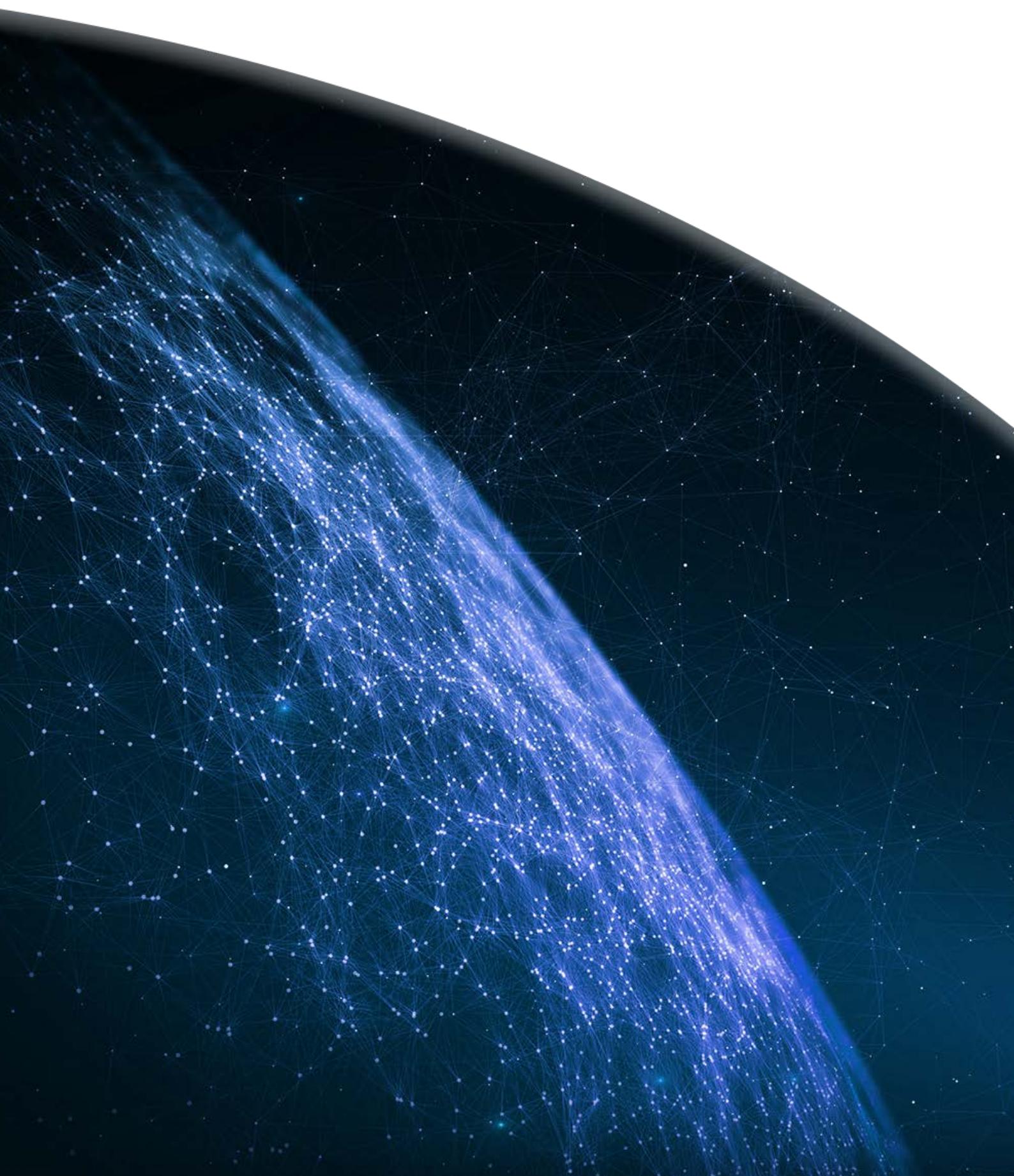


⁸ <https://www.thecccc.org.uk/publication/building-a-low-carbon-economy-in-wales-setting-welsh-carbon-targets/>

⁹ See agenda and minutes at <https://www.thecccc.org.uk/document/minutes-ccc-meeting-7-july-2017/>

¹⁰ For example, see the supporting research for the UK fifth carbon budget advice.

Chapter 2: Science and international circumstances



The Environment (Wales) Act requires that the Committee consider scientific knowledge about climate change and international circumstances when providing our advice. In this chapter we consider those issues.

This chapter sets out the Committee's thinking in three sections:

1. The latest climate science
2. International circumstances and the Paris Agreement
3. Implications for Welsh emissions to 2050

1. The latest climate science

The evidence that climate change is happening, driven by human activity and will have large impacts, is supported by many lines of research and agreed by the world's leading scientific bodies:¹¹

- Global average temperature has risen around 0.9°C since the late 19th Century, accompanied by rising sea levels and warmer seas, retreating ice and changing extreme weather patterns.
- Many impacts are already being detected across the world.¹²
- Further emissions of greenhouse gases will lead to further warming and change. There is no known simple threshold beyond which climate change moves from safe to dangerous. The Intergovernmental Panel on Climate Change (IPCC) has concluded that:¹³
 - Warming of 1.5°C entails high risk of damage from extreme weather and of losing sensitive ecosystems (such as those in the Arctic, on mountains and coral reefs).
 - Warming of around 2.5°C brings high risk of large-scale singularities (such as irreversible ice sheet loss, leading to more sea level rise) and severe global impacts on the economy and environment.
 - Warming of around 4.5°C would lead to very severe damage and puts global food security in doubt.

Global temperature rise depends primarily on cumulative CO₂ emissions over time. Temperature limits will therefore only be met if global emissions of CO₂ (and probably other long-lived greenhouse gases such as nitrous oxide and some F-gases) reach net zero. Other, shorter-lived gases (e.g. methane) drive temperature mainly by their rate of emission; the lower the emission rates, the greater the available cumulative budget for the longer-lived gases.

We undertook an in-depth assessment of the latest climate science for the UK fifth carbon budget advice.¹⁴

¹¹ See for instance Royal Society and US National Academy of Sciences Climate Change Evidence & Causes: https://royalsociety.org/~media/Royal_Society_Content/policy/projects/climate-evidence-causes/climate-change-evidence-causes.pdf; and the Climate Communique written by 24 UK academic societies: http://www.iop.org/news/15/jul/file_65971.pdf

¹² See CCC (2016) *UK Climate Change Risk Assessment 2017 – Synthesis report*.

¹³ IPCC Fifth Assessment Report: <https://www.ipcc.ch/report/ar5>

¹⁴ See CCC (2015) *Advice on the fifth carbon budget - Chapter 2 Overview of climate science and international circumstances*.

2. International circumstances and the Paris Agreement

International negotiations on climate change are governed through the United Nations Framework Convention on Climate Change (UNFCCC). In 2008, when the UK Climate Change Act was legislated, there was neither a UNFCCC-agreed nor a global quantitative goal for limiting climate change, nor a universal effort to reduce emissions.

The Paris Agreement was reached at the UNFCCC negotiations in 2015, and marked a number of new developments in international climate policy. These include commitments to reduce emissions from around the world, a more ambitious aim for limiting temperature, and an aim to reach net zero global emissions this century:

- The overarching aim of the Paris Agreement is to hold the increase in global temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit it to 1.5°C. Previous UNFCCC texts have referred to the aim of limiting to below 2°C.
- To achieve this, it sets a new aim of balancing “anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century” (i.e. net zero global emissions by sometime between 2050 and 2100).
- Each party to the agreement is required to make a national pledge of action, either to 2025 or 2030, to contribute to emissions reduction. Nearly all parties have now made pledges.¹⁵ The EU (on behalf of Wales, the UK and the other EU nations) pledged to reduce its emissions by at least 40% below 1990 levels by 2030.

Despite the now-global effort to reduce emissions, current pledges of action to 2030 do not add up to a credible pathway to achieve either 2°C or more ambitious temperature aims.

Recognising this, the Paris Agreement created a ‘ratchet’ mechanism designed to encourage greater action over time:

- The pledges indicate a wide range of ambition from different nations. In aggregate, achievement of the pledges would lower emissions compared to previous expectations, but they would still grow from current levels of around 50 billion tonnes of CO₂-equivalent annually (50 GtCO₂e) to around 56 GtCO₂e in 2030.¹⁶
- Parties to the Paris Agreement recognised 40 GtCO₂e as the 2030 level consistent with a path below 2°C.
- The Agreement sets a five-yearly 'ratchet' system to review pledges, starting in 2023, with the intention that their ambition will rise over time in a nationally-determined manner. Ahead of this, nations agreed to a "facilitative dialogue" in 2018 to take stock of the current pledges.

We concluded in our report on *UK Climate Action Following the Paris Agreement* that aligning to the aims of the Paris Agreement would entail a steeper downward path for global emissions than implied by the UK 2050 target, on the assumption that countries have approximately equal per-capita emissions in 2050 (Table 2.1):¹⁷

¹⁵ <http://www4.unfccc.int/Submissions/INDC/>

¹⁶ UNFCCC (2016) Updated synthesis report on the aggregate effect of INDCs:
http://unfccc.int/focus/indc_portal/items/9240.php

¹⁷ An assumption of equal per-capita 2050 emissions is the basis of the Committee recommendation for the UK 2050 target in 2008, enacted within the Climate Change Act, for an emissions reduction of at least 80% on 1990. See <https://www.theccc.org.uk/wp-content/uploads/2013/03/Interim-report-letter-to-DECC-SofS-071008.pdf>

- The UK's current targets are already at the more ambitious end of the range of international pledges to 2030 (in terms of percentage reduction below 1990 levels), and is broadly aligned to limiting temperature rise to 2°C.
- Keeping emissions below 2°C requires a reduction in global emissions to 17-29 GtCO₂e, equivalent to 1.8-3.0 tCO₂e per capita. A reduction to this level of per-capita emissions in the UK implies a reduction of 71-83% on 1990 levels.
- Aligning more closely to 1.5°C ambition would imply global emissions reducing to 4-14 Gt in 2050 (0.4-1.4 tonnes per capita). Reaching this level of per-capita emissions would imply UK emissions of greenhouse gases in 2050 at least 86-96% below 1990 levels.
- Aligning to the 1.5°C ambition also implies reaching net zero CO₂ emissions by 2050, whereas keeping temperature rise below 2°C implies that this would need to occur sometime between 2055 and 2075.

These emissions paths assume significant net CO₂ removals (i.e. net negative emissions) after reaching net zero (through afforestation, bioenergy with carbon capture and storage, direct air capture or other methods). To the extent that significant net removals cannot be achieved, emissions would have to reach net zero even sooner to stay within a global CO₂ budget. Also, global paths consistent with 1.5°C overshoot on the median temperature increase (i.e. entail temporary temperature increases of more than 1.5°C) before returning to 1.5°C by 2100.

The UK Government has signalled an intention to set a new target in the future that reflects the global need to reach net zero emissions. We agreed with this intention in our report to the UK Government in October 2016.¹⁸ However we made it clear that, to be credible, a new target needs to be evidence-based, accompanied by strong policies to deliver existing targets and a strategy to develop technology that is likely to be important to meeting any such target (notably greenhouse gas removals).

Table 2.1. UK emissions in 2050 and time to reach net zero emissions for paths consistent with the range of ambition implied by the Paris Agreement, assuming emissions per person equal the global average

	Below 2°C	Return to 1.5°C
UK 2050 GHG emissions (reduction on 1990 levels)	71-83%	86-96%
Year to reach zero CO ₂ emissions	2055-75	2045-50

Source: CCC calculations based on UNEP (2015) *The emissions gap report 2015*.

¹⁸ CCC (2016) *UK Climate Action Following the Paris Agreement*.

3. Implications for Welsh emissions to 2050

The Environment (Wales) Act places in legislation a target for 2050 of a reduction in greenhouse gas emissions of at least 80% on 1990 levels. This is the same level of reduction from 1990 as the 2050 target under the UK Climate Change Act, which was based on a global path that keeps central (i.e. 50% likelihood) estimates of global temperature rise close to 2°C.

There is a question about whether it is reasonable for Welsh emissions to reach the same per-capita level as the rest of the UK on a 'production basis' (i.e. on the basis of emissions actually occurring in Wales). Wales has historically had higher emissions per capita than the rest of the UK, whilst deep reductions are more challenging in Wales than for the UK as a whole:

- Welsh emissions per capita were significantly higher in 1990 than for the UK as a whole. A reduction of 80% in Welsh emissions on 1990 levels would cut them to a level of around 3.5 tonnes of CO₂-equivalent per capita in 2050, still significantly higher than the level for the UK as a whole (2.1 tCO₂e/capita) in achieving an 80% reduction from 1990.
 - Reaching 2.1 tCO₂e/capita, consistent with the average level of emissions at UK level under an 80% reduction, would imply a reduction of 88% on 1990 emissions in Wales.
 - The range of per-capita emissions at global level consistent with staying below 2°C would imply reductions of between 83% and 90% in Wales.
 - The range of per-capita emissions levels for 1.5°C would imply reductions of between 92% and 98% in Wales.
- The extent of reductions possible in Wales is less than that in England or Scotland. Our analysis of the challenges and opportunities for decarbonisation in Wales indicates that reaching a reduction of 80% in Wales will be more difficult for Wales than for the UK as a whole. The Central scenario for achieving a reduction of 80% for the UK would imply Wales reducing emissions by 76% on 1990 levels, and our assessment is that the maximum feasible reduction by 2050 is 85% (see Chapter 3). This is due to a greater share of 'hard to reduce' emissions and lesser access to opportunities for carbon capture and storage (CCS):
 - **Hard to reduce sectors.** Wales has a higher share than the rest of the UK of emissions in 'hard to reduce' sectors such as industry, for which a path to very low levels of emissions by 2050 has not yet been identified (see Chapter 3).
 - **Carbon capture and storage (CCS).** Our Welsh scenarios allow an important role for carbon capture utilisation and storage (CCUS) applied to heavy industry (see Chapter 3). However, given potential CO₂ storage sites are not conveniently situated for sequestration of Welsh emissions, it is unlikely that CCS energy generation (e.g. power stations) would be sited in Wales rather than elsewhere in the UK. For this reason, we do not assume any deployment of bioenergy with CCS (i.e. BECCS) or application to fossil power stations in our Welsh scenarios. The absence of BECCS in particular means that it is extremely hard for overall emissions in Wales to reach very low levels.

For these reasons, our assessment is that it is not sensible to plan for Welsh emissions on a production basis reaching as low a per-capita level by 2050 as those for the UK as a whole. The legislated requirement for a reduction in Welsh emissions of at least 80% by 2050 is more stretching than the equivalent reduction at UK level, and close to the maximum feasible reduction identified in our scenarios.

It is likely that on a consumption basis (i.e. taking into account the emissions resulting from Welsh consumption of goods and services), Welsh emissions are considerably lower than the estimates on a production basis. It may therefore be that in reducing emissions on a production basis by 80%, consumption emissions in Wales would be well below the UK average in 2050 even while being higher on a production basis. The Welsh Government is in the process of producing estimates of Welsh emissions on a consumption basis.

Chapter 3: Scenarios for reducing Welsh emissions



In recommending the levels of emissions targets, we take account of the current context in terms of emissions, trends and policies. We also assess the particular challenges and opportunities to reduce emissions in Wales, which differ significantly from the picture for the UK as a whole. Based on these assessments, we build scenarios for decarbonisation to 2050, on which the recommended targets are based.

This chapter sets out our analysis and assessment of the appropriate path for Welsh emissions in four sections:

1. Current emissions
2. 'Business as usual' projections
3. Developing emissions scenarios for Wales
4. Developing a Welsh scenario on which to base recommended targets and budgets

1. Current emissions

Welsh emissions in 2015 were 19% below 1990 levels, with emissions reduction to date mainly from waste, buildings and industry (Figure 3.1). Emissions fell by 1.4% in 2015, but progress remains a long way short of the Welsh Government's existing target to reduce them to a level 40% below 1990 levels by 2020.

The rate of progress to date has been slower than that in the UK as a whole, partly reflecting the different balance of emitting activities in Wales (Figure 3.2). Wales accounts for 9% of UK-wide emissions, but only around 5% of UK population. The pattern of emissions in Wales differs to that for the UK as a whole, with a much higher share of industry emissions leading to a greater share of emissions covered by the EU emissions trading system (EU ETS):

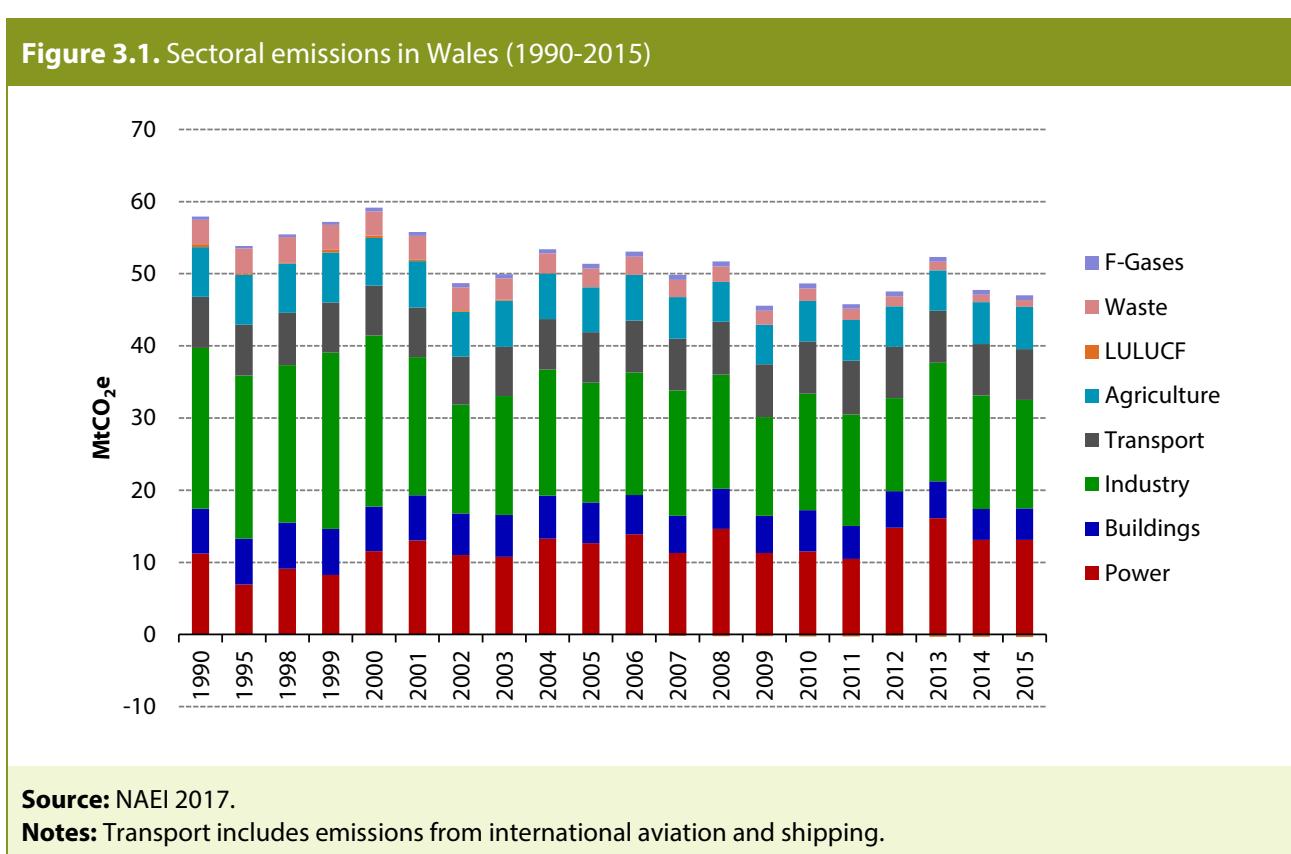
- Between 1990 and 2015, emissions in Wales fell 19% (compared to 37% across the UK). Within this, power sector emissions rose by 17%, while there have been reductions in industry, buildings and waste:
 - **Power** sector emissions in Wales have increased 17% since 1990, due to an increase in gas-fired generation and continued emissions from Aberthaw coal-fired power station. Aberthaw represented 51% of Welsh power emissions and 14% of total Welsh emissions in 2015.
 - **Industry** emissions in Wales have been broadly flat since 2008, although they have fallen by around 31% since 1990. This fall is less than the 48% reduction in industrial emissions for the UK as a whole over the period to 2015, during which UK manufacturing output has shown fairly steady slow growth (with the exception of the financial crisis).¹⁹
 - **Buildings.** Direct emissions from buildings are down 26% on 1990 levels, largely due to increased efficiency of boilers and improvements to building fabric. The Welsh Government's Arbed and Nest schemes have been successful in delivering insulation measures to over 45,000 households.
 - **Waste** emissions in Wales have fallen by 72% since 1990. Wales has the highest recycling rates in the UK (64% of municipal waste is reused, composted or sent for recycling in

¹⁹ See CCC (2017) *Report to Parliament – Meeting Carbon Budgets: Closing the policy gap*.

2016/17), and the second best in Europe, as a result of meeting strong regulatory targets for waste reduction through the Towards Zero Waste strategy.

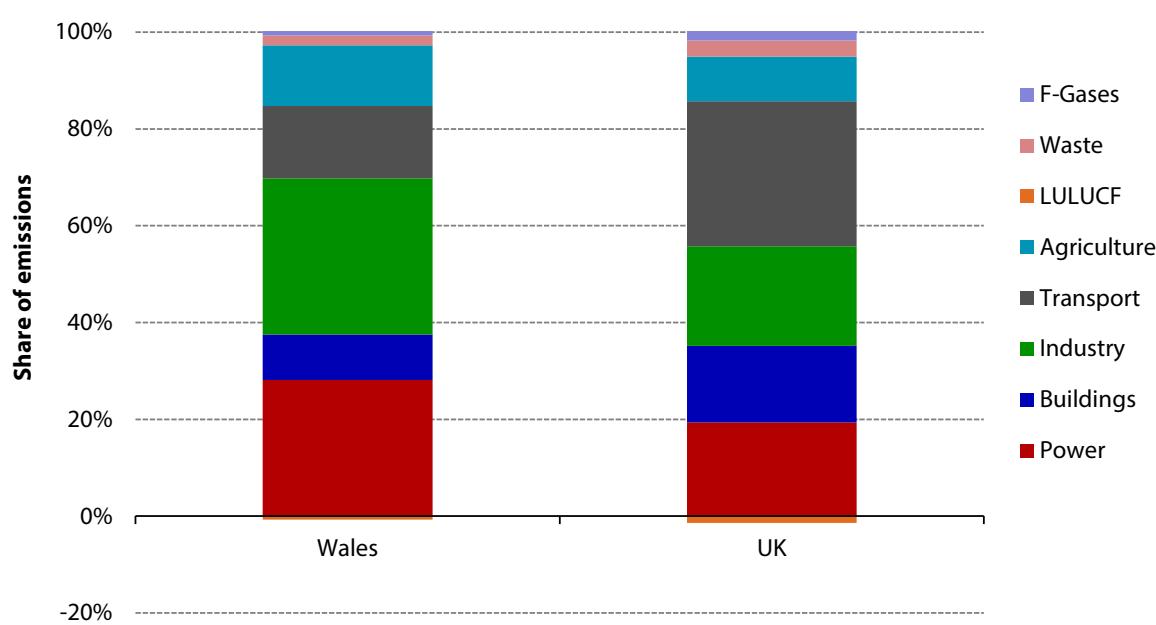
- **Agriculture and land use.** Agriculture emissions have fallen 15% since 1990, although they have risen slightly since 2009. The size of the land-use sink has decreased due to more land being converted to settlements and a reduction in tree-planting rates.
- **Transport** emissions have been broadly flat since 1990.
- Within industry, emissions from the Port Talbot steelworks represented 50% of Welsh industrial emissions and 16% of total Welsh emissions in 2015. Consequently the EU ETS, which applies to the power sector and heavy industry, covers a greater proportion of emissions in Wales, at around 55% compared to around 40% in the UK as a whole.
- The Government's commitment to end unabated coal-fired generation in the UK means that at some point by 2025, the large amount of emissions (6.7 Mt in 2015) from the Aberthaw coal plant will cease.

Achieving a reduction of at least 80% on 1990 emissions²⁰ in Wales by 2050 will require a reduction from 2015 of 75% (Figure 3.3).



²⁰ Formally, the reduction under the Environment (Wales) Act is against 'baseline' emissions, calculated from 1990 emissions for all greenhouse gases except for HFCs, for which the earliest available data (1995) is used. Throughout this report, unless otherwise specified, references to 1990 emissions should be taken to mean 'baseline' emissions for the purposes of putting the targets into legislation.

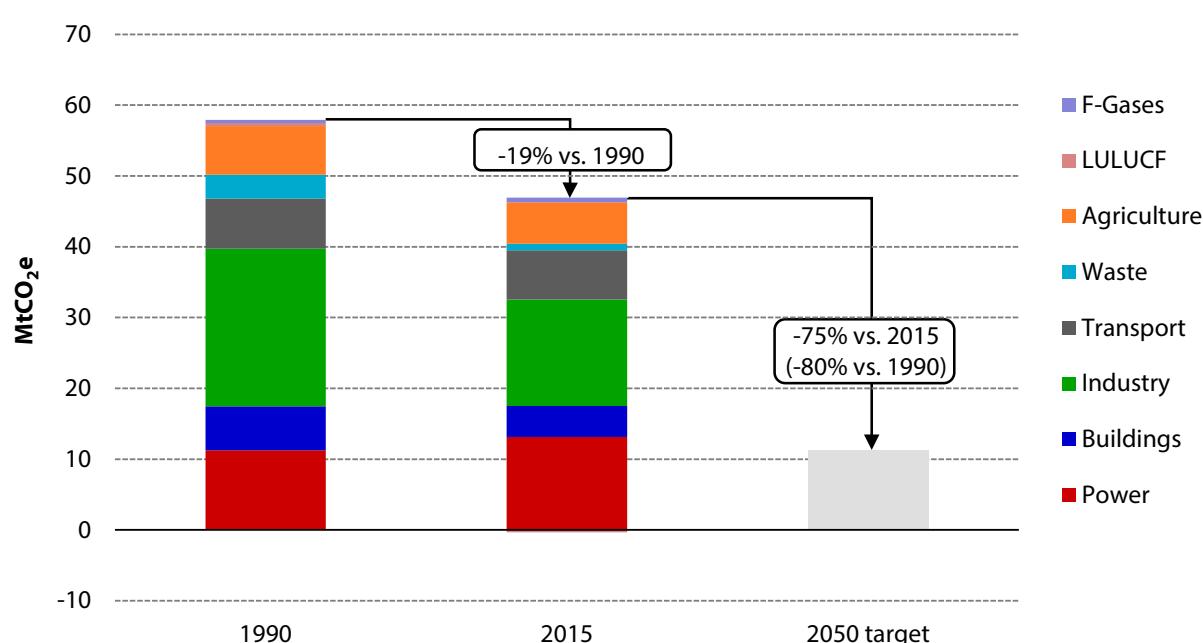
Figure 3.2. Sectoral shares of emissions in Wales and the UK (2015)



Source: NAEI 2017.

Notes: Transport includes emissions from international aviation and shipping.

Figure 3.3. Emissions reduction in Wales from 1990 to 2050



Source: NAEI 2017, CCC analysis.

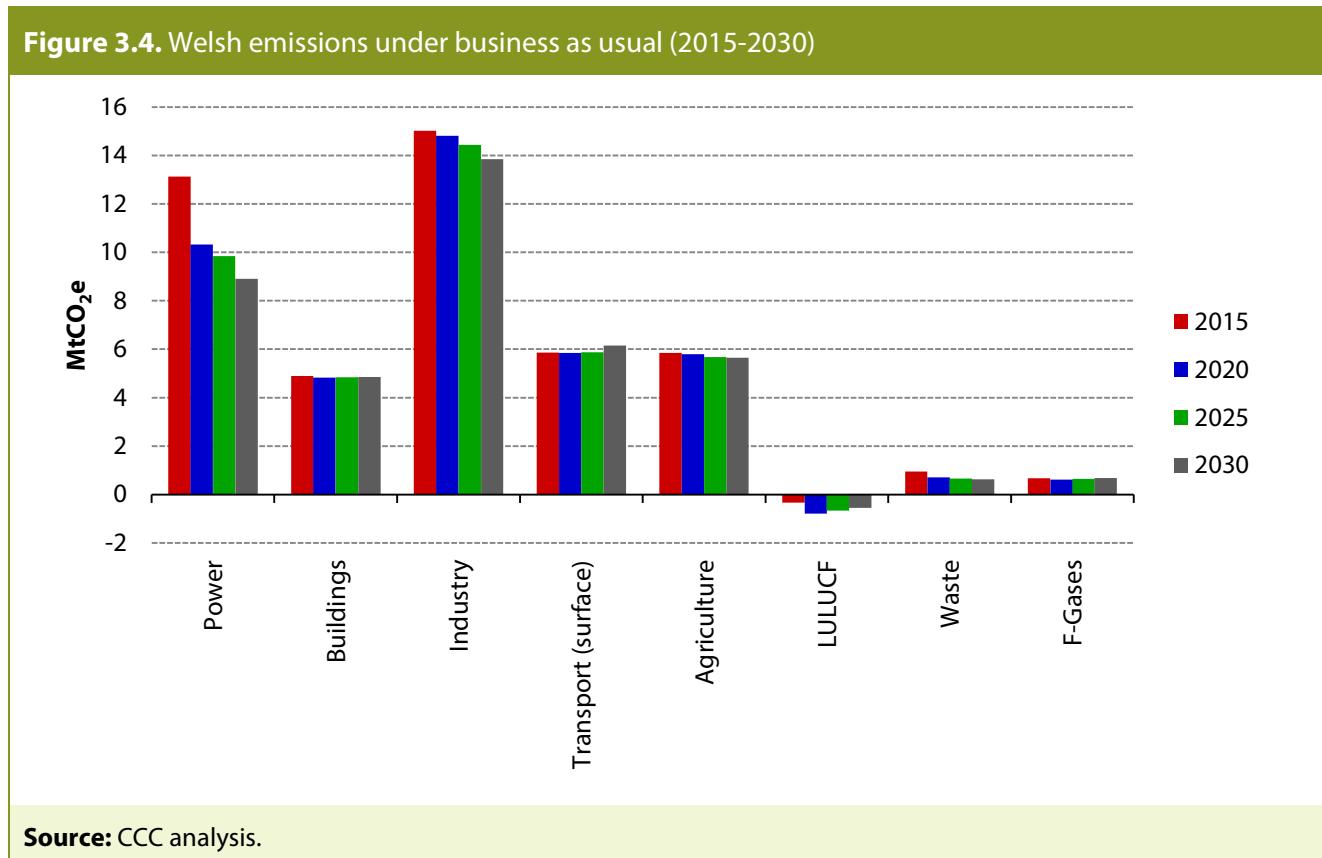
Notes: Transport includes emissions from international aviation and shipping.

2. 'Business as usual' projections

Without any new policies, emissions are projected to decrease by around 13%²¹ from 2015 to 2030 (Figure 3.4), mainly driven by anticipated reductions in the power sector. These 'business as usual' baseline emission projections have been compiled from a number of sources (Box 3.1), and provide the baseline against which to judge the costs and benefits of additional action.

We do not assume deindustrialisation in Wales through significant reductions in output or closure of industrial facilities, although we project baseline emissions to fall slightly over the period to 2035 through incremental improvements to energy efficiency. We do not assume any further reductions in 'business as usual' emissions after 2035.

In the power sector, the future of the Aberthaw coal-fired plant in South Wales will have a large impact on emissions. This has already been operational for around 45 years, and would need further investment in order to comply with the Industrial Emissions Directive (IED), which limits emissions of SO₂ and NOx. It is also subject to the UK Government commitment to phase out unabated coal generation by 2025. We assume that under business as usual, generation at Aberthaw will decline slightly before 2020, with running hours then being limited to 1,500 hours per year from the middle of 2020, as required under the IED for plants that have not complied with the stringent emissions limits, before emissions are assumed to cease in 2025.



²¹ This excludes Wales's shares of international aviation and international shipping emissions. Whilst these are included in the targets and in our analysis, we do not have 'business as usual' projections for these sectors.

Box 3.1. Sources used to compile the 'business as usual' (baseline) projections

- **Power.** The power sector baseline projections are based on modelling by Imperial College London.
- **Buildings.** The residential emissions baseline uses the National Household Model, replicating the method used for our UK analysis. Emissions from new homes are based on DCLG household projections. The non-residential emissions baseline for commercial and public buildings uses the devolved administration CO₂ projections produced by Cambridge Econometrics and previously used for the CCC's 2016 advice on Scottish targets.
- **Transport.** For our baseline emissions projection we use the run of the Department for Transport's National Transport Model (NTM) commissioned for our fifth carbon budget advice, which includes a separate projection for Wales.
- **Industry.** The baseline emissions projection is based on a combination of data from the Welsh National Atmospheric Emissions Inventory (NAEI), the Government's Energy and Emissions Projections (EEP) and CCC-commissioned projections from Cambridge Econometrics.
- **Agriculture.** Welsh baseline emissions projections are compiled by scaling BEIS 2016 projections for UK baseline emissions.
- **Land use, land-use change and forestry.** We use 'Projections of emissions and removals from the UK LULUCF sector to 2050' published by BEIS in March 2017 for LULUCF baseline emissions.

3. Developing emissions scenarios for Wales

The emissions targets under the Environment (Wales) Act should provide a steady and realistic path from current emissions to the 2050 target. The targets are intended to ensure that Wales, using its devolved powers and working with the UK Government in reserved areas, takes action to remain on track from year-to-year. They can be used to monitor progress and guide corrective action if progress appears to be off-track.

To be effective guides to action, the targets need to meet the criteria set out in the Act and, overall, they should balance ambition with achievability. They must be sufficiently ambitious to ensure they are genuinely on track to the long-term target, but also feasible in terms defined by the Act given what is known today.

The Committee uses scenarios to inform these judgements. We construct scenarios for each sector based on detailed analysis, combining assumptions about new technology and investments (e.g. new vehicle purchases, heating system replacements, energy efficiency installations, power plant investments) and how consumers behave (e.g. how vehicles are driven, how buildings are heated). Our scenarios are informed by an assessment of the costs and barriers of different options (both technologies and behaviours), by the need to reduce emissions on the path to 2050 and by our projections for a business as usual scenario set out in the previous section.

The scenarios help to ensure that the Committee recommends targets that are consistent with the Act. They are not intended to prescribe the precise route that must be taken to achieve the targets.

Our starting point for the scenarios for emissions reduction in Wales is the UK scenarios developed for the Committee's 2015 advice on the fifth carbon budget,²² making them more specific to Wales. This involved several steps:

- **Starting point.**
 - Wales has reduced emissions to date by 19% on 1990 levels (Figure 3.3), compared to 37% for the UK as a whole.²³ There is also a substantial difference in the balance of emissions across sectors in Wales compared to the UK (Figure 3.2). Some sectors, such as power generation and waste, have a relatively clear path to very low emissions. Others, such as agriculture and industry, have significantly greater challenges, and still have residual emissions in 2050 under our UK scenarios.
 - We have adjusted our scenarios from those produced in 2015 to reflect the latest emissions data and known trends to date. Given the time required to develop and implement new policies, we consider the emissions path to 2020 to be largely locked in. The Clean Growth Strategy has only recently been published and we have had very limited opportunity to reflect it within our analysis.
- **Wales-specific challenges and opportunities to reduce emissions.** The overall opportunities to reduce emissions in Wales are broadly similar to those overall for the UK. However, there are important differences:
 - Wales has a greater proportion of emissions from large point-sources, both in the power sector and industry. The proportion of Welsh emissions covered by the EU emissions trading system (EU ETS), which covers point-source emissions from electricity generation and industry, is around 55% compared to around 40% for the UK as a whole.
 - Compared to the UK housing stock, Wales has higher proportions of solid-wall homes (29% as against 27% for the UK) and properties off the gas grid (21% as against 15% for the UK).
 - Cars in Wales are, on average, both smaller and older than those in the UK as a whole. Whilst on average trip distances are only slightly longer than those in the rest of Great Britain, there are significantly fewer short trips that are amenable to being switched to walking or cycling.
 - The lack of potential CO₂ storage sites close to South Wales presents a greater challenge in deploying carbon capture and storage (CCS).
- **The Environment (Wales) Act** contains a requirement for emissions to fall by 80%, which we take into account constructing the scenarios for Welsh emissions not only in 2050 but on the path to that goal.
- **The wider Welsh framework.** The Well-Being of Future Generations (Wales) Act 2015 (WFGA) sets out seven well-being goals. We have considered these well-being goals in identifying the wider benefits of actions to reduce greenhouse gas emissions in Wales and prioritising those measures that offered wellbeing benefits (Chapter 4).

²² See Chapter 3 of the Committee's advice on the fifth carbon budget, and the accompanying report on sectoral scenarios. Available at: <https://www.theccc.org.uk/publication/the-fifth-carbon-budget-the-next-step-towards-a-low-carbon-economy/>

²³ Including international aviation and shipping.

Whilst some of the measures to reduce emissions within our Welsh scenarios are deliverable by the Welsh Government under devolved powers, the relevant powers for others are reserved to the UK Government (Chapter 1). Wales has taken a decision to put in place legislation to require a reduction of at least 80% in emissions by 2050 and, following advice from the Committee, that legislated targets will cover all Welsh sources of emissions. It will not be possible to achieve this without action across all emitting sectors in Wales. We therefore include both devolved and reserved measures in our assessment, although we take particular account of devolved powers in considering wider benefits of actions to reduce emissions.

Taking into account the levels of emissions today in each sector, together with the challenges and opportunities in each sector, we have translated the UK scenarios for each sector into Welsh-specific sectoral scenarios. We did this for each sector for two UK scenarios:

- A **UK Carbon Budgets sectoral scenario**, reflecting Wales's contribution to the Central scenario for the UK, consistent with the UK carbon budgets and the 2050 target for an emissions reduction of at least 80% by 2050.
- A **Max sectoral scenario**, reflecting the Committee's assessment of the greatest feasible emissions reduction over the period to 2050.

Aggregation of the sectoral 'UK Carbon Budgets' scenarios reflects Wales's contribution towards meeting the UK 80% target, and provides an economy-wide reduction of 76% in Wales against 1990 emissions (69% on 2015 emissions). Given that this reflects existing legal commitments for emissions reductions, we describe this as the 'Wales Minimum' economy-wide scenario.

Similarly, combining the Max sectoral scenarios for Wales produces the 'Wales Maximum' economy-wide scenario. This would reduce Welsh emissions by 85% on 1990 levels (81% on 2015).

4. Developing a Welsh scenario on which to base recommended targets and budgets

The process of translating UK scenarios into the Wales-specific Wales Minimum and Wales Maximum economy-wide scenarios established that a reduction of at least 80%, as enshrined in the Environment (Wales) Act, can be achieved in Wales. However, it will require going beyond the reduction of around 76% that is our assessment of Wales's contribution to achieving an 80% reduction at UK level.

In order to provide a basis for the recommended targets and budgets, we therefore constructed an economy-wide scenario for Wales that achieves a reduction of 80% by 2050, building on the Wales Minimum scenario and adding additional measures to reduce emissions (Box 3.2). Taking into account the wider framework within Wales and powers available to the Welsh Government, these extra measures are mainly in areas in which action provides wider benefits and/or where powers are devolved to Wales.

Whilst not intended to be prescriptive, the 80% scenario outlines how the legislated 2050 target could be met in a way that limits overall costs and provides significant benefits to Welsh society.

The Wales 80% scenario contains reductions across all sectors between 2015 and 2050 (Figures 3.5 to 3.7). Early emissions reduction occurs in the power sector, together with waste and F-gases. Emissions reduction in the industry sector occur predominantly in the 2030s and 2040s, with an important role for carbon capture utilisation and storage (CCUS):

- **Buildings.** For residential and non-residential buildings, emissions reductions stem from improved energy efficiency and deployment of low-carbon heating systems. The scenario to reduce emissions is consistent with our UK scenarios, but takes into account Wales-specific challenges and opportunities to reduce emissions, including the higher proportions of solid-wall homes and properties off the gas grid.
- **Transport.** Abatement in transport comes from efficiency improvements of new conventional vehicles and a higher share of electric vehicles. By 2030, we assume 60% of new car sales to be ultra-low-emission vehicles, in line with our UK Central scenario.
- **Power.** Reductions in power emissions come from the phase out of coal generation by 2025 and a longer-term reduction in gas generation (Box 3.3), accompanied by increases in low-carbon generation. As Wales is a net-exporter of electricity to England, increased renewable generation increases exports but does not impact significantly on Welsh emissions.
- **Industry.** Our assessment is that Wales will be unable to achieve the legislated emissions reduction of at least 80% by 2050 without a significant contribution from carbon capture utilisation and storage (CCUS) (Box 3.4). We do not assume any CCUS deployment until the second half of the 2030s. In the nearer term, abatement stems from energy efficiency improvements, bioenergy and electrification of heat. By 2050, 58% of abatement in industry is achieved by CCUS.
- **Agriculture.** Our abatement scenarios comprise abatement from existing uptake and future uptake of measures. Those further measures include better crops and soil management, improved livestock health measures and diets & breeding, better waste and manure management and fuel efficiency improvement. We also assume demand-side measures such as diet change and food waste reduction.
- **Land use, land-use change and forestry.** The main source for abatement in the LULUCF sector is afforestation. We assume a level of tree planting of around 4,000 hectares a year.

Box 3.2. Minimum, 80% and Maximum scenarios for Wales

The 'Wales Minimum' scenario achieves a reduction of 76% on 1990 levels by 2050, based on the set of actions that would contribute to an 80% reduction at UK level. In order to produce a scenario that achieves the required minimum 80% reduction on 1990 levels by 2050, we have added additional measures from the sectoral Max scenarios.

Around 57% of the additional abatement in the Wales 80% scenario comes from measures that offer benefits beyond greenhouse gas reduction, such as supporting the seven well-being goals of the Well-Being of Future Generations Act:

- **Forestry:** The Wales Minimum scenario includes planting rates increasing to around 2,000 hectares per year. For the Wales 80% scenario, we increase this to around 4,000 hectares per year, as under the Wales Max scenario. This would deliver around 40% of the additional abatement required to achieve a reduction of 80%.
 - This level of afforestation is less than the current Welsh Government aspiration of 100,000 hectares between 2010 and 2030, which averages 5,000 hectares a year. However, progress to date is far short of this, and it is not clear that this rate of planting can be achieved.

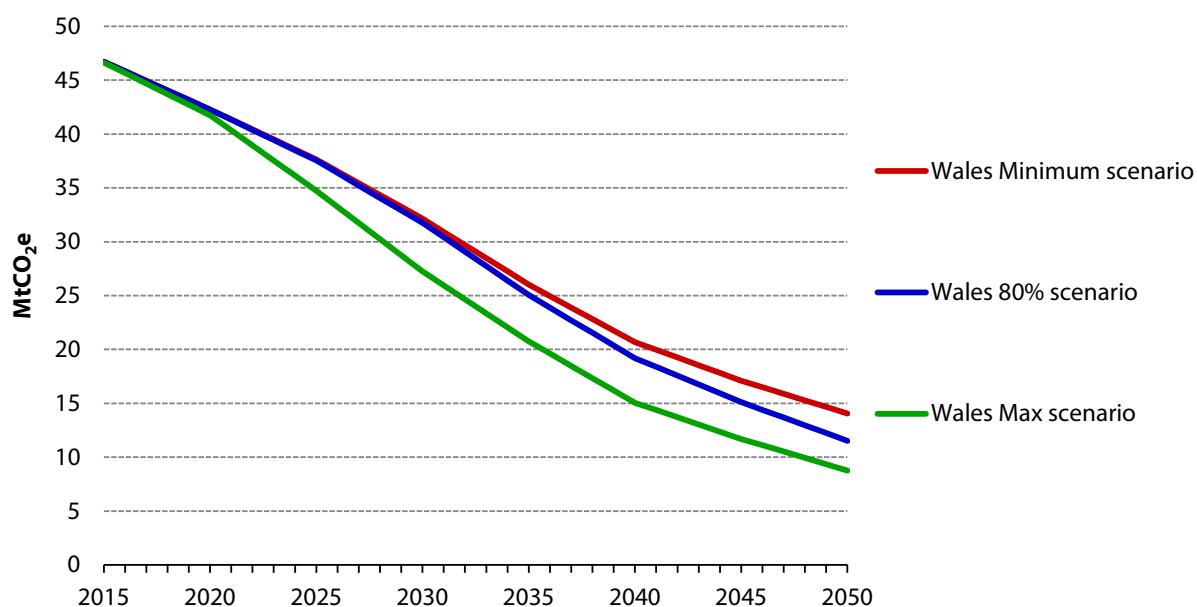
Box 3.2. Minimum, 80% and Maximum scenarios for Wales

- Afforestation has wider benefits, including creating new habitats for animals and reducing flood risk, in line with the seven well-being goals of the Wellbeing of Future Generations Act (Chapter 4).
- **Agriculture:** The Wales Minimum scenario does not include demand-side measures, such as diet change and reduction in consumer food waste. Inclusion of measures in these areas could deliver around 10% of the additional abatement required to achieve a reduction of 80%
- **Buildings:** The Wales 80% scenario includes further uptake of solid-wall insulation. This will deliver around 8% of the additional abatement required to achieve a reduction of 80%. There is potential for improved energy efficiency to improve comfort, reduce damp and reduce fuel poverty.

The remaining third of the additional abatement required for the Wales 80% scenario has only limited co-benefits. When deciding which additional measures to include, we focused on those that are most deliverable or impose least costs on the Welsh society. For example, we did not include more CCUS in the industry sector, due to greater deployment challenges in Wales. Instead, we included the following measures:

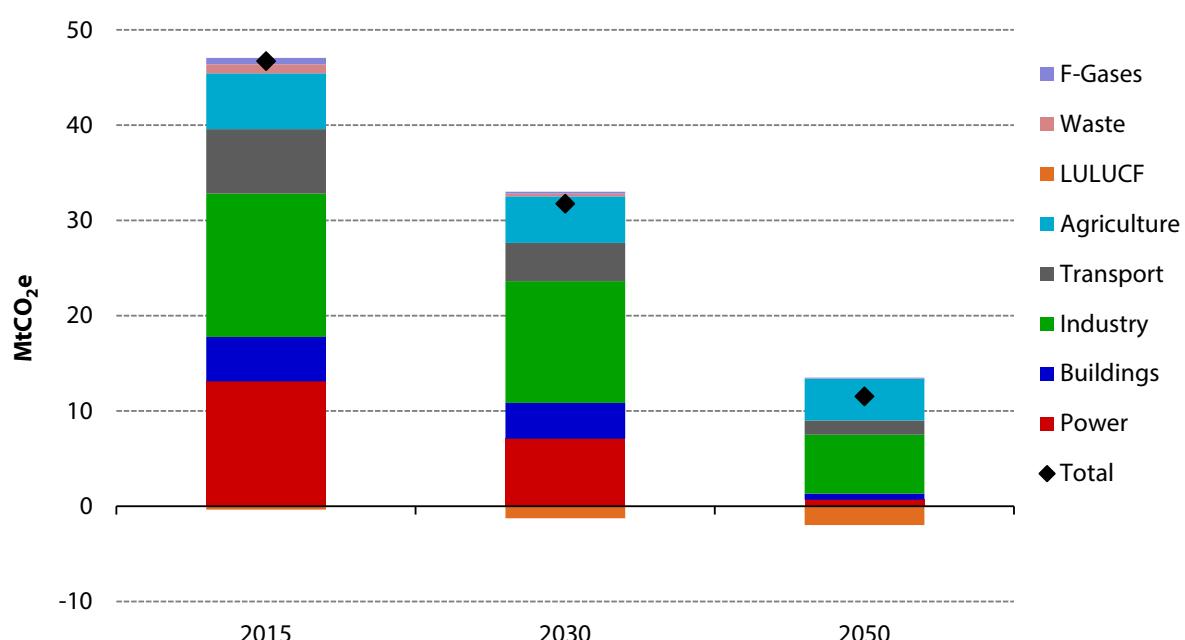
- **Power:** The Wales Minimum scenario includes around 4 TWh of electricity generated by gas plants in 2050. Our Wales 80% scenario reduces this level of generation by half, consistent with the Wales Max scenario. Up to 2030, we assume gas generation consistent with the Wales Minimum scenario, then reducing steadily until reaching the Max scenario generation level in 2050. This could be consistent with lower overall unabated gas generation on the GB system or a lower Welsh share of gas capacity by 2050. This would deliver around 28% of the additional abatement required to achieve an 80% reduction in 2050.
- **F-Gases:** For the Wales 80% scenario, we include the Wales Maximum scenario abatement level for F-Gases. This would deliver around 3% of the additional abatement required to achieve an 80% reduction in 2050.
- **Buildings:** Additional to the further uptake of solid-wall insulation, we also include further uptake of high-temperature waste heat from the industry and power sectors and further uptake of air source heat pumps. Both measures can be implemented at similar costs to other measures to reduce buildings emissions in the Wales Minimum scenario. This would deliver around 12% of the additional abatement required to achieve an 80% reduction in 2050.

Figure 3.5. Emissions paths for Minimum, 80% and Maximum scenarios for Wales



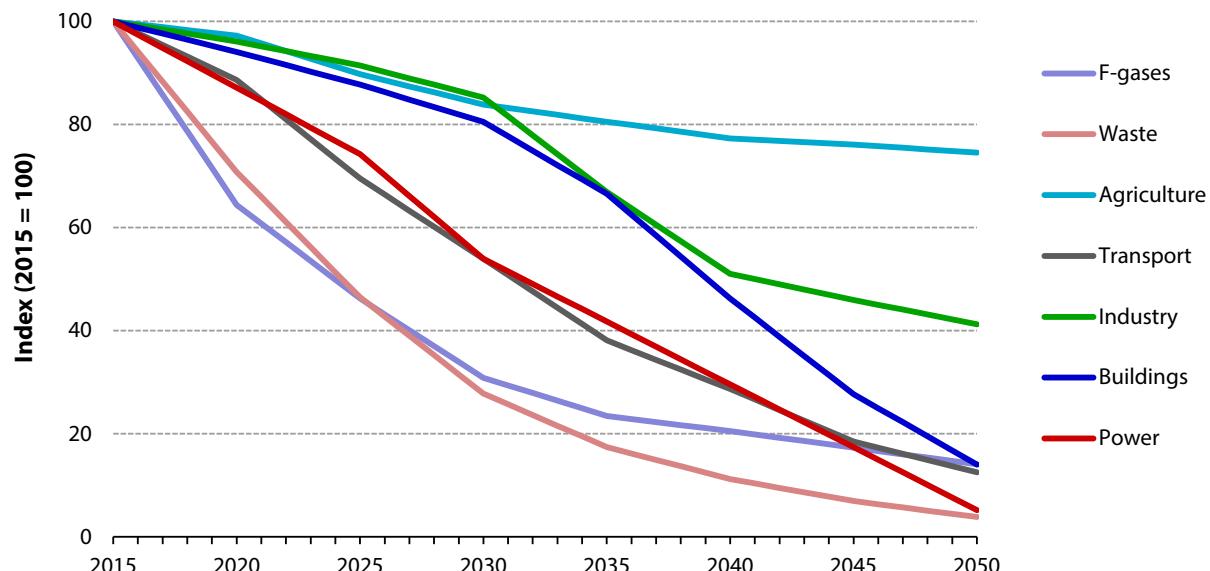
Source: CCC analysis.

Figure 3.6. Sectoral contributions to emissions reductions in the Wales 80% scenario (2015, 2030, 2050)



Source: CCC analysis.

Figure 3.7. Sectoral emissions reductions in the 80% scenario (2015-2050)



Source: CCC analysis.

Box 3.3. Assumptions on gas-fired generation in the CCC scenarios for Wales

In 2015, 16% of Welsh power generation was from renewables, 12% was from nuclear, with 51% of Welsh power emissions and 24% of Welsh generation coming from the coal-fired plant at Aberthaw and the remainder of emissions and 48% of generation coming from gas-fired plants.

The key developments that affect emissions from the Welsh power sector relate to the operation of fossil-fired plants:

- Although low-carbon generation is important in decarbonising the overall GB system, from a system-wide perspective low-carbon generation could equally be in Wales, England or Scotland.
- It is unlikely that the level of low-carbon power generation in Wales will affect the load factors and therefore emissions of the Welsh fossil plants significantly.²⁴

In developing scenarios for future Welsh power sector emissions, it is necessary to consider the type and size of operating fossil-fired capacity, together with the extent to which they will operate across the year:

- Emissions from the Aberthaw plant will cease by 2025 at the latest, under the UK Government's commitment to phase out unabated coal-fired generation by that date (see section 2).
- With the exception of Wales' newest CCGT plant (Pembroke), Welsh gas-fired plants currently operate at average load factors significantly below those for gas capacity across the rest of the GB system. In 2015, load factors for gas plant Wales were 14% (excluding Pembroke, which generated at 61%), compared with 33% for the GB-wide system.

²⁴ See modelling by Imperial College London published alongside this advice.

Box 3.3. Assumptions on gas-fired generation in the CCC scenarios for Wales

- By 2030, our published scenarios at a UK level have a similar level of unabated gas-fired generation as in 2015, with the coal ultimately replaced by low-carbon generation.²⁵ However, it is expected that as a result of the coal phase-out gas generation will increase temporarily to compensate in the mid-2020s, while low-carbon capacity continues to ramp up.
- By the 2030s, it is likely that gas capacity will be broadly divided into plants with carbon capture and storage (CCS) that operate at relatively high load factors and unabated plants that operate at significantly lower load factors. Given the challenges relating to deploying CCS in South Wales, it is likely that the majority of any new gas capacity in Wales will be in the latter category.

Wales already has 5.5 GW of gas-fired capacity, which is high as a share of GB gas-fired capacity (around 18% of gas capacity compared with around 6% of electricity consumption). However, in terms of new-build capacity, it appears likely that the share will be considerably smaller as Wales has only 4% of proposed gas projects with planning permission:

- For GB as a whole, the capacity of gas-fired projects that have planning permission but have not commenced construction is 21 GW.²⁶
- In Wales, there are only three small gas-fired projects that have planning permission but are not under construction, with a capacity totalling just under 900 MW. The capacity of each (299 MW) is just below the 300 MW threshold for new plants to be 'CCS ready'.²⁷

The requirement for new-build gas capacity by 2030 on the GB system will depend on the precise retirement dates of existing gas capacity, but is likely to be well below the 21 GW already with planning permission. However, it is uncertain which of those projects that already have planning permission, or any new projects, will actually be built.

Our assessment is therefore that it is reasonable to anticipate limited new build of gas-fired capacity in Wales, and that capacity added will operate at relatively low load factors in the longer term. Fossil-fired plants on the GB system derive revenue both from the electricity generated and from the provision of capacity. A lower load factor for a gas plant need not mean lesser profitability of that plant, as it will still be rewarded for providing capacity.

We have not assumed any deployment of CCS on power generation in Wales, given the constraints relating to access to CO₂ storage. To the extent that this is deployed on the UK system, we assume that it happens closer to likely CCS clusters (e.g. down the East coast).

In constructing our scenarios we have assumed:

- **UK Carbon Budgets scenario.**
 - To 2030, gas generation equivalent to the existing level of Welsh gas-fired capacity operating at load factors similar to those for unabated gas plants across the GB system as a whole and within a GB system that reaches 100 gCO₂/kWh by 2030. This could also be consistent with a situation in which some limited new gas capacity is built in the 2020s but where average load factors on gas plant remain below the GB average.

²⁵ CCC (2015) *Power sector scenarios for the fifth carbon budget*.

²⁶ Based on the National Infrastructure Planning Register of Applications (planninginspectorate.gov.uk) and the EMR Delivery Body Capacity Market Prequalification Database (emrdeliverybody.com).

²⁷ In 2009, Section 36 of the UK Electricity Act 1989 (licensing of power plants) was amended to implement the CCS Directive requirement that all new combustion power plants over 300MW must be constructed as CO₂ Capture Ready.

Box 3.3. Assumptions on gas-fired generation in the CCC scenarios for Wales

- To 2050, we assume that Wales's share of gas capacity within the GB system remains at the 2030 level (around three times higher than the share of electricity consumption), within a system that reaches 20 gCO₂/kWh by 2050.
- **Max scenario.**
 - To 2030, gas generation equivalent to the existing level of Welsh gas-fired capacity operating at load factors similar to those for unabated gas plants across the GB system as a whole and within a GB system that reaches 50 gCO₂/kWh by 2030. This could also be consistent with a situation in which some limited new gas capacity is built in the 2020s but where average load factors on gas plant remain below the GB average.
 - To 2050, we assume that Wales's share of gas capacity within the GB system reduces from the 2030 level to half the level in the UK Carbon Budgets scenario (still around 50% higher than the share of electricity consumption), within a system that reaches 20 gCO₂/kWh by 2050.

For the purposes of the Wales 80% scenario we have assumed that the UK Carbon Budgets scenario occurs to 2030, with a transition to the Max scenario by 2050 given the need for extra emissions reductions to achieve an 80% reduction (Box 3.2) and the expected retirement of all currently existing gas plant by that date.

Box 3.4. Carbon capture utilisation and storage (CCUS) in the CCC scenarios for Wales

In our UK scenarios, deployment of carbon capture and storage (CCS) plays a very important role to 2050, in providing a pathway for the partial decarbonisation of 'hard to decarbonise' industry, as well as in maximising the emissions savings from bioenergy and providing extra decarbonisation options for other sectors (e.g. power and heat). Without CCS, we have estimated that the cost of meeting the UK 2050 target would approximately double, due to the need to find additional emissions savings to offset the lost opportunities in industry and with bioenergy.²⁸

Use of CCS implies the permanent sequestration of CO₂ in a geological formation, such as a depleted oil or gas field, or a saline aquifer. Overall the UK is very well placed for access to potential storage sites, with offshore opportunities available particularly down the east coast of the UK, but also in the Irish Sea. The Irish Sea sites provide an opportunity to abate industrial emissions in North Wales. However, there are no identified sites close to South Wales, where most of the large Welsh industry emissions point-sources are situated (Figure B3.4a).

Whilst sites in South Wales are not in close proximity to identified potential CO₂ storage facilities, it could be possible to transport the CO₂ by ship to where it can be sequestered. The additional costs of this, compared to CCS without shipping, are around £20 per tonne of CO₂ abated. Although this raises the costs of applying CCS to CO₂ sources in South Wales, it could still be worth undertaking this abatement in Welsh industry, as the costs are still below the value of carbon saving (see Box 4.1 and our accompanying Technical Annex). We do not assume that CCS is applied to large-scale use of bioenergy nor to fossil power generation in Wales.

Captured CO₂ can alternatively be used as a feedstock in industrial applications, known as carbon capture and utilisation (CCU). Given the challenge of deploying CCS, CCU may be attractive for industry based in South Wales. Tata Steel are currently supporting CCU research through the FLEXIS project. However, there are questions over the extent to which CCU can directly substitute for CCS:

²⁸ CCC (2012) *The 2050 Target*.

Box 3.4. Carbon capture utilisation and storage (CCUS) in the CCC scenarios for Wales

- The scale of the opportunity for CCU, which depends on the how large a market can be developed for the CO₂, is not yet clear.
- There is a question over the extent to which CCU would lead to a permanent reduction in emissions, given that CCU does not always entail permanent sequestration of CO₂.
- Even if CCU leads to an overall reduction in emissions, it is not clear what the balance would be between reductions that would occur within Wales as opposed to in other countries. While emissions reductions are welcome regardless of where they occur, the emissions reductions from undertaking CCU in Wales may not be reflected fully within Welsh progress against targets.

In constructing our scenarios we have assumed that carbon capture, utilisation and storage (CCUS) can save 5-6 Mt of Welsh emissions by 2050 (Figure B3.4b). For the purposes of quantifying the emissions saving and the costs of this abatement, we have assumed that CCS is applied to a significant amount of Welsh industry, with the CO₂ being transported to a storage network by ship.

The assumed emissions reductions could instead result from CCU or a mixture of CCU and CCS. There is potential for some of these reductions to be substituted by switching to a low-carbon fuel such as hydrogen, although some of the potential to abate emissions from cement and steel production relate to capturing CO₂ emissions from chemical reactions, which would not be fully avoided by provision of lower-carbon energy.

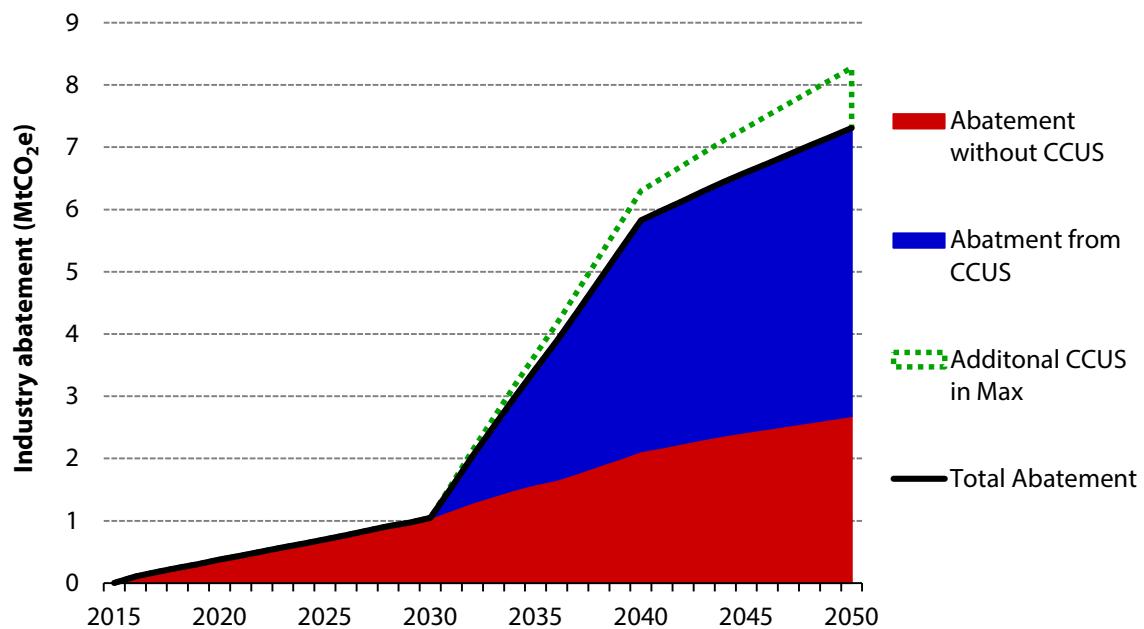
The deployment of CCUS in our Welsh scenarios starts in the late 2030s, and is towards the end of the window of UK deployment, reflecting the greater practical difficulty and cost in the Welsh context relative to other parts of the UK.

Figure B3.4a. Location of large point-source industrial CO₂ emissions in Wales



Box 3.4. Carbon capture utilisation and storage (CCUS) in the CCC scenarios for Wales

Figure B3.4b. Contribution of carbon capture utilisation and storage to our industry scenarios



Source: CCC analysis.

Chapter 4: Economic costs and wider well-being benefits



When building our scenarios for decarbonisation in Wales, we take the economic costs to society of abatement measures into account. Decarbonisation also offers other benefits to society beyond mitigating climate change. The wider well-being benefits of action are emphasised in Wales, under the framework of the Well-Being of Future Generations Act. In developing the Wales 80% scenario, we also took these wider well-being benefits into account when selecting ways of reducing greenhouse gas emissions.

This chapter sets out the economic costs and wider well-being benefits of action to tackle climate change, in two sections:

1. Economic costs of abatement
2. Wider well-being benefits of decarbonisation

1. Economic costs of abatement

The Wales Minimum scenario is based on the Welsh contribution to meeting the Committee's Central scenario to meet UK carbon budgets.²⁹ This scenario is primarily built up from a detailed assessment of actions that are cost-effective against the UK Government's carbon values for policy appraisal, designed to be consistent with action required under the UK Climate Change Act (Box 4.1).

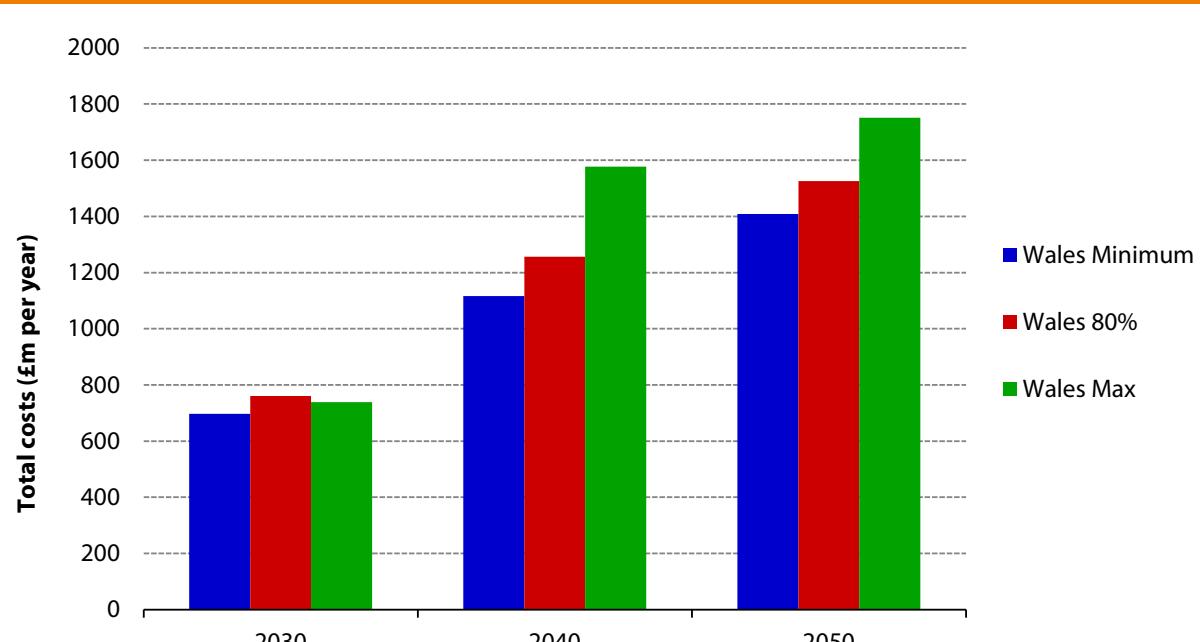
In assessing the economic costs to society of reducing emissions in Wales, we have largely used the cost estimates that were derived for the Committee's advice on the UK's fifth carbon budget. Even so, in the Welsh context the average costs of reducing emissions will be different, as the pattern of measures to reduce emissions will be different for Wales than that for the UK as a whole. That is reflected in the cost estimates presented in this Chapter.

The social costs we represent in this chapter should not be interpreted as fiscal costs to the Welsh Government or as costs that Welsh businesses or consumers have to carry. Many of the actions to reduce emissions will be paid for at UK level. We provide estimates of the costs of taking action but do not identify how these will be paid for, either in terms of policy design or who pays.

Our assessment of costs has been undertaken for the Wales 80% scenario, which underpins the recommended targets. It is worth noting that due to more measures with net benefits (e.g. behavioural and efficiency measures that reduce energy consumption), the Wales Max scenario does not start to add costs compared to the other scenarios until the late 2020s (Figure 4.1). However, within this we do not attribute any additional costs to the additional power sector emissions reductions in the Max scenario, as we assume that this scenario only transpires if cost reductions are achieved for low-carbon generation technologies.

²⁹ CCC (2015) *Sectoral scenarios for the fifth carbon budget*.

Figure 4.1. Welsh abatement costs in all three scenarios



Source: CCC analysis.

Where relevant, we have made comparison against the costs for the UK Central scenario from the Committee's fifth carbon budget advice.³⁰ Our assessment is that the costs of reducing emissions in Wales are broadly comparable to those in the UK as a whole:

- Based on our Wales 80% scenario, we estimate that annual abatement costs would be around 6% of total UK costs of decarbonisation in 2030, falling to around 5% by 2050 (around £0.8 billion in 2030, around £1.6 billion in 2050) (Figures 4.1, 4.2). For comparison, Wales currently comprises around 5% of UK population, 3% of UK GVA and 9% of UK greenhouse gas emissions.
- In the medium term costs are estimated to be slightly higher in Wales than the UK, but by 2050 the costs for Wales are lower than the UK average (Figure 4.3).
 - The lower cost in Wales in 2050 is partly because the relatively expensive emissions reduction from bioenergy with carbon capture and storage (BECCS) in the UK analysis has not been included for Wales.
 - Therefore, although it is more difficult for Wales to achieve the same overall degree of abatement by 2050, the average cost of what can be achieved is lower than that for the UK as a whole.
- The most cost-effective sector for abatement is the agriculture sector, whilst social costs in the power sector are high and costs in the industry sector increase in the 2040s and 2050s (Figure 4.4).

³⁰ CCC (2015) *Advice on the fifth carbon budget*.

Box 4.1. Methodology to assess economic costs of abatement

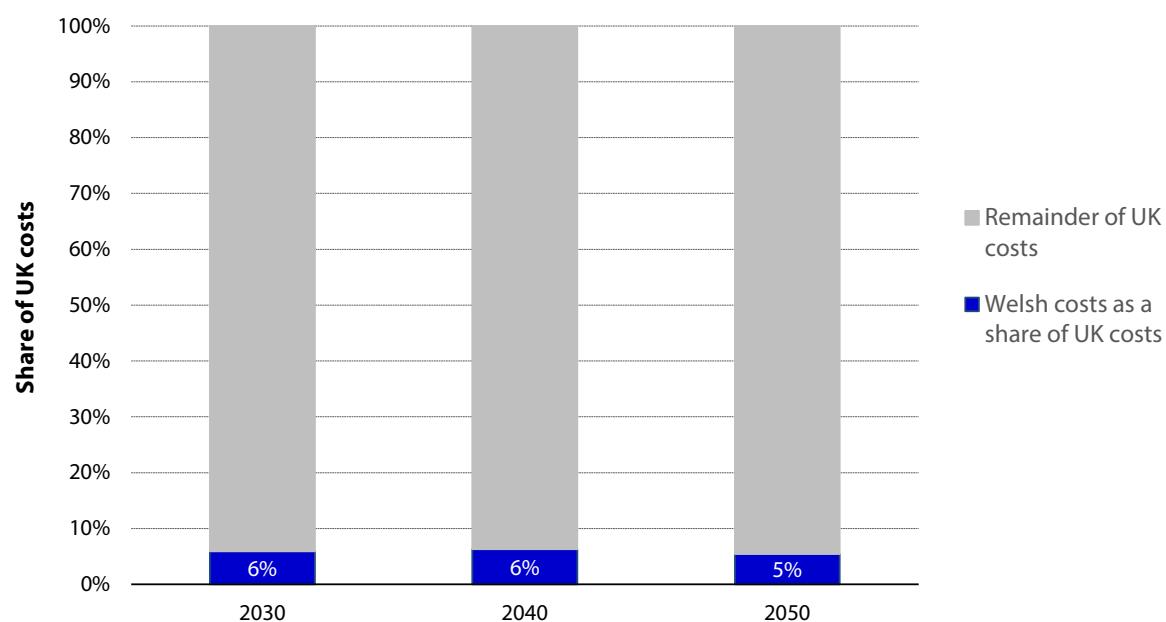
We use the UK Government's carbon values to assess whether low-carbon investments represent good value. Every abatement measure has an associated cost per tonne of CO₂e abated. These unit costs represent social cost, i.e. they estimate the cost of abatement to the whole of society in monetary terms. These costs can be negative (i.e. net benefits), for example in the case of efficiency improvements. Negative costs occur when the total costs to society would be negative, but the costs that have to be carried by the consumer / business are too high. The government can intervene to lower those barriers.

For a few of the sectors, we deviate from the above described methodology. We currently do not have enough evidence to estimate abatement costs in the F-gas sector or for international aviation and shipping. Costs for these sectors are not included in our estimates for Wales or the UK.

Our approach for estimating costs in the power sector differs from our methodology for the other sectors. Wales is part of the wider power system in Great Britain, within which it is relatively unimportant whether low-carbon generation occurs in Wales as opposed to England. Furthermore, Welsh power sector emissions relate to the quantity of fossil generation in Wales, but are not directly linked to the amount of low-carbon generation that occurs there. Therefore there could be a wide range of scenarios for Welsh low-carbon generation – from essentially no expansion to new capacity for tidal, nuclear, onshore wind and solar – that could be consistent with the emissions levels assumed in our advice.

Rather than linking our cost estimates to a particular scenario for Welsh low-carbon generation, we instead take a Welsh share of the costs of expanding low-carbon generation across the GB system, based on estimates of its share of electricity consumption.

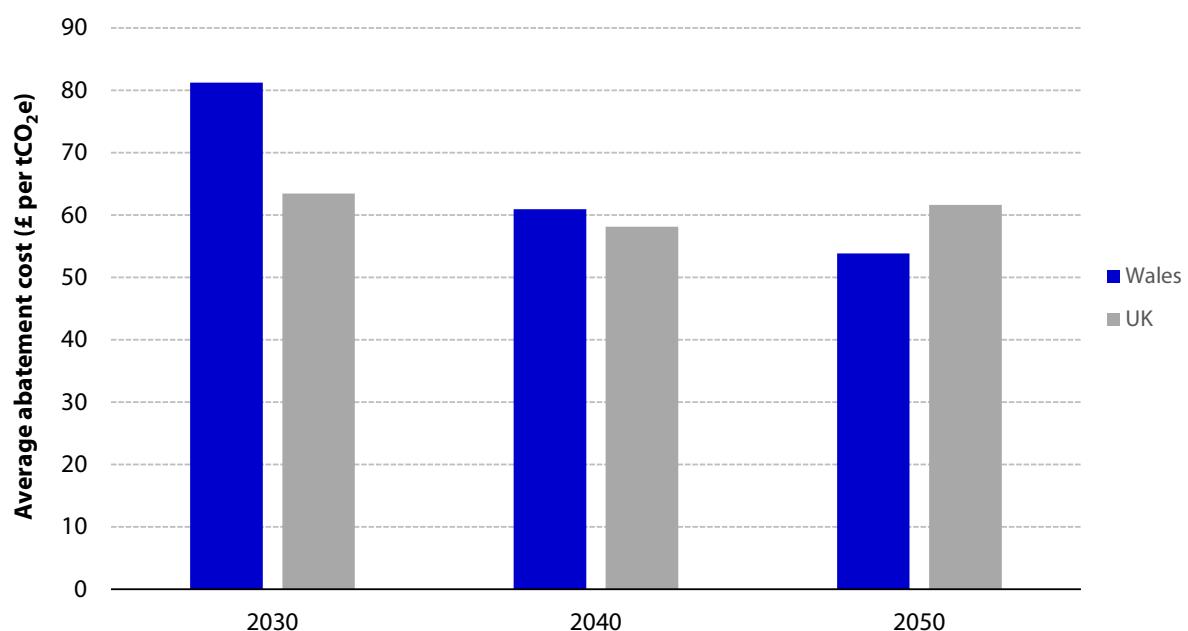
Figure 4.2. Welsh abatement costs as a proportion of UK abatement costs (2030, 2040 and 2050)



Source: CCC analysis.

Notes: Costs presented for Wales relate to the Wales 80% scenario, which underpins the recommended targets. Costs for the UK as a whole relate to the Committee's Central scenario from the advice on the fifth carbon budget.

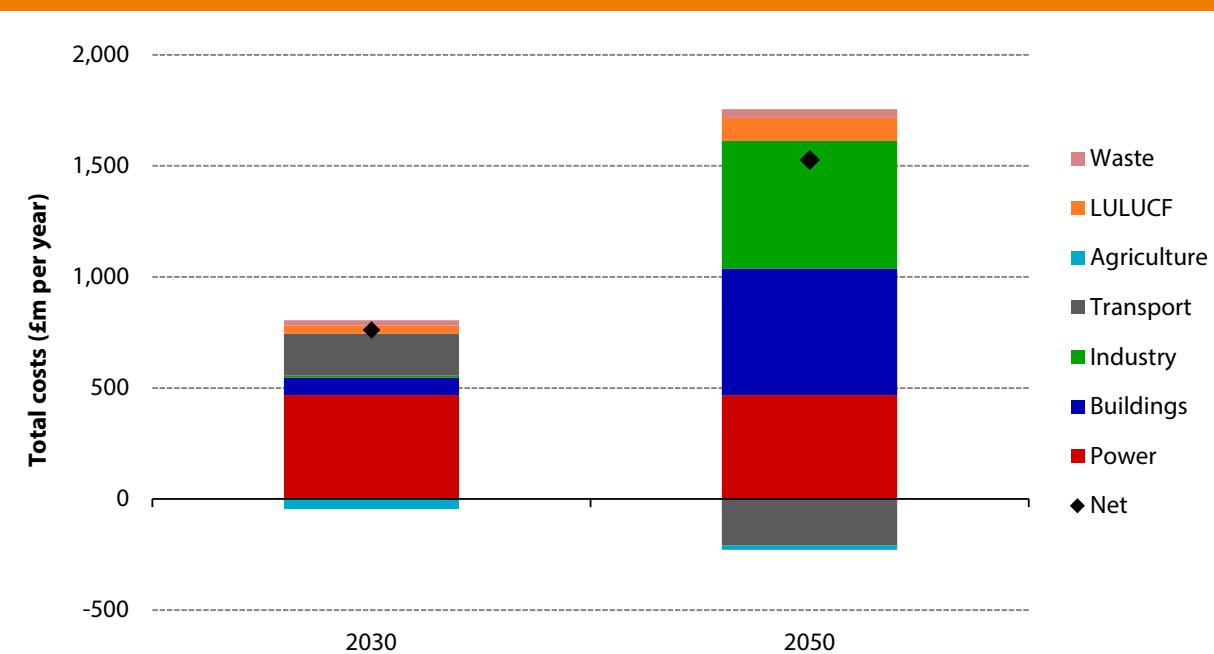
Figure 4.3. Average abatement costs in Wales and the UK as a whole (2030, 2040 and 2050)



Source: CCC analysis.

Notes: Costs presented for Wales relate to the Wales 80% scenario, which underpins the recommended targets. Costs for the UK as a whole relate to the Committee's Central scenario from the advice on the fifth carbon budget.

Figure 4.4. Social abatement costs in 2030 and 2050 by sector in the Wales 80% scenario



Source: CCC analysis.

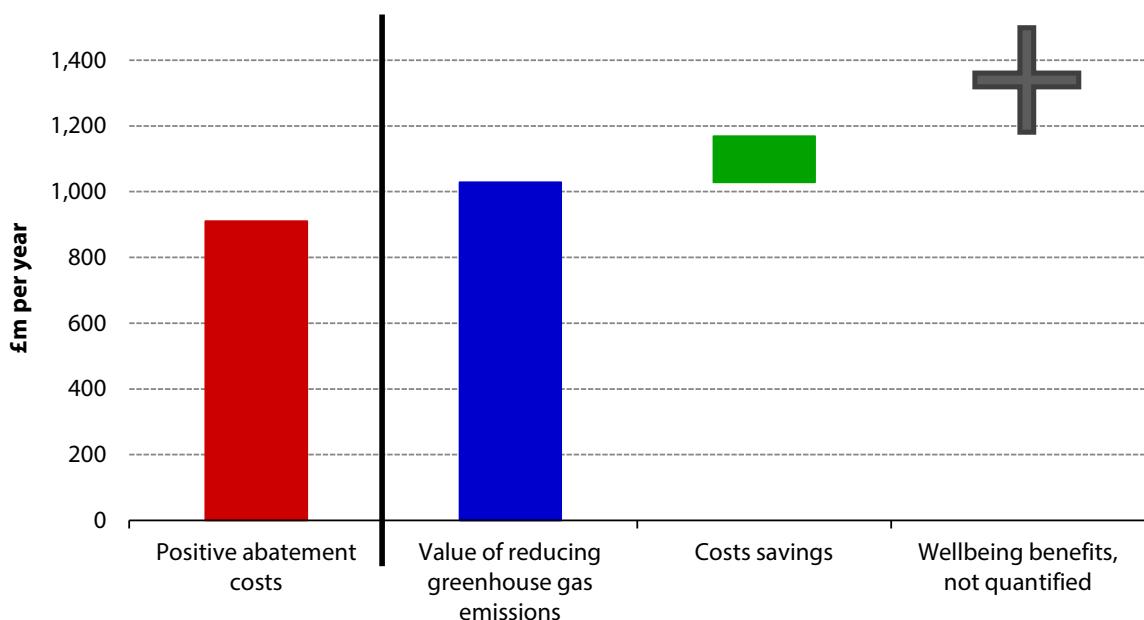
The economic costs presented in this chapter can be divided into measures with positive costs and those with cost savings:

- Abatement measures that are not cost-effective without consideration of climate change will be costly to society in monetary terms.
- Some abatement measures provide cost savings, even excluding consideration of climate change (e.g. through efficiency gains).

We can measure the value of mitigating climate change by applying the BEIS carbon value. This shows that the value of the greenhouse gas emission reduction, that the Wales 80% scenario alone would deliver, outweighs the costs of mitigation. Together with cost savings, the Wales 80% scenario delivers a significant net benefit to Welsh society (Figure 4.5).

In addition, there are well-being benefits of these abatement measures that go beyond decarbonisation. Some of these benefits are difficult to quantify in monetary terms, but can be very significant. Section 2 of this chapter describes these wider benefits in more detail.

Figure 4.5. The Wales 80% scenario's carbon and other benefits outweigh the costs (2030)



Source: CCC analysis.

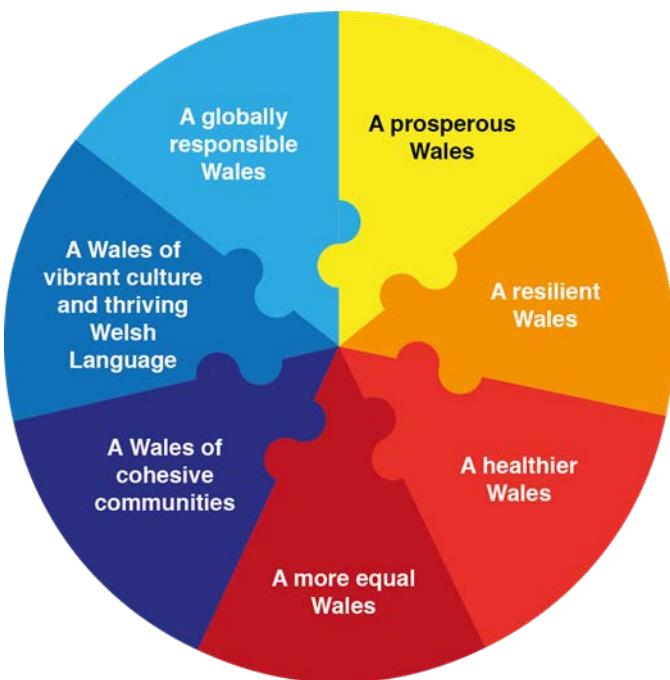
Notes: Measures have been separated into those that have a net cost and those that are cost-saving. The value of reducing greenhouse gas emissions is based on UK Government appraisal values for 2030. These increase over time, and by 2050 the value per tonne of abatement is nearly three times that in 2030; by contrast the average costs of abatement fall between 2030 and 2050 (Figure 4.3).

2. Wider well-being benefits of decarbonisation

Wales has a holistic approach to sustainable development with the Well-Being of Future Generations Act (WFGA). The Act puts sustainable development at the centre of government and the public service in Wales. It established the Future Generations Commissioner for Wales, who has identified climate change as one of four emerging priorities.

Our scenarios in this advice are developed with a focus on decarbonisation, but many of the abatement measures in our scenarios deliver not only reductions in greenhouse gas emissions but also benefits in other areas. We assessed these co-benefits using the framework of the WFGA and its seven well-being goals (Figure 4.6). Our assessment of co-benefits and wider impacts of decarbonisation directly influenced the development of our Wales 80% scenario, as outlined earlier (Box 3.2). This chapter describes the wider well-being benefits of decarbonising the Welsh economy along the lines of our scenarios.

Figure 4.6. The Well-being of Future Generations Act



Source: <http://gov.wales/topics/people-and-communities/people/future-generations-act/?lang=en>

Fuel poverty

Households in Wales are defined as being in fuel poverty if they spend 10% or more of their income³¹ on energy costs. A household is in severe fuel poverty if it spends 20% or more of its income on energy costs. The latest available estimates have suggested 23%-30% of households were in fuel poverty in Wales in 2016.³²

The importance of fuel poverty reduction has been recognised by the Future Generation Commissioner,³³ in terms of improved economic and environmental well-being, but also wider benefits such as improvements in health outcomes. Reducing fuel poverty has the potential to contribute to meeting the well-being goals such as 'a healthier Wales' and 'a more equal Wales':

³¹ including Housing Benefit, Income Support or Mortgage Interest or council tax benefits.

³² <http://gov.wales/docs/caecd/research/2016/160711-production-estimated-levels-fuel-poverty-wales-2012-2016-en.pdf>

³³ Well-being in Wales - Planning for a better tomorrow 2017. https://futuregenerations.wales/wp-content/uploads/2017/07/FGCW_Well-being_in_Wales-Planning_today_for_a_better_tomorrow_2017_edit.pdf

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- Most fuel-poor households include a child, older person, or someone who is disabled or has a long-term illness.
 - There is evidence that fuel poverty can lead to increases in respiratory illnesses and the risk of heart attack and stroke, and that cold homes are contributing towards excess winter death.
 - Wider negative impacts of fuel poverty are recognised by the Welsh Government in their Energy Efficiency Strategy. These include increased stress and levels of mental illness, as well as impacts on the educational attainment of children lacking a warm home to study and experiencing greater school absences due to illness.

We include a range of energy efficiency measures in our scenarios, including insulation of solid wall and cavity wall properties. The Wales 80% scenario includes additional insulation because of those benefits. This will provide benefits in terms of improved comfort and health outcomes as well as lower energy bills, the balance of which will depend on the extent to which the benefits of improved building efficiency are taken back in increased internal building temperatures:

- **Lower energy consumption.** If internal building temperatures are maintained, improved building efficiency will lead to lower energy consumption. This will lead to reduced energy bills and lower heating emissions.
- **Improved comfort.** Many households cannot afford to heat their homes to a comfortable level. For these households, improved energy efficiency may be 'taken back' in higher internal temperatures. This would leave bills and heating emissions less affected, but will tend to improve comfort levels and reduce health impacts resulting from cold, damp housing.

In our analysis we assume that when energy efficiency of homes is improved, 15% of the improvements to the energy performance of the building are taken back in higher comfort levels rather than leading to reductions in energy consumption and therefore emissions.

To achieve improved energy efficiency and reduced fuel poverty, measures should be carefully targeted. Lower-income households will need financial support to be able to retrofit their homes. The 2016 Energy Efficiency Strategy³⁴ has already acknowledged that "investment in energy efficiency is the most effective way to tackle fuel poverty" within the devolved powers. The Welsh Government should also work together with the UK where powers are reserved.

Air quality

Air pollution results from fuel combustion in energy generation, home heating, industrial processes and transport.

As well as damaging the environment, air pollution currently reduces average life expectancy by at least six months, according to Government estimates. In March 2017, Public Health Wales called air pollution a 'public health crisis' that is estimated to cause around 2,000 deaths per year in Wales. Air pollutants can also impact ecosystem services negatively (Box 4.2). Due to these significant impacts, tackling air pollution, a devolved matter, supports the seven well-being goals in the WFGA. National indicators include average nitrogen dioxide concentrations.³⁵

³⁴ <http://gov.wales/docs/desh/publications/160223-energy-efficiency-in-wales-en.pdf>

³⁵ <http://gov.wales/docs/desh/publications/160316-national-indicators-to-be-laid-before-nafw-en.pdf>

There has been some progress in reducing air pollution in Wales, but more is needed:³⁶

- Emissions of almost all pollutants have decreased significantly since 1990, with the exception of ammonia (NH_3), which has only decreased by 5% since 1990. Ammonia emissions mainly occur in the agriculture sector and contribute to acid deposition and eutrophication, which in turn can lead to potential changes occurring in soil and water quality, putting ecosystems at risk.
- Since 2010, emissions of carbon monoxide and ammonia have increased by 7% and 6% respectively. Of the main air pollutants, only sulphur dioxide (SO_2) has shown a significant decrease (-30%).

Reducing vehicle emissions and a switch away from unabated coal-fired power will reduce air pollution. There are, however, trade-offs between reducing GHG emissions and air quality in burning biomass, especially as a replacement for gas in heating.

Our scenarios contain a range of measures that would improve air quality in Wales:

- **Reduced combustion of coal.** The closure of the Aberthaw coal-fired power plant will significantly reduce emissions of air pollutants.
- **Switch to ultra-low-emission vehicles.** A switch away from internal combustion engine vehicles will lead to a significant reduction in emissions of pollutants from petrol and diesel vehicles.
- **Switch away from polluting fuels for heating.** For off-gas grid properties, reduced fossil fuel combustion for heating is likely to lead to a reduction in air pollution. We assume relatively little use of biomass for residential heating, partly due to the potential impacts on air quality given the challenges in capturing pollutants from combustion at a small scale.
- **Afforestation.** Our Wales 80% scenario includes additional afforestation, planting around 66,000 hectares of new trees by 2030. As the State of Natural Resources report by Natural Resources Wales³⁷ outlines, trees contribute significantly to cleaner and healthier air. These benefits can be maximised by planting trees close to pollution hotspots, for example along transport corridors.

We note that air quality in Wales is the subject of current legal proceedings.³⁸

Box 4.2. Impacts of air pollutants

Air pollutants have a range of negative impacts on human health and ecosystems and habitats:

- Ammonia (NH_3) mainly occurs in the agriculture sector and contributes to acid deposition and eutrophication. These, in turn, can lead to changes in soil and water quality, putting ecosystems at risk and causing damage to forests, crops and other vegetation.
- Carbon monoxide (CO) is predominantly produced by road transport, in particular petrol vehicles. This gas prevents the normal transport of oxygen by the blood. This can lead to a significant reduction in the supply of oxygen to the heart, particularly in people suffering from heart disease.

³⁶ NAEI (2017) *Air Quality Pollutant Inventories for England, Scotland, Wales and Northern Ireland: 1990 - 2015*

³⁷ <https://naturalresources.wales/evidence-and-data/research-and-reports/the-state-of-natural-resources-report-assessment-of-the-sustainable-management-of-natural-resources/?lang=en>

³⁸ <http://www.bbc.co.uk/news/uk-wales-42228458>

Box 4.2. Impacts of air pollutants

- Nitrogen dioxide (NO_2) is created when nitric oxide, a transport and industrial emission, oxidises in the atmosphere. Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infections such as influenza. Continued or frequent exposure to high concentrations can cause increased incidence of acute respiratory illness in children.
- Sulphur dioxide (SO_2) is produced when a material, or fuel, containing sulphur is burned. The predominant source is power stations burning fossil fuels, principally coal and heavy oils. Even moderate concentrations may result in a fall in lung function in asthmatics. Tightness in the chest and coughing occur at high levels, and lung function of asthmatics may be impaired to the extent that medical help is required.
- Fine particulate matter (PM10, PM2.5 and PM1) is composed of a wide range of materials arising from a variety of sources including road traffic (both from internal combustion engines and other sources such as tyres). Fine particles can be carried deep into the lungs where they can cause inflammation and a worsening of the condition of people with heart and lung diseases.

Source: <http://www.welshairquality.co.uk/> and <https://www.eea.europa.eu/data-and-maps/indicators/eea-32-ammonia-nh3-emissions-1>

Active travel

There are significant co-benefits to health of active travel, such as walking and cycling. Lack of exercise is clearly linked to diabetes, dementia, depression, heart disease and some cancers. This is reduced by greater use of active travel (i.e. walking and cycling).

Our scenario avoids around 6% of projected car journeys by 2030. These avoided journeys are compensated by a combination of increased public transport, active travel and avoided journeys. This corresponds to a reduction in car-kilometres driven of 1%. Assuming one-third of the reduction in car-kilometres is due to active travel, the health benefits are worth more than £14m in 2030. This has a greater impact on greenhouse gas emissions in the near term, as emissions per kilometre will fall over time. However, even with a largely decarbonised vehicle fleet, active travel will still provide significant health benefits.

Natural capital

Natural capital comprises all ecosystem services that are provided by natural assets, including soil, air, water and all living things. Ecosystem services are the benefits people obtain from ecosystems. The concept of ecosystem services and how they contribute to well-being in Wales is described in the 'State of Natural Resources Report. Chapter 5: Well-being in Wales' (Box 4.3). Based on this assessment, improving natural capital and enhancing ecosystem services supports the seven well-being goals of the WFGA.

Box 4.3. State of Natural Resources report on ecosystem services and well-being

Chapter 5 of the State of Natural Resources report focuses on well-being. It provides an assessment of the ecosystem services that contribute to well-being in Wales, using the seven well-being goals as a framework. The Millennium Ecosystem Assessment defines ecosystem services as:³⁹

- **Provisioning Services** are the products obtained from ecosystems, for example food or timber.
- **Regulating services** are benefits obtained from the regulation of ecosystem processes, such as water regulation or purification
- **Cultural Services** are the non-material benefits people obtain from ecosystems ,for example through spiritual enrichment, recreation or aesthetic experiences
- **Supporting Services** are necessary for the production of all other ecosystem services. Their impacts on people are either indirect or occur over a very long time, for example nutrient cycling, soil formation and provisioning of habitat.

The State of Natural Resources report outlines how our natural assets (i.e. the soil, air, water and living things in Wales) contribute to Wellbeing in Wales:

- **Resilient Wales Goal:** Natural resources and ecosystems support the functioning of social and economic systems, particularly the capacity to adapt to climate change. Welsh habitats contribute to social, economic and ecological resilience, ranging from purification of water by grasslands, flood risk management by woodlands or mental health and national identity provided by mountains, moorlands and heath.
- **Prosperous Wales Goal:** Food and fibre production and fisheries are significant contributors to Welsh GVA and employment. Other provisioning services include renewable energy and water supply. Water and hazard regulation, as well as the amenity value of 'green space' also contribute to a prosperous Wales.
- **Healthier Wales Goal:** Natural resources contribute to the physical health and mental well-being of people in Wales, both through health improvement and health protection. Regulation of air, water and soil quality offers significant health benefits and can increase people's life expectancy. Woodlands can contribute to flood management and other forms of hazard control, and also offer amenity and recreation benefits that have mental health benefits
- **Equal Wales Goal:** Ecosystems can help reduce risks to vulnerable people, such as flood risks or overheating. For example, urban trees can provide cooling and prevent night-time overheating.
- **Cohesive Communities Goal:** Connections between natural resources and people can shape communities. The provisioning of well-managed and attractive green-space can provide a safe space for residents and visitors.
- **Vibrant Culture and Welsh Language Goal:** Wales has three National Parks and 5 Areas of Outstanding Natural Beauty. Its iconic landscape and nature provide a large part of Welsh national identity and culture.
- **Globally Responsible Goal:** Ecosystems can play a significant role in reducing greenhouse gas emissions in Wales, contributing to the global effort to mitigate climate change. Ecosystems also contribute to Wales' international commitment to biodiversity improvements.

Source: Natural Resources Wales (2016). *State of Natural Resources Report (SoNaRR): Assessment of the Sustainable Management of Natural Resources*.

³⁹ Millennium Ecosystem Assessment: Ecosystems and Human Well-being: A Framework for Assessment
<http://www.millenniumassessment.org/documents/document.300.aspx.pdf>

Our scenarios include measures that will improve natural capital. Measures that offer significantly improved ecosystem services have been included at the Max scenario level in the Wales 80% scenario:

- **Provisioning services.** Our scenarios include an increase in renewable energy generation, potentially consistent with the Welsh Government's recently announced target to generate electricity equivalent to 70% of Welsh consumption by 2030.
- **Regulation services.** Our scenarios include the planting of around 60,000 trees, which will also contribute to improved air quality. Trees filter rain water before it reaches receiving waters, thus improving water quality. Strategic planting of trees on flood plains can also regulate flooding.⁴⁰ Trees also reduce storm water runoff and slow storm flow.
- **Cultural services.** Trees provide a range of cultural services, such as increased amenity benefits, increased mental health, educational benefits and spiritual well-being.⁴¹
- **Supporting Services.** In agriculture, our 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.

Due to the range of significant ecosystem service provisions and significant GHG abatement, we have included a very ambitious level of tree planting in our Wales 80% scenario of more than 66,000 hectares (ha) by 2030. It remains, however, at a level below the stated ambition of the Welsh Government (100,000 ha by 2030), reflecting that progress to date has been far below the rate necessary to meet the existing target.

Opportunities for the Welsh economy

The Future Trends report states that Wales has great untapped growth potential to generate energy from renewable sources. Renewable energy sources can bring a range of co-benefits to Wales, mainly supply chain benefits but potentially social and community benefits as well. This will not necessarily reduce GHG emissions in Wales directly, but contribute to reducing UK emissions and to mitigating climate change globally.

There are also considerable opportunities for low-carbon manufacturing in Wales, given the strength of the sector currently. A switch to production of low-carbon materials could be assisted via the procurement powers of the Welsh Government and public bodies, as well as UK Government.

We have previously recommended that carbon budgets should be flexible enough to allow for unexpected changes in Welsh industrial output. The recommended carbon budgets are designed with this flexibility in mind, and need not impact the Welsh economy and industry in a significant adverse way.

⁴⁰ Dixon, S. J., Sear, D. A., Odoni, N. A., Sykes, T., and Lane, S. N. (2016) *The effects of river restoration on catchment scale flood risk and flood hydrology*. Earth Surf. Process. Landforms, 41: 997–1008.

⁴¹ Tabbush, Paul (2010), *Cultural Values of Trees, Woods and Forests*. The Research Agency of the Forestry Commission.

Chapter 5: Recommendations



The Welsh Government requested advice from the Committee on the levels of the first two carbon budgets (covering 2016-20 and 2021-25) and the interim targets for 2020, 2030 and 2040, together with the highest level of achievable emissions reduction by these dates. We also include advice on the limits to the use of emissions credits and on policies to achieve the targets.

We set out our recommendations on each of those aspects in this Chapter. As some of these issues are inter-related, we have provided the advice in five sections:

1. Emissions reductions to 2050
2. Interim targets for 2020, 2030 and 2040
3. Carbon budgets to 2025
4. Use of emissions credits
5. Policies to meet the recommended targets

1. Emissions reductions to 2050

The Environment (Wales) Act set a target for 2050 to reduce emissions by at least 80% on 1990 levels. This is the same as that for the UK in the Climate Change Act 2008, which was derived as a contribution to a global emissions path aimed at keeping global temperature rise by the end of the century close to 2°C.

Following the Committee's advice in April 2017, this has now been defined as a reduction in actual Welsh emissions across all sectors, including the relevant shares of international aviation and international shipping emissions.

The Paris Agreement's ambition to limit warming to "well below 2°C, and to pursue efforts to limit it to 1.5°C" and to reach global net zero emissions in the second half of the century could imply going beyond an 80% reduction in emissions by 2050. There is a question over whether it is appropriate to set more ambitious targets now or whether it is better to wait until the evidence to support more ambitious targets is stronger. As the 2050 targets for both the UK and Wales specify a reduction of "at least 80%", neither precludes going beyond an 80% reduction.

The 'ratchet' mechanism created by the Paris Agreement sets a schedule of global stocktaking intended for nations to revisit their commitments and increase them when possible. At UK level, this creates a number of decision points over the next few years (Figure 5.1).

In our October 2016 report on *UK Climate Action Following the Paris Agreement*, we concluded that it is too early for the UK to set new, more ambitious, emissions targets. We do not currently have scenarios of the technologies and behaviours that the UK should deploy to reach zero-emissions, and there is already a significant shortfall in action to meet existing UK carbon budgets. In order for a new target to be credible it would need to be evidence-based, accompanied by strong policies to deliver existing targets and a strategy to develop greenhouse gas removals. These steps should be the priority for the UK Government.

In our advice to the Scottish Government on their new legislation, we highlighted the possibility to set a 2050 target for a reduction of more than 80%, based on the opportunity afforded by this new legislative process, the progress already made in Scotland (where emissions in 2015 were already around 40% below 1990 levels) and our evidence base that suggested that a reduction of 90% could be achieved in Scotland under a High Ambition scenario.

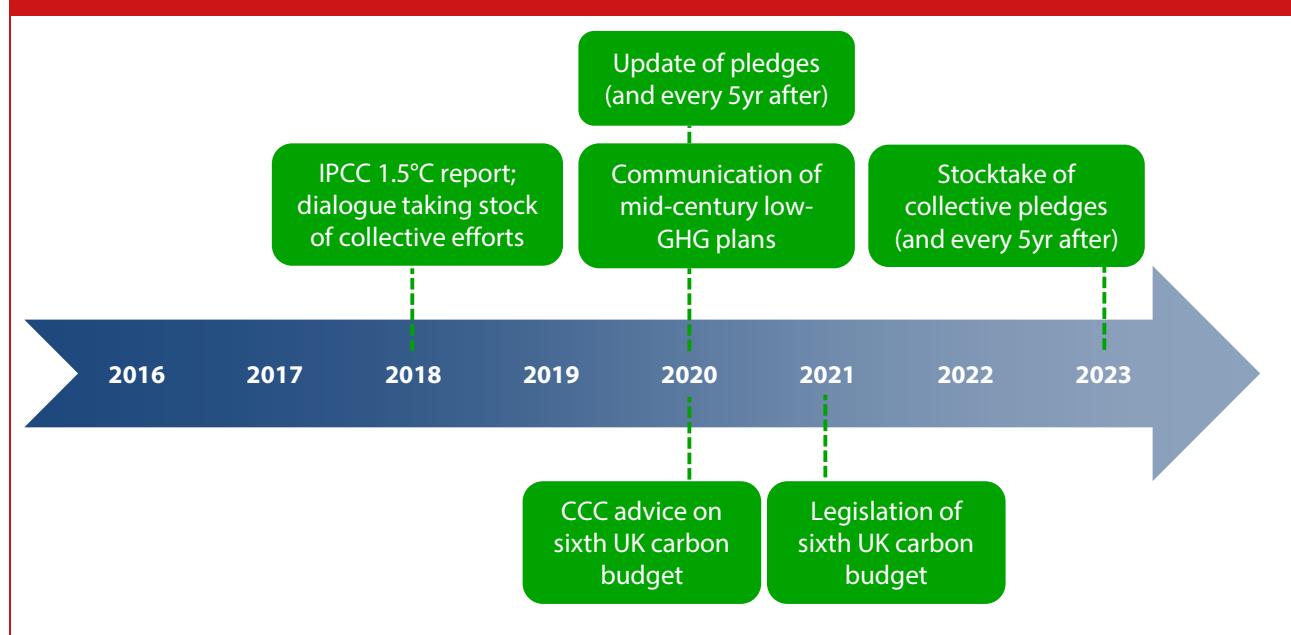
The analysis presented in Chapter 3 set out scenarios to 2050 for Welsh emissions. As Wales faces different challenges and opportunities to the rest of the UK in reducing emissions, a contribution towards meeting an overall 80% reduction for the UK is likely to achieve a reduction in Wales of 76% while the most ambitious scenario can achieve a reduction of 85% by 2050.

Given Wales's greater emissions from sectors that are difficult to decarbonise it is reasonable for Welsh per-capita emissions on a 'production basis' to remain higher in 2050 than average across the UK as a whole, and for Wales to achieve a slightly lesser percentage reduction on 1990 emissions.

Once the evidence base has been strengthened with regard to the implications of the Paris Agreement for the levels of domestic targets, the Committee could provide further advice to the Welsh Government on whether to increase the legislated 2050 ambition.

It will be important to ensure that actions taken in the nearer term keep open the possibility of reductions beyond 80% by 2050. We set out our approach to this for interim targets in section 2 below.

Figure 5.1. Timeline of decision points set by national and international legislation for reassessing UK emissions targets



2. Interim targets for 2020, 2030 and 2040

The scenarios we have developed for Welsh emissions over the period to 2050 (Chapter 3) provide the basis for our advice on interim targets for 2020, 2030 and 2040, as required under the Environment (Wales) Act.

The levels of emissions reduction recommended for 2020, 2030 and 2040 are based on the Committee's 'Wales 80%' scenario. For 2020 and 2030 this is very close to the level of reduction consistent with meeting UK carbon budgets (Figure 5.2):

- **We recommend a 2020 target for an emissions reduction of 27% on 1990 levels.**
- **We recommend a 2030 target for an emissions reduction of 45% on 1990 levels.**
- **We recommend a 2040 target for an emissions reduction of 67% on 1990 levels.**

Action to meet the medium-term targets should also keep open the option of going beyond a reduction of 80% by 2050, should this be necessary (e.g. to the reduction of 85% in the Wales Maximum scenario).

The Committee is of the view that targets should be set that are achievable but that require stretching policy ambition. Setting the target for 2020 presents a particular challenge:

- There are only around two years before 2020 begins, and by the time the target is placed in legislation there will be little more than one year. The scope for new policies to affect the level of emissions in 2020 is very limited, especially if the Welsh Government waits until after the target is legislated to bring forward policies to achieve it.
- There is a large amount of uncertainty over the future emissions from the Aberthaw coal-fired power station. It is reasonable to assume that there will be no emissions from this plant from 2025, the date committed to by the UK Government for phase-out of unabated coal generation. However, given the difficult economics of operating coal-fired plants, it is possible that emissions will drop sharply or cease well before 2025. If this were to occur before 2020, the level of 2020 emissions would be very strongly affected.

The Act requires an interim target to be legislated for 2020. There is no target that would be achievable should the Aberthaw plant continue to emit that would also be appropriate should it cease to do so.

It is therefore not appropriate simply to recommend a single number for the level of the 2020 target. Our recommendation is to allow for some continued generation from Aberthaw by 2020, and to adjust the target in the event of its closure prior to this:

- Our recommended 2020 interim target is set based on continued significant levels of emissions from Aberthaw to 2020. This implies a target for a reduction of 27% on 1990 levels (9% on 2015 levels).
- Should the Aberthaw coal plant cease to emit at significant levels prior to 2020, we recommend that the level of the target change to reflect this. This would imply a target for a reduction of 32% on 1990 levels (16% on 2015 levels).

The recommended level of the 2020 target allows it to be met in the case that the Aberthaw plant continues to generate. The recommended adjustment in the event of its closure would be important, to maintain the ambition of the target for the rest of the Welsh economy.

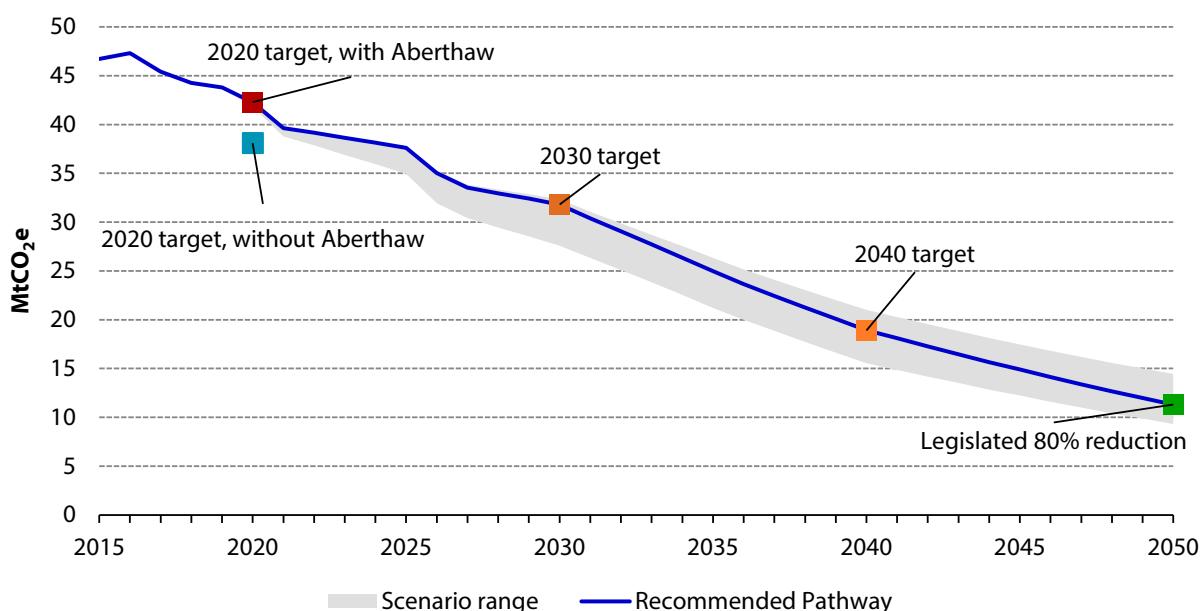
The recommendations for 2030 and 2040 are unaffected by uncertainty over the timings related to Aberthaw. We therefore provide a single level of the recommended target for each of these

years. The Act requires us both to provide advice on the levels of the targets and also to provide an estimate of the highest achievable reduction. We set these out in Table 5.1.

There is also potential for emissions from the industry sector to be significantly higher or lower level of emissions than we have assumed. Our projections assume that Welsh industrial output will remain broadly similar to today, but it may be that industrial output turns out to be significantly higher or lower:

- As we recommended in our advice on the design of the targets, should industrial output, and therefore emissions, turn out to be significantly higher than currently projected, this could justify either a loosening of the targets or the purchase of emissions credits to the extent that this effect cause the targets to be missed.
- Should industrial output turn out to be significantly lower than currently projected it may be appropriate to tighten the legislated targets, in order to maintain the intended overall level of ambition from other sectors.

Figure 5.2. Recommended targets and emissions scenarios for Wales over the period to 2050



Source: CCC analysis.

Table 5.1. Recommended targets and highest achievable emissions reduction (2020, 2030 and 2040)

	2020 with Aberthaw	2020 without Aberthaw	2030	2040
Recommended target	-27%	-32%	-45%	-67%
Highest achievable reduction	-28%	-35%	-53%	-74%

3. Carbon budgets to 2025

As well as the interim targets, the Act requires the setting of carbon budgets for five-year periods aligned with the Welsh parliamentary cycle. The first two of these carbon budgets, covering the periods 2016 to 2020 and 2021 to 2025, must be legislated by the end of 2018. The third carbon budget, for 2026 to 2030, must be set by the end of 2020.

Similar to the setting of the interim target for 2020, making a recommendation for the level of the first carbon budget is very challenging and affords almost no opportunity for policy to drive emissions reductions so that it can be met:

- The most recent available emissions data for Wales are for 2015. Assessing the appropriate level of the carbon budget for the period 2016 to 2020 requires:
 - Estimation of emissions for periods already passed (i.e. 2016 and a large part of 2017), based on analysis of what data is available relating to emitting activities in Wales since 2015; and
 - Projection of emissions for 2018 to 2020, based largely on continuation of existing trends and policies, given little scope for new policies to affect emissions.
- An important driver of Welsh emissions over this period will be the amount of generation from the Aberthaw coal-fired plant.

Whether the first carbon budget is met or missed is likely to be determined by whether the Committee has tended to under- or over-estimate emissions that have already occurred and those already locked in, rather than the effect of new policies to reduce emissions in Wales.

As the Environment (Wales) Act requires that a carbon budget is set for this period, we provide a recommendation in Table 5.2 for a reduction of 23% on average against 1990 emissions. In order to maintain the overall ambition of the budget, we provide alternative levels of the budget in the case that the Aberthaw coal plant ceases to emit by 2020.

Table 5.2. Recommended level of the first Carbon Budget

	Recommended budget (assuming Aberthaw operates to 2020)	Adjusted budget if Aberthaw closes in 2019	Adjusted budget if Aberthaw closes in 2018
Level of Carbon Budget 1 (average reduction from 1990)	-23%	-24%	-25%

Setting the second carbon budget is less problematic, as there is greater time for policy to respond to this challenge. Our recommended level for the second carbon budget is for a reduction of 33% on average against 1990 emissions.

This assumes that the Aberthaw plant is limited to operating for 1,500 hours per year, required under the Limited Hours Derogation to the Industrial Emissions Directive (IED) for plants that fail to fit equipment to meet the full IED requirements. Again, should Aberthaw close prior to 2025, we recommend that an appropriate quantity of emissions is removed from the budget in order to maintain the overall level of ambition (Table 5.3).

Table 5.3. Recommended level of the second Carbon Budget

	Recommended budget (assuming Aberthaw operates to 2025)	Adjusted budget with earlier Aberthaw closure				
		In 2024	In 2023	In 2022	In 2021	By 2020
Level of Carbon Budget 2 (average reduction from 1990)	-33%	-34%	-35%	-35%	-36%	-37%

4. Use of emissions credits

Our report in April 2017 on the design of Welsh carbon budgets and emissions targets⁴² advised that the Welsh Government should not plan to use emissions credits to contribute towards meeting them.

This advice did, however, identify a situation in which their use might be appropriate, should Welsh industrial output turn out higher than assumed when setting the targets, causing the targets being missed.

Beyond this role, the option for the Welsh Government to purchase credible, international emissions credits should be retained to provide flexibility for unforeseen circumstances:

- The role of these credits should be as a back-up option rather than their use being planned for and should require prior advice from the Committee on Climate Change.
- Credible international credits include those linked to international agreements (i.e. Kyoto and the Paris Agreement) or allowances that are part of meeting EU emissions targets.

We do not recommend placing a specific limit on the use of emissions credits in legislation, due to the recommendation that we have made regarding their appropriate use in the case that higher industrial output causes industrial emissions to be significantly greater than anticipated. Placing a limit on credit purchase for this reason is not sensible.

However, any unplanned use of emissions credits to provide flexibility more widely should be small. For example, based on our assessment on historical variability in Welsh buildings emissions, a year with cold winter months could add an extra 0.6 MtCO₂e to Welsh emissions (i.e. one percentage point relative to 1990 emissions).

5. Policies to meet the recommended targets

Following the legislation of the carbon budgets, the Environment (Wales) Act requires the Welsh Government to set out proposals and policies for meeting them. For the first budget period, these must be published as soon as reasonably practicable after the budget has been legislated. For subsequent carbon budgets, this must be done by the end of the first year of the budget (i.e. by the end of 2021 in the case of the second carbon budget).

⁴² CCC (2017) *Advice on the design of Welsh carbon targets*.

However, it is not clear that this allows enough time for policies to be implemented and to take effect in order to meet the carbon budgets.

- In particular, this timetable suggests the proposals and policies to meet the first carbon budget would be published sometime during 2019. This leaves virtually no time for the implementation of these policies to affect emissions during that carbon budget period, which finishes in 2020.
- Even for subsequent periods, publishing proposals and policies by the end of the first year of the budget period risks a situation in which new policies don't take significant effect until the second half of the budget period, given lead-times for policy implementation.

It is therefore essential that the policy-making process is active outside of these required windows, and that policies extend beyond the life of the carbon budget (and therefore the Welsh Parliamentary term). There needs to be a stable, long-term policy framework to drive down emissions in Wales.

Meeting the targets recommended will require concerted policy effort across a wide range of sectors. Some policy areas are fully devolved to the Welsh Government, while others are reserved or only partially devolved (see Box 1.2). In the areas where powers are reserved to the UK Government, it will be important for the Welsh and UK Governments to work together to ensure that the policy framework is strong. There is also potential for Wales to access a greater share of UK-wide funding opportunities.

Our policy recommendations include areas where powers are devolved, together with actions that the Welsh Government can take indirectly in areas such as planning, procurement and the potential to act as a convenor to facilitate action.

Our key policy recommendations are:

- **Building standards.** The Welsh Government has devolved powers on building standards for new-build properties. These should be used to ensure new buildings have a high standard of energy efficiency and are designed for low-carbon heating systems. This will avoid costly retrofit in future and ensure household energy bills are no higher than needed. This is an area in which Wales can play a leading role in UK action to reduce emissions.
- **Retrofit energy efficiency and low-carbon heat.** Improvements to the energy efficiency of the existing building stock is of major importance, in order to reduce emissions, energy bills and levels of fuel poverty, as well as to enable deployment of low-carbon heating systems. This should be a high priority for the Welsh Government. Heating and regulations around retrofit of energy efficiency are both reserved areas of policy, although the Welsh Government is able to provide funding to retrofit programmes. Despite limited policy levers, under existing powers there are important actions that can be taken to drive and facilitate emissions reductions from buildings:
 - **Funding and 'soft' support for building energy efficiency and low-carbon heat.** There is a lot that the Welsh Government can do to join up and support the chain of decision-makers (e.g. householders, social landlords, installers and suppliers) for energy efficiency and low-carbon heating systems. This should focus on what has worked elsewhere: local area-based schemes, zoning of incentives well supported by advice, a local list of trusted installers and 'one-stop shop' communication. The public can be engaged through face-to-face contact, Street Champions and engaging parents through schools.

- **A strategy for heat decarbonisation in Wales.** Consideration of the local context is important in considering the long-term decarbonisation of heat. The Welsh Government should develop a heat decarbonisation strategy that includes engagement with the public, which can help to secure a local mandate for infrastructure and can help avoid costs and delay.
 - **Use of waste heat from industry.** Wales has a large amount of heavy industry, and where heat is recoverable it represents an important opportunity for decarbonisation via heat networks. Welsh Government has a key potential role to use its ability to bring community and industry stakeholders together to find mutually beneficial solutions.
- **Transport policy** is devolved only on the demand side. We therefore focus on ways that Wales can cut emissions by using these levers, which also have wider benefits, together with actions that can facilitate uptake of ultra-low-emissions vehicles:
 - **Public transport and especially active travel** can reduce emissions from road transport, especially in the nearer term. Walking and cycling can have considerable health benefits, whilst reduced car use should improve air quality. There is potential to recycle revenue from clean-air zones into cycling infrastructure and public transport, including procurement of ultra-low-emissions buses.
 - **Supporting uptake of ultra-low-emission vehicles.** Uptake of electric vehicles has been slow in Wales to date. It is important to develop a better network of charging points, especially in mid-Wales, and tackle other non-financial barriers (e.g. through parking, use of priority lanes, raising awareness and public procurement).
- **Agriculture** policy is fully devolved to the Welsh Government, which should now take the opportunity to put in place farming policies to reduce emissions that move beyond the current voluntary approach and replace the Common Agricultural Policy with a framework that links support to measures aimed at emissions reduction and removals, and to improving the resilience of the natural environment to the impacts of climate change.
- **Forestry** is also devolved to Wales. Whilst the Welsh Government has previously announced highly ambitious tree-planting targets, current rates are far below the level needed to reach these. The Welsh Government should simplify and streamline the process for supporting tree planting, in order to reduce the barriers to action.
- **Electricity generation.** The recently announced target for electricity equivalent to 70% of Welsh consumption to be generated from renewables in Wales by 2030 is consistent with our scenarios and complements the emissions reduction targets under the Environment Act. Renewable generation in Wales can contribute to decarbonisation of the GB system and provide local economic benefits. The Welsh Government, together with many Welsh energy and environmental organisations, has called on the UK Government to do more to support onshore wind and solar development in Wales.⁴³ It is important that a way is found to deploy these technologies where they meet local planning criteria.
- **Procurement.** The Welsh Government's consultation on a target for the public sector to reach carbon neutrality is a positive step, although the details of this are yet to be determined. The public sector in Wales can use procurement rules positively to help drive emissions reductions in a number of areas (e.g. uptake of ultra-low-emission vehicles, low-

⁴³ <http://gov.wales/newsroom/environmentandcountryside/2017/171129-wales-calls-on-uk-government-to-do-more-to-support-onshore-wind-and-solar-development/?lang=en>

carbon products). The Welsh Government should develop a strategy to ensure that climate change is fully reflected in public procurement.

- **Planning.** The planning framework is another useful lever that needs to be well aligned to objectives for emissions reduction in Wales, for example through encouraging walking, cycling and use of public transport, and ensuring readiness for or installation of electric vehicle charging points in new developments.

There are also important gaps in the evidence base relating to the potential for decarbonisation in Wales. We recommend that efforts are made to improve the available evidence base, including in the following ways:

- The Welsh Government should commission a full housing condition survey. The last full survey was done in 2007, although a small survey is currently underway.
- Since the National Travel Survey stopped covering Wales in 2013, there has been a lack of data on trip patterns in Wales. The Welsh Government should commission a regular survey on trip patterns, which would help identify potential for switching from private cars to walking, cycling, public transport and electric vehicles.
- Greater disaggregation of energy statistics, to provide a full detailed picture of how energy is consumed in Wales, for example disaggregating energy consumption data between the industry and commercial buildings sectors.
- Given the importance of industry in South Wales and the difficulty of deploying carbon capture and storage (CCS) given the lack of identified local CO₂ stores, it is important to understand in detail the challenges for CCS in South Wales. We recommend that a detailed study is undertaken on the feasibility of CO₂ transportation and storage from emissions sources in South Wales (e.g. shipping of CO₂ to stores elsewhere).

Taking the policy framework forward in these ways there is potential for Wales to provide an example to the rest of the UK in moving towards a low-carbon society.



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