National Assembly for **Wales**
Cynulliad Cenedlaethol **Cymru**

Carbon Dioxide Emissions in Wales

Abstract
This research paper provides a short synopsis of climate change, and looks at the policy framework guiding action on carbon dioxide emissions.

The paper examines carbon dioxide emissions at a national level, compares Welsh emissions with those of other countries internationally, and also provides information on per capita carbon dioxide emissions for each local authority in Wales.

July 2007

Members' Research Service / Gwasanaeth Ymchwil yr Aelodau

Members' Research Service: Research Paper
Gwasanaeth Ymchwil yr Aelodau: Papur Ymchwil

Cynulliad Cenedlaethol Cymru
National Assembly for Wales

Carbon Dioxide Emissions in Wales

Gareth Clubb
July 2007

Paper number: 07/1116

Enquiry no: 07/1116/Gareth Clubb Date: 11 July 2007

Cynulliad Cenedlaethol Cymru
National Assembly for Wales

Executive Summary

There is compelling scientific evidence that the activities of humankind are responsible for changing the climate of the planet. Carbon dioxide is the most important human-produced greenhouse gas, and measures are being taken at various policy levels to reduce carbon dioxide emissions.

Despite the numerous policies acting to reduce emissions, carbon dioxide emissions in Wales have increased since 1990 – the year from which reductions are calculated under international obligations.

One interpretation of the Welsh Assembly Government's aim to 'contribute fully to meeting UK-wide targets' is a target to reduce Welsh carbon dioxide emissions by 20 per cent below 1990 levels by 2010. Welsh emissions in 2004 were 15 per cent greater than the level needed to attain the target: in order to reach the target, emissions need to be reduced by 4 per cent per year between 2005 and 2010.

Excluding small island states, Wales had the 12th-highest carbon dioxide emissions per capita in the world in 2004.

Torfaen, Powys, and Monmouthshire have the highest per capita carbon dioxide emissions from domestic sources, while the Vale of Glamorgan and Blaenau Gwent have the lowest emissions per capita from domestic sources.

Cynulliad Cenedlaethol Cymru
National Assembly for Wales

Contents

Cynulliad Cenedlaethol Cymru
National Assembly for Wales

Carbon Dioxide Emissions in Wales

1 Climate Change

> "This is the biggest problem facing us globally this century. There is no bigger problem. The threat is quite simple; it's a threat to our civilisation"[1].
>
> *Professor Sir David King, Chief Scientific Adviser to the UK Government*, June 2004

The climate of planet earth has been varying for millions of years, and some variation is natural and expected. However, recent, rapid pollution loading has changed the composition of both the atmosphere and the oceans, leading to an increase in the amount of heat retained within the planetary circulation systems. There is compelling scientific evidence that the activities of humankind are responsible for changing the climate of the planet[2]; this human-induced change is what is usually referred to as 'climate change'.

Direct observations of climate change include the following[3]:

- Eleven of the last 12 years (1995-2006) rank among the 12 warmest years in the instrumental record of global surface temperature.
- Widespread changes in extreme temperatures have been observed over the last 50 years, with less frequent cold days, cold nights and frost, and more frequent hot days, hot nights and heat waves.
- The average temperature of the global ocean has increased to depths of at least 3000m. The ocean has been absorbing more than 80 per cent of the heat added to the climate system, causing sea water to expand, and contributing to sea level rise.
- Mountain glaciers and snow cover have declined across the globe, contributing to sea level rise. Ice sheets on Greenland and in Antarctica have lost mass, which is very likely to have contributed to sea level rise.
- Global sea level rose at a rate of 3.1mm per year between 1993 and 2003, which is substantially faster than the rate of 1.8mm per year between 1961 and 2003.

The Intergovernmental Panel on Climate Change notes that continued greenhouse gas emissions at or above current rates will cause further warming and induce many changes in the global climate system that will be larger than those observed during the 20th century[4]. The great majority of organisms and ecosystems in Europe will have difficulties adapting to climate change[5], with 40 per cent of species around the world becoming extinct if temperatures exceed 4°C above the 1980-

[1] The Climate Group, *Viewpoint: Professor Sir David King*, 28 June 2004, http://theclimategroup.org/index.php/viewpoint/professor_sir_david_king/
[2] Oreskes N, 2004, The Scientific Consensus on Climate Change, *Science* 306 (5702), p. 1686, http://www.sciencemag.org/cgi/content/full/306/5702/1686
[3] Intergovernmental Panel on Climate Change, *IPCC Working Group 1: The Physical Basis for Climate Change, Assessment Report 4 Final Report, Summary for Policymakers*, February 2007, p. 5, http://www.ipcc.ch/WG1_SPM_17Apr07.pdf
[4] *ibid*, p. 13
[5] Intergovernmental Panel on Climate Change, *IPCC Working Group 2: Impacts, Adaptation and Vulnerability, Fourth Assessment Report, Summary for Policymakers*, April 2007, p. 9, http://www.ipcc-wg2.org/

1999 average. At this level of temperature increase, sea level rise will start to threaten major world cities, including Shanghai, New York, Tokyo and London[6]. Over a timescale of centuries, the Greenland and West Antarctic ice sheets are likely to at least partially melt. The complete melting of these sheets would lead to a contribution to sea level rise of about 7m and 5m respectively[7].

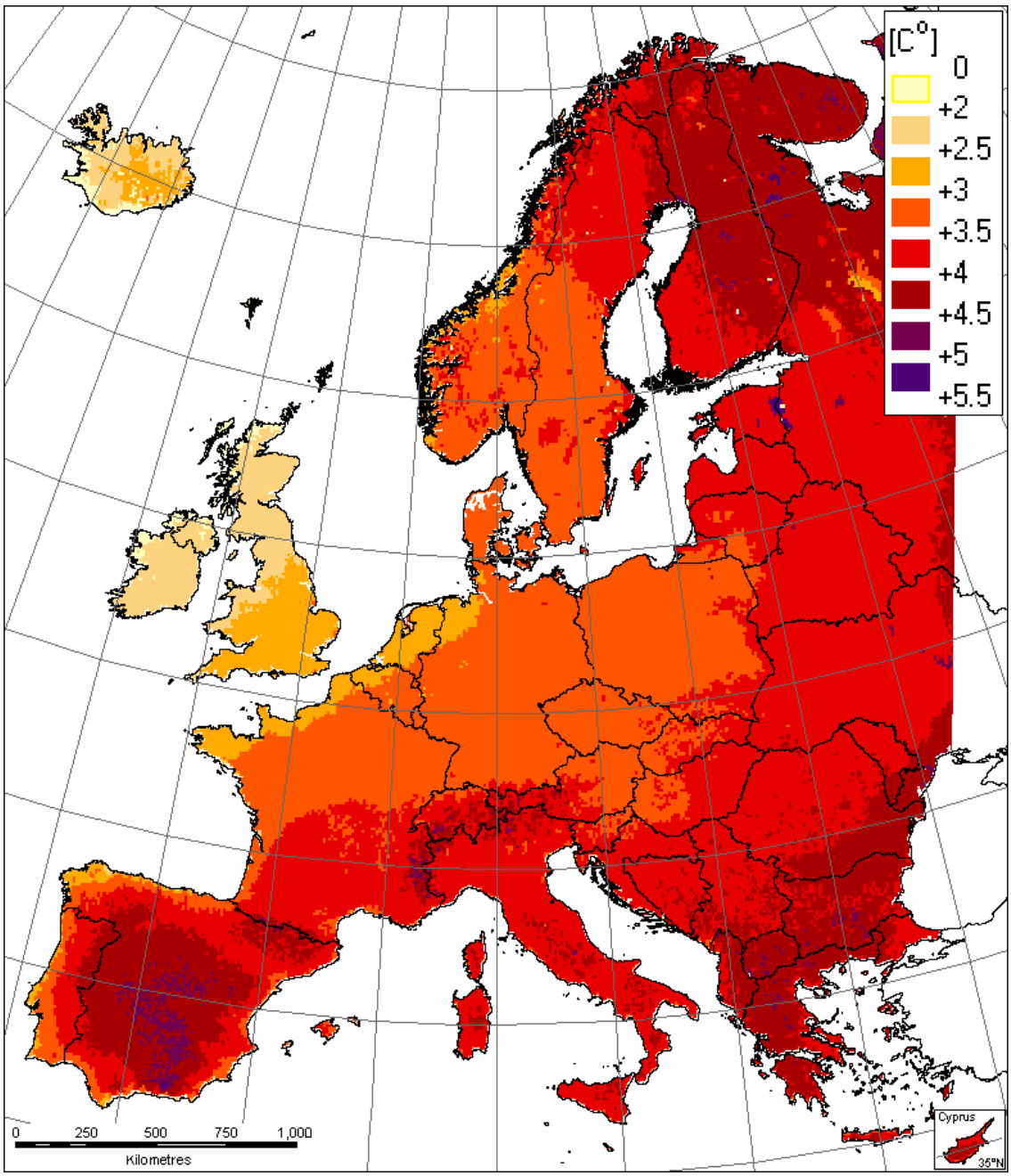

Figure 1 Change in mean annual temperature by the end of the 21st Century[8]

[6] Stern N, 2006, *Stern Review: The Economics of Climate Change*, p. v
http://www.hm-treasury.gov.uk/media/8AC/F7/Executive_Summary.pdf
[7] Intergovernmental Panel on Climate Change, *IPCC Working Group 2: Impacts, Adaptation and Vulnerability, Fourth Assessment Report, Summary for Policymakers*, April 2007, p. 15,
http://www.ipcc-wg2.org/
[8] Based on IPCC SRES scenario A2, taken from European Commission, *Green Paper from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: Adapting to climate change in Europe – options for EU action*,
http://eur-lex.europa.eu/LexUriServ/site/en/com/2007/com2007_0354en01.pdf

> "Climate change… is the greatest and widest-ranging market failure ever seen"[9].
>
> *Sir Nicholas Stern, Head of the UK Government Economics Service*, October 2006

Mitigation efforts over the next two or three decades will have a large impact on opportunities to achieve lower stabilisation levels of atmospheric amounts of greenhouse gases[10], or, as Sir Nicholas Stern puts it: "the benefits of strong, early action [on climate change] considerably outweigh the costs"[11]. The Intergovernmental Panel on Climate Change confirms that current and planned technology will be sufficient to achieve rapid stabilisation of greenhouse gases in the atmosphere, if appropriate incentives to their adoption are applied[12]. According to Sir Nicholas Stern, a 'business as usual' approach to climate change will incur costs equivalent to a 20 per cent reduction in consumption per person, now and into the future[13], whereas achieving deep but attainable cuts in emissions would cost approximately 1 per cent of GDP by 2050[14].

Carbon dioxide is the most important human-produced greenhouse gas[15]; the global atmospheric concentration of carbon dioxide has increased from a pre-industrial average of about 280 parts per million (ppm) to 379ppm in 2005[16]. The atmospheric concentration of carbon dioxide in 2005 far exceeds the natural range over the past 650,000 years[17]. The primary source of the increased atmospheric concentration of carbon dioxide since the pre-industrial period is fossil fuel combustion[18].

[9] Stern N, 2006, *Stern Review: The Economics of Climate Change*, p. i
http://www.hm-treasury.gov.uk/media/8AC/F7/Executive_Summary.pdf
[10] Intergovernmental Panel on Climate Change, *IPCC Working Group 3: Mitigation of Climate Change, Fourth Assessment Report, Summary for Policymakers*, May 2007, p. 22,
http://www.ipcc.ch/WG1_SPM_17Apr07.pdf
[11] Stern N, 2006, *Stern Review: The Economics of Climate Change*, p. ii
http://www.hm-treasury.gov.uk/media/8AC/F7/Executive_Summary.pdf
[12] Intergovernmental Panel on Climate Change, *IPCC Working Group 3: Mitigation of Climate Change, Fourth Assessment Report, Summary for Policymakers*, May 2007, p. 25,
http://www.ipcc.ch/WG1_SPM_17Apr07.pdf
[13] Stern N, 2006, *Stern Review: The Economics of Climate Change*, p. x
http://www.hm-treasury.gov.uk/media/8AC/F7/Executive_Summary.pdf
[14] *ibid*, xii-xiii
[15] Intergovernmental Panel on Climate Change, *IPCC Working Group 1: The Physical Basis for Climate Change, Assessment Report 4 Final Report, Summary for Policymakers*, February 2007, p. 2,
http://www.ipcc.ch/WG1_SPM_17Apr07.pdf
[16] *ibid*
[17] *ibid*
[18] *ibid*

2 The Policy Background

> "The urgency of the situation means tough decisions need to be taken now to provide disincentives to carbon emissions"[19].
>
> *Martin Rees, President of the Royal Society*, May 2007

2.1 International policy

2.1.1 The United Nations Framework Convention on Climate Change

The UN Framework Convention on Climate Change[20] (UNFCCC) sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognises that the climate system is a shared resource whose stability can be affected by emissions of carbon dioxide and other greenhouse gases. The Convention has been ratified by 190 countries[21], and entered into force on 21 March 1994. Under the Convention, governments:

- Gather and share information on greenhouse gas emissions, national policies, and best practices
- Launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries
- Cooperate in preparing for adaptation to the impacts of climate change

2.1.2 The Kyoto Protocol

The Kyoto Protocol[22] is the main international instrument for tackling climate change. 171 Parties have ratified the Protocol to date[23]. The Kyoto Protocol entered into force on 16 February 2005.

The Protocol's major feature is that it has mandatory targets on greenhouse gas emissions for the world's leading economies (Annex I Parties[24]) which have accepted it. These targets range from -8 per cent to +10 per cent of the countries' individual 1990 emissions levels, "with a view to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012". The EU-15 countries have a target to reduce emissions by 8 per cent, and this has been distributed between its member states such that emissions will need to

[19] Martin Rees, The Royal Society press release, *A time for global action on global warming*, 16 May 2007, http://www.royalsoc.ac.uk/news.asp?id=6639
[20] United Nations Framework Convention on Climate Change, www.unfccc.int
[21] The countries that have not ratified are Andorra, Brunei Darussalam, Iraq, and Somalia
[22] United Nations, *Kyoto Protocol to the United Nations Framework Convention on Climate Change*, 1998, http://unfccc.int/resource/docs/convkp/kpeng.pdf
[23] The countries that have not ratified are Afghanistan, Andorra, Australia, Brunei Darussalam, Central African Republic, Chad, Comoros, Croatia, Iraq, Kazakhstan, Moldova, Montenegro, Saint Kitts and Nevis, San Marino, Sao Tome and Principe, Serbia, Somalia, Tajikistan, Timor-Leste, Tonga, Turkey, United States of America, and Zimbabwe
[24] The Annex I Parties are the EU-15, Bulgaria, Czech Republic, Estonia, Latvia, Liechtenstein, Lithuania, Monaco, Romania, Slovakia, Slovenia, Switzerland, United States of America, Canada, Hungary, Japan, Poland, Croatia, New Zealand, Russian Federation, Ukraine, Norway, Australia, and Iceland. Of these, United States of America, Croatia, and Australia have not ratified the Protocol, and are therefore not bound by its requirements.

range between a reduction of 28 per cent in Luxembourg, and an increase of up to 27 per cent in Portugal. The UK has agreed to reduce its emissions to at least 12.5 per cent lower than base year levels[25].

The Protocol offers flexibility in how countries may meet their targets. For example, they may partially compensate for their emissions by increasing carbon 'sinks' such as forests, which absorb carbon dioxide as they grow. They may also pay for projects elsewhere that result in cuts in greenhouse gas emissions.

2.2 European policy

The European Union participated in both the UNFCCC and the Kyoto Protocol on behalf of its Member States. A European Council Decision[26] in 2002 approved the Protocol on behalf of the Community.

The European Commission launched the European Climate Change Programme (ECCP) in June 2000. Its aim was to help identify the most environmentally- and cost-effective policies and measures that could be taken at the European level to cut greenhouse gas emissions. The second ECCP was launched in October 2005[27]. It consists of several working groups, which examine issues including aviation, carbon capture and storage, adaptation, and the EU Emission Trading Scheme.

The EU has developed numerous policies and measures related to climate change. The following are some examples:

- Green Paper COM(2007) 354[28] outlines the changes that European societies will need to make in order to adapt to the consequences of climate change.
- Communication COM(2007) 2 final[29] sets out the EU's objective of limiting global temperature increase to less than 2°C compared to pre-industrial levels.
- Green Paper COM(2006) 105[30] suggests six priority areas for implementing a European energy policy.
- Green Paper COM(2005) 265[31] introduces a variety of actions and measures to be taken by government, industry and consumers that will make efficiency savings of 20 per cent of current use by 2020.

[25] DEFRA, *The United Kingdom's Initial Report under the Kyoto Protocol*, November 2006, http://www.defra.gov.uk/environment/climatechange/uk/progress/pdf/uk-kyoto-1206.pdf
[26] European Council, *Council Decision of 25 April 2002 concerning the approval, on behalf of the European Community, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the joint fulfilment of commitments thereafter*, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002D0358:EN:HTML
[27] European Commission, *The European Climate Change Programme*, http://ec.europa.eu/environment/climat/eccpii.htm
[28] European Commission, *Green Paper from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: Adapting to climate change in Europe – options for EU action*, http://eur-lex.europa.eu/LexUriServ/site/en/com/2007/com2007_0354en01.pdf
[29] European Commission, *Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: Limiting Global Climate Change to 2 degrees Celsius The way ahead for 2020 and beyond*, January 2007, http://eur-lex.europa.eu/LexUriServ/site/en/com/2007/com2007_0002en01.pdf
[30] European Commission, *Green Paper: A European Strategy for Sustainable, Competitive and Secure Energy*, http://eur-lex.europa.eu/LexUriServ/site/en/com/2006/com2006_0105en01.pdf
[31] European Commission, *Green Paper on Energy Efficiency or Doing More With Less*,

- Decision 280/2004/EC[32] established a new mechanism for monitoring and reporting greenhouse gas emissions.
- Directive 2003/30/EC[33] requires that 5.75 per cent of transport fuels sold in Member States by 2010 should be biofuels.
- Directive 2003/87/EC[34] established an emission trading system (the EU Emission Trading Scheme) limiting carbon dioxide emissions from 11,500 large emitters in the Member States.
- Directive 2002/91/EC[35] sets minimum energy efficiency standards that must be met by all new buildings and large existing buildings undergoing major refurbishment.
- Directive 2001/77/EC[36] requires Member States to meet an indicative target of 21 per cent of EU electricity consumption being produced by renewable energy by 2010. Conclusion (7224/07)[37] requires the production of 20 per cent of energy in Europe to be from renewable sources by 2020, and requires greenhouse gas emission reductions of 20 per cent from 1990 levels by 2020.
- White Paper COM(2001) 370[38] envisaged a shifting of transport mode from road to rail and water. Its review (Communication COM(2006) 314[39]) changed the emphasis from curbing transport demand to disconnecting mobility from its negative consequences.
- Directive 1999/31/EC[40] requires Member States to gradually reduce the amount of biodegradable waste landfilled to 35 per cent of the 1995 level by 2020 (biodegradable waste produces methane, one of the greenhouse gases).

2.3 UK policy

In 1997, the UK committed itself to a domestic target of reducing carbon dioxide emissions by 20 per cent below 1990 levels by 2010[41]. The Draft Climate Change Bill[42], published in March 2007, looks to provide a legal framework to manage future greenhouse gas emissions:

---

http://eur-lex.europa.eu/LexUriServ/site/en/com/2005/com2005_0265en01.pdf

[32] European Parliament and Council, *Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol*, http://eur-lex.europa.eu/LexUriServ/site/en/oj/2004/l_049/l_04920040219en00010008.pdf

[33] European Parliament and Council, *Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport*, http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_123/l_12320030517en00420046.pdf

[34] European Parliament and Council, *Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC*, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32003L0087:EN:HTML

[35] European Parliament and Council, *Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings*, http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_001/l_00120030104en00650071.pdf

[36] European Parliament and Council, *Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market*, http://europa.eu.int/eur-lex/pri/en/oj/dat/2001/l_283/l_28320011027en00330040.pdf

[37] European Council, *Presidency Conclusions: Brussels European Council 8/9 March 2007*, http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/93135.pdf

[38] European Commission, *White Paper on European Transport Policy for 2010*, http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&lg=en&type_doc=COMfinal&an_doc=2001&nu_doc=370 (not available in English from this site)

[39] European Commission, *Communication from the Commission to the Council and the European Parliament: Keep Europe moving – sustainable mobility for our continent*, http://ec.europa.eu/transport/transport_policy_review/doc/2006_transport_policy_review_en.pdf

[40] European Council, *Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste*, http://europa.eu.int/eur-lex/pri/en/oj/dat/1999/l_182/l_18219990716en00010019.pdf

[41] DEFRA, *Progress towards national and international targets*, http://www.defra.gov.uk/environment/climatechange/uk/progress/index.htm

[42] HM Government, *Draft Climate Change Bill*, March 2007, http://www.official-documents.gov.uk/document/cm70/7040/7040.pdf

- The carbon dioxide reduction targets (a reduction of 26-32 per cent by 2020 and a reduction of 60 per cent by 2050) become legally binding
- An independent body will be established to advise on carbon budgets and report on progress
- Government will be required to report regularly to Parliament on its progress

In March 2006, the UK Government published its Climate Change Programme[43], which sets out the policies and priorities for action on climate change, both across the United Kingdom as a whole, and internationally. The Programme covers adaptation to climate change, and emission reductions – in the domestic setting, in energy supply, business, transport, land use management, and in the public sector. The document also includes a section about Wales-specific factors (pp. 163-168).

2.4 Welsh policy

The Welsh Assembly Government's commitment to tackling climate change is outlined in its Environment Strategy[44] and Action Plan[45]. 'Addressing climate change' is one of the five key environmental themes of the Strategy, and the headline target is to cut greenhouse gas emissions by 20 per cent between a 2000 baseline of 14.9 Megatonnes of carbon equivalent[46], and 2020. It also aims to 'contribute fully to meeting UK-wide targets'[47].

The Energy Wales Route Map consultation[48] contains the following commitments:

- Securing 4TWh per annum of renewable electricity production by 2010 and 7TWh by 2020
- Much greater energy efficiency in all sectors
- More electricity generation from cleaner, higher efficiency fossil-fuel plants
- Significant energy infrastructure improvements
- On a holistic basis, achieving measurable carbon dioxide emission reduction targets for 2020

In February 2007, the Welsh Assembly Government published a consultation[49] on a climate change adaptation action plan for Wales. The deadline for contributions expired in April 2007. The document highlights some of the changes anticipated as the Welsh climate changes, and illustrates steps that are being taken in response. A consultation on planning for climate change[50] has also closed.

---

[43] HM Government, *Climate Change: The UK Programme 2006*, March 2006, http://www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/ukccp06-all.pdf
[44] Welsh Assembly Government, *Environment Strategy for Wales*, May 2006, http://new.wales.gov.uk/topics/environmentcountryside/epq/Environment_strategy_for_wales/About_the_strategy/?lang=en
[45] Welsh Assembly Government, *Environment Strategy for Wales: First Action Plan*, http://new.wales.gov.uk/docrepos/40382/4038231121/118554/Env_strat_rewrite/Action_Plan_e.pdf?lang=en
[46] Baggot L et al., 2005. *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-2003*, http://www.airquality.co.uk/archive/reports/cat07/0509211321_Reghg_report_2003_Main_Text_Issue_1.doc
[47] Welsh Assembly Government, *Environment Strategy for Wales*, May 2006, p. 21, http://new.wales.gov.uk/topics/environmentcountryside/epq/Environment_strategy_for_wales/About_the_strategy/?lang=en
[48] Welsh Assembly Government, *Energy Wales: Route map to a clean, low-carbon and more competitive energy future for Wales*, 2005, http://new.wales.gov.uk/docrepos/40382/4038231141/40382112412/energyroutemape.pdf?lang=en
[49] Welsh Assembly Government, *Responding to our changing climate: Consultation on a climate change adaptation action plan for Wales*, February 2007, http://new.wales.gov.uk/topics/environmentcountryside/climate_change/whatarewedoing/adaptingtocc/?lang=en
[50] Welsh Assembly Government, *Planning for climate change: Consultation document*, December 2006, http://new.wales.gov.uk/docrepos/40382/4038231121/403821/403821/403827/40382/1095043/Planning_for_Climate_Change1.pdf?lang=en

3 Carbon Dioxide Emissions in Wales

There are two broad approaches to calculating carbon dioxide emissions. Some organisations use the concept of calculating emissions according to where they are produced, whereas others base their calculations on consumption, so that all the carbon dioxide emissions that Wales' residents are responsible for are accounted for, rather than those from within Wales' boundaries. This paper uses the 'emissions production' definition in sections 3.1 and 3.2, but where consistent 'emissions consumption' data are available, as in section 3.3, we have used those figures.

3.1 The national picture

Wales has performed inconsistently in reducing greenhouse gas emissions over the past fifteen years. In particular, emissions of carbon dioxide in 2004 (the most recent year for which data are available) had increased by 2.5 per cent since 1990[51]. The First Minister has ruled out annual emission reduction targets because of the nature of the industrial sector in Wales; a year of low steel production, for example, would cause a reduction in emissions unrelated to energy conservation measures[52]. Likewise, a mild winter will tend to lead to less energy consumption.

In 1997, the UK committed itself to a domestic target of reducing carbon dioxide emissions by 20 per cent below 1990 levels by 2010[53]. One of the aims of the Welsh Assembly Government's Environment Strategy is to 'contribute fully to meeting UK-wide targets'. One interpretation of this aim is that the Welsh Assembly Government has a target to reduce Welsh carbon dioxide emissions by 20 per cent below 1990 levels by 2010. A path can be plotted of the 'desired emissions' – the steadily decreasing emissions that would have been necessary since the UK commitment in 1997 in order to achieve a 20 per cent emission reduction by 2010.

Table 1 shows the carbon dioxide emissions for Wales between 1990 and 2004[54], along with the difference between these emissions and both baseline emissions (1990), and 'desired emissions'.

Table 1 Carbon dioxide emissions for Wales

Year	Carbon dioxide emissions (Mt)[a]	Change since 1990 (percentage points)	Difference from desired emissions (per cent)[b]
1990	40.8	-	-
1995	39.0	-4.4	-
1998	41.7	+2.2	+4.0
1999	42.1	+3.2	+6.9
2000	44.0	+7.8	+13.6
2001	41.9	+2.7	+10.0
2002	35.6	-12.7	-4.9
2003	38.1	-6.6	+3.6
2004	41.8	+2.5	+15.6

[a] Baggot L et al., 2005. *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-2004*, http://www.airquality.co.uk/archive/reports/cat07/0611081428-419_Reghg_report_2004_Main_Text_Issue_2.pdf

[b] Calculated by MRS

[51] Baggot L et al., 2005. *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-2004*, http://www.airquality.co.uk/archive/reports/cat07/0611081428-419_Reghg_report_2004_Main_Text_Issue_2.pdf

[52] RoP pp.31-32, 12 June 2007, http://www.cynulliadcymru.org/bus-home/bus-chamber/bus-chamber-third-assembly-rop.htm?act=dis&id=52854&ds=2007/6

[53] DEFRA, *Progress towards national and international targets*, http://www.defra.gov.uk/environment/climatechange/uk/progress/index.htm

[54] Information is only available for the years specified in Table 1

In order to meet the 2010 emissions target, Welsh emissions need to reduce by 4.1 per cent per year between 2005 and 2010[55]. This emission reduction path is shown in Figure 2, along with the actual carbon dioxide emissions up to 2004, and the 'desired emissions' path. The value for 1997 that has been used is the point on the trend line between the values for 1995 and 1998.

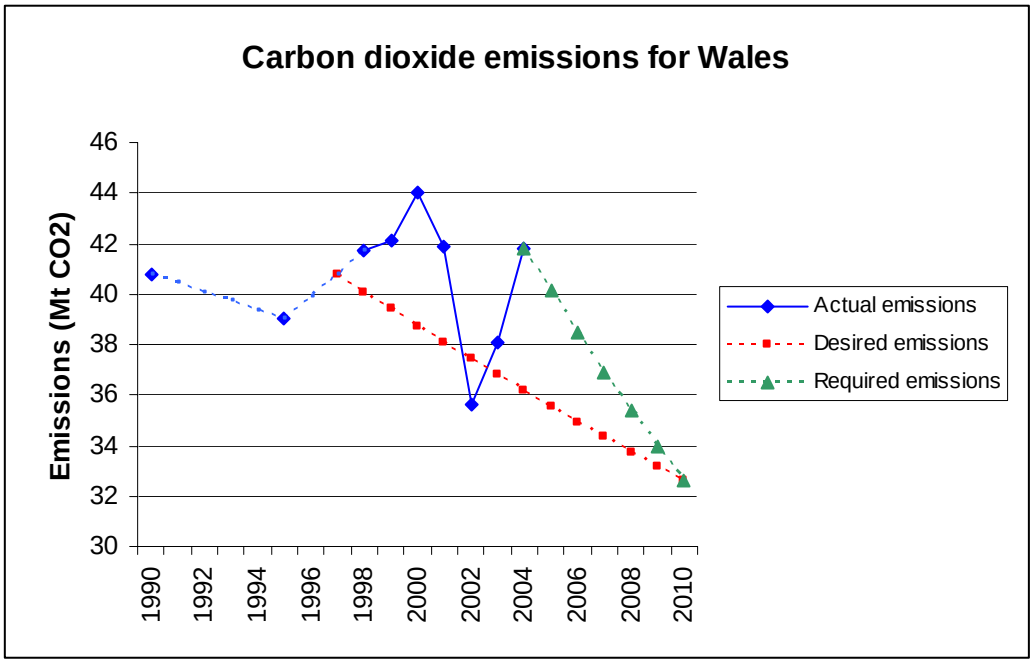

Figure 2 Carbon dioxide emissions for Wales: actual, desired, and required

Actual emissions: Baggot L et al., 2005. *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-2004*, http://www.airquality.co.uk/archive/reports/cat07/0611081428-419_Reghg_report_2004_Main_Text_Issue_2.pdf
Desired and Required emissions calculated by MRS

3.2 International comparisons

Comparisons of carbon dioxide emissions with those of other countries can be difficult due to different calculation methodology, but they can also be interesting for reference purposes. Carbon dioxide emissions per capita is the total amount of carbon dioxide emitted by a country as a consequence of human (production and consumption) activities, divided by the population of the country[56]. It is strongly affected by climate, transport demand, and use of fossil fuels[57]. Countries with a similar climate but with different per capita emissions will differ primarily as a result of the amount of fossil fuel combusted.

Carbon dioxide emissions per unit of GDP is a measure of carbon intensity, with a lower value indicating more efficient use of (carbon) resources in achieving economic output. An Oxbridge

[55] 2010 target emissions are 40.8 x 0.8 = 32.6Mt. Latest emission figures (2004) are 41.8Mt. Reduction required is therefore 9.2Mt, or 4.1 per cent per year. A steady percentage decrease relies on larger absolute decreases early in the time series.
[56] World Bank, *Carbon dioxide emissions (per capita) and consumption of ozone-depleting CFCs (ODP tons)*, http://ddp-ext.worldbank.org/ext/GMIS/gdmis.do?siteId=2&contentId=Content_t28&menuId=LNAV01HOME1
[57] DTI, *Energy – its impact on the environment and society*, Annex 5A, July 2006, http://www.dti.gov.uk/files/file32554.pdf

study[58] on CO_2-GDP relationships noted that emissions are "to an important degree" a function of policy and choice, which in turn determines the energy efficiency of economies.

The carbon dioxide emissions in 2004 of Wales and selected other countries are shown in Table 2. Countries have been chosen for one of the following reasons:

- They are interesting points of reference, for example, the Scandinavian countries
- They have similar carbon dioxide emissions to Wales
- They have similar carbon dioxide emissions per capita to Wales
- They have similar carbon dioxide emissions per unit GDP to Wales

Cells shaded grey indicate values within 10 per cent of the Wales figure. Cells shaded green in the two end columns indicate values more than 10 per cent lower than those of Wales, and cells shaded amber in the two end columns indicate values more than 10 per cent higher than those of Wales.

Wales performs particularly poorly in terms of carbon dioxide emissions per capita. Of the 210 countries listed by the US Energy Information Administration, Wales would appear in the poorest-performing 20 countries. For comparison, both Scotland and England would rank outside the top 50. Excluding small island states[59], Wales had the 12th-highest carbon dioxide emissions per capita in the world in 2004[60].

Of the 195 countries listed for carbon dioxide emissions per unit of GDP by the US Energy Information Administration, Wales would have been approximately 70th in carbon intensity in 2004. England would have been outside the most carbon-intense 100 countries.

[58] Grubb *et al.*, 2004. *The relationship between carbon dioxide emissions and economic growth*, Oxbridge study on CO2-GDP relations, Phase I results, http://www.oxfordenergy.org/presentations/OxbridgeCO2_GDP_analysis.pdf

[59] Smaller than 1,400km^2: Aruba, Bahrain, Faroe Islands, Gibraltar, Guam, Netherlands Antilles, Singapore, and US Virgin Islands.

[60] The countries with higher per capita emissions, in descending order of per capita emissions, were: United Arab Emirates, Qatar, Kuwait, Trinidad and Tobago, Luxembourg, USA, Australia, Canada, Netherlands, Brunei Darussalam, and Belgium.

Table 2 Carbon dioxide emissions for different countries in the year 2004

Country	Carbon dioxide emissions (Mt)	Carbon dioxide emissions per capita[61] (tonnes)	Carbon dioxide emissions per thousand US dollars PPP 2000[62] (tonnes)
Wales	**41.8**	**14.2**	**0.46**
England	440.8	8.8	0.35
Northern Ireland	16.3	9.5	0.45
Scotland	43.0	8.5	0.38
Denmark	55.6	10.3	0.36
Finland	61.5	11.8	0.45
Iceland	3.6	12.1	0.42
Norway	51.1	11.2	0.32
Sweden	59.1	6.6	0.24
Bangladesh	37.9	0.3	0.06
Ireland	42.5	10.7	0.33
New Zealand	37.8	9.5	0.42
Qatar	38.9	46.3	1.90
Puerto Rico	39.3	10.1	0.58
Aruba	1.0	14.2	0.59
The Bahamas	4.2	14.0	0.65
Belgium	147.6	14.3	0.54
Estonia	18.2	13.6	0.81
Taiwan	308.0	13.5	0.61
Croatia	21.6	4.8	0.45
Germany	862.2	10.5	0.42
Guinea-Bissau	0.4	0.3	0.48
Hungary	56.4	5.6	0.44
Zimbabwe	11.9	1.0	0.44
China	4,707.3	3.6	0.72
United States of America	5,912.2	20.2	0.55

Source: All information from the US Energy Information Administration, http://www.eia.doe.gov/pub/international/iealf/tableh1cco2.xls, http://www.eia.doe.gov/pub/international/iealf/tableh1co2.xls, and http://www.eia.doe.gov/pub/international/iealf/tableh1pco2.xls, except for UK countries, for which additional information is taken from Baggot L et al., 2005. *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-2004*, http://www.airquality.co.uk/archive/reports/cat07/0611081428-419_Reghg_report_2004_Main_Text_Issue_2.pdf

[61] Per capita emissions for the UK countries was calculated using population estimates for 2004 from the following sources:
StatsWales, *Mid-year population estimates (2001 onwards), by local authority (single year of age, gender, Welsh LAs)*, http://www.statswales.wales.gov.uk/ReportFolders/ReportFolders.aspx
National Statistics, *2004-based subnational population projections: 11: England and GOR summary table for total persons*, http://www.statistics.gov.uk/downloads/theme_population/2004_BasedProj/11_England_and_GORs_selected_summaries.xls
Northern Ireland Statistics and Research Agency, *Home population by sex and single year of age*, http://www.nisra.gov.uk/archive/demography/population/midyear/NI_Home_pop_by_sex_and_single_year_of_age(1961%20to%202005).xls
Registrar General for Scotland, *Mid-2004 population estimates Scotland: Population estimates by age, sex and administrative area*, http://www.gro-scotland.gov.uk/files/04mype-cahb-booklet.pdf

[62] Relative weighting of UK countries' GDP for 2004 is as follows: Wales 95.8, England 126.0, Northern Ireland 99.0, Scotland 117.5, from Eurostat, *Regional GDP per inhabitant in the EU 27*, http://epp.eurostat.ec.europa.eu/pls/portal/docs/PAGE/PGP_PRD_CAT_PREREL/PGE_CAT_PREREL_YEAR_2007/PGE_CAT_PREREL_YEAR_2007_MONTH_02/1-19022007-EN-AP.PDF, either directly, or via calculation

3.3 The local picture

There are two different methodologies for allocating emissions to local authorities. One uses emissions data for every 1km square in the UK by source of CO_2[63], while the other allocates emissions to the end user[64] – defined as a "re-allocation of all emissions from the production and distribution of energy to the users of that energy (electricity, refineries, oil and gas production, mining)". Since the values arising from this second methodology[65] give an idea of geographical use, rather than production, they are more useful in informing about emissions from use of energy in local authority areas. The carbon dioxide emissions for 2004, for each local authority, are shown in Table 3.

As a result of the methodology used, the total emissions figure calculated (31.3Mt CO_2) does not match the inventoried all-Wales total (41.8Mt CO_2). The information is therefore more useful to enable comparisons to be made between the local authorities in Wales, rather than as a definitive value of emissions.

Table 3 Carbon dioxide emissions for 2004 for Welsh local authorities, ranked in order of biggest emitter

Local authority	Carbon dioxide emissions by category (kilotonnes)				
	Industry and commercial	Domestic	Road transport	Land use, land change and forestry	Total
Neath Port Talbot	2,400	387	370	-27	3,130
Cardiff	1,168	714	585	5	2,473
Newport	1,496	402	536	1	2,435
Flintshire	1,537	425	419	4	2,385
Carmarthenshire	1,063	493	516	-4	2,068
Swansea	705	591	403	14	1,713
Rhondda Cynon Taf	699	595	408	-35	1,667
Wrexham	941	335	243	-7	1,512
Bridgend	866	347	284	-22	1,475
Caerphilly	627	486	224	-6	1,331
Vale of Glamorgan	773	249	255	25	1,301
Pembrokeshire	573	346	317	62	1,298
Monmouthshire	591	267	435	-12	1,281
Powys	507	399	559	-229	1,236
Gwynedd	369	347	393	-119	989
Torfaen	511	298	111	0	921
Ynys Môn	492	204	164	42	902
Conwy	266	325	340	-30	902
Denbighshire	325	273	251	-33	817
Ceredigion	242	203	246	-52	638
Blaenau Gwent	248	144	71	-5	457
Merthyr Tydfil	140	127	113	-7	373
WALES	16,539	7,954	7,244	-433	31,303

Source: DEFRA, *Local and regional CO_2 emissions estimates for 2004 for the UK*, http://www.defra.gov.uk/environment/statistics/globatmos/regionalrpt/laregionalco2rpt20061127.pdf

[63] Data available from the National Atmospheric Emissions Inventory, http://www.naei.org.uk/data_warehouse.php
[64] DEFRA, *Local and regional CO_2 emissions estimates for 2004 for the UK*, http://www.defra.gov.uk/environment/statistics/globatmos/regionalrpt/laregionalco2rpt20061127.pdf
[65] DEFRA, *End user local and regional estimates of carbon emissions, 2004*, http://www.defra.gov.uk/environment/statistics/globatmos/regionalrpt/laregionalco2rpt20061127.xls

Per capita emissions as a result of domestic activities provide an indication of energy efficiency at a local authority level; these emissions figures for 2004 are calculated in Table 4, and shown in Figure 3.

Table 4 Per capita carbon dioxide emissions from domestic sources in Welsh local authorities, ranked in order of biggest per capita emissions

Local authority	Domestic emissions (kilotonnes)	Population in mid-2004[66]	Per capita emissions from domestic sources (tonnes per capita)[67]
Torfaen	298	90,000	3.3
Monmouthshire	267	87,000	3.1
Powys	399	131,000	3.1
Ynys Môn	204	69,000	3.0
Pembrokeshire	346	117,000	3.0
Gwynedd	347	118,000	2.9
Conwy	325	112,000	2.9
Newport	402	139,000	2.9
Denbighshire	273	96,000	2.9
Neath Port Talbot	387	136,000	2.9
Caerphilly	486	171,000	2.8
Flintshire	425	150,000	2.8
Carmarthenshire	493	178,000	2.8
Bridgend	347	130,000	2.7
Swansea	591	226,000	2.6
Ceredigion	203	78,000	2.6
Wrexham	335	130,000	2.6
Rhondda Cynon Taf	595	232,000	2.6
Merthyr Tydfil	127	55,000	2.3
Cardiff	714	317,000	2.3
Blaenau Gwent	144	69,000	2.1
Vale of Glamorgan	249	122,000	2.0
Wales	**7,954**	**2,952,000**	**2.7**

Source: MRS calculation based on Welsh Assembly Government and DEFRA statistics (see Table 3)

Several factors influence domestic energy consumption:

- Climate has an impact on heating; coastal, lowland, and southern counties will benefit from reduced heating requirement
- Access to information has an impact on people's uptake of low-energy or low-carbon forms of energy (eg biomass heating, energy-efficient lighting)
- Poverty has an impact on heating because even the more basic insulation techniques can run into hundreds of pounds
- Gas is a more carbon-efficient means of heating homes than electricity, coal or oil, so connectivity to the grid is important (people living in counties with poor connectivity will be more reliant on solid fuels and electricity for heating)

[66] Population figures are mid-2004 estimates from StatsWales http://www.statswales.wales.gov.uk/ReportFolders/ReportFolders.aspx
[67] Rounding errors for population statistics mean that the actual per capita emissions differ slightly from a calculation using the figures in the table for Denbighshire, Powys and Neath Port Talbot

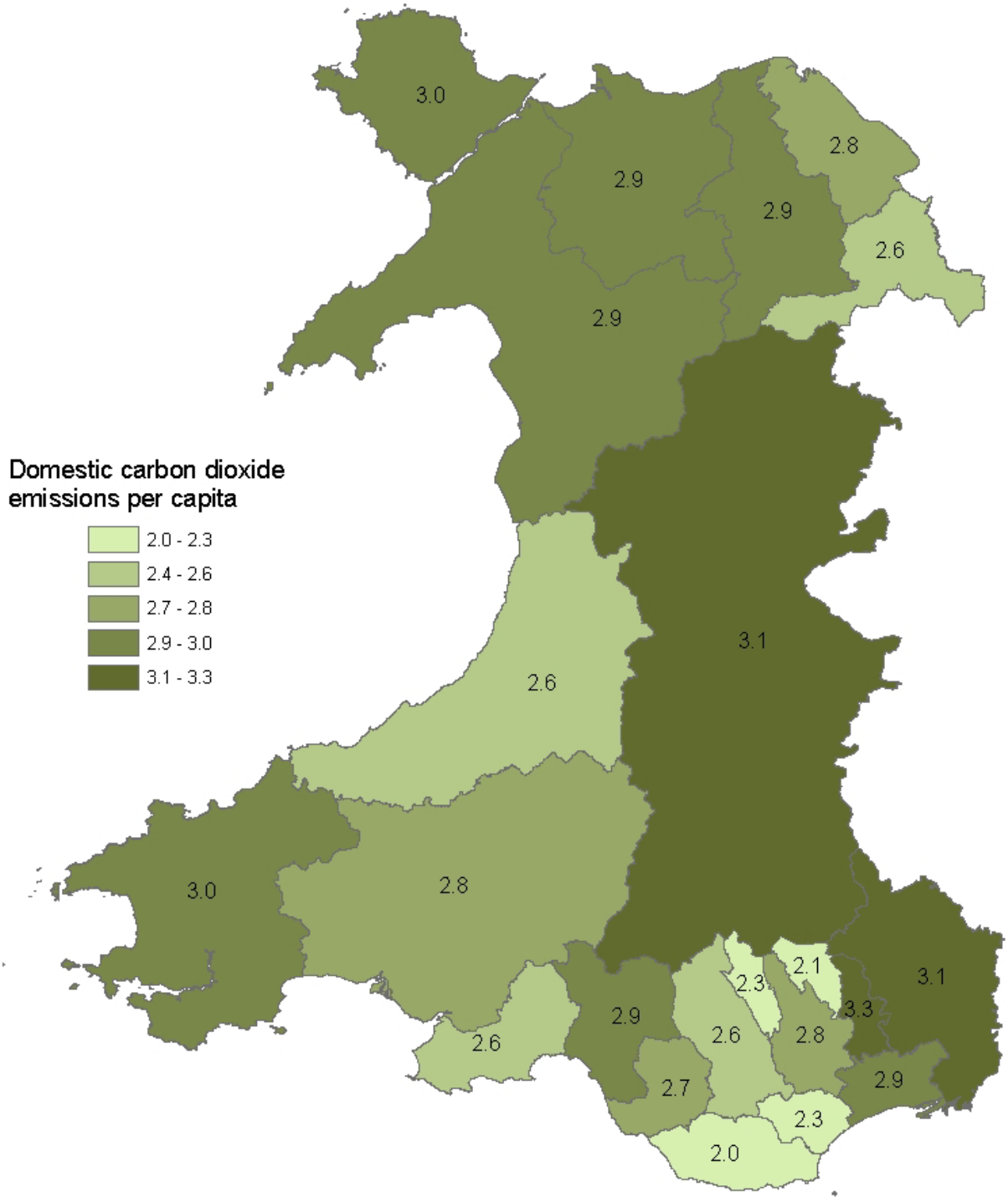

Figure 3 Per capita carbon dioxide emissions from domestic sources in Wales in 2004

The domestic activities of the residents of Torfaen, Monmouthshire and Powys emit 50 per cent more carbon dioxide, per capita, than the activities of the residents of the Vale of Glamorgan.

A total of 9 of the 22 local authorities are at or below the Wales average.