TyndallManchester
Climate Change Research

Consumption Based Emissions Accounting for Manchester

Client:	Manchester Climate Change Agency
Document Reference:	MCCA CONSUMPTION
Version:	V.4.1 FINAL
Date:	February 2019
Prepared by:	Dr Christopher Jones

NB: All views contained with this report are attributable solely to the authors and do not necessarily reflect those of researchers within the wider Tyndall Centre.

Summary

Consumption and production based approaches are two different ways of counting the climate impact of a city by adding up quantities of greenhouse gas (GHG) emissions. A consumption based approach is more comprehensive in understanding overall impact, but difficult to accurately and consistently assess. Therefore while consumption based approaches provide valuable insights into how to reduce climate impact, setting and monitoring commitments is very challenging at a city scale. The Manchester carbon budget is an energy-only CO_2 budget based on a production emissions approach. The size of this budget reflects that Manchester is not a net exporter of goods and services and should intend to reach zero emissions earlier than other regions. Differences in data quality and potential double counting mean that a consumption based carbon budget compatible with the current Manchester carbon budget is not recommended. It is however recommended that Manchester take stock of its estimated consumption based emissions and sets goals to address emissions from these sources through more sustainable consumption practices.

Introduction

In June 2018 the Tyndall Centre for Climate Change Research at the University of Manchester was commissioned by Manchester Climate Change Agency to advise on science-based carbon reduction targets for Manchester. This led to the development of the Agency's 'Playing our Full Part' proposal (http://www.manchesterclimate.com/targets-2018) and the formal adoption of science-based carbon reduction targets for Manchester's direct[1] / energy-only CO_2 emissions by Manchester City Council, in November 2018.

In November 2019 the Tyndall Centre was commissioned by the Agency to review the city's climate change targets and recommend revised targets, as required. The review covers four areas of activity:

- Direct / energy-only CO_2 emissions
- Indirect / consumption-based CO_2 emissions
- CO_2 emissions from flights from Manchester Airport
- Target-setting and reporting methodology for organisations and sectors

The full brief is available from http://www.manchesterclimate.com/targets-2020.

This report covers a review of sub-national consumption based emissions accounting approaches and comments on how a consumption based emissions approach relates to the current production based emissions target. Recommendations are made on future steps on how to approach indirect /consumption based emissions from the city

[1] This definition of 'direct' refers to fuel use (Scope 1) and electricity use (Scope 2) within the local authority geographic area.

Key Recommendation

Existing studies of consumption based emissions in the UK and the wider C40 cities group should be used to indicate likely hotspots of imported emissions – food and drink, construction, manufactured goods and water. On this basis, studies should be undertaken of hotspot areas of imported consumption to develop sustainable consumption strategies that enable and incentivise waste reduction and supply chain engagement to lower the carbon emissions associated with the provision of goods and services.

Consumption Based Accounting

A city's contribution to climate change extends beyond the direct greenhouse gas (GHG) emissions within its geographic boundary. There are GHG emissions associated with the provision of all products and services used and very rarely does an area consume only what is produced within its boundary. Considering GHG emissions only within a given geographic area is likely to understate the overall contribution to climate change for areas that are net importers of goods and services. It is therefore important to acknowledge geographic distinctions in the production and consumption of goods when setting carbon targets, and to consider actions that contribute to wider decarbonisation through supply chains.

Consumption based emissions accounting aims to provide a more complete view of a region or nation's GHG emissions by considering all emissions associated with products on the basis of where they are consumed [1]. This can be done by identifying where a thing is produced and consumed (trade between producers and end users) and the GHG emissions associated with providing it across its life cycle (i.e. from manufacture to disposal). For the UK as an example, by quantifying everything imported for consumption along with what is produced and also consumed within the country, an inventory of consumed goods can be created. Goods and services produced in the UK, but exported, would not be included in this inventory and would be part of the inventory for the country they are exported to. This inventory of consumed goods can then be used with data on the average GHG emissions for a particular product from a given producer region to calculate total GHG emissions for the UK [2]. This approach is important for showing that if a nation or region 'offshores' the production of goods it continues to consume to another region or country those emissions remain at the global level even if that country's direct emissions have reduced as a consequence. In the UK for example, GHG emissions produced within the country fell through the 1990s to 2007, while if the UK's emissions are considered on the basis of goods consumed, then overall UK emissions rose over this period [3]. Despite an overall trend of emissions decline on a production and a consumption basis since 2007, UK GHG emissions were still estimated to be 52% greater on a consumption basis in 2016 [3].

A key challenge for the consumption based approach is in obtaining accurate and up-to-date data for consumption inventories and the GHG emissions data for products [4]. Environmentally extended input-output (EEOI) models have been developed to provide a robust way to link global trade flows between regions/countries to consumption inventories [1], However it is acknowledged that although the consumption based approach gives a more complete picture of GHG emissions, the overall results are unlikely to be as accurate as they are for direct, production based emissions alone [1, 4]. This is largely due to the data requirements and

modelling assumptions needed for a consumption based approach and how up-to-date the GHG emissions data for products by origin can be kept [4]. The results from a consumption based approach are therefore considered an indicative representation rather than necessarily a precise characterisation of GHG emissions [1]. These considerations have implications for how feasible it is to implement ongoing monitoring and reporting against a target using an aggregated consumption account. This is a key reason why production based accounting of emissions remains typical in national climate change target setting and in international climate change negotiations [4, 5].

The challenges with data and modelling product flows are amplified further when looking at a sub-national entity like a city. At the UK city level there is no existing dataset that can track flows of goods into and outside of the city boundary in the same way as is done for the UK as whole. There are however methods for downscaling consumption datasets at larger geographic scale to a city level to supplement gaps in local datasets [6]. Local authority scale consumption based accounting by Millward-Hopkins, Gouldson [7], Martire, Mirabella [8] and Berners-Lee, Hatter [9] use downscaled national datasets on a per capita basis for non-energy service consumption in the locality. A similar approach could be done using an economic indicator such as GVA or household expenditure data to refine downscaling of data [6]. While the approaches used in these studies can give valuable insights into the city's wider environmental impacts beyond its border, the results require that the city broadly follows average national or regional consumption trends. While this is a reasonable assumption for estimating baseline sources of consumption impact, if the city implements actions that deviate from the national or regional picture, these changes would be difficult to observe through such an approach. Therefore setting an aggregate consumption based emissions target for a city may not be feasible, however specific targets for key areas of consumption based on a consumption based account could be a practical and effective strategy. For example Millward-Hopkins, Gouldson [7] highlights food and drink as a major contributor to overall consumption based GHG emissions and therefore a priority area for action to reduce waste and emissions through the supply chain.

Understanding a city's wider climate change impact through its relationship to goods and services produced worldwide is important for helping cities to extend their global influence on GHG emissions by working with supply chains to promote low carbon practices and cut product waste [10]. While production based emissions accounting is more accurate it does not fully represent a city's contribution to climate change and therefore a consumption based action plan can complement production based targets [1].

This can happen in two ways. Firstly production based emissions targets are set with an acknowledgement that net exporters of carbon emissions are in a different position to net importers. This is a case for not using a per capita allocation of the remaining carbon budget, which can be seen as unfair for areas which export a large proportion of their produced emissions to meet consumption demands elsewhere – e.g. all countries converge on zero emissions by 2050 regardless of their current contribution to global emissions. Instead net importers of emissions should have targets to reach zero at an earlier date to reflect this. Secondly, a consumption based inventory of emissions highlights key hot-spot areas where further action could be taken. While this may not lead to an aggregated consumption emissions target, separate targets for these areas could be implemented.

Consumption Based Emissions in Manchester

A primary goal of a consumption based approach to understanding Manchester's contribution to GHG emissions would be identify key areas of consumption where the city could take action to influence a global reduction in emissions through product supply chains. As noted there are particular issues in obtaining trade flow data at the city boundary which presents a challenge for consumption based accounting approaches at this scale. There are, however, a number of studies that have looked at city level consumption based emissions that can provide an indicative assessment of key contributors to a city's overall contribution to global GHG emissions. While Manchester could commission a new consumption based emissions account, if such a report were to rely on downscaling regional or national consumption datasets on a per capita or GVA basis it is likely to produce similar indicative findings as previous studies. The following section uses existing consumption based emissions reports to identify likely contributors Manchester's wider GHG emissions impact.

Key Contributors to Consumption Emissions in Cities

Existing consumption based accounts show how for countries and cities that are net importers of goods and services, the GHG emissions attributed to them are higher on a consumption basis than if emissions produced locally alone are considered. Analysis by the University of Leeds for Defra suggests that in 2016 (the most recent year this data is available) the UK's overall greenhouse footprint is 52% larger on a consumption basis compared to a production based emissions accounting approach [3]. Work by the C40 group on GHG emissions from leading climate change cities reports that on average across the cities studies consumption based emissions are 60% higher than the total for 'in-boundary' production emissions [6]. This however is the average for the 79 cities studied, and there may be variation across city types. Millward-Hopkins, Gouldson [7] in their sub-national study of a UK city estimate that Bristol's GHG footprint is three times higher with a consumption based approach compared to a production based approach – primarily due to including non-CO_2 gases associated with food and drink production.

Sub-national consumption based studies in Millward-Hopkins, Gouldson [7] and Berners-Lee, Hatter [9], for Bristol and Greater Manchester respectively, are particularly useful for understanding Manchester's potential sub-division of consumption based emissions. The reports have slightly different methods – e.g. in accounting for resident's aviation and calculating energy use emissions – that prevent straightforward comparison between them. They both however use 2010 UK trade data to characterise product flows and downscale on a per capita basis, making the results comparable to Manchester if Manchester is assumed to be near to the UK average.

Both studies show common groupings of goods and services as main sources of emissions; energy, food and drink, public and commercial services. Other goods such as electronic equipment, clothing and general 'non-food shopping' also make up a significant share of the consumption emissions in these reports, although they are grouped differently in the reported results. Emissions from the construction sector are relatively low in both studies, which may be a result of drawing from 2010 UK level data. Given the level of construction happening in Manchester in 2020 it may be that this sector is a much greater contributor to overall city consumption emissions than the reference studies suggest. Understanding these more localised issues (that deviate from national average data) is a particular challenge for consumption based

accounting which relies on downscaling a regional or national dataset. A more specialist study of the construction sector in Manchester in this case would be needed to complement an area wide overall consumption GHG emissions account.

While Berners-Lee, Hatter [9] explicitly include aviation for Greater Manchester residents, it is not made clear that aviation is included in Millward-Hopkins, Gouldson [7], meaning that direct comparison cannot be made between them. The proportional shares of emissions highlighted in these reports are only indicative – as noted above they apply slightly different methods and the underlying data is from 2010 – however the key areas of emissions also resonate with the findings of the C40 on the average consumption based emission across their members

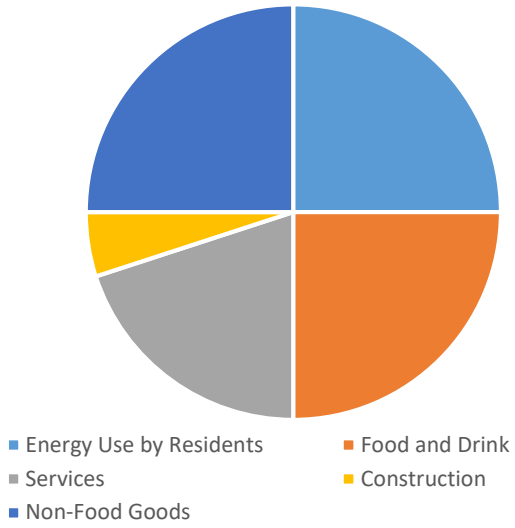

Figure 1: Indicative shares of typical UK city level consumption GHG emissions. Based on [7]

Energy used by residents: In a consumption based approach energy consumption in the city includes emissions associated with producing and transporting fuels and electricity (upstream emissions). Measures to reduce energy use and switch to renewable energy sources will also reduce these upstream emissions. Millward-Hopkins, Gouldson [7] and Berners-Lee, Hatter [9], estimate that use of energy in the city may be around 25% of a city's total GHG emissions. Millward-Hopkins, Gouldson [7] suggest that on a CO_2 only basis this it is around a 50% share. The direct emissions from fuel combustion (i.e. in homes, transport and industrial processes) in the city and the city's proportional share of electricity emissions (on a Scope 2 basis) are included in the existing Manchester carbon budget.

Food and Drink: The majority of emissions associated with the GHG impact of food and drink in the emissions are non-CO_2 gases, particularly methane (CH_4) and nitrous oxide (N_2O) [7]. They also represent around 25% of the consumption GHG emissions accounts in the studies. This highlights a significant contributor to a city's GHG emissions that is not directly covered in Manchester's carbon budget for energy-related CO_2.

Services: The emissions associated with services to residents including health care, public administration, education and financial services are around 20% of GHG emissions in these studies. Many of these services are by their nature locally situated, therefore energy use by organisations within the city providing these services is included in the current Manchester

carbon budget. However emissions associated with a service produced outside of the city and used within it (such as some financial services) is not. Conversely, emissions arising from services from Manchester based organisations that are exported outside of the city are included in the city carbon budget, but not the consumption based account.

Non-Food Goods: In the two UK studies non-food shopping consumption is grouped differently. In aggregate for both studies they appear to be around 15% to 20% of the share of GHG emissions. Millward-Hopkins, Gouldson [7] disaggregate their results to show a particularly prominent contribution from clothes, textiles and apparel. In both instances emissions from electronic goods have relatively low contribution to overall GHG emissions on a consumption basis. Imported non-food goods are another source of emissions not directly covered in the Manchester carbon budget that could be considered through additional action by Manchester. Further work may be needed to better understand the sub-categories within this segment, however there may be commonalities across this segment in terms of the interventions reduce waste products and working with the supply chain to incentivise low carbon practices.

Conclusion

Energy related CO_2 emissions from Manchester resident's energy use and goods and services produced within the city for export or consumed within the city are included in Manchester's existing carbon budget target. The size of this production based carbon budget is adjusted through a grandfathering approach so that the UK, as a developed nation that is a net importer of carbon, has smaller carbon budget than it would only a purely per capita share of the global budget [11]. This budget should be complemented with actions to reduce the city's non-CO_2 gases, limit aviation growth [12] and address sources of imported emissions, such as food and drink.

The complexity and assumptions needed for city-level consumption emission accounting make setting an aggregated consumption emissions target for Manchester and ongoing monitoring and evaluation difficult. In particular if the consumption account is downscaled for regional or national dataset on a per capita basis, it may not be possible to get a locally specific baseline and see how the city has deviated from broader trends. While providing precise and easily updatable results for consumption based accounting is currently a challenge, consumption based approaches are valuable in giving an indicative understanding of the wider climate change impact of a city and can highlight key areas for intervention. For example if food and drink are shown to be significant share of a city's wider carbon footprint, interventions that aim to tackle waste and source from more sustainable production can be taken forward.

Further work can be undertaken to better understand Manchester's role as a consumer in emissions of GHG from key imported emissions hotspots – food and drink, construction, clean and waste water, and non-food manufactured goods. This work should determine what ambitious actions on consumption look like and what interventions this implies. While measuring overall consumption patterns at a city scale is challenging, this is not necessarily the case at an organisation level, where procurement data can be used to understand baseline sources of emissions in finer detail. By developing or implementing best practice measures on consumption across the hotspot areas Manchester can extend its influence in reducing GHG emissions globally. For example organisation such as the Green Building Council provide standards on

construction materials and practices that the City Council and other organisations should promote to reduce imported emissions through construction. Similarly Manchester could set ambitions for organisations in the city to align with, and potentially extend, existing initiatives to reduce food waste and promote low carbon diet options.

References

1. Barrett, J., et al., *Consumption-based GHG emission accounting: a UK case study.* Climate Policy, 2013. **13**(4): p. 451-470.
2. Barrett, J., A. Owen, and M. Sakai, *UK Consumption Emissions by Sector and Origin Report to the UK Department for Environment, Food and Rural Affairs*. 2011, UK Department for Environment, Food and Rural Affairs
3. Defra, *UK's Carbon Footprint 1997 – 2016* F.a.R.A. Department for Environment, Editor. 2016, Defra: https://www.gov.uk/government/statistics/uks-carbon-footprint#history.
4. Afionis, S., et al., *Consumption-based carbon accounting: does it have a future?* WIREs Climate Change, 2017. **8**(1): p. e438.
5. Franzen, A. and S. Mader, *Consumption-based versus production-based accounting of CO2 emissions: Is there evidence for carbon leakage?* Environmental Science & Policy, 2018. **84**: p. 34-40.
6. Arup, C40, and University of Leeds, *The Future of Urban Consumption in a 1.5°C World; Method Report*. 2019: https://www.c40.org/consumption.
7. Millward-Hopkins, J., et al., *Uncovering blind spots in urban carbon management: the role of consumption-based carbon accounting in Bristol, UK.* Regional Environmental Change, 2017. **17**(5): p. 1467-1478.
8. Martire, S., N. Mirabella, and S. Sala, *Widening the perspective in greenhouse gas emissions accounting: The way forward for supporting climate and energy policies at municipal level.* Journal of Cleaner Production, 2018. **176**: p. 842-851.
9. Berners-Lee, M., W. Hatter, and C. Hoolohan, *The Total Carbon Footprint of Greater Manchester*. 2011, Small World Consulting: http://media.ontheplatform.org.uk/sites/default/files/gm_footprint_final_110817.pdf.
10. Bows, A. and J. Barrett, *Cumulative emission scenarios using a consumption-based approach: a glimmer of hope?* Carbon Management, 2010. **1**(1): p. 161-175.
11. Kuriakose, J., et al., *Quantifying the implications of the Paris Agreement for Greater Manchester*. 2018, Tyndall Centre for Climate Change Research: 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.
12. Kuriakose, J., et al., *Quantifying the implications of the Paris Agreement for city of Manchester*. 2018, Tyndall Centre for Climate Change Research: http://www.manchesterclimate.com/sites/default/files/Manchester%20Carbon%20Budget.pdf.