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The Carbon Impacts of the Circular Economy

Summary Report

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Summary Report: The Carbon Impacts of the Circular Economy

1 Introduction

This project uses Scotland's ground-breaking Carbon Metric, as well as other peer reviewed research conducted by Zero Waste Scotland, to quantify the potential carbon impacts of a more circular economy in Scotland.

The report's key findings are:

1. **Material consumption** is responsible for over two thirds of Scotland's carbon emissions.
2. **A more circular Scottish economy** could reduce *territorial emissions* by 11 million tonnes CO2e per year by 2050 compared to BAU, while providing continued economic growth.
3. **Nearly 1 in every 5 tonnes** of material flowing through the Scottish economy is waste.
4. **Regardless of carbon accounting methodology** (*territorial* vs. *consumption*), a more circular could significantly reduce Scotland's carbon footprint without sacrificing economic prosperity.

The methodology used to arrive at these findings involved the creation of a baseline to assess the carbon impacts of Scotland's material consumption in 2012. This was subsequently used to compare the carbon impacts of four different economic scenarios for 2050, each characterized by different levels of material circularity. These 2050 scenarios do not predict the future; rather they have been designed to highlight the carbon reductions that could be possible with a more circular Scottish economy.

This project is the first attempt to quantify the carbon impacts of a circular economy in Scotland and is one of the first globally to quantify the environmental impacts of the circular economy at a national scale. Decision makers should consider the uncertainties which are inherent to any new area of study when drawing conclusions from the results. The analysis represents a bespoke approach, drawing on a life cycle thinking method to give an initial, high level description of the possible carbon impacts of a circular economy in Scotland. This life cycle approach could be built on and strengthened in the future, using input output analysis for example, to understand the potential impacts and opportunities of a more circular economy in greater detail.

2 What is the Circular Economy?

The way we obtain, use and dispose of material in Scotland has a significant impact on our national carbon footprint. Scotland's material economy today is predominantly linear – materials are extracted from the environment and enter the economy as resources, are manufactured into products, and eventually leave the economy as waste.

An alternative to this 'take, make and dispose' economic model is the circular economy, which uses smart product design, remanufacturing, repair, and reprocessing activities to keep products and materials circulating within the economy, thereby extracting maximum value from them. By recirculating products rather than disposing of them after use, the circular economy retains product and

Circularity: a Climate Change Solution

'By recirculating products rather than disposing of them after use, the circular economy retains product and material value much better than the linear economy we have today and as a result, reduces demand for both raw resource inputs and waste disposal, two activities with high carbon impacts.'

material value much better than the linear economy we have today, and as a result, reduces demand for both raw resource inputs and waste disposal - two activities with high carbon impacts.

3 Methodology

3.1 Creating a 2012 Baseline

The 2012 baseline was creating using Scottish material flows data on domestic production, imports, exports and waste management systems in order to estimate Scotland's direct material consumption for that year. The resulting 2012 material flow dataset was then combined with carbon emissions factors for material production and waste (adapted from the Scottish Carbon Metric[1]) to determine the carbon impact of Scotland's material consumption in 2012.

3.2 2050 Scenarios

Using the 2012 baseline, four economic scenarios for 2050 were created: 1) Business as Usual, 2) Resource Efficiency, 3) Limited Growth and 4) Circular Economy. As seen in Diagram 1, each scenario was designed to incorporate different levels of material production and consumption, expressed through variations in five economic drivers (Appendix A). These scenarios are not economic forecasts, but rather highlight the opportunity for carbon savings in a more circular Scottish economy.

- **Business as Usual (BAU) scenario –** production and consumption remain at high levels, continuing on from current trends.
- **Resource Efficiency (RE) scenario –** producers, retailers and other businesses reduce production impacts but consumers do not change their behaviours.
- **Limited Growth (LG) scenario –** businesses fail to adapt their resource use meaning production impacts remain high but consumption is limited by poor economic growth from rising resource scarcity and costs. This scenario is both unlikely and undesirable, however it has been included to highlight the correlation between economic growth and emissions that is typical of a linear economy, and underscore how in a circular economy, economic growth *and* emissions reductions are both attainable.
- **Circular Economy (CE) scenario –** both businesses and consumers embrace the benefits of altered design and new business models to adopt a more circular economy leading to a low material impact society.

Diagram 1. Matrix of the material production and consumption levels considered in 2050 scenarios

		Material and energy production impacts	
		HIGH	LOW
Consumption impacts	HIGH	Business as usual scenario	Resource Efficiency scenario
	LOW	Limited growth scenario	Circular economy scenario

[1] ZWS (2014) The Scottish Carbon Metric Technical Report
http://www.zerowastescotland.org.uk/sites/files/zws/ZWS369Carbon_Metric_Technical_Report2014_Final.pdf

3.3 Territorial vs Consumption Accounting

There are two different ways to measure the carbon impacts of economic activity – *territorial accounting* and *consumption accounting*. *Territorial accounting*, also known as *producer-based accounting*, centres on the idea of 'producer responsibility' – it only considers emissions *produced* within a region or country. Using *territorial accounting*, the emissions required to produce and transport imported products do not contribute to Scotland's carbon footprint, while those from Scottish exports do.

In contrast, *consumption accounting* is based on the idea of 'consumer responsibility'; it includes all the emissions resulting from *consumption*. Under *consumption accounting*, emissions required to produce imported products contribute to Scotland's carbon footprint, but the emissions from Scottish exports do not.

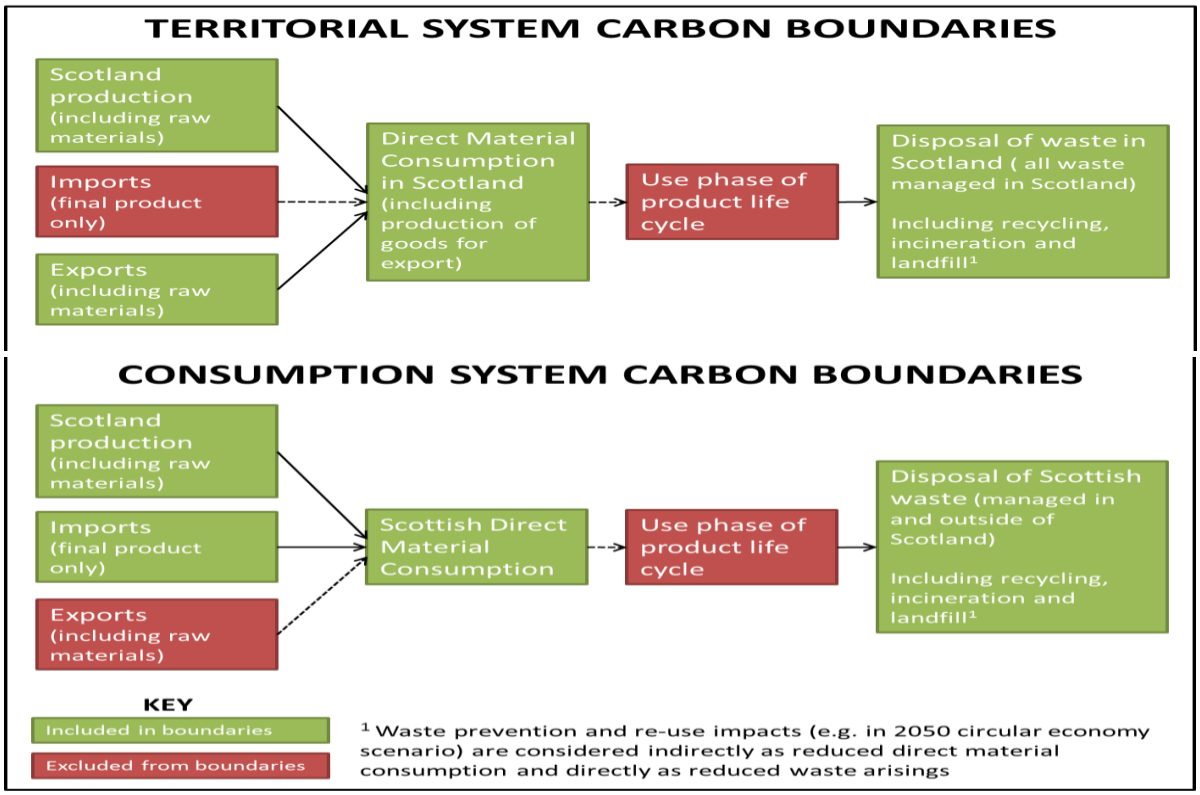
Regional Emissions vs. Global Emissions

'Using territorial accounting, a region's carbon footprint can decrease without reducing global emissions, simply by 'offshoring emissions.

'In contrast, consumption accounting includes all emissions resulting from consumption, regardless of where in the world they occur. This guarantees that any reduction in Scotland's consumption emissions also reduces global emissions.'

The distinction between territorial and consumption accounting methods is important when thinking about the global problem of climate change. Using *territorial accounting*, a region's carbon footprint can decrease *without* reducing global emissions, simply by 'offshoring emissions'. In contrast, *consumption accounting* includes all emissions resulting from consumption, regardless of where in the world they occur. This guarantees any reduction in Scotland's consumption emissions also reduces global emissions. While international climate change agreements like Kyoto have favoured territorial accounting, a better understanding of climate change issues means consumption accounting is possible. Diagram 2 illustrates the main boundaries of the two accounting systems.

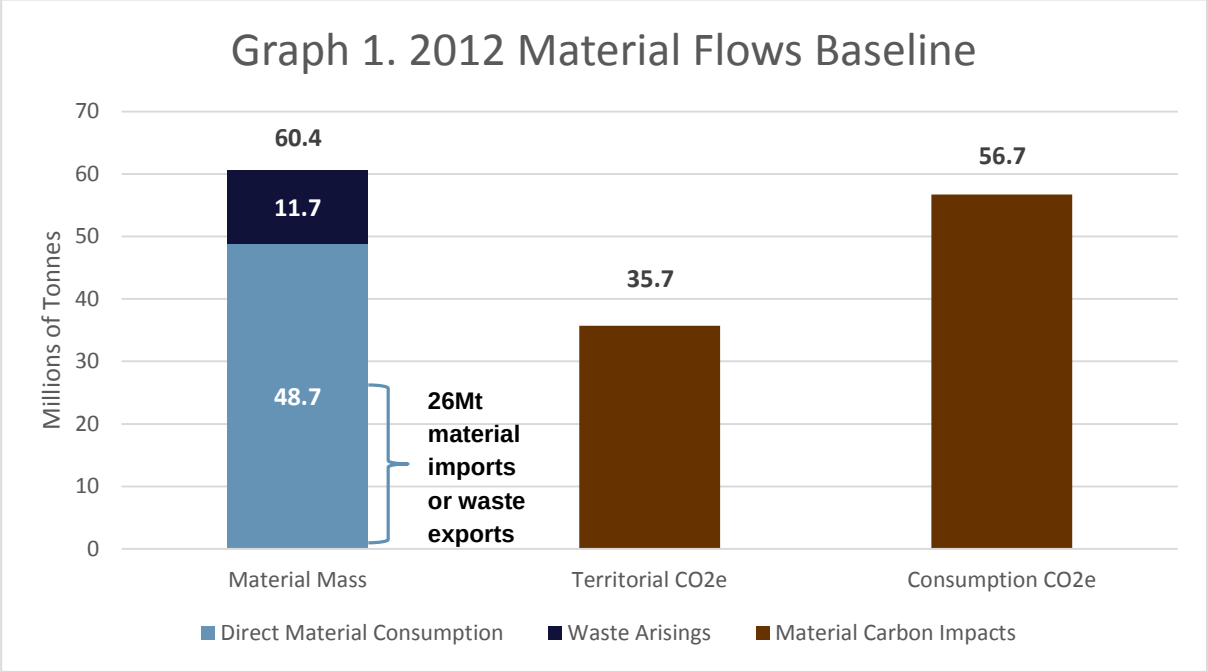
Diagram 2. System boundaries using territorial and consumption accounting



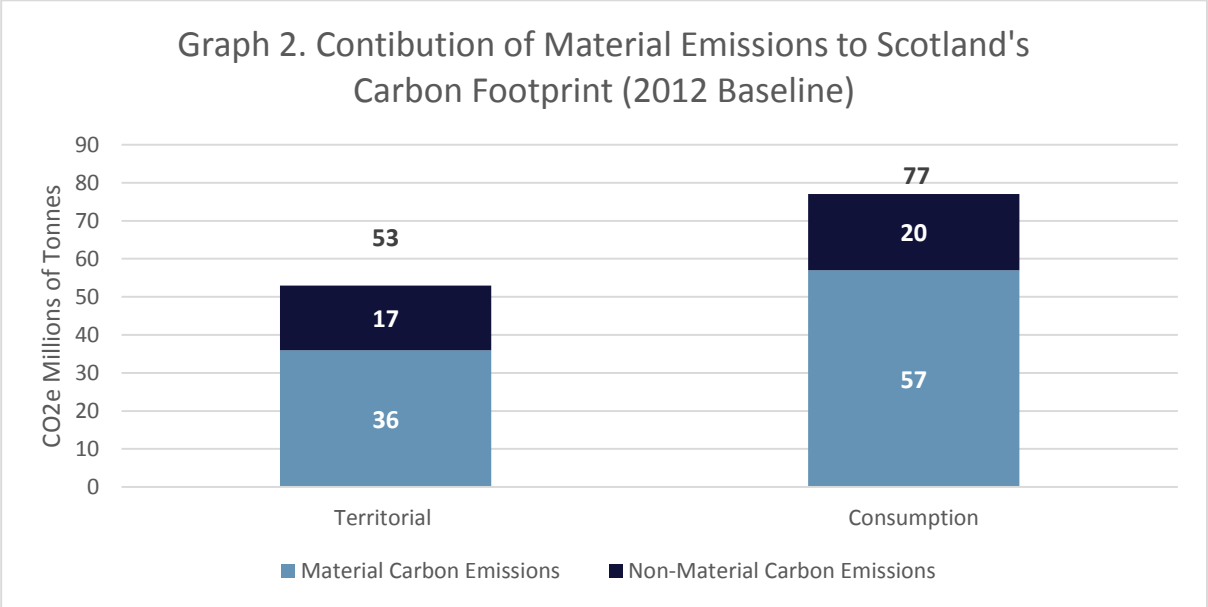
4 Results

4.1 2012 Baseline

Scotland's direct material consumption for 2012 is estimated at 60.4 Million Tonnes (Mt) or 11.4 tonnes per person, of which 26 Mt (43%) was either imported materials or exported waste. In total, 11.7 Mt, or 19% of all Scottish material flows in 2012 was waste (see Graph 1).

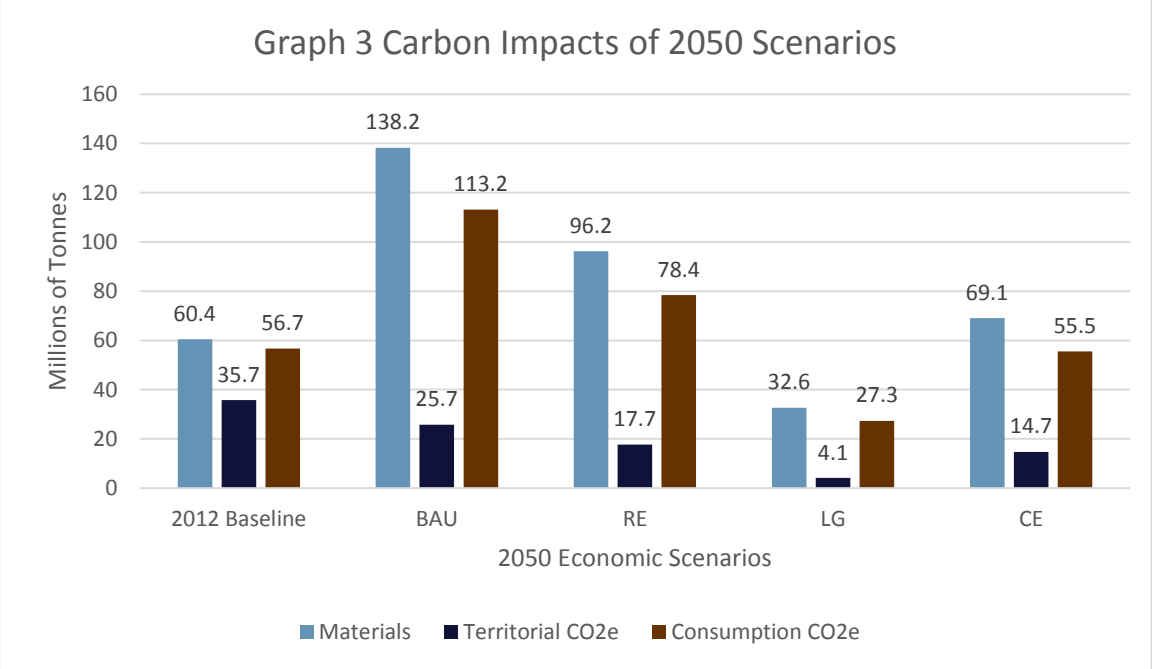


The carbon equivalent impact of Scotland's material consumption in 2012 accounts for the majority of the nation's overall emissions, whether using *territorial* (68%) or *consumption* (74%) *accounting* methods. Using *consumption accounting* however, Scotland's material carbon emissions and national carbon footprint are both much greater than under *territorial accounting* (see Graph 2) because the former includes the emissions associated with imported materials and exported waste, which together account for 43% of Scottish material flows.



4.2 2050 Scenarios

The results of the 2050 scenario analysis (see Graph 3) show that direct material consumption and its associated carbon impacts vary significantly depending on the different assumptions made about economic growth, material production and consumption, and changing import/export ratios. These findings also highlight the importance of carbon accounting methodology. Under BAU and RE scenarios, material consumption increases but via a continued and growing reliance on imports, resulting in falling *territorial emissions* but rising *consumption emissions*. In contrast, the LG scenario exhibits reduced territorial *and* consumption emissions, reflecting a decline in material consumption, a large increase in imports, and very low economic growth (0.2% a year). **Only under a Circular Economy scenario do material flows increase while both territorial and consumption emissions decline relative to 2012 levels, reflecting the economy's much greater resource efficiency**.



5 Discussion and Conclusion

This study has illustrated the significant contribution our material consumption makes to Scotland's overall carbon footprint. This is a new way of thinking about Scotland's material use, and one that reveals the substantial opportunity to achieve Scotland's climate change targets[2] through a more circular economy. Significant progress has been made in reducing overall waste volumes in recent years, however Scotland is still primarily a 'linear economy' and therefore produces significant amounts of waste each year; in 2012 just over 19% of material flows, or nearly 1 tonne of material out of every 5, was waste. There is an enormous

Wasted Opportunities

'Today in Scotland nearly 1 tonne of material out of every 5 is wasted… an enormous opportunity for improved circularity*'*

[2] The Climate Change (Scotland) Act 2009 sets targets to reduce Scotland's emissions of greenhouse gases by at least 42% by 2020 and 80% by 2050 compared to the 1990/95 baseline.

opportunity for Scotland to benefit from improved circularity, leading to emissions reductions, as well as new job creation[3].

Producing more while emitting less

'Only under a Circular Economy scenario do material flows increase and consumption emissions decrease relative to the 2012 baseline.'

5.1 Territorial vs Consumption Accounting

This study has illustrated how different carbon accounting methods can produce very different results. In Scotland, *territorial* accounting produces substantially lower carbon impact estimates than *consumption* accounting due to the large amount of material imports and waste exports (44% of total material flows). As Diagram 3 illustrates below, the carbon accounting method used also affects the relative contribution of individual materials to Scotland's carbon footprint. This has important policy implications since Scotland's current weight-based waste reduction targets are not designed to maximize emissions reductions from waste management.

Diagram 3. Top 5 Scottish material flows in 2012

Significance	Tonnage	Territorial carbon impact	Consumption carbon impact
1	Minerals	Food and plants	Food and plants
2	Construction material	Minerals	Minerals
3	Food and plants	Non-ferrous metal	Ferrous metal
4	Ferrous metal	Vehicles	Non-ferrous metal
5	Wood	Construction material	Textiles

5.2 The Carbon Impacts of the Circular Economy

Scotland's material consumption accounts for 68-74% of its entire carbon footprint. By producing and consuming materials more efficiently, a more circular economy could provide Scotland with substantial carbon emissions savings.

Using the *territorial accounting* method, a circular economy scenario in 2050 would produce an estimated 10.9 MtCO2e less than a BAU scenario, and 21 MtCO2e less than the 2012 baseline.

Under consumption accounting, savings would be 57.7 MtCO2e and 1.2 MtCO2e respectively.

Whilst a limited growth scenario could potentially reduce emissions even more than a circular economy scenario, this would require very low economic growth (0.2% annually). In contrast, a circular economy could deliver substantial emissions reductions and at the same time, strong and sustained economic growth for Scotland. These results suggest that in future, a more circular economy could play a key role in achieving Scotland's emissions targets; building on Scotland's existing climate change strategy: "Low Carbon Scotland – Meeting the Emissions Reduction Targets 2013-2027" (also known as the RPP2 report)[4].

[3] ZWS (2015) Circular Economy Evidence Building Programme: Remanufacturing Study. http://www.zerowastescotland.org.uk/sites/files/zws/Remanufacturing%20Study%20-%20Full%20Report%20-%20March%202015_0.pdf

[4] Scottish Government (2013) Low Carbon Scotland – Meeting the Emissions Reduction Targets 2013-2027 http://www.gov.scot/Topics/Environment/climatechange/scotlands-action/lowcarbon/meetingthetargets

6 Appendix

Driver	BAU 2050 impact	Resource efficiency 2050 impact	Limited growth 2050 impact	Circular economy 2050 impact
Economic growth and material consumption	Economic growth and material consumption grow at 2.2% annually	Economic growth of 2.0% annually. Material consumption reduced by 25% by 2050.	Economic growth of 0.2% annually. Material consumption reduced 50% by 2050	Economic growth of 2.2% annually. Material consumption reduced 50% by 2050
Proportion of materials imported	Slight increase in most imports (WRAP estimates)[5]		Large increase in most imports (double WRAP estimates)	Substantial reduction in imports (half WRAP estimates), offset by increases remanufacturing, product longevity and leasing models.
Decarbonisation of grid and transport	Domestic production and export carbon factors change in line with projections from UK Committee on Climate Change[6]. Imports remain unchanged.			
Waste management	Arisings reduced by 15% by 2017. Remaining waste managed 70% recycled or composted, 25% incinerated and 5% landfilled (In line with SSR[7] and ZW Regulations[8])		Arisings reduced by 65% (reflecting reduced consumption) and 70/25/5 mgmt. split.	Arisings reduced by 65% and 75/20/5 mgmt. split.
Proportion of recyclate exported	Same as 2012.			Substantially reduced for key materials.

[5] WRAP (2010) Securing the Future: the role of resource efficiency http://www.wrap.org.uk/sites/files/wrap/Securing%20the%20future%20The%20role%20of%20resource%20efficiency.pdf

[6] Climate Change Committee (2010) The Fourth Carbon Budget – reducing emissions through the 2020s http://www.theccc.org.uk/publication/the-fourth-carbon-budget-reducing-emissions-through-the-2020s-2/

[7] Scottish Government (2013) Safeguarding Scotland's Resources http://www.scotland.gov.uk/Publications/2013/10/6262/downloads

[8] Scottish Government (2012) The Waste (Scotland) Regulations http://www.legislation.gov.uk/sdsi/2012/9780111016657/contents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