Methodology

Comparison of estimated building emissions rate (BER) to actual emissions:

To compare the BER ($kgCO_2/m^2/yr$) to actual emissions we took the figures for electricity ($kWh/m^2/yr$) and gas usage ($kWh/m^2/yr$) from a study by Innovate UK which looked at a range of different non-domestic buildings.[1] We then multiplied this by the carbon intensity factors for electricity (0.233 $kgCO_2/kWh$) and gas (0.210 $kgCO_2/kWh$) from the Standard Assessment Procedure (SAP) 10 methodology. In the graphic on page ten we report mean values for the different building types.

City estimates of energy savings from AI optimisation and building for performance culture

Example methodology for Manchester:

Data were downloaded on display energy certificates (DECs) and non-domestic energy performance certificates (EPCs) for office buildings in Manchester from https://epc.opendatacommunities.org.

Non-domestic EPCs were first sorted to remove duplicate entries via the building reference number. Where multiple EPCs were lodged for the same building, the most recent was retained. This gave a dataset of 745 properties.

DECs were sorted to remove entries with no data then sorted to remove duplicate entries via the building reference number. Where multiple DECs were lodged for the same building, the most recent was retained. This gave a dataset of 93 properties.

Given the large performance gap between EPC modelled energy usage and actual, in-use energy (which is more closely reflected by DECs), we estimated in use energy performance of private sector offices based on measured data for offices in the public sector. The comparability of the building stock in the two datasets was assessed via their asset ratings. This showed no significant difference (proved using the following statistical test: unpaired Student's $t=0.9334$, $p=.3509$, $df=836$) between the DEC rating for public sector offices and the EPC rating of private sector offices in Manchester.

The mean energy use per m^2 was calculated from the DEC dataset and multiplied by the total floor area in the EPC dataset to give an estimate of total operation energy use for private sector offices in Manchester. This process was then repeated for the other cities in the analysis.

Calculating energy and cost savings for each city:

Potential short term savings from AI building optimisation were estimated using the lower end of results for university office buildings from Building IQ (14 per cent).[2] Potential long term savings were estimated by using the average improvement in office energy demand after ten annual ratings under the Australian NABERS scheme (38 per cent).[3]

The estimate of the amount of energy wasted by businesses was based on the estimate of current usage (as per methodology above) compared against this potential 38 per cent saving, had the UK adopted similar rules to Australia on in-use performance of buildings. This level of energy saving is comparable to the difference between the average building stock in London (and other UK cities) and the best performing prime office buildings in London.[4] Note that, based on the comparison between performance of new prime office buildings in London and Melbourne, further energy savings could be achieved in the UK. As such, our estimate of energy wasted in the current building stock is likely to be a conservative estimate.

Wasted energy, as defined above, was then compared to average domestic electricity usage of 3,100 kWh/year per household.[5] Carbon savings were calculated using the SAP 10 carbon factors as previously discussed. To estimate the number of cars, we used the average emissions per km per car in use in the UK of 149.6 gCO2/km[6] and average annual mileage of 7,712.[7]

To calculate cumulative cost savings to 2030 we assumed the 38 per cent energy savings could be achieved as a linear improvement between 2020 and 2030, after the initial 14 per cent improvement in the first year. Over this modelled period, we assumed a growth in office floor space of 4.8 per cent outside London and 5.6 per cent in London.[8] We compared estimated operational energy use in this policy scenario to a business as usual case of one per cent per annum energy efficiency improvement to calculate cumulative emissions savings.

Cumulative savings for gas and electricity were converted to pound value using 4p/kWh for gas and 14p/kWh for electricity, at 2020 prices.[9] This is comparable to UK Greenbook estimates of energy prices for 2020 to 2030.

This method was then repeated for the other cities used in the report. Summary values are listed in the table below.

	Manchester	Birmingham	Leeds	Bristol	City of London
Current wasted energy cost	£8,931,702	£3,984,502	£7,043,794	£5,198,247	£35,744,544
Emissions equivalent to how many cars?	12,227	5,761	10,299	7,390	46,225
Power how many homes?	15,544	6,568	11,475	8,719	65,436
From how many offices?	745	970	952	593	953
Savings within a year (using BuildingIQ)	£3,325,828	£1,483,677	£2,622,842	£1,935,630	£13,413,941
Cumulative savings to 2030	£82,798,774	£35,478,458	£65,645,374	50,378,653	£366,763,334

Endnotes

[1] Innovate UK, 2016, *Building performance evaluation programme: findings from non-domestic projects*
[2] https://buildingiq.com/resources/case-studies/
[3] https://nabers.info/annual-report/2018-2019/life-of-program-statistics/
[4] R Cohen and P Bannister, 2017, *Why is Australia better than the UK at building energy efficiency?*; average across a selection of six prime office building in London shows energy use of 80 to 160 KWh/m^2.
[5] www.ukpower.co.uk/home_energy/average-household-gas-and-electricity-usage
[6] SMMT, *New car CO_2 report 2018*
[7] https://data.gov.uk/dataset/e3939ef8-30c7-4ca8-9c7c-ad9475cc9b2f/anonymised-mot-tests-and-results
[8] www.cushmanwakefield.co.uk/en-gb/research-and-insight/uk/united-kingdom-office-snapshot
[9] www.ukpower.co.uk/home_energy/tariffs-per-unit-kwh