

Measuring Progress Toward a Low Carbon Economy in Manchester

Report prepared by Benjamin Irvine (Steady State Manchester) for *Manchester a Certain Future* Low Carbon Economy Steering Group - July 2015. All rights reserved.

Subject

Report on indicators which could be developed for tracking progress toward a Low Carbon Economy in Manchester.

Purpose

To provide a comparative overview of indicators of city sustainability and measures of progress toward a Low Carbon Economy. To inform decisions on which type of indicators the group may wish to develop in the longer term to complement and build upon those currently being used to measure progress against the MACF aim of 'rapid transition to a low carbon economy'.

More specifically, the aim is to consider indicators which provide insight into aspects of low carbon economic development which may not be fully captured by the current headline measures. Indicators which capture the issues and variables which are of relevance in the transition to sustainable low carbon economy in the city, considered in broader terms as the efficient production of sustainable economic welfare. These sorts of variables include for example well-being, equality and the broader ecological footprint of the city, as well as data on key city level policy levers for achieving sustainability and well-being such as transport, green space and air quality.

Background

The 2014 MACF Annual Report states that: 'From 2013 MACF contains three headline objectives and a fourth (on low carbon economy), which is currently being considered in further detail.'¹

This report relates to this fourth objective: 'make a rapid transition to a low carbon economy' and hopes to make a contribution to the questions: 'what does a low carbon city economy look like?...And how do we measure progress?'²

There are two measures of LCE progress currently in use in the MACF plan and reports:

- 1) Manchester's carbon emissions per £1m GVA.
- 2) Data on the Low Carbon and Environmental Goods and Services (LCGES) sector within the city.³

Section 1 assesses the 'blind spots' of these two measurements, what they do and don't measure, in order to inform the logic and desirability of complementary indicators and provides a rationale for the criteria against which further complementary indicators will be compared.

Section 2 compares various approaches to measuring sustainable economic welfare and a low carbon economy in cities, against this set of criteria.

1. Headline Indicators of Progress Toward a Low Carbon Economy: Establishing Criteria for Further complementary Indicators

The current headline indicators of progress toward a low carbon economy are:

- 1) Manchester's carbon emissions per £1m GVA.
- 2) Data on the size and number of jobs in the Low Carbon and Environmental Goods and Services sector within the city.ⁱ

i It is understood that the LCEGS sector definition is currently being re-defined by Department for Business Innovation and Skills, and as such up to date data is not available. The MACF annual report for 2015 will include

The two measures are the most appropriate concise measures of progress towards a low carbon economy; measuring the carbon intensity of the city's economy as well as a 'leading' indicator in the form of the LCGES sector which gives some indication of take-up of products and services that facilitate de-carbonisation by businesses and households.

Data on the number of jobs within the sector also provides an important impression of whether the economic opportunities of low carbon transition, through the growth of this sector, are broadly felt.

Indicators of the type considered below should not displace the current headline measures, however, by considering what they fail to capture, the rationale for further complementary indicators of low carbon economic development can be established. There are significant additional components and sectors in the route to a low carbon economy and achieving sustainable economic welfare, which may be captured by other indices and could give a fuller picture of progress.

1.1 Carbon Intensity of GVA (CO₂/£1m GVA)

a) Total carbon footprint/ecological footprint is missed

The figure for carbon emissions per unit of Gross Value Added is for direct or territorial emissions only, this is only a partial representation of the total carbon footprint of Manchester's economy (perhaps less than 50%) as it does not account for the impact of goods consumed in the city but produced elsewhere.ⁱ

The work of the MACF thematic group 'Sustainable Consumption and Production' is specifically geared toward tackling these wider, indirect emissions, 'as it aims to reduce the emissions embedded in the products and services we purchase and dispose.'⁴ If only direct emissions are measured, knowledge and opportunities for reducing the city's total carbon footprint are less clear.

When a calculation of Manchester's total carbon footprint was carried out in 2011, areas which make up only a small portion of emissions from a territorial perspective were revealed to be far larger on a consumption based measure (food made up 20%) and therefore present significant opportunities for reductions.⁵

Indicators which give a fuller picture of the environmental impact of the economy, through measuring consumption based emissions or other environmental impacts such as ecological footprint would be of value.

Implication for Criteria: Further complementary progress indicators should ideally capture a fuller picture of the environmental impact of the economy through measuring total carbon footprint, although there are some conceptual and methodological hurdles to overcome⁶. Similarly, measures which track progress in reducing the city's ecological footprint and/or impact on the 7 key planetary boundaries⁷ are of merit in assessing the sustainability of the economy, as would those which track progress in key sectors for sustainability.

b) GVA is an imperfect measure of welfare and well-being

The goal of a low carbon economy is reducing the environmental impact of the economy whilst maintaining and enhancing human welfare/well-being. The carbon intensity per unit of GVA doesn't reflect differences in how GVA might be distributed or tell us much about people's well-being. Both the distribution of income and a more detailed understanding of peoples welfare and well-being are important, as they can play a significant part in the route to a low carbon economy.

A more equitable distribution of income is cited by many ecological economists⁸ as an essential part of a low carbon economy as it enables the most essential welfare gains at the bottom of the income distribution with less aggregate economic growth and corresponding environmental impacts: those with greater disposable

case studies in lieu of aggregate data on the size of the sector, but the intention is that the size and number of jobs in the LCEGS will be a key measure of progress.

i It is understood that there are those in MACF working on applying a total carbon footprint, this point is raised to demonstrate the value of additional indicators in providing insights if this data remains unavailable for some time.

income tend to spend it on products and services that have greater carbon emissions⁹

Similarly, moves towards measuring and targeting well-being as opposed to income have been advocated by policy makers in relation to sustainability for some time. Shorter and more flexible working hours could play a significant role in reducing carbon emissions per capita and the absolute quantity of emissions, whilst maintaining access to employment and increasing well-being, especially in the context of stalled growth or post-growth.¹⁰

A more equal distribution of income and reductions in working hours are both routes to a low carbon economy that are not captured by the carbon intensity per unit of GVA but complement attempts to decouple emissions from growth by reducing the scale of the challenge.

Implication for criteria: Indicators should ideally include a measure of equality for the income (and wealth) distribution, as well as well-being and/or key determinants of well-being due to their relevance to sustainable prosperity.

1.2 Size of the LCEGS Sector

a) Doesn't measure other key sectors and leading indicators of a low carbon economy in cities

Data on LCGES sector is a very good leading indicator of low carbon economic development but it is not the only key sector.

Indicators which include other key sectors of transition such as local food production and other key city level levers for low carbon economic development and well-being such as transport, air quality and access to green space can give a fuller picture of the city's sustainability by emphasising progress in these key areas. Whilst data on these areas is tracked by other groups in MACF there is a benefit to aggregating them into measures of economic sustainability as progress and trends can become more apparent. This is especially the case in areas, like local food production, where carbon savings would not be picked up by the current territorial emissions methodology.

Other aspects of sustainable consumption and production include the sharing economy, collaborative consumption, repair and re-use. These economic trends and activities do not directly reduce emissions embedded in goods but rather reduce the total amount of goods produced and consumed through allocating access to them more efficiently and extending their use-able lifespan. This shift away from the sale of goods and towards the sale of services derived from these goods has been defined as a significant characteristic of 'ecological enterprise' in a Green Economy.¹¹ Carbon savings through these dynamics may not necessarily be picked up by the carbon intensity of GVA as currently measured.ⁱ These development may be captured by data on the durability of consumer goods or, less effectively, through non-income measures of welfare such as reported levels of satisfaction.

Finally there is the question of what the rest of the economy is doing: are higher carbon sectors shrinking and lower carbon sectors increasing, and by how much?

Implication for Criteria: Indicators should ideally capture other significant aspects of a low carbon economy such as the durability of goods, the case for including measures of well-being is also reinforced. Other key sectors and city level levers for low carbon economic development and well-being would also help to give a fuller picture of progress.

1.3 Criteria

Based on this analysis three distinct criteria for complementary indicators of a low carbon economic development can be established:

i Especially in the free sharing economy such as 'Freecycle.org', where the reduction in demand for consumer goods, achieved through the efficient re-allocation of unwanted goods without exchange, is not replaced in economic output by an increase in the sale of services associated with access to these goods. Indeed these options if adopted at scale would probably reduce GVA as measured.

1. Degree of capture of total environmental impact. Indices which take consumption based emissions into account are of value as are those that integrate other environmental impacts.

2. Degree of capture of aspects of sustainable economic welfare. These include income distribution/work and leisure time and key determinants of well-being such as health and education. These areas are integral to sustainable economic welfare and therefore key routes to a low carbon economy.

3. Degree of capture of key sectors and levers for a low carbon economy in the city. This allows for a fuller picture of city sustainability by magnifying key areas of activity. Many of these areas have dual low carbon and well-being benefits such as initiatives on air quality, green space and commuting times. Indices which incorporate those areas that are not captured by the current measures, sectors like local food production and trends in the durability of goods, are also of value.

Two further criteria have been requested by the Low Carbon Economy monitoring group for the purposes of practical application:

4. Quality and availability of data. How readily available is the data for the index, and how readily can the index be applied.

5. Standardization of use for comparability against cities, nationally and internationally. How broadly used is the indicator and how broadly collected is the data it requires.

2. Comparison of Low Carbon City-Economy Indicators

The indicators considered are mostly composite indices¹² and focus on the measuring issues most pertinent to the opportunities and challenges of city-scale sustainability. The exception is the Regional Index of Sustainable Economic Well-Being (R-ISEW), which is based on the Index of Sustainable Economic Welfare and Genuine Progress Indicator methodologies.¹³ It is an adjusted measure of economic welfare and has been applied at national and sub-national levels. It was developed as a better indicator for economic welfare than Gross Domestic Product. Environmental and social costs and benefits are costed and internalized into GDP or GVA giving an adjusted monetary value of national/sub-national or per capita welfare.¹⁴

The indicators were selected for consideration based on their prominence and/or potential to fulfil the criteria. There are a large number of other indicators of sustainable development which could be applied or adapted to the city scale and may fit the criteria but it was not possible within the scope of this report to consider all of them. The ones considered nevertheless represent a broad sample of the type of indices which could be used or developed.

The indices are presented in Table 1, along with the individual data components they include, grouped by theme. The indices are compared against the criteria in Table 2 and each is discussed in more detail in the analysis.

Table 1: Overview of Indices And Their Components Grouped By Theme

	Environmental Sustainability	Economy, Income, Distribution	Well-Being
The Green City Index¹⁵	CO ² / Energy / Buildings / Transport / Water / Waste and Land Use / Air Quality / Environmental Governance	-	-
PWC Good Growth For Cities¹⁶	CO ² Intensity	Income / Income Distribution / Unemployment / Housing Affordability / Household Savings / Sectoral Balance	Health / Work-Life Balance / Commuting Time
ELITE Cities Tool¹⁷	Climate / Energy / Mobility / Water / Waste / Land Use / Air Quality	Unemployment / Housing Affordability	Health / Education / Green Space
Forum For The Future: Sustainable Cities Index¹⁸	Ecological Footprint / Waste / Air Quality / Biodiversity / Transport / Local Food / Recycling / Environmental Governance	Unemployment / Number of Start-ups	Health / Education / Green Space
Regional Index of Sustainable Economic Well-Being¹⁹	CO ² / Resource Depletion / Land Loss / Air / Water / Noise Pollution / Transport	Economic Welfare (adjusted for consumer durables) / Income Distribution / Capital Growth / Net International Position	Value of Health and Education / Value of Domestic and Voluntary Labour / Cost of Crime / Cost of Divorce / Cost of Commuting

Table 2 Indices Compared Against Criteria The indices have been given basic ratings to reflect the degree to which they fulfil each of the criteria (equal weights): None=0, Low=1, Medium=2, High=3. The basis for the rating is given in brackets and an overall score is given in the total column.

Fulfilment of Criteria	Environmental Impact	Sustainable Economic Welfare	Key City-Level Sectors And Levers	Sub-total	Quality And Availability	National And International Comparability	Total
<i>The Green City Index</i>	High (CO ² / Energy / Water / Waste and Land Use)	None	High (Air Quality / Governance / Buildings / Transport)	6	Medium (Strong quantitative basket, also comprehensive, but not immediately available)	Medium (Has been calculated for many cities internationally but only one in the UK)	10
<i>Good Growth For Cities</i>	Low (CO ² Intensity)	High (Income Distribution / Unemployment / Health / Work-Life Balance)	Low (Commuting Time / Housing Affordability)	5	Medium (Highly available but weightings are somewhat arbitrary for purpose)	Medium (Nationally comparability is high but internationally low)	9
<i>ELITE Cities Tool</i>	High (Climate / Energy / Water / Waste / Land Use)	Medium (Unemployment / Health / Education)	High (Air Quality/ Transport / Buildings / Green Space / Organic Agricultural Land)	8	Low (Excel tool is available upon request but would need adaptation)	Medium (Developed for Chinese context but data has international commonality)	11
<i>Sustainable Cities Index</i>	High (Ecological Footprint / Waste / Biodiversity)	Medium (Unemployment / Health / Education)	High (Air / Transport / Local Food / Green Space / Recycling / Governance)	8	Low (Data is available but weighting contentious, index calculation is no longer being updated)	Medium (National comparability is high, less so internationally)	11
<i>Regional Index of Sustainable Economic Well-Being</i>	Medium/High (CO ² / Resource Depletion / Water / Land Loss)	High (Durability of Goods / Income Dist. / Health / Education / Domestic and Voluntary Labour)	Medium/High (Air / Noise Pollution / Cost of Commuting)	8	Low (Data is attainable but would require significant resource to calculate)	High (Despite variations in ISEW methodologies, per capita adjusted income is highly comparable)	12

2.1 Analysis of Indices Against Criteria

The Green City Index

'The Green City Index' is a research series carried out by the *Economist Intelligence Unit* and commissioned by *Siemens*.²⁰ It comprises indices calculated for Europe, Asia, The US and Canada, Africa and Latin America. The European Index²¹ includes 30 indicators across the categories outlined in Table 2, 16 of which are quantitative indicators and 14 qualitative indicators; which refer to governance, policies and standards.

The strength of the index is the wealth of data on environmental impact where CO² emissions and intensity data is supplemented by data on air quality (nitrogen dioxide, sulphur dioxide and particulate matter), water consumption, water leakages, and waste production and recycling. It is worth noting that accurate city level data on CO² emissions was not collected by all cities and the index relied on extrapolating from national per capita CO² emissions²².

The index also captures key levers for de-carbonisation effectively. Multiple data points in the key sectors of buildings and transport are considered. The index also directly measures the extent to which key city levers are being applied, and therefore the sustainability intentions of the city, through qualitative indicators of environmental governance as well as initiatives, policies and standards in each of the sectors considered.

The index includes no social or economic data points to capture aspects of sustainable economic welfare.

Whilst the qualityⁱ of the data is generally good it is not without issues, such as the extrapolation of city CO² emissions from national data in some cases. The index has not been calculated for Manchester so it is not immediately available, the data required to do so is available but it would require some resource.

The potential for comparability is high although it has only so far been calculated for one UK city (London). International comparability is ostensibly relatively high as versions have been calculated for 120 cities worldwide. However due to differences in data collection only 2 of the indicators are genuinely comparable worldwide with other other data points comparable across 2 or more regions but not all.²³

Good Growth For Cities

The 'Good Growth for Cities Index' is an index of 'urban economic well-being' calculated for UK cities by *PWC* and *Demos*.

The index provides no additional information about the cities' environmental performance as the CO² intensity of GVA is the only measure of environmental impact included.²⁴

i The question of data quality is a very complex one as the indices all draw on multiple indicators. Data may sometimes be extrapolated from national data, making tracking local progress difficult. There are also wider questions of scientific rigorousness in the weighting given to the component indicators in each index, which has been a criticism levelled at many sustainable development indices; (See for example: Böhringer, Christoph; Jochem, Patrick (2006) 'Measuring the immeasurable: a survey of sustainability indices', ZEW Discussion Papers, No. 06-73 <http://core.ac.uk/download/pdf/6407068.pdf>) These issues as well as technical points on data sources have not been fully treated here, but I have referred to them where possible.

The index captures key aspects of sustainable economic welfare very well; it includes data on income distribution and unemployment, as well non-income well-being measures like work/life balance and health.

Key levers for city sustainability are captured through data on commuting times, and to a lesser extent housing affordability which could be conceived as a measure of non-income well-being which cities have some policy control over. However, this is a small degree of capture compared to other indices in this comparison.

The data quality and availability is high, the index has been calculated and is available for Manchester and for comparison with many other UK cities using both local authority and 'Travel To Work Area' data sets.

The purpose of the index is not explicitly low carbon development, and although it is similar to a 'Beyond-GDP' indicator it differs from the index of sustainable economic welfare because environmental costs are not given an economic cost but rather a weighting based on focus group questioning. There is therefore an issue with the robustness of the weightings in the index for its use as a measure of a low carbon city-economy or sustainable economic welfare in the city.

The index was also not designed for international comparability and it has not been applied internationally.

The index nevertheless represents an example of a robust index of aspects of sustainable economic welfare including key levers for city transition using local data sets.

ELITE Cities Tool

The Eco and Low-Carbon Indicator Tool for Evaluating Cities (ELITE Cities Tool) was developed by US researchers for the evaluation of progress towards low-carbon eco-cities in China, it compares them against benchmark performance goals as well as ranking them against other Chinese cities. It was developed based on a comprehensive international review of indicators of low carbon cities.²⁵

It comprises 33 key indicators within the 8 primary categories. Its fulfilment of the criteria is similar to but somewhat surpasses The Green City Index, providing a wealth of quantitative data on environmental impacts as well as including some key city levers such as air quality, transport, buildings, green space and uniquely the percentage of organic certified agricultural land. In addition aspects of non-income well-being are captured including employment, health and education.

In terms of data quality the indicators are all quantitative and selected based on the SMART²⁶ criteria.²⁷ The Excel tool is available upon request from the Lawrence Berkeley National Laboratory website but would require significant adaptation to UK data sources.²⁸ The potential for national and international comparison is high, if not immediately available, as the indicators were chosen based on international commonality.²⁹

It's overall score would be higher were it not for the difficulties of availability associated with the need for significant adaptation. It's merits are that it combines a wealth of information on environmental impacts as well as aspects of sustainable economic welfare and key city levers for

de-carbonisation.

Sustainable Cities Index

The Sustainable Cities Index, produced by *Forum for the Future*, tracked progress on sustainability in 20 of Britain's largest cities between 2007-10. It is a ranking Index and Manchester placed 13th out of 20 in the last year the rankings were calculated.³⁰

It comprises 13 indicators across 3 baskets: 'Environmental', 'Quality of Life' and 'Preparing for the Future', all are quantitative apart from one; points awarded for policy and action planning for climate change.

The index effectively captures additional information on environmental impacts including ecological footprint per capita, which is calculated based on the footprint of the goods consumed in the city wherever they may have been produced.³¹ It also include information on biodiversity and waste. Key city levers and sectors for transition are also captured including air quality, transport, green space, recycling governance and local food (measured by access to allotments).

The index receives a medium score for its capture of aspects of sustainable economic welfare; it includes data on employment, health and education.

In terms of data quality there are no obvious issues other than the inclusion and equal weighting given to certain indicators which could perhaps be charged with being weak or arbitrary such as, but not limited to, the indicator for 'economy' under the 'future-proofing' category; business start-ups per 10,000 residents.

The data for calculating the index is available but the calculation is a ranking system of the 20 cities and is no longer being updated by *Forum for the Future*. The potential for national comparability is obviously high but not currently available 'off the shelf' and international comparability is likely possible but has not been explored.

Regional Index of Sustainable Economic Well-Being

The Regional Index of Sustainable Economic Well-Being (R-ISEW) was developed and applied by Tim Jackson et al. at the New Economics Foundation and was commissioned by a consortium of Regional Development Agencies in 2008.³² The framework is based on a range of related attempts to construct an adjusted measure of GDP at the national level; the Index of Sustainable Economic Welfare (ISEW) and the Genuine Progress Indicator.³³

The R-ISEW was calculated for all the English regions over the period 1995 to 2005. Sub-national versions of the ISEW have also been applied in Alberta, Canada, parts of Vermont State in the USA, the Province of Siena in Italy, as well as four cities in China.³⁴

The index has a high degree of capture of environmental impacts; adjusting for losses associated with 'local' air and water pollutants and noise pollutions from local/regional level data sources as well as for the costs of land loss. Carbon emission costs are priced as an accumulated ecological debt that needs to be paid off, which is an effective way of representing the absolute level of emissions reduction required. The downside is that the source is effectively territorial emissions so costs to the region are based on production not consumption.³⁵ The index also includes the cost of depletion of non-renewable resources (fossil fuels). A weakness of the index is that it doesn't

capture trans-boundary environmental impacts particularly well.³⁶

The index's capture of sustainable economic welfare is excellent as this is its purpose by design. It is the only index considered that includes the reduction in material intensity of the economy and increase in welfare associated with increases in the lifetime of consumer durables. This is based on an estimate of the difference between expenditure on and the service flow from consumer durables, accounting for depreciation and obsolescence.³⁷ Although rigorous accounts of the stock of consumer durables is not available for the UK significant differences in expenditure upon consumer durables amongst regions is apparent as well as shifts in purchasing patterns between durables and non-durables.

Other key aspects of sustainable economic welfare are included including adjustments made for inequality, the valuation of domestic and voluntary labour, amplification of the welfare benefits of health and education and deductions made for social costs such as crime. The index also includes aspects of economic weren't discussed in the criteria; net international position and net capital growth. These may be of merit in indicating the resilience and sustainability of the city economy in terms of levels of investment and it's trade balance.³⁸

In terms of key sectors and levers for city transition the local environmental factors discussed above also contribute to this criteria. The index comprehensively incorporates the the relevance of sustainable transport patterns to a low carbon city economy. The adjustment for the costs of commuting, capture the loss of leisure time to time spent commuting, direct expenditure on car travel and public transport and the costs of road accidents.

In terms of quality and availability the index has received a score of low, mainly due to the significant resource that would likely be required to apply it to the city scale. Whilst there are some data quality issues such as the weakness in capturing trans-boundary environmental impacts, the comprehensiveness of the data points and the rigorous weighting procedure redeem the index to some extent for data quality.

Calculating an ISEW for the city may not be such an insurmountable challenge. A form of the ISEW named 'The Sustainable Prosperity Index' was developed for the Local Authority level by the consultancy firm *Regeneris* in 2007.³⁹ Although, it is noted by the authors of the R-ISEW that due to its calculation at a smaller geographical level, 'it uses a much reduced algorithm to the ISEW and must resort to estimated values for some data.'⁴⁰

In terms of national and international comparability, despite slight differences in data sources and methodologies ISEW's have been calculated at various national and sub-national levels, so comparisons could be made against these.⁴¹ Recently the US states of Maryland and Vermont have applied and are reporting on progress in their Genuine Progress Indicators.⁴² The monetary per capita welfare value is also highly communicable and comparable.

Conclusion

Of the indicators considered no 'off the shelf' indicator is available which fulfils the criteria well and for which up to date data is being calculated for the city. However, a number of the indices fulfil the criteria relatively well and could be calculated for the city with the application of some resource. Some indices fulfil certain aspects of the criteria better than others and decisions on which one to pursue will depend on prioritizing some criteria over others.

Of the indices with the highest overall scores The Sustainable Cities Index would require the least resource to obtain up to date data for the city. Comparability and benchmarking would be problematic as the index is a ranking system and the data for other cities is no longer being updated. The downsides are with regards to the data quality, specifically the contentiousness of the weightings given to certain indicators ,which make it a less robust measure of a low carbon economy. Nevertheless the cities progress against these indicators could be measured through tracking this index, providing additional information on the sustainability of the city.

Both the ELITE Cities tool and the R-ISEW are better indicators of a low carbon economy than the Sustainable Cities Index in terms of their degree of capture of the substantive categories of environmental impact, sustainable economic welfare and key city levers. But both require greater resource to obtain data and calculate for the city.

The ELITE-Cities tool is more comprehensive and less contentious. It also includes internationally derived benchmarks for comparability and tracking progress.

The R-ISEW is, by design, an indicator of sustainable economic welfare so surpasses other indicators on this criteria. The R-ISEW also aggregates the environmental and social indicators into monetary values using econometric techniques, which though not without it's issues, reduces potential criticisms of arbitrary weighting and produces a recognisable figure in the form of a per capita adjusted income which is highly comparable.

Decisions on which of these indicators will be developed and tracked by the MACF Low carbon Economy Steering Group will no doubt be determined by what resources are available and further debate regarding the relative importance of the criteria against which these indicators have been compared. Hopefully this report has contributed to illuminating the strengths and weaknesses of these indicators and will help to inform the development of an appropriate indicator for measuring low carbon economic development and sustainable economic welfare in the city.

- 1 *Manchester: A Certain Future* (2014) 'Annual Report 2014' p.8
<http://media.onthepatform.org.uk/sites/default/files/MACF%202014%20Report.pdf>
- 2 Ibid. p.18
- 3 Ibid. p.18
- 4 Ibid. 2014
- 5 Mike Berners-Lee , Warren Hatter, Claire Hoolohan, (2011) '*The Total Carbon Footprint of Greater Manchester* ' Small World Consulting http://www.agma.gov.uk/cms_media/files/gm_footprint_final_110817.pdf?static=1
- 6 Knox, H. (2013). *The Social and Cultural Dynamics of Total Carbon Footprinting in Greater Manchester*. Manchester: CRESC, University of Manchester. Retrieved from <https://thinkinglikeaclimate.files.wordpress.com/2015/06/total-carbon-footprinting-in-greater-manchester.pdf>
- 7 Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., ... Foley, J. A. (2009). A safe operating space for humanity. *Nature*, 461(7263), 472–475. <http://doi.org/10.1038/461472a>
- 8 Tim Jackson, (2009) *Prosperity Without Growth* Earthscan, London, Chapters 9 and 11
- 9 Joseph Rowntree Foundation: *Distribution of carbon emissions in the UK: Implications for domestic energy policy* <http://www.jrf.org.uk/publications/carbon-emissions>
- 10 Anna Coote, Jane Franklin and Andrew Simms (2010) '*21 Hours: Why a Shorter Working Week can Help us all to Flourish in the 21st Century*', New Economics Foundation <http://www.neweconomics.org/publications/entry/21-hours>
- 11 Tim Jackson and Peter A. Victor (2013) '*Green Economy at Community Scale*', Metcalf Foundation p.26-32 <http://metcalfoundation.com/wp-content/uploads/2013/10/GreenEconomy.pdf>
- 12 A composite index is an index that averages statistical changes in a large numbers of data points in order to summarize complex or multi-dimensional issues in a simple manner.
- 13 Robert Costanza, Carol Franco, Ida Kubiszewski, Philip Lawn., John Talberth, Tim Jackson, Camille Aylmer (2013), '*Beyond GDP: Measuring and achieving global genuine progress* ' *Ecological Economics* 93 57–68 <http://dematerialism.net/beyondGDP.pdf>
- 14 The ISEW is still a composite index but the way the component data points are normalized to give a monetary value and its origin as an alternative measure of national income mark it out as distinct from the other composite indices considered.
- 15 The Economist Intelligence Unit (2012) '*The Green City Index*', Siemens AG http://www.siemens.com/entry/cc/features/greencityindex_international/all/en/pdf/gci_report_summary.pdf
- 16 PWC and Demos (2012) '*Good Growth for Cities*' <http://www.pwc.co.uk/government-public-sector/good-growth/>
- 17 Nan Zhou, Gang He, Christopher Williams, David Fridley (2015) '*ELITE cities: A low-carbon eco-city evaluation tool for China* ' *Ecological Indicators* 48 448–456 <http://www.sciencedirect.com/science/article/pii/S1470160X14004269>
- 18 Forum for the Future (2010) '*The Sustainable Cities Index 2010*' <https://www.forumforthefuture.org/project/sustainable-cities-index/overview>
- 19 Tim Jackson, Nat McBride, Saamah Abdallah and Nic Marks , (2008) '*Measuring regional progress: regional index of sustainable economic well-being (R-ISEW) for all the English regions* ' New Economics Foundation http://ec.europa.eu/environment/beyond_gdp/download/factsheets/bgdp-ve-isew.pdf
- 20 The Economist Intelligence Unit (2012)
- 21 The Economist Intelligence Unit, (2012a) '*The European Green City Index*', Siemens AG http://www.siemens.com/entry/cc/features/greencityindex_international/all/en/pdf/report_en.pdf (Forms the basis for the other regional indexes.)
- 22 The Economist Intelligence Unit, (2012a) p.37
- 23 The Economist Intelligence Unit (2012) p.36 – 37 (This is likely to be an issue for the international comparability of any of the indexes considered.)
- 24 (The data source is ONS, presumably territorial emissions only) PWC and Demos (2011) '*Good Growth*' p.18 http://www.pwc.co.uk/en_UK/uk/assets/pdf/pwc_good_growth.pdf
- 25 Zhou et al. (2015) p.449 (It draws upon the many of the indexes considered alongside it here including The Green City Index and the Sustainable Cities Index.)
- 26 (Specific, Measurable, Achievable, Reportable, Time-bound)
- 27 For data sources see Table 3 in: Zhou et al. p.454
- 28 Lawrence Berkeley National Laboratory Website, China Energy Group, Energy Analysis and Environmental Impacts Division Webpage: <https://china.lbl.gov/tools/elite-cities>
- 29 Zhou et al. 2015 p.449
- 30 Forum for the Future (2010)
- 31 Ibid. p.27
- 32 Jackson et al. (2008)
- 33 For an overview of the evolution of the ISEW and GPI and their national and sub-national applications to date see: Costanza et al. 2013

- 34 Wen Z, Zhang K, Du B, Li Y, Li W (2007) 'Case study on the use of genuine progress indicator to measure urban economic welfare in China' *Ecological Economics* 63: 463– 475. Cited in: Jackson et al. (2008) p.11
- 35 Jackson et al. (2008) p.24
- 36 Costanza et al. (2013) p.66
- 37 Jackson et al. (2008) p.13
- 38 Ibid. p.13
- 39 Regeneris (2007) 'The Regeneris Sustainable Prosperity Index' (A link to the original report is no longer hosted on the consultancy website, but should be available upon request, tables of the components and the results are reproduced in: Commission for Rural Communities, 'State of the countryside 2008' Ch.3: 'Economic Well-being ' p.92 <http://www.rsnonline.org.uk/phocadownload/soc2008-3-economic.pdf>
- 40 Jackson et al. (2008) p.75 footnote n.56
- 41 Sources of some of the sub-national applications of the ISEW from Jackson et al. (2008):
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