The Economics of Low Carbon Cities

A Mini-Stern Review for the City of Leeds (2017)

Executive Summary

Andy Gouldson, Andrew Sudmant, Joel-Millward Hopkins, Rafael Luciano Ortiz

Can-do Cities

Leeds Climate Commission

Centre for Climate Change Economics and Policy

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

UNIVERSITY OF LEEDS

£1.2 billion

Leeds spent a total of £1.2bn last year on all of its energy and fuel bills

5.9 percent

That means 5.9% of everything that is earned leaves the city to pay for energy

£277 million

If it invested in profitable energy and low carbon stuff, it could save £277m a year

£81 million

This means households in Leeds could save £81m a year

£31 million

Schools, hospitals, offices and other buildings could save £31m a year

£13.8 million

Industry in the city could cut its costs by £13.8m a year

4,200 job years

This would create 4,200 years of extra employment in the city

23 percent

This would allow the city to cut its carbon emissions by 23%, over and above what is happening anyway

Executive Summary

Populations, economies and energy use are concentrated in cities, and this means that many opportunities for climate action are found in cities too. But policymakers, businesses, communities and individuals need reliable, locally relevant evidence before they can decide which of the thousands of low carbon options available they should focus on. A lack of information limits the extent to which cities can generate not only a business case, but also a social, political or environmental case for action.

This report sets out the longer term trends in energy use and carbon emissions for the different sectors in Leeds. It sets out a long list of the measures that homes, businesses, communities and individuals could take to reduce carbon emissions. Ranging from changing light bulbs to upgrading factories, this analysis assesses both the economic and the climate case, both for single actions and for the wider programmes that could be implemented across the city. Individually, many of these actions have only a small impact on energy use and carbon emissions. Leeds, after all, is a city of more than 700,000 people, with an economic output or Gross Value Added (GVA) of more than £21 billion and total annual expenditure on energy of £1.2 billion. Collectively, however, thousands of small actions, and some larger ones, could generate massive savings in energy use and bills and also carbon emissions, whilst also leading to significant benefits more broadly, for example in job creation, cleaner air, reduced energy poverty, and improved mobility.

By evaluating the viability of these options, this report highlights the opportunity facing Leeds. But it also clarifies the challenges that will need to be overcome if these opportunities are to be realised. Low carbon measures can require large investments, coordination between policymakers, businesses, and individuals and sometimes changes to way we live and work. However, the analysis shows that the benefits of change can far outweigh the costs – a low carbon future for Leeds will not just improve the global climate, but create jobs, reduce energy bills, clean our air and fight fuel poverty. A low carbon future for Leeds is fully compatible with Leeds being a happier, healthier, more inclusive and more prosperous city.

Approach to the Analysis

Drawing on modelling techniques that were developed in Leeds in 2012 and that have since been employed in multiple cities around the UK and in more than a dozen global cities, the analysis draws on both national and local information and data to understand the economics of climate action in Leeds.

The analysis proceeds in three steps.

First, data is collected to understand the landscape of energy use and emissions in Leeds, both in recent years and into the future. This involves understanding trends in both the population and the economy in Leeds, as well as the state of the current building stock and transport networks, using local and national data to project how these might change in the future. Second, a long list of the possible actions to reduce energy use and carbon emissions in the domestic, commercial, industrial, transport and waste sectors is refined for the local context through stakeholder consultations. During this process some actions that are not locally relevant are removed, and some new actions are added. Following this, the economic case for and the carbon impacts of actions are assessed individually using local costs and potential rates of deployment. Finally, actions are combined into scenarios to understand the extent that the city as a whole can reduce energy use and carbon emissions. These scenarios take into consideration interactions between measures and between sectors. For example, measures to improve the efficiency of boilers are effected by how well insulated buildings are.

Three scenarios are then developed. The 'cost effective' scenario includes the set of profitable actions with a positive net present value, meaning that their benefits more than offset their costs over their lifetime. The 'cost neutral' scenario generates the largest carbon savings without generating a net cost. For this scenario, the benefits of all the measures equal their costs, so that the net present value is approximately zero.

Finally, the 'technical potential' scenario includes all measures that could generate carbon savings, regardless of their costs and benefits. While the economic case for this scenario is asessed, the scenario itself reflects what could technically be done to cut energy use and carbon emissions across the city of Leeds.

Our analysis includes both Scope 1 emissions, meaning those emitted by using fossil fuels within the city, and Scope 2 emissions that come from the use of electricity within the city. Together, these are known as production-based or territorial emissions. For this analysis, we exclude Scope 3 emissions, or those emissions that come from the supply of goods and services consumed in the city. These emissions are known as consumption-based or extra-territorial emissions. Although we don't analyse consumption-based emissions, a consumption-based emissions profile is provided for reference in figure 1.

Baseline Emissions: Sources and Targets

Our analysis shows that production-based emissions peaked in Leeds in 2001, with consumption-based emissions peaking in 2005. As a result of a decarbonisation of the electricity grid, improving vehicle efficiencies and reduced energy use in homes and offices, both consumption and production emissions baselines have each fallen by more than one-quarter between 2001 and 2017.

However, the rate of decline is expected to diminish in the near future, and without further actions at the national or local levels, Leeds will not meet its carbon reduction targets. Leeds 2030 target of reducing emissions 40% by 2030 based on a 2005 baseline will be missed by approximately 1.5 Mt, and the 2050 target of reducing emissions 80% based on a 2005 baseline, will be missed by 2.5 Mt CO2e.

Figure 1: Baseline Emissions and targets

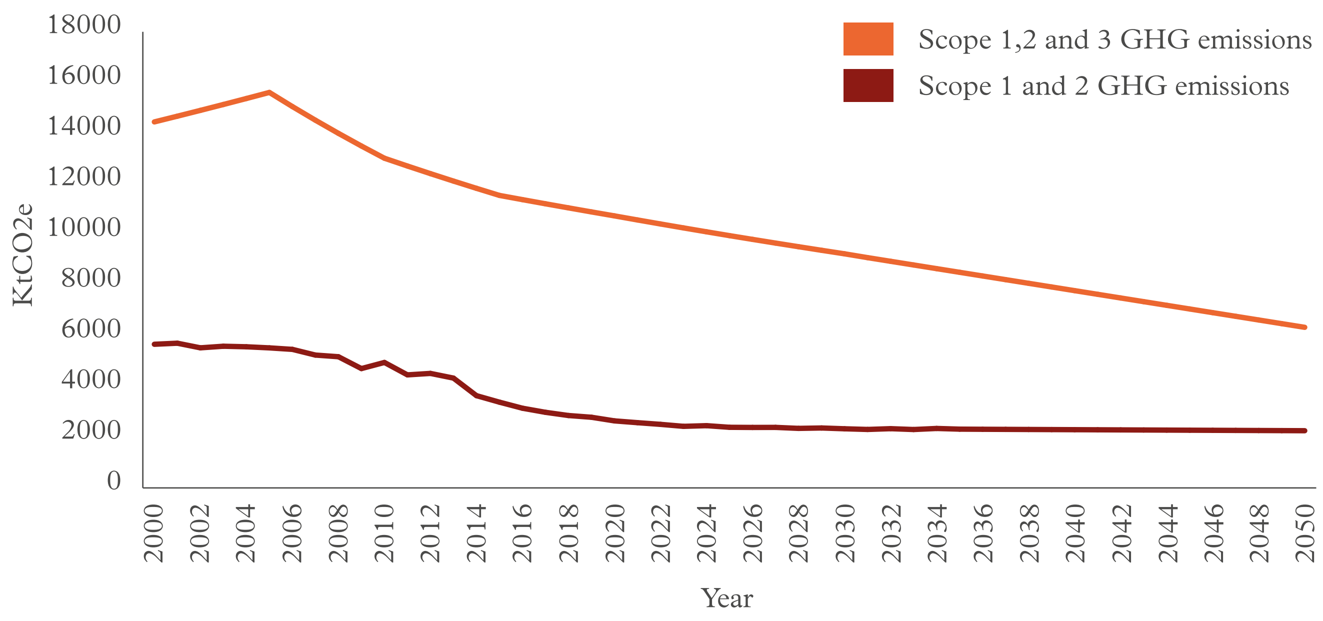
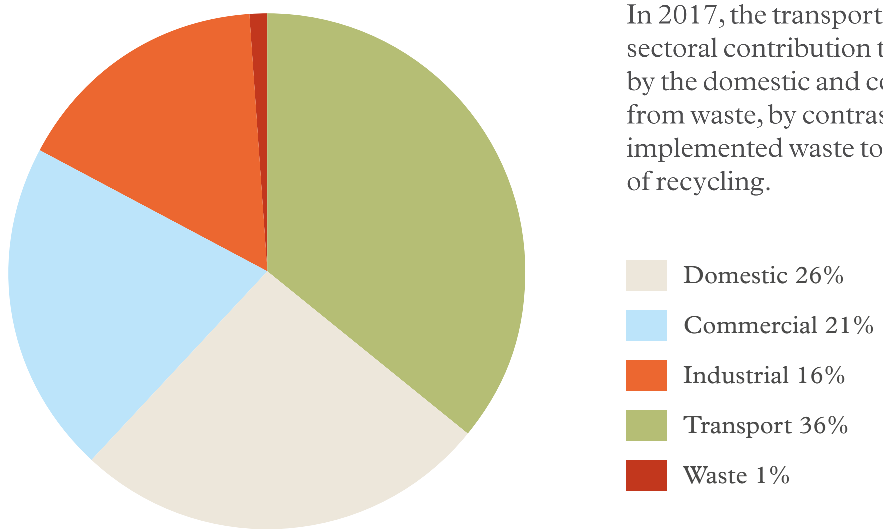


Figure 2: Source of emissions in 2017 by sector



In 2017, the transport sector represented the largest sectoral contribution to emissions in Leeds, followed by the domestic and commercial sectors. Emissions from waste, by contrast, are very low due to a recently implemented waste to energy facility and a high rate of recycling.

The Potential for Reducing Carbon Emissions

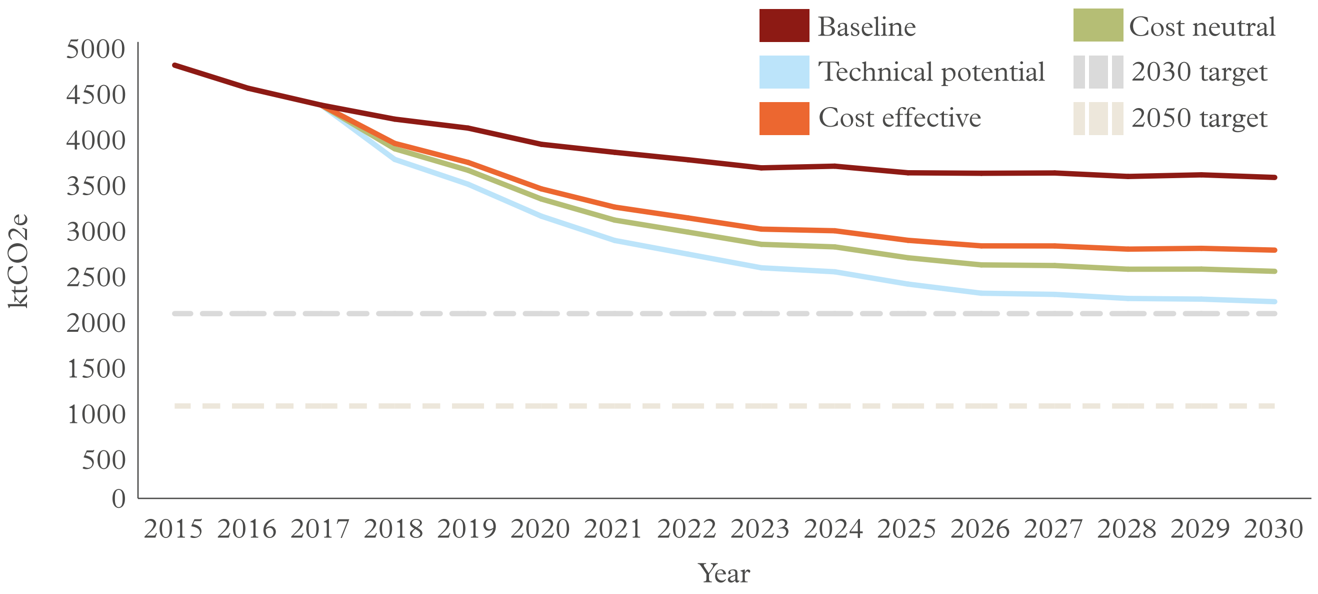
Looking forward, our results show that the Leeds could substantially reduce its energy use and carbon emissions. More specifically, we forecast that by 2030 Leeds could reduce its 2017 levels of emissions by:

— 22.7% through cost effective investments that would pay for themselves (on commercial terms) over their lifetime. This would require an overall investment of £2.18 billion over the next 13 years, with these investments generating annual savings of £277 million, paying back the investment in 7.8 years before generating further savings for the lifetime of the measures.

— 29.5% through cost neutral investments that could be realised at no net cost to the city's economy if the savings from cost effective measures were captured and re-invested in further low carbon measures. This would require an investment of £5.8 billion over the next 13 years, with these investments generating average annual savings of £328 million, paying back the investment in 10 years before generating further savings for the lifetime of the measures.

— 39.2% with the exploitation of all of the technical potential of the different measures. This would require an investment of £12.6 billion over the next 13 years, which would generate annual savings of £392 million, paying back the investment in 32 years and providing further savings over the lifetime of the measures.

Figure 3: Leeds' emissions under the baseline and carbon reduction scenarios



We predict that to meet its carbon reduction target for 2030, Leeds would have to exploit the full technical potential of all of the energy efficiency and low carbon options identified in this report, and also hope that new options become available before 2030.

Of course it is possible that new measures will come through in this period, and that new ways of unlocking their potential will be found, but this does highlight the scale of ambition that will be needed if Leeds is to meet its stated carbon reduction targets.

The Most Cost and Carbon Effective Options

The unique attributes of Leeds' transport network and building stock lead to a set of key opportunities for reducing emissions and generating economic returns. Among those opportunities to reduce emissions, heating and cooling in domestic and commercial buildings represent two of the areas with the largest potential. Among the opportunities where a reducing carbon emissions generates net economic returns for investors, hybrid vehicles, insulation of domestic buildings, investments in energy-efficient appliances and investments in the cooling in commercial buildings were found to present the largest opportunities.

Table 1: The Most Carbon Effective Options

Carbon Effectiveness	Potential carbon savings	Measure	Sector
Highly effective	1 to 5 Mt CO2	Insulation (cost-effective insulation: cavity, loft and floor)	Domestic
		Heating (boilers, heat pumps, controls)	Domestic
		Landfill gas utilisation	Waste
		Cooling in retail buildings	Commercial
Very effective	500 to 1000 kt CO2	Boilers and Steam Piping (cost-effective measures)	Industrial
		Demand reduction (minor heating, lighting and appliances shifts)	Domestic
		Insulation (cost-effective fabric improvements)	Commercial
		Landfill gas flaring	Waste
		Appliances (refrigeration, cookers, TVs, washing machines)	Domestic
Effective	10 to 500 kt CO2	Lighting (low energy)	Domestic
		Electric vehicles (cars, goods vehicles and buses)	Transport
		Pumps (cost-effective measures)	Industrial
		Compressed Air Systems (cost-effective measures)	Industrial

Table 2: The Most Cost Effective Options

Cost Effectiveness	Potential cost savings	Measure	Sector
Highly effective	£250 to £500 million	Cooling in retail buildings	Commercial
		Hybrid cars (diesel and petrol)	Transport
		Insulation (cost-effective insulation: cavity, loft and floor)	Domestic
		Appliances (refrigeration, cookers, TVs, washing machines)	Domestic
Very effective	£100 to £250 million	Demand reduction (minor heating, lighting and appliances shifts)	Domestic
		Heating (boilers, heat pumps, controls)	Domestic
		Heating (boilers, heat pumps, controls)	Domestic
		Hybrid heavy goods vehicles, hybrid buses	Transport
Effective	£25 to £100 million	Pumps (cost-effective measures)	Industrial
		Compressed Air Systems (cost-effective measures)	Industrial
		Fans (cost-effective measures)	Industrial
		Boilers and Steam Piping (cost-effective measures)	Industrial

Impact on Energy Bills

We calculate that Leeds currently spends £1.2 billion on energy each year, or 5.9% of all money earned in the city. We estimate that by 2030 the city's energy bill will rise to £1.6 billion, which would equate to 5.3% of all money earned in the city. We also find though that:

— With investment in cost effective measures, the 2030 annual energy bill could be cut by £277 million (17%), or £327 per person.

— With investment in cost neutral measures, the 2030 energy bill could be cut by £677 million (20%), or £386 per person.

— With investment to exploit all of the realistic potential the 2030 energy bill could be cut by £392 million (25%), or £462 per person.

This indicates that the city of Leeds could significantly enhance its energy security through investments in energy efficiency and low carbon options.

The Impact on Employment

Investments in low carbon options in Leeds would have wider effects on the local economy. In particular, a substantial body of research has shown that investment in a low carbon economy can generate new employment opportunities[1]. Using established employment multipliers, we find that:

— Investments in cost effective measures between 2018 and 2030 would generate nearly 4,200 years of extra employment in the city of Leeds[2].

— Investment in cost neutral measures would generate more than 11,000 years of extra employment in Leeds.

— Investment in technical potential would generate more than 26,000 years of extra employment in Leeds, or approximately 650 jobs for 40 years.

This indicates that the city of Leeds could significantly enhance its energy security through investments in energy efficiency and low carbon options.

It is important to note that changes in labour market conditions, technologies and the specifics of individual investments mean that these figures, while appropriate at a high level, cannot be applied to specific actions.

Table 3: Net jobs created 2018-2030 as a result of low carbon investments

	Total	Domestic	Industry	Transport	Commercial	Waste
Cost effective investments	**4197**	1717	477	1565	431	6
Cost neutral investments	**11401**	3532	1478	4122	2246	23
Technical potential investments	26215	9753	6739	7454	2246	23

Conclusions and Recommendations

From their peak in 2001, Leeds' emissions from using fossil fuels and electricity have fallen by 37%, or approximately 2.8% per year. This is the result of a decarbonisation of the national electricity grid, improved energy efficiency in homes and vehicles and changes in the economy within Leeds. Looking forward to 2030, Leeds' emissions will decline by a further 9%, or 0.7% per year, even as the economy and population grow substantially. This report shows that Leeds could do more, that some of the things it could do could generate significant economic benefits, and that it needs to do more if it is to meet its carbon reduction targets.

Cost effective actions could reduce expenditure on energy across all sectors of the city by more than £300 per person, or by more than £650 for each and every household, each year. Cost effective investments could generate hundreds of new long term jobs – many in areas that require specialised skills and that are well paid. Adoption of the energy saving and low carbon options investigated by this study could also generate a large set of additional social, environmental and economic benefits, such as improved public health, reduced energy poverty and improved economic productivity[3]. Investments in all of the cost neutral and technically possible measures would provide a smaller economic return, but could result in even greater reductions in expenditure on energy, larger numbers of new jobs, and an even greater impact on public health, energy poverty, and economic productivity.

Our results also demonstrate that Leeds could meet and exceed their contribution to national carbon reduction targets at low cost. At a national scale the UK has committed to cutting emissions 80% by 2050 from 1990 levels and has established 5-yearly carbon budgets to guide emissions reductions. These imply that local authorities need to reduce their emissions by 33% between 2017 to 2030, and results here find that 30% of emissions could be cut at near to zero net cost in Leeds even without further actions at the national level such as further reductions in electricity emissions beyond those current forecast. Meeting the more ambitious carbon reduction targets set by Leeds, however, may be more challenging. Leeds' 2030 emissions target would require a 42% reduction in emissions from 2017, in excess of the 39% reduction identified in the 'technical potential' scenario. Further reductions in emissions could be achieved with coordination between the government, businesses and citizens of Leeds and other local authorities and regions. Emissions from commuters to Leeds, for example, could be reduced if the regional transport network were improved and minor changes in the emissions intensity of electricity and gas networks could substantially influence emissions in Leeds, but are only possible at the national level.

The challenge Leeds faces in meeting its 2030 target also emphasises the need for carbon reduction strategies to be dynamic and ongoing processes. Technological change will bring new options for reducing emissions, and may lower the cost of existing options. In the transport sector the effect of technological change on the price of electric vehicles is one area that could have a dramatic impact on emissions, as could the adoption of a hydrogen gas network within the city. But new approaches will be needed to stimulate investment and guide the adoption of measures such as these if Leeds is going to realise the economic, social and environmental potential of a low carbon transition.

Endnotes

1 Blyth, W., Gross, R., Speirs, J., Sorrell, S., Nicholls, J., Dorgan, A., & Hughes, N. (2014). Low carbon jobs: The evidence for net job creation from policy support for energy efficiency and renewable energy. London: UK Energy Research Centre.

2 These are net jobs, after considering for losses in the energy sectors and only include local jobs, assumed to be 50% of the total employment generated.

3 Von Stechow, C., McCollum, D., Riahi, K., Minx, J. C., Kriegler, E., Van Vuuren, D. P., ... & Mirasgedis, S. (2015). Integrating global climate change mitigation goals with other sustainability objectives: a synthesis. Annual Review of Environment and Resources, 40, 363-394.

Further Information

For further information on the Leeds Climate Commission or to download a full version of this report please visit: leeds.candocities.org/climate

For further information on the study or on applications for other areas please contact:

Prof Andy Gouldson
School of Earth and Environment,
University of Leeds,
Leeds, LS2 9JT, UK.
email: a.gouldson@see.leeds.ac.uk
Tel: +44 (0)113 343 6417

Centre for Climate Change Economics and Policy

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

UNIVERSITY OF LEEDS