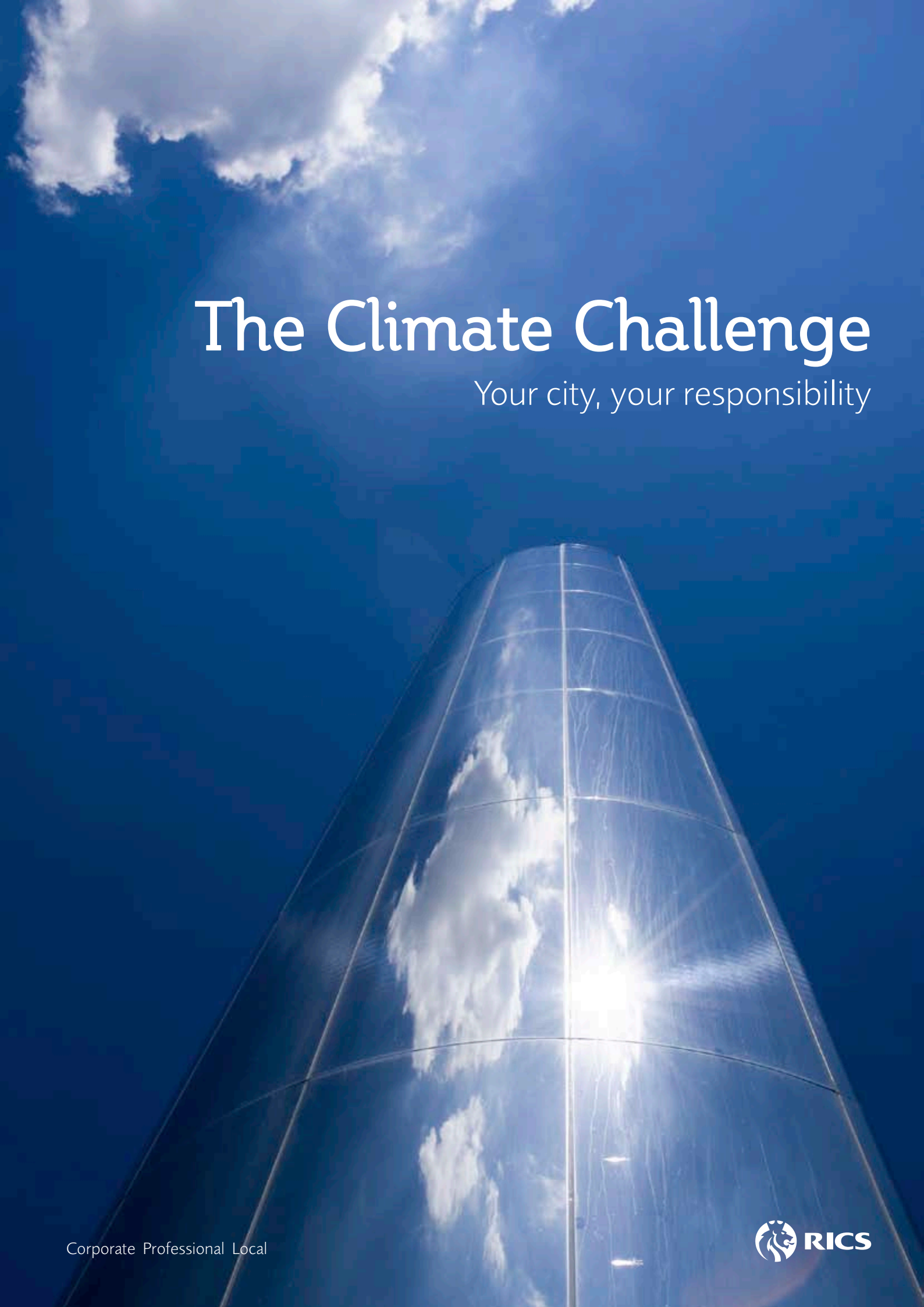


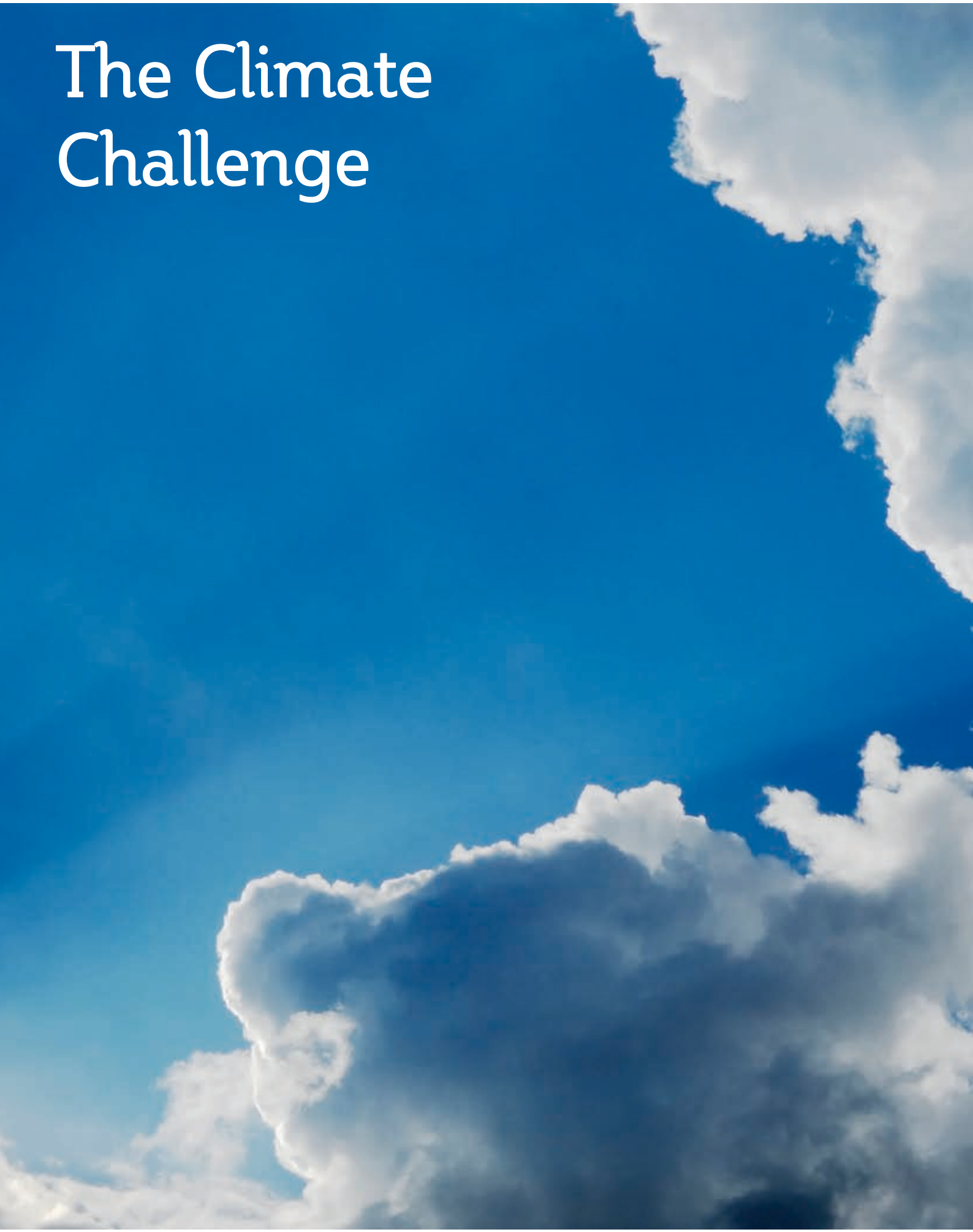
The Climate Challenge

Your city, your responsibility

Corporate Professional Local

RICS

The Climate Challenge



Climate change is the biggest environmental threat we are facing as a nation. It is all of our responsibilities to reduce our carbon emissions and address climate change. Ambitious targets have been set by Wales for itself and the Welsh Assembly Government seems to be leading the way, but is it enough?

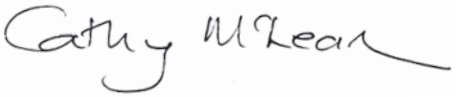
RICS Wales has commissioned this report to examine how energy is used in some of our towns and cities and what changes are needed for Wales to meet its targets for a low-carbon economy. The results make a sobering read and offer a wake-up call on the challenge ahead for all of us.

We should be under no illusion of the size of the task we are facing. Although Wales has made some hugely positive steps forward already, current carbon emissions in Wales are still too high.

Historically, Wales led the industrial revolution in exploring our resources of carbon in the form of coal, we should now play a leading role in reducing carbon emissions.

Carbon can be used at an alarming rate. For example, one photocopier left on standby overnight uses enough energy to make 30 cups of tea and air-conditioning an office for just one extra hour a day uses enough energy in one month to power a TV for over a year, according to the Carbon Trust Wales. Put into context, it's easy to see how carbon emissions are so easily created and how even the smallest change can make a big impact – but Wales needs to make some big changes too.

The challenge for government is to put in place mechanisms that will encourage individuals, households and communities to live a low carbon lifestyle. The challenge for us as individuals is to understand how we contribute to climate change in our daily lives, at home and at work. Some changes will be easy, but others will require a real change in behaviour – and that's where our biggest challenge will lie and where we need to begin.



Cathy McLean
Director, RICS Wales

It is all of our responsibilities to reduce our carbon emissions and address climate change

What are the key challenges?

It was only fairly recently that a new report on the impact of climate change would be consigned to the inside pages of newspapers – now they are the main news. We have had the Stern Report and the 2007 report of the Intergovernmental Panel on Climate Change – the evidence is building up and, around the world, the need for action is becoming increasingly apparent.

Climate change is now the defining challenge of the 21st century, brought about by the impact on our natural environment of the coming together of our carbon intensive patterns of consumption and the way in which we have chosen to supply our energy needs. There now seems to be a consensus that we simply cannot carry on as if nothing is happening – we have to respond to this.

The response in the UK has been to make a commitment both to a 20% reduction in CO_2 emissions by 2010 (taken against 1990 levels) and a longer term reduction of 60% by 2050 (taken against 2000 levels).

It is in our towns and cities that this challenge will be won or lost – this is where the vast majority of the population lives and works. If solutions can be found anywhere, they will be found here.
What will be the impact on our towns and cities and on the way in which we go about our daily lives? We have looked at three aspects of this – transport, the built environment and the supply of energy – and explored these in three cities in Wales – Bangor, Cardiff and Swansea. What do we find? The results are sobering.

- First, we should be under no illusions about the **scale of the challenge** facing us. Technological solutions will not deliver the cuts that are required. We have to consider **different transition pathways** to a low carbon city of the future. The results have demonstrated, for example, that technology alone is highly unlikely to achieve the necessary reductions without being accompanied by substantial changes in behaviour.

- If we do nothing to reduce energy demand the only way in which the necessary cuts could be made through changes in the way in which we supply energy would be through the expansion of the energy supply network on an unprecedented scale. Therefore, any hopes that we have been harbouring about 'fixing' the problem through a new fleet of hybrid cars, or the mass take up of wind power, or a new generation of nuclear power plants, need to be quickly re-thought.

- Third, any of the given changes proposed will in turn instigate a series of **wider impacts**, and these need to be considered and understood. In this report we have only touched upon some of the possibilities – for waste reprocessing and industrial symbiosis, for food distribution, public health, lifestyles and consumption choices - and positioned them as exploratory examples that require further work.

What next?

We set the following challenges:

- Launch a new UK-wide urban climate change research programme that focuses specifically on the implications of climate change mitigation and adaptation for our towns and cities across England, Scotland, Wales and Northern Ireland. This should comprise a number of research blocks that aim to map out transition paths to a low carbon future for each of the key morphological features of the urban form (e.g. energy, transport, buildings).

- In parallel to the research streams, hold a national forum to debate the distributional and equity implications of climate change within urban areas. This should tie into existing work, for example Defra's work with the Environment Agency on environmental inequalities.

- Drawing on both of these, require the development of "city climate change plans", akin to strategic planning document, which clearly set out the full package of responses required to achieve the 60% and, indeed the 80%, reduction (not just actions in one or two areas piecemeal).

- The plans should set out both the strategic vision for the city in 2050 as well as the actions required to get there. For example, it is no longer acceptable to know that by increasing the proportion of renewables or introducing new efficient models of cars that we are vaguely heading in "the right direction". Each city must have a clearer sense of how many renewables, or how many cars operating at which level of efficiency.

What about the UK?

In the UK, the Government has set its own emissions reduction targets; firstly committing itself to a 20% reduction in CO_2 emissions by 2010 (a target which it has admitted will be very difficult to meet).

More recently, the Climate Change Bill has proposed longer term, legally binding reductions of at least 60% on 1990 levels by 2050 with "real progress" (considered to be a reduction of 26-32%) by 2020.

The original target of 60% was proposed by the Royal Commission on Environmental Pollution (RECP) in 2000, based on an assessment of what was necessary for the UK to make a fair contribution to staying below 2˚C warming. Many scientists and environmental campaigners have recently pointed out, however, that the science behind these recommendations has now been updated, and that the need is now clear for the UK to make an 80% cut. Therefore, this report also looks at the potential implications of an 80% target to reflect the growing possibility of the implementation of such a far-reaching and ambitious goal.

...and Wales?

"Wales led the world in the first industrial revolution that was based on exploiting our resources of carbon in the form of coal, we must now play a leading role in creating a new low carbon future which will be vital to ensuring a sustainable future for generations to come."[1]

Peter Davies, Vice-Chair Sustainable Development Commission for Wales.

Wales is the first Government in the world to legally embed sustainability into all its activities

Legislative mandates

Wales was granted its own devolved administration through the Government of Wales Act 1998, which transferred the powers of the old Welsh Office and Secretary of State for Wales to the new National Assembly for Wales. One of the key components of this Act was Section 121 which set out a duty for the Assembly to promote sustainable development in the exercise of its functions and to build sustainable development in all policies and practices, making it the first Government in the world to legally embed sustainability into all its activities.[2]

Carbon emissions and reduction targets

Wales could be considered as carrying great responsibility for the emission of greenhouse gases, both in the past due to its history as a centre of heavy industry and coal mining, and into the present, as highlighted by a recent report comparing emissions from the different areas and regions of the UK.[3] The report stated that, in 2004, Wales produced 41.8 million tonnes of CO_2 and had the twelfth highest carbon emissions per capita in the world (excluding small island states). Also, at 14.2 tonnes per person, emissions were much higher than in any other part of the UK (the equivalent figure was 8.8 tonnes in England, 8.5 tonnes in Scotland and 9.5 tonnes in Northern Ireland). It should be pointed out, however, that some people feel that this comparison is unfair. A Welsh Assembly Government spokesperson stated that,

"Carbon emissions in Wales appear higher because of the amount of heavy industry and electricity generation in Wales. Road transport and residential emissions are in line with the rest of the UK."[4]

In its 2006 *Environment Strategy for Wales*, the Welsh Assembly Government committed itself to reducing emissions in Wales, contributing to the UK's target under the Kyoto Protocol (a 12.5% reduction in emissions of greenhouse gases by 2008-2012) and to UK Government goals of a "20% reduction in CO_2 emissions below 1990 levels by 2010 and a 60% reduction by 2050, with real progress by 2020." In addition it has also set a target of a 20% cut in greenhouse gas emissions by 2020 on a 2000 baseline of 46.114 mega tonnes of CO_2.[5]

The 2004 Welsh Assembly Government report into carbon emissions showed, however, that carbon emissions were actually 2.5% higher than in 1990. This would mean that, just six years before the first target date (20% reduction by 2010), emissions were actually over 15% higher than the 'desired emissions', and would need to be reduced by 4% each year in order achieve the goal.[6]

In terms of long-term targets, however, Wales aims to match the UK-wide target of a 60% reduction by 2050. These targets represent clear commitments that the Welsh Assembly Government will be compelled to work towards, despite the fact that it can only indirectly influence some of the major areas that will need to be addressed, notably heavy industry and power generation industries.

Climate change strategy, action plan and initiatives

In order to meet emission reduction targets, the Welsh Assembly Government has set out a number of initiatives, notably releasing the Energy Wales Route Map consultation in 2005, which contained 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; and
- On a holistic basis, achieving measurable carbon dioxide emission reduction targets for 2020.[7]

The Welsh Assembly Government also appears to be attempting to lead by example, with 90% of its energy currently supplied from renewable sources. It aims to increase this to 100% by 2010.[8]
In addition, the document "One Wales: A progressive agenda for government in Wales" sets out the aims of the new Labour Plaid Cymru coalition government formed in July 2007. This agreement comprises a number of initiatives which, if implemented by the new Welsh Assembly Government, could have a significant impact on efforts to reduce greenhouse gas emissions in Wales.

These initiatives include the formation of a Climate Change Commission for Wales which will "assist with the development of new policies and the creation of consensus on climate change," and the development of an Energy Strategy, to be integrated with a planning framework, which will promote "energy efficiency, micro-generation, eco roofs, diversified renewable energy generation and biomass, an improved advisory service for citizens and communities, and support for a study on the proposed Severn Barrage, including its environmental impact."[9]

The document also states that the new government will:

- Continue to provide energy efficiency grants, including a non-means tested element within the context of a National Energy Efficiency and Savings Plan;
- Revise upwards the targets for energy from renewables, drawn from a range of sources;
- Promote research and development into renewable technologies including their application on-shore and off-shore;
- Develop a support programme to promote energy efficiency and renewable energy production in farms; and
- Explore the introduction of a grant scheme to convert to energy crops.[10]

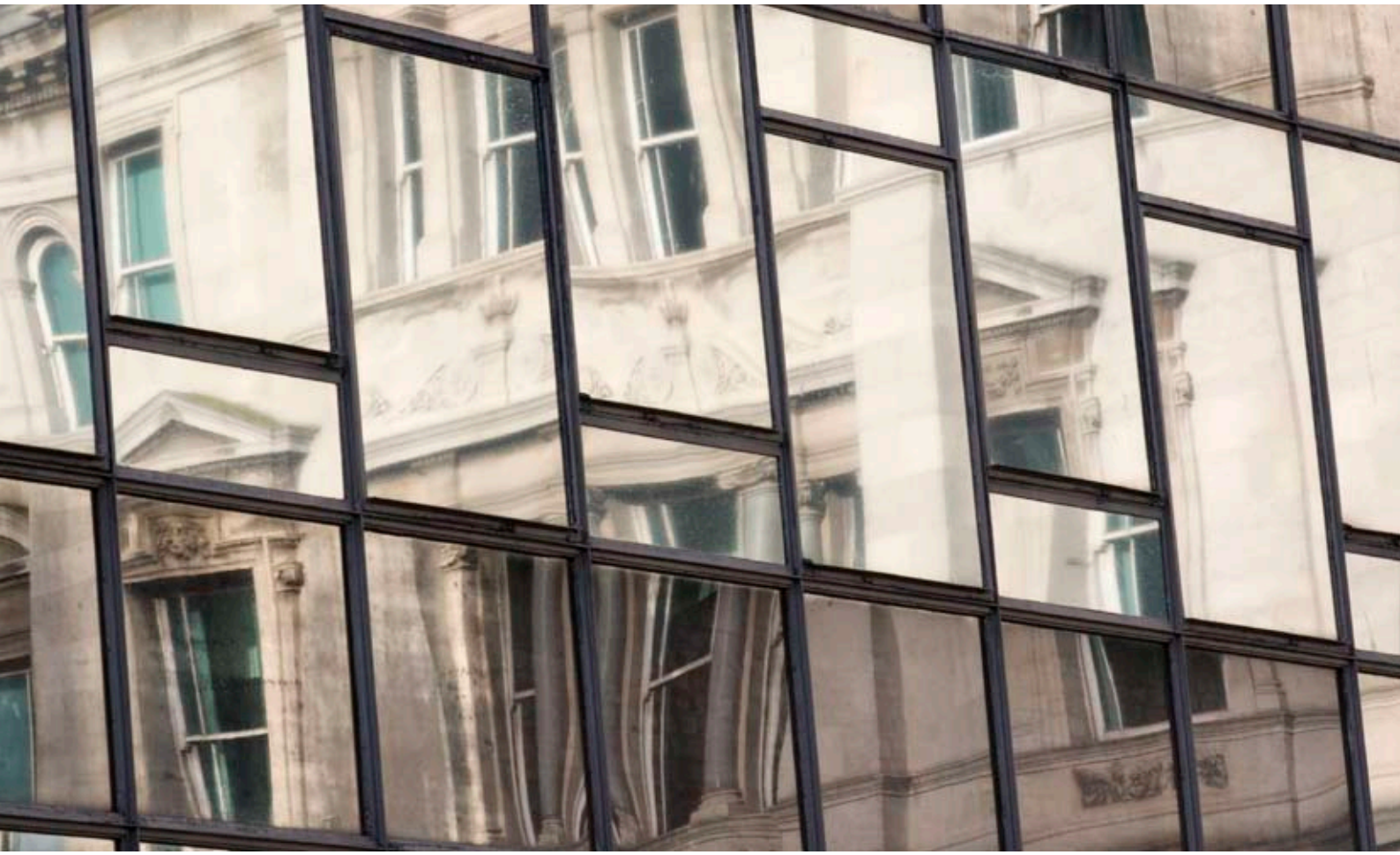
In a further initiative, in April 2006 all 22 unitary authorities in Wales, the three National Park Authorities and the Fire and Rescue Authorities signed the Welsh Commitment to Address Climate Change. This

The Welsh Assembly Government also appears to be attempting to lead by example

commits each authority to work to reduce emissions and adapt to the effects of climate change, and makes Wales the only EU country where all local authorities have signed a public commitment to tackle climate change.[11]

Clearly, a great deal of work is being done in Wales to reduce CO_2 emissions, by the Welsh Assembly Government, by local authorities as well as other organisations and UK-wide initiatives. This, and the Welsh Assembly's legal duty to build sustainable development in all policies and practices, means that Wales is on a good footing to take the necessary steps towards the significant reductions in emissions required. As stated earlier, however, current emissions levels in Wales are particularly high, and changes will need to be made if Wales is to meet the targets it has set itself. Some of the potential changes are highlighted in this report.

Wales is on a good footing to take the necessary steps towards the significant reductions in emissions required



How have we done this?

The work draws on various sources of information including recent developments in scenario planning, the wider climate change literature and formal statistical data sources. Using these, we present three investigative case studies which are intended to both provoke debate and discussion, and illustrate the possible transition paths to a low carbon future. Each case study covers one issue in one Welsh city in order to illustrate the extent of change needed by each urban feature individually:

Issue	Case study location
Transport	Bangor
Energy demand from the built environment	Cardiff
Energy Supply	Swansea

Background to data sources

Statistical data and trends were sourced largely from Government departments (e.g. DfT, DBERR and Defra) and, in terms of local level data for each of the three cities, local authorities (e.g. Swansea City and County Council and Welsh Assembly Government). Additional documentation from experts and practitioners in the fields of transport, the built environment and energy supply was also reviewed (e.g. The Society of Motor Manufacturers and Traders, Carbon Trust and British Wind Energy Association).

The work also draws on scenario planning. Scenario planning is a relatively well established tool, even if its application in the environmental arena has been relatively recent. The strength of scenario planning lies in its ability to illustrate possible future 'paths', consider emerging (or possibly emergent) issues and so aid in the management of risks and opportunities.

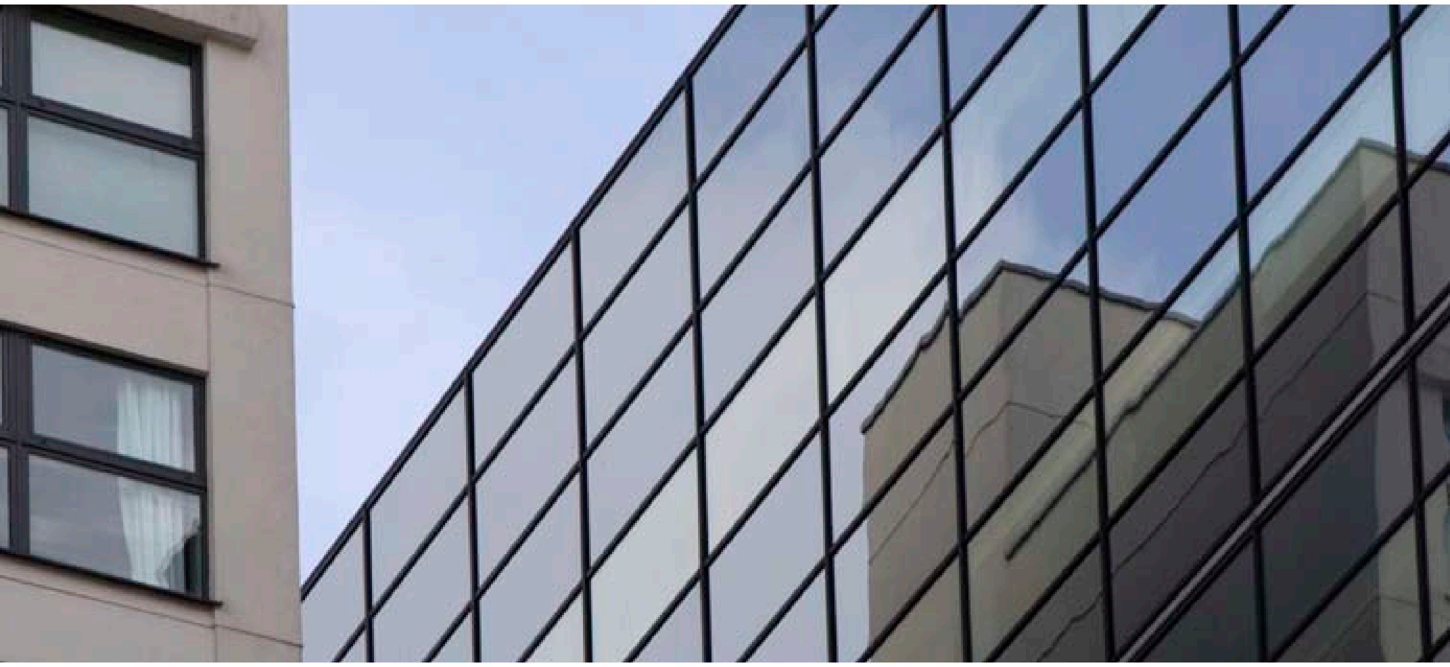
Nonetheless, interpreting scenario work needs careful consideration. Whilst scenarios ostensibly all consider the same thing – what the world will be like at some point in the future – they always present subtly different visions of the future.

In our view, their value is in enabling understanding rather than providing answers. Indeed, it matters rather more to take account of several scenarios, rather than to attempt to meld a variety of scenarios into a single 'right' scenario.

We have chosen to draw upon scenarios from four sources in order to set the back drop to our analysis these are **Tyndall Centre,**[12] **Foresight Futures,**[13] **Henley Centre/ Environment Agency**[14] and **Contraction and Convergence.**[15]

Not all these scenarios are consistent with a low carbon future; nevertheless they help to set the scene for the different potential alternatives for the future. In the main the focus of this work is on the scenarios describing a low carbon future, although for the purpose of contrast we do briefly reflect at times on the latter. Further details on each of the scenarios can be found in the main report.

Bangor Transport



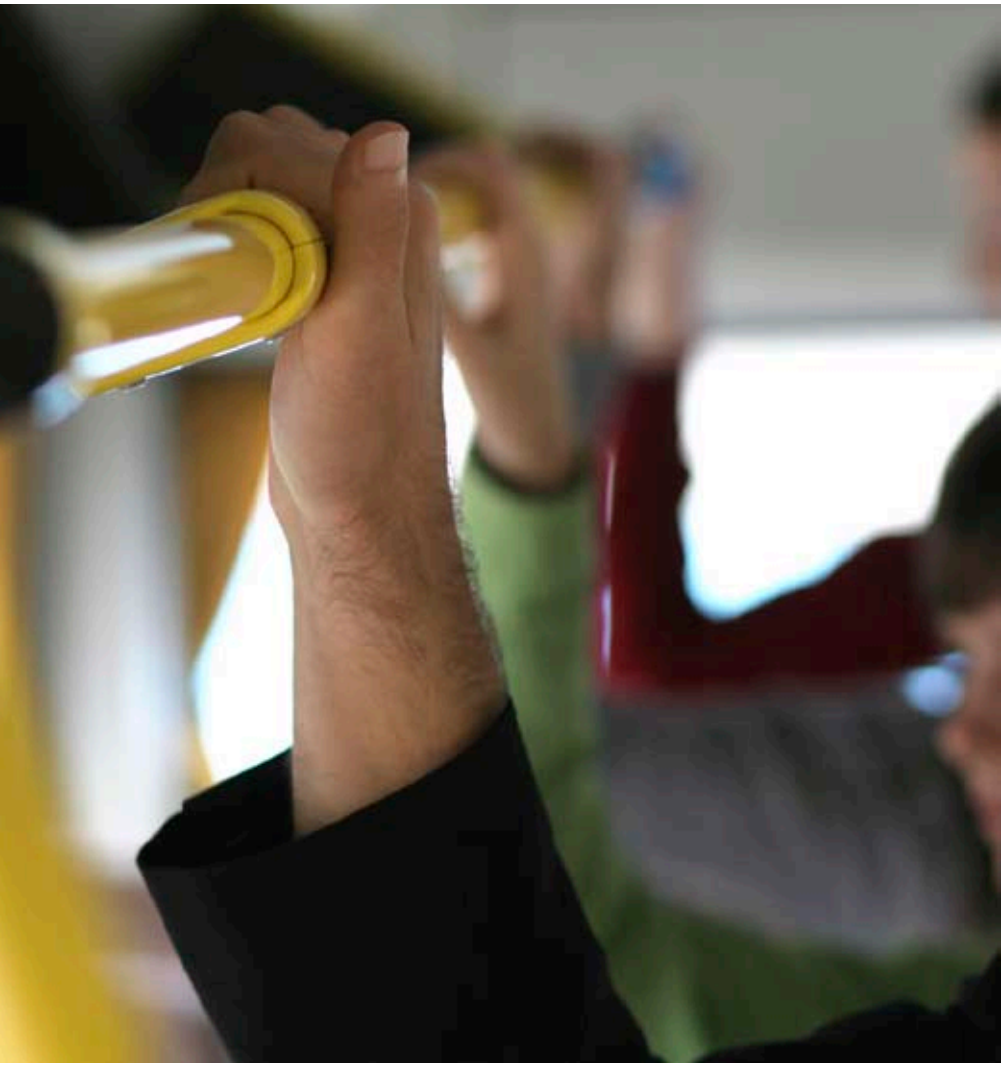
Cardiff Energy demand from the built environment

Swansea Energy supply

Key findings

This section outlines the key findings of our research. There are two parts to each of the case studies. First, we begin by outlining what the scenarios tell us about possible futures for each of the three urban issues. Then, using key UK and Welsh trends alongside local data from each of the three cities, we undertake our own calculations to highlight what a 60% and 80% reduction in CO_2 could look like in practice. We explore one urban issue in each city in order to single out the extent of the change needed and its effects.

1 CASE STUDY: Transport in Bangor



WHAT DO THE SCENARIOS TELL US?

Certain aspects of transport – namely technological advancement and the role for a strong system of spatial planning in prioritising public transport - are consistently identified as important ingredients of the transition to a low carbon transport future.

Other features appear in some scenarios but not in others. For example, the Tyndall 'low energy demand' scenarios are predicated on a societal value shift where private car use is no longer socially acceptable within urban areas. By contrast, the 'low carbon' Foresight scenarios are based on the development of a modernised, integrated and eco-efficient transport and freight network.

Those scenarios which appear less consistent with a reduction in CO_2 provide a powerful contrast. They depict a future of continued growth in travel, where the large scale development of new transport infrastructures is not sufficient to prevent widespread congestion in urban centres.

IMPLICATIONS FOR CAR TRANSPORT IN BANGOR

We looked at trends across three key variables (number of cars, total distance travelled/mileage and average CO_2 emissions) and made the following assumptions:[16]

- In Bangor there are currently about 6,600 cars, and the number is expected to increase (driven by fuel costs, increasing incomes and higher car ownership per household). If a 25% increase in the existing stock is assumed then there will be about 8,200 cars by 2050.
- The average distance travelled per car within Wales is C14,600 km per year (9,072 miles). As the number of cars per household increases this figure will likely decrease slightly. Some of the Henley scenarios predict a decrease to an average of 13,000 km/year (8,077 miles).
- The average CO_2 emission per car in Gwynedd (the county in which Bangor resides) is 0.171 kg/km (0.6 pounds/mile). Future projections are more problematic with no clear consensus. By 2050 we have assumed that this will have reached an average of 0.095 kg/km (0.336 pounds/mile) across the entire car fleet (with some cars – such as the Honda Insight – performing better while others perform worse). This figure is being considered by the European Commission as the limit for average emissions by 2020.

The current situation and predicted/possible trends are outlined in the table opposite.

Current and possible future car trends in Bangor*

Year	Today	Future (2050/2030)
Number of cars in Bangor	6,579	No change: 6,579 25% growth rate: 8,224
Average distance travelled per car within Wales	14,596 km (9.069 miles)	No change: 14,596 km (9,069 miles) Henley prediction: 13,000 km (8,077 miles)
Average CO_2 Emissions per car in Gwynedd	0.171 kg/km (0.6 pounds/mile)	0.095 kg/km (0.336 pounds/mile)

Currently, Bangor's cars emit **16,421** tonnes of CO_2 per year. To achieve a 60% reduction by 2050, emissions must therefore fall to **6,568 tonnes of** CO_2 **per year** and for an 80% reduction emissions must fall to **3,284 tonnes of** CO_2 **per year.**

We present two alternative approaches to delivering this reduction – one delivered by technological advances; and another led by behaviour change among the public and supplemented by more modest advances in technology. Taking the technology-only path, we make two projections based upon varying numbers of cars and the distance they travel in 2050:

Projection 1

Assuming no change in the number of cars and distance travelled – a conservative assumption - the average car would have to emit 0.068 kg/km of CO_2 (0.24 pounds/mile) for a **60% reduction** in emissions and 0.034 kg/km of CO_2 (0.12 pounds/mile) for an **80% reduction** in emissions.

Projection 2

Assuming an increase in the number of cars by 25% (to 8,200 cars) and using Henley's projection for distance travelled (to 13,000 km, or 8,077 miles) the average car would have to emit 0.061 kg/km of CO_2 (0.216 pounds/mile) for a **60% reduction** in emissions and 0.031 kg/km of CO_2 (0.109 pounds/mile) for an **80% reduction** in emissions.

The box below attempts to contextualise the above figures with what is available on the market in terms of car transport.

In all cases, every car in the Bangor of 2050 has to perform significantly better than the best model currently available (excluding solely electric models): the Honda Insight (hybrid petrol/electric) emitting 0.08 to 0.085 kg/km of CO_2 (0.283 to 0.301 pounds/mile). It is worth noting that only approximately 500 are in circulation in the UK as Honda stopped selling this model in May 2006. The next best performing model, which is much more widely available, the Toyota Prius, has emissions of 0.104 kg/km of CO_2 (0.368 pounds/mile).

Indeed, with the exception of a technological breakthrough like shifting to a hydrogen economy, technological advancement does not appear able to deliver the cuts required on its own: the behaviour of the driving public must also undergo a sea change.

*see glossary

...the people of Bangor would have to be persuaded to drive 28% fewer miles

WHAT DOES A TONNE OF CARBON DIOXIDE LOOK LIKE?

We talk about the emissions that a car makes in a year, and how much carbon dioxide is emitted by a power station. But what does that actually mean? Well, one tonne of carbon dioxide takes up about 556 cubic metres, which is about the same volume as:

a three bedroomed house or 679,000 bottles of wine

Assuming that technology does allow for improvements in fuel emissions but is limited to an average 0.095 kg/km (0.336 pounds/mile)across the car fleet, then the bulk of the 60% or 80% reduction targets need to be achieved through behaviour change.

Projection 1

Assuming no increase in the number of cars, for a 60% reduction the average distance driven must be reduced to 10,500 km (6,524 miles)- a 28% reduction, and for an 80% reduction this figure must be reduced to 5,300 km (3,293 miles) - a 64% reduction.

Projection 2

Assuming no change in distance travelled then the number of cars must be reduced to 4,700 for a 60% emissions reduction - again approximately a 28% reduction and 2,400 for an 80% emissions reduction - again approximately a 64% reduction.

We also took the opportunity to begin to think about the wider impacts that such changes may have. Although there are no certainties, the kinds of developments that could be consistent with this transition path include, for example, a significant expansion in the public transport network, the redistribution of shopping facilities, a transfer of space used by the road network to public spaces and, with less congestion, a renewed focus on community, health and leisure uses of public space.

SUMMARY

The figures presented above are sobering. Either every single car in Bangor by 2050 would have to perform at a standard above the best model currently in circulation or, alternatively, the people of Bangor would have to be persuaded to drive 28% fewer miles or collectively own 28% fewer vehicles – significantly less if the targets for CO_2 reduction are increased to 80% as called for by many environmental campaigners.

There are numerous examples in Wales of moves towards more sustainable transport, with behaviour change measures designed to encourage the Welsh to be less reliant on their cars. There are a vast number of workplace travel plans, such as the Active Travel Scheme at Singleton Hospital in Swansea which invested in improvements such as installing lockers, shower rooms, pool bikes, cycle shelters and extra security measures, and provided discounts for bicycles.[17]

Most local authority Transport Plans in Wales are also geared towards getting people out of their cars and onto public transport. Cardiff's plan, for example, prioritised investment in the bus service, with the creation of an Express/Core Bus Network focus on the City Centre and the implementation of priority measures (e.g. reallocation of road space to buses),[18] while the Council has also set up its own car share scheme.[19]

Technology is also beginning to play a part in transport CO_2 reductions in Wales, including through localised efforts, such as the programmes in Swansea, Cardiff and Newport to convert the city and county council vehicle fleets to LPG vehicles, and Pembrokeshire National Park Authority's decision to lease vans that run on 100% bio-diesel.[20]

It is clear that the opportunities to drastically reduce transport emissions in Wales do exist, and that the first steps along this road are being taken, both through technological and behaviour change interventions. If the ambitious targets for emissions reductions are to be met, then equally, if not more patent, is the need for further, more radical action.

2 CASE STUDY: Demand from the built environment in Cardiff

WHAT DO THE SCENARIOS TELL US?

With regards to the built environment and energy demand there are several common features across the scenarios, most notably a focus on reducing energy demand alongside improvements in energy efficiency. Furthermore, most of the scenarios advocate a strong role for regulation in driving buildings' resource and energy efficiency (as well as efficiency across the supply chain in general).

Nonetheless, there are several variations specific to individual scenarios. For example, the Tyndall scenarios envisage national policy facilitating the emergence of Energy Service Companies, setting housing performance standards, and providing low cost finance to homeowners to implement improvements.

By contrast, the Foresight scenarios focus more on development controls (which create dense, low-rise developments by prioritising development in existing urban centres and 'brownfield' sites); while the Henley scenarios focus on domestic housing and envisage communal living stemming the rise of single person households.

By way of contrast, those scenarios which are less consistent with a low carbon future envisage weaker planning controls and more 'sprawl' in development, where the boundary between city and countryside is blurred. Furthermore, a number of other broader themes are raised which may have important equity implications. For example, several scenarios envisage an increase in "gated" communities and an increase in affluent households securing their own private water and energy supplies.

IMPLICATIONS FOR BUILT ENVIRONMENT IN CARDIFF

We looked at data in Cardiff for three key variables (number of buildings, floor space of commercial and industrial premises, and the CO_2 emissions associated with each) which are set out in the table below:

BUILT ENVIRONMENT DATA FOR CARDIFF

Type of building	No. of buildings	m^2 in thousands	CO_2 emissions
Domestic Occupied Households	123,580	Figure not available	712 kilo-tonnes
Industrial & Commercial	9,270	3,867,000 m^2	1,302 kilo-tonnes

Current CO_2 emissions from the average house in Cardiff are 5,760 kg of CO_2 per year. We make two projections based on varying household numbers in the future:

Projection 1 - Assuming no change in the number of households (a conservative assumption), to achieve a 60% reduction by 2050, emissions from the average house must fall to 2,310 kg of CO_2 per year and 1,150 kg of CO_2 per year for an 80% reduction.

Projection 2 - Assuming the number of households increased by 22% as per the Welsh Assembly projections of the South East Wales growth rate (by 2026) to 151,000 households, then each household could only emit 1,890 kg of CO_2 per year to achieve the 60% emissions reduction, and 950 kg of CO_2 per year for the 80% reduction.

Projection 3 - Assuming the number of households increased by 33% (to 164,000 households) by 2050, in line with the UK increase projected by The Environmental Change Institute, then each household could only emit 1,700 kg of CO_2 per year to meet the 60% overall emissions reduction target and 870 kg of CO_2 per year to meet the 80% target.

...if there is any growth in housing, then every house would need to perform better than an average home built to the current stringent building regulations

The next two boxes attempt to contextualise the calculated household emissions for Cardiff with current best practice housing standards and building regulations:

Even if every house in Cardiff performed as per the Advanced Practice Energy Efficiency Best Practice Housing Standards (approximately 2,300 kg CO_2/year for a detached bungalow) this would only be sufficient to meet the smaller 60% reduction target in the case of no growth. If the target is increased at all, or if there is any growth in housing, these standards would not be sufficient.[21]

Current emissions from each square metre (m^2) of commercial and industrial space in Cardiff are 340 kg of CO_2 per year. For the 60% target, this would mean that assuming no growth each business site could only emit 140 kg of CO_2 per m^2, while for the 80% target it would have to be reduced to 70 kg of CO_2 per m^2, as opposed to the current figure of 340 kg.

Assuming an 11% growth in the commercial and industrial sector in line with the employment projected for Cardiff by 2021, each building could only emit 120 kg of CO_2 per m^2 in order to meet the 60% overall emissions reduction targets. In order to meet the 80% emissions reduction targets each premises could emit just 60 kg of CO_2 per m^2. For an illustration for what this could mean to individual offices see section 3.4 of the main report.

SUMMARY

Assuming that the 60% or indeed the 80% cut in CO_2 emissions for the built environment were to come solely from the demand for energy (rather than supply) then, just as was the case with transport, the calculations presented above offer pause for thought.

To envisage the scale of reductions required we have to think beyond what is currently best available; in the case of Cardiff, if there is any growth in housing, then every house would need to perform better than an average home built to the current stringent building regulations – no small task given that the majority of homes were built before these regulations were brought in, and therefore fall significantly short of these standards. In addition, every business site would need to significantly reduce the CO_2 emissions per metre squared, with the average non-industrial emissions brought down to a level currently achieved only by office buildings considered good practice.

Moves to lessen the demand for energy from the built environment are clearly underway in Wales. In the Wales Spatial Plan currently under consultation, for example, the Welsh Assembly Government has set out its aspiration that all new buildings or developments should achieve an 'Excellent' rating under the BREEAM environmental assessment framework, and plans to have this as a core requirement for receiving Assembly funding. It is also aiming for all new developments to be built to zero carbon standards from 2011.[22]

Concentrating solely on new build, however, is clearly not sufficient, given that it is estimated that 80% of the homes we will inhabit in 2050 are already standing today.[23] Indeed, there are a number of initiatives in Wales to improve the efficiency of existing buildings. The Wales Home Energy Efficiency Scheme, funded by the Welsh Assembly Government, offers grants and advice to help people reduce their energy consumption,[24] while the Welsh Housing Quality Standard has set a minimum energy rating for all social housing.[25] A great deal of action is also being taken at the local level. For example, Caerphilly County Borough Council has developed an investment system of revolving funds to pay for energy efficiency improvement and recoup the costs from future savings, while Gwynedd Council has partnered with British Gas to extend their 'Here to Help' scheme from the social sector into private sector housing, offering grants and advice in the area of Dyffryn Nantlle. In addition, as part of the 'Warm Wales/Cymru Gynnes' programme, the entire housing stock in Neath Port Talbot is being surveyed, assessed and treated with energy efficiency measures such as insulation.[26]

It is clear that much is being done in Wales to reduce CO_2 emissions from the built environment, particularly the housing sector, and the above are just some of the examples of initiatives underway. However, the scale of the task at hand should not be underestimated, as highlighted by the fact that, despite the improved building regulations and various initiatives that have been implemented, "Carbon dioxide emissions from the housing sector have risen by more than 5% since 1997 and account for 27% of Wales' carbon footprint."[27]

3 CASE STUDY: Energy supply in Swansea

WHAT DO THE SCENARIOS TELL US?

The scenarios consistently identify energy supply mix and energy security as key features of a low carbon future. The mix of energy supplies is specific to each of the scenarios, although there is full coverage and reliance to greater or less extent on coal and gas (with and without carbon capture and storage), renewables (wind, wave and solar), nuclear, hydrogen, combined heat and power, fossil fuels and biofuels.

There are also occasions when the focus of the scenarios diverges. For example, the Tyndall 'low energy demand' scenarios require strong and internationally accepted energy standards and taxes. In contrast, the Foresight scenarios consistent with low demand envisage the restructuring of the supply network to enable a focus on local energy resources and the expansion of small-scale renewable technologies.

The Henley scenarios highlight the importance of international agreements following on from the Kyoto Protocol. In addition, as some of these scenarios envisage an energy crisis and therefore high energy costs, micro-generation units have thrived within local communities. In order to respond to the short-term crises, fuel rationing schemes and individual carbon quotas are introduced intermittently. The scenarios that envisage high energy demand require large scale investment in energy supply infrastructure, in some cases (but not all) involving nuclear power. Some foresee a market take off in renewables, whereas others predict that even though such technologies become commercially viable, high discount rates and low fossil fuel prices continue to preclude their widespread adoption.

IMPLICATIONS FOR ENERGY SUPPLY IN SWANSEA

In terms of the local energy supply system in Swansea, natural gas accounts for the largest proportion (49%), followed by petroleum for transport (22%), electricity (19%) and petroleum for the built environment (8%). Other sources including manufactured fuels, coal, renewables and waste account for just 1% of supply.

Swansea needs a total supply of 4,486 x 106 KWh for its domestic, industrial and commercial sector. Assuming no change in current levels of energy consumption, in order to achieve the 60% reduction 2,691 x 106 KWh needs to come from non CO_2 emitting sources of energy. To achieve the 80% emissions reduction, this figure would need to be 3,589 x 106 KWh.

The four types of non CO_2 emitting energy sources discussed are nuclear, wind, solar PV and hydro power. The electricity generated by each of these is outlined in the table opposite.

...Without action on energy demand, it would require energy infrastructure development, with the associated impacts, on an unprecedented scale

ELECTRICITY GENERATED BY NON CO_2 EMITTING ENERGY SOURCES

Type of Energy Source	KWh of electricity generated per year
A Nuclear Power Reactor	3,644 x 10^6 KWh/year
A Wind Turbine (1.8 MW)	4.7 x 10^6 KWh/year
A Solar PV (20 m^2 roof)	1500 KWh/year
A Small Scale Hydroelectric Turbine	240 x 10^3 KWh/year

To put this in context:

Just in order to sustain current consumption levels but cut emissions by the 60% target, Swansea's domestic, and commercial and industrial sector would need the equivalent of

- 0.74 of a nuclear power plant
- 573 wind turbines
- 1.79 million PV roofs
- OR 11,215 small hydro-electric turbines

In order to meet the 80% emissions reduction target, this would require

- 0.98 of a nuclear power plant
- 764 wind turbines
- 2.39 million PV roofs
- OR 14,953 small hydro-electric turbines

These numbers would rise if there is any further increase in energy consumption.

As a further illustration, based on a total of 94,400 households in Swansea, to reach the 60% target:

Each household in Swansea would need 19 solar PV panels OR

- one small hydro-electric turbine would be needed for approximately every 8 households

To achieve the 80% target:

- Each household in Swansea would need 25 solar PV panels OR
- one small hydro-electric turbine would be needed for approximately every 6 households

SUMMARY

The prospect of every city like Swansea needing a fleet of wind turbines, or needing more roofs for PV panels than it physically has, or almost one nuclear power plant or more than 10,000 small hydro power stations like the hydroelectric turbine at Talybont-on-Usk, highlights the scale of the challenge. Without action on energy demand, it would require energy infrastructure development, with the associated impacts, on an unprecedented scale.

The implications of changes in energy supply for other facets of urban life are wide reaching. There may be significant implications for green belt policy, areas of outstanding natural beauty and biodiversity. The question of whether energy provision remains national or becomes more local raises interesting distributional and equity questions about the ability of communities to take control of their own power supplies.

Furthermore, energy supply changes could drive a re-orientation of attitudes towards waste whereby it ceases to be viewed as an unavoidable by-product of production and instead is considered a valuable material input. This could lead to the need for a new generation of waste reprocessing technologies in urban areas, and to a renewed focus on eco and resource parks and the notion of 'industrial symbiosis'. Again, Wales is taking small steps in the right direction also in terms of energy supply. As highlighted in Defra's *Climate Change – The UK Programme 2006* report, "Wales has tremendous natural potential for renewable and alternative energy."[28] For example, in addition to the many renewable energy projects mentioned earlier in this section, the Welsh Assembly Government is also now considering a major tidal power scheme at the Severn Barrage[29] and, as previously mentioned, it has committed to significantly increase the amount of renewable energy produced in Wales. Indeed, there are currently 39 wind farms under construction across Wales, with a total of 578 turbines.[30]

Action will also need to be taken at a more local level, and there are signs of this taking root across Wales. A number of community renewable energy projects have been set up in many different parts of the country, such as the Dyfi Valley Community Renewable Energy Project. This project has been instrumental in the installation of a wide range of measures including a hydro-electric unit, a number of solar PV and solar water heating units and a community wind turbine.[31] The hope is that this will mark the new thinking in the supply of energy, moving from a centralised, inefficient system relying heavily on coal and gas-fired power stations, to decentralised, renewable or low carbon energy sources.

Much remains to be done to reach this situation although a number of communities are showing the way. Residents in the village of Talybont-on-Usk near Brecon, for example, are now taking steps to make their village carbon-neutral after setting up a hydro-electric scheme in 2006 with the help of a local not-for-profit energy company.[32] Whilst it may be some time before every community is able to take measures such as this, the more that do so, the more chance Wales will have of achieving the 60%, or indeed 80%, reduction in emissions required to limit the effects of climate change.

Some closing remarks

This section draws together the research findings and provides some concluding remarks about the implications for policy.

Our first remark is overarching and relates to the current state of the research base. We have found that, in spite of the work already undertaken to understand and respond both to climate change mitigation and adaptation, there remains, in our judgement, surprisingly little detail about the implications for UK towns and cities. So while we know, for example, that renewable technologies or making fewer journeys by car are 'good things' and part of the solution, we know rather less about how many renewable technologies are required or how much less we need to drive.

In particular, information needed in order to ascertain 'how much less' we need to drive or consume energy or rely on non-CO_2 emitting energy sources is not readily available, i.e. there is little detail on the practicalities. In this report, for example, some difficulties were encountered whilst conducting the research for commercial buildings in Cardiff with regards to floorspace coverage. While there were figures on this available, they only cover premises considered "bulk class"*, due to the fact that the data is collected for the purposes of assigning business rates payable (for non-bulk class buildings floorspace is not a consideration in the assigning of these rates). In addition, information on CO_2 emissions were not easily attributable to different sectors – in this case it was not possible to find emissions from office buildings. In order to facilitate the understanding of the scale of the challenge, in future such information needs to be not only more accessible but also of better quality so as to enable comparison.

Our work addresses some of these questions and is a useful starting point for debate in Wales. Using some unashamedly simple calculations it has demonstrated the following:

First, it is true that in recent years there has been an increase in the amount of energy produced from renewable sources, and that there are further increases on the way There are, for example 578 wind turbines currently under construction in Wales. However, we should be under no illusions about the scale of the challenge facing us. Taking energy supply issues in isolation, the finding that Swansea would need in the region of 11,215 small scale hydro-electric turbines or 573 wind turbines if it were to deliver its CO_2 cuts from the supply side of the equation without any focus on energy demand should draw a deep breath from even the most optimistic of policy makers (even more so if the target is increased to 80% as many scientists and campaigners are demanding). While the proposed Scarweather Sands offshore wind farm three miles off the coast of Porthcawl in Swansea Bay would be able to supply the majority of Swansea's energy (enough for 82,000 out of a total of 94,400 homes), this is still less than 7% of the total occupied homes in Wales. Furthermore, the fact that construction has been postponed due to financial viability issues highlights the vast array of problems to be overcome.

Turning to car transport, the findings highlight similar issues: a purely technological solution to the need for a 60% emissions reduction would require the entire Welsh car fleet to surpass the best performing model currently available (of which only 500 are in circulation in the UK). Such action is not just required in one or two areas. What the work demonstrates is that concerted action is required to achieve a 60% or 80% reduction in energy as well as a 60% or 80% reduction in transport as well as a 60% or 80% reduction in built environment energy consumption, and so on.

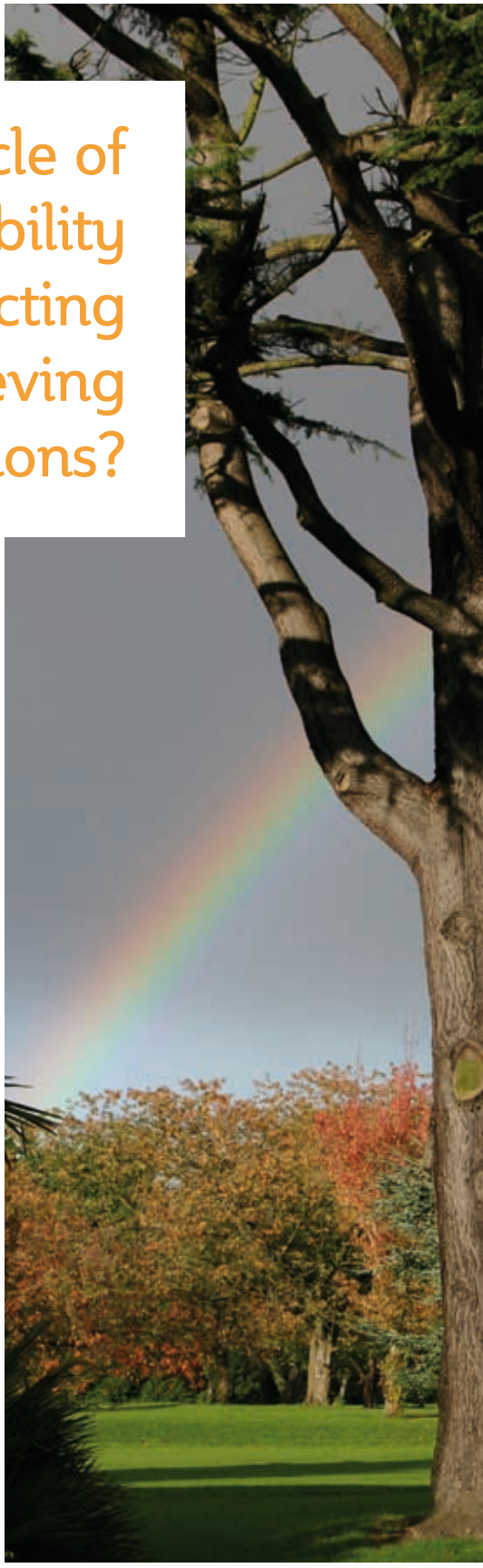
Second, there is a need to consider different transition pathways to the low carbon city of the future. The results have demonstrated, for example, that technology alone is highly unlikely to achieve the necessary reductions without being coupled with substantial changes in behaviour. In the absence of any action to reduce energy demand the only way in which supply could meet its contribution would be through the expansion of the energy supply network on an unprecedented scale.

Therefore, any hopes that we have been harbouring about 'fixing' the problem through a new fleet of hybrid cars, or the mass take up of wind power, or a new generation of nuclear power plants, need quickly to be re-thought. As highlighted, in the main body of this report, a number of schemes are under way in Wales to reduce energy demand, for example through workplace travel schemes, home energy-efficiency schemes etc. What is clear, however, is that these types of initiatives need to be greatly expanded and rolled out across the entire country, encompassing all aspects of life in Wales (including, for example the industrial and commercial sector and a vastly increased public transport network), if the targets are to be met.

Third, the calls for an 80% reduction in emissions by 2050 add significant new challenges. This by no means suggests that we should not aim for this target. Indeed, many scientists claim that anything less would fail to halt the most devastating effects of climate change. The target is not impossible to meet, and reports such as the recently released Environmental Change Institute's *Home Truths* and the IPPR's *80% Challenge* describe the policy measures needed to achieve such a goal. However, from simply looking at the figures included in this report, there can be no doubt that an 80% cut will be an extremely difficult task requiring radical action.

*see glossary

...how do we square the circle of encouraging equality of mobility while at the same time restricting journeys as a means of achieving CO_2 reductions?



Fourth, any of the given changes proposed will in turn instigate a series of wider impacts, and these need to be considered and understood. In this report we have only touched upon some of the possibilities – for waste reprocessing and industrial symbiosis*, for food distribution, public health, lifestyles and consumption choices - and positioned them as exploratory examples that require further work. UK targets need to be translated to the urban level through reduction strategies covering the three key areas examined (transport, built environment and energy) as well as other themes like water, health and waste.

Finally, we wish to draw attention to a much neglected area in the literature and scenario work: equity and distribution. These issues are at times flagged in the scenarios (and subsequently in this report), but there is no systematic appraisal. Furthermore, even with the Contraction and Convergence model - of which equity is a key tenet – there appears to be currently no framework for translating the general principles of inter- and intra-generational equity into specific details at the level of towns and cities.

This is an oversight in the literature, given the implications of both climate change mitigation and adaptation for issues of distribution and social equity. For example, on the adaptation side of the debate, access to insurance and proximity to risk will be key themes in relation to flood potential and extreme weather events. At the global level the disproportionate impact of weather-related disasters on poorer countries is widely accepted, while at the city level the differential social impact of Hurricane Katrina provides a recent and poignant example. We note the synergy here with the environmental inequalities agenda, led by Defra and the Environment Agency.

Climate change mitigation also raises a range of distributional issues, including car ownership and use. For example, while the poorest sections of society tend not to own as many cars or drive as much, rising incomes mean they will increasingly be able to in the future. If a transition path demands fewer cars on the road or, at the very least, fewer journeys, how do we square the circle of encouraging equality of mobility while at the same time restricting journeys as a means of achieving CO_2 reductions? Can the more affluent households be persuaded or compelled to give up their third (or even their second) car on the grounds of social equity?

*see glossary

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About the study

This study was carried out Brook Lyndhurst, a research and strategy consultancy that applies creative thinking and analysis to questions of sustainability. Brook Lyndhurst devises strategies and plans that will deliver more sustainable outcomes – at the level of individual and household behaviour, through to local communities, to whole markets and strategic policy.

Glossary

UNITS USED

GWh	Gigawatt hours (10^9 watt hours)
kg/km	Kilograms per kilometre
km	Kilometre
KWh	Kilowatt hours (10^3 watt hours)
MW	Megawatt (10^6 watt hours)
Tonne	A metric measure of mass equal to 1,000 kilograms or 2,204.6 pounds.
TWh	Terawatt hour (10^{12} watt hours)

Bulk class

'Bulk classes' is a term broadly used to refer to types of non-domestic (commercial and industrial) premises, also known as hereditaments, in England and Wales which Communities and Local Government, the Valuation Office Agency and University College London have data on. These hereditaments are grouped into bulk classes and the non-bulks. From 2005 onwards, the bulk classes are retail premises, offices (commercial and other), factories, warehouses and 'other bulk premises' (e.g. garden centres and social clubs).

The 400,000 hereditaments not in any one of the five bulk classes are collectively known as the 'non-bulks'. The non-bulks include hotels, public houses, schools, hospitals, libraries, and leisure premises. Floorspace and other descriptive statistics are generally not available for non-bulk hereditaments and have been excluded from the statistics presented. The most prevalent non-bulk properties from April 2007 are public houses, advertising rights, car parks, communication stations and holiday homes.

In summary, bulk class properties are those where floorspace is used to set the rateable value for the property. The non-bulk category includes hereditaments that are rated using other criteria (for example, turnover, in the case of public houses, the most prevalent non-bulk hereditament type), or those that are not conventional premises at all, such as ATMs and advertising rights.

Industrial symbiosis

The idea of industrial symbiosis is that local companies co-operate to achieve greater resource efficiency by reducing resource input costs and waste management costs, and identifying new products. For example, waste materials or surplus heat and power from one company can be an input to the manufacturing process of another. Developing commercially viable synergies (in areas such as materials use, human resources, energy/water use and logistics) can generate economic, social and environmental benefits to business, Government and communities. The keys to industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity.

Transport in Bangor

At the time the research was conducted the three key variables used here (number of cars, average distance travelled per car and average CO2 emissions per car) were the most recently available, the closest in geographical proximity to Bangor and the most comparable with the rest of the available data. No formal projections specific to Bangor were available as car monitoring data is not collected at this local level. Therefore, we opted for the plausible assumption of a 25% increase in the existing stock which is based on UK trends discussed in The Future of Transport: Modelling and Analysis (March 2005).

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