The City Climate Challenge for 2050: Your city – your responsibility

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The Climate Challenge

There is now compelling evidence that carbon emissions are leading to climate change. The UK has responded by setting ambitious targets for reducing such emissions. According to Sir David King, the UK Government's Chief Scientific Advisor, 'Climate change is the most severe problem we are facing today.'

Many of the high profile debates on climate change have focused on how energy is generated, rather than addressing the question of how we use energy. We have therefore commissioned Brook Lyndhurst to examine what the potential impact would be on our towns and cities, and on the way we go about our daily lives. The results make sobering reading and raise important challenges for all of us.

The key 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 all contribute to climate change in our daily lives and activities. What is needed is strong leadership from the Government to encourage personal responsibility.

These are our principal recommendations to the government, to help to achieve its aim of reducing carbon emissions:

- Building regulations should be brought into line with the best European and international standards
- We should also look at the energy efficiency of existing buildings. To encourage people to take up energy efficiency measures, the Government should introduce fiscal incentives such as council tax rebates
- Changes should be made to the planning system in order to make it easier for householders to install microgeneration equipment
- Introduce domestic, tradable carbon allowances as a way to change personal behaviour
- Encourage local food production to reduce transport energy and emissions associated with supplying food from far away
- Ensure new development is high density and energy efficient, taking place in Transport Development Areas (TDAs) around transport hubs. This will reduce the need to travel and help create sustainable communities
- Create an energy one-stop-shop to provide access to a more coherent set of measures with information on free help, including audit services, financial support and information on accredited installers
- Ensure domestic fuel bills contain clear information on energy consumption, so that consumers can compare themselves with others and monitor their own consumption. As technology allows, smart metering should be introduced.

Doing nothing is not an option. The questions are how much will we do, and how quickly.

Louis Armstrong
RICS Chief Executive

What are the key challenges?

Climate change is 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 England – Manchester, Bournemouth and Brighton. 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 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.

We set the following challenges:

- Require the development of 'city climate change plans', akin to a strategic planning document, which set out the full package of responses required to achieve the 60% 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. This would not simply suggest that cities are heading in the right direction but would ensure that each city would have a clear sense of, for instance, how many renewables, or how many cars are operating at which level of efficiency
- Hold a national forum to debate the distributional and equity implications of climate change within urban areas
- Launch a UK urban climate change research programme that focuses specifically on the implications of climate change mitigation and adaptation for our towns and cities. This should aim to map out transition paths to a low carbon future for each of the key features of the urban form.

UK commitment

UK government has made a commitment to reduce carbon emissions by 60% by 2050. How can this be achieved?

The purpose of the work is to prompt questions and debate about the futures of UK towns and cities in a carbon constrained world that is also adapting to a changing climate. It is a scoping piece of work to begin the process of translating national targets and strategic policy around CO_2 reductions into actual implications for the form and function of our towns and cities.

Doing this won't be pain-free – there will be big impacts on the way that we live and the way in which we carry out our daily business. In a world where we have an increasingly urban lifestyle, what might the possible impacts be in our towns and cities? What might low-carbon cities look and feel like?

We can't hope to imagine every detail of this, but we can look at some key aspects of this, which will give us pointers and clues as to the ways in which we might be able to make this transition.

If we look at three key issues in the transition to a low-carbon environment – transport, energy demand from the built environment and energy supply – and three contrasting but typical cities in the UK, we can begin to build up a picture.

Issue	Case study location
Transport	Manchester
Energy demand from the built environment	Bournemouth
Energy Supply	Brighton

We also present a fourth, composite case study in London which draws together the three issues and shows the combined reductions needed.

How have we done this?

The work uses various sources of information including recent developments in scenario planning, the wider climate change literature and formal statistical data sources.

Statistical data and trends were sourced largely from Government sources and local authority data for each of the three cities. This was supplemented with authoritative sources in the fields of transport, the built environment and energy supply (e.g. The Society of Motor Manufacturers and Traders, Energy Saving Trust and Building Research Establishment).

The work also draws on scenario planning. This is a relatively well established tool, even if its application to environmental issues has been relatively recent. Its strength lies in its ability to illustrate possible future 'paths', consider emerging issues and so aid in managing risks and opportunities.

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

We have used 13 scenarios from four sources:

The Tyndall Centre[1] – four scenarios – these focus on the different ways in which a 60% reduction in CO_2 emissions can be achieved by 2050. The four scenarios are based upon varying levels of economic growth and energy demand.

Foresight Futures[2] – four scenarios – although not specifically based on climate change, they contain scenarios consistent with CO_2 reduction. They are based upon different sets of social values (either individual or community focused) and governance arrangements (either interdependent or autonomous).

Henley Centre/Environment Agency[3] – four scenarios – these focus on 'environmental futures' in the round and are based on different visions of consumption (dematerialised or material consumption) and UK governance systems (sustainability-led compared to growth-led).

Contraction and Convergence[4] – one scenario - while not strictly a scenario planning tool, this approach provides a valid and important input by virtue of its strong focus upon (social) distributional issues and equity.

Many either describe – or are at least consistent with – a low carbon future. In contrast, others appear less consistent. In the main the focus of this work is on the former, 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 full report, which can be found at **www.rics.org/climatechange**

For references please see page 17

Key findings

So, what do we find?

For each case study city, we first look at what the scenarios have to say and we then undertake our own calculations to highlight what a 60% reduction in carbon emissions might look like on the ground.

Transport in Manchester

Key messages from the scenarios

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.

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

Implications for car transport in Manchester

- In Manchester there are currently around 126 500 cars, and the number is projected to increase (driven by falling fuel costs, increasing incomes and higher car ownership per household). If the number of cars continues to grow at the current rate – an unlikely scenario given that 'saturation level' in car ownership will likely be reached – then there will be 326 000 cars by 2050. We also include two other projections: one based on 'no increase' (by contrast a conservative assumption) and one based on a more modest 25% increase in the existing stock to 158 000
- The current UK average distance travelled per car is 14 500 km per year. 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
- The average CO_2 emission per car in Manchester is 173.5g/km. Future projections are more problematic with no clear consensus. We have assumed that by 2050 this will have reached an average of 110 g/km across the entire car fleet (with

some cars – such as the Honda Insight – performing better while others perform worse). This figure was selected because, without a technological breakthrough on the scale of the UK switching to a fully functioning hydrogen economy, there are self-limiting functionality factors in the design of cars.

The current situation and predicted/possible trends are outlined in the table on this page.

Current and possible future car trends in Manchester

Year	Today (2004/5)	Future (2050)
Number of cars in Manchester	126 463	No change: 126 463 Growth at current rate: 326 102 25% growth: 158 080
National UK average distance travelled per car (km)	14 500 km	No change: 14 500 km Henley prediction: 13 000 km
Average CO_2 emissions per car in Manchester (g/km)	173.5 g/km	110 g/km

Currently, Manchester's cars emit 318 200 tonnes of CO_2 per year. To achieve a 60% reduction by 2050, emissions must therefore fall to 127 300 tonnes of CO_2 per year.

We present two alternative approaches to delivering this reduction – one delivered entirely by technological advancement and another led by behaviour change among the public and supplemented by more modest advancements in technology.

Taking the technology-only path, we make three 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 the average car would have to emit no more than 69.4 g/km of CO_2.

Projection 2 Assuming an increase in the number of cars by 25% alongside a reduction in distance travelled per car, the average car would have to emit no more than 61.9 g/km of CO_2.

Projection 3 Assuming continuing growth at the current rate, the average car would only be able to emit 30 g/km of CO_2.

In each case, **every car** in the Manchester of 2050 has to perform **significantly better** than the best model currently available – the Honda Insight (hybrid petrol/electric) emitting **80 g/km of CO_2**. This model has a CO_2 emission less than half the UK average, and only three were registered in 2005.

Indeed, with the exception of a technological step change, 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.

Therefore, assuming technology can take us only part of the way (with the average performance of the UK fleet reaching at best 110 g/km of CO_2) this means that either the number of cars or distance travelled must decrease. We illustrate two possibilities:

Projection 1 Assuming no increase in the number of cars then the average distance driven must be reduced to 9 150 km – nearly a 35% reduction

Projection 2 Assuming no increase in distance travelled then the number of cars must be reduced to 79 800 – again a 35% reduction.

In each case, significant action is required to either **reduce car ownership** or **reduce distance travelled**. The aim is to both halt and then reverse the trends of the past 50 years with profound implications for our lifestyles.
If either the number of cars or distance travelled increases, then the reductions would have to be even more severe.

It is also important 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. More work is required here.

Demand from the built environment in Bournemouth

Key messages from the scenarios

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 the resource and energy efficiency of buildings (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 the built environment in Bournemouth

We looked at data in Bournemouth 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:

Type of building	No. of buildings	m^2 in thousands	CO_2 emissions
Domestic – Occupied Households	72 212	N/A	446 kilo-tonnes
Industrial and Commercial	4 521	1 230	313 kilo-tonnes

Current CO_2 emissions from the average house in Bournemouth are 6 176 kg CO_2 per year. We make two projections based on varying households 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 2 471 kg CO_2 per year.

Projection 2 Assuming the number of households increases by 25% by 2050, in line with the national increase projected by The Environmental Change Institute, then each household could only emit 1 976 kg CO_2 per year – a cut of 70%.

Therefore, even if every house performed as the **Advanced Practice Energy Efficiency Best Practice Housing Standards** (approximately **2 300kg CO_2/year** for a **detached bungalow**) this would just be enough to achieve the 60% target assuming no growth in households, but insufficient if the number of households increases.

Current CO_2 emissions from each metre squared of commercial and industrial space are 254.5 kg of CO_2 per year. The 60% reduction target (assuming there is no overall increase in the number of commercial properties) means that emissions from a metre squared must fall to 101.8 kg CO_2 per year.

Energy supply in Brighton

Key messages from the scenarios

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 a greater or less extent on a mix of 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 times 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 envision 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 Brighton

In terms of the local energy supply system, natural gas accounts for the largest proportion (53%), followed by petroleum for transport (22%), electricity (22%) and petroleum for the built environment (3%). Other sources including manufactured fuels, coal, renewables and waste account for just 0.42% of supply.

Brighton needs a total supply of 3 730.2 x 10^6 KWh for its domestic, industrial and commercial sector. If we assume that there is no change in current levels of energy consumption, in order to achieve the 60% reduction then 2 238.12 x 10^6 KWh needs to come from non CO_2 emitting sources of energy.

The three types of non CO_2 emitting energy sources discussed are nuclear, wind and solar PV. Of course, they are not truly carbon neutral, in that there is some carbon impact in their construction, but they are largely carbon-free in their operation. The electricity generated by each of these is outlined in the table.

Electricity generated by non CO_2 emitting energy sources

Type of Energy Source	KWh of electricity generated per year
A Nuclear Power Reactor	3.27×10^9 KWh/year
A Wind Turbine (1.8 MW)	4.7×10^6 KWh/year
A Solar PV (20 m^2 roof)	1500 KWh per/year

So, to put this in the context of Brighton, if we simply relied on supply side measures to achieve our desired 60% reduction in CO_2 emissions:

In order to sustain current consumption levels, Brighton's domestic, commercial and industrial sectors would need the equivalent of

475 wind turbines
OR 1.49 million PV roofs
OR 0.7 of a nuclear power plant

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

The prospect of every city like Brighton needing a giant fleet of wind turbines, or needing about ten times more roofs for PV arrays than it physically has, or its own nuclear power plant for that matter, 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 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'.

Reflections for London

How about London? Can we move away from thinking about these issues in isolation and start to build a picture of the CO_2 reductions required from transport alongside those from the built environment alongside those from the energy supply network. In this way it outlines a more complete picture of the task ahead.

Transport implications
Using the same assumptions as in Manchester, a technological solution requires average CO_2 emissions across the car fleet to fall to between 47.9g/km – 73.9g/km, depending on future trends in car ownership and distance travelled. Just as in Manchester, in all cases every car in London has to perform better than the best current model – the Honda Insight (hybrid petrol/electric) car emitting 80 g/km of CO_2.

If the reductions are delivered by more moderate advancements in technology alongside a behaviour change among the public, the scale of the behaviour change required is daunting – either a 35% reduction in cars owned or a 35% reduction in km travelled. If either cars owned or distance travelled increases, these cuts would need to be even more severe.

Built environment implications
The UK capital, with a population of 7 388 000 residing in 3 015 997 households and a thriving commercial and financial sector, consumes a huge amount of energy (more than Ireland and about the same as Greece or Portugal).

The average house in London currently emits 6 278 kg CO_2 per year. Using the same assumptions as in Bournemouth, a 60% reduction would require every home in London to emit 2 511 kg CO_2 per year (assuming no increase in the number of households) or 2 009 kg per year (if projected increases in households are borne out). The latter would in effect require a 70% reduction in emissions.

It is sobering to note that a detached bungalow built to the Advanced Practice Energy Efficiency Best Practice Housing Standards emits 2 300 kg CO_2/year.

Energy supply implications
The composition of Greater London's energy supply is broadly similar to Brighton, although the total amount of energy required – and hence the volume of energy supply needed – is considerably higher. Indeed, in 2003 Greater London needed a supply of 133 458.6 x 10^6 KWh from all the energy sources for both its domestic, industrial and commercial sector.

Assuming no change in current energy consumption levels, in order to achieve the 60% reduction 80 075.16 x 10^6 KWh needs to come from non CO_2 emitting sources of energy. Taking the same assumptions as in Brighton, London would need the equivalent of 17 037 wind turbines, OR 53.38 million PV roofs OR 24.5 nuclear power plants.

What next?

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 in relation to both 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.

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

- First, we should be under no illusions about the **scale of the challenge** facing us. Taking car transport in isolation, the finding that a technological solution would require the entire UK car fleet to surpass the best performing model currently available (of which only three had actually been sold in 2005) should draw a deep breath from even the most optimistic of policy makers. The same is true of the finding, in terms of energy supply, that London would need in the region of 25 new nuclear power plants or 17 000 wind turbines if it were to deliver its energy cuts from the supply side of the equation without any focus on energy demand. 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% reduction in energy as well as 60% reduction in transport as well as a 60% reduction in housing, and so on
- Second, there is a need 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. Furthermore, 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 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 symbosis, for food distribution, public health, lifestyles and consumption choices – and posited them as exploratory examples that require further work.

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, but there is no systematic appraisal or means of 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, the differential social impact of Hurricane Katrina – which raised issues about access to insurance and proximity to climate-related risk – provides a recent and poignant example.

Likewise, climate change mitigation raises a range of distributional issues, for example car ownership and use. While the poorest sections of society tend not to own as many cars or drive as much, rising medium 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?

About the study

The study was conducted by 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

g/km – Grams per kilometre

km – Kilometre

KWh – Kilowatt hours (10^3 watt hours)

MW – Megawatt (10^6 watt hours)

Reference

1 Anderson, K (2005). Decarbonising the UK: Energy for a climate conscious future, Tyndall Centre for Climate Change Research.

2 Berkhout, F (co-ordinator), Foresight, SPRU (Science and Technology Policy Research) and University of Sussex (2002). Foresight Futures 2020 – revised scenarios and guidance.

3 Henley Centre Headlight Vision (2006), 'DRAFT Environment Agency Scenarios 2030,' report prepared for Environment Agency.

4 For further information on 'Contraction and Convergence' refer to the Global Commons Institute's web-site: www.gci.org.uk The initial workings of 'Contraction and Convergence' stemmed from the GCI Proto published in 1991: www.gci.org.uk/signon/OrigStatement2.pdf

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