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Greater Manchester's *Places for Everyone* Plan: the Carbon Impact

Summary

In this report we argue that Greater Manchester (GM) is likely to over-run its carbon budget due to the impact of its spatial plan for the Region. The impact takes place both directly through emissions in the sectors covered by that budget and indirectly through emissions in other sectors which will reduce the global space for carbon emissions. Our analysis finds that the Places for Everyone strategic plan, covering nine out of the ten boroughs in the conurbation, would have an estimated total carbon impact of some 16.5 Mtonnes CO_2^e, which is equivalent to 25 per cent of the Paris-compliant carbon budget for Greater Manchester. If the proposed increase in aviation is included, the figure rises to some 37 Mtonnes (55 per cent of the size of the GM carbon budget).

A large-scale programme of building development (such as *Places for Everyone*) has major environmental consequences. This report is focused on our concerns relating to greenhouse gas emissions, expressed as carbon dioxide equivalent. Our aim is to model the consequences of the policy decisions inherent in the *Places for Everyone* plan, together with the impacts of contextual policies.

In the absence of information from Greater Manchester's Combined Authority (GMCA), we have produced our own high-level estimate of the carbon consequences of the *Places for Everyone* plan. We believe that the results of our calculations suggest that GM must identify where and how it will make additional deep cuts to greenhouse gas emissions in advance of implementing *Places for Everyone*, given the legislated requirement to demonstrate how land use changes climate change[1], that it is already exceeding its own carbon budget[2], it has declared a climate and biodiversity emergency[3] and it has commissioned a science-based carbon budget[4]. GM will also have to show how the operational emissions consequential to the implementation of the *Places for Everyone* plan will tend to zero by 2038.

Our results demonstrate that it is probable that this challenging task will not be achieved and that alternative strategies should replace *Places for Everyone*. We suggest, for example, that all plans for new development would have to demonstrate a net reduction in carbon emissions, prioritising re-use, refurbishment, re-purposing, retrofitting and extension of existing buildings rather than new construction. Results imply that construction on green field sites should be prevented: losing green space to building construction will reduce the scope for reducing carbon emissions via the natural processes of biological sequestration. Furthermore, building on this land means foregoing opportunities for significant improvements to carbon capture, from tree planting, peatland restoration and improved agricultural practices. In addition, where new construction takes place, it should use a high proportion of materials that sequester carbon (chiefly timber, but also other biomass-based materials such as hempcrete and alternative mineral products such as lime cement) and recycle previously used materials. In terms of spatial design, the 15-minute principle should be followed, to minimise travel from home to work and to other resources.

GMCA should think again. The target date (2038) is less than 16 years away. Action is needed today and it starts with rethinking this flawed plan.

[1] *Planning and Compulsory Purchase Act* 2004; Planning Act, 2008 (full references in the body of the report).
[2] *Greater Manchester is over spending its carbon budget and Places for Everyone will make it much worse*. https://themeteor.org/2022/03/25/greater-manchester-carbon-budget/
[3] Climate emergency declaration, Biodiversity emergency declaration
[4] Kuriakose, J., Anderson, K., Broderick, J., & Mclachlan, C. (2018). *Quantifying the implications of the Paris Agreement for Greater Manchester.* University of Manchester. https://www.research.manchester.ac.uk/portal/en/publications/quantifying-the-implications-of-the-paris-agreement-for-greater-manchester(d2e50584-952e-472b-a2b0-1c7e7d1651e1).html

Table of Contents

Introduction

Places for Everyone is the Greater Manchester Combined Authority's spatial plan, covering nine of the ten districts that make up the conurbation (following the withdrawal of Stockport council in 2021). It provides a strategic framework within which each council's "Local Plan" will be developed. Key elements include expectations for the scale of building of homes, offices, industrial and warehouse sites as well as the implications for green belt in the Region.

By 2037, *Places for Everyone* plans to deliver *"1,900,000 sqm of accessible new office floorspace"* – but 3,352,371 has been earmarked. For Industry and warehousing, "at least 3,330,000 sqm of new, accessible, industrial and warehousing floorspace will be provided", but 4,185,793 has been identified. For housing, "minimum of 164,880 net additional dwellings will be delivered over the period 2021-37, or an annual average of around 10,305."[5] Again, they have identified space for more, 190,752. The allocation of land, in hectares, is as follows, for the period, 2021-2037 (calculations from the detailed P4E documentation[6], which differs somewhat from the headline figures quoted above, and Freedom of Information Act responses in respect of housing areas).

Category	**"Existing supply" ha**			**Green belt ha**	**Total ha**
	Brownfield	**Greenfield**	**Mixed**		
Offices	301.39	23.28	2.94	2.15	329.75
Industry & warehousing	117.17	59.14	14.46	215.99	406.76
Housing	1,968.93	1,007.32	392.80	2,211.26	5,646.12
Totals	**2,379.5**	**1,089.7**	**410.2**	**2,429.4**	**6,477.0**

So, the total green space to be built on (not including the brownfield areas that have reverted to nature and the "mixed" category) will be approximately 3,500 ha, more than 13 square miles.

This is an enormous scale of development which will have several types of carbon impact.

Building on green space means:

- the loss of the natural ability of the plants and soil to capture and lock away (sequester) carbon; and
- the loss of the opportunity to enhance the capacity of these spaces to capture and sequester carbon, for example by conservation cultivation techniques, additional plantings and restoration of wetlands and other soils.

While building anywhere involves,

- the carbon emissions that arise from construction of the new buildings, roads and other infrastructure, both on-site and all along the supply chain;

[5] The quotations are from *Places for Everyone*, 2021. They are using the period 2020-2037. We have used the period 2021-2037 in our calculations.

[6] *Places for Everyone* tables 6.1 (Offices), 6.2 (Industry and Warehousing) and for Housing, our calculations from Freedom of Information Act responses (and for Bury, which did not supply information, an estimated figure based on P4E H*ousing Topic Paper*, Table 17: Housing supply by land type (2020-2037) and the average number of units per hectare, using the this source with the FOIA data for neighbouring Bolton and Rochdale).

- the carbon emissions that will be generated by all these new buildings, their heating, lighting, and machinery in use;
- the carbon emissions from the transport that these buildings require to reach and supply them, including workforce movements from residential to employment space every day; and
- the additional emissions that would be caused by any overall increase in the scale of the economy due to this new investment (a key objective for GMCA in doing all this construction is to stimulate economic growth, which inherently generates further carbon emissions).

A further consequence of the plan is the additional emissions due to the projected increase in passengers using Manchester Airport, with an anticipated rise from 28 million p.a. in 2019 to 55 million p.a by 2037.

Although an assessment of the full impact of the proposed developments should be part of the Strategic Environmental Assessment required under legislation[7] and the National Planning Policy Framework[8], the necessary detail is not apparent, either in the plan, or in the voluminous supporting documentation. Freedom of Information Requests asking for the data and details of the methodology also failed to yield the relevant methodology and figures[9]. GMCA has stated that the assessment was outsourced to the firm Arup but that they do not have details of the methodology, nor, apparently, any figures[10].

In the absence of reported carbon metrics, we have produced our own high-level estimate of the carbon consequences of the plan.

Methods

The following areas were covered:

- Land Use: store;
- Land Use: sequestration losses;
- Housing: operational;
- Housing: embodied;
- Industry and warehousing: operational;
- Industry and warehousing: embodied;
- Offices: operational;
- Offices: embodied;
- Transport;
- Water-related; and
- Aviation.

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[7] *The Environmental Assessment of Plans and Programmes Regulations* 2004. UK Statutory Instruments, 2004, No. 1633, PART 3, Regulation 12. https://www.legislation.gov.uk/uksi/2004/1633/regulation/12/made *Planning and Compulsory Purchase Act* 2004, section 19, F2(1A) "Development plan documents must (taken as a whole) include policies designed to secure that the development and use of land in the local planning authority's area contribute to the mitigation of, and adaptation to, climate change.]" - as amended by the *Planning Act 2008*, c. 29, Part 9, Chapter 2, Climate change Section 182. https://www.legislation.gov.uk/ukpga/2004/5/section/19

[8] Ministry of Housing, Communities and Local Government. (2021). *National Planning Policy Framework* (p. 75). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf

[9] https://www.whatdotheyknow.com/request/carbon_metrics_places_for_everyo#incoming-1875367 https://www.whatdotheyknow.com/request/the_methodology_for_how_the_inte

[10] https://www.whatdotheyknow.com/request/831815/response/2029236/attach/html/2/Internal%20Review%204117776.pdf.html

These are all sectors that will be affected by the proposed plan. The main sector not included is the other infrastructure construction that will be necessitated by the developments in the plan, for example roads and water services to the new construction areas.

For the areas covered, the data sources, assumptions and methodology used are set out in the following paragraphs.

Land use change.

The area of green space from the existing supply, and the green belt allocations, together were used as an estimate of the land area that would change in character during the construction period. This amounts to 3519.1 ha., of which 2429.4 ha. is designated as green belt. We did not include brownfield sites that have reverted to nature but are identified for building.

A detailed breakdown of the land types over this area was not available. As a proxy we used the land area identified in the Greater Manchester Natural Capital Account (eftec et al., 2018)[11]. A simple arithmetic apportionment was made, based on the natural capital audit for Greater Manchester as a whole. The category of built-up areas and gardens was not included since we do not generally expect to find these in the green spaces listed for development.

Figures for flux (the balance between carbon emissions and carbon sequestration) and carbon store are from Gregg et al. (2021), and Alonso et al. (2012).[12] The Gregg study is an update of Alonso but Alonso et al. included some land types not included in the later work. Land types identified in the Greater Manchester Natural Capital study do not map exactly onto the categories in these two Natural England studies. Where they did not match, the most similar land type was used. For peatlands, Gregg et al. give figures for four different classes of bog: wooded; arable; grassed; and re-wetted. In the absence of more detailed information, we split the Greater Manchester land into four equal areas.

Flux figures are annual. For carbon store, we used an arbitrary 50% loss on development. The figure for soil loss is likely to be lower while that for above ground biomass is likely to be greater. A linear rate of loss of green space was assumed over the period of the plan. No allowance was made for the lost opportunity for considerably improved sequestration rates, for example by tree planting, peatland re-wetting, and improved cultivation and land management practices[13].

Housing

Places for Everyone provides the following house-building forecast.

[11] https://issuu.com/greatermcr/docs/gm-natural-capital-investment-plan-

[12] Gregg, R., Elias, J. L., Alonso, I., Crosher, I. E., Muto, P., & Morecroft, M. D. (2021). *Carbon storage and sequestration by habitat: A review of the evidence.* (second edition) [Natural England Research Report NERR094.]. https://tinyurl.com/NatEngGregg
Alonso, I., Weston, K., Gregg, R., & Morecroft, M. (2012). *Carbon storage by habitat: Review of the evidence of the impacts of management decisions and condition of carbon stores and sources* (Natural England Research Report). Natural England. http://publications.naturalengland.org.uk/file/1438141

[13] Paustian, K., Larson, E., Kent, J., Marx, E., & Swan, A. (2019). Soil C Sequestration as a Biological Negative Emission Strategy. *Frontiers in Climate*, 1, 8. https://doi.org/10.3389/fclim.2019.00008

Annual average 2021-2037	2021-2025 (annual)	2025-2030 (annual)	2030-2037 (annual)	Total 2021-2037	Total Houses (41% of total)	Total Flats (59%)
10,305	8,732	10,305	11,204	164,881	67,601	97,280

From this data we apportioned the numbers of flats and houses, pro rata, to the phases of construction. We then apportioned these to housing units of different sizes, assuming that 60% of flats were 1 bedroom and 40% 2-bedroom, while for houses 90% were 3 bedroomed and 10% had 4 or more bedrooms.

Type of housing	1-bed	2-bed	3 bed	4+ bed	Totals
Number of units to 2030	30,604	20,403	31,901	3,545	86,453
Number of units for period 2021-2025	13,602	9,068	14,178	1,575	38,424
Number of units 2025-2030	17,002	11,335	17,723	1,969	48,029
Number of units after 2030	27,764	18,509	28,940	3,216	78,428

For operational emissions, we computed carbon emissions using government mean floorspace statistics for each of these accommodation sizes[14].

For the units built up to the year 2024-25 we used the "New Standard" emissions per square metre figure from the large international study by Röck et al. (2020). This figure, (Röck et al., 2020, Supplementary material table S2) of 24.27 kg CO_2 equivalent per m^2 per year, is equivalent to current required standards in most of the countries in the study's sample (largely temperate climate, the largest number from Europe).

In 2025 the UK government will introduce a "gas boiler ban" on new housing construction. We assume that this will require greatly improved insulation standards. We therefore used the "New Advanced" figure of 14.36 kg CO_2^e/m^2a from Röck et al. which they derived from "studies assessing passive houses, low-energy buildings or near/net zero energy or emission (NZEB) buildings". We then applied a 74% reduction to that (i.e. 3.73kg), which is the proportion of domestic gas in domestic fuel, Greater Manchester, 2019[15]. This is possibly an overcompensation. This we applied to all housing built from 2025. We note that *Places for Everyone* envisages a requirement for all new development to be net zero carbon by 2028 at the latest. We consider that the emission standard we have used from 2025 covers this. We note that the requirement is for *net* zero, not absolute zero emissions, implying that residual emissions be mitigated elsewhere, so our model does include some residual operational emissions at a the rate of 3.73 kgCO_2^e/m^2a.

[14] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/725085/Floor_Space_in_English_Homes_main_report.pdf Fig. 5.2
[15] https://data.gov.uk/dataset/723c243d-2f1a-4d27-8b61-cdb93e5b10ff/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-to-2019

We carried out two "sense checks" on the $kgCO_2^e/m^2a$ figure. 1) We used median gas and electricity consumption figures for UK homes, 2017, together with the UK government conversion factors to derive carbon emissions from energy use and the average dwelling size (2008, but little changed since then) of 85 sq m [16]. This gave a higher figure than the New Standard (24.27 kg) rate of 34.25 kg CO_2^e/m^2a. 2) Using 2019 UK carbon emissions data for all domestic fuel types, for Greater Manchester, a still higher figure of 37.87 $kgCO_2^e/m^2a$ was derived. These comparison figures are not surprising given the preponderance of older stock but they indicate that our figures are of a plausible order of magnitude.

We calculate the sum of operational emissions at 50% for each building phase (e.g. for the higher emission properties built prior to 2025) plus 100% for properties built before the subsequent building phases (e.g. those same properties for 2025 to 2037). This reflects a linear rate of building over the construction phase: no homes have been built at the start, 100% have been built at the end, so the mean number built over those years is 50% of the total[17].

For embodied emissions we use the same construction numbers and computed average embodied emissions for each of the four sizes of housing unit, based on a mid-range figure of 345 $kgCO_2^e/m^2$. This was derived from estimates by the Green Building Council (2017)[18] (415 kg) and the Institute of Structural Engineers (2020)[19] (275 kg), using different methodologies. Note that far higher and far lower estimates have been published.

Since many of the flats will be in multi-story buildings, and since it is known that embodied emissions rise with the height of the building, we applied a multiplier of an additional 0.04X for each story above 3 floors, derived from Resch et al. (2016)[20]. We made the assumption that the average number of stories for 1-bed flats was 10, and for 2-bed flats it was 4, while the houses of any size would average at 2 stories.

We had not been able to make a similar adjustment to the operational carbon estimates since although operational (energy) emissions are known to rise steeply with height of residential buildings, the literature does not suggest a formula to apply (Hamilton et al, 2017)[21].

We made no assumptions for improvement on embodied carbon over the period.

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[16] Consumption statistics: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1018725/efus-Household-Energy-Consumption-Affordability.pdf p. 67;
Conversion factors: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1049332/conversion-factors-2021-condensed-set-most-users.xls
Average floor space per dwelling: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/725085/Floor_Space_in_English_Homes_main_report.pdf table 8.1.

[17] It may help to understand the thinking here to consider the formula for the area of a right-angled triangle, *height x base / 2*, where height represents number of building units and base represents time.

[18] Green Building Council. (n.d.). *Embodied Carbon: Developing a Client Brief* (p. 32). https://www.ukgbc.org/wp-content/uploads/2017/09/UK-GBC-EC-Developing-Client-Brief.pdf

[19] Orr, J., & Gibbons, O. (2020). *A brief guide to calculating embodied carbon*. 6. https://www.istructe.org/IStructE/media/Public/TSE-Archive/2020/A-brief-guide-to-calculating-embodied-carbon.pdf (p. 33)

[20] Resch, E., Bohne, R. A., Kvamsdal, T., & Lohne, J. (2016). Impact of Urban Density and Building Height on Energy Use in Cities. *Energy Procedia,* 96, 800–814. https://doi.org/10.1016/j.egypro.2016.09.142

[21] Hamilton, I; Evans, S; Steadman, P; Godoy-Shimizu, D; Donn, M; Shayesteh, H; Moreno, G; (2017) All the way to the top! the energy implications of building tall cities. *Energy Procedia,* 122 pp. 493-498. https://discovery.ucl.ac.uk/id/eprint/10024280/1/Hamilton_1-s2.0-S1876610217329004-main.pdf

Industry and Warehousing

Operational emissions were calculated on the basis of floor space identified in *Places for Everyone*[22], using an overall figure of 70 $kgCO_2e/m^2a$ which is a median estimate from Godoy-Shimizu et al. (2018)[23]. This is an overall estimate based on separate calculations for low rise office buildings (and therefore a proxy for industrial buildings). We assume a linear build rate over the period. An assumption for improving carbon efficiency over the period was made at a 40% reduction of the total. We are thereby assuming some decarbonisation over the plan period but at a lower rate than for housing.

For embodied emissions we made two estimates and averaged them. The first estimate used the example given by Orr, Gibbons and Arnold (2020)[24] for a single-storey structure with shallow concrete footings and concrete slab floor, braced steel frame construction and flat "CLT supporting non-accessible roof". This construction of 792 m^2 accounted for 146.2 tonnes CO_2^e, i.e. 184 kg/m^2. Note, this was presented as an example but as a single storey, module-built warehousing shed, it would be typical of the main type of warehouse construction under the *Places for Everyone* proposals. The second estimate was based on the figure of 580kg given for retail sites by the Green Building Council[25]. It is assumed that industrial and warehousing construction is overwhelmingly low rise so no high-rise weighting was applied. We made no assumptions for improvement on embodied carbon over the period.

Offices

Operational emissions were calculated on the basis of floor space identified in *Places for Everyone*[26], using an overall figure of 89 $kgCO_2e/m^2a$ based on separate calculations for low, medium and high-rise office buildings from Godoy-Shimizu et al. (2018)[27]. We assume a linear build rate over the period. An allowance is made for improving carbon efficiency over the period at a 40% reduction of the total.

For embodied emissions we used a figure of 735 kg CO_2e/m^2, given for office sites, again by the Green Building Council. We assumed an average mid-rise elevation of 12 stories, broadly consistent with the assumption made for operational emissions. As for flats, we applied the multiplier of an additional 0.04X for each story above 3 floors. No assumption was made for improvements in embodied carbon over the period.

Transport

Transport emissions in 2019, for the nine local authorities participating in *Places for Everyone*, were 3,968,457 tonnes CO_2^e [28]. We arrive at an estimate for the additional emissions from *Places for Everyone* by multiplying that by the 6.19% increase in population projected over the plan period. That gives a figure as if no decarbonisation of transport were to take place over the plan period. We, therefore, work out a decarbonisation coefficient for each year on a linear trajectory from 2019 to the UK 2050 net zero date and apply those figures annually for the sixteen years, 2021 to 2037.

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[22] *Places for Everyone*. Table 6.2 'Industry and warehousing land supply 2020-2037', page 121.
[23] Godoy-Shimizu, D; Steadman, P; Hamilton, I; Donn, M; Evans, S; Moreno, G; Shayesteh, H; (2018) Energy use and height in office buildings. Building Research and Information, 46 (8) pp. 845-863.DOI 10.1080/09613218.2018.1479927 also at https://discovery.ucl.ac.uk/id/eprint/10052909/
[24] Orr, J., & Gibbons, O. (2020). *A brief guide to calculating embodied carbon*. https://www.istructe.org/IStructE/media/Public/TSE-Archive/2020/A-brief-guide-to-calculating-embodied-carbon.pdf
[25] op. cit.
[26] *Places for Everyone*. Table 6.1 Office land supply 2020-2037 , page 116.
[27] op. cit.
[28] https://data.gov.uk/dataset/723c243d-2f1a-4d27-8b61-cdb93e5b10ff/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-to-2019

It could be argued that the decarbonisation programme needs to be steeper in the early years since otherwise the UK 2050 carbon budget will be exceeded. It should be noted, however, that we do not have such a function to apply and so far there is little evidence that transport emissions are declining steeply.

We did not estimate the (considerable) embodied emissions from transport, namely the new fleet of vehicles and the infrastructure of new roads, railways etc.

Water

Water-based emissions are cited as an average 2.6 kg CO_2^e/m^2 per household/day[29]. Ten percent of the above figure is emissions from water companies supplying water and removing and treating wastewater, the remainder should be already counted in the operational emissions for housing.

The water sector has recently committed to reaching Net Zero by 2030 for its operational emissions[30]. *Places for Everyone* forecasts 86,453 new households for the period to 2030. We therefore compute the total based only on the growth up until 2030.

Aviation

Places for Everyone projects an increase in air passengers going through Manchester Airport from 28 million p.a. to 55 million p.a by 2037[31]. At 3,392,838 tonnes CO_2^e, emissions for the 28 million passengers were an average 121 kg each[32]. As for transport we applied a decarbonisation coefficient for each year of the plan period, using the UK 2050 net zero carbon trajectory (linear basis). There are, however, two caveats:

1 Such emissions reductions are highly unlikely since the technology does not exist to decarbonise mass aviation to this degree.
2 The UK carbon budget assumes additional space for aviation emissions, an overshoot of the carbon budget on the assumption of subsequent GHG removals, again using unproven technology.

The figure presented assuming decarbonisation is, therefore, likely to be a significant underestimate. Accordingly, we report the mean of the raw and the decarbonised emissions totals.

Results

Land use change

For land use fluxes, we estimate an annual net sequestration loss of 2.7 ktonnes CO_2^e. If we assume a linear loss of land over the plan period, this implies a total of 22 ktonnes. This does not include any estimate for the lost opportunity to improve carbon sequestration through changed land management practices.

The carbon store in the green-space land to be developed is estimated at 502 ktonnes. If we assume that half of the carbon store in the land were lost, then approx 251 ktonnes of emissions would be generated. This excludes losses from brownfield sites, many of which have a substantial soil carbon and biomass component.

[29] Net Zero and the role of Water Efficiency: A Water & Energy T&F Group Briefing Paper (February 2021) https://www.waterwise.org.uk/wp-content/uploads/2021/02/Net-Zero-and-the-role-of-Water-Efficiency-9-2-21.pdf
[30] Ibid
[31] *Places for Everyone*, pages 26-27
[32] Manchester Airport Group, Greenhouse Gas Emission Report, 2019/20. Page 12. Table 9. GHG Emission inventory, Manchester Airport. https://www.magairports.com/media/1688/mag-emissions-report_2019-20_final.pdf

Housing

We estimate total operational emissions from the building of homes to be 1,733 ktonnes.

Embodied carbon emissions would amount to 6,054 ktonnes.

Industry and warehousing

We estimate operational emissions from the new industry and warehouse sites at 1,367 ktonnes CO_2^e over the plan period.

Embodied emissions for this sector were calculated at 750 ktonnes CO_2^e, using the Institute of Structural Engineers approach, or 2,359 ktonnes using the Green Building Council benchmark. Given the uncertainties, we use the mean of these two, 1,555 ktonnes, in our summary table and graphics.

Offices

The office building programme would account for an estimated 1,409 ktonnes of operational CO_2^e and 3,102 ktonnes of embodied CO_2^e.

Transport

We estimate transport emissions arising from the plan's population increase at 1,195 ktonnes. These are the operational emissions only.

Water

Water-related operational emissions from the planned developments are estimated at 37 ktonnes CO_2^e. This is the figure for residential-related water system emissions not already included in the operational emissions from housing.

Aviation

Unmitigated additional aviation-related emissions due to the doubling of flights from Manchester Airport over the plan period are estimated at 24,633 ktonnes CO_2^e. If we applied the UK government net zero by 2050 decarbonisation trajectory over the plan period, then this would decrease to 16,265 ktonnes. The average of these two figures is 20,449 ktonnes.

Results Tables and Figures

The appendix presents these results in detail. Figure 1 below shows the headline figures in comparison with Greater Manchester's Paris-compliant 2038 budget: we discuss what this means below. Figures 2 to 5 below show the results for visual comparison.

Figure 1: Summary

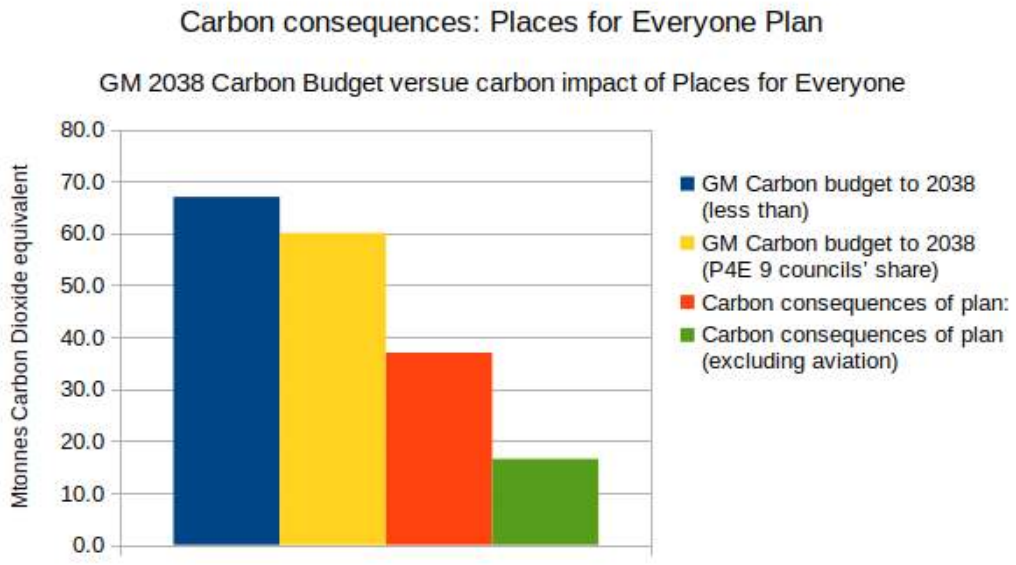


Figure 2: Emissions by sector

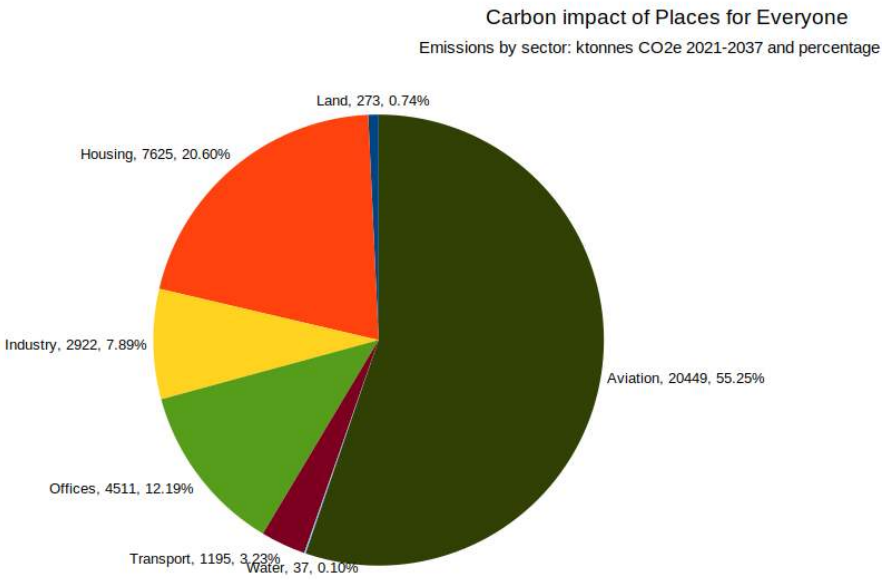


Figure 3: Emissions by sector (detail)

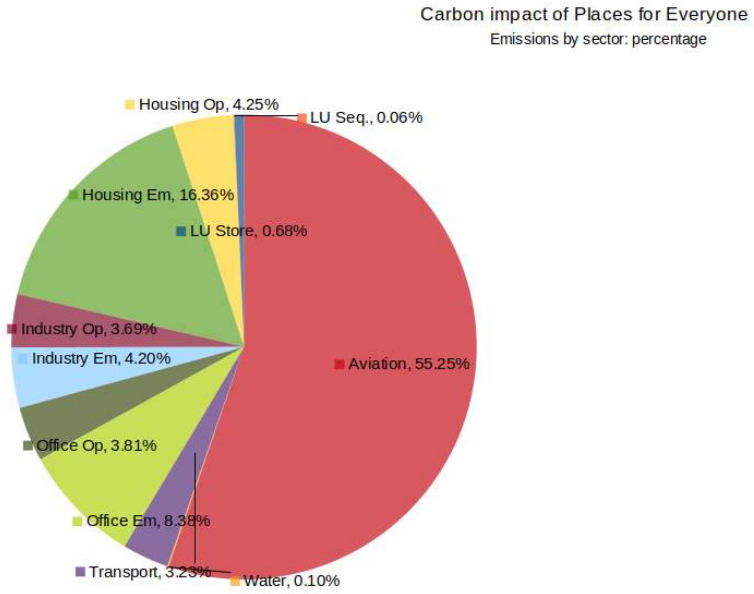


Figure 4: Emissions by sector excluding aviation

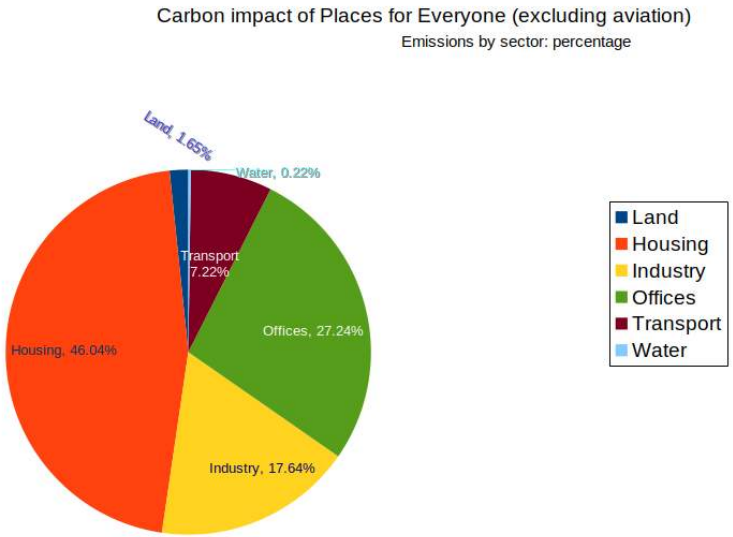
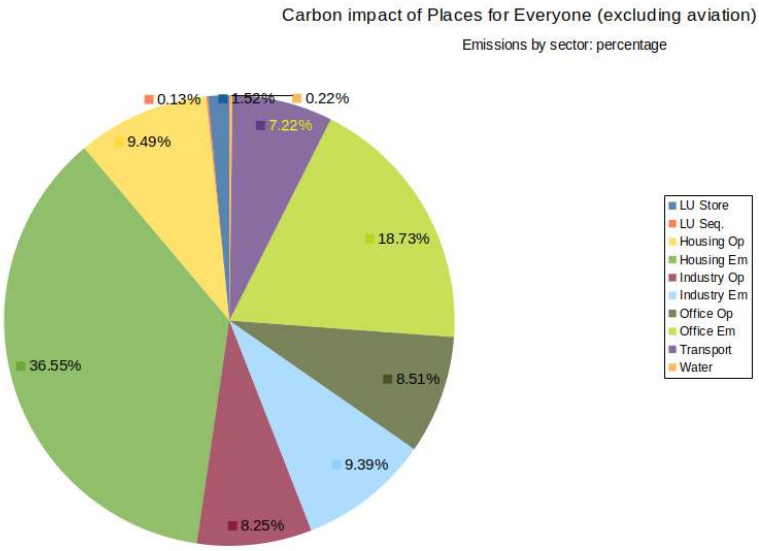


Figure 5: Emissions by sector (detail) excluding aviation



Discussion

Our aim here is to model consequences of the policy decisions inherent in Greater Manchester's *Places for Everyone* plan, together with the impacts of contextual policies (chiefly UK national decarbonisation legislation). Such a large-scale programme of building development has major environmental consequences. Our concern here is with greenhouse gas emissions, expressed as carbon dioxide equivalent.

Greater Manchester Combined Authority commissioned scientists from the Tyndall Centre at the University of Manchester to define an evidence-based carbon budget for the city region[33]. At "less than 67 Mtonnes" carbon dioxide equivalent, the Paris agreement-consistent budget is significantly smaller than a proportionate share based on the UK carbon budget. In the section entitled *"Why are the recommended GM carbon budgets different to the UK's legislated carbon budgets"*, p. 5, they note that *"current UK budgets correlate with an expected probability of exceeding 2°C of more than 56%"*. That would constitute unacceptably dangerous odds. Tyndall, therefore, suggest using a 33% chance instead. They also note that "*We provide a greater proportional allocation to the poorer parts of the world and account for cement production at the global level…"*.

Our analysis finds that the *Places for Everyone* strategic plan, covering nine out of the ten boroughs in the conurbation, would have an estimated total carbon impact of some 16.5 Mtonnes CO_2^e, or 25 per cent of the Paris-compliant carbon budget for Greater Manchester. If the proposed increase in aviation is included, the figure rises to 37 Mtonnes (55 per cent of the carbon budget). This is in the context of the city region already failing to meet the planned reductions in greenhouse gases that are required to stay within this carbon budget[34].

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[33] Kuriakose, J., Anderson, K., Broderick, J., & Mclachlan, C. (2018). *Quantifying the implications of the Paris Agreement for Greater Manchester. University of Manchester.* https://www.research.manchester.ac.uk/portal/files/83000155/Tyndall_Quantifying_Paris_for_Manchester_Report_FINAL_PUBLISHED_rev1.pdf

[34] GMCA Five Year Environment Plan performance report, March 2022: https://democracy.greatermanchester-ca.gov.uk/documents/s19936/05a%20Annex%205_Year_Environment_Plan_Performance_Overview_Mar_22.pdf
For discussion see https://steadystatemanchester.net/2022/03/24/

However, the GM Paris-consistent 2038 carbon budget only includes what are known as scope 1 and 2 emissions, those from energy (scope 1 are emissions from activity within the area and scope 2 covers the power system emissions attributable to the area). That includes our categories of operational emissions for housing, industry and warehousing, offices, water and transport. It does not include consumption emissions (scope 3), i.e. those emissions that, although a result of making and distributing the goods and services used in Greater Manchester, are produced elsewhere. The vast majority of embodied emissions fall into this category. It also excludes emissions from land use changes and from aviation. If we only count the P4E emissions projected to arise from the sources included in the GM carbon budget, the total is 5.58 Mtonnes, still approaching 10% of the budget and therefore representing an additional pressure upon it. However, all emissions matter. Firstly, they add to the total global emissions and thereby reduce the world's available carbon budget, the supposedly safe limit on what can be emitted. If Greater Manchester causes emissions, wherever they are, then inexorably, its available carbon budget will be effectively reduced: the effect, other things being equal, would be that the calculation of the available carbon budget will eventually have to be adjusted down. Secondly, as we noted above, planning authorities (here Greater Manchester Combined Authority and the nine participating councils in *Places for Everyone*) have to show how their plans contribute to the mitigation of greenhouse gas emissions. Moreover, having declared a climate emergency, then these authorities really have to act as if they meant it (or why make the declaration?). We therefore use the GM declared carbon budget as a yardstick for comparison with the carbon emissions that would arise from the P4E plan. Whether those emissions are actually counted in the budget is of lesser importance.

Projected operational emissions (including those from land use change), at 26 Mtonnes CO_2^e, account for 71 per cent of the total, if aviation is included, or 5.8 Mtonnes (35 per cent) excluding aviation. This finding is important, since there could be further scope for reducing operational emissions through, for example a more assertive programme of energy demand reduction across all sectors, and earlier decarbonisation. Much of the operational emissions total, however, is determined by factors outside Greater Manchester's control, for example, the proportion of clean energy in the electricity supply mix.

Embodied emissions at some 11 Mtonnes CO_2^e, or 29 per cent of the total emissions impact of the plan (65 per cent if aviation were excluded from the emissions total) would be harder to mitigate with the proposed building programme. If low carbon ways of substituting concrete, or of manufacturing steel and glass were to be implemented, then there would be scope for considerable reduction. Concrete alone currently accounts for some 87 per cent of the embodied carbon emissions in construction[35]. There are alternatives but they do not exist for deployment at scale as yet[36]. Consequently, serious thought must be given each time a building is proposed as to whether the need could be met in another way, for example by retrofitting, repurposing, or refurbishing existing stock, or indeed, whether there really is a need and the build is not essentially speculative.

Not all of these emissions would immediately be counted against the Greater Manchester carbon budget. Most of the embodied emissions take place outside the conurbation, much of that outside the UK. Aviation emissions are currently accounted for separately in the national carbon accounts. Those carbon emissions, however, will reduce the available global carbon budget for staying within supposedly safe levels of global heating, and as a result the national and Greater Manchester shares will have to be adjusted downwards.

[35] *Low Carbon Concrete Routemap: Setting the agenda for a path to net zero*. (undated). Institution of Civil Engineers. https://www.ice.org.uk/media/200i0yqd/2022-04-26-low-carbon-concrete-routemap-final_rev.pdf

[36] "UK concrete industry's GHG emissions are likely to exceed HMG targets until at least the mid-2030s. If Route 3 can be accelerated" [using a combination of methods including legacy fly-ash, pulverised limestone and carbon capture], "it may be possible to meet the HMG targets before 2040." *ibid.*

Greater Manchester is already exceeding its carbon budget. If it is to embark on such an extensive programme of building, then it will, if serious about the climate emergency and its science-based carbon budget, need to identify where it will make additional deep cuts to emissions elsewhere. It will also have to show how the plan's operational emissions, like those for the rest of the region, will tend to zero by 2038. That will be an enormously challenging task, so challenging that we advise that alternative strategies should replace *Places for Everyone*. These could rest upon a "presumption against development": plans for new developments would have to demonstrate a net reduction in carbon emissions, and this would prioritise re-use, refurbishment, re-purposing, retrofitting and extension of existing buildings rather than new construction, especially construction on green field sites. Where new construction took place, it would have to have a high proportion of materials that sequester carbon (chiefly timber, but also other biomass-based materials like hempcrete), and re-use previously used materials. In terms of spatial design, the 15-minute principle would need to be followed, so minimising travel from home to work and to other resources.

It will help that the plan appears to over-estimate the likely scale of economic expansion: it uses a scenario for economic growth that is higher than many forecasts, while taking no account of economic scarring from the pandemic. It is arguable that the economic consequences of Brexit have been under-estimated. Finally, the likelihood of further geo-political-economic-ecological shocks (there has been one this year already) has not been allowed for. This means that the drivers of building construction and of growth in transport, including aviation, will be weaker that the plan assumes, meaning lesser material and energy flows and hence lower carbon emissions.

The Tyndall carbon budget assumes that there will be some small continuing carbon emissions after 2038 (the carbon budget of 67 Mtonnes is for the period to 2038. *Places for Everyone* is for the period 2021-2037). It sees these as being taken out of the atmosphere by the natural processes of biological sequestration. Losing green space to building construction will reduce the scope for this. While land use change emissions, both increases in emissions from changes and release of stored carbon during construction, are relatively small compared to the large direct operational and embodied emissions from the construction and transport, the loss of this natural resource will have a negative effect on the ongoing carbon balance. Moreover, building on this land means foregoing opportunities for significant improvements to carbon capture, from tree planting, peatland restoration and improved agricultural practices.

Limitations

Our estimates are dependent on the assumptions and data sources that we cite in the method section. There were a number of elements that we were not in a position to estimate, given the lack of data. Proportions of land types identified for building were approximated on a pro-rata basis from the overall non-urban Greater Manchester land types. Since the proportion of overall emissions from land are small, this would not significantly alter the overall headline figures. We made a best guess of the distribution of housing types, based on the overall occupancy rate planned and the proportions of flats and houses. Since those proportions determine the floor space of the accommodation to be built, a different ratio would give somewhat different results, but again, it would not be of a different order of magnitude.

A number of elements, had they been included, would have been likely to add to the total of carbon emissions:

- A high-rise factor for operational emissions from housing.
- Water-related embodied carbon outside the construction sites – e.g. new pipelines to new housing estates, additional sewerage capacity for denser housing in the Centre, supply and effluent treatment plant for industrial sites.
- Operational carbon from constructing new water-related infrastructure.
- Transport related embodied carbon.
- Operational carbon from new transport infrastructure construction.

- A realistic trajectory for aviation emissions reduction given that even net zero emissions by 2050 is implausible[37].
- Multiplier effects from the supposed economic growth engendered by the plan.

Three elements would reduce the total of carbon emissions:

- Reductions in embodied carbon due to improved technology over the plan period (e.g. alternative methods of steel and concrete manufacture, or substitution of alternative materials).
- More rapid decarbonisation of transport than the 2050 UK net zero trajectory.
- Further decarbonisation of the UK electricity supply.
- Economic shocks, stagnation and recession, constraining the proposed building programme.

We regard the above limitations as acceptable given that the purpose of the study was to provide an illustration of the carbon consequences of the plan, rather than a precise measurement. If the emissions to be produced by the planned development are of a similar scale to our estimates, then it is inconsistent with the plan's stated objective of staying within the 67 Mtonne carbon budget, and it also fails to demonstrate how the development will meet the legislative requirement that,

> *"Development plan documents must (taken as a whole) include policies designed to secure that the development and use of land in the local planning authority's area contribute to the mitigation of, and adaptation to, climate change."* [38]

Authorship

Report written by Mark H Burton with contributions from Matthew Broadbent and Marj Powner. Methodology and data analysis by Mark H Burton and Matthew Broadbent.

Acknowledgements

We are grateful to Dr Jaise Kuriakose, Tyndall Centre, University of Manchester, who led the work to propose the science based carbon budget for Greater Manchester, for commentary on the methodology and on the carbon budget as comparator. However, responsibility for the report contents is ours.

[37] Chapman, A. (2022, April). On a wing and a prayer. *New Economics Foundation*. https://neweconomics.org/2022/04/on-a-wing-and-a-prayer

[38] *Planning and Compulsory Purchase Act , 2004* ,as amended. Op cit.

Appendix

Estimated carbon emissions by category

Category (detail)	ktonnes CO2e over plan period	Share of total estimate	Share excluding aviation
Land Use: store	251	0.68%	1.52%
Land Use: sequestration losses	22	0.06%	0.13%
Housing: operational	1,572	4.25%	9.49%
Housing: embodied	6,054	16.36%	36.55%
Industry and warehousing: operational	1,367	3.69%	8.25%
Industry and warehousing: embodied	1,555	4.20%	9.39%
Offices: operational	1,409	3.81%	8.51%
Offices: embodied	3,102	8.38%	18.73%
Transport	1,195	3.23%	7.22%
Water-related	37	0.10%	0.22%
Aviation	20,449	55.25%	
Total	**37,012**	**100.00%**	
Total excluding aviation	16,563		100.00%
GM – Tyndall carbon budget to 2038 GM 10 Authorities	67,000		
GM- Tyndall carbon budget 9 Authorities to 2038 (2021 population ratio)	60,078		
Proportion of GM 2038 Carbon Budget used by P4E	55.24%		
Proportion of GM 2038 Carbon Budget (9 Authority share) used by P4E	61.61%		