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United Kingdom

Counting consumption

CO_2 emissions, material flows and Ecological Footprint of the UK by region and devolved country

Biffaward Programme on Sustainable Resource Use

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Foreword

Every generation has new challenges to face, and sometimes these challenges are so great that they quite simply define our time.

Living in a world with environmental limits will define ours. Never before have we had to face such enormous unintended consequences of our past endeavours: consequences that are global in scale and which will require united global effort to address.

Preventing a 2°C rise in the global average temperature will be hugely challenging. It will require steering humanity on a new course that is as much about change and transformation in economies and markets as it is in our own lives and behaviour. The consensus now is not about whether we should or could change the way we live, but of the more urgent and immediate questions of when, how and at what cost?

We cannot embark upon such a transformative journey unprepared. To bring the vision of a One Planet Economy – as set out in the government Sustainable Development Strategy – into reality, we need to understand the connection between our lifestyles, the goods and services that underpin them, and the real impacts on the planet such as the use of material resources and energy.

Ecological Budget UK is a giant step in this direction. By providing the most comprehensive analysis yet attempted, it helps us to track materials, CO_2 and our Ecological Footprint through every form of production and consumption of the UK economy by industrial sector, geographical area and socio-economic group. Understanding the relationship between the economy and the environment on which it is based is a prerequisite if we are to move towards sustainability.

I urge the UK government carefully to consider this analysis, and to use it as one part of the evidence base for creating policy and fiscal frameworks which support the long-term transformation of the economy. In moving to a sustainable future, we will need to pay as much attention to the stocks and flows of materials and energy as we now do to the stocks and flows of money.

Andrew Lee

Director, Sustainable Development Commission

Executive summary

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Ecological Budget UK provides a much needed evidence base to better understand the important issues of Sustainable Consumption and Production (SCP). It provides a statistical and scientific basis for SCP strategies in the UK at national and regional levels. It shows the total global impact of UK consumption, not only by accounting for direct resource flows and emissions within the UK, but also by including the manufacture of imported products and materials. Ecological Budget UK's three headline indicators – CO_2 emissions, material flow analysis, and the Ecological Footprint can be used together or side-by-side for different purposes.

The Ecological Budget UK has produced the following headline results.

Material flow

- The total material input is 15.2 tonnes per person (also described as tonnes/capita or t/cap).
- Of this total, 26 per cent comes from imports.
- The average household directly purchases 2.5 tonnes a year and throws away a tonne of waste each year.
- 35 per cent of all material goes to capital stocks (new buildings, roads and other infrastructure).
- 21 per cent of all material is exported.
- 37 per cent of all material ultimately ends up as waste.

Ecological Footprint

- The total Ecological Footprint per person in the UK is 5.4 global hectares (an area equivalent to a normal hectare but adjusted for average global productivity).
- The highest footprint of all devolved administrations and English regions is the South East at 6.3 global hectares per person.
- The lowest footprint of all devolved administrations and English regions is Wales at 5.2 global hectares per person.
- If the footprint was to be distributed evenly among the global population, the UK is currently overshooting that by a factor of three. In other words, if everyone lived like we do in the UK, we would need three planets to support our current lifestyles.

CO_2 emissions

- The total carbon emissions from UK production is 10.8 t/cap.
- The total carbon emissions from UK consumption is 11.9 t/cap.
- The total carbon emissions in imports for consumption is between 10 and 30 per cent of the total UK emissions.
- In terms of carbon emissions, the most resource intensive sectors are the cement industry followed by electricity generation.
- The most indirectly resource intensive sector is banking and finance.
- The consumption type with the highest impact is domestic energy consumption followed by car use.
- The consumption type with highest impact per £ spent is electricity generation.

This baseline report concludes that it would require three planets to support the world's consumption if everyone used as many of the Earth's available resources ("bio-capacity") as the average UK resident. This level of resource use is unsustainable, and demonstrates the need for a 'One Planet Economy' – an economic system of production and consumption which respects environmental limits while being financially and socially sustainable. A One Planet Economy will require a 75 per cent reduction in resource flows and the Ecological Footprint – this is commonly known as a Factor Four reduction. This is a hugely challenging target.

But it is essential to long-term sustainability, even if achieved at the distant horizon of 2050. A Factor Four reduction in resource consumption means a year-on-year reduction of -3 per cent in resource flows and Ecological Footprint. Set against an economic growth rate averaging 2.25 per cent per year, this implies 'decoupling' economic and material growth at a rate of -5.25 per cent per year – over twice the rate seen in recent years.

One of the key outputs of the Ecological Budget UK project, the Resources and Energy Analysis Program (REAP), provides an essential contribution to the UK policy evidence base. Following the launch of this report, a five year programme of research and development is now taking shape. This includes a contribution to the evidence base for the One Planet Economy:

- national material/energy accounts and budget implications, to be shown alongside the fiscal and monetary budget, on an annual basis;
- a full breakdown of direct, external, embedded and induced impacts of economic activity, using CO_2, material flow analysis, Ecological Footprint analysis and other appropriate measures;
- an investigation of key supply chains (e.g. construction, chemicals) for their total environmental costs and benefits on a life cycle/risk management basis;
- an investigation of critical policy options (e.g. nuclear power) for the total environmental costs and benefits on a life cycle/risk management basis.

Ecological Budget UK has taken the first step in understanding how the decisions we take every day affect the environment around us. It is an essential step in creating a platform to enable us to move from the current UK 'three planet economy' to a One Planet Economy.

1 Learning to count:

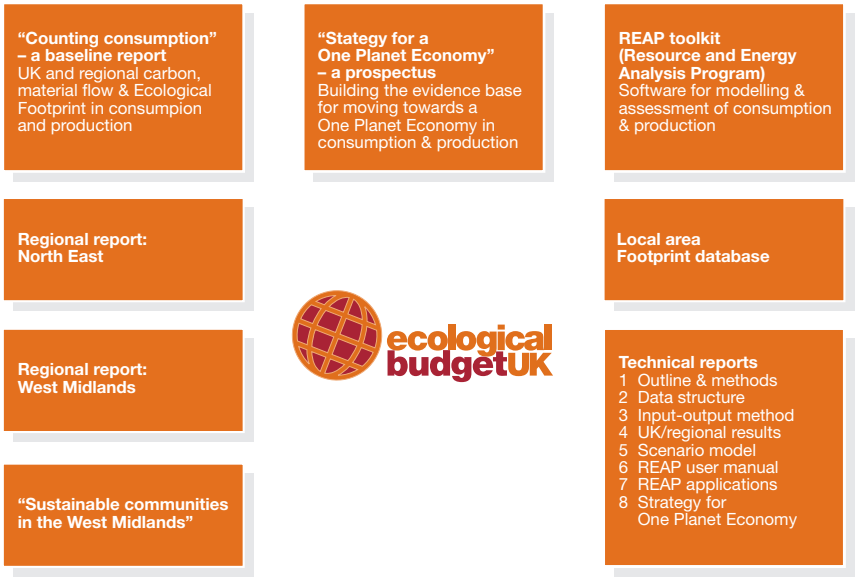
The Ecological Budget UK project

If everyone on Earth had the same consumption patterns as the average UK resident, humanity would need the resources of three planets to support itself. Many government policy-makers, scientists, businesses and citizens are aware of this, and share an interest in moving towards a more sustainable and equitable use of the planet's natural resources.

Sustainable development – development that meets the needs of people today without compromising those of future generations – is now an urgent necessity. However, accurate standardised measures are required if the UK's impact on nature is to be determined reliably. Recognising this, the Department for Environment, Food and Rural Affairs (Defra) has called for environmental policy decisions to be based on sound evidence that can be tested for validity, consistency and robustness.

However, like most other countries, the UK has so far had no comprehensive understanding of which countries, regions, sectors and activities contribute to its environmental impact. Which activities contribute most to CO_2 emissions? Where do resources come from or end up? What are the environmental impacts of trading with other countries? This missing information is crucial if we are to develop sound sustainable consumption and production strategies and policies for the UK.

The Ecological Budget UK project not only provides this much needed evidence base, but also offers a way to measure core requirements for sustainability. The UK Sustainable Development Strategy itself raises the idea of a One Planet Economy; Ecological Budget UK provides the detail and the measuring stick for this.



Ecological Budget UK: a route map

The project has four main outputs:

1 This **current baseline** report summarises national and regional results – a comprehensive set of physical accounts (CO_2 emissions, the Ecological Footprint, and material flow analysis) that reflect the global impacts of resource consumption. Although not a full exposition of the methodology, it does show some of the most important applications. For those interested in a more technical treatment of Ecological Budget UK and resource accounting than is available in this summary report, see the eight full technical reports and publicly available spreadsheets at www.ecologicalbudget.org.uk.

2 **Strategy for a One Planet Economy** is a prospectus for continuing research on the question of how to steer the UK economy towards a One Planet Economy. It provides a demonstration and research programme for a more joined-up system of national accounts, a One Planet Economy comprehensive spending review, and One Planet Economy strategies for each sector of production and consumption.

3 **REAP** (Resource and Energy Analysis Program) is the project's software application. It enables interactive access to Ecological Budget UK's resource accounting data and can assess future scenarios and policy options in terms of sustainability. You can learn more about REAP at www.sei.se/reap

The Ecological Budget UK project was funded by Biffaward and regional partners and jointly fulfilled by WWF-UK, the Stockholm Environment Institute and the Centre of Urban and Regional Ecology at Manchester University.

"The Ecological Budget UK project is a huge advance in measuring the effect of UK consumption"

4 There are also regional applications of the Ecological Budget UK in the North East and West Midlands; an analysis of "sustainable communities" in urban regeneration in the West Midlands; and a parallel project in the North West which focuses on the benchmarking of business sustainability.

Why is the Ecological Budget UK project important?

The Ecological Budget UK project is a huge advance in measuring the effect of UK consumption, providing a statistical and scientific basis for sustainable production and consumption strategies in the UK at national and regional levels. Currently, national and regional agencies do not have a reliable and comparable measure of the impacts of their resource consumption. This report demonstrates how those measures can be constructed and used in policy-making, and the project features many unique advances.

It shows the total global impact of UK consumption, not only by accounting for direct resource flows and emissions in the UK, but also by including the manufacture of imported products and materials. Ecological Budget UK's three headline indicators – CO_2 emissions, material flow analysis, and the Ecological Footprint – can be used side by side for different purposes.

Ecological Budget UK's three indicators all show the indirect effects of consumption along with the direct effects, both upstream and downstream of any sector or product. This is particularly relevant in the UK's service-dominated economy, where the effects of resource consumption are often hidden through offsite supply chains. These indicators enable comparisons between the production side of the economy (including exports) and the consumption side (including imports). Since sustainability involves consumption as well as production, a full environmental trade balance such as this is essential.

The indicators presented here also show detailed differences between the resource flows and Ecological Footprint of local authorities and different social groups.

We suggest that the Ecological Budget UK provides the reliable measure of human demand on nature that the UK government has called for in chapter 3 of its Sustainable Development Strategy, and we believe that this knowledge can and should be applied directly to policy.

What does Ecological Budget UK suggest?

This baseline report concludes that it would require three planets to support the world's consumption if everyone used as many of the Earth's available resources ("biocapacity") as the average UK resident. This level of resource use is unsustainable, and demonstrates the need for a One Planet Economy – an economic system of production and consumption which respects environmental limits while being financially and socially sustainable. A One Planet Economy will require a 75 per cent reduction in resource flows and the Ecological Footprint: this is commonly known as a Factor Four[1] reduction.

This is a hugely challenging target. But it is essential to long-term sustainability, even if achieved at the distant horizon of 2050. A Factor Four reduction in resource consumption means a year-on-year reduction of -3 per cent in resource flows and Ecological Footprint. Set against an economic growth rate averaging 2.25 per cent per year, this implies decoupling economic and material growth at a rate of -5.25 per cent per year – more than twice the rate seen in recent years. This reality is the theme of the accompanying Strategy for a One Planet Economy, which suggests the next steps for government, consumers and businesses.

1 Von Weizacker, E., Lovins, A.B. & Lovins, L.H., 1997, *Factor Four: Doubling Wealth, Halving Resource Use – A Report to the Club of Rome*, London, Earthscan.

2 Sustainability policy and Ecological Budget UK

The concept of Sustainable Consumption and Production (SCP) was first highlighted at the Earth Summit in 1992. More recently, the UK government's framework for SCP has restated its commitment to address development needs and quality of life issues in ways that respect environmental limits. This chapter outlines how the Ecological Budget UK project supports this agenda.

Ecological Budget UK developed a number of indicators to contribute evidence to the UK Sustainable Consumption and Production (SCP) Framework. It developed detailed material flow accounts, and carbon dioxide and Ecological Footprint accounts by sectors and regions, to understand how policy intervention can contribute to the goal of a One Planet Economy. These results can be found in chapter 3. For a full account of what Ecological Budget UK contributed to the material flow analysis, CO_2 and Footprint accounts, see Appendix. Below we have described how our work relates to specific policy areas in the UK SCP Framework. Chapter 6 takes this further by looking at the policy levers to achieve a One Planet Economy by analysing the supply chains in consumption and production for two key sectors.

The concept of SCP was initiated at the United Nations Conference on Environment and Development (UNCED) in 1992. It is rooted in the acknowledgement that many of today's most pressing global environmental problems, such as climate change, biodiversity loss and deforestation, are associated with the sheer volume of resources used in developed countries such as the UK[1]. With the establishment of its framework for SCP,[2] the UK government has restated its commitment "to deliver continuous economic and social progress that respects the limits of the Earth's ecosystems, and meets the needs and aspirations of everyone for a better quality of life now and in the future".[3]

The Resource and Energy Analysis Program (REAP) model has three unique features which make it suitable to address SCP:

- analysis of total impacts of consumption to meet final demand, not only the emissions and resource use, in the UK;
- analysis of inter-dependencies between sectors and supply chains, which show market transformation effects in the round; and
- analysis of material flow at regional and local authority levels, enabling a closer connection with regional and local policies.

The REAP system of accounting opens up new possibilities in comprehensive analysis of global impacts (see Figure 1):

- the "internal" UK emissions accounts at present include only emissions from energy conversion within the UK, as specified by the Kyoto Protocol and its accounting conventions;
- an "extended" account includes aviation and international shipping to and from the UK, which are the fastest growing emissions sources. This wider boundary has been analysed by the Tyndall research below;
- an "embodied" account then tracks the goods and products produced overseas and consumed in the UK (this is the logic of the consumption-based approach); and
- an "induced" account aims to measure the ultimate environmental and social damage, in terms of deforestation, desertification, etc. These effects are often more uncertain and more indirect, but no less important. The Ecological Footprint is increasingly popular as a measure because it has the potential to reflect this more global view, even though its calculations are less certain.

To demonstrate the application of REAP to the UK's SCP framework, its potential contribution to seven key policy areas of the framework has been identified below.

Products
Strengthening UK and international measures to improve the environmental perfomance of products and services, including improved product design.

Production
Improve resource efficiency and reduce waste and harmful emissions across business sectors.

Consumption
Influence consumption patterns, including proposals for new advice for consumers.

Procurement
Sustainable procurement in the public sector to make the UK a leader within the EU by 2009.

Innovation
Support for innovation to bring through new products,materials and services.

Sustainable business
Increase transparency, corporate responsibility and skills in business and other organisations.

Waste
Increased emphasis on reducing waste at source and making use of it as a resource.

1 UN, 1992, Agenda 21, New York.
2 DTI and Defra, Sustainable Development Strategy, 2003 (available from www.sustainable-development.gov.uk).
3 ibid, p6.
4 One Planet Development Strategy, available from www.ecologicalbudget.org.uk

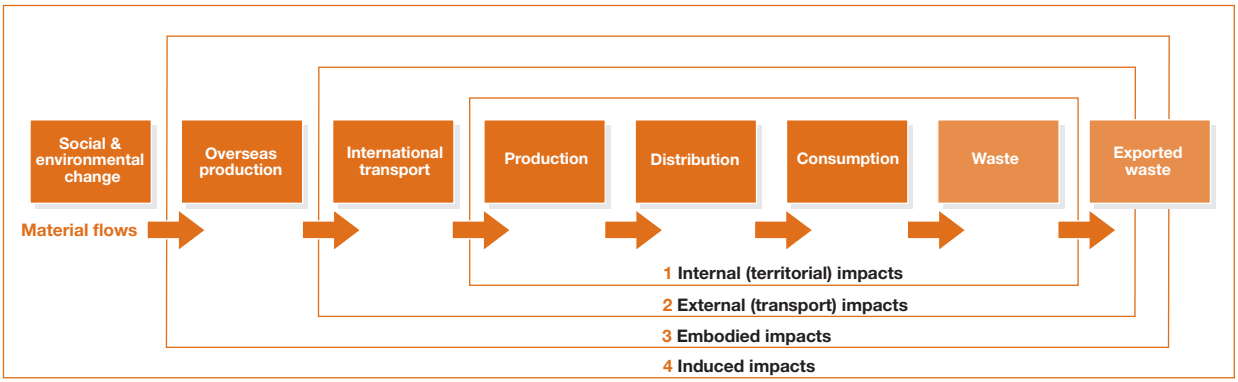


Fig 1 **Measuring the external impacts of regions**

Products

SCP policy: Strengthening UK and international measures to improve the environmental performance of products and services, including improved product design.

The REAP program shows improvements in performance by changing consumer demand for energy, and the direct and indirect performance of service sectors. On a number of fronts, better performance may or may not be enough to counteract increasing consumption. For instance, a refrigerator may become twice as efficient, but have no gain in efficiency, if it is twice the size. For some products, most impact occurs during the production phase and others in the use phase. REAP has the ability to identify where in the supply chain a product's impact lies, thereby providing valuable insights to improve product efficiency.

Production

SCP policy: Improve resource efficiency and reduce waste and harmful emissions across business sectors.

The Ecological Footprint is a valuable measure of energy and material intensity in production. So far, gains in technological efficiency have just kept pace with rises in consumption. With a detailed understanding of the direct and indirect material and energy use of production patterns in the UK, Ecological Budget UK data can highlight where intervention can be made to achieve the greatest improvement. The need for capturing impacts across the entire upstream and downstream supply chain is of particular importance and has been noted in the Guidelines of the Global Reporting Initiative (GRI) and by the World Business Council on Sustainable Development. Ecological Budget UK has made a major step in understanding this down to the sectoral level.

Consumption

SCP policy: Influence consumption patterns, including proposals for new advice for consumers.

One of Ecological Budget UK's strengths is that it has provided the most detailed analysis of the environmental consequences of consumption in the UK to date. The data is organised by the standard consumption classification system (COICOP) and gives room for a number of analyses helping to combine expenditure data with environmental impacts and social welfare issues. The Ecological Footprint also has great potential to raise awareness, but it remains to be seen to what degree people will change their consumption habits.

Procurement

SCP policy: Sustainable procurement in the public sector to make the UK a leader within the EU by 2009.

REAP can analyse procurement choices. Increasingly, as public services are privatised, the first objective for the public sector is to minimise short-term costs which can work against attempts to invest in sustainable procurement. As a good test of the REAP toolkit, the Sustainable Development Commission has commissioned SEI to explore the CO_2 Footprint of the education sector. Again, the fact that REAP can consider both the direct and indirect flows of procurement is a considerable advancement with significant policy application.

Research

A technical description of the research undertaken for the Ecological Budget UK project can be found in the Appendix.

Innovation

SCP policy: Support for innovation to bring through new products, materials and services.

While not directly highlighting the barriers that exist in achieving resource efficiency gains in new products, Ecological Budget UK does benchmark the average performance of a sector, allowing comparisons to be made with new products entering the market.

Sustainable business

SCP policy: Increase transparency, corporate responsibility and skills in business and other organisations.

This is clearly essential; government alone cannot bring about sustainable consumption and production. To help with this, the REAP toolkit provides evidence about industry and raw material supply chains, the effects of innovation, performance benchmarking and so on. Combined with future work on structural path analysis, information from Ecological Budget UK can help unravel a company's supply chain. This provides extensive detail of the impact of sector or company activities. In the case of a company, control over the input procurement process then provides the possibility of substituting impact-intensive suppliers with more sustainable suppliers.

Waste

SCP policy: Increased emphasis on reducing waste at source and making use of it as a resource.

The One Planet Development Strategy[4] shows that this needs a comprehensive market transformation programme in each key sector. Combining waste data with resource input data helped identify resource-greedy sectors and establish where noteworthy changes can be made.

3 National results:

Ecological Footprint, CO_2 emissions and material flow analysis

The Ecological Budget UK project analysed the Ecological Footprint, CO_2 emissions and material flows of the UK. Each of these indicators is an important measure of resource flows in the UK economy and offers an insight into how the economy impacts upon the global and local environment. Below is a summary of the results of each indicator.

Ecological Budget UK indicator 1: CO_2 emissions

The UK interacts with the rest of world through trade – exchanging resources, services, cultures and ideas. In terms of resources, this means importing more than 230m tonnes of materials and products and exporting 193m tonnes, exchanging resources with most countries in the world. CO_2, emitted when most of these materials and products are produced, contributes significantly to climate change – a fact which is undisputed in the published scientific literature. Highlighted by key political figures in the UK as one of the greatest threats to mankind, climate change has risen up the political agenda. The Kyoto Protocol demonstrates a global consensus that action to reduce CO_2 emissions is a priority.

If they are to be reduced, it is important to monitor and measure CO_2 emissions and which human activities cause them. At present, the government measures CO_2 physically emitted within the UK's boundaries, as specified by the Reporting Convention of the COP (Consumption according to Purpose). The indicator can be described as "territorial emissions" or "emissions from production". The Ecological Budget UK CO_2 indicator also estimates emissions from consumption as well as production. Figure 1 juxtaposes these two methods of allocating emissions.

Emissions from production include all CO_2 emissions from goods and services produced in the UK wherever they are consumed (either in the UK or exported).

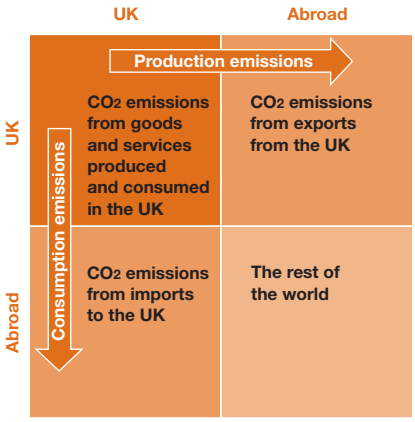


Fig 1 **CO_2 emissions from consumption and production**

This measure does not take into account import-related emissions. The "emissions from consumption indicator" includes the emissions from goods and services consumed within the UK, wherever they come from (UK goods and services produced + imports – exports). While including import-related emissions in the estimation procedure, this indicator excludes export-related emissions.

Each approach has a different application and there are, of course, advantages and disadvantages to both. The production indicator can help pinpoint the drivers behind changes in emissions rooted in the way the UK provides its goods and services to final consumers across the world, while the consumption indicator can help to identify drivers behind changes in the worldwide impact of emissions from the UK's consumption patterns. Both indicators are required to enable informed decisions, more efficacious and fair policies, and more specific abatement strategies.

Hypothetically, one way to reduce CO_2 emissions from production (territorial emissions) would be to close down all UK manufacturing, shift it to other countries, then import the goods and services that the UK consumes. However, although this would eliminate many emissions from production, it would do nothing to curb total global emissions (due to continuing consumption). To a much lesser degree, this pattern has occurred within the UK as its economy has shifted from heavy industry towards services – a sector which, more than any other, depends on indirect, "hidden" resource flows far away from its final consumed product.

The current absence of a "CO_2 emissions from consumption" indicator is a shortcoming of present UK monitoring approaches, which Defra has recognised. The Department is working with the Stockholm Environment Institute to identify the most appropriate approach to constructing such an indicator for the UK. It is essential that a CO_2 indicator that accounts for trade and overall consumption be included in the UK's headline indicators for sustainable development.

At present, there is no commonly accepted method for calculating embodied CO_2 emissions of imports. Most frequently, these embedded emissions are estimated based on the assumption that imports are produced with the same economic structure and the same resource efficiency as in the UK. Considering that many goods and services come from regions of the world where resource efficiency is lower (and therefore emission intensities are higher than in the UK), there is a wide consensus that ignoring different production technologies results in an under-estimation of the overseas impact of UK consumption. Therefore, some authors[1,2] have proposed models that use specific information about production processes and efficiencies in other countries. In order to establish a robust indicator for calculating import-related CO_2 emissions, Defra has

Fig 2 **CO_2 emissions from consumption and production**

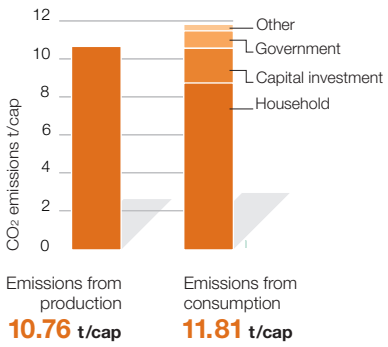
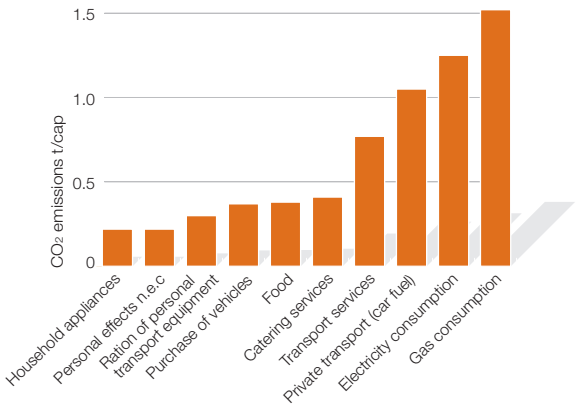


Figure 2 shows the difference in CO_2 emissions from consumption and CO_2 emissions from production. The difference is due to trade of goods and services that emits CO_2 in their production.

Fig 3 **UK household CO_2 emissions from consumption**



commissioned SEI to review existing approaches and to propose an appropriate estimation framework. This work is continuing.

Recognising that it is insufficient to use only national data for calculating the CO_2 emissions embodied in imports and the current lack of a standard procedure for doing it differently, SEI is adopting a careful estimation approach by taking an average of a lower and a higher bound estimate of models that use specific information of the different world regions. The lower bound estimate accounts for specific resource efficiencies of 12 economic sectors in eight world regions.[3] The higher bound estimate of import-related emissions is taken from the National Footprint Accounts.[4] Therefore, at first stage there is still significant uncertainty of the scale of issue. Some analyses suggest a "CO_2 from consumption" indicator is 30 per cent higher than the UK territorial emissions, while others suggest a very small variation.

Employing the methodology described above, Figure 2 shows the difference of CO_2 emissions from consumption and those from production. The difference is due to trade of goods and services that emit CO_2 in their production.

More than 636m tonnes of CO_2 are emitted in the UK. On the other hand, UK consumption causes 703m tonnes of emissions, both within the UK and in the rest of the world. This is 11 per cent higher than emissions from production. Household activities are the single largest contributor to CO_2 emissions from consumption. Figure 3 provides a breakdown of what kinds of household activities contribute most to the UK's emissions from consumption.

In households, the consumption of gas and electricity is responsible for 23 per cent of total CO_2 emissions. This is closely followed by personal transport use. Emissions from car purchase, use, maintenance and repair, and all public transport, account for 21 per cent of total emissions (most being from cars). These two key categories represent nearly 50 per cent of total emissions from consumption. Food contributes significantly to CO_2 emissions from consumption. Combining eating out and food purchased for consumption at home accounts for more than 7 per cent of emissions.

Onsite vs. offsite production of CO_2

Because industries trade goods and services with each other in the process of producing goods for final demand, it is possible to distinguish between onsite production emissions (CO_2 emitted directly from an industry's production centres) and offsite production emissions (those emitted elsewhere to provide goods or services for a particular production industry). It is important to note that offsite emissions take into account sectoral interdependencies between industries in their production processes.

In Figure 4, column 1 displays the onsite CO_2 emissions of different industrial sectors. As may be expected, onsite carbon releases from the energy sector are the most significant, amounting to 179m tonnes, followed by the transport sector with 114m tonnes and metal manufacturing with 72m tonnes.

Column 2 reflects the interdependencies of industries, and takes into account the industrial supply chains (and resulting CO_2 emissions) that provide materials for production of particular goods or services. The measure assigns emissions to the final product or service at the end of the chain. This is called a "lifecycle" perspective, and accounts for all relevant onsite and offsite CO_2 flows required to provide for the final deliveries of the various industrial production sectors. Another way to put it is that a lifecycle measure of CO_2 from production only measures the carbon emitted from the final product delivered to individual consumers.

Measuring CO_2 onsite versus measuring CO_2 in terms of lifecycle emissions of a product (including offsite emissions) considerably changes the total emissions assigned to each sector. For instance, once the energy sector is held responsible only for the emissions it triggers by delivering energy directly to consumers, its CO_2 account drops to 77m tonnes. This is a considerable reduction of more than 100m tonnes, and in terms of lifecycle CO_2 emissions from production makes the transport sector the single largest CO_2-emitting sector – around 84m tonnes.

Emissions no longer allocated to the energy sector (in this case) are re-allocated to the other industrial sectors that use energy to produce their final goods and services. While the energy industry's lifecycle emissions are smaller than its onsite emissions, the opposite is true for most service industry sectors – wholesale and retail trade, construction and finance ("financial intermediation") for example. While the finance sector emitted only 1.6m tonnes of CO_2 from its own sites, it caused

1 Harris, R., 2000, "Methodologies for estimating the levels of atmospheric emissions arising from the production of goods imported into the UK", ONS Eurostat contract No.: 97/09/57/013 Part 1. London, Office for National Statistics.

2 Lenzen, M., Pade, L.L. & Munksgaard, J., 2004, "CO_2 Multipliers in Multi-region Input-Output Models", *Economic Systems Research, 16:391-412 pp.*

3 Wiedmann, T., Moro, M., Hammer, M. & Barrett, J., 2005, "National and Regional Physical Accounts (Material Flows) for the United Kingdom". *REAP Report No. 4*, Resources and Energy Analysis Program, Stockholm Environment Institute, York, November 2005. Available at www.ecologicalbudget.org.uk

4 Wiedmann, T., Minx, J., Barrett, J., Wackernagel, M., 2006, "Allocating Ecological Footprints to Final Consumption Categories with Input-Output Analysis", *Ecological Economics 56, 2006, 28-48.*

Code	Industry	CO_2 emissions from production (measured on-site)	Lifecycle CO_2 emissions from production (taking into account off-site emissions & trade between industries)	The difference
1-2	**Agriculture**	8.85	8.03	0.81
3	**Fishing**	3.27	1.17	2.10
4-5	**Mining of energy producing materials**	26.07	11.06	15.00
6-7	**Other mining**	2.79	4.45	1.65
8-20	**Food**	17.27	26.73	9.46
21-28	**Textiles**	9.61	12.90	3.29
29-30	**Leather**	1.10	1.21	0.11
31	**Wood**	6.60	1.43	5.17
32-34	**Paper**	23.61	9.96	13.65
35	**Petroleum products**	22.51	15.23	7.27
36-46	**Chemicals**	61.09	36.34	24.75
47-48	**Rubber & plastics**	24.34	10.24	14.10
49-53	**Other non-metal mineral products**	18.98	6.25	12.72
54-61	**Basic metals**	71.91	34.66	37.24
62-68	**Machinery**	30.76	40.58	9.82
69-76	**Electricals**	34.31	41.83	7.52
77-80	**Transport equipment**	31.32	51.90	20.58
81-84	**NEC**	43.72	37.15	6.56
85-87	**Electricity, gas and water supply**	179.07	76.80	102.27
88	**Construction**	6.17	37.83	31.66
89-91	**Wholesale and retail trade**	12.33	69.92	57.58
92	**Hotels and restaurants**	2.62	32.35	29.73
93-99	**Transport, storage & communication**	113.81	84.06	29.74
100-102	**Financial intermediation**	1.58	18.81	17.23
103-114	**Real estate**	6.50	28.89	22.38
115	**Public administration & defence**	9.96	32.28	22.32
116	**Education**	5.87	16.52	10.65
117-118	**Health & social work**	7.25	26.13	18.88
119-122	**Other community activities**	7.61	16.12	8.51
123	**Private households with employed persons**	-	-	-
	Total	790.99	790.99	-

Fig 4 **Onsite and "lifecycle" CO_2 emissions from production, by industrial sectors (millions of tonnes) 2001**

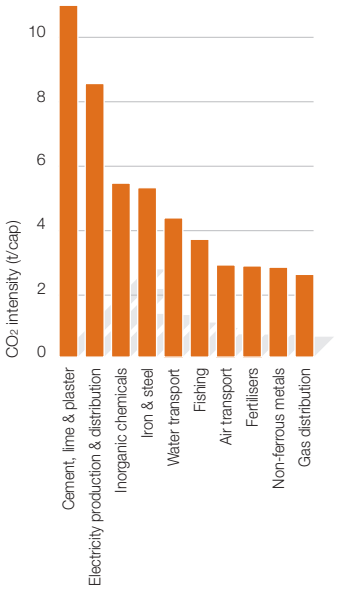


Fig 5 **Top ten shares of offsite CO_2 intensities**

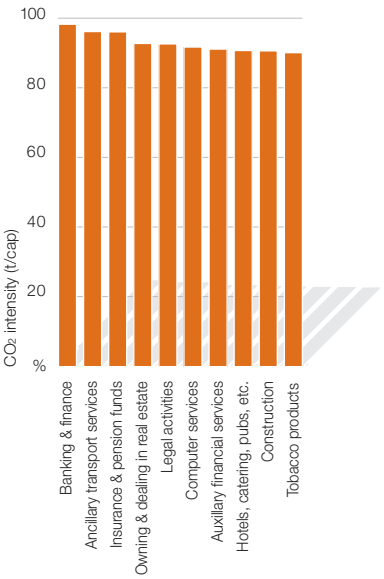


Fig 6 **Top ten shares of offsite CO_2 flows**

another 17m tonnes of offsite emissions in other sectors.

The offsite emissions in the wholesale and retail trade sector amounted to about 58m tonnes, while onsite emissions were just about 12m tonnes. This approach has significant policy relevance. Onsite accounts help identify target sectors, while lifecycle emissions help identify the most important supply chains. Information from our models can be used to identify the most resource-intensive processes within these supply chains.

While the above table reflects the total emissions triggered by industrial sectors from two different perspectives, Figure 5 shows the 10 most CO_2-intensive industrial production chains in the UK economy per £ spent on final demand. While the production of non-mineral products, including the "cement, lime & plaster" industry, only triggers a total of about 13m tonnes of CO_2 along its lifecycle, it is the most CO_2-intensive production process per £ spent on final products, followed by the energy sector and the production of inorganic chemicals. Again, this information has a clear policy relevance because it identifies the most intensive production supply chain priority sectors that can be targeted. Figure 6 estimates offsite CO_2 emissions compared with total lifecycle emissions per £ spent on final demand. In effect, this shows which industries have the highest "hidden" emissions – required by their extended supply chains but emitted by other sectors. Service industries lead this measure, since they produce little physical output while heavily relying on intermediate inputs from other industries. Per £ spent on final demand, 98 per cent of the CO_2 emissions triggered in the banking and finance sector are triggered offsite. Similarly, 96 per cent of emissions from the insurance and pensions sector are caused offsite, followed by 93 per cent of emissions for the real estate sector.

		Supply				Demand						
Code	Industry	Total supply	Regional production (2001)	Imports from rest of world	Imports from other regions in the UK	Total demand	Direct material flows of household consumption	Indirect material flows of household consumption	Direct material flows of capital investment	Indirect material flows of capital investment	Residual material flows (incl.trans-formation, stock changes & waste)	Exports to rest of world
1-2	**Agriculture**	112.20	96.24	15.96	-	112.20	42.22	44.01	2.09	4.45	15.95	3.46
3	**Fishing**	1.29	0.91	0.37	-	1.29	0.05	0.70	-	0.01	0.36	0.15
4-5	**Mining & quarrying**	333.03	255.69	77.33	-	333.03	11.24	126.25	2.95	17.45	80.70	94.41
6-7	**Other mining**	332.78	310.81	21.97	-	332.78	-	42.99	-	3.06	268.01	18.71
8-20	**Food**	99.68	80.22	19.46	-	99.68	42.70	33.42	-	0.65	15.72	7.17
21-28	**Textiles**	5.12	2.39	2.73	-	5.12	2.03	0.90	-	0.22	1.07	0.88
29-30	**Leather**	0.73	0.05	0.67	-	0.73	0.21	0.11	-	0.06	0.24	0.09
31	**Wood**	14.80	7.62	7.18	-	14.80	1.32	4.53	0.40	4.80	2.90	0.83
32-34	**Paper**	25.06	14.34	10.71	-	25,06	0.30	5.61	0.02	5.26	10.52	3.33
35	**Petroleum products**	19.93	-	19.93	-	19.93	2.50	6.02	-	1.33	11.65	21.72
36-46	**Chemicals**	47.15	29.06	18.09	-	47.15	2.13	14.21	0.007	3.96	13.80	13.03
47-48	**Rubber & plastics**	9.27	6.17	3.09	-	9.27	0.73	3.12	0.12	1.70	1.61	1.98
49-53	**Other non-metal mineral products**	131.47	127.10	4.37	-	131.47	3.24	30.41	5.21	57.85	31.25	3.49
54-61	**Basic metals**	44.72	31.00	13.72	-	44.72	0.18	9.30	1.88	9.65	8.23	15.46
62-68	**Machinery**	12.39	8.25	4.14	-	12.39	0.95	1.72	2.58	0.62	4.02	2.47
69-76	**Electricals**	20.84	17.89	2.95	-	20.84	0.39	2.02	3.26	1.96	11.11	2.07
77-80	**Transport equipment**	16.87	11.44	5.43	-	16.87	3.88	2.66	2.25	0.51	4.34	3.21

Fig 7 **The material flows of the UK economy (millions of tonnes)**

Ecological Budget UK Indicator 2: material flow

While in the past most environmental initiatives focused on containing concentrated toxins and pollutants, many contemporary environmental problems are a result of the sheer volume of resources required by the human economy. The material flow analysis (MFA) results from the Ecological Budget UK catalogue the tonnages of material resources needed to supply every form of consumption and production in the UK. Ecological Budget UK's MFA shows, in terms of volume of resources used, why the UK's Ecological Footprint is as big as it is. It suggests that, in order to reduce this Footprint, it is necessary to reduce the volume and increase the efficiency of resources flowing through the economy. To this aim, MFA can identify resource-greedy production and consumption sectors, at which the government can target efficiency efforts.

Figure 7 is a summary of the material flows of the UK economy by industrial sectors. The "Input" side documents the total material input into the UK's economy and comprises production in the UK and imports from the rest of the world. All this data can be viewed on the Ecological Budget UK website in considerably more detail (www.ecologicalbudget.org.uk).

Figure 7's "Output" shows where products were consumed: either directly by households or capital investment, or indirectly by other industrial sectors higher up in the supply chain in order to produce their own "output". Industrial sectors 1 to 7 represent the primary sectors, which provide the raw materials for industrial processes. A considerable proportion of their output to the UK economy is purchased by other industries (called "intermediate demand"). The output side includes waste by industrial sectors.

Overall, the total raw material input to the UK economy in 2001 was 664m tonnes. This figure corresponds with the Office of National Statistics' (ONS) total, ensuring that these accounts are compatible. These accounts, however, go further than the ONS totals and provide a comprehensive breakdown of the resource requirements and outputs of each sector, and their destination by final demand category. The food, beverage and tobacco industry, for example, provided 100m tonnes of products, of which 80m tonnes were domestically produced and 20m tonnes imported. This is the highest output across manufacturing sectors. Some 43m tonnes of these products were consumed by private households directly, while another 33m tonnes occurred indirectly during production. The remaining 24m tonnes were exported or added to the physical stock of the economy.

Sectors 8 and onwards do not produce their own raw materials, but draw them entirely from sectors 1 to 7. The output figures of secondary or manufacturing sectors (8-80) show the amount of products provided to the UK economy domestically and from abroad. Service sectors have been excluded here, because they use rather than produce materials or products.

As with most material flow accounts, construction materials dominate. Responsible for more than 200m tonnes of materials in 2001, capital investment[5] accounts for over a third of UK resource flows. This highlights the importance of ensuring at the national policy level that resource efficiency is integrated into new capital investment.

Manufacturing is a lower proportion of the whole UK economy than in the past. However, the UK still exports a considerable amount of products – 193m tonnes – and a considerable proportion of the materials produced in the UK stay here.

5 Capital Investment refers to money used by a business to purchase fixed assets (for example land or buildings).

Fig 8 **Predicted increase in millions of tonnage of waste arisings between 1998/9 and 2020/21 (additional tonnage to 1998/9 position)[11] [12]**

Region	Min growth % annum	Max growth % annum	Municipal solid waste tonnage	Commercial waste tonnage	Industrial waste tonnage	Special waste tonnage	Construction & demolition waste tonnage	Total
North West	3.00	3.51	4.55	1.72	0.90	0.95	14.74	**22.02**
North East	3.00	3.71	1.78	0.54	0.92	0.87	4.41	**7.75**
Yorkshire & Humberside	2.53	3.00	2.57	1.21	2.31	1.46	2.59	**8.85**
West Midlands	3.00	4.00	3.76	0.34	1.27	0.66	3.44	**8.90**
East Midlands	3.00	3.56	2.56	0.97	1.44	1.52	3.34	**8.49**
London	2.59	4.60	7.04	2.37	0.50	1.09	3.60	**13.63**
East of England	3.00	4.50	4.86	1.35	0.89	1.59	3.91	**11.18**
South West	3.00	4.13	3.49	0.98	0.71	0.73	3.71	**8.98**
South East	2.18	3.00	4.76	2.20	1.21	0.11	7.16	**15.46**
West	3.00	6.00	4.05	0.62	1.22	0.10	1.79	**7.78**
Total			39.46	12.36	11.40	11.06	48.74	**113.08**

Many exports are materials that at one point in their lifecycle were imported. Influenced, like most countries, by policies supporting globalisation and world trade, the UK swaps and transports millions of tonnes of materials to and from countries around the world.

Waste in the UK

The UK's pattern of waste "arisings" (waste production) and waste management is crucial to understanding its material "metabolism" (how materials flow through the economy). The national material flow accounts show the economy's material inputs, imports, exports and waste streams. This evidence can be applied in various ways: the first conclusion is that at a conservative estimate, British industry is putting up to 8 per cent of its gross profit into landfill.[6]

Waste data at the sectoral level has been derived from the 2002/3 commerical and industrial survey compiled by the Environment Agency (EA). Figures for waste covered a number of industrial and commerical sectors. Therefore the total net production of waste within the grouping was used to determine what proportion of the EA's "total group waste figure" was apportioned to that particular industry sector.[7]

At the regional level, poorer regions (for example the North East and Wales, which also tend to produce more goods than they consume) have far more waste arisings and disposal shortfalls. This will become more crucial as landfill taxes and transport costs rise, as the local waste trading system gets under way, and as new opportunities emerge in waste recovery for environmental technologies[8].

Waste arisings have been projected to 2020/21 in the ODPM *Companion Guide to Planning Policy Statement 10: Spatial planning for integrated waste transport* (March 2006).[9] The average growth rate in municipal solid waste for England and Wales was 3 per cent per year.[10] Figure 8 provides a summary of each UK region's projected growth rate for waste arisings, along with a predicted increase in tonnages of waste needing disposal or recovery from 1998/9 to 2020/21.

Figure 8 shows that on current trends, an extra 113m tonnes of waste will need to be dealt with by 2020. Of this, 48m tonnes (42 per cent) is mostly inert waste from the construction and demolition industry, much of which is reused in aggregates and construction. For the remainder, if we convert the regional arisings to tonnages per capita within each region using 2001 census data, we conclude that, within the next 15 years, each UK resident will produce 1 extra tonne of waste per annum. Most local authorities predict that they will only have capacity for about 25 per cent of this to be landfilled by 2021, which will mean that many extra facilities must be provided to recycle, reuse, recover or convert this material to energy by that year.

"On current trends, an extra 113m tonnes of waste will need to be dealt with by 2020"

6 Cambridge Econometrics & AEA Technology, 2004, *Benefits of Greener Business*, report to the Environment Agency, available at www.reward-uk.org

7 For more information on the approach visit www.ecologicalbudget.org.uk

8 Note: Scotland and Northern Ireland operate their own systems and data is pending.

9 This Guide takes details from the Strategic Waste Management Assessments (SWMAs) reports on each region, based on 1998/99 figures for waste arisings, and predicts increases in waste arisings per region. Each sub-region has different rates of growth, depending on what was reported in regional reports and the Defra Municipal Waste Survey.

10 UK Prime Minister's Strategy Unit (PMSU), Waste Report, 2002.

11 A further breakdown of waste arisings can be found on the Ecological Budget UK website (www.ecologicalbudget.org.uk) by municipal, commercial, industrial and special waste.

12 EA predictions. Note: with the exception of municipal waste data, there is a lack of detailed waste data for most waste streams. Agricultural waste growth predictions not available.

13 A global hectare is the same size as a normal hectare and is adjusted for average world productivity.

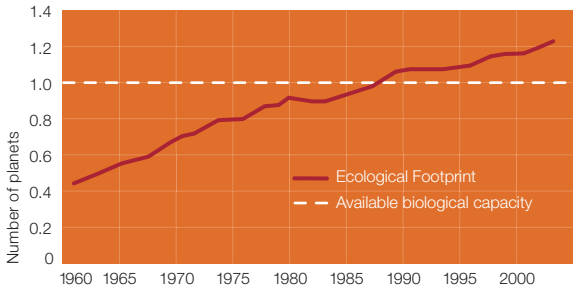


Fig 9 **Humanity's Ecological Footprint (WWF Living Planet Report 2004)**

Household energy consumption, food consumption and transport dominate the Ecological Footprint of the UK.

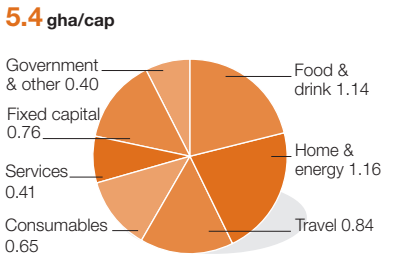


Fig 10 **Ecological Footprint of the UK (gha/cap)**

Indicator 3: Ecological Footprint

The Ecological Footprint is a calculation method that estimates the demand of human activities on nature. Any sort of resource use – going out for a meal, flying to Spain, building a house, or even paying into a pension scheme, leaves an Ecological Footprint on the planet.

The Ecological Footprint is a comprehensive measure of the resources consumed by a population (the UK, in this analysis). It measures the balance between human demand and nature's supply. The Footprint calculates how much productive land and sea is needed to provide the energy, food and materials we use in our everyday lives, and how much land is required to absorb our waste. It also calculates the emissions generated from the oil, coal and gas we burn, and determines how much land is required to absorb them.

The Ecological Footprint can be estimated for individuals, households, schools, businesses, cities, regions or countries, and can assess the demand a population is placing on the environment.

Sustainability requires living within the regenerative capacity of the planet. At present, human demand is exceeding this capacity by about 20 per cent. This is called "overshoot" (see Figure 9). In essence, ecological overshoot means the overuse of domestic or overseas land resulting in overgrazed pastures, depleted fisheries, degraded forests and the accumulation of carbon emissions in the global atmosphere. The Ecological Footprint is an important tool in attempting to understand this phenomenon.

Eliminating overshoot is crucial to the long-term well-being of the planet. Unfortunately, overshoot is often not obvious until it is too late, since natural capital can continue to be harvested even if it is being used at an unsustainable rate. For example, it is possible to over-fish and eventually deplete a local area, but fish yields might continue even as the system teeters on collapse.

Sustainable development means accepting ecological limits and the reality of overshoot. It is not possible to draw on ecological services faster than they can be replenished and still be sustainable, even if the consequences aren't immediate. As it is, the Ecological Footprint of the UK is 5.4 global hectares per person[13] (gha/cap) – compared with a world average of 2.2 gha/cap and an available global biocapacity of 1.8 gha/cap. On a per person basis, the UK has an Ecological Footprint among the highest 15 countries. This exceeds global ecological limits, particularly as developing countries continue to increase their Ecological Footprint and take up a larger share of global biocapacity.

For this study, the UK Ecological Footprint has been categorised according to different final demand (consumption) categories. Primarily, these involve various kinds of household consumption, but also include consumption by government and capital investment, as seen in the box right.

The main components of the UK's Ecological Footprint (gha/cap)

Home and energy 1.16
Domestic fuel including gas and electricity, oil and bio-fuel. Also includes the building, maintenance and repair of dwellings.

Food and drink 1.14
Food and drink purchased for home consumption, alcoholic drinks purchased in pubs, restaurants, takeaways, and other catering establishments.

Travel 0.84
Car fuel, the impact associated with purchasing and maintaining private vehicles, and public transport.

Capital investment 0.76
Investment in tangible fixed assets such as plant and machinery, transport equipment, dwellings and other buildings and structures.

Consumables 0.65
Includes durable and non-durable items including newspapers, clothing, appliances, glassware, tools, medical products, audio-visual equipment, personal effects, etc.

Services 0.41
Includes education, postal, telephone, water supply, recreation, insurance, private hospital, financial services, etc.

Government and other 0.40
Includes the resources used by national and local government, universities and colleges.

Fig 11 **The Ecological Footprint of ACORN types**

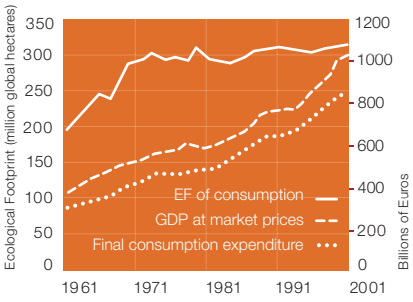


Fig 12 **Trends in economic growth and Ecological Footprint in the UK**

In general, it is still the case that the more the UK spends, the greater its Ecological Footprint. This sets an interesting challenge when attempting to move towards sustainable development. To what degree is it possible to continue economic development, increase household expenditure and reduce the UK's Ecological Footprint?

The Ecological Footprint of every local authority area in the UK

Combined with funding from other projects, the Ecological Budget UK project has produced an Ecological Footprint for every local authority area in the UK. Figure 13 provides an insight into the variation of the Ecological Footprint across the country. All this data, and a detailed description of the methodology used to calculate these Footprints, is available free of charge at www.sei.se/reap and www.ecologicalbudget.org.uk

There tend to be high Ecological Footprints in the Home Counties and wealthier London boroughs, and in some rural areas, especially the East of England and Cheshire. The lower-income areas of Wales, the South West, and the "Northern Way" areas in the North have lower Footprints.

The connection between wealth and the Ecological Footprint

Even data at the local authority level hides many variations in the UK's Ecological Footprint. The variation between the largest and smallest local authority areas is 26 per cent. When we look at the Ecological Footprint of socio-economic groups across the UK, the group with the largest Ecological Footprint has a 40 per cent larger Footprint than the group with the smallest. Figure 11 shows the Footprint of all the ACORN[14] groups in the UK, highlighting the impacts of different groups in the UK. The challenge of sustainable development is to decouple a high quality of life from a high Ecological Footprint.

What makes up the high Ecological Footprints of the South East and other areas surrounding London?

- higher income means greater access to resources, particularly noticeable in more purchases of furniture, personal effects and household appliances;
- very high travel demand dominated by low-occupancy, high-polluting vehicles;
- regular purchase of new cars: in some areas of the South East the Footprint of buying and maintaining cars is higher than the national average Footprint for using them;
- long-distance exotic holidays more than once a year;
- large and often old inefficient homes with low occupancy compared with their size;
- heavy reliance on the service sector for eating out, recreational and cultural activities;
- large gardens that need maintenance and treatment;
- more short weekend breaks in the UK;
- and
  - a lower Footprint for tobacco;
  - an average Footprint for alcohol;
  - an average Footprint for food eaten at home.

"There tend to be high Ecological Footprints in the Home Counties and wealthier London boroughs, and in some rural areas, especially the East of England and Cheshire"

14 ACORN – A Classification of Residential Neighbourhoods – is produced by CACI. For more information visit www.caci.co.uk

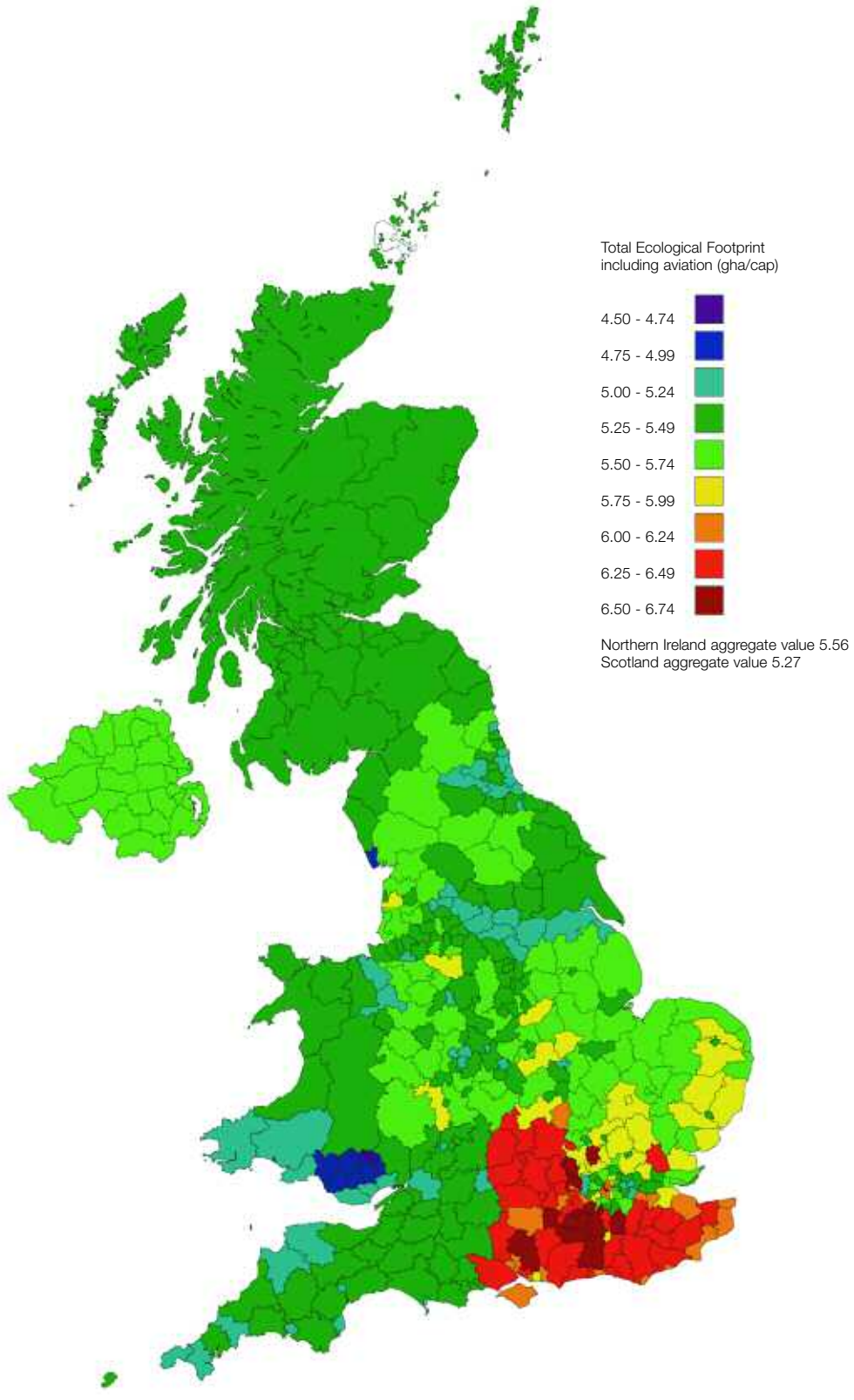


Fig 13 **UK Ecological Footprints (England and Wales by NUTS4 District; Scotland and Northern Ireland aggregated)**

4 Regional overview

In the past 10 years, the UK government has devolved increasing power to the English regions, Wales, Scotland and Northern Ireland. As a result, they have more responsibility for delivering the growing sustainability agenda. However, this is difficult without a region-specific, standardised measure of both local and global environmental impacts and limits. This chapter provides an overview and comparison between different parts of the UK, and sets the direction for a more detailed review in chapter 5.

The Ecological Budget UK project provides the most comprehensive understanding yet of the UK's physical production and consumption, and of the resource flows between regions, devolved administrations, and the rest of the world. This then provides the vital evidence to feed back into future economic and spatial strategies.

1. Why look at regions and devolved countries?

In some ways, regions and devolved administrations are the cornerstones of sustainable development, where there is often a "fit" between physical, social, economic and political activities. Water catchments, air dispersion patterns, soil types and agricultural markets are each quite clearly defined at the regional level. So are urban hinterlands, travel patterns and housing markets. Economic flows, industrial profiles, higher education, research and media awareness are strong at this level. Around the UK there is a long history of regional identity, linked with dialects and kinship patterns.

In general the regional level offers an opportunity to make new linkages for the sustainable development agenda, between the local and the national scale, where economic and urban policy is often in a greater state of flux. The new plethora of regional and devolved development agencies, assemblies, government offices, quangos and others are each intended to add value at the appropriate level, and if properly coordinated could so do.[1]

In practice the rhetoric is way ahead of the reality: while each UK region or devolved country produces its sustainability strategies and appraisals, it continues to increase its global impacts through material consumption and mobility.[2] It is clear that "more of the same" is unlikely to deliver solutions to complex and deep-rooted problems, but that new thinking is needed on the potential at the regional level for linking public, private and community sectors.[3]

The Ecological Budget UK project aims to contribute to this new agenda. By targeting its analysis at the regional level, it provides a practical yardstick for assessing problems and potential solutions. By looking at both the consumption and production sides, it brings together the regional economic strategies and spatial strategies which often point in different directions.

The UK space

The UK comprises nine English regions including London, and the three devolved administrations of Northern Ireland, Scotland and Wales. Each has a different mix of political and economic power, and each is at the upper level of a local government structure of counties, rural districts, metropolitan boroughs and unitary authorities.

In terms of collecting consistent resource-use data and developing sustainable development strategies, dividing the UK into regions and devolved administrations is a good starting point. In practical and functional terms, other classifications may be more useful, and there is an active debate on how best to organise and plan the "UK space". This applies to the questions highlighted by the Ecological Budget UK project – resource flows, supply chains, total environmental impacts – and their policy implications for economic and urban development.

For instance, there is a debate on city-regions, or conurbations plus hinterlands, as more natural functional units. The Core Cities group argued for the case of the eight largest provincial centres as the gateways and generators of activity for most of England.[4] Other definitions include the "travel to work" areas, based on 75 per cent self-containment of labour markets, or "functional urban regions"[5]. On a larger scale there are experiments with inter-regional schemes such as the Northern Way and Midlands Way, and the national Sustainable Communities plan.

The "bio-region" concept applies clearly to more remote territories, where there is often a direct fit between river catchments, natural resources and landscape types. In the more urbanised parts of England, bio-regions are often obscured and may differ from social or economic units. However, with new agendas for rural enterprise and landscape management, such as community forests and local food markets, the bio-regions may emerge once more.

The Ecological Budget UK data provides a platform for further research on each of these units, using the detailed breakdowns of local authorities, supply chains and social group consumption choices. For the moment we focus on the regions and devolved administrations as the main units.

1 Sustainability North West (SNW), 2004, *Regional Governance and Sustainable Development*, Manchester, SNW. Available at www.snw.org.uk (as of June 2005).
2 SDC (Sustainable Development Commission), 2005, *The next steps: An independent review of sustainable development in the English regions*, London, SDC.
3 Ravetz, J., 2000, *City-Region 2020: integrated planning for a sustainable environment*, (with foreword by the UK Secretary of State for the Environment), London, Earthscan, in association with the TCPA.
4 Office of the Deputy Prime Minister, 2003, *The Strategic Environmental Assessment Directive: Guidance for Planning Authorities on applying European Directive 2001/42/EC*, London, ODPM.
5 ERN (English Regions Network), with RDA Planning Leads Group, Office of the Deputy Prime Minister, Department for Transport, 2005, *Regional Futures: England's Regions in 2030: Final Report*.

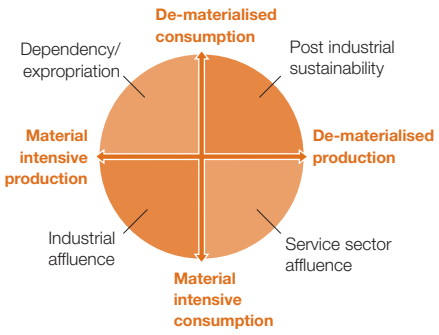


Fig 1 **Regional types and material balances**

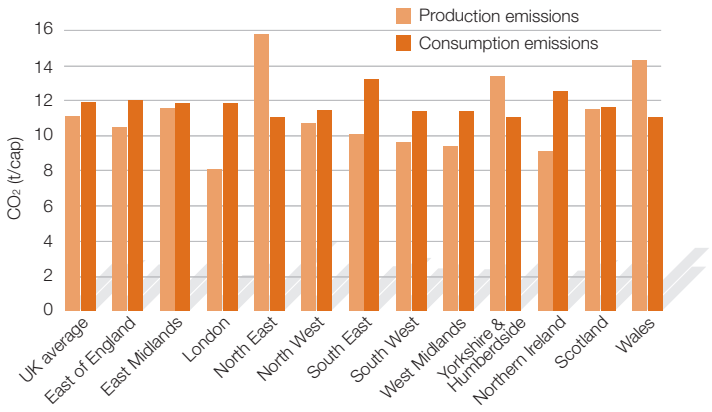


Fig 2 **Regional CO_2 emissions from consumption and production**

The regional balance of production and consumption

Regional economies vary as to their material intensity in production or consumption. For instance, Greater London is a high-volume material consumer but its economic activity is in the service sector, far along the supply chain from the material-intensive manufacturing of other more industrial regions.

In terms of material intensity, there are four general types of production/consumption balance, as shown in Figure 1:

1. a conventional model of industrialised affluence is seen where both production and consumption are material-intensive;
2. if production is material-intensive but consumption is not, this may show the dominance of extractive industries such as mining or intensive agriculture, which are often associated with poverty or dependency;
3. if consumption is more intensive than production, this may show a service sector economy which sucks in resources from elsewhere, and thereby exports its environmental impacts; and
4. low material-intensity for both production and consumption – as shown in the top right corner of the diagram – represents a post-industrial model of sustainability – the goal of the Sustainable Consumption and Production concept.

The interaction of production and consumption takes place through many long and complex supply chains in a modern economy. The Ecological Budget UK data can identify these effects which are otherwise hidden from view. The service sector may induce higher material flows than manufacturing activity – for instance, financial services demand resources from a long supply chain that includes manufacturing of goods such as paper and electronics, and extraction of resources to make those products.

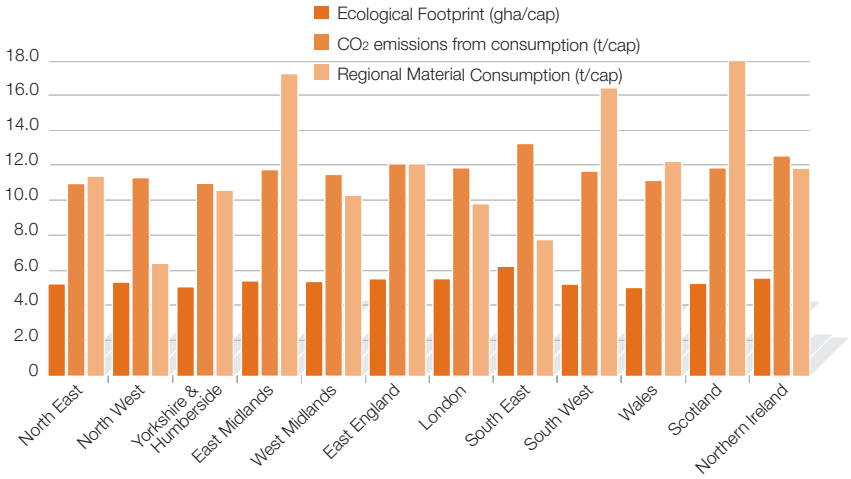


Fig 3 **Regional Ecological Footprint, CO_2 emisssions and material consumption**

The picture of the UK's material supply chains shows clearly a North-South divide, where the northern regions tend to produce more and consume less, while the southern regions consume more and produce less – as can be seen in the CO_2 results for the regions (Figure 2).

This shows a pattern of burden shifting at different scales: between regions, within regions, between wealthy and poor communities, between the regions and devolved administrations of the UK, and between the UK and the rest of the world.

There is further evidence shown by the comparison of the three main measures of the Ecological Budget UK – Ecological Footprint, CO_2 emissions and material flow analysis, here defined as Regional Material Consumption (RMC) after subtracting exports (Figure 3).

This shows how wealthy regions such as the South East may have the highest Ecological Footprint but lower material consumption than others. London is obviously the most dominated by service activity, but appears to draw in material at quite a healthy level. In contrast, the North East has a low Ecological Footprint and CO_2, but a higher than average material consumption.

CO_2 emissions: consumer and producer regions

In general, the South of England consumes more and produces fewer CO_2-emitting resources, and the North consumes less and produces more. London, for instance, has the lowest CO_2 emissions from production, but is among the highest in emissions from consumption.

Net consumer regions:
London, South East, South West, West Midlands. Also Northern Ireland and the East of England.

Net producer regions & countries:
North East, Wales, Yorkshire and Humberside. Also Scotland, the East Midlands and the North West.

The mega-city region

This central powerhouse of the UK economy includes Greater London, the South East and part of the East of England: some definitions would include parts of the South West, East and West Midlands, with a population approaching 20 million people, or a third of the UK. The economy is generally more service- and knowledge-based, with the London financial sector at its centre. The population is more affluent, although this is partly negated by the higher cost of living.

Many urban households are in flats (generally more efficient); further away from the centre, houses are on average larger (generally less efficient). In London itself, household travel distances are less and there is a higher than average proportion of public transport use. This mega city region also hosts three international airports that serve most of the UK's travel demand and are hubs for overseas travellers. There are more extended supply chains coming through to the service sector, and more globalised markets for production and consumption. Much of the physical landscape is protected, where productive uses are giving way to leisure and amenity.

Industrial or post-industrial regions

This regional type is more centred on manufacturing, processing and distribution, although local and public services still form the majority of employment. In large, mixed conurbations, housing is often smaller and in poorer condition, with lower distances travelled. In peri-urban and rural areas, travel distances are higher and there is new affluence overlaid on historic poverty. Although there are generally higher proportions of dependants, material consumption continues to grow, and retail and leisure services continue to drive economic growth. This regional type is found in parts of Wales, Scotland, East of England and West Midlands, North East and North West, and Yorkshire and Humberside.

Rural/peripheral regions

The more rural and remote territories are scattered around the west and north of the UK. While there is more farming and forestry, land-based activity is shifting to tourism as the main employer. There are local production sectors such as forestry and mineral extraction, but even these are small parts of the rural economy. Settlements are more in market town and village patterns, and the more extended travel distances rely on private transport. There are problems with second home ownership and housing poverty traps, so more of the local housing tends to be unimproved and inefficient.

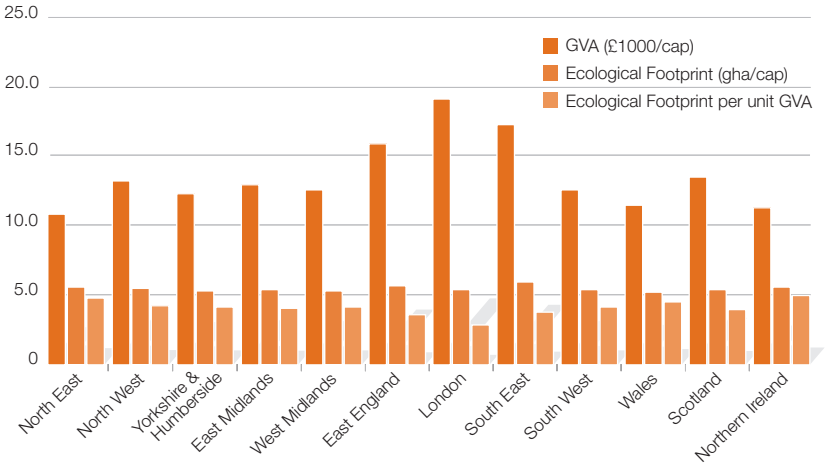


Fig 4 **Regional Footprint/economy intensity**

Devolved administrations

Northern Ireland, Scotland and Wales each show a mixture of regional economic and physical types, from large urban areas to remote countryside. In both urban and rural areas there are pockets of poverty and historic wealth. There are also new forms of wealth creation via creative and information and communication technology (ICT) industries. Tourism is one of the main growth areas, while agriculture sheds labour and acquires capital. Energy production varies – Scotland has much hydropower, while Northern Ireland still relies on coal for housing and industry. Travel distances are relatively lower, partly due to many local economies that are more self-contained.

The Republic of Ireland should naturally be included in any wider picture of the UK, the more meaningful functional unit being the British Isles. But Ireland, in contrast with the UK, is a special case: it has a newly industrialising economy, a lower population density, and a more remote agrarian-based society. Irish data could be included in future versions of the Ecological Budget UK.

A further view on these regional types can be seen by comparing the conventional measure of wealth in Gross Value Added (GVA), with Ecological Footprint as the aggregate measure of consumption impact (Figure 4).

This shows very clearly the divided UK in terms of wealth and poverty. London, the East of England and the South East are one end of the scale, and the North East, Wales and Northern Ireland at the other. The GVA figures appear to have some parallel to the Ecological Footprint figures – in other words, the wealthy consume more with greater Footprint than the poor. What is topical here is the ratio of "Ecological Footprint per GVA", which shows how much impact is caused for each unit of economic activity. On this measure, London and the South East are the most efficient, while the North East and Northern Ireland are the least.

2. Linking regional consumption and production to policy

There is a growing aspiration towards the ideals of the One Planet Economy, but a huge gap between the reality of regional development policy. Most of the regional strategy documents now quote "sustainability" on every page, but on closer inspection, the main agenda still revolves around "growth."[6] For the UK's Regional Economic Strategies (RES) this often means economic growth *per se*, tempered with some social inclusion, while for the Regional Spatial Strategies (RSS) it means enabling, managing and coping with the effects of "growth."

From the viewpoint of the Ecological Budget UK project, it is not the *quantity* but the *quality* of such growth that is most important – what kind of growth, for whom and at what cost. These questions are

explored in depth in the parallel report *Strategy for a One Planet Economy*. Here we present a very simplistic sustainable development growth agenda for the UK and its regions, with three measures:

- *environmental impacts* from resource use – rapid reduction, measurable with the Ecological Footprint at a net rate of 3 per cent per year;
- *economic growth*, as measured by monetary activity – a rate which appears to be self-sustaining for the UK within the global economy, currently about 2.25 per cent long term (including variations between regions); and
- *social welfare* (quality of life, equity and inclusion) – high growth, although recognising this can be difficult to measure.

This development triangle questions many of the basic assumptions about regional development, and helps clarify the basic policy options:

- *production:* further growth in high-impact industries and distribution systems, or more resource efficient industries, compatible with a One Planet Economy;
- *consumption:* assumption of high growth in material consumption, or a sustainable consumption agenda. This underlies the success or failure of many regional policies: urban renaissance, public transport, local food markets and social inclusion, for example;
- *housing:* further growth in conventional construction and household energy use, or more sustainable building patterns;
- *transport:* further growth in traffic and road construction, or lower impact modes of transport, with better integration between supply and demand; and
- *energy, water, waste, etc.:* more power stations, dams and landfills, or alternative ways of managing demand with less cost and environmental impact.

These and many more policy options are long and complex issues. However, the aims of growth and development are basic principles that need to be debated, analysed and then put into regional targets.

6 See footnote 2

7 SEERA (South East England Regional Assembly), 2005, "Stabilising the ecological footprint in the South East Plan: A report to SEERA by the Centre for Urban & Regional Ecology". Available at www.southeast-ra.gov.uk/southeastplan/publications/research/se_footprint_summary_report_july05.pdf (as of June 2005).

8 See footnote 5

Many policy-makers have done so. For instance, the South East England Regional Assembly has declared its aim to "stabilise the growth in the South East ecological footprint by 2016"[7]. This shows a new kind of thinking about the power and responsibility of regional and devolved government.

3. Regional economic development – The RES

Regional economic issues

The RES are produced by the UK's Regional Development Agencies and by devolved administrations as a comprehensive action plan that garners both EU and national funding. Each RES is benchmarked against a series of "floor" targets set by the Department of Trade and Industry, and a parallel target for sustainable development has been the subject of debate. Most regions aspire to perform equal to or better than the national average, although this is logically impossible. In reality, the UK economy continues to feature long-running tensions and conflicts which play out on the level of regional development policy:[8]

- the large differential in productivity (GVA/employed person) between the South and the North and Midlands shows no signs of reducing;
- there are signs that the major cities are beginning to lead GVA growth now that office-based service activities are increasingly important;
- manufacturing employment will continue to fall as a result of static output and productivity improvements, with the largest direct impacts on the Midlands and parts of the North;
- the highest formation rate for high technology companies is in the South, along with the UK's main concentration of research and development activity; and
- hidden unemployment (including long-term sickness, training and other government schemes) is higher in the North than in the stronger economies surrounding London.

Regional economic options

Valuing the *quality* of growth more than the *quantity* raises many questions about alternative development paths and policy options. Is an RES focused on economic growth alone, or more on growth in quality of life and reduced environmental impacts? Is the shift towards services dependent on increasing imports of material goods from overseas, which increases environmental impacts? How can a low-impact, high-quality plan for the future be compared to the alternatives and implemented?

The RES theme of resource productivity is central to this, and can be defined in various ways – output per investment, per employee, or per tonne of waste or emissions. Energy efficiency and CO_2 emissions rates will improve through a combination of regulatory power, financial investment, market development and technology innovation. It is fair to say that Regional Development Agencies have only indirect leverage on most of these factors. An overall agenda for consumption is hardly mentioned in the average RES, it being taken for granted that rising affluence contributes to a healthy retail sector.

The typical RES contains a mixture of supply-side and demand-side actions, each of which has some scope for influence on a region's material flows and Ecological Footprint:

- *promoting business clusters:* these have the opportunity for environmental technology innovation, low-impact infrastructures such as waste or sewage treatment, employers' green travel planning, and other features of an "eco-industrial park";
- *enhancing competitiveness and productivity:* this involves energy and material efficiency in industry. It may also extend towards a market transformation of both supply and demand sides – meeting consumer needs in new ways;
- *mobilising the knowledge base:* this reflects the shift towards knowledge-based innovation, high technology and use of advanced ICT – each of which can be a catalyst in new low-impact patterns of production and consumption;
- *economic inclusion and mobilising the labour market:* this works at the human scale of training and career support, incentives for graduates, entrepreneurs and intermediate labour markets (the latter is particularly relevant where it revitalises the social economy, increasing social welfare while reducing material impacts);
- *sites and premises:* this traditional core of economic development is still hugely relevant to land use, construction rates, transport demand and other services;

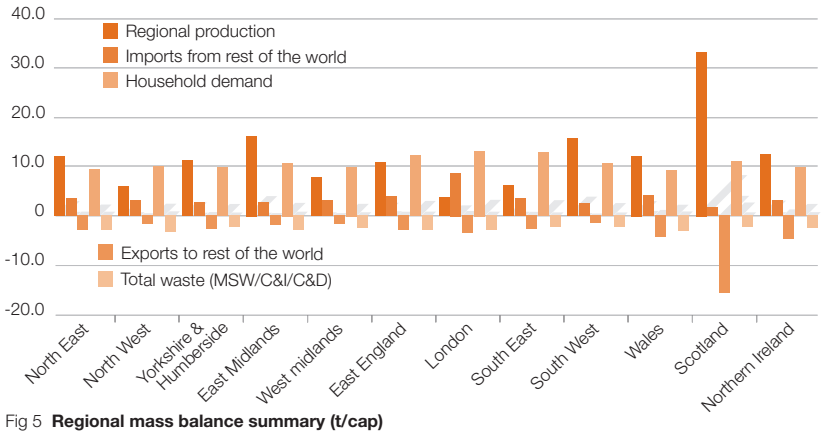


Fig 5 **Regional mass balance summary (t/cap)**

> *urban and rural renaissance:* these agendas contain the economic and employment sides of the spatial strategies. In each, there is an urge for policy integration, so that economy, housing, transport and services all reinforce each other; and
> *image and environment:* in many RES the environmental agenda might be seen as a surface level add-on, although it can be argued that image and quality of life factors are totally essential in a globalising economy. An important question raised by resource accounting is to what degree local environmental improvements are achieved by displacing the impacts elsewhere – for instance if a local steel mill closes, and the same amount of steel is then imported from overseas.

Looking around the various RES documents, their attempt to acheive sustainability through these measures often lacks the ambition or clout needed to meet the challenge of a One Planet Economy. With that in mind, a further set of more strategic measures is proposed in chapter 7 of this report

4. Regional physical development – The RSS

Regional and national spatial issues

Across each of the regions and devolved administrations there are tensions and conflicts about managing growth and mitigating decline. The current lack of a national spatial framework is a hindrance – for instance, any attempt to plan in the crucial zone between Bedford and Bristol would involve five different RSS with totally uncoordinated maps and policies. Yet the global impact of the UK space largely depends on the ability to cope with these regional and national spatial issues.[9] In the UK as a whole, there are several issues and trends of particular importance to future spatial planning:

> Climate change, flooding and water supply – all influenced by current development in the UK – have inter-regional significance. These issues are of greatest relevance in the South, and parts of the East Midlands.
> Changing working practices are leading to increasing demand for travel, with a trend for commuting less often but over greater distances. These pressures are evident in most regions but particularly the South, significantly affecting railways as well as the road network. There is increasing demand for international travel, which future airport expansion seeks to accommodate. International connections, including surface access to airports, can be a stimulus for city and regional economies.
> The centres of major cities are active areas of growth. An example is the economic success of central London and its wider "mega-city region," which contains some 18.6 million people.
> Some city regions in the Midlands, the North and South West are also experiencing increasing economic growth. At the same time, there are significant variations within these city regions. The resurgence of core city centres and some outlying towns is in stark contrast with some inner urban areas and former industrial towns which experience severe deprivation and population decline. There are areas of deprivation in the South, particularly in inner London and the costal towns.

RSS issues

The RSS are being produced by the Regional Assemblies and their devolved administration counterparts as a more comprehensive and responsive strategic tool in the spirit of sustainable development. They are also subject to lengthy processes of consultation and sustainability appraisal.[10] As the main framework for the physical functioning of the region, they have a bearing on its material flows and Ecological Footprint. However, their scope is limited by policy pressures and industry norms, and often RSS debate is about the levels and locations of growth, rather than the quality and purpose of growth. These are the key issues that many RSS address:

> *housing planning options:* the location of housing influences transport demand and accessibility to employment and services;
> *transport supply options:* regional policy options include development of new infrastructure such as trams or new motorways, or constraint measures such as parking charges or road pricing schemes. The EU and the UK government are calling for increased vehicle efficiency, fuel quality and emissions controls;

- *housing construction options:* this is an economic sector with potential for increased efficiency in energy and waste. Household demand dictates how much energy must be produced, how much water supplied, and which utilities must be provided;
- *energy supply options:* this is a topical national debate with growing implications at the local and regional level, as fossil fuels begin to look increasingly expensive and unreliable. Many forms of renewable energy, particularly biofuel and tidal schemes, have impacts on land-use and landscape, while the nuclear alternative has many risks and liabilities;
- *waste management options:* this is the other end of the pipe to the regional material consumption shown above.

The pattern of waste arisings and waste transfers around the regions is crucial to understanding their material metabolism. Ecological Budget UK accounts show by each sector the overall balance of material inputs, imports, exports, stocks and waste streams (Figure 5).

This evidence can be applied in various ways: the first conclusion is that at a conservative estimate, British industry is putting up to 8 per cent of its gross profit into landfill. At the regional level we can see that some of the poorer regions have waste arisings and waste disposal shortfalls way in excess of other more wealthy regions. This will become more crucial as landfill taxes and transport costs rise, as the local waste trading system gets under way, and as new opportunities emerge in waste recovery for environmental technologies.

Taking sustainable production and consumption forward in the regions

In conclusion, this discussion comes back to the question of "what is a successful region?" – in other words, "what is a sustainable region?" The regional footprint indicator is perhaps the nearest to a single measure of sustainability when set against the long-term targets of the parallel report *Strategy for a One Planet Economy*.

The evidence of Ecological Budget UK can also be linked to the wider view on sustainable develpment, as shown by the Regional Quality of Life headline indicators.[12] The latest version of these did not include Ecological Footprint and material flow analysis (MFA), as reliable data did not exist at that time. However, no fewer than half the indicators can be seen to be directly related to Ecological Footprint and MFA in some way (economic output, housing conditions, climate change, air quality, traffic volume, river quality, land use, household waste, total waste). Future versions of the regional indicators should be refined to show more insight into the underlying patterns and causes of these trends.

Meanwhile, promoting Sustainable Consumption and Production (SCP) is now one of five strategic priorities for Defra, and a major theme in *Securing the Future*, the UK government's Sustainable Development Strategy. Defra also published a set of indicators for assessing progress towards SCP in 2005. The regions are being increasingly called on by central government to provide strategic added value to the SCP agenda, which is now funded through the Business Resource Efficiency and Waste (BREW) programme.

Regions have already taken the initiative in many areas such as renewable energy, sustainable construction and waste recovery. They are also beginning to develop their strategic capacity for evidence-based policy, working through regional observatories, university partnerships and industrial collaborations.

The recently formed SCPNet (Sustainable Production and Consumption Network) will develop and support the use of tools, data and analysis to influence regional decision-making in a positive, practical and effective way.[13] Ecological Budget UK provides an ideal evidence base and opportunity to take work in this area forward in the regions and devolved administrations, by building on existing networks and projects. It will help to answer topical regional questions such as:

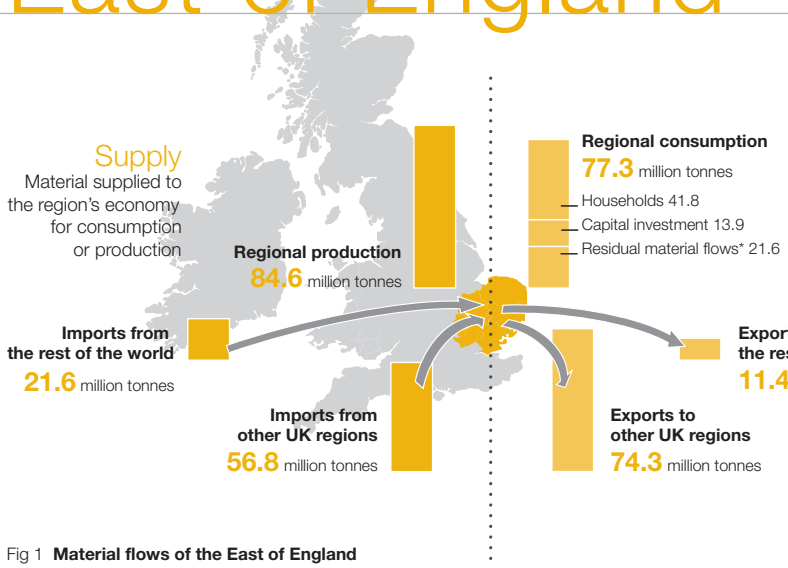
- What level of CO_2 emissions are likely in 2020 with current trends in economic activity and transport growth?
- Which policy measures could reduce commercial and industrial waste impacts by 20 per cent by 2020, given alternative trends in business formation?
- What is the effectiveness of different strategies and technology options in promoting regional resource efficiency, and how do we measure it?

These and other issues are explored in the next chapter on regional and devolved administration issues, and the following chapter on the analysis of SCP.

9 Wong, C., Ravetz, J. & Turner, J., 2000, *The UK Spatial Planning Framework: a discussion document*, London, Royal Town Planning Institute.
10 See footnote 4
11 Cambridge Econometrics & AEA Technology, 2004, *Benefits of Greener Business*, report to the Environment Agency, available at www.reward-uk.org
12 Defra with ONS, 2003, *Regional quality of life counts – 2003*, available at www.sustainable-development.gov.uk/documents/publications/rqolc2003.pdf (as of Jan 2006).
13 Materials available at www.scpnet.org.uk

East of England

Material flow analysis



*including transformation stock changes and waste

Regional material inputs and consumption

RMI	RMC
133.4 million tonnes	47.6 million tonnes
RMI/cap	**RMC/cap**
24.7 tonnes	8.8 tonnes

Fig 1 **Material flows of the East of England**

Ecological Footprint

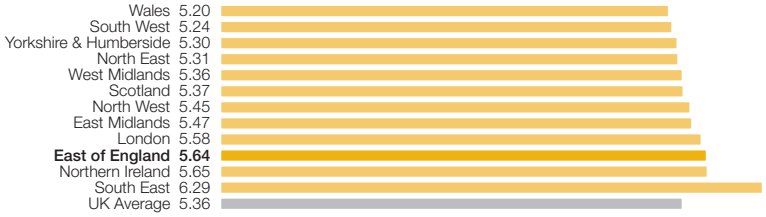


Fig 2 **Regional Ecological Footprints (gha/cap)**

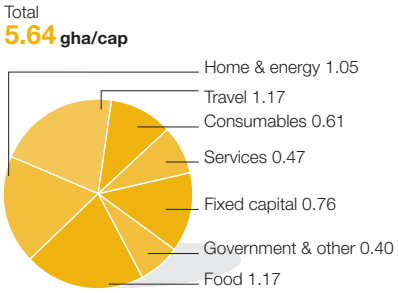


Fig 3 **The East of England's Ecological Footprint (gha/cap)**

Analysis

Material flow

Reflecting its role as a shipping and transportation hub, the East of England has very high material flows both into and out of the region. It exports 75m tonnes of materials and goods to the rest of the UK; more than any other region except the East Midlands. A considerable proportion of exports are agricultural and food products, totalling over 20m tonnes, and paper products, totalling 16m tonnes.

The East of England's imports even more than it exports. It relies more heavily on the rest of the world to provide all its goods and services than the rest of the world relies on it. The East of England's Regional Material Consumption (RMC) is also higher than average. Even more so than the South East, high transport demands dominate the Ecological Budget UK results for the East of England.

Transportation

The issue of aviation is of critical importance to the East of England. Given the region's airports and its overall affluence, it is not surprising that its per capita Ecological Footprint for aviation is over 15 per cent higher than the national average. Variation within the region is even more extreme. In 2001, residents from St. Albans – one of the wealthiest areas with easy access to Stanstead, Luton and Heathrow within Hertfordshire – travelled 235 per cent further by plane than other residents from the local authority with the lowest rate of air travel.

The predominance of semi-rural and, in parts, wealthy communities in the East of England have resulted in the highest CO_2 emissions from transport of any region; 13 per cent higher than the national per capita average. The impact of commuting is noticeable, and is intensified by low car occupancy for commuting in some areas (1.1 persons per car in East Hertfordshire). This combination of high car ownership, low car occupancy, and high distance travelled leads to an Ecological Footprint for transport that is nearly 40 per cent higher than the UK average.

Energy

The East of England's lower than average household energy consumption somewhat makes up for its high transport Footprint, and brings its total Footprint closer to average. While the East of England's consumption of electricity is similar to the UK average, its consumption of gas – mainly used to provide heat – is about 15 per cent lower. The East of England's residents buy less electrical and audio-visual equipment, but have a higher Footprint from private education and weekend breaks within the UK. Overall, the region's consumption pattern and inflated Footprint reflect a society that is more affluent than the UK average and one that also travels long distances for work and leisure.

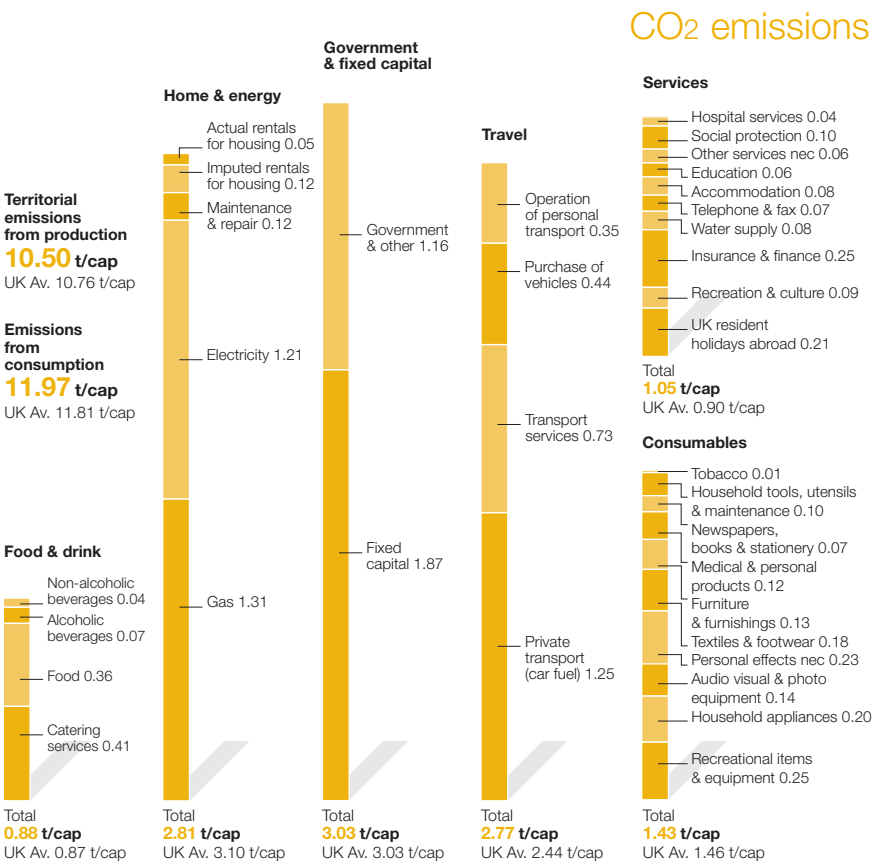


Fig 4 **CO_2 emissions from consumption in the East of England (t/cap)**

"Reflecting its role as a shipping and transportation hub, the East of England has very high material flows both into and out of the region."

Overview

Sustainable development in the East of England

> The East of England has many distinctive regional cities, large towns, and a significant rural landscape, and is home to around a fifth of England's market towns.

> With a growing population of 5.4 million, the region has one of the strongest and fastest growing economies in the UK, and is home to extensive Research and Development activity.

> The East contains many of the UK's most important international gateways and transport corridors.

> The Regional Economic Strategy (RES) aims to build on these existing strengths and also maintain its natural resources as a base for food, farming, and renewable energy. It also seeks to improve workforce skills, business enterprise and productivity, and counter-act deprivation and social exclusion.

> The region's high level of growth has created increasing pressures on housing, transport, and other infrastructure and services, while per capita levels of public expenditure are the lowest in the country.

Future implications

Though the sustainable consumption and production agenda itself is not directly visible in the RES, it does address renewable energy, rural diversification, and the controversial question of the rate of new housebuilding. Major new public transport is not likely in the foreseeable future, but the continued growth of the Cambridge – Stansted corridor, the northern Thames Gateway, and other growth areas may bring opportunities for more integrated sustainable development. Under the current status quo, the increase in demand for personal transport will be met mostly by private vehicles.

Spotlight

Scenarios for waste and transport in the East

The region is currently developing a new Regional Spatial Strategy (RSS) which will help plan through to the year 2021 for issues such as economic growth, housing, transport, waste management, and mineral extraction. The final RSS will be published later in 2006. To demonstrate how Ecological Budget UK data can be applied, we have selected some of the draft RSS targets related to waste and transport, listed the various scenarios they have projected for meeting those targets, and assessed how these different scenarios would impact the East of England's Ecological Footprint.

Waste

The draft East of England RSS[1] sets out a strategy to reduce the total amount of material that ends up as waste. Researchers affiliated with the Ecological Budget UK project undertook an extensive Ecological Footprint analysis of the different possible future waste scenarios for the County of Hertfordshire. Hertfordshire represents nearly 10 per cent of the East of England's population, making it a good statistical sample size for the region as a whole. However it should be noted that Hertfordshire is not a representative social or economic template for the whole of the region, as this would mask key regional variations. This Hertfordshire analysis demonstrates the importance of a waste minimisation target. Recycling without overall waste minimisation is not highly effective. As it is, Hertfordshire's waste programme (scenario 4) has both a waste minimisation programme (which the RSS currently does not have) and more stringent recycling requirements than the RSS.

The results – the Ecological Footprint of five different waste scenarios in Hertfordshire

Scenario 1 – RSS targets for recycling + no waste minimisation
Continuing to meet existing RSS waste targets will bring a 5 per cent increase in the Ecological Footprint from 2001 to 2023.

Scenario 2 – RSS targets for recycling + Hertfordshire Waste Minimisation Plan
This scenario will decrease the Ecological Footprint by 10 per cent.

Scenario 3 – Hertfordshire Recycling Targets + no waste minimisation strategy
If Hertfordshire recycles 50 per cent of its waste and its discarded waste grows by 2.5 per cent (a decrease of the RSS targeted waste growth of 3 per cent) each year after 2012, the Ecological Footprint will decrease by 20 per cent.

Scenario 4 – Hertfordshire Recycling Targets + Hertfordshire Waste Minimisation Plan
This scenario will bring about a 25 per cent reduction in the Ecological Footprint by 2021 but a 5 per cent increase from 2021 to 2023.

Scenario 5 – Hertfordshire Waste Minimisation Plan + Potential Best-Practice Recycling Targets (72 per cent of waste by 2023).
If Hertfordshire uses our best practises recycling model in their plan, they will recycle 72 per cent of their waste by 2023, and the Ecological Footprint will be reduced by 35 per cent.

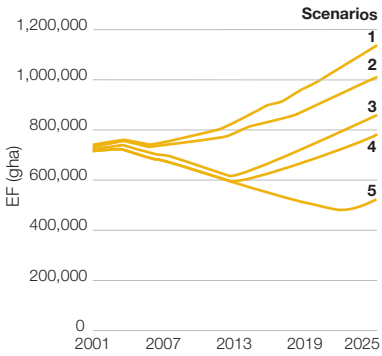


Fig 5 **Ecological Footprint waste scenario results**

The existing Waste Strategy (Scenario 4) will bring a 5 per cent increase in the Ecological Footprint from 2021 to 2023.

ROGER SCRUTON/COLLECTIONS PICTURE LIBRARY

Scenario 5 provides an insight into how recycling and waste generation relate. Even if increased recycling achieves a significant Ecological Footprint reduction for a time, an increasing tonnage of total waste will eventually outweigh that. All scenarios demonstrate what would happen in the long term if recycling is successful but waste generation continues to increase: an initial dip in Ecological Footprint, but a long-term increase. In short, recycling must be coupled with a waste minimisation plan in order to reduce the Footprint over the long term.

The projected Footprint under Scenario 5 suggests that it would be helpful to have an even more aggressive waste minimisation plan in Hertfordshire and the East of England in general. For example, the region could work towards a goal of zero waste growth after 2012. One controversial but proven technique to achive this is enforcing a fee on residents and businesses based on the weight of their waste. In terms of waste, Hertfordshire is an instructive model for how sustainable waste policy in the East of England might look.

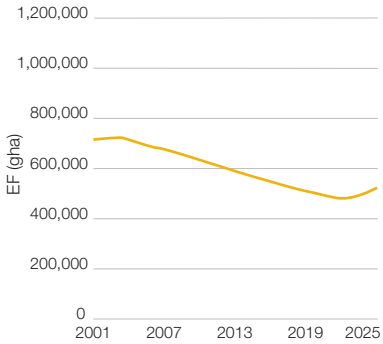


Fig 6 **Waste scenario 5**

Transport

Again using Hertfordshire as a sample size for the East as a whole, we will analyze the impacts of current transport policies on the Ecological Footprint. The East of England's draft RSS has some measures in place that might reduce car travel. These include: (1) target 4, to increase the proportion of people that work locally; (2) target 34, to increase non-car transport use; and target 36, to stabilize car journeys into urban areas.2 If Hertfordshire were to introduce no additional measures on top of those recommended in the draft RSS, its projected Footprint from travel would continue to increase by 1.1 per cent per year, a 17 per cent increase over 15 years.

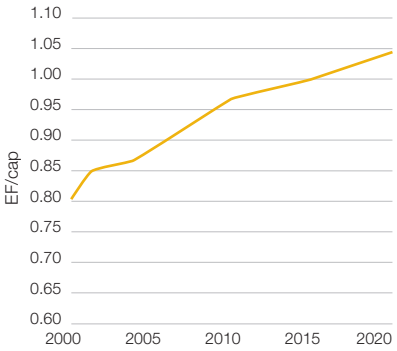


Fig 7 **Projected Ecological Footprint per resident given existing Hertfordshire policies**

The 6 per cent increase in fuel efficiency has done very little in comparison to the growth in the Ecological Footprint through increased mobility (17 per cent increase in Ecological Footprint).

1 See the East of England's RSS Target 53 at http://www.eera.gov.uk/category.asp?cat=120
2 See the East's RSS at http://www.eera.gov.uk/category.asp?cat=120

Results: The projected Ecological Footprint of transport in Hertfordshire, under current policies.

Listed below are all the components that comprise Hertfordshire's total transport Footprint. Some components reduce the Footprint or have little effect on it; others increase it dramatically. This is why the total transport Footprint continues to rise in the graph (left), a 17 per cent increase from 2005 to 2020.

1 If the *number of occupants per car* is reduced from 1.56 to 1.50, this will bring about a 1.2 per cent increase in the Ecological Footprint between 2005 and 2020.

2 An increase in the total *distance travelled by cars* will bring about a 21 per cent increase in the Ecological Footprint from 2005 levels by 2020.

3 Increased *efficiency in cars and buses* will reduce the Ecological Footprint of transport by 6 per cent from 2005 levels.

4 Increased *use of buses and trains* will bring about a 0.2 per cent increase in the Ecological Footprint from 2005 levels to 2020.

5 An increase in the *purchasing of* (predominantly *second) cars* per household will contribute to a 3 per cent increase in the Ecological Footprint from 2005 levels to 2020.

6 An increase in the *use of taxis* will bring about a 0.3 per cent increase in the Ecological Footprint from 2005 levels to 2020.

East Midlands

Material flow analysis

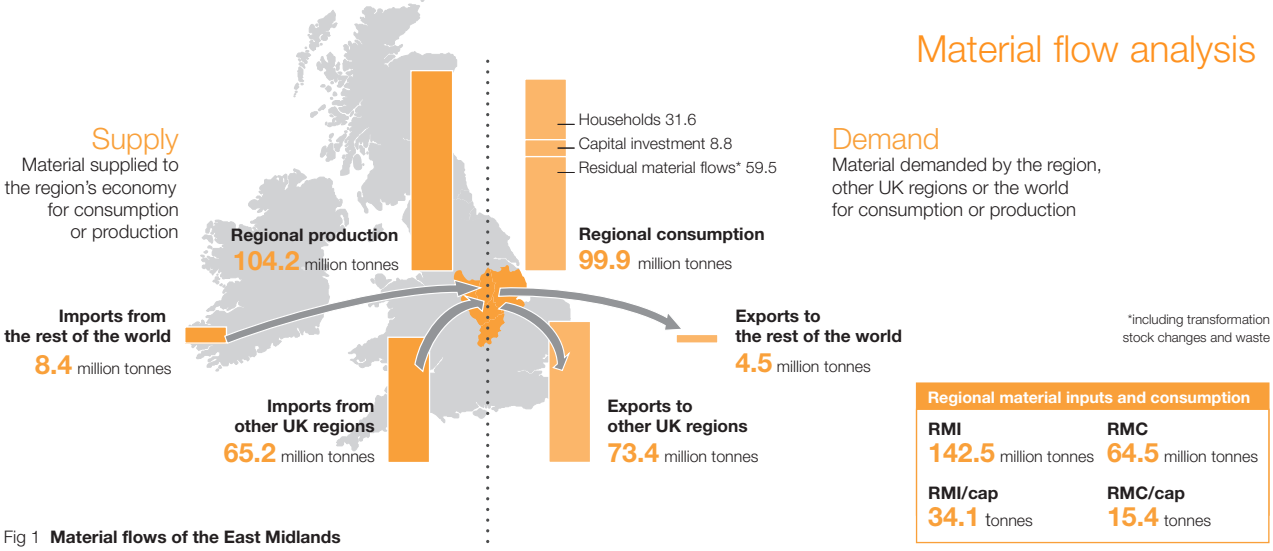


Fig 1 **Material flows of the East Midlands**

Ecological Footprint

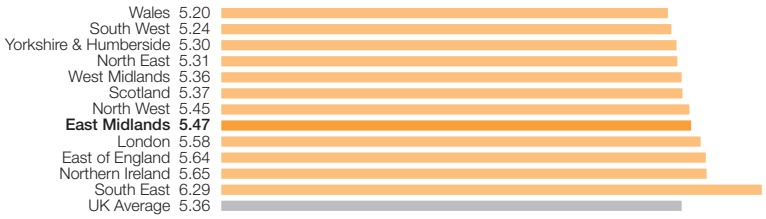


Fig 2 **Regional Ecological Footprints (gha/cap)**

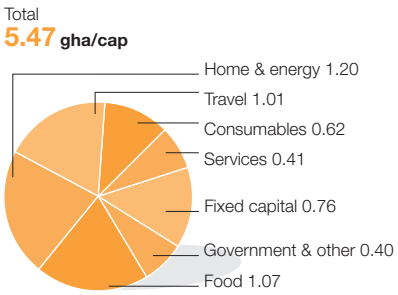


Fig 3 **The East Midlands' Ecological Footprint (gha/cap)**

Analysis

The East Midlands' Ecological Footprint and per capita carbon dioxide emissions from consumption are very near the UK average. However, like the rest of the UK, there is significant variation between the Ecological Footprint and CO_2 emissions of different local authorities and socio-economic groups[1].

A more detailed look reveals significant differences within the East Midlands. The biggest local authority Footprint is 11 per cent larger than the smallest. The difference between socio-economic groups is more extreme. The group with the biggest Footprint has one that is 35 per cent larger than the smallest. To put this in context, the difference between the largest Footprint UK region (the South East, at 5.86 gha/cap) and the lowest (Yorkshire and Humberside, at 5.00 gha/cap), is around 16 per cent.

Very distinct differences in consumption are responsible for variations within the East Midlands. Energy consumption in prosperous enclaves (see Figure 5) is 74 per cent higher than in areas of high employment, and the high-low variation for the Footprint of air travel between these two groups is 62 per cent. In contrast, the variation between the Ecological Footprint of food is less extreme – about 20 per cent. Wealth generally leads to a higher individual Footprint, but this variation is due less to essential consumer items such as food than non-essential optional items such as air travel and high energy use. In light of this, it is possible to lower a population's Ecological Footprint without threatening the basic quality of life.

As a general rule, Ecological Footprint and CO_2 emissions are higher from a meal

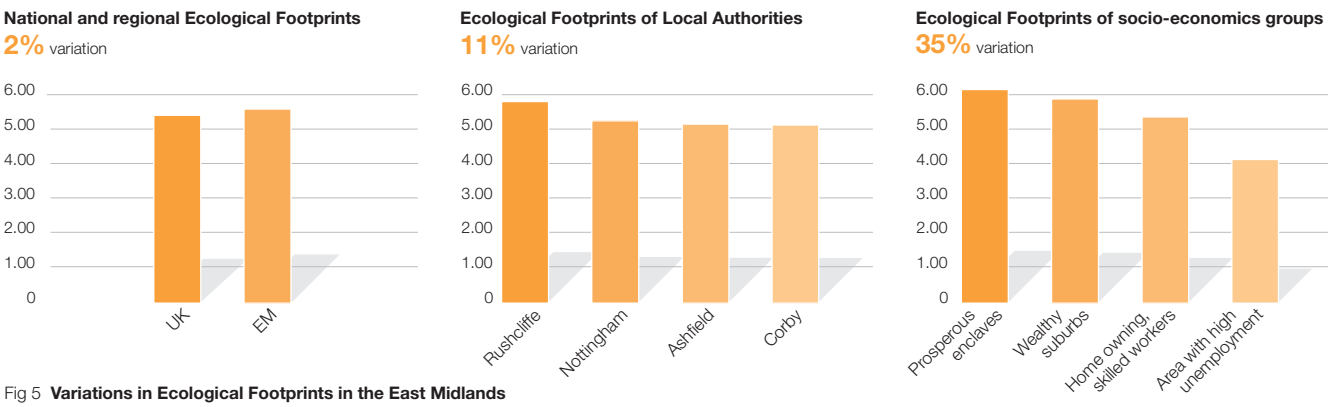


Fig 5 **Variations in Ecological Footprints in the East Midlands**

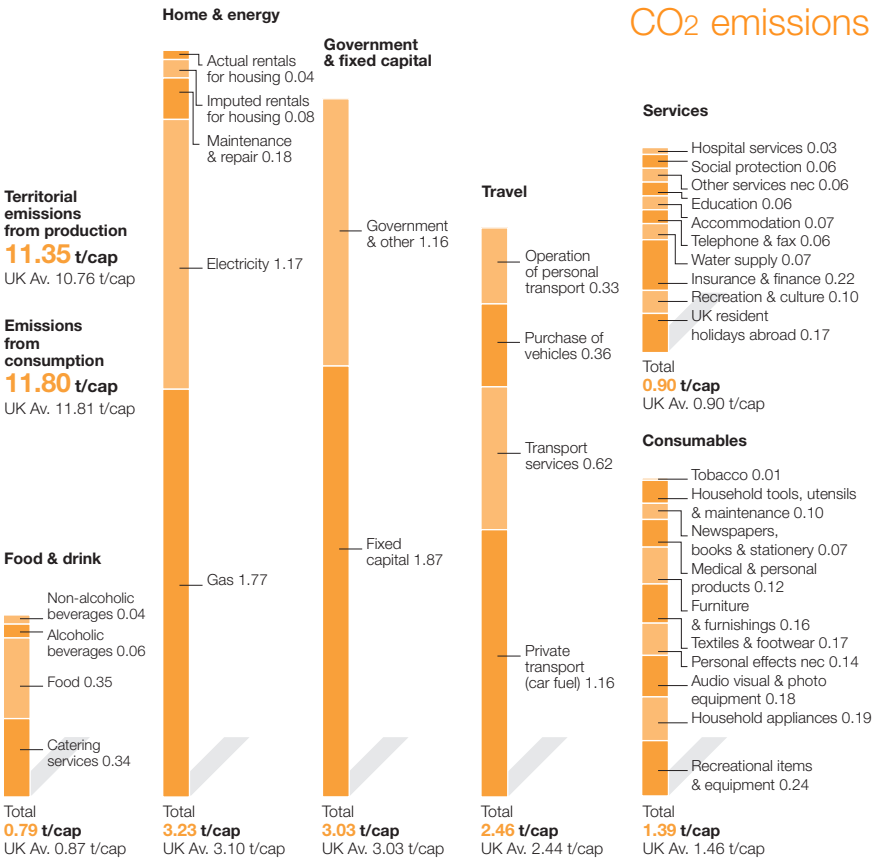


Fig 4 **CO_2 emissions from consumption in the East Midlands (t/cap)**

at a restaurant than at home. Residents of the East Midlands eat out less often than the national average, so CO_2 emissions from eating out are 10 per cent lower than the national average.

Material flow

The East Midlands contributes substantially to the weight of the UK's economy. It has the second highest Regional Material Input (RMI) and third highest Regional Material Consumption (RMC), amounting to 34.1 t/cap and 15.5 t/cap respectively. About 48 per cent of the physical flows into the East Midlands economy (that is, originating within the region) are from regional material production: at 68.8m tonnes total or 16.5 t/cap this is second highest on a per capita basis across the UK. A further 46 per cent or 15.62 t/cap of the RMI indicator stem from imports from other regions, which is the highest across the UK.

However, this is only one side of the East Midlands' heavy involvement in regional trade: it is also the biggest material/physical exporter to other UK regions at 17.59 t/cap. Overall, it therefore involves most heavily in regional physical trade, shipping 138.7m tonnes of materials in and out.

While this physical trade with other UK regions is most pronounced, the East Midlands' material exchanges with the rest of the world are much less developed. Per capita, both imports and exports rank third lowest among regions, making only 4 per cent and 2 per cent of the UK's imports and exports from/to other countries respectively. However, this cannot belittle the overall importance of trade. Summing

continued over the page

Overview

Sustainable development in the East Midlands

- The East Midlands, between the expanding mega-city of London and the former industrial areas of the North, includes traditional rural communities but increasing intensive agriculture and urban commuting. Its three urban centres are Nottingham, Leicester, and Derby.
- The East Midlands' Regional Economic Strategy (RES) is a good example of a typical UK regional strategy document, with themes including enterprise, employment, transport, tourism and culture, rural development, and urban regeneration.
- The East Midlands' Regional Development Agency seeks to measure economic performance against a Top 20 Index of sustainable development criteria, which include Gross Domestic Product per head, unemployment rate, differences between highest and lowest performing localities, and measures of energy use and waste production.
- There is a long history of environmental initiatives in the region. Leicester was the UK's first "Environment City," Newark and Sherwood had some of the UK's first low-energy housing, and Nottingham has a sustainable urban transport initiative.

Future implications The East Midlands Top 20 Index format for measuring sustainable development succeeds in covering a variety of sustainable development issues, but could be expanded to more explicitly reflect how ecological limits and environmental impacts link to economic growth, social welfare, and quality of life.

1 For this example, "Socio-economic groups" are organised by the ACORN Classification – A Classification of Residential Neighbourhoods". For further information visit www.caci.co.uk.

Analysis continued

all material exchanges with other regions as well as the rest of the world, the East Midlands still exhibits the highest per capita level of trade at 36.3 t/cap.

On a net basis, the East Midlands exports more than it imports. Taking into account all trade flows within the UK and the rest of the world, the East Midlands is a net material exporter, with a physical export surplus of 4.3m tonnes. Interestingly, like some other regions and devolved countries, this physical weight of trade activities outweighs the total regional material intake from regional production and imports: in other words, the East Midlands trades more materials than it uses within all production and consumption processes.

"East Midlands trades more materials than it uses within all production and consumption processess"

So far we have mainly expressed the regional material flows in terms of production – where the various material flows occur. We can also express them in terms of consumption and allocate the required domestic and import flows across various final demand activities. Household activities in the East Midlands, for example, are also more material-intensive than the UK average. To provide the goods and services consumed in the East Midlands, 7.6 t/cap or 31.6m tonnes of materials were required through the various lifecycle stages in the production chain. As much as 9.7m tonnes or 31 per cent of these were from mining energy-producing materials, another 6.3m tonnes from agriculture, hunting and forestry, and 5.5m tonnes from food, beverages and tobacco.

Spotlight

Low Footprint transport in Nottingham

In contrast to most other cities in the UK, Nottingham is moving towards decreasing its per capita transport Footprint. It is very difficult to decouple growth in transport from a higher transport Footprint and higher CO_2, but Nottingham is attempting to do this. Its Ecological Footprint for transport is 36 per cent lower than neighbouring Rushcliffe, demonstrating how much a Footprint can vary among local authorities in the East Midlands.

To begin with, Nottingham has a compact city centre that encourages alternatives to car transport. In that context, the city and county's joint Local Transport Plan, launched in 2001, has developed a new transport network that integrates buses, trams, cars, taxis, walking and cycling. An updated five-year plan, to be launched in April 2006, aims to continue "reducing traffic growth and encouraging the use of alternatives to the car".[2]

Average road traffic in the East Midlands has increased by 20 per cent over the last 10 years.[3] However, over the past seven years, overall traffic in Nottingham has dropped by 0.4 per cent, and bus and tram use has increased by over 8 per cent.[4]

A compact city centre

Nottingham's compact city centre reduces its transport Footprint. This compactness is an intrinsically low-Footprint design that many other UK towns also share. When shops and services are close together, it is easier to walk, cycle or take the bus than to drive. Central Nottingham, for instance, has an average of 0.7 vehicles per household, compared with 1.1 vehicles for the greater Nottingham household. Low car ownership always contributes to a lower Ecological Footprint and lower CO_2 emissions.

Many UK cities have (or have had) a compact, lower Footprint city centre. As they work towards sustainability, they have an advantage over cities that are historically more vehicle-focused. Nottingham city centre's pedestrian-friendly, car-restricted "Clear Zone"[5] – a model that many other UK towns also share – further enhances the appeal of low-Footprint transport options. Economically, walkable city centres also tend to increase a city's commercial appeal by attracting more people.

"When shops and services are close together, it is easier to walk, cycle or take the bus than to drive"

LONELY PLANET

Travelling to work and work travel plans

The way people travel to work affects the transport Footprint. Commuting makes up 20 per cent of Nottingham's transport Footprint (excluding air travel), and a quarter of all miles driven in cars and vans are miles driven to work.[6] In Nottingham, commuter travel is particularly important, as it is the UK's ninth largest "travel to work" area.[7]

Nottingham was a pioneer of the "workplace travel planning" concept in the early 1990s. A workplace travel plan is a coordinated effort to promote alternatives to driving to work. In Nottingham, this has meant greatly improving bus, cycle and walking routes as well as promoting car share schemes, offering financial incentives for not driving, and implementing car park restrictions and charges.
Nottingham decided to focus its efforts on a handful of the city's largest employers. Now, 25 employers and some 52,000 employees promote and use alternative commuting plans.

PHOTODISC

Soft policies and behaviour change

"Soft policies" contribute to a change in behaviour without major infrastructure change. Travel plans, car sharing schemes, travel awareness campaigns and the encouragement of teleworking and home shopping are all "soft policies" in which Nottingham has invested. Although there are limits to what they can achieve, these policies often offer high returns for minimal investment. For example, one study suggests that having groceries delivered to the home instead of driving to a shop or supermarket reduces the Footprint of grocery shopping by 70 per cent per load delivered. Travel plans have worked effectively in Nottingham and elsewhere, and teleworking generally reduces car use.

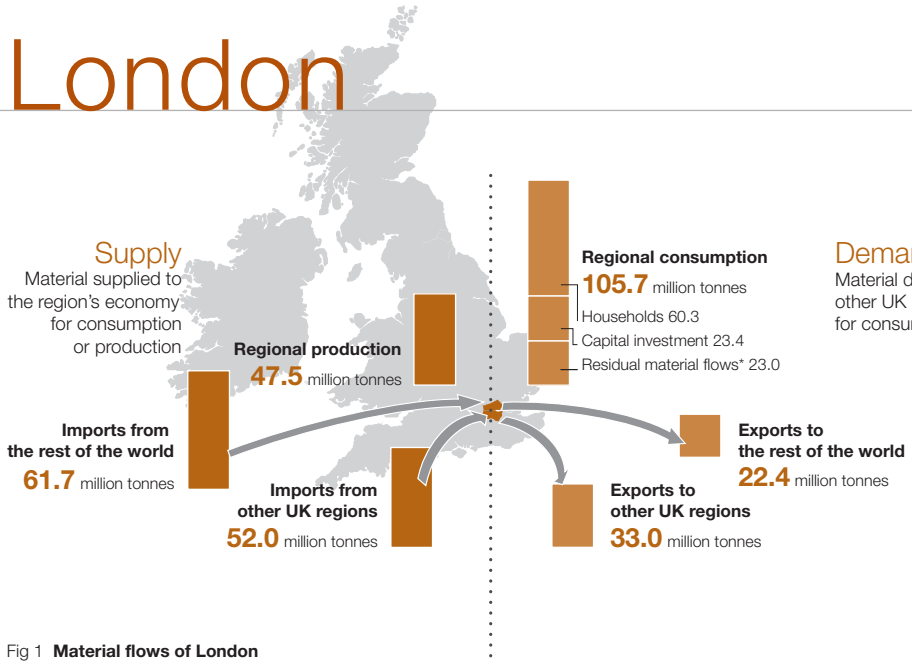
Scenarios for the future

It is estimated that 28 per cent of Nottingham's working population is involved in some sort of travel plan. Assuming that the city's travel plans have had the same effect as the average UK travel plan (18 per cent less car travel for people using the plan), the transport Footprint of someone involved in a Nottingham travel plan is reduced by 10 per cent. Nottingham's travel plans still have room for improvement; the travel plan at Orange Telecommunications in Temple Point, Bristol[8] managed to reduce commuters' car mileage by 66 per cent, using a combination of initiatives such as limited parking and parking charges.
If Nottingham City's plan were as successful as this, and the whole of greater Nottingham were involved, the transport Footprint of the average travel plan commuter would be reduced by 38 per cent. In which case, the total Ecological Footprint of Nottingham would be reduced by 33,000 hectares (gha) – an area almost half the size of Greater Nottingham.

2 www.nottinghamcity.gov.uk/ltp2_executive_summary_oct05.doc
3 www.sustainable-development.gov.uk/performance/performance.htm
4 www.nottinghamcity.gov.uk/sitemap/transport_and_streets.htm
5 www.nottinghamclearzone.com
6 Focus on Personal Travel, 2005, DfT
7 Report to the Executive directors, Nottingham express transit, 2002, www.netphasetwo.com/downloads/EXE2404B.pdf
8 Cairns, S., Sloman, L., Newson, C., Anable, J., Kirkbride, A. & Goodwin, P., 2004, "Smarter Choices – Changing the Way We Travel". Final report of the research project: The influence of soft factor interventions on travel demand. Department for Transport, London, 20 July 2004. www.dft.gov.uk. See report at www.dft.gov.uk/stellent/groups/dft_susttravel/documents/page/dft_susttravel_027707.pdf.

London

Material flow analysis



*including transformation stock changes and waste

Regional material inputs and consumption

RMI	RMC
145.3 million tonnes	89.7 million tonnes
RMI/cap	**RMC/cap**
20.0 tonnes	12.0 tonnes

Fig 1 **Material flows of London**

Ecological Footprint

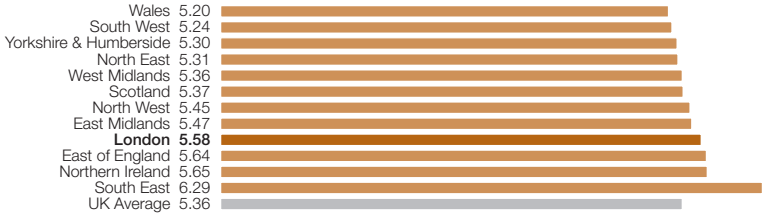


Fig 2 **Regional Ecological Footprints (gha/cap)**

Total
5.58 gha/cap

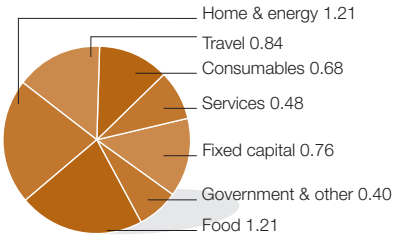


Fig 3 **London's Ecological Footprint (gha/cap)**

Analysis

Material flow

More than any other region, London's consumed resources come from outside of the region. There is little industry (hence its low CO_2 emissions from production, around 8 tonnes per capita), little food production, little fibre production, little capacity to absorb CO_2, and its waste is largely exported. Service industries are greatly concentrated in London, particularly financial services, which rely exclusively on resources from other countries or regions.

There is a considerable flow of resources through the capital: 113m total tonnes of materials were imported and 56m tonnes were exported in 2001. It is not surprising that London imports more material and goods than it exports since it is predominately a service economy. Only 13.5m tonnes of new goods physically enter all households in London ("direct flows"), meaning that on average, each household directly consumes 4.5 tonnes of materials per year. Of the total tonnes goods consumed, 7m tonnes of these direct flows into all households are food.

As is always the case with material flows, the "indirect flows" resulting from household consumption are much higher than direct flows into houses. This is predominantly due to construction and maintenance materials; they make up a smaller portion of direct flows into houses than food does, but require many more resources to be produced. Primarily because of construction materials, every tonne of material directly consumed by Londoners produces 3.5 tonnes of "indirect flows" that never enter the house.

Ecological Footprint

London's Footprint follows the general pattern of many metropolitan areas. Its Ecological Footprint from goods and services is high, while its transport Footprint is relatively low. Primarily because of high rates of eating out, London's food Footprint is the UK's second highest (1.21 gha/cap, against a UK average of 1.14 gha/cap). Its Ecological Footprint from services is the UK's highest (0.39 gha/cap, as compared to a national average of 0.31 gha/cap). On the other hand, because it relies heavily on non-car transport, its total transport Footprint is 0.60 gha/cap, significantly lower than national average of 0.68 gha/cap.

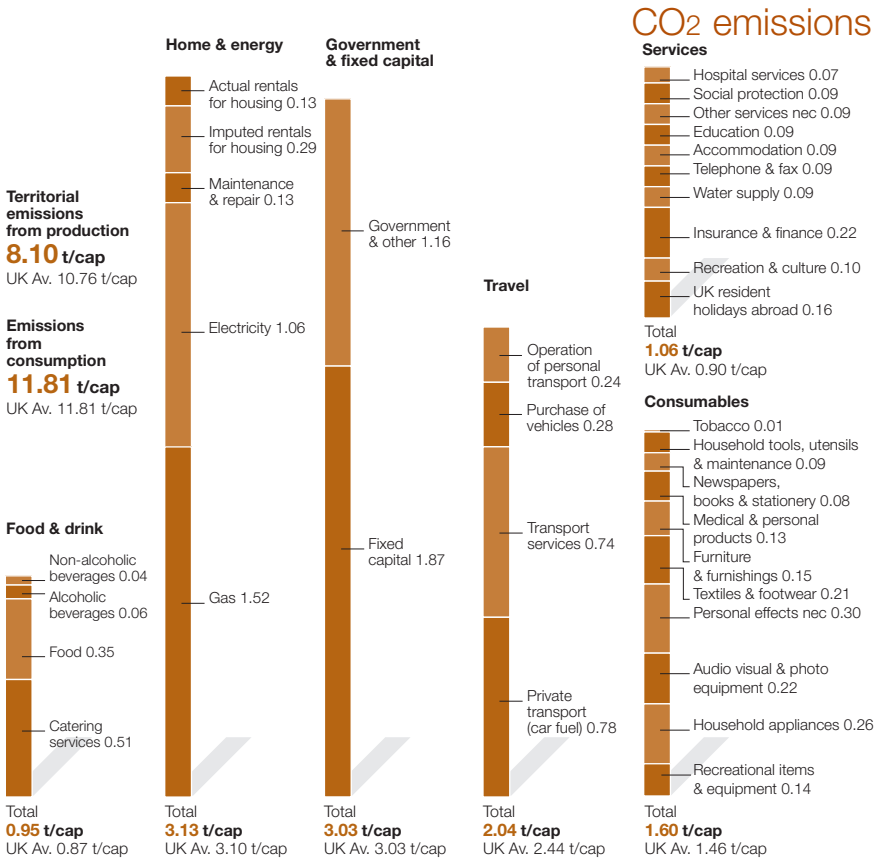


Fig 4 **CO_2 emissions from consumption in London (t/cap)**

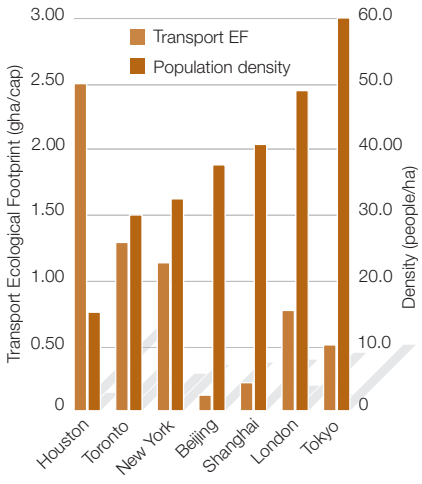


Fig 5 **The relationship between urban density and transport footprint**

The analysis above, compiled for the Ecological Budget UK project, describes the Ecological Footprint and density of seven cities. London's Ecological Footprint is magnitudes lower than some lower density cities, supporting the carbon dioxide and Footprint results.

CO_2 emissions from consumption

London is among the highest in the UK for carbon dioxide emissions from consumption, outpaced only by the East of England and the South East. London's carbon dioxide emissions from consumption are 15 per cent higher than the UK average, due mainly to three activities: travelling abroad, eating out, and "recreational and cultural services."

Recreational and cultural services include the impacts associated with venues and events for sports, cinema, theatre, music and entertainment. Not surprisingly, London has higher than average emissions as a result of services provided at these facilities. However, it is also important to remember how "consumer responsibility" emissions are reflected in Ecological Budget UK. Some entertainment that takes place within London is allocated to consumers from elsewhere; for example, a North East

continued over the page

Overview

Sustainable Development in London

- London has a highly productive global economy, and is also an increasingly expensive and congested place to live or do business (by 2016, population is projected to grow by 800,000).
- London has high unemployment, child poverty and concentrations of disadvantage.
- London's Economic Development Strategy seeks to address these challenges by 1) investing in people: increasing employment, reducing workforce disparities, and addressing concentrated areas of disadvantage, and by 2) investing in enterprise: encouraging business start-ups, improving workforce skills, and continuing productivity and innovation in London's enterprises.
- Much of London's economic strategy depends on the physical and infra-structure issues in the spatial strategy (London Plan); many social inclusion measures depend on government schemes such as New Deal for Communities and Sure Start, and local environmental measures largely depend on the 33 London Boroughs.
- The London Plan aims for ultra-efficient new and existing buildings, though much depends on complex coordination of local efforts and the level of sustainability in London's 1,400 neighbourhood centres.

Future implications It is clear that London will always be a net importer of materials and a net exporter of value-added services. Therefore, for London to achieve its Footprint targets, it must both address rising consumption and bring about changes in production further up the supply chain, encouraging environmental and social sustainability in corporations and public organisations. The London Plan is an opportunity to transform the housing and building stock to ultra-efficient development. On the transport front, major Footprint-reducing steps (such as London's city-centre congestion charge on private automobiles) have been taken, and will reduce London's transport Footprint. However, these gains are generally overtaken by year on year increases in air travel.

Spotlight

The Ecological Footprint of services and housing

resident visiting London to see an opera is responsible for those emissions. Thus, the numbers shown for recreational and cultural services emissions represent emissions resulting from Londoners at their leisure.

"London's recent 'bus renaissance' has been almost entirely responsible for a 12 per cent increase in total bus use in the UK"

Transport

Personal transport Footprints and CO_2 emissions for Londoners are noticeably lower than average. Residents of London do not travel as far or use cars as much as the rest of the UK. This reflects an increase in urban density, low car use, and a continually improving public transport system.[1]

London's recent "bus renaissance" has been almost entirely responsible for a 12 per cent increase in total bus use in the UK. The Footprint of buses does not necessarily increase within increased bus patronage. In London, while more buses have been brought into service and new routes established, inefficiencies in the system have also been removed. Bus occupancy is an excellent example that has risen in London peak time from 28 people per bus in 1994 to 44 people today[2]. Nationally, buses are only 22 per cent full. In London peak travel time this has increased to nearly 100 per cent, reducing the Ecological Footprint of travelling one km by bus in London by 80 per cent.

The Ecological Footprint of services in London

As highlighted, the demand for services in London is high. Earlier analyses about the impact of services have only taken into account the "on-site" impacts of consumption, the direct energy used and waste produced. This has resulted in a previous underestimation of the true impact of consumption. However, for a service to function, it demands resources from nearly all industrial sectors. Ecological Budget UK's analysis of London has taken into account the direct (on-site) and indirect (off-site) impacts. This provides a unique and detailed insight into the service economy of London. The Ecological Budget UK project's Extended Environmental Input-Output Model re-allocates the indirect flows of energy and materials to services in London, tracing the demands of the service economy on all industrial sectors. Figure 6 indicates the variation between the indirect and direct carbon footprint in London for several key services.

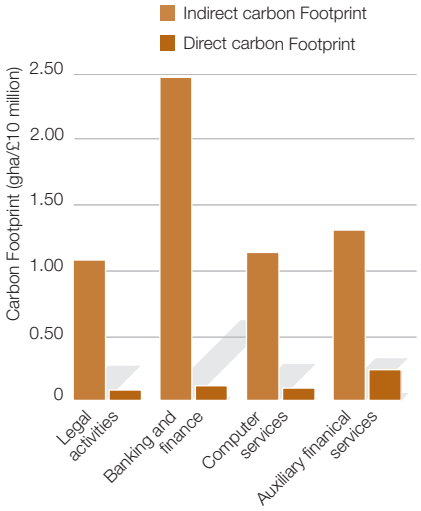


Fig 6 **The indirect and direct carbon footprint of key London services**

This new analysis demonstrates the importance of taking indirect flows into account, particularly in the service sector, where many effects are hidden. For example, the legal sector's direct emissions only account for 9 per cent of its total impact. For the banking and finance sector, direct impacts only account for 5 per cent of their total, meaning that in the past 95 per cent of the impact has been ignored. Most of the impact from London's services occurs outside London, though this has not been documented in previous analyses. Because these indirect flows have been ignored, the data would lead

1 Stead, D., Williams, J. & Titheridge, H., 2000, "Land use, transport and people: identifying the connections" in Williams, K., Burton, E. & Jenks, M., *Achieving Sustainable Urban Form,* London, E & F Spon.
2 http://www.tfl.gov.uk/tfl/press-centre/press-releases/press-releases-content.asp?prID=596
3 To learn more about REAP, see www.sei.se/reap

LONELY PLANET

us to believe that a simple shift to a "service economy" is a viable way to achieve sustainability. Yet in simply shifting to a service economy to achieve sustainability locally, the ecological impacts are simply moved elsewhere.

Supplementary Planning Guidance and REAP

There is considerable evidence that London actively and explicitly seeks to be a sustainable city. The Mayor and the GLA have correctly targeted London's housing as a key sustainability issue and have taken steps to improve standards through the London Plan and associated Supplementary Planning Guidance.

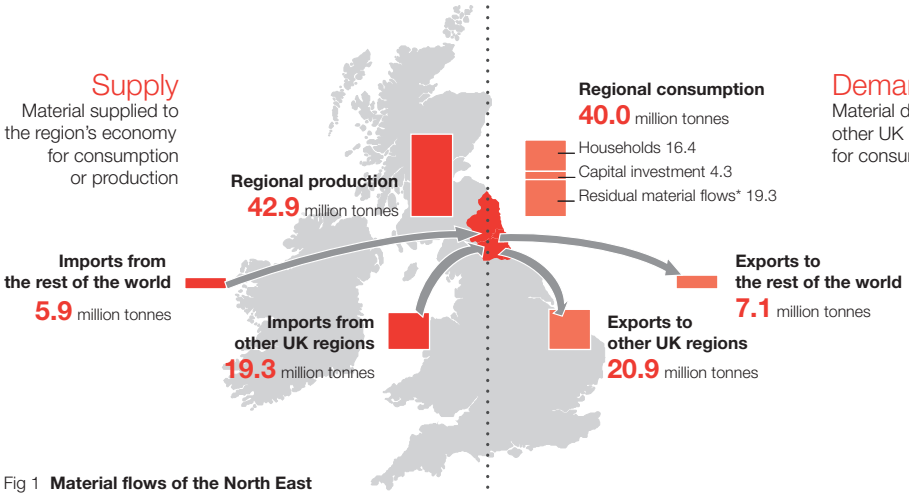
Currently, emissions from household energy consumption in London are substantial, accounting for 27 per cent of total CO_2 emissions (taking into account all indirect energy flows such as maintenance of the energy infrastructure and energy required in mining and drilling). The London School of Economics (LSE) is working with the Ecological Budget UK project to assess potential Footprint savings that could result from London's Supplementary Planning Guidance on Sustainable Design and Construction.

The LSE will use the Resources and Energy Analysis Program (REAP) scenario projection software that has been developed as part of Ecological Budget UK.[3] LSE will create housing construction scenarios for London based on the 'Mayor's preferred standards'. and use REAP to compare the resource-use impacts of these scenarios. The detailed component-based ecological footprint data that is produced in REAP can then be used as a tool for local planners and policy makers to compare the ecological impacts of different planning standards and combinations of standards. If applied more widely, this project could be used to establish a baseline for sustainability appraisals of local plans and enable local authorities to empirically assess sustainable housing policies and rate progress.

"In shifting to a service economy to achieve sustainability locally, the ecological impacts are simply moved elsewhere"

North East

Material flow analysis



*including transformation stock changes and waste

Regional material inputs and consumption

RMI	RMC
55.2 million tonnes	27.1 million tonnes
RMI/cap	**RMC/cap**
22.0 tonnes	11.0 tonnes

Fig 1 **Material flows of the North East**

Ecological Footprint

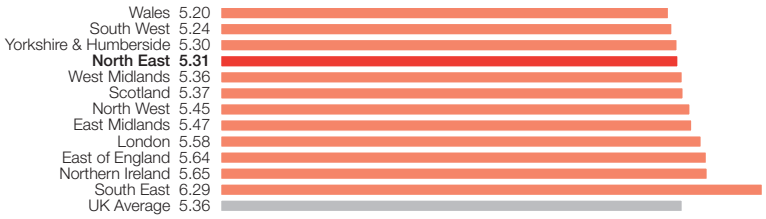


Fig 2 **Regional Ecological Footprints (gha/cap)**

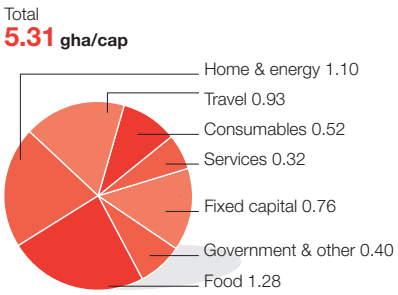


Fig 3 **The North East's Ecological Footprint (gha/cap)**

Analysis

The North East has the largest variation between "producer responsibility" and "consumer responsibility" carbon dioxide emissions of any UK region or devolved administration. Emissions from regional production are close to 16 tonnes per person, while emissions from consumption are only 11 tonnes per person – a 32 per cent difference.

The North East's role as a big producer gives it considerable influence over total emissions produced in the UK. Improved production efficiency could help offset high consumption elsewhere, whereas less efficient production will magnify the effects of consumption in other regions. In contrast to its high emissions from production, the North East has the lowest CO_2 emissions from consumption of any UK region or devolved administration. Together, these echo a pattern found in other regions and devolved countries. The North East's CO_2 emissions are 7 per cent lower than the UK average, and 18 per cent lower than the South East. The analysis below gives some insight into why this is so.

Material flow

Because the North East has high production and low Domestic Material Consumption, many of its imported materials are used in production and then re-exported. The North East economy required 36m tonnes of materials to function, of which a considerable proportion was imported from other UK regions (19m tonnes) and a lesser amount from the rest of the world (6m tonnes). Most of these resources (28m tonnes) are then exported to the rest of the world.

This is consistent with the North East's very low Regional Material Consumption (RMC) (which is in turn consistent with its low Ecological Footprint and low CO_2 emissions from consumption). The North East has the lowest per capita household consumption in the UK at 6.5 t/cap. The highest in the UK are the South East (9 t/cap) and London (8.5 t/cap). Compared with other categories, the household consumption category is quite evenly distributed across the UK. Yet it is the biggest driver of material production, so even small variations in measurement have large ripple effects on the production chain and total resource use. The North East also has the lowest material flows in the UK into capital investment (1.72 t/cap), compared with a national average of around 2.31 t/cap and London, the region with the most at 3.13 t/cap.

Food and nutrition

Per capita CO_2 emissions from food consumption in the North East is near the UK average. North East households consumed 1.45m tonnes of food in 2001, or 0.6 tonnes per household. Just less than 120,000 tonnes of this was never eaten but disposed of in landfill, and a further 240,000 tonnes of food packaging waste was generated. A growing proportion of this packaging is being recycled: recent figures suggest 23 per cent of municipal waste is now recycled[1]. Food makes up a considerable proportion of the total Ecological Footprint (24 per cent), which is typical.

Transport

The average North East resident travels 9,500km a year. London is the only UK region or devolved country whose residents

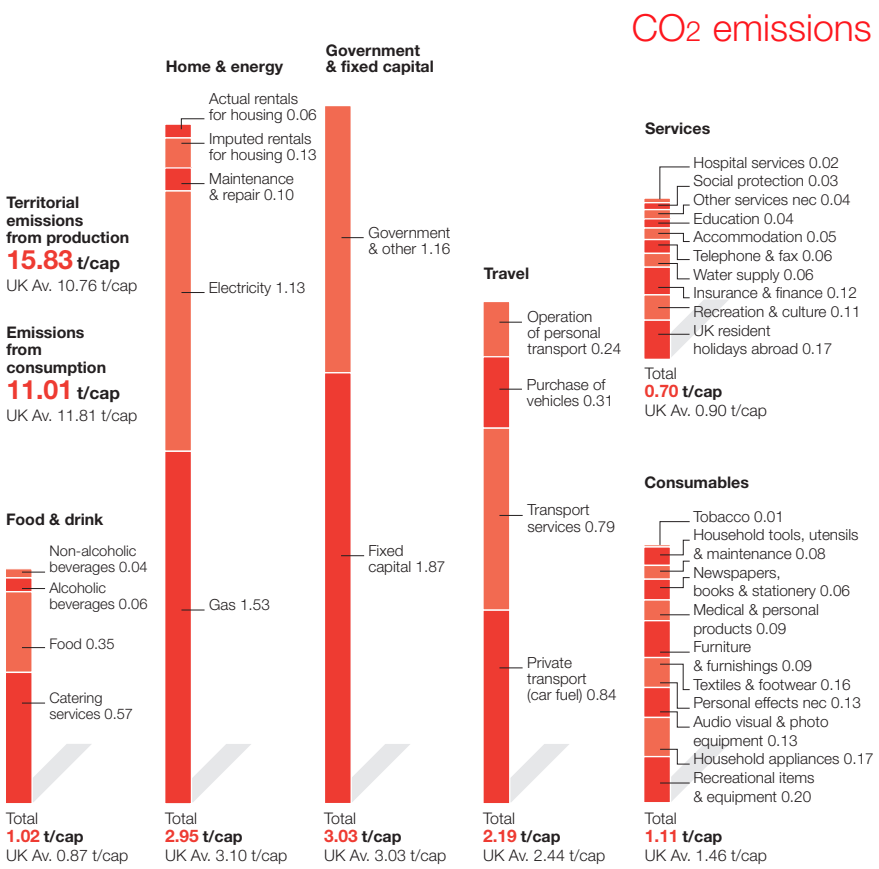


Fig 4 **CO_2 emissions from consumption in the North East (t/cap)**

travel less. This means that there is a lower material requirement for mobility and lower CO_2 emissions in the North East.

In terms of car ownership, the North East is also lower than the UK average, although ownership is growing faster than in any other English region. In 2001, this was 0.36 cars per person in the North East compared with the UK average 0.43 per person. As the average car in the UK weighs just over a tonne, this variation means that material consumption in the North East is 180,000 tonnes less than the UK average. The North East also avoids many indirect flows associated with car production. Research[2] suggests that some 20 tonnes of materials are required for one car – so the North East's relatively low car ownership creates a potential saving of 3.6m tonnes of materials a year.

Lower CO_2 emissions can be attributed more to less travel in general than to the use of more sustainable modes of transport such as rail and bus. Therefore, the challenge for both the Regional Economic Strategy (RES) and the Regional Transport Strategy is to ensure a low material input for future mobility while still meeting basic transport needs in the North East. This will keep CO_2 emissions stable in the region.

Eco-efficiency in production

Because a considerable amount of materials are produced in the region, the North East has a unique opportunity to address eco-efficiency of production. Such a change could be set comfortably within a RES, attempting to drive economic growth at the same time as maximum resource efficiency. By combining valuable data from this study and REWARD (Regional and Wales Resource Productivity and Development project)[3], the North East agencies can work with key local resource and energy users. Increased efficiency in production will also contribute to a reduction in CO_2 emissions from consumption in other UK regions and devolved administrations. At present, they consume nearly 20m tonnes of materials and goods produced in the North East.

1 Data from Defra Waste Statistics, available from www.defra.gov.uk/environment/statistics/waste/kf/wrkf07.htm

2 Moll, H.C., 2002, "Changing material use in passenger cars: a road to sustainable use of materials and energy?" in: *Proceedings of the OECD International Conference "Towards sustainable transportation"*, Hull (Quebec), Canada.

Overview

Sustainable development in the North East

> The North East economy is still effected by the 20th century collapse of shipbuilding and then coal mining. Rural areas are being re-discovered with a raft of eco-tourism activities, though the North East still has lower than average levels of entrepeneurship and job skills.

> The Regional Development Agency (RDA) strategy aims to raise business productivity and entrepeneurship, increase workforce skills, rely on the training capacity of the region's universities, meet arising transport needs, and realise the renaissance of rural and urban communities.

> The regional Science and Industry Council is working to build a stronger research base and improve performance, and five North East Centres of Excellence will form a link between university-based Research and Development and businesses.

> The region has a history of green initiatives; Newcastle, for instance, is the UK's first Carbon Neutral city, and now has a green urban renaissance strategy.

Future implications With its lower population, history of green initiatives, and strong levels of social and economic cohesion, the North East has great potential in terms of sustainable consumption and production. In terms of infrastructure, immigration and the demand for housing is lower than average, so market forces are less likely to spur major upgrading of the regional building stock and transport network in the near future.

3 REWARD is a research partnership linking the Environment Agency, the National Assembly of Wales and five Regional Development Agencies plus a supporting group of expert consultants. It is now expanding to all regions, including London. www.reward-uk.org

Spotlight

Sustainable communities in the North East

The city of Sunderland aims to develop sustainable communities. This is against the backdrop of the UK's new sustainable development strategy, *Securing the Future*, which has caused some debate in government about the definition of "sustainable communities". Ecological Budget UK can help benchmark what it means for a community to be sustainable. It also confirms that sustainable communities cannot focus on one isolated issue. Production, consumption and waste all influence each other, and successful sustainable communities require a broad, coordinated approach to sustainability.

Delivering sustainability at a community level is a way for people immediately and directly to reduce their Ecological Footprint and CO_2 emissions. Because of the smaller size of an individual community, residents can often move forward very quickly with their efforts, and have substantial impact around the UK and the world.

Housing and sustainable communities

The North East faces the challenge of dwindling traditional industries and a shrinking population. Economic prosperity is also declining, and the region has a widening poverty gap and low life expectancy compared with other parts of the UK. Most of the North East's many rural settlements and small market towns lie at a distance from major employment centres, lack affordable housing and have low access to public services. In terms of development, then, the North East's challenge is not to manage rapid growth, as is the case in much of the southern UK. Instead, it is to meet a basic standard of living, to ensure that vital infrastructure is maintained, and to encourage residents to stay in the area.

Developing attractive housing is one way to do this. As in other communities developing housing, the North East has an opportunity to build sustainability widely into its infrastructure at the same time as it seeks to provide affordable housing.

Recognising this, the multi-regional agency The Northern Way[4] addresses housing and sustainability. Its report, *Creating Truly Sustainable Communities*, suggests several programmes related to housing and low-Footprint design. It plans to use Ecological Footprinting to advise city regions on sustainable development, and embed the development of sustainable infrastructure into regional and local planning strategies. It also plans to complement increased energy efficiency in new homes with high quality design.[5] The North East's draft Regional Spatial Strategy is the first to be developed using The Northern Way's sustainability principles mentioned above, and the Regional Housing Strategies of all three northern regions have been developed under guidance from The Northern Way.

Sunderland: working towards a sustainable community

Sunderland City Council is an example of a local authority taking the lead on sustainable community development. Its Sustainable Development Strategy has been incorporated in the Community Strategy, which is supported by the Ecological Footprint as an environmental indicator. This is helping the authority achieve regional targets, such as those highlighted by The Northern Way, and is moving the council towards developing Sustainable Community Strategies, as encouraged by the Deputy Prime Minister.

Sunderland City Council has also launched a sustainability appraisal of its key strategies, beginning with the Local Development Framework. This has already highlighted the key sustainability challenges facing Sunderland: outward migration, an ageing population, high levels of land-filling, and others. The next step is to make sustainable communities the prime focus of Sunderland's Local Development Framework, helping clarify future options for waste and energy.

"Successful sustainable communities require a broad, coordinated approach to sustainability"

INGRAM PUBLISHING

"Neighbourhood groups generated ideas to reduce their Footprint in several ways, including growing food locally and organising box deliveries"

Community participation and Ecological Budget UK

The technique of participatory appraisal has been widely used in Sunderland to increase community input into development, increase community satisfaction, and garner community support for more sustainable designs. Successes include community-informed housing development on the Lambton Cokeworks site, and a better understanding of community needs for the Hetton Sustainable Transport Project.

As part of the Ecological Budget UK project, WWF-UK is working with Sunderland City Council to develop the Ecological Footprint more widely as a communication tool, and to demonstrate to community organisations how they can use the Footprint for planning. Through a series of community workshops, Sunderland engaged diverse groups such as St Anne's RC Primary School, the Pennywell Neighbourhood Centre, the Farringdon Jubilee Centre, The Access Point – Racecourse Estate, and the Quarry View Primary School, among others, to generate ideas for Ecological Footprint-reducing projects.

With help from the council, these neighbourhood groups generated promising project ideas to reduce their Footprint in several categories: raising awareness of sustainability through practical projects with groups, growing food locally and organising box deliveries of fruit and vegetables, distributing advice leaflets for sustainable practices in the home, and promoting cycling/walking initiatives. By encouraging the voluntary participation of community groups and using the Footprint as an instructive tool in plans and strategies, Sunderland is working towards a successful sustainable community programme.

National and local strategies for developing sustainable communities

> *Securing the Future*, the UK government's new sustainable development strategy, names sustainable communities as a priority.

> The Egan Review *Skills for Sustainable Communities* provides a broader definition of sustainable communities than had previously been used by the Office of the Deputy Prime Minister (ODPM).

> The Academy for Sustainable Communities, based in Leeds, was founded by the ODPM and provides training in achieving sustainable communities.

> The Local Strategic Partnership's Learning Programme on Sustainable Communities is jointly funded by Defra and the Academy for Sustainable Skills, and investigates how best to engage LSPs in learning about sustainable communities.

> The Audit Commission published the Ecological Footprints of all local authority areas in January 2006. This information will be available free of charge as a tool for communities seeking to measure their sustainability.

WWF-UK is using the information and results from the Sunderland project to explore the development of a community Ecological Footprint tool. Its main feature will be to develop a method to enable community organisations to measure their Ecological Footprint – in terms of transport, homes and energy, consumables, food, services, leisure and holidays, and other categories – then plan to reduce it.

The future of sustainable communities

The future of sustainable communities Sustainable development can start at the community level. Effective community programmes such as Sunderland's take a coordinated approach to sustainability, and capitalise on the smaller, more accessible size of their community. Increasingly, customised Footprint application tools and methods, such as the one being developed following the work in Sunderland, will be available to communities across the UK.

With the Ecological Budget UK project's release of the REAP modelling software[6], regions and communities will have an even more powerful tool to assess the potential ecological impacts of different development options.

4 The Northern Way was initiated by the Office of the Deputy Prime Minister and is led by three regional development agencies: One North East, Yorkshire Forward, and the North West Regional Development Agency. See more at www.thenorthernway.co.uk/index.html

5 This is a summary of The Northern Way's report *Creating Truly Sustainable Communities*. See the whole report at www.thenorthernway.co.uk/app_june05.html

6 To learn more about REAP, see www.sei.se/reap

North West

Material flow analysis

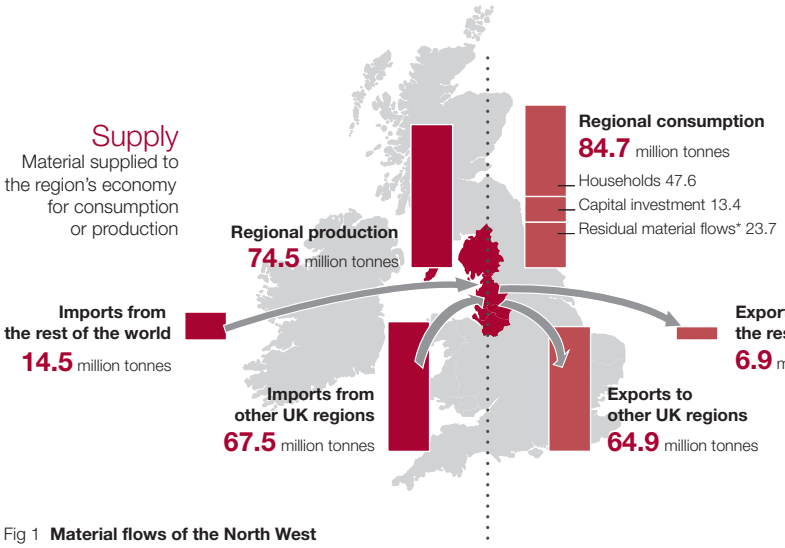


Fig 1 **Material flows of the North West**

*including transformation stock changes and waste

Regional material inputs and consumption

RMI 117.6 million tonnes	**RMC** 45.6 million tonnes
RMI/cap 17.4 tonnes	**RMC/cap** 6.7 tonnes

Ecological Footprint

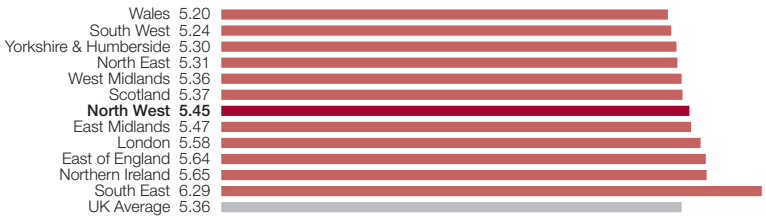


Fig 2 **Regional Ecological Footprints (gha/cap)**

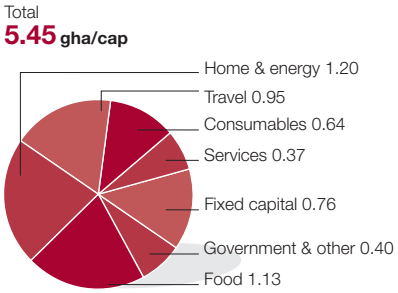


Fig 3 **The North West's Ecological Footprint (gha/cap)**

Analysis

Material flow

The North West has a remarkably low amount of materials flowing through its economy. Both Regional Material Input (RMI) – 17.5 t/cap – and Regional Material Consumption (RMC) – 6.8 t/cap – are the lowest of any UK region or devolved country. This is due to a low throughput of energy carriers and mining materials. Per capita, only 1.2 tonnes of energy carriers are required for the North West economy – the lowest in the UK. The demand for mining materials is third lowest, with 4.9 t/cap.

On the other hand, the North West has the highest throughput of chemicals of all UK regions and countries – 2.0 t/cap. This not only shows the dominance of chemical and related industries in the region, but also demonstrates that a high flow of chemicals does not necessarily come with a high flow of energy materials, and that some types of flows don't affect total throughput tonnes as much as others – even if, like chemicals in the North West, they are much higher than average.

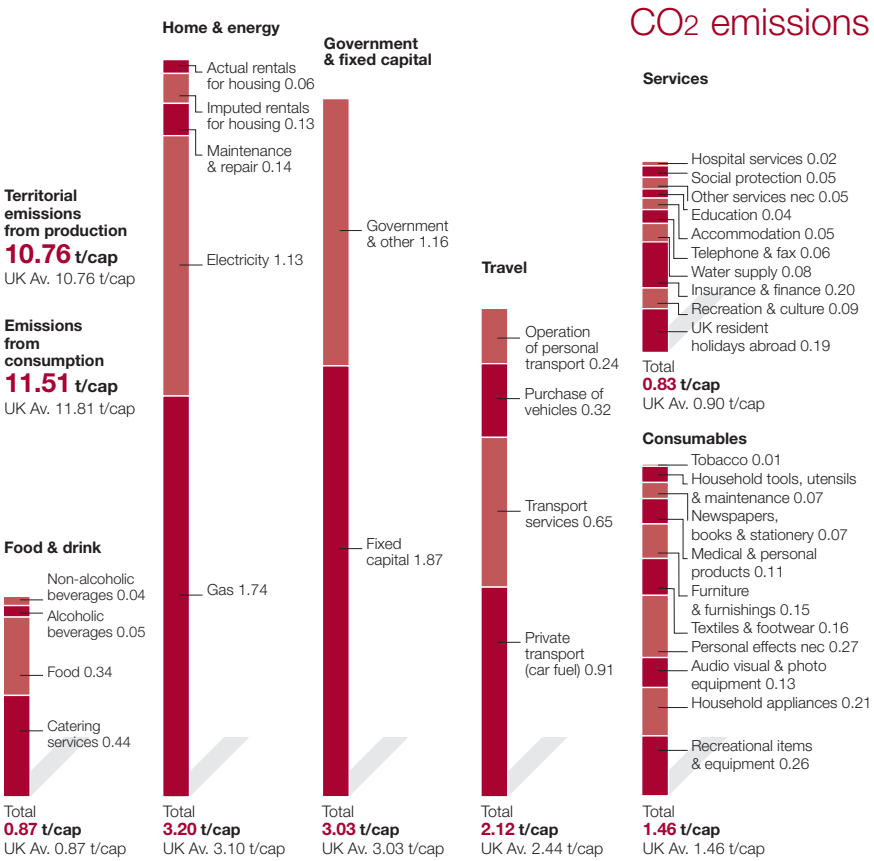
In terms of physical trade, the North West shows the archetypal pattern for an English region heavily involved in intra-UK trade and much less in material exchanges with the rest of the world. With 133m tonnes, this is the second highest physical exchange with other UK regions, being equally driven by imports (51 per cent) and exports (49 per cent). While the North West mainly imports quarrying materials as well as wood or wood products, it predominantly exports food as well as pulp and paper products. Taking into account all trade with other regions and countries and subtracting imports from exports, the North West is one of five net importing regions with an import surplus of 10.2m tonnes.

Ecological Footprint

The North West's Ecological Footprint of 5.12 gha/cap is lower than the UK average, but still higher than that of four other English regions, and of Wales and Scotland. A more detailed analysis reveals that the Footprint of car use and electricity consumption are particularly low. Residents in the North West have the third lowest transport Footprint at 0.62 gha/cap, after London and Yorkshire and Humberside, which both have 0.60 gha/cap. This is mainly due to low car mileage and low related expenditure for private transport. In terms of electricity consumption and gas distribution, the North West ranks second lowest with 0.39 gha/cap, after London with 0.37 gha/cap.

CO_2 emissions

Total consumer-related carbon dioxide emissions are 11.5 t/cap – slightly lower than the UK average of 11.8 t/cap but higher than the territorial emissions of the North West of 10.8 t/cap. Notably, domestic energy consumption in the North West is responsible for 1.7 tonnes of CO_2 per capita, which is well above the UK average of 1.5 t/cap and third highest of all regions and countries: only the East Midlands and Northern Ireland are higher at 1.8 and 2.7 t/cap respectively.



"The North West is one of five net importing regions with an import surplus of 10.2m tonnes"

Fig 4 **CO_2 emissions from consumption in the North West (t/cap)**

Overview

Sustainable development in the North West

> As the birthplaces of the industrial revolution, Manchester and Liverpool suffered extreme levels of poverty and pollution, followed by 50 years of decline and restructuring. From the challenges of social exclusion, ill-health, obsolescence and dereliction, the 'metropolitan' North West is now re-inventing itself as a globalized hub for creative and knowledge-based industries in the 'new urbanism' mode.

> The North West's regional economy as a whole is diverse, and catching up with the UK, but in GVA/per capita lags behind by about 10 per cent.

> The North West Development Agency aims to transform the region through sustainable economic development into a competitive, high added value, knowledge-based inclusive economy:

- raising the output of businesses and the productivity of workers;
- creating more & better jobs;
- ensuring skills for life, especially for those without qualifications;
- enabling people to access work, including for disadvantaged groups;
- helping disadvantaged communities;
- reducing variations across the region.

> The Development Agency has expressed support for renewable energy, environmental technology, community-based recycling, ethical finance and corporate responsibility.

> The North West's Regional Spatial Strategy (RSS) has several levers with which to direct its construction sector. The strategy encourages use of previously developed land, re-use of disused buildings and land, and higher density building where practicable.

Future implications Developers have an opportunity to provide more floor space per Footprint hectare by building at higher densities (which reduces built-up land), and making more available certain services – such as transport – that are important for sustainable communities. The RSS Policy DP3: Quality in New Development – requires new development to demonstrate "good design quality." This can encourage innovative, eco-friendly, and adaptable buildings with improved energy and materials efficiency.

However, these moves towards sustainable development may not yet be enough to turn the tide of material growth. For instance, Manchester Airport, the major air hub in the North, continues to double in size (and, roughly, in Footprint and CO_2 emissions) every 10-15 years.

Spotlight

Construction and building in the North West

With more than a quarter of a million businesses, the North West accounts for 11 per cent of the UK's total business base. In 2001 the North West out-performed the UK economy as a whole. The region remains relatively dependent on more traditional manufacturing, mainly of chemicals and transport equipment, and is under-represented in some higher growth sectors such as business, financial services and electronics.

Longer-term economic trends are difficult to determine, but GDP growth will probably be somewhere between 2-3 per cent per year. Construction and the public sector are key drivers of regional growth, although the shift to services is likely to continue in this region as elsewhere, with a reduction of primary and manufacturing employment towards 15 per cent of the total.

The North West is home to 6.9 million people in 2.8 million households. It has the second largest population of the UK's regions and is three times more densely populated than the European average. Even so, the population has reduced since the 1970s, which can be linked to migration to the more prosperous South. The population is still booming, with current projections of a slight rise over the next 20 years.

Residential and commercial building

Today, there are 2.8 million dwellings in the North West. In recent years some 20,000 houses have been built annually. Net of clearance, almost 13,000 dwellings are expected to be built annually between now and 2016 – that's 143,000 new houses over the next 11 years. If this level of construction continues through to 2050, it would result in 585,000 new dwellings in the region – a 20 per cent increase over today's levels.

Commercial building continues at approximately 1-2 per cent of the building stock per year. About 63 per cent of new development is on recycled land, short of the regional target of 70 per cent. Derelict land is expected to remain at its current level of 4.3 per cent of the total, while the current vacant housing total will remain consistent at about 130,000 dwellings.

Construction is the largest resource-using sector, both in direct materials use and the energy demand of its products. With rising costs of energy and waste disposal, and forthcoming Building Regulations and EU directives, there will be increasing pressure on construction to raise its game. Many contracts will be based on environmental as well as financial performance.

In order to achieve a more sustainable way of constructing and housing, major efforts are required by all participants, including builders, designers, architects, construction companies, home owners and tenants.

Type of material (commodity group)	Construction	Maintenance and repair
Mining & quarrying materials	2,568.0	584.7
Structural clay products	366.0	29.4
Cement, lime & plaster	281.0	156.7
Articles of concrete, stone, etc.	1,974.0	475.0
Wood & wood products	145.9	155.0
Paints, varnishes, etc.	13.0	16.4
Rubber products	2.0	3.5
Plastic products	39.2	46.8
Glass & glass products	18.5	8.6
Ceramic goods	14.1	4.8
Iron & steel	47.1	23.9
Structural metal products	37.3	15.2
Electric motors & generators, etc.	17.6	8.7
Total	**5,523**	**1,529**

Fig 5 **Materials used for construction purposes in the North West region (kilotonnes/year, 2001)**

In the course of the Eco Region NW project (see box right), a detailed material flow analysis of the construction sector in the North West was undertaken. This can help identify where the problems are and what the solutions could be.

The construction industry is by far the most mass-intensive of any sector: construction materials make up 40 per cent of the 118m tonnes of total regional material input (RMI) from all activities. Quarry products, including aggregates, sand, crushed rock and limestone, constitute by far the largest type of material flow, accounting for 28 per cent of the total RMI. Raw materials make up roughly 90 per cent of material inputs for the construction sector, while only 10 cent are recycled or secondary.

Construction and Ecological Budget UK

The detailed material flow analysis by Ecological Budget UK and Eco-Region NW enables us to identify for which purpose construction materials are directly being used in the regional economy. Figure 5 shows these details for the main construction activities – building new dwellings and the maintenance and repair of existing dwellings. In 2001, 5.5m tonnes of materials were used for the construction of new dwellings, followed by 1.5m tonnes for maintaining and repairing existing properties.

This shows that although new-build (especially commercial) projects attract most media and professional attention, repair, maintenance and refurbishment are also very significant consumers of construction services and materials. It also suggests that for every new-build house, about 300 tonnes of materials have to be moved and put in place; of this, around 160 tonnes actually make up the house itself.

Fig 6 **Total Ecological Footprint (gha) per tonne of material**

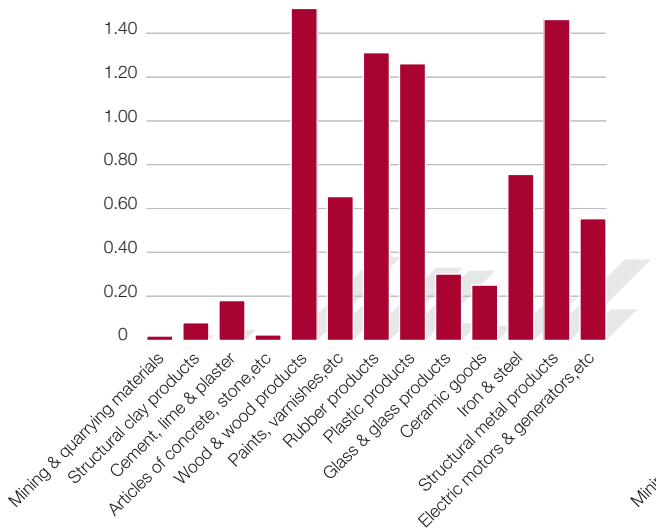
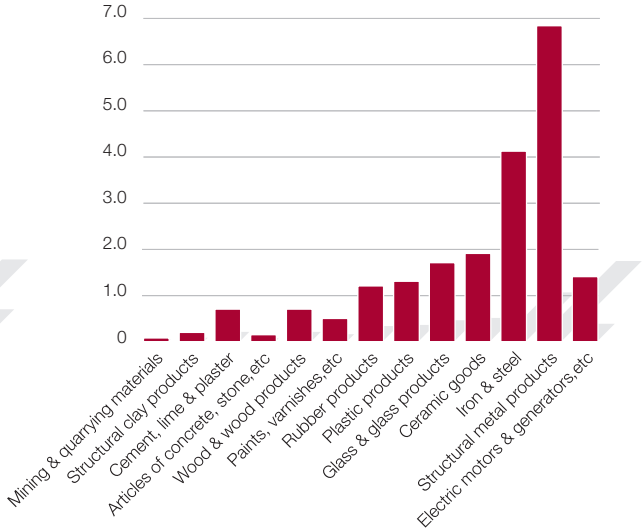


Fig 7 **Total CO_2 emissions (tonnes) per tonne of material**



Eco-Region North West

The Eco-Region NW is a project developed from the Biffaward national research programme of waste/resource flow analysis. Eco-Region NW sets a new standard for analysis of waste and material flows at the regional scale and is coordinated with the national level system, Eco-Budget UK. It provides a "joined up" information system which measures environmental performance at both the regional level and the firm level.

The Eco-Region NW extends the national system, with a particular focus on:

> waste management sector
> construction sector
> business applications
> policy applications.

The Eco-Region NW information system also makes links between the flows of resources and waste, and their causes in production and consumption. It also connects a top-down analysis at the regional level with a bottom-up environmental report template at the firm level.

Environmental impacts of construction

Carbon dioxide and other emissions released during the extraction and transport of raw materials are not normally added to the construction sector's carbon balance, yet applying the consumer principle allows us to see what the total impacts of demand for construction activities are. Following this principle, we calculated total CO_2 emission and Footprint factors for the main construction materials. These take into account all emissions and impacts that occur along the production and supply chain of these materials. Results are depicted in Figure 6 and Figure 7.

The picture is different for the two indicators. Structural metal products show very high relative impacts for both CO_2 emissions and the Footprint. All other construction materials have lower CO_2 emissions per tonne, especially aggregates and bulk materials which don't require many steps of manufacturing. However, wood, rubber and plastic products show a high specific Footprint per tonne which is due to their additional land requirements.

Using the information from both the material flow analysis and the environmental impact analysis allows the calculation of total impacts of construction activities in the North West – for example for the construction of one average new home.

Key facts from this analysis are:

> The construction of one new dwelling in the North West sets free 62 tonnes of CO_2;
> The highest CO_2 impact – 14 tonnes or 22 per cent – is due to structural metal products, 11 tonnes are due to iron and steel products and 10 tonnes are due to cement, lime and plaster products;
> An average new house in the North West requires an Ecological Footprint area of 30 gha. Most of this area is due to wood products which require 12 gha, followed by concrete and structural metal products with 3 gha each; and
> On a per capita basis, total housing in the North West is responsible for CO_2 emissions of 0.33 t/cap and for a Footprint of 0.18 gha/cap.

Regional Spatial Strategy and housing strategy

The RSS has several levers with which to direct the construction sector. It encourages use of previously developed land, re-use of disused buildings and land, and building at higher densities where practicable. Building at higher densities, which reduces land take and makes some services that are important for sustainable communities such as transport more viable, may be viewed by some developers as an opportunity to sell more floor space for a given development Footprint. The RSS *Policy DP3: Quality in New Development* requires new development to demonstrate quality design. This means innovative design that results in eco-friendly and adaptable buildings with improved energy and materials efficiency.

South East

Material flow analysis

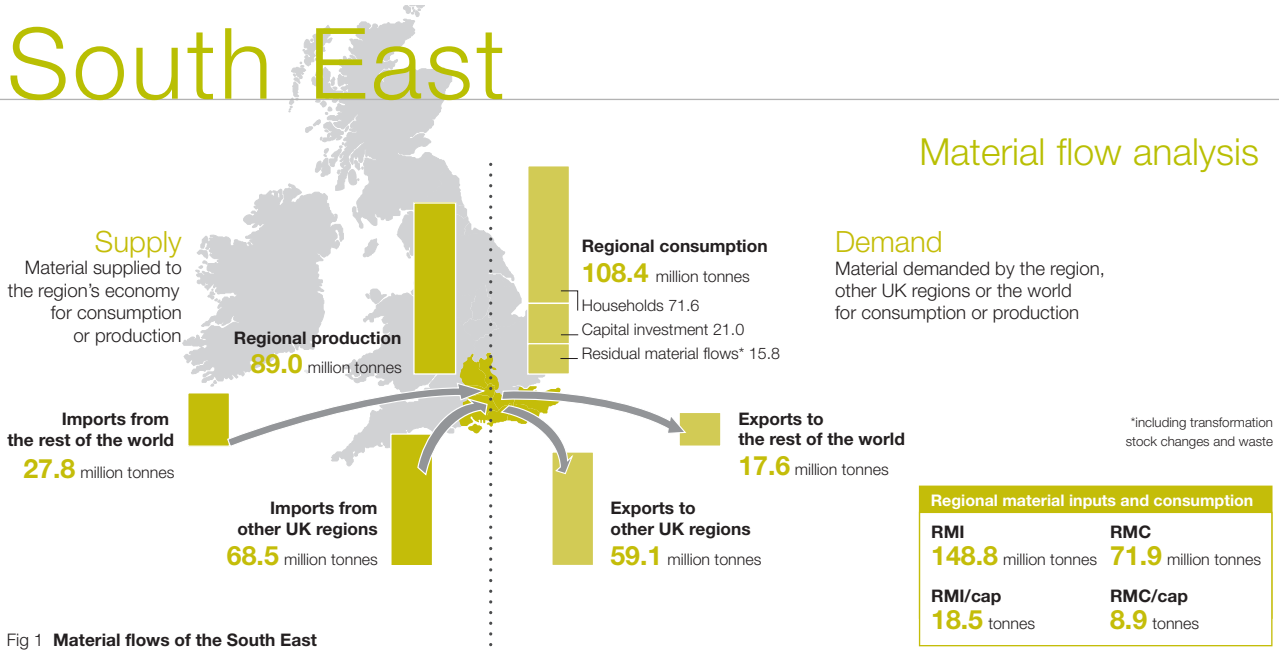


Fig 1 **Material flows of the South East**

Ecological Footprint

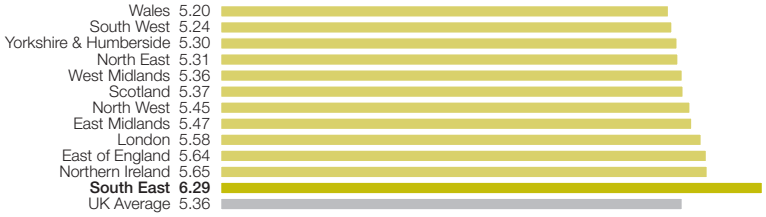


Fig 2 **Regional Ecological Footprints (gha/cap)**

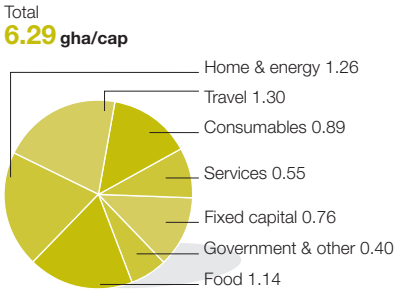


Fig 3 **The South East's Ecological Footprint (gha/cap)**

Analysis

The South East's CO_2 emissions from consumption are high and its Ecological Footprint is large. CO_2 emissions from consumption are 13.4 tonnes per person, 13 per cent higher than the national average and 21 per cent higher than the North East (the region with the lowest CO_2 from consumption per capita). The South East's Ecological Footprint is 6.3 global hectares per capita, 17 per cent higher than the national average and 21 per cent higher than Wales' Footprint per capita (the lowest in the UK). Particularly within a small country, this variation is significant.

Transport

The South East's emissions from personal transport are among the highest in the country. Ironically, many emissions are due to residents who commute daily to London – which has the lowest transport emissions of any region. The difference between the two regions is substantial: the CO_2 emitted as a result of South East residents' transport is 45 per cent higher than emissions from London residents' transport. The only other region that travels further per capita is the East of England, the other major region bordering the capital. Because numerous South East residents commute to London, many of their travel emissions are released in the capital. While in terms of health this is not significant for CO_2 (which is distributed quite evenly in the atmosphere, no matter where it is emitted) it means that London is subject to other harmful local pollutants because of the people who travel there. This is true even though residents of London drive less and emit less CO_2 from transport.

South East residents place greater demand on all transport modes, travelling nearly 13,000km a year. A "high mobility" society uses more resources. The continual purchasing of new cars in the South East has indirect manufacturing emissions of 0.44 t/cap, while car maintenance releases a further 0.41 t/cap.

Emissions from an individual in the UK who purchases and maintains a car are equal to the average person's total emissions in Pakistan for one year[1].

Material flow

At first sight, the South East shows a surprisingly small intake and consumption of materials. With 18.59 t/cap of total Regional Material Input (RMI), it is second smallest among UK regions, and its Regional Material Consumption (RMC) is fourth lowest at 8.98 t/cap. While the 52.4m tonnes (or 6.55 t/cap) of regional material production/extraction is moderate in comparison to the UK average, both figures are mainly determined by the South East's high imports. In fact, it is the largest material importer from other UK regions with 68.6m tonnes, and the second largest when imports from the rest of the world, totalling 96.4m tonnes, are counted. Its exports, in contrast, are comparatively low: the South East is the UK's second largest net material importer with a surplus of 19.5m tonnes.

One reason the South East's total RMC and RMI aren't as large as might be expected (given its very large Ecological Footprint) is the fact that RMC and RMI only account for materials that physically flow within, into and out of a region's borders. They do not account for "indirect resource flows" which occur in other regions

CO_2 emissions

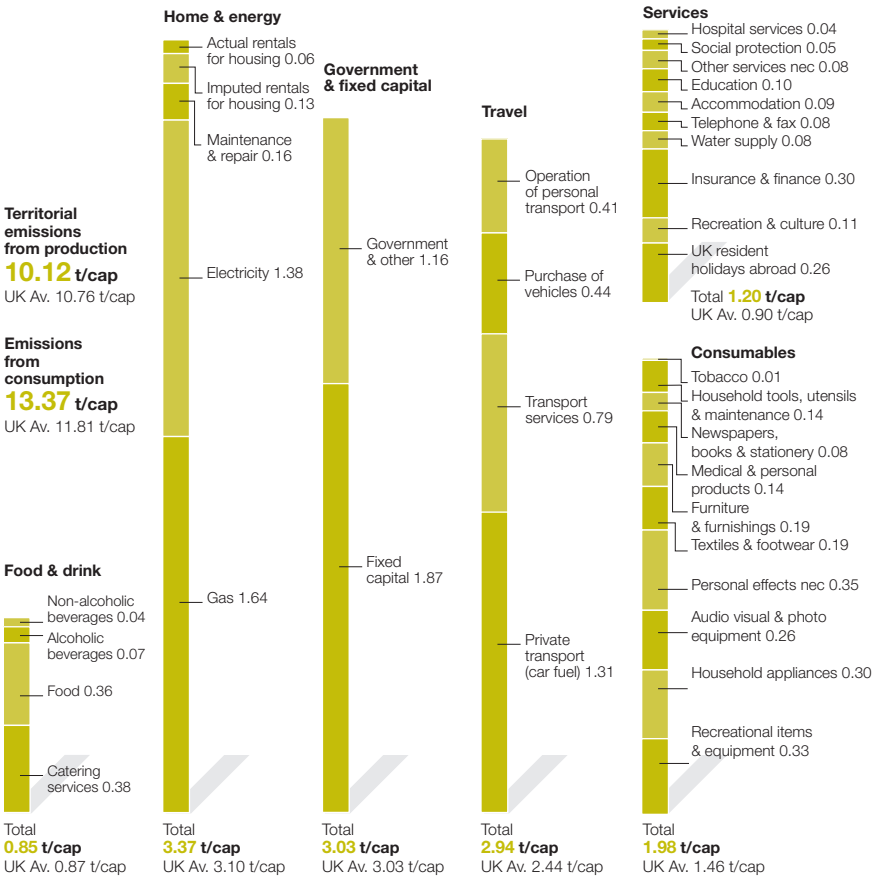


Fig 4 **CO_2 emissions from consumption in the South East (t/cap)**

during production processes of goods and services consumed elsewhere – in this case, the South East. Taking indirect material flows into account, household consumption is the most material-intensive of any UK region, amounting to around 9 t/cap per year, compared with a national average of 7.5 t/cap per year. This rate of consumption is mainly driven by material flows from the agricultural sectors (13.6m tonnes), the mining sector (22m tonnes) and the food industry (11.8m tonnes).

The CO_2 emissions and Ecological Footprint results for the South East clearly demonstrate the impacts of a booming economy that spends more money than average on most kinds of consumption. In contrast to many UK regions and devolved countries, the South East's CO_2 from consumption is considerably higher than CO_2 from production. Emissions from production are still significant (more than 10 tonnes per person), reflecting the fact that the South East has an active manufacturing base in addition to its service economy. The heavy flows depicted in the Direct Material Inputs table also demonstrate the large amount of resources that the South East economy exchanges with the rest of the UK and the world.

Goods and services

The South East spends more than the average on goods and services, which is reflected in its high CO_2 emissions. The production of jewellery for South East residents emits 0.35 t/cap, 55 per cent higher than the national average.

Generally, services have lower CO_2 emissions per £ spent than goods, with a few exceptions such as eating out.[2] But although services are often efficient, they still have a high overall impact when consumed at high rates. The South East spends more on goods and services than any other region, and it is not surprising that the resulting CO_2 emissions are higher than the national average (35 per cent higher for goods and 32 per cent higher for services). This analysis demonstrates that the development of eco-efficient services is of particular importance to the South East in terms of reducing their overall Footprint.

1 International emissions information obtained from the UN Common Database (CDIAC) via "Globalis – Interactive World Map"

Overview

Sustainable development in the South East

- The largest and most successful economy in the UK by far, it is also one of the most unequal, congested and overheated.
- Together with London and the East of England, the South East accounts for over 50 per cent of the UK's Research and Development, and alongside the North West is the largest manufacturing region in the UK.
- Polarisation has increased as greater wealth generates a demand for more services, creating an 'hourglass' economy, dependent on lower paid, lower value jobs.
- In the Regional Economic Strategy (RES) there is a tangible realization that this kind of growth rate is unsustainable, and it makes a priority of sustainable consumption and production.

Future implications The South East's RES makes a priority of sustainable consumption and production – delivering products and services with lower environment impacts, while boosting competitiveness. The South East is well-placed to lead this new approach to consumption and production, with its strong research base and many businesses in both the product design and environmental technology sectors. Developments in the technology of reuse, remanufacturing and recycling offer a significant economic opportunity for the region. The South East is expected to experience greater climate change impacts than the rest of the UK by 2050.

2 Discussed in more detail in chapter 6, "A framework for sustainable consumption and production".

Spotlight

Home construction and the South East's attempt to stabilise its footprint

With population growth projected for the entire South of England, the South East region is under continuing pressure to build new homes. The South East England Regional Assembly's (SEERA) draft RSS plans 28,900 new homes a year. Already, the South East's Ecological Footprint of 1.26 gha/cap for home-building and energy use is the second highest in the UK.

The Draft Regional Spatial Strategy

The RSS commits to stabilising the region's per capita Footprint by 2016. A stable Footprint is one where the Footprint per capita is no longer increasing, although the total Footprint may be. SEERA has pursued a low-Footprint home construction policy – a main component of Footprint stabilisation. Other SEERA plans have also focused on lowering the housing Footprint.[3]

Stabilising the South East's footprint: The housing component

SEERA seeks to counteract the South East's .025 gha/cap per housing Footprint with several specific measures:

- make existing housing more energy efficient (0.005 gha/cap savings per year);
- use low-impact construction for all house-building (0.005 gha/cap savings per year);
- use low-impact construction for all other construction (0.004 gha/cap savings per year);
- use low-energy housing design to the EcoHomes "excellent" standard (0.001 gha/cap savings per year);
- use low-energy design for all other construction (0.004 gha/cap savings per year); and
- avoid traffic increases as a result of new housing by providing public transport and a cycling/walking infrastructure (0.006 gha/cap savings per year).

"Some South East local authorities are already building more sustainable housing on their own"

Local authorities

SEERA's RSS will not become operational until 2007, and other policies in the plan both support and contradict Footprint stabilisation in the South East. While the Strategy expresses a commitment to sustainable construction, its draft version (March 2005) had dropped a requirement that all new homes be built to EcoHomes "very good" standards.

Against this backdrop, some South East local authorities are already building more sustainable housing on their own without being required to by law. For example, Ashford Borough Council's draft Local Development Framework will require most new development to be built according to EcoHomes "excellent" standards by 2008, and to be carbon neutral by 2015. Chichester already requires an EcoHomes "excellent" rating for new housing, and Brighton's Supplementary Planning Guidance calls for a "very good" rating for new development. Croydon's Supplementary Planning Guidance requires new developments to be carbon neutral.

3 For example, SEERA's *Southeast Integrated Regional Framework*, "Objective 16," the *Southeast's Regional Economic Strategy* and the *Taking Stock* resource use analysis.
4 ibid

PEGGY ALLCOT/WWF-UK

The SEERA Draft Regional Spatial Strategy: Policy CC3

In order to reflect the Plan's emphasis on more sustainable resource use, SEERA will promote measures that seek to stabilise the South-east's Ecological Footprint by 2016, and to reduce the Footprint during the second half of the Plan period. Implementation will require a sustained new programme of action incorporating:

- increased efficiency of resource use in new development;
- adapting existing development to reduce its use of energy, water and other resources;
- introducing complementary legislation and fiscal measures by government; and
- changing behaviour of organisations and individuals.

The future

Not only has SEERA committed to stabilising its Footprint, but it has also to "reduce the global, social and environmental impacts of consumption of resources".[4] Ecological Budget UK can help determine what this will mean in terms of practical strategy and policy-making. It shows what resources housing requires, and enables the South East to compare its Footprint with other regions. Ecological Budget UK also provides a standardised baseline measurement for future studies. All this information is included in the Resource and Energy Analysis Program (REAP), a scenario modelling tool for decision-makers in the region.

In the South East as a whole, the RSS sets relatively low targets for using renewable energy. There is also great pressure to expand the region's airports, and the South East's general economic expansion is among the fastest in the country. These factors may counteract Footprint and CO_2 reductions as a result of more sustainable housing designs.

Despite some of these unresolved tensions, the South East has taken steps towards low-Footprint housing, sustainable resource use and a stabilised Footprint by 2016. Future Footprinting, CO_2 consumption monitoring and resource flow analysis will gauge these efforts. But most important of all, the South East has an opportunity to introduce sustainable building into the mainstream – an advance that will affect its Footprint far beyond the next 10 years.

"Most important of all, the South East has an opportunity to introduce sustainable building into the mainstream"

South West

Material flow analysis

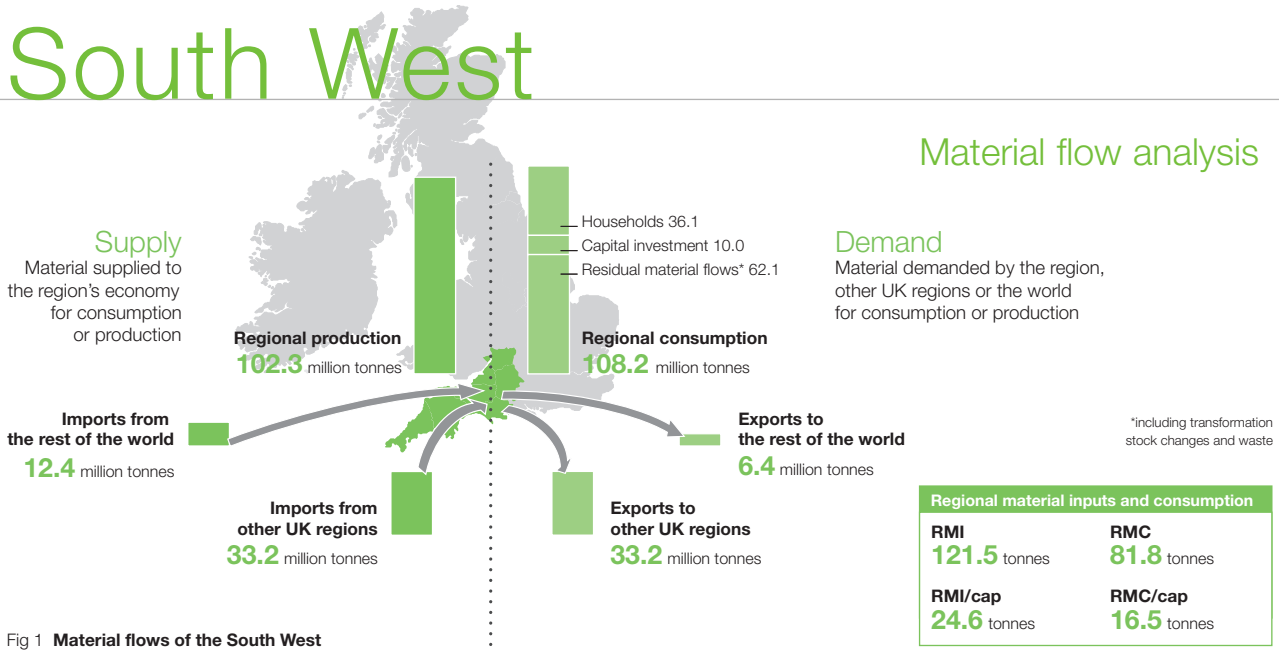


Fig 1 **Material flows of the South West**

Ecological Footprint

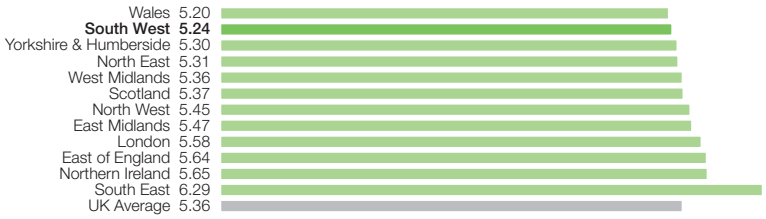


Fig 2 **Regional Ecological Footprints (gha/cap)**

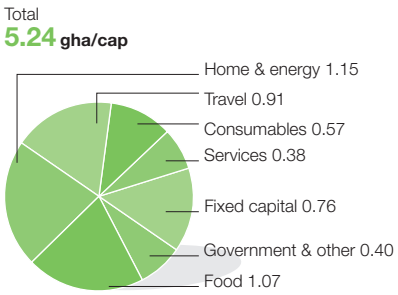


Fig 3 **The South West's Ecological Footprint (gha/cap)**

Analysis

The South West is England's largest region, parts of which are very peripheral: the northern tip in Gloucestershire is as close to Scotland as it is to Land's End[1]. It is also a rural region with a dispersed population, of whom around 35 per cent live in settlements of fewer than 10,000. The South West also possesses a higher proportion of very small villages than any other region.

Its peninsula character means that it has nearly 1,120km of coast, 60 per cent of which is designated Heritage Coast. More than three million people (62 per cent of the population) live within 10km of the coastline. Nearly 37 per cent of the region comprises protected landscape, and with good reason – its two national parks and 14 Areas of Outstanding Natural Beauty attract 26 million tourists a year.[2]

Despite the perceived high quality of life, the region nevertheless suffers from huge internal disparities. The north and east are close neighbours to the Midlands, the South East and London, while the far south-west suffers from marked under-investment and lack of opportunities. This is illustrated not only by below average productivity levels, but also marked differences across the region – for example, 153 per cent of UK productivity (Gross Value Added per head) is in Swindon, but only 57 per cent in Cornwall, which is classified as a European Union Objective One area.[3]

Notably, two of the region's key strategies – the draft Regional Economic Strategy (RES)[4] and draft Regional Spatial Strategy (RSS)[5] – recognise the need to reduce the South West's Ecological Footprint[6], to develop within environmental limits, and to promote sustainable consumption and production. This is a significant commitment for a region expecting to see rapid growth in the coming 20 years (recent research suggests a population increase of 600,000, the creation of 450,000 new jobs and the provision of some 550,000 new homes.)[7] Resolving the tension between an increased population and economic growth, and the urgent need to reduce resource consumption and CO_2 emissions, will be a major sustainability challenge in the coming years.

Ecological Footprint

The South West's Ecological Footprint is 5.24 gha, the second lowest in the UK to Wales at 5.20 gha. The UK average is 5.36 gha. Consistent with the UK, home & energy and food are the largest components, accounting for 22 per cent and 20 per cent of the Footprint respectively. Travel accounts for a further 17 per cent, consumables 11 per cent, and services 7 per cent. The South West has an above-average Ecological Footprint only in travel and services, while home & energy is a fraction below the national average.

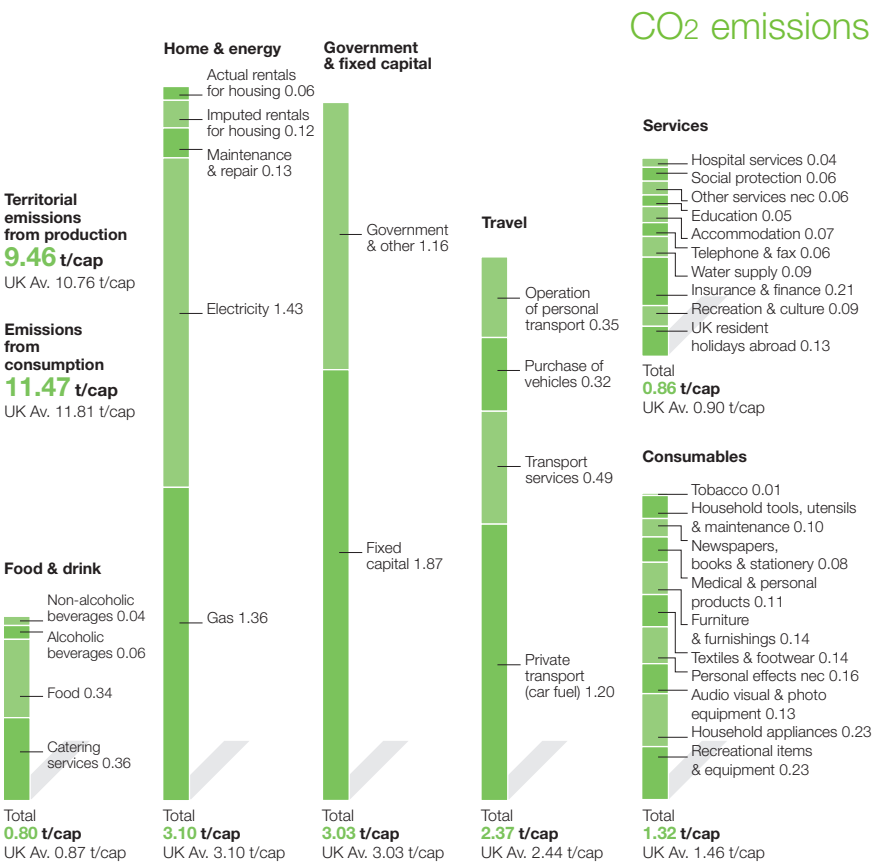


Fig 4 **CO_2 emissions from consumption in the South West (t/cap)**

CO_2 emissions

The South West's "territorial" CO_2 emissions are 9.46 tonnes/capita, below the UK average of 10.76 tonnes/capita, and the fourth lowest in the country. Consumer emissions are 17 per cent higher than territorial emissions at 11.47 t/cap incomparison to the UK average of 11.81 t/cap.

Home & energy use accounts for 27 per cent of the South West's CO_2 emissions. This is the largest component and is consistent with the rest of the UK.

Travel is the second largest contributor to the South West's CO_2 emissions, accounting for 21 per cent (2.37 t/cap) of the Ecological Footprint. Although this is below the UK average of 2.44 t/cap, it is worth noting that CO_2 emissions from private vehicle use (120 t/cap) account for 51 per cent of total travel CO_2 emissions – the largest proportion in the UK and the third highest in the country. Only the South East (131 t/cap) and East (125 t/cap) have higher levels.

But in sharp contrast, the South West also has the lowest CO_2 emissions (0.49 t/cap) from public transport services in the country and the biggest gap between private and public transport emissions – 2.5 t/cap of CO_2 are produced from private vehicle users for every t/cap produced by users of public transport.

Travel patterns in the region are also different from the rest of the UK. Visiting friends and holidays/day trips account for the most kilometres travelled, compared with commuting and shopping in the rest of the UK. South West residents also have the lowest CO_2 emissions from holidays abroad, at 0.13 t/cap – half the amount of the South East, which has the highest (0.26 t/cap).

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1 'First Draft RSS', SW Regional Assembly, Version 1.92, October 2005.
2 'First Draft RSS', SW Regional Assembly, Version 1.92, October 2005.
3 'Just Connect – An Integrated Regional Strategy for the South West 2004-26', SW Regional Assembly, 2004.
4 'SW Regional Economic Strategy – Draft for Consultation', SWRDA, September 2005.
5 'Draft RSS – Version 2.2', SW Regional Assembly, RSPTG meeting papers, 12 January 2006.
6 In April 2005, the South West published 'Stepping Forward', its first material flows and Ecological Footprint study, undertaken by Best Foot Forward. For an explanation of any differences in the results between these studies, refer to the Ecological Budget website. For more details of Stepping Forward, visit www.steppingforward.org.uk
7 See footnote 4.

Overview

Sustainable development in the South West

> The South West is characterised by its largely rural landscape, long coastline, few major cities and many small settlements. Rural communities play an important role in the South West's economy.
> Over the next 20 years, the South West's population could rise by 600,000.
> The South West's Regional Development Agency has a detailed and explicit sustainable development strategy. It recognizes that:
- business efficiency can be enhanced through better environmental management;
- quality of life in the region is a major attractor of investment, business, workers and tourists;
- environmental technologies and services, such as renewable energy, represent a huge global market where the South West can become a leader;
- in identifying the environment as a key 'driver' for the economy, it is important to build rather than diminish the region's environmental and cultural capital;
- over 12 per cent of regional economy relies directly on the land and landscape.

Future implications Sustainable development is a mounting challenge for the South West – taking needed steps to develop its regional economy whilst still securing environmental and social benefits. As it grows, the South West will need to answer many major questions about transportation, housing, agriculture, and energy: Is it possible to attract new visitors to the region without major new transport infrastructure? How might the South West sustainably meet the demand for housing and visitor lodging? What role might low-impact farming play in revitalizing rural areas? Which renewable energy options will the region pursue?

Analysis continued

Another noticeable difference in the South West concerns food and drink, which is 8 per cent lower than the UK average and the second lowest in the county. Food prepared and consumed at home is identical to the UK average (0.34 t/cap), but South West residents are among the least likely to eat out, with CO_2 emissions from catering the second lowest in the country at 0.36 t/cap.

Material flow

The South West has an Regional Material Imput (RMI) of 24.64 t/cap, the fifth highest in the UK. This is mainly driven by the regional production and extraction of materials (such as agriculture or minerals), which at 75.9m tonnes is the second largest in the UK. The region's mining and quarrying sector (except energy products) is the largest in the country, accounting for 58.4m tonnes, as is its agriculture, hunting and forestry sector, which produces 13.9m tonnes. The South West also has the second largest fishing industry in the UK (Scotland is the largest), producing 128,000 tonnes a year.

In terms of physical trade, the South West has the smallest exchange among English regions and the second smallest across all regions of the UK on a per capita basis – 17.31 t/cap. This is driven equally by limited trade with other UK regions and the rest of the world, and the low level of exports (it's the second smallest per capita exporter) and imports (third smallest per capita importer).

Overall, the South West is one of five net material importers in the UK with a surplus of 6m tonnes across all industrial sectors. However, at the sectoral level a much more heterogeneous picture emerges with most of the sectoral net trade taking place in the mining industry. While the South West shows an import surplus of 7m tonnes of energy-producing materials, it has an even bigger export surplus of 7.4m tonnes stemming from trade with all remaining non-energy related mining materials – mainly copper and tin.

Agricultural products as well as basic and fabricated metals are the next big hitters, with an import surplus of 1.3m and 1.1m tonnes respectively. Due to the high regional material production and the overall import surplus, the RMC indicator is relatively high compared with other regions.

Spotlight

Energy consumption and production in the South West

As highlighted above, energy use in the South West is a major contributor to the region's Ecological Footprint and CO_2 emissions. This is a pattern which is observed across the UK, with energy use making a significant contribution to the country's global environment impact, especially in relation to climate change.

The UK government's White Paper on energy recognised that a more sustainable path towards domestic energy production involved the greater development of renewables such as wind, wave, combined heat and power, tidal, solar and biomass. As many of these are readily available across the UK, some advocates are now envisaging a departure from the traditional, centralised system of generating power in which large power stations, often located in the North, feed the country's energy needs. A more sustainable approach, compatible with harnessing the UK's renewable resources, is a decentralised power system in which more regions, communities and even individual homes become power generators.

This vision is also consistent with the "consumer responsibility" approach taken in this report, which asserts that the consumer should take responsibility for the environmental impact of production wherever that production takes place – be it another UK region or overseas. Across a range of sectors, this report has found that the UK is broadly defined by "producer" regions in the north and "consumer" regions in the south. Energy is no exception and the South West conforms to the pattern as a net consumer of energy.

In 2003, the UK produced 174.5m tonnes of CO_2 emissions from the power sector, with the South West creating the lowest direct emissions (2.7m tonnes) from energy generation compared with Yorkshire and Humberside, which produced the highest (47.9m tonnes). If the South West adopted "territorial" accounting for these CO_2 emissions, this figure would translate as 0.5 tonnes per average resident.

However, if the South West were to adopt the "consumer responsibility" principle, it would need to account for a total of 13.4m tonnes of CO_2 resulting from energy consumption and production.[8] For the average South West resident, this translates into 2.7 tonnes of CO_2 emissions – a rise of 81 per cent above "territorial" accounting. If the South West is to succeed in reducing its Ecological Footprint and CO_2 emissions, it must begin to tackle the two most important factors governing its energy use – reducing consumption and increasing production of renewable, low-carbon energy.

Reducing consumption

Recent research by the Government Office for the South West and the South West Regional Assembly forecast the region's expected electricity demand in 2020. They looked at two possible scenarios – and the results were very different. The first assumed that the government's climate change programme continued to provide energy efficiency measures and demand reduction policies, and found that demand in the region may increase by some 15 per cent by 2020, from 25,120 GWh to 28,888 GWh. The second assumed

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all the savings forecast in the energy White Paper would be met, and found that estimated demand may decrease by more than 11 per cent, down to 22,509GWh.[9] While the second scenario is a significant improvement, the South West's first Ecological Footprint report, *Stepping Forward*, discovered the importance of getting to grips with the energy efficiency of the existing housing stock. The report found that simple measures, such as all householders replacing white goods with A-rated ones, fitting low-energy light bulbs, improving insulation levels and installing condensing boilers, could reduce CO_2 emissions by 35 per cent. It also found that further savings could be made if 80 per cent of householders fitted solar hot water heating systems and other such measures.[10]

Renewable energy

One way the South West can reduce consumption of imported energy is by developing and using its own renewable energy. The region has identified increased production of renewable energy as a priority in many of its key strategies. In 2003, RegenSW, the regional renewable energy agency, published the first Renewable Energy Strategy which set a target of meeting 11-15 per cent renewable electricity production by 2010.[11] In addition, the draft RSS sets additional targets of meeting 20 per cent of demand by renewable energy by 2020[12], and it includes new policies on promoting "integrated renewables" into new housing schemes.

Unfortunately however, only about 3 per cent of the region's electricity demand is met by renewable sources at present, with 102 renewable electricity projects currently operating.[13] Recent research suggests that by 2020 the South West's accessible resource of renewable energy could be as much as 2,504MW – 96 per cent more than it already utilises – and that meeting a 20 per cent target would require harnessing about half that amount (1,247MW).[14]

Regional case study: marine renewables

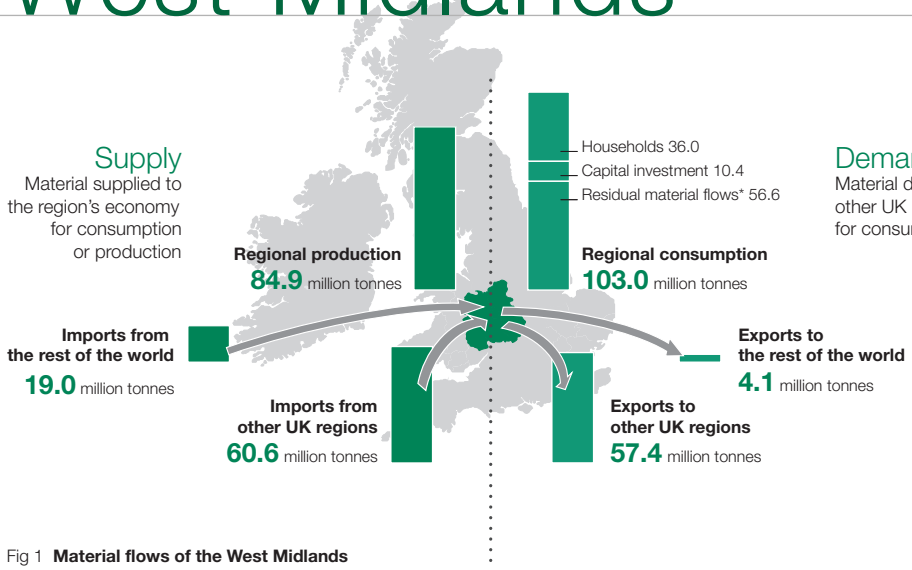
The coast of the South West offers tremendous potential for marine renewables – in particular, the high tidal ranges of the north coast and Severn Estuary, which averages as much as 11 metres on spring tides. Potential tidal power options such as lagoons, barrages and tidal stream technologies have been explored for the Severn Estuary. Some of these schemes, such as the barrage, have been rightly criticised for their significant adverse environmental impacts. However, tidal lagoon technology has the potential to be less environmentally damaging, as does the deployment of wave and tidal stream devices. The DTI has sent out positive signals to developers by approving the construction of a 60MW tidal lagoon generation project in Swansea Bay, across the estuary from the South West. Tidal lagoons could produce as much as 4,500 MW of power if all available resources were developed in the Severn Estuary. Similarly, at Lynmouth Bay on the north coast of Devon, small-scale tidal stream technology has been tested and would seem to offer great potential as the South West is considered to have "a tidal stream resource of national significance".[15] The South West is also investing in the Wave Hub, which will enable renewable electricity from up to four separate devices to be delivered to the main grid by 2007. The development phases of the Wave Hub are designed to coincide with the development of appropriate renewable technologies. It is hoped that both wave and tidal stream technology will play a large part in contributing to the region's 2020 target, with 250MW and 100MW of installed capacity respectively, contributing nearly 28 per cent of the required capacity to meet the 2020 target.[16]

Given the right investment within a supportive political climate, marine renewables offer a safe and reliable source of energy, and therefore must constitute a potentially cost-effective source of future energy.

8 Defra, Local & Regional CO_2 emissions estimates for 2003, www.defra.gov.uk/environment/statistics/globatmos/galocalghg.htm
9 "REvision 2020 – Final Report", GOSW & SW Regional Assembly, June 2005.
10 For more details of Stepping Forward, visit www.steppingforward.org.uk
11 Regional Renewable Energy Strategy for the SW of England 2003-2010, RegenSW, April 2003).
12 The South West's Regional Spatial Strategy, October 2005 Draft, "Policy E1." See Policies E1-E5 for a more detailed plan of how renewable energy will be deployed.
13 "Survey identifies 100 renewable electricity schemes saving 313,000 tonnes of CO_2 a year". Southwest Renewable Agency, February 2005. www.rege+nsw.co.uk/press/news-read.asp?id=30
14 'REvision 2020 – Final Report', GOSW & SW Regional Assembly, June 2005.
15 SW RDA Seapower SW Review – Resources, Constraints and Development scenarios for Wave and Tidal Stream Power, 2004.
16 See footnote 14.

West Midlands

Material flow analysis



*including transformation stock changes and waste

Regional material inputs and consumption

RMI	RMC
118.6 million tonnes	56.9 million tonnes
RMI/cap	**RMC/cap**
22.5 tonnes	10.8 tonnes

Fig 1 **Material flows of the West Midlands**

Ecological Footprint

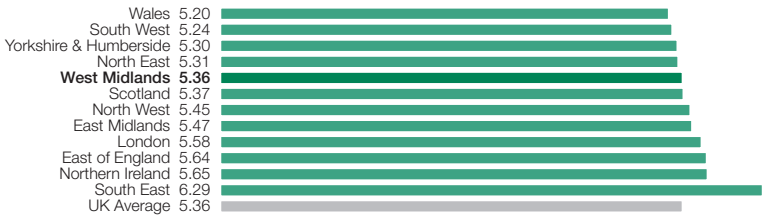


Fig 2 **Regional Ecological Footprints (gha/cap)**

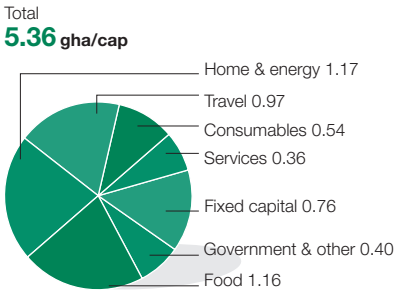


Fig 3 **The West Midlands' Ecological Footprint (gha/cap)**

Analysis

The West Midlands' Ecological Footprint is marginally lower (by 3 per cent) than the UK average, with a higher impact for food consumption and energy use and a lower impact for goods and services and transport. West Midlands residents also buy fewer things such as electrical equipment, newspapers and other daily consumables. This results in lower emissions for both consumables and durable items (16 per cent below the national average).

Like most other regions and devolved countries, car use dominates CO_2 emissions related to transport (74 per cent of the transport total – slightly higher than the national average). Household gas and electricity consumption is also significant, and car and household energy use combine to represent 35 per cent of the region's total CO_2 emissions from consumption, compared with the national average of 37 per cent.

Material flow

Total Regional Material Input (RMI – the total tonnes of materials used in the region's economy) and Regional Material Consumption (RMC – the total tonnes of materials used up in the region) in the West Midlands are just below the regional average in the UK: 22.5 t/cap and 10.8 t/cap respectively. With regional material production being comparatively low (the third smallest) at 7.39 t/cap of materials (33 per cent of RMI), 67 per cent of RMI input was provided by imports – 60.6m tonnes from other UK regions and 19.1m tonnes from the rest of the world. Most prominently, the West Midlands imported from other world regions 8.6m tonnes of energy-producing materials, accounting for 45 per cent of total non-UK imports, as well as 2.7m tonnes of basic and fabricated metals and 2.1m tonnes of coke and petroleum products. Imports from other UK regions were dominated by products from very different industries: 25 per cent of their weight stemmed from publishing and printing, while 23 per cent came from the food, beverages and tobacco industry. Even though the West Midlands also exported a substantial 61.7m tonnes of materials, it still depended on other places in the UK and abroad on a net basis. In other words, subtracting total exports from total imports, the West Midlands is the third largest net material importer across the regions with a surplus of 18m tonnes. Due to this surplus, the RMC is slightly higher than the RMI when compared with other regions.

RMC and RMI take into account all material flows that occur within the West Midlands and implicitly assign responsibility for these to the region. However, a considerable amount of physical flows might actually occur to produce the goods and services produced elsewhere. Re-allocating these upstream lifecycle material flows to the region of final consumption provides an alternative view of regional material flows (see Figure 4).

Taking into account all the flows that West Midlands consumers trigger in other UK regions, within the West Midlands itself and in the rest of the world, the average West Midlands consumer requires a total of 6.8t/cap of materials compared with a national average of 7.5t/cap. This is the third smallest in the UK (equal with Yorkshire

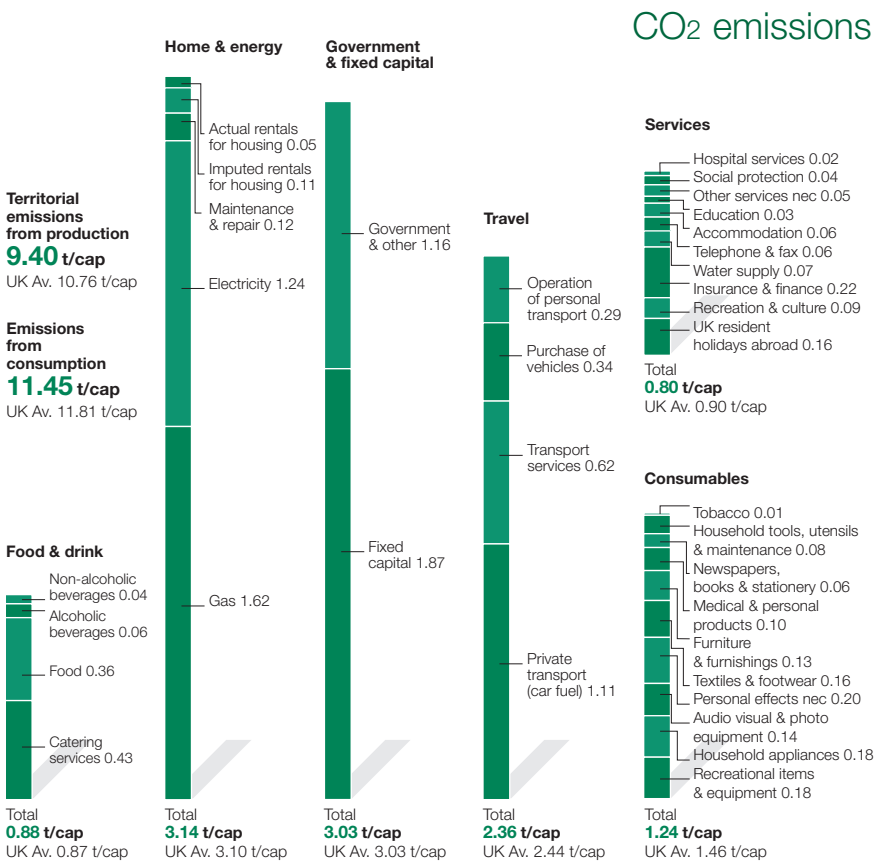


Fig 4 **CO_2 emissions from consumption in West Midlands (t/cap)**

and Humberside and behind only the North East and Wales). It also compares with the South East, which at 8.5 t/cap is the highest in the UK, followed by London, at 8.5 t/cap. Compared with others, the household consumption category is quite evenly distributed across the UK. Yet it is the biggest driver of material production, so even small variations in the measurement have large ripple effects on the production chain and total resource use.

Housing

While most individual components of the West Midlands' total Footprint are slightly lower than average, some are higher. The construction of new homes, repairing of old ones, and use of operational energy are the most significant components of the West Midlands' Ecological Footprint, and make up a higher than average proportion of the total Footprint. This supports earlier findings that 20 per cent of West Midlands households suffer from fuel poverty, due to the poor condition of the existing housing stock[1]. The remaining analysis investigates why West Midlands housing makes up a higher than average proportion of its Ecological Footprint, material flows and CO_2 emissions.

Of the 150 tonnes required to build the average West Midlands house, most comprises concrete and stone. An average 4.8 tonnes of materials is consumed in the house each year, and an extra 0.50 tonnes

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1 UK government Sustainable Development Indicators: www.sustainable-development.gov.uk/indicators/regional/2003/h04.htm

The average house in the West Midlands...

- > is occupied by 2.41 people, 0.4 cats and 0.3 dogs;
- > consumes 9,127 KWh of energy, producing 5.18 tonnes of CO_2;
- > weighs about 150 tonnes, with another 137 tonnes for the foundations;
- > lasts for about 60 years;
- > requires 0.50 tonnes of materials each year for maintenance and repair; and
- > uses energy derived from natural gas (66 per cent) and electricity (24 per cent).

Overview

Sustainable development in the West Midlands

- > The region is transitioning from a former engineering base, to a more mixed knowledge-based economy, although 20 per cent of the workforce are still in manufacturing compared to 15 per cent nationally.
- > In comparison to the overall UK economy, the West Midlands has lower GVA and income levels and fewer business start ups. The dynamism of Birmingham city centre is the equal of any, but often major financial and professional services have gone either to London or to Manchester and Leeds.
- > Highlights of the Regional Economic Strategy (RES): coordinate competing urban development agencies, diversify business base, capitalize on region's universities to promote learning, create conditions for growth, and regenerate communities.
- > Environmental improvement is mentioned in the West Midlands' RES, but the wider sustainable consumption and production theme does not appear directly as a first priority.

Future implications Sustainable consumption and production is not a priority in the RES, which will influence regional planning. The West Midlands' newly trained, entrepreneurial and affluent workforce may tend to outmigrate from the crowded conurbation and encourage high-Footprint development. The West Midlands can utlize urban renaissance strategies, introduce sustainable consumption and production policies, and lean on green belt constraints to counteract this.

Analysis continued

is required for maintenance and remodelling. In total, the average West Midlands house requires 5.3 tonnes of products a year.

Building the average West Midlands home produces 61 tonnes of CO_2 – approximately 1 tonne a year over the lifetime of the building. Yearly emissions from maintenance and repair add another 0.19 tonnes of CO_2. However, the most significant emissions come from direct energy used to operate the house – around 5.38 tonnes a year. This is more than 4.5 times greater than emissions from construction and maintenance.

Surprisingly, the building materials used in the greatest quantities to construct a house do not necessarily have the greatest CO_2 impact. Only 2 tonnes of metal products (1.3 per cent of the total average materials used for home building) are used in an average house, but these are responsible for the most CO_2 emissions occurring during their production. Material flow tables have allowed us to take into account such "indirect flows" as the mining required to extract ore, the energy to produce metal products, and transport.[2]

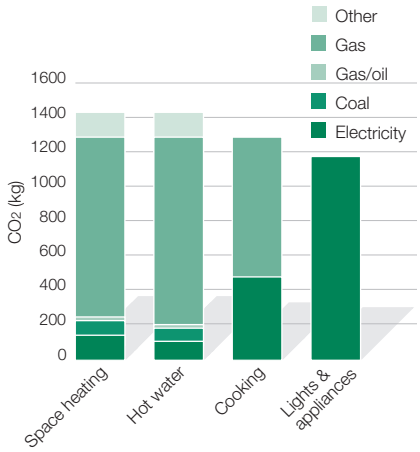


Fig 5 **Final demand sectors for energy in the West Midlands**

Per unit used in the UK, gas produces less CO_2 than electricity. While gas represents 66 per cent of all the energy used in the West Midlands, it accounts for only 54 per cent of its CO_2 emissions from consumption. Electricity use accounts for 24 per cent of energy used in the West Midlands, but only 37 per cent of emissions.

These four types of energy use are similar in terms of total CO_2 emissions. More total energy (in terms of Kilowatt hours) is used for space and water heating, but these rely on gas, which emits less CO_2 per Kilowatt hour.

Spotlight

Housing, density and transport in the West Midlands

Ways to achieve increased home energy efficiency through design

Loft insulation (100mm-200mm)
Cavity wall insulation
Draught stripping
Double glazing with low 'e' glass
Floor insulation
Gas central heating controls
Hot water tank insulation
Hot water tank thermostat
Primary pipework insulation
Condensing boiler

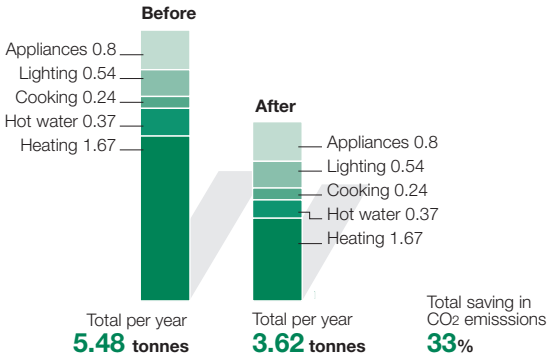


Fig 6 **Tonnes of CO_2 emissions per year for a household, before and after energy saving measures are implemented**

The West Midlands' Regional Spatial Strategy (RSS) plays a key role in deciding how future housing will be provided. Planning decisions about housing distribution, location and type of development will make or break the urban and rural renaissance agendas. They will also have profound affects on future CO_2 emissions and the region's Ecological Footprint.

Designing for efficiency in new housing

Many houses in the West Midlands are poorly insulated, leading to high CO_2 emissions from consumption. Some houses are impossible to make more efficient; for instance, most Victorian houses have solid wall construction, so cavity wall insulation is out of the question. Often it is difficult to retrofit a house if it has not been designed with energy efficiency in mind.

However, designers can include options for efficiency in new housing. Various steps that require no lifestyle change by the occupants can be taken to make a house much more efficient (see Figure 6). Our analysis demonstrates the potential savings to be made from including these measures in housing design. It is important to note that this is not an exhaustive list, merely a demonstration of some Footprint-reducing options that could become standard features of a house design.

Interestingly, most of these options could be fitted retrospectively, given that the house design originally allowed for retrofitting. This decrease in emissions from energy consumption could be coupled with a similar decrease from energy production. Many local authorities have a target of using 10 per cent renewable energy to power new housing developments. Combined with the energy efficiency steps recommended above, emissions would be reduced by 38 per cent from the current design.

Durability in housing

While many houses in the UK are not energy efficient, numerous others are old and durable. Even though some may be inefficient, they last a long time, and the emissions and Footprint impacts of their construction are spread out over the lifetime of the house. Using this analysis, a house that is energy efficient but lasts only a short time may have the same emissions and Footprint impacts as a house that is energy inefficient but lasts a long time.

The benefits of building sturdy houses, in terms of their CO_2 emissions and Ecological Footprint, can be seen right (Figure 7).

Housing density and transport

Growth in the West Midlands' low-density rural population has meant a corresponding growth in transport demand. The region has been increasingly unable to cope with its position at the hub of the national rail network, making low-Footprint train travel less reliable and affordable. Increased car travel makes West Midlands urban areas less attractive through diminished air quality and streets that are unsafe for walking and cycling.

As demonstrated in the regional analysis of London, higher density development leads to a lower Ecological Footprint, particularly of transport. Many new developments in the West Midlands have adopted this ethos. The Southbank development in Wolverhampton's Canalside quarter features high-density residential space developed around an English Heritage Grade II-listed historical building. Advantage West Midlands – the regional government's redevelopment agency – has invested a substantial portion of its £300 million annual budget in urban revitalisation projects, promoting city centre living. These projects include the East Side development in Birmingham, the Swanswell and Electric Wharf mixed-use developments in Coventry city centre, and St John's Urban Village in Wolverhampton. The Ecological Budget UK project is analysing building density in the West Midlands, which will be documented in a detailed regional report later this year.

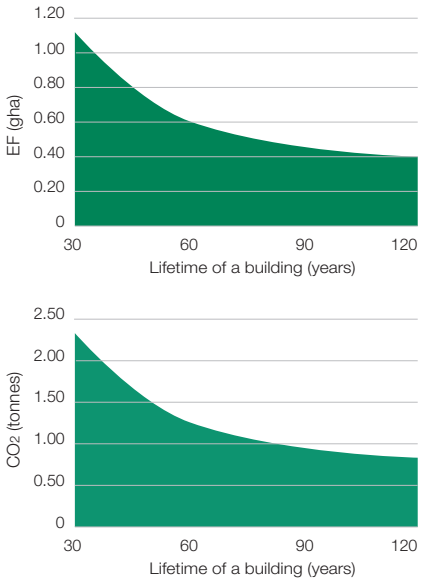


Fig 7 **Ecological Footprint and CO_2 emissions of a building's construction**

If a building lasts 30 years, the 60 million tonnes of CO_2 from its construction average 2 tonnes a year. If a building lasts 120 years, the average drops to 0.70 tonnes a year – an annual savings of 1.3 tonnes of CO_2 emissions. This can be compared with the energy efficiency saving over the same period. If the average floor space is 98m², the CO_2 emissions of a 1900 house would be 10 tonnes a year compared with a 1982 house producing 7 tonnes – an annual saving of 2.8 tonnes.

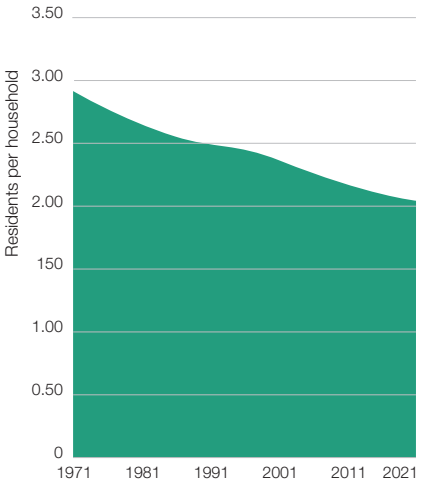


Fig 8 **The deline in the size of UK households**

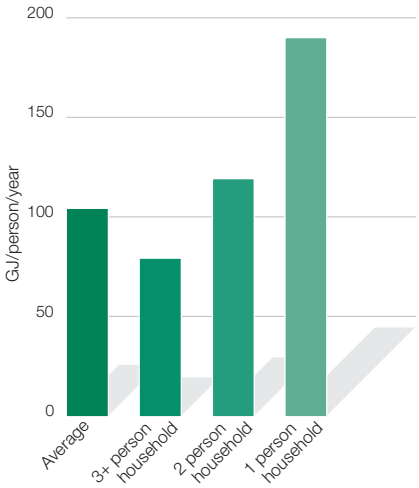


Fig 9 **Energy consumed by West Midlands' households**

use and construction of the house have all been taken into account.

Figure 10 indicates the potential change in household sizes that could occur as the average number of people per house reduces to two by 2021.

Using these figures and combining them with an analysis of energy requirements helps us project the CO_2 and Ecological Footprint to 2021. The analysis suggests that if occupancy levels are as low as two by 2021 there would be a 13 per cent increase in energy demand. Even as builders seek to introduce sustainability into design, housing will continue to have a major impact on the CO_2 emissions and Ecological Footprint of the West Midlands for many years to come.

The impact of declining household sizes

All regions in the UK have seen a decline in the size of households over the past four decades. Figure 8 highlights how they could decline to about two people per house by 2021.

Fewer people per household means lower energy efficiency per person. Figure 9 highlights the energy consumed in the region by households of varying sizes[3].

A household with fewer people uses much more energy per person. In addition to this direct energy use, fewer people per home means more homes are required, which increases the per capita impact of housing construction.

The REAP analysis has calculated the impacts of this. Maintenance, direct energy

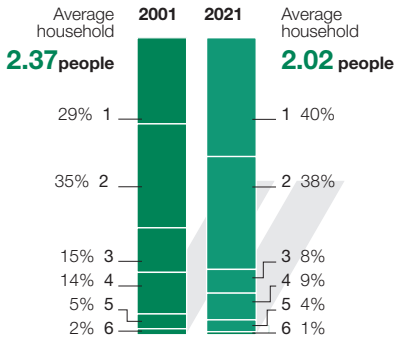


Fig 10 **Projected household sizes by 2021**

2 For further information on the methodology, refer to REAP Report 2 "The Use of Input-Output Analysis in REAP", available from http://sites.wwflearning.co.uk/data/files/reap-report-no-2-83.pdf

3 Original Data obtained from INCPEN, 2001, *Towards Greener Households: Products, Packaging and Energy*, ISBN 1901576507

Yorkshire and Humberside

Material flow analysis

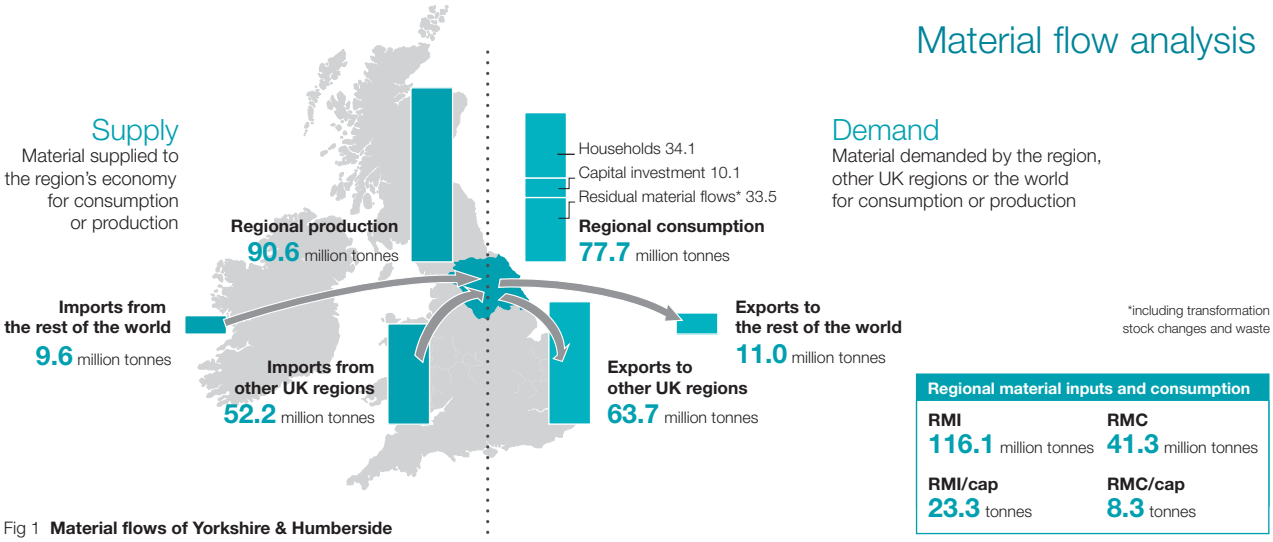


Fig 1 **Material flows of Yorkshire & Humberside**

Ecological Footprint

Fig 2 **Regional Ecological Footprints (gha/cap)**

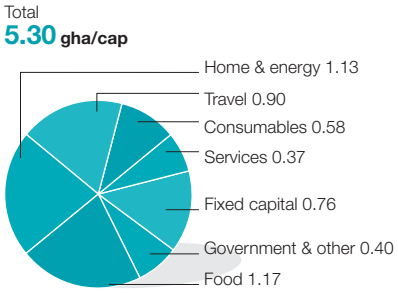


Fig 3 **Yorkshire & Humberside's Ecological Footprint (gha/cap)**

Analysis

The results for Yorkshire and Humberside are a study in contrasts, mainly of high production and low consumption. On the one hand, the region is one of the highest emitters of CO_2 from production (mainly energy production in coal-fired power plants), emitting 13.37 tonnes of CO_2 per capita. On the other hand, it has low CO_2 emissions from consumption of energy and fuel – its 10.07 tonnes per capita is one of the lowest for any English region. This means that Yorkshire and Humberside exports much of the power and manufacturing it produces. This phenomenon is also demonstrated in the material flow analysis below.

Yorkshire and Humberside contains 18 per cent of the electricity generating capacity in the UK, and produces 58 per cent of regional greenhouse gas emissions.[1] This is primarily a result of the area's coal mining legacy. A large number of coal-fired power stations – including DRAX, the biggest coal-fired power station in the UK – were built around the region's supply of coal. More recently, Yorkshire and Humberside has become home to a number of gas-fired plants. It is worth noting that Yorkshire and Humberside is one the most instructive regions in terms of the difference between CO_2 emissions from consumption and production. Although emissions from production are documented, tracking emissions from consumption makes it possible empirically to compare the two.

Material flow

Yorkshire and Humberside has an average Regional Material Input (RMI), amounting to 23.4 t/cap. In contrast, it has the second lowest Regional Material Consumption (RMC) in the UK, with 8.3 t/cap of materials consumed in the region. This difference is driven by the structure of the region's physical trade activities. Netting out physical imports and exports, Yorkshire and Humberside shows an export surplus of 12.9m tonnes – only Scotland shows larger net exports. So 84 per cent of all trade takes place with other UK regions rather than the rest of the world. Imports from the rest of the world (besides the UK) are particularly low at 2t/cap. This is the second lowest per capita import level across regions. These high exports and moderate total imports mean that even though an average amount of materials enter its economy (RMI), most flow out again – hence the low RMC.

Yorkshire and Humberside ties with the West Midlands for the third lowest material impact of household consumption in the UK. To provide the goods and services consumed in the region's households, 6.8 t/cap were required across the various lifecycle stages of production and consumption. While only households in the North East and Wales had a smaller impact, this compares with 9 t/cap in the South

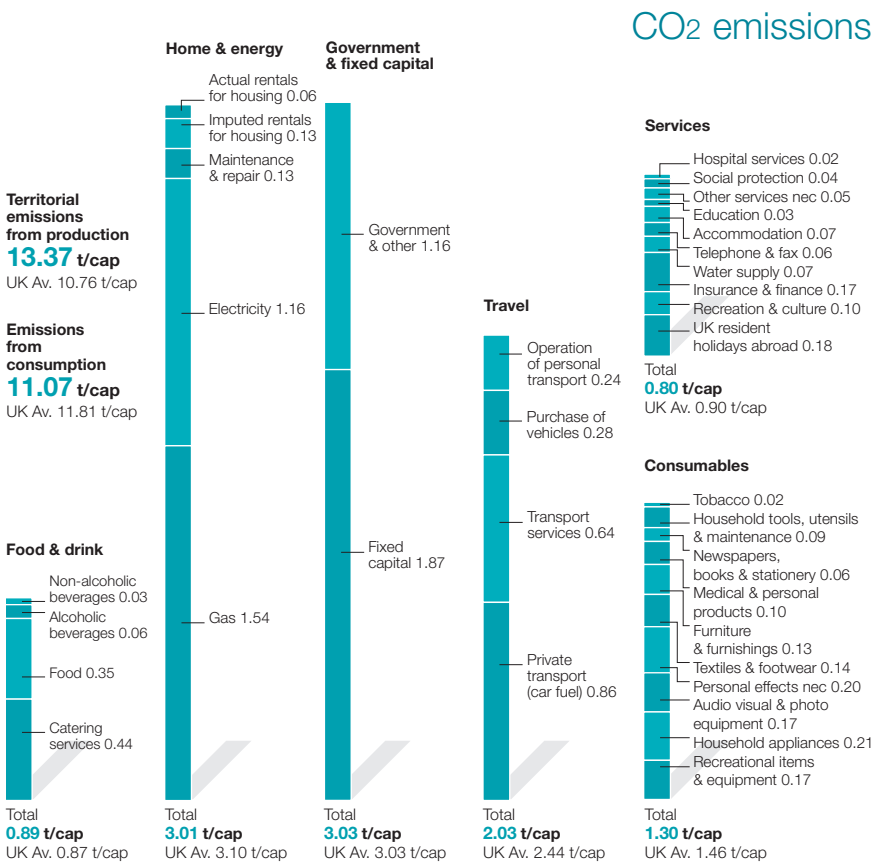


Fig 4 **CO_2 emissions from consumption in Yorkshire & Humberside (t/cap)**

East and 8.4 t/cap in London. In contrast to other categories, household consumption is quite evenly distributed across the UK. Yet it is the biggest driver of material production, so even small variations in the measurement have large ripple effects on the production chain and total resource use.

Different types of consumption

Due to lower consumption of gas and electricity, CO_2 emissions from household energy use are lower in the region than the national average. There is a similar pattern for transport, which is responsible for lower emissions and a decreased Ecological Footprint. The region's residents still rely on cars as the main mode of transport, but they travel less than the average UK resident each year. As with the surrounding northern regions, residents simply consume less and rely less on services. This is in sharp contrast to many of the UK's southern regions.

Food is the one exception to Yorkshire and Humberside's low Ecological Footprint and low CO_2 emissions from consumption. The region's high CO_2 emissions and Footprint from food mainly reflects people's high consumption of meat, which has a higher Footprint than crops. In summary, there is a significant contrast between production and consumption results.

This demonstrates the importance of a region-specific understanding of resource use and CO_2 emissions from both the production and consumption point of view.

1 Source: Regional Greenhouse Gases Emissions Monitoring and Modelling Study – update of baseline 2003 – Cambridge Econometrics

Overview

Sustainable Development in Yorkshire and Humberside

- Yorkshire and Humberside includes the growth hubs of Leeds and York, the old industrial areas of South Yorkshire and the Humber, the large shire county areas of North Yorkshire; and the two national parks where development is highly constrained.
- The Yorkshire and Humberside Regional Development Agency is outwardly supportive of sustainable development principles, particularly in developing renewable energy.
- Its Regional Economic Strategy (RES) makes priority for manufacturing and industrial clusters.
- The RES aims to put 10,000 young people into jobs, and fosters a pro-active partnership with employers and training organizations to make the most of the labour market.
- In Yorkshire and Humberside's Regional Development Agency, there is strong emphasis on urban design as an enabler of investment in a series of market towns, and on Urban Regeneration Companies as the catalyst for transforming the secondary cities of Sheffield, Bradford and Hull.

Future implications Yorkshire and Humberside's air travel increase will continue to grow as a perceived gap in aviation capacity is filled. Some progressive urban transit schemes are pending government approval. The region will also continue to experience the familiar storyline of increased congestion on motorways and trunk roads. The Regional Development Agency's strong emphasis on urban design as an enabler of investment in a series of market towns – and on Urban Regeneration Companies as catalysts – will continue to transform the secondary cities of Sheffield, Bradford and Hull.

Spotlight

Climate change, CO_2 and biomass in Yorkshire and Humberside

In order to deal with its high CO_2 production legacy, Yorkshire and Humberside became the first UK region to contribute to the UK emissions reduction targets through publishing its RES in 2002. The RES target is to reduce greenhouse gas emissions by at least 20 per cent between 1990 and 2010.

The region has subsequently built climate change response plans into major regional strategies, including the Regional Spatial Strategy (RSS) and the overarching regional strategic framework *Advancing Together*. In 2002 Yorkshire and Humberside also published *Warming Up the Region*, a detailed assessment of the potential impacts of climate change, and how the region might adapt to these. On 9 December 2005, the region launched a full Climate Change Action Plan – *Your Climate: Yorkshire and Humberside's Climate Change Action Plan*.[2]

These strategies are a critical first step. A main target of the Climate Change Action Plan is to integrate a concern for climate change into a relevant regional document. Other documents include the RSS, the RES and waste, energy and transport strategies. Ecological Budget UK provides detailed information about all these sectors, and can contribute to both processes by suggesting realistic targets and high CO_2 sectors. It also confirms that Yorkshire and Humberside's main contribution to CO_2 emissions is not from high consumption, but from high production which is driven by consumption elsewhere. This means that increasing production efficiency can have a large impact on reducing the UK's overall CO_2 emissions. The Climate Change Action Plan document highlights a number of emission reduction projects in the region; additional assessment with Ecological Budget UK indicators (CO_2 and Ecological Footprint) can help assess the relative success of these projects.

> "Yorkshire and Humberside's main contribution to CO_2 is not from high consumption, but from high production which is driven by consumption elsewhere"

The Ecological Footprint of biomass

Yorkshire's Climate Change Action Plan identifies biomass (fuel created from any recently living organism such as crops or chipped wood) as an alternative energy source to fossil fuels in the region. Biomass could be integrated into the present energy production infrastructure as it releases almost no CO_2 compared with fossil fuels. Through a CO_2 emissions analysis and an Ecological Footprint analysis of biomass, we concluded that its advantage is that it does reduce CO_2 emissions substantially. The disadvantage is that it delivers very little Ecological Footprint savings.

At present, the Ecological Footprint and CO_2 emissions results for Yorkshire and Humberside follow many of the same contours. This is because of a heavy reliance on fossil fuels that is represented in both indicators. Using biomass extensively in the region would make differences appear between the two indicators. Carbon dioxide emissions would drop. A change in the Ecological Footprint would range anywhere from a reduction by half to no change at all.

Figure 5 provides an insight into the Ecological Footprint of different biomass crops. For the sake of comparison, coal – the current fuel of choice in Yorkshire and Humberside – has been included in the graph above. Apart from ethanol from maize (which is not an option), all biomass crops have a lower Ecological Footprint than coal. The Footprint reduction could be less than some might expect.

The reason for this is that the Ecological Footprint "space" taken up by CO_2 emissions and absorption can often be replaced by "space" taken up by cropland and biomass refinement. Biomass products that need more refinement to become useful fuel have a similar Ecological Footprint to coal. Yet biomass fuels that can be used directly for heat generation have considerable scope at reducing both CO_2 emissions and the Ecological Footprint.

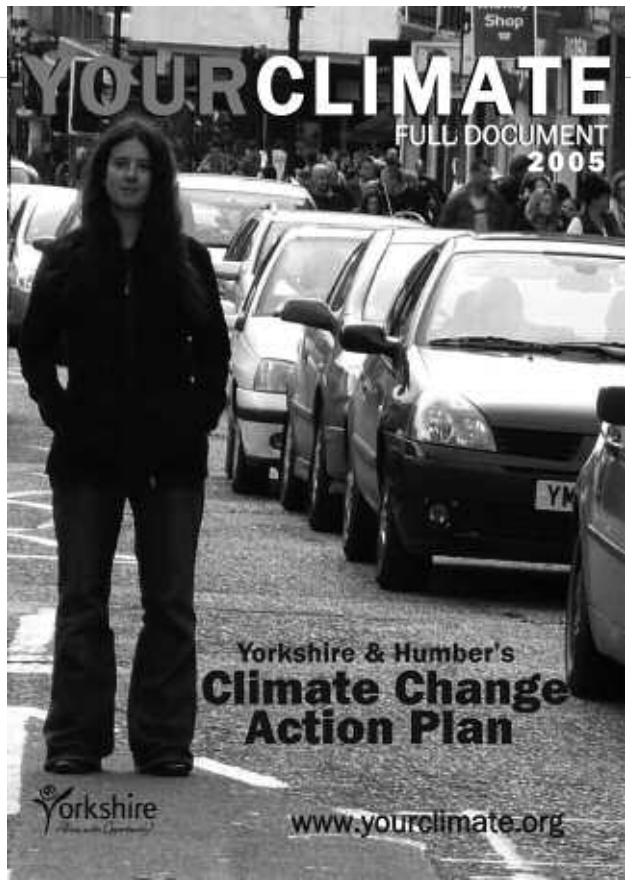
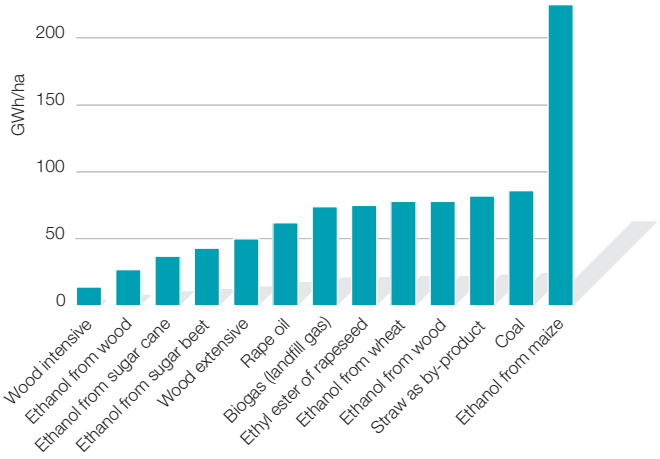


Fig 5 **Ecological Footprint of different biomass crops**



Biomass and land use

The overall effect of using biomass for fuel, particularly as it relates to land used for food, is complex and needs further study. At present, Yorkshire and Humberside produces more than 8.5m tonnes of agricultural products and imports 4.8m tonnes more, although only 2.8m of these tonnes are consumed as food by the region. The rest is eaten elsewhere, and a substantial portion is used for non-food products. Increasing use of biomass could raise the demand for non-food agricultural products.

As it is, Yorkshire has the opportunity to reduce its food Footprint by developing more local food supply chains (importing and exporting less in order to eat more food grown locally). It is unclear how biomass would affect such efforts. In summary, current analysis of biomass shows that its impact is mixed. More extensive study is needed to find out which land-use policy will most effectively reduce CO_2 emissions and the Ecological Footprint. How best to use land is a complex and constantly evolving question that all UK regions face.

Prudently, Yorkshire and Humberside is relying on multiple solutions – not only biomass – to achieve its ambitious CO_2 emission targets. Its Climate Change Action Plan also understands the importance of public communication. It seeks to ensure the participation of all stakeholders who are able to influence change. Ecological Budget UK provides empirical evidence to assess the current status of the programme, and a benchmark with which to compare future measurements. As Yorkshire and Humberside continues to craft future policy, Ecological Budget UK's Resources and Energy Analysis Program (REAP) software[3] can help suggest low-Footprint, low-CO_2, low-resource options.

"Current analysis of biomass shows that its impact is mixed. More extensive study is needed to find out which land-use policy will most effectively reduce CO_2 emissions *and* the Ecological Footprint"

2 This programme was launched just before publication of the Ecological Budget UK report. See more at www.yourclimate.org

3 For more about REAP, see www.sei.se/reap

Northern Ireland

Material flow analysis

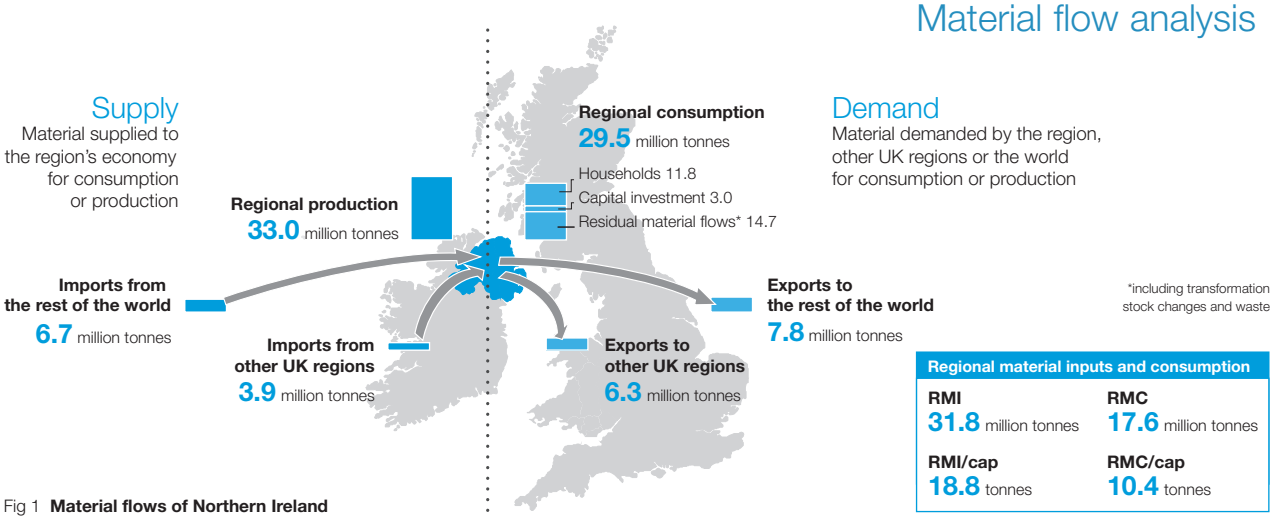


Fig 1 **Material flows of Northern Ireland**

Ecological Footprint

Fig 2 **Regional Ecological Footprints (gha/cap)**

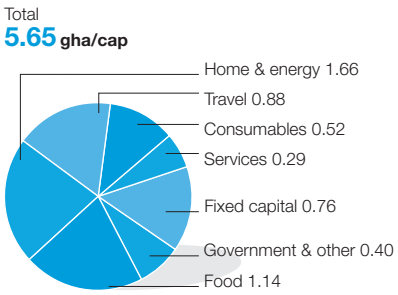


Fig 3 **Northern Irelands' Ecological Footprint (gha/cap)**

Analysis

Material flow

The various sectors of Northern Ireland's material flows are almost without exception the smallest compared with other parts of the UK. This is true both per capita and in terms of total material flows. Northern Ireland's total Regional Material Input (RMI) and total Regional Material Consumption (RMC) is 18.9 t/cap and 10.5 t/cap respectively. This is the lowest among the three devolved administrations and all UK regions.

In household consumption (a major component of RMC) Northern Ireland contributes only 3 per cent to the national total. In the capital investment component of RMC, the Province also adds the smallest share of 2 per cent, compared with London and the South East at 17 per cent and 15 per cent respectively.

While per capita physical trade with other countries in the world is near the UK average, Northern Ireland has by far the lowest physical trade of materials with other UK regions. Imports from and exports to other regions amounted to 6.1 t/cap, compared with a UK average of about 18 t/cap. Such low flows may be due to Northern Ireland's geographic position, which is more isolated from Great Britain than any other devolved administration or region. As a result, it is likely that Northern Ireland trades more with the Republic of Ireland than with the rest of the UK. The only material flow sector where Northern Ireland shows above average flows is in exports to the rest of the world. All other categories, including household consumption and capital investment, are lower than in most of the UK's other regions.

CO_2 emissions

For reasons mentioned below, Northern Ireland's current CO_2 emissions measurement from production may be unreliable. As it is, it shows that emissions from production in the Province are 9.16 t/cap. This would be the second lowest in the UK, and substantially lower than the national average of 10.76 t/cap. Many private households in Northern Ireland are heated by coal fires. Since these emissions do not come from power stations on the national grid, they may be under-measured, even though they produce CO_2. It seems likely that Northern Ireland's emissions from production are actually higher than indicated here.

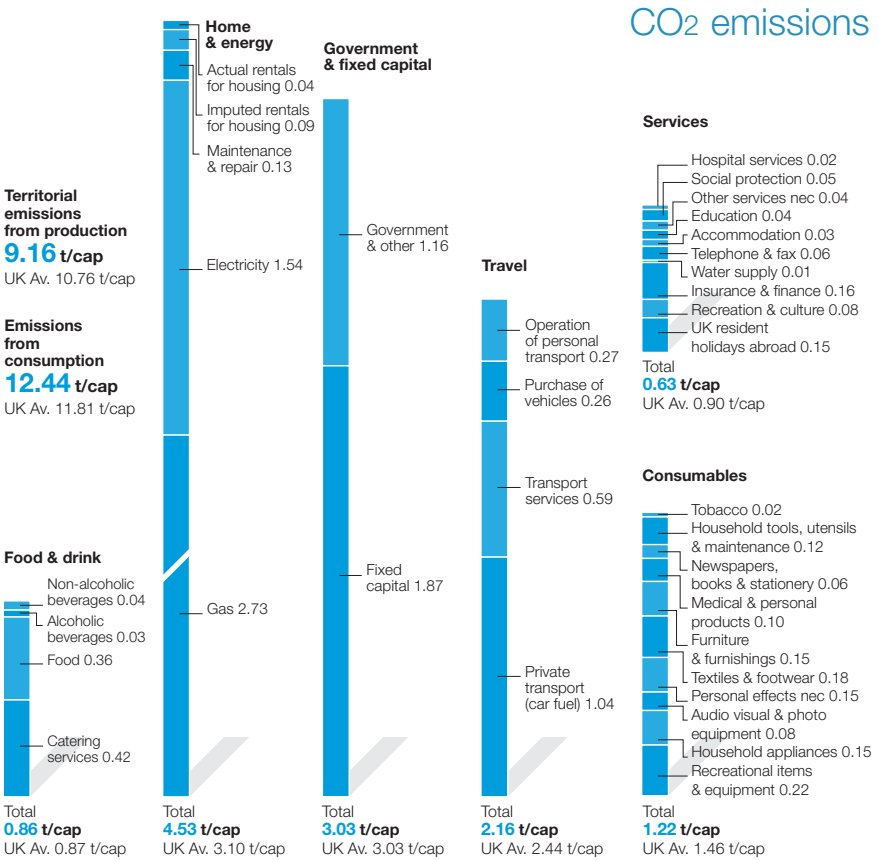


Fig 4 **CO_2 emissions from consumption in Northern Ireland (t/cap)**

Measurements of emissions from consumption are more reliable, and reflect domestic coal burning. Northern Ireland is high – 12.44 t/cap versus the national average of 11.81 t/cap, largely because of high coal burning.

Ecological Footprint

In the same way that Northern Ireland's emissions from consumption are high, its Ecological Footprint is also high, mainly as a result of energy consumption. At 5.65 gha/cap, its Footprint is second only to the South East. The largest component of Northern Ireland's Footprint, "home and energy" (1.66 gha/cap), is driven by ineffective insulation and heating practices. The food Footprint is also large (1.14 gha/cap), as is the travel Footprint (0.88 gha/cap) – the latter due mainly to high car use and distance travelled.

"In household consumption (a major component of RMC) Northern Ireland contributes only 3 per cent to the national total"

Overview

Sustainable development in Northern ireland

> In relation to the rest of the UK, Northern Ireland is a small and peripheral region with a growing regional economy, economically linked with the Republic of Ireland.

> Northern Ireland has continued its recent trend of steady growth, benefiting from greater political stability. Since 1998 employment levels are up, unemployment rates down and GVA has grown steadily. At the same time, it maintains the highest economic inactivity rates in the UK, relatively low skills levels in the workforce, and low productivity.

> The 'Economic Vision' partnership strategy put forth by the office of the Secretary of State for Northern Ireland sets out fairly typical themes:

- Increase investment in Research and Development and promote innovation/creativity
- Promote and encourage enterprise
- Ensure the right skills for future employment opportunities
- Ensure a modern infrastructure in place to support business.

Future implications In the current Economic Vision there is emphasis only on 'sustainable economic development' as the process of modernization and moving away from public sector dependency. In this context, the definition of "sustainability" can be expanded for Northern Ireland to include the impact of development on resource flows. Elsewhere, the strategy encourages specific action in sectors such as agriculture and tourism, and addresses the energy sector, which has been historically centred on coal. An active Local Agenda 21 programme in the green and community lobby will continue to bring to the fore the environmental impacts of resource consumption.

Spotlight

Regeneration in Northern Ireland

Driven by new investment, the physical transformation of Northern Ireland over the past 10 years has been dramatic. This change is expected to continue with heavy investment in public infrastructure, offices, hotels and residential property. The Northern Ireland administration's investment strategy for the next 10 years envisages an expenditure of some £16 billion on critical improvements. This includes £3.3bn on schools, £2.2bn for health facilities, £2bn in public housing and £2bn on water supply and sewage treatment.

Given the comparatively low investment in the Province's infrastructure and economy and a lack of social and economic opportunity over the last 30 years, regeneration is necessary and exciting. Northern Ireland's regeneration plan can invest in both sustainable and unsustainable infrastructure.

Author	Short-term	Long-term (3+ years)
SACTRA		50-100%
Goodwin	28%	57%
Johnson and Ceerla		60-90%
Hansen and Huang		90%
Fulton, et al.	10-40%	50-80%
Marshall		76-85%
Noland	20-50%	70-100%

Fig 5 **Portion of new capacity absorbed by induced traffic**

The Ecological Footprint of low-density development

Half of all new homes in Northern Ireland are single family (or "single person") detached dwellings outside towns and cities. In terms of energy, transport and built-up land, low-density development has an intrinsically higher Footprint than development closer to city centres. Heating is less efficient than in terraced houses or flats. Building is often on land that could be used for food production or green space. Most dramatically, low-density development increases Northern Ireland's already high dependency on the car, which always has a Footprint higher than any other form of local transport.

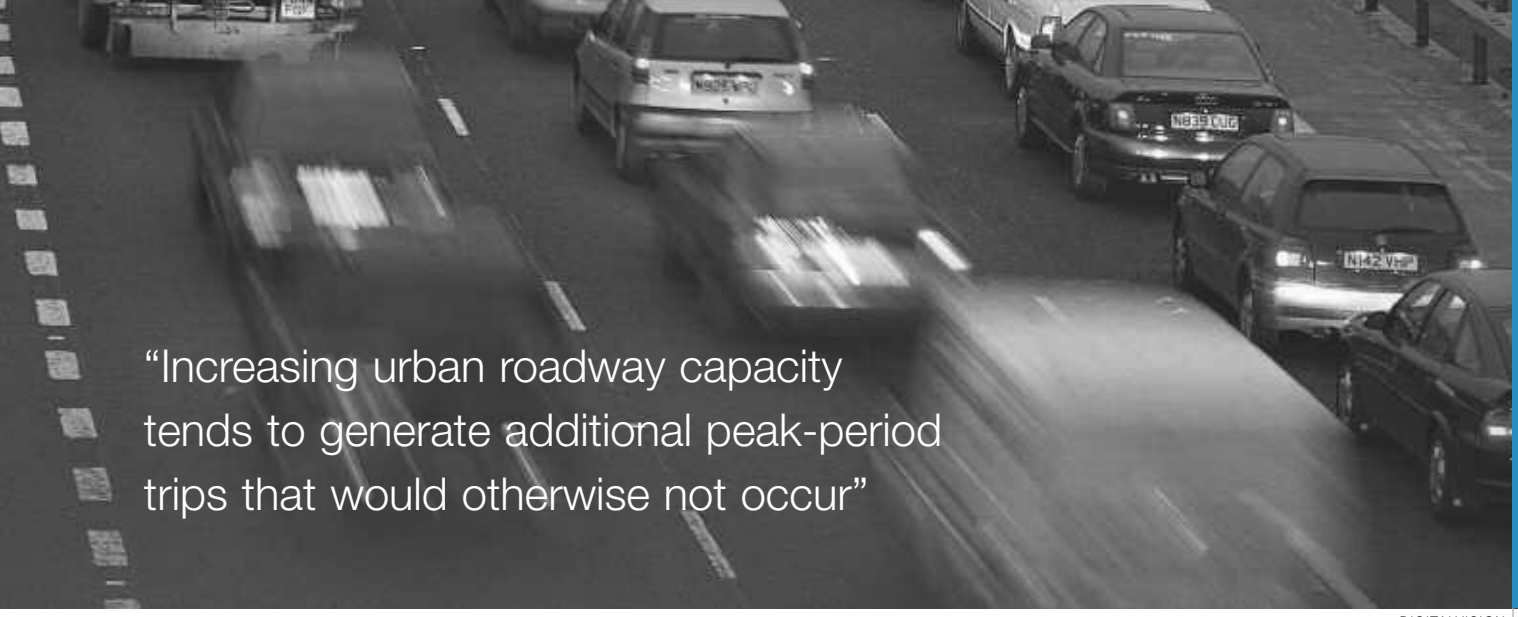
Development of road transport

The administration's strategy in general affirms sustainable development, although many projects in the budget will drastically increase Northern Ireland's Ecological Footprint. More than £2bn is allocated to road transport development – driven by suburban development – while less than a quarter of that sum is planned for lower-Footprint options such as rail, bus and cycling.

Northern Ireland is already heavily reliant on road transport. This accounts for 31 per cent of its CO_2 emissions, overtaking energy production as the single largest contributor, the only part of the UK where this is the case. It is also the only part of the UK in which domestically-produced greenhouse gas emissions are still rising: they were 2 per cent higher in 2002 than in 1990.

Studies suggest that increasing urban roadway capacity tends to generate additional peak-period trips that would otherwise not occur, in effect negating reductions in traffic congestion. This consists of a combination of diverted vehicle trips (trips shifted in time, route and destination), and induced vehicle travel (shifts from other modes, longer trips and new vehicle trips). Over time, "generated traffic" often fills a significant portion (50-90 per cent) of added urban roadway capacity[1,2] Figure 5 summarises the results of various studies that measure the amount of added urban roadway capacity that is filled with induced travel.

Most studies conclude that the additional road space is "filled" within three years. This partly explains why Northern Ireland is facing a potential increase in the Ecological Footprint of personal travel over the next 10 years[3].



"Increasing urban roadway capacity tends to generate additional peak-period trips that would otherwise not occur"

DIGITALVISION

Sustainable building

Some projects in the Northern Ireland administration's initiative will reduce its Ecological Footprint. The school-building programme proposes that new schools be designed according to the best possible sustainable construction practices.
The Department of Education also seeks to operate its schools more sustainably and to incorporate sustainable development as a key theme in the curriculum. This demonstrates the potential of government agencies to reduce their own Footprint, and in the process to set a benchmark for the region. Another of the administration's initiatives, worth £50m over the next two years, envisages Northern Ireland taking a UK lead in developing renewable energy technologies, including wind, tidal and biomass systems.

There are other movements towards low-Footprint regeneration in Northern Ireland. In Belfast, a new £11m comprehensive community treatment and care centre is being subjected to an independent sustainability audit, the results of which will inform similar future buildings throughout the Province.

"The Ecological Footprint of an EcoHomes "excellent" house is 35 per cent less than the typical UK house"

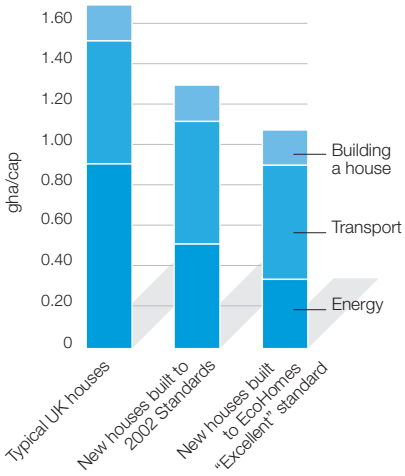


Fig 6 **The Ecological Footprints of UK housing**

Also in Belfast, Cavehill Primary School is housed in an energy-efficient building that includes passive solar design, high-efficiency gas boilers, maximum daylight usage, photovoltaic cells and rainwater harvesting. And one of the UK's largest renewable energy plants has been opened in County Fermanagh, producing an innovative biomass fuel.

The Ecological Footprint of efficient housing

Figure 6 highlights the benefits that can be achieved by setting an EcoHomes "excellent" standard for new buildings.

Modifying and implementing public policy is a challenging process. However, the above analysis shows the potential benefits of building more energy efficient homes: an average home built according to 2002 UK standards has a lower Footprint than does the general UK housing stock.

Homes built according to the "excellent" EcoHomes standard have a lower Footprint than those built to 2002 standards. Overall, the Ecological Footprint of an EcoHomes "excellent" house is 35 per cent less than the typical UK house.

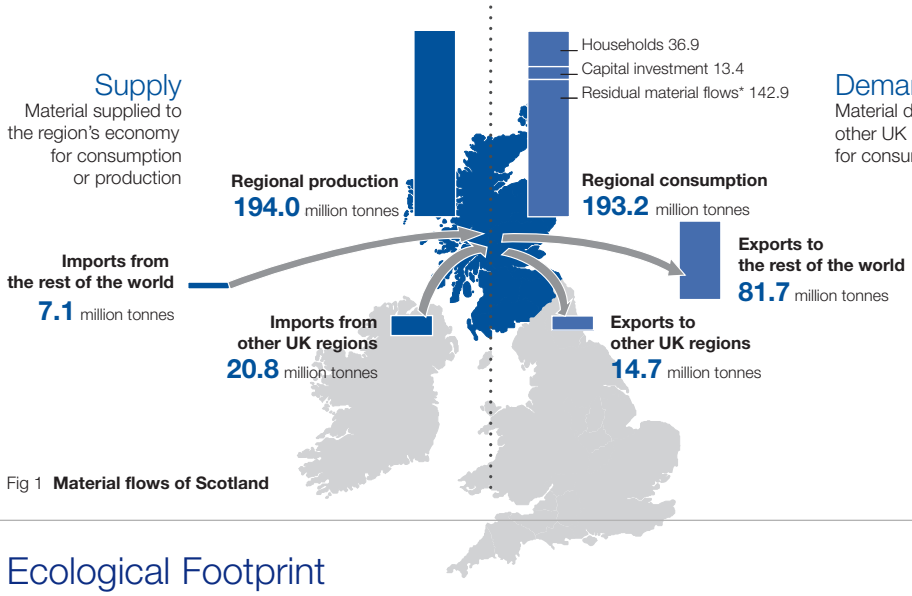
The future of sustainable development in Northern Ireland

Like the rest of the UK, Northern Ireland still struggles to initiate a major shift to sustainable regeneration, and the temptation of growth and regeneration at all costs may threaten its future environmental stability. Having said that, many of the policies and projects mentioned here demonstrate sustainable regeneration in Northern Ireland. Gauges such as the Ecological Footprint and CO_2 accounting can help decision-makers differentiate between sustainable regeneration and simple economic expansion. Putting sustainable development at the heart of regeneration can achieve both concepts at the same time.

1 Hansen, M. and Huang, Y., 1997, "Road Supply and Traffic in California Urban Areas," *Transportation Research A*, Vol. 31, No. 3, 1997, pp. 205-218.
2 Noland, R., 2001, "Relationships Between Highway Capacity and Induced Vehicle Travel," *Transportation Research, A*, Vol. 35, No. 1, January 2001, pp. 47-72; also available at www.epa.gov/tp/trb-rn.pdf.
3 Data obtained from: "A Position Report on the Future Investment Needs of the Northern Ireland Railway Network (2004). Available from: www.foe.co.uk/resource/consultation_responses/future_railway_investment.pdf

Scotland

Material flow analysis



*including transformation stock changes and waste

Fig 1 **Material flows of Scotland**

Regional material inputs and consumption

RMI 193.5 million tonnes	**RMC** 97.0 million tonnes
RMI/cap 38.2 tonnes	**RMC/cap** 19.1 tonnes

Ecological Footprint

Fig 2 **Regional Ecological Footprints (gha/cap)**

Total
5.37 gha/cap

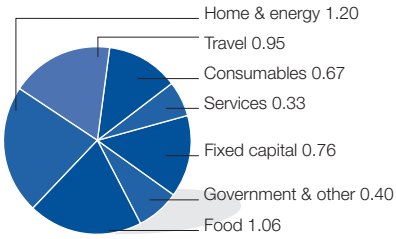


Fig 3 **Scotland's Ecological Footprint (gha/cap)**

Analysis

Although the consumption patterns of people in Scotland result in an Ecological Footprint and carbon dioxide emissions from consumption that are similar to the UK average, a breakdown by household activities does show variation. Scotland has a lower than average Footprint for food, housing, services and holiday activities, but its CO_2 emissions are higher for household energy.

CO_2 emissions

Scotland's CO_2 emissions from production and consumption are very similar. On a per capita basis, its territorial emissions are higher than the UK average and its CO_2 emissions from consumption are lower.

CO_2 emissions from household energy consumption are higher than the UK average: 3 t/cap compared with an average of 2.75 t/cap. This may be partially due to Scotland's colder climate. Even though much of Scotland is rural, it emits only 1.3 tonnes of CO_2 from transport, compared with the UK average of 1.7 t/cap.

Material flow

Imports and RMI Scotland's material flow picture is distinctive from its Ecological Footprint and CO_2 emissions.[1] Total and per capita, Scotland has the highest Regional Material Input (RMI) in the UK, amounting to 193.6m tonnes or 38.22 t/cap. This compares with a regional average of 24.17 across the UK.

The high RMI figure is mainly driven by the high level of material extraction in Scotland – some 25 per cent (165.5m tonnes) of the overall extraction in the UK. Most of this is North Sea oil extraction, which accounts for almost all the 119.9m tonnes of materials from the mining and quarrying sector specialised on energy carriers – 64 per cent of the total RMI. Another 34.7m tonnes is added by all other activities in the mining industry.

However, imports contribute comparatively little to the high RMI figure. Imports to the rest of the world are the smallest and imports from other UK regions are second smallest across the UK at 1.41 t/cap (compared with a national average of 3.5 t/cap) and 4.13 t/cap (compared with a national average of 9.0 t/cap) respectively. Although it does not contribute significantly to overall material flows, Scotland is the largest producer of fish in the UK. Two thirds of UK fish catches come from Scotland – a mass flow of 609,000 tonnes. Only 82,000 tonnes of fresh fish are directly exported to other regions in the UK or abroad. Most is processed into fish products, which are then either exported or consumed.

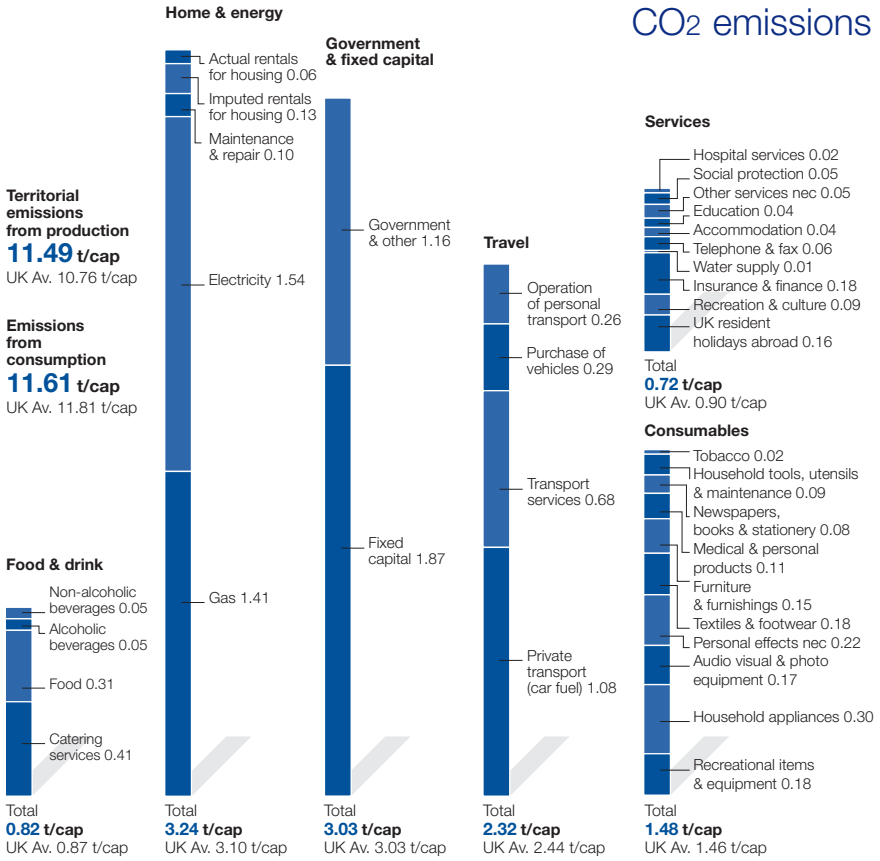


Fig 4 **CO_2 emissions from consumption in Scotland (t/cap)**

Exports and RMC While Scotland's imports rank among the lowest in the UK, no other region exports as much to the rest of the world. Driven by 59m tonnes of sales in oil and other energy carriers, Scotland exported 81m tonnes – 42 per cent of the UK's total exports – to other parts of the world in 2001. At the same time, however, per capita exports to other UK regions were smallest at 2.91 tonnes, compared with a national average of 9.0 tonnes. In this sense, Scotland shows a typical physical trade pattern for the devolved countries, being more involved in world trade than in intra-UK trade compared with the English regions.

Overall, the indicated trade patterns lead to a physical export surplus for Scotland of 68.5m tonnes across the regions. This is not only the highest in the UK, but it also compares with net imports of 11.8m tonnes on the national level. This huge export surplus leads to the largest difference between the RMI and Regional Material Consumption (RMC)[2] estimate across the regions. However, the high level of regional material extraction still leaves Scotland with the highest RMC figure of 19.17 t/cap, compared with a regional average of 11.7 across the UK.

1 One important difference between material flows and CO_2 from emissions should be noted here: in material flows, energy-producing materials converted into electricity are attributed at "Regional Material *Consumption*" to the region that converted them to electricity, simply because electricity has no mass so is not considered a "material flow". In CO_2 emissions measurements, however, the same energy-producing materials converted into electricity are attributed as "CO_2 emissions from *production*" to the region that converted them into electricity. CO_2 emissions from consumption would be attributed to the region or country that consumed the electricity. Generally, a high RMC will mean a high Ecological Footprint, although Scotland shows some exception to this.

2 It should be noted that Scotland's total RMC may be high due to inconsistent data from official sources. The Ecological Budget UK material flow analysis relies on the best available data, but sometimes this does not allocate material flows exactly to all regions and devolved countries. In 2001, for example, the official data source allocated 90m tonnes to an "unknown" region. Much of this uncertainty relates to oil processing, so it is likely to affect the data for Scotland. Therefore, the RMC figure for Scotland requires further investigation. This example also demonstrates clearly that considerable improvements in the tracking of resources in the UK are necessary.

Overview

Sustainable Development in Scotland

- Scotland has a dynamic economy, and at the same time continues to have low productivity, the highest rate of child poverty in the UK, and the extra challenge of working in the remote highlands and islands.
- As compared to its population, Scotland has a large overall land area and greater access to natural resources, but there is much wastage and inefficiency in resource use and industry.
- The Framework for Economic Development in Scotland, updated in 2004, sets out four goals:
  1. Economic Growth – with growth accelerated and sustained through greater competitiveness in the global economy
  2. Regional Development – with economic growth a pre-requisite for all regions to enjoy the same economic opportunities
  3. Closing The Opportunity Gap – social development in turn contributing to national economic prosperity
  4. Sustainable Development – in economic, social and environmental terms
- This fourth goal includes a Green Jobs strategy, and a large scale renewable energy programme. It is yet to be seen how this will translate to growth sectors such as that of chemical-intensive salmon farming on the west coast. Meanwhile, modernization of regional economies is expected to raise transport demand and other material flows.

Future implications Scotland's innovative new Sustainable Development Strategy recognises the need for a significant shift towards more sustainable consumption and production patterns, and represents a change in Scottish sustainability strategy. It prioritizes reducing the inefficient use of resources, exploring the impact of products and materials across their whole lifecycle, and encouraging people to think about the social and environmental consequences of their purchases. Ecological Budget UK project results can inform these efforts and, combined with the efforts of many local authorities in Scotland, the Scottish Parliament has an opportunity to be a leader in sustainability.

Spotlight

Renewable energy in Scotland

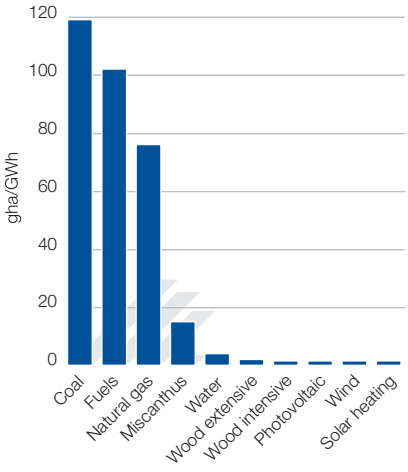
Scotland produces 11 per cent of the UK's total CO_2 emissions,[3] and produces more energy from oil, gas and coal than it consumes. Because the rest of the UK consumes these fuels, changing Scotland's energy sources from fossil fuels to renewable energy would contribute significantly to lowering the UK's overall CO_2 emissions.

Many Scottish politicians already aspire to make Scotland the "renewable energy capital" of the UK by harnessing its impressive renewable sources – wind, hydro, wave, tidal and biomass. The ruling coalition (Labour and Liberal Democrat) appears genuinely committed to promoting renewable energy in Scotland, as does the Scottish National Party, the Greens and the Scottish Socialists. The government also sees developing renewable energy as a way to promote economic growth, particularly in rural areas that are short of jobs.

The Yorkshire and Humberside case study (see pages 56-57) assessed the impacts of using biomass for energy and found that it may be beneficial in terms of CO_2 emissions, but not always in terms of Ecological Footprint. The analysis in Figure 5 compares the Ecological Footprint of other kinds of renewable energy and shows the various benefits of renewables. With the exception of biomass, CO_2 emissions savings are similar.

Efforts are slowly moving forward to produce and use less CO_2-intensive energy in Scotland. The Scottish Parliament published an Energy Efficiency Strategy in early 2006 and is due to update its 2000 Climate Change Programme. This plans for increased reliance on renewable energy, and may commit Scotland to domestic CO_2 reduction targets for the first time. It is hoped that the Resource and Energy Analysis Program (REAP) will contribute to the analysis of these strategies, assessing the effectiveness of the adopted policies.

Fig 5 **The Ecological Footprint of different fuels**



The role of renewables and micro-generation in eliminating "fuel poverty"

The Parliament also seeks to eradicate "fuel poverty" by 2016 – giving all people in Scotland access to adequate energy. So far, this strategy has not relied on efficiency or renewables; it depends on cheap fuel, available to more people with rising incomes, provided by wider connection to the national natural gas grid. Given the rising price of fossil fuels, this strategy will become less tenable, and renewable energy will become more competitive.

Another low-CO_2 cost-effective alternative to fossil fuels is microgeneration – the generation of heat or electricity at the community or household level instead of in large centralised generating plants. It is particularly cost-effective in rural areas, of which Scotland has many.

Microrenewables take pressure off the centralised and usually CO_2-based production grid and still deliver energy. A great deal of money is spent on eradicating fuel poverty; in future, this money might instead drive the development of renewables and microrenewables.

A commitment to renewable energy: the 2003 Partnership Agreement between Scotland's Labour and Liberal Democrat parties

"We will work towards our target for 40 per cent of Scottish electricity generation to be from renewable energy sources by 2020. We will support the development of wave, tidal and solar energy and support the development of technologies to promote the greater use of fuel from wood and other energy crops. We will press the UK government and electricity companies to strengthen the electricity grid. We will encourage participation in renewable energy projects by communities and local authorities."

HIE/STOCKSCOTLAND.COM

Regional case study: Wick

A number of projects across the UK have demonstrated the advantages of local energy systems based on community heating. For the domestic sector, heat generation is by far the most significant issue related to CO_2 emissions. Community heating links buildings with homes via a system of pipes known as the heat network, with heat provided from a central source. Sustainable fuel sources can be used, and a serious reduction in energy lost through transmission can be achieved. Probably the best Scottish community energy scheme is in Wick. Led by Highland Council, it is the largest of its kind in the UK.

The first phase of this continuing project was to link a local distillery to 400 houses, utilising waste heat. The second phase will build on the existing heat network to encompass most of the town, including the hospital, secondary school and a further 1,000 homes. The system is using wood fuel (forestry residue) as the source which will generate heat and electricity through a gasification process. They will add to the fuel mix by incorporating gas from an anaerobic digestion system fed by the local fish processing plant. In terms of reducing the CO_2 Footprint, Wick is a good example: it is currently off the gas network and liquefied gas is transported to the town via road. All the renewable fuel is being sourced locally and many "green" jobs are being created. It is estimated that the scheme will save around 5,000 tonnes of CO_2 over its lifetime of 25 years and the cost savings will be around £2m to the end users.

REAP in Scotland

The Resource and Energy Analysis Program (REAP) is being piloted by a number of local authorities in Scotland – Aberdeen City, Aberdeenshire, and North Lanarkshire Councils. Using REAP, they will produce a baseline assessment of their CO_2 emissions and Ecological Footprint, and assess the Footprint and CO_2 impacts of transport strategies, development and other future scenarios.[4]

The three-year project, running to June 2007, is:

- measuring the footprint of each local authority area;
- developing a software tool for policy-making;
- developing a strategy and projects to reduce the footprint; and
- producing education materials for schools to measure a "whole school" footprint.

Conclusions

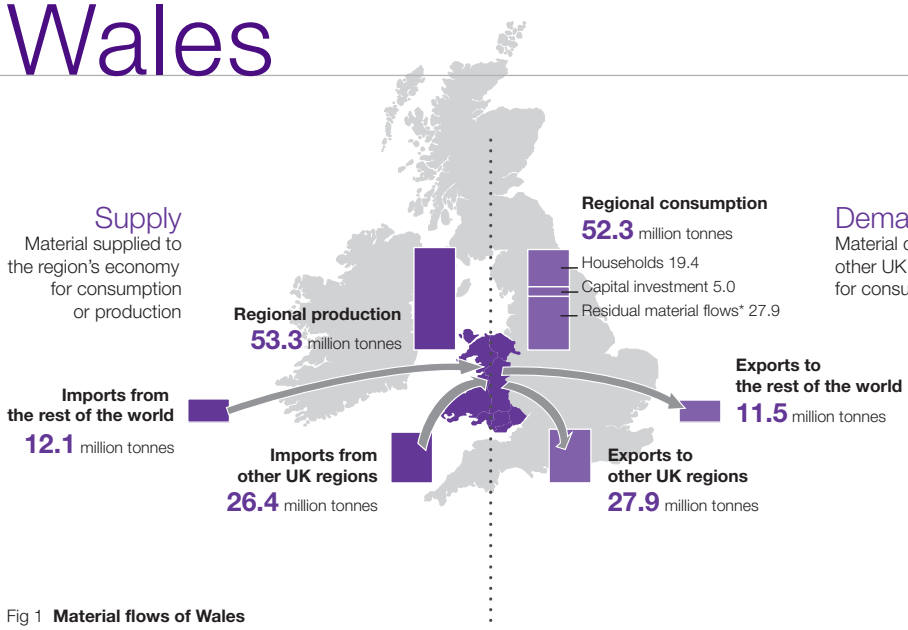
Although UK energy policy is set by the national government, the Scottish Parliament and local authorities can set their own targets for CO_2 reduction and use of renewable energy as part of their contribution to reducing the overall UK CO_2 emissions. They also administer many other areas that influence CO_2 levels – housing, planning and transport, for example.

The energy coin always has two sides: consumption and production. More efficient production can be cancelled out by less efficient consumption. However, because Scotland produces more than it consumes, and because of its vast capacity for renewable energy, it stands to make a great contribution to reducing the overall UK CO_2 emissions.

3 Key Environment Statistics 2005, Scottish Executive Publication www.scotland.gov.uk/Publications/2005/08/15135632/56521#2
4 For further information visit www.scotlandsfootprint.org

Wales

Material flow analysis



*including transformation stock changes and waste

Regional material inputs and consumption

RMI 73.1 million tonnes	**RMC** 33.7 million tonnes
RMI/cap 25.2 tonnes	**RMC/cap** 11.6 tonnes

Fig 1 **Material flows of Wales**

Ecological Footprint

Fig 2 **Regional Ecological Footprints (gha/cap)**

Total
5.20 gha/cap

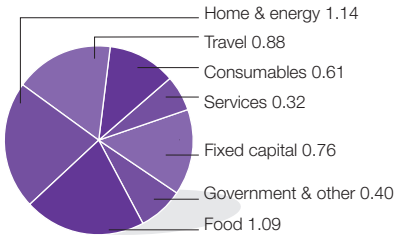


Fig 3 **Wales' Ecological Footprint (gha/cap)**

Analysis

Wales is one of the four devolved countries of the United Kingdom. As a nation Wales is a young and modern country, with the National Assembly – in existence for only seven years – now exercising some limited devolved powers. However, in those seven years Wales has achieved a lot in the creation of Sustainable Development policies and legislation, for unlike the UK as a whole – the Assembly has a legal duty under Section 121 of the Government of Wales Act to "make a Scheme setting out how it proposes, in the exercise of its functions, to promote sustainable development." In particular, and of most relevance to this report, Wales has the only Government in the world that has adopted the Ecological Footprint as a headline indicator.

Wales is characterised by having a high agricultural and manufacturing base when compared to the UK. Of the 2.9 million people living in Wales only 72.7 per cent of people of a working age are in employment, amongst the lowest for the UK. The average gross weekly earnings for full-time employees are £414.50, again amongst the lowest for the UK. These figures underline 'West Wales and the Valleys' as one of the poorer regions in the EU which have been in receipt of significant EU Structural Funds, through the current Objective One Programme. This funding has been available for those regions with average GDP per capita below 75 per cent of the EU as a whole. However, from a global perspective Wales is one of the world's richer countries, with GDP per capita in the top fifth of the world's countries.

Wales now faces a unique challenge: how to increase the quality of economic development without increasing the associated environmental costs of such development. Existing policies to increase household disposable income per head of population to 95 per cent of the UK average may result in increased CO_2 emissions (consumer responsibility) and Ecological Footprint. While it is understood that this may be an unintended effect of policy, it is now widely understood that real decoupling can be achieved if policies emphasise a quality of economic development that is not dependent upon traditional quantity-based economic indicators like GDP.

CO_2 Emissions

Unlike most of the UK Wales is a net exporter of energy and has some of the highest territorial CO_2 emissions in the whole of the country at 14.31 t/cap – almost 25 per cent higher than the UK

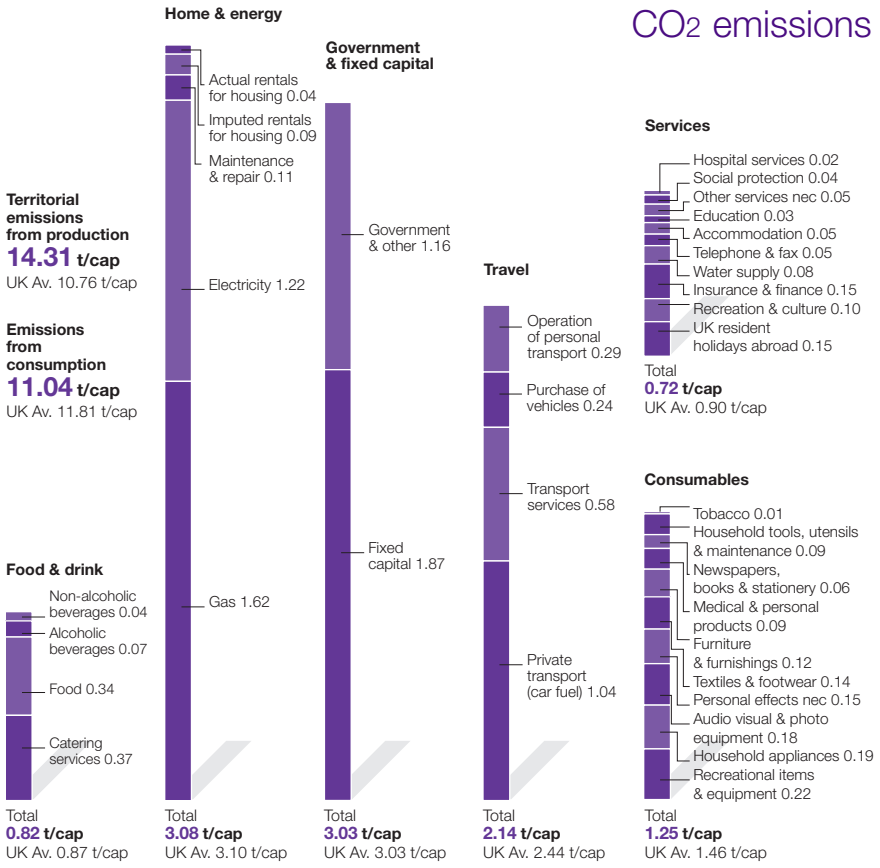


Fig 4 **CO_2 emissions from consumption in Wales (t/cap)**

average of 10.76 t/cap. Only the North East exceeds this at 15.83 t/cap.

As a result of lower household expenditure than the UK, Wales has the lowest CO_2 emissions from consumption, again with the exception of the North East. Such reduced consumption has resulted in a fifth less CO_2 emissions than the UK average when measured in this way. The fact that these emissions are lower demonstrates that, in terms of carbon dioxide emissions, Wales is carrying the environmental burden for consumption that occurs outside its territory.

Material flow

With 25.21 t/cap Wales' Regional Material Input (RMI) indicator is the third highest across the UK. This is equally driven by an above average regional production of materials amounting to 11.93 t/cap and an above average material import of 13.28 t/cap. For example, 21.95m tonnes or 63.37 per cent of Wales' regional extraction stems from the mining of non-energy producing materials. Excluding material exports to the rest of the world and the other UK regions leaves a Regional Material Consumption (RMC) estimate of 11.62 t/cap, which ranks fifth across regions, but performs just below the regional average of 11.7 t/cap.

Trade activities of Wales seem to show a pattern quite characteristic for the devolved countries. Like for Scotland and NI the physical trade with other UK regions is not so developed. Even though Wales trades with 54.4m tonnes of materials about 20m tonnes more than Scotland and about 44m tonnes more than NI, the NE is the only English region less involved in intra-UK trade in total terms. However, on a per capita basis this picture is skewed and Wales performs just above UK average.

continued over the page

1 Source for data: Office for National Statistics, Wales. Selected Key Statistics and Regional Profile (2005)
2 WAVE. Wales A Vibrant Economy. Strategic Framework for Economic Development Consultation Document (2005).
3 Reducing Wales' Ecological Footprint: Report Summary. SEI and WWF. 2005.

Overview

Sustainable Development in Wales

- Wales has a mountainous terrain, and is historically the back yard to British imperial aspirations.
- It is a former site for coal and steel, though is now moving into a knowledge-based role.
- It retains its own language, but is increasingly integrated into the English economy, e.g. through supply chains, tourism and second homes.
- The vision for the Regional Economic Strategy (RES) equivalent, *A Winning Wales*, is "to achieve a prosperous Welsh economy that is dynamic, inclusive and sustainable, based on successful, innovative businesses with highly skilled, well-motivated people". The key areas for action to achieve this vision include:
  "
  - increase the knowledge, research and development, and innovation capacity in all parts of the Welsh economy;
  - help more people into jobs to bring down our levels of economic inactivity;
  - build on our considerable strengths in manufacturing;
  - increase the number of jobs in financial and business services;
  - encourage the development of our country's green economy;
  - promote opportunities for Welsh companies to develop international trade;
  - support the social enterprise sector which can bring growth and opportunity to disadvantaged communities."

Future implications

The regeneration of the South Wales coalfields was a major achievement that continues to generate new clusters of environmental technologies. The South Wales terrain is resistant to intensive agriculture, and encourages small scale eco-farming, eco-tourism and other diversification. However, this same terrain also makes ground transport more difficult – for instance, linking the south and the north of the country will probably involve an air shuttle system. Wales' strong national culture, language and high-quality community life can offer something of a counter-weight to intensive consumerism.

Analysis continued

Typically for a devolved country trade with the rest of the world is more developed than in most of the English regions amounting to 8.15 t/cap. In fact only London as (one of the) the centre(s) of the UK economy is the only English region which trades more with the rest of the world in physical terms. At the same time both Scotland and NI have a higher per capita trade with ROW than Wales. Overall, Wales' trade balance is almost even showing a slight export surplus of 0.9m tonnes across industries. However, looking at individual industries gives a much richer picture. "Metal products" and "energy materials" from mining are mainly exported with a net balance of 4.8 and 1.7m tonnes respectively, while products from "agriculture, hunting and fishing", "mining and quarrying except energy producing materials", as well as "food, beverages and tobacco" are mainly imported with a net balance of 1.0m tonnes, 2.3m tonnes and 2.4m tonnes respectively. However, so far this analysis has only looked at flows which actually occur within the region or which cross its political boundaries (borders). If the regional lifestyle is to be assessed, such a picture can be misleading, because flows in one regions might occur to support consumption activities in another region without actually crossing the region's borders.

Looking, for example, on the lifecycle impacts of household consumption activities, Wales only triggers 6.7 tonnes of materials per capita compared to a national average of 7.5 t/cap once all material flows are assigned to the consuming region. This is the second smallest material impact of households' across UK's regions. The same is true for capital investment, which only gives rise to per capita flows of 1.73 tonnes compared to a national average of 2.31 tonnes.

Spotlight

Food and farming in Wales

Food production and consumption is the basis for a significant proportion of our material flows and waste production, and is the single largest component of the Ecological Footprint of Wales, as it is in the UK.

Over the last 50 years, our relationship with food has changed considerably. The food we eat has hidden impacts on the world around us. We have become used to year round produce flown thousands of miles across the globe, cheaply available in vast supermarkets. The production of food in farms has become increasingly mechanised, large-scale and more specialised, and food supply-chains have become more complicated and transport-intensive.

Food retailing has become concentrated within a small number of multiple retailers, with many of their stores located away from the traditional high street, now accounting for over three-quarters of food sales. Takeaway food and ready-to-eat meals are now very popular. All these changes have influenced the resource production, consumption and environmental impacts of the Welsh food and farming system.

Scenarios for food and farming in Wales

The Welsh Assembly Government has acknowledged these changes to our production and consumption of food, and has recommended that "10-15 per cent of agricultural land in Wales is to be organic or in-conversion by the end of 2010".[1] This target is consistent with the Welsh Assembly Government's vision of an innovative agri-food industry, creating high quality, value added food products while at the same time enhancing the biodiversity of the Welsh countryside, supporting tourism and the survival of the Welsh family farm. The Welsh Assembly Government has also developed key consumption targets that help promote a healthier diet through *Food and Well Being: Reducing inequalities through a nutrition strategy for Wales (2003).*

Relevant Welsh Assembly Government targets and policy

- *Second Organic Action Plan for Wales 2005-2010* – "10-15 per cent of agricultural land in Wales to be organic or in-conversion by the end of 2010"
- *Food and Well Being: Reducing inequalities through a nutrition strategy for Wales* – "Knowledge of recommended number of portions of fruit and vegetables, and correct estimation of a portion size will increase by 10 per cent from 31 per cent by 2005"

While organic farming may be one of several approaches to delivering such policy goals, it is the only approach that is seriously attempting to address all of them simultaneously. However, in the last few years, while production and consumption of organic food has grown rapidly in the UK, in Wales it is still only 3.2 per cent of all food production and 1.1 per cent of all consumption.

Researchers at SEI undertook an extensive analysis of the production and consumption of food in Wales as part of the Reducing Wales' Ecological Footprint Project[2]. This analysis has demonstrated the importance of linking local production and consumption systems, to deliver integrated benefits that encompass a reduced environmental impact of our food and farming system and an increase in healthy diets in the population of Wales – especially in key target groups.



LEFT & MIDDLE; IAN HOMER/WWF-UK, ABOVE; COLLECTIONS/FIONA PRAGOFF

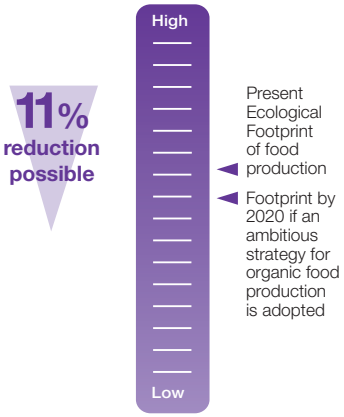


Fig 5 **Ecological Footprint reduction for Organic Food Target**

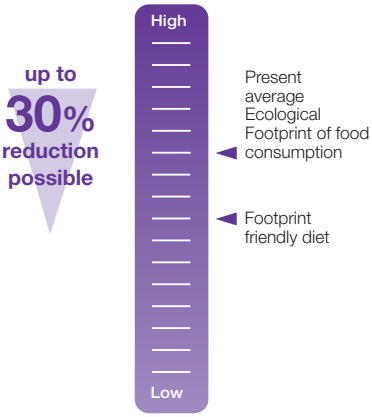


Fig 6 **Ecological Footprint reduction for Changing Diets Scenario**

Scenario 1: Linking supply chains

The advantages of organic farming, the current level of demand, the current policy opportunities and Welsh Assembly Government targets mean that organic production should now be taken up as a mainstream policy for Welsh agriculture.

The scenarios constructed by SEI explore what would happen if the target was reached and if the organic food produced was also consumed in Wales.

The area of organically managed farmland in Wales has increased significantly from under 1 per cent in 1998 to 4 per cent, or 58,000 ha, in 2002. However, growth has stagnated leaving a major challenge to achieve the objective. If the ambitious target of 15 per cent organic production by 2010 was achieved and if further growth in organic production can be maintained until 2020, there would be a reduction in the Ecological Footprint of 11 per cent.

Scenario 2: Changing diets

An increase in organic food production and consumption is not enough: it's not just about the quality of the food we eat but also what types of food our diets are composed of. This is where the nutrition strategy complements the organic strategy, highlighting the need for complementary approaches. The scenario exploring the potential reduction due to eating fresh, seasonal, organic food with a low-meat diet reduced the Ecological Footprint from 1.24 to 0.89 gha/cap (a reduction of 30 per cent). By achieving key policy objectives, we can also achieve direct health benefits and could also indirectly contribute to ecological sustainability. The scenario results also suggest that a healthy diet will usually have a low Ecological Footprint meaning benefits to the individual and the environment.

Conclusions

The ability to link both organic production and consumption is crucial. Simply increasing the proportion of organic agriculture doesn't result in a reduction in the Ecological Footprint. This is a strong indication that a reduced environmental impact relies as much on the quality of the food we eat as on what types of food make up our diets. The best approach is a complementary one: combining both the nutrition strategy with an organic strategy.

To increase the procurement of organic food products in Wales it is realised that there needs to be a reliance on existing supply chains. Two major supply chains that could be explored are the NHS and schools. Both are large purchasers of food and could potentially purchase a large proportion from the Welsh organic market.

A recent study of the NHS[3] demonstrated that over 53, 256 tonnes of food were purchased in 2001, and it is estimated that Welsh hospitals consume around 4,000 tonnes. This suggests that significant capacity is already available. Apart from certain product groups – for example tropical fruits – Welsh agriculture has the ability to produce sufficient volumes to cover demand if all food in the NHS were to be organic and local.

1 Second Organic Action Plan for Wales 2005-10, Welsh Assembly Government, 2004.
2 Barrett, et al., 2005, *Reducing Wales Ecological Footprint*, WWF Cymru.
3 www.materialhealth.com

6 A framework for sustainable consumption and production

So far, Ecological Budget UK has shown a cross-section of the national economy as a whole, and the implications for regional development. Here we look at the agenda for Sustainable Consumption and Production (SCP), which is at the centre of the sustainability debate.

Ecological Budget UK provides a far-reaching "SCP framework" to help analyse the supply chains in consumption and production. This framework underpins each "activity sector" such as food, housing, transport, products and so-on, and the policy options for the SCP agenda.

SCP trends and targets

The first issue is to define sustainable consumption and production, then to see how Ecological Budget UK can help measure it, assess trends and targets and set priorities. Further discussion of alternative trends, targets and strategies are contained in the parallel report Strategy for a One Planet Economy.

One Planet Economy

The summary of the evidence so far shows that:

- the Ecological Footprint measure reveals that consumption, mainly by wealthy nations, is using up the Earth's resources at several times their share;
- as a service-led economy, the UK is now exporting our environmental burdens by importing goods from overseas;
- the UK government has set a long-term target for a 60 per cent reduction in climate emissions – but this should build in the principle of global equity (i.e. that the difference between wealthy polluters and poor recipients needs to be reduced);
- this then translates into a long-term goal of 75 per cent reduction in resource use – i.e. a Factor Four increase in resource efficiency;[1] and
- such resource efficiency improvement can be both cause and effect of economic growth and competitiveness.

When the UK economy is clearly moving on this strategic path towards a Factor Four step change, it will take up the challenge of the UK Sustainable Development Strategy, and move towards a real One Planet Economy. As this was not defined in the UK Strategy, we provide here a working definition: a system of production and consumption which respects environmental limits, local and global, while being economically and socially sustainable.

Timescales and targets

Clearly, the transformation of the UK into a One Planet Economy is not going to happen overnight. But we can define the target rate of progress by setting the Factor Four goal at a strategic point such as 2050, the current horizon for UK climate policy.

- This equates to a year on year reduction in total resource use of about -3 per cent per year, as measured by Ecological Footprint.
- By 2020, at this rate, the reduction in total Ecological Footprint would be about -40 per cent, and by 2050 about -75 per cent.
- If we factor in long-range economic growth at 2.25 per cent, the required rate of decoupling or improvement in the resource efficiency (EF/£GDP) would be -5.25 per cent per year reduction. This is about twice the rate of decoupling in the recent past.

Implications for SCP

The question is, should the decoupling be on the production or consumption side? Recent improvements in energy efficiency in production – for instance in vehicles – are generally outweighed by increases in car ownership and travel per person. This then raises issues on consumption; on whether people really need or want to travel greater distances every year, or whether there are more sustainable ways of meeting those needs. The contribution of Ecological Budget UK, as in the next section, is to integrate both consumption and production sides for a balanced view on SCP.

We can start to estimate the likely effects of an SCP agenda on resource flows and the shift towards a One Planet Economy. Clearly, there would be changes right through the supply chain. Input of raw materials would be greatly reduced, as would energy in distribution and manufacturing. Added value on manufacturing and services would increase, as would the recycling and re-manufacturing of used products, in a nearly zero-waste and zero-emissions economy. At the same time, human welfare and social equity would increase.

For each stage in the supply chain there are also economic implications – for firms, sectors, consumers and the UK economy. As explored in the Strategy for a One Planet Economy, there are direct, indirect and induced effects at every level. While businesses naturally argue against energy taxes, there is clear evidence that competitiveness, innovation and quality management are all stimulated by environmental policy, as well as the obvious environmental and social benefits.

SCP Framework

The above outline of the SCP agenda and its implications for resource flows suggests many questions for investigation. Which is more important – consumption or production? How can we measure the effects on complex supply chains? Is it better to replace old buildings with more efficient new ones?

1 Von Weizacker, E., Lovins, A.B. & Lovins, L.H., 1997, *Factor Four: Doubling Wealth, Halving Resource Use – A Report to the Club of Rome*, London, Earthscan.
2 ONS, 2005

Consumption and production balance

First we look at how consumption and production are represented in the Ecological Budget UK system. This shows three main measures which are different but interrelated, each providing a contrasting view on resource flows and their impacts.

- *CO_2 emissions:* this is the most common and easily calculated resource flow, and the most topical as the largest human cause of climate change. As in chapter 4, this is usually measured in terms of "production" or territorial emissions; however, Ecological Budget UK provides an alternative view in consumption. CO_2 is mainly generated by energy production and consumption – in other words energy flow, which runs in parallel with material flow.
- *Material flow:* this can be measured in Direct Material Consumption (DMC) – the total amount of materials directly used or consumed in the region, excluding exports. There is also the larger Total Material Consumption (TMC), which includes the indirect or "hidden" material flows generated.
- *Ecological Footprint:* this includes the land area equivalent for the sequestering of CO_2 emissions plus other impacts on bio-productive land use, and is a simpler measure of total impact than Life Cycle Analysis (LCA). Ecological Footprint is allocated on the "consumption responsibility" basis – measuring total impacts from all material flows which are implicated in the delivery of products to household and government "final demand".

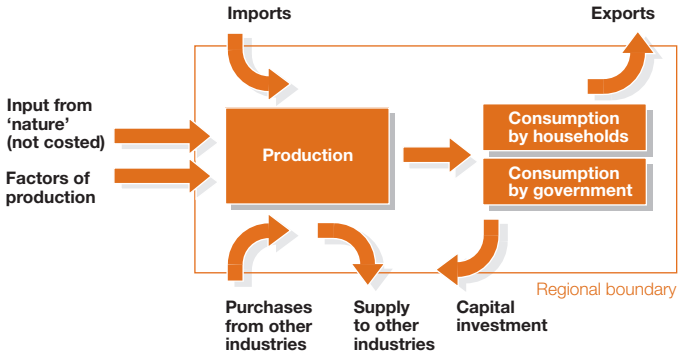


Fig 1 **Mass balance of consumption and production**

For each of these measures there is a standard accounting arrangement for consumption and production, as for instance in the Blue Book tables of UK national accounts.[2] This shows the contribution of imports, exports and capital investment, and the supply and demand from other industries, as in Figure 1. A similar structure can also be followed to show the resource flows above – the material and energy flows – which generate CO_2 and Ecological Footprint. In the arrangement of the economic accounts, the total production equals exactly the total consumption, which is also reflected in the "mass balance" principle of Ecological Budget UK.

SCP framework

The scheme above is a start, but does not say very much about the multiple supply chains involved in producing sophisticated consumer items in a complex service-dominated economy. A more realistic picture of a typical supply chain, greatly simplified, is shown by the SCP framework below (Figure 2). The logic of this SCP framework is to apply standard accounting practice to the resource flow issues in the SCP agenda: raw materials, energy, emissions, waste, recycling and so-on. Such a framework can only be as good as the data available: for instance, current UK waste data does not contain details of its material content, its industry source or its location of origin. So the framework shown here is greatly simplified compared with the reality, where many materials are used to make many products, at many intermediate stages, in many sectors, with many environmental effects.

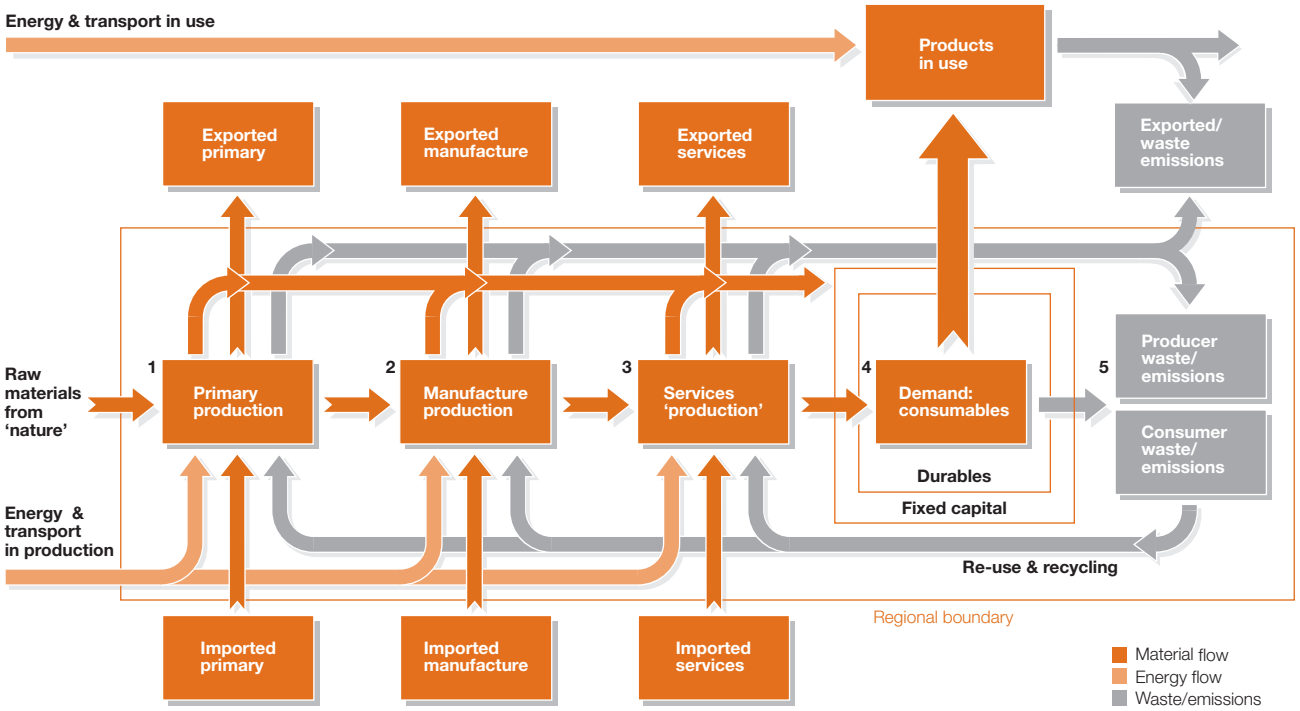


Fig 2 **SCP framework**

However, the Ecological Budget UK data is enough to provide an outline five-stage resource flow model of the UK and regional economies.

> The five stages correspond to the primary, secondary, tertiary, demand and "externalities" classification of economic sectors. Each type shows a particular material intensity from the gross tonnages of minerals and agricultural sectors through to services where materials are involved but of little value compared with the human-added value.
> Various kinds of waste streams are shown by the shaded boxes on the right hand side, coming off each stage.
> Various inputs of the "factors" of energy and transport are also shown at each of the five stages.
> On the consumption side is a simple breakdown: consumables are items with less than a year's life, durables are items with a life of more than a year, and fixed capital describes items such as buildings with an indefinite lifespan. For each type, a stock-flow model can be constructed if needed.
> The "products in use" circle shows the lifecycle demands and impacts of products and infrastructure such as vehicles or buildings.

The implication of this more evolved scheme is that resource productivity – the useful outputs per unit of input – can be measured in different ways at each stage of the supply chain in terms of material inputs or outputs, energy, emissions or waste.

There is also a parallel concept on the agenda for further research – resource consumption effectiveness. This represents the human welfare output per unit of consumption input: for instance, buying one car may bring a certain benefit, but buying two cars does not (usually) bring double that. In reality it is often very difficult to quantify the level of human welfare on the consumption effectiveness side, so the measures have to be taken with a pinch of salt. However, the combined view is crucial to the analysis of the SCP concept.

SCP framework and the SCP agenda

We can then use the SCP framework to highlight the various effects of the shift towards Factor Four and a One Planet Economy, at each stage of a typical supply chain. This would include:

> *On the production side*, reducing the input of natural materials to the system;
> reducing the volume of resource flows at various points;
> increasing energy efficiency and transport efficiency in production;
> reducing the Ecological Footprint per tonne of resource flows; and
> generally increasing resource productivity (the amount of added value for producers per unit of resource flows).

> *On the consumption side*, increasing the energy efficiency of products in use;
> increasing the average lifetime of both consumable and durable products; and
> increasing the rate of re-use, recycling and re-manufacturing, and reducing the waste and emissions leaving the system.

To achieve all this in a consumer-led market economy will need innovation to increase the welfare added of products – so that consumers will prefer to buy long-life, low-impact, zero waste products, for example.

REAP activity sectors

The "activity sectors" sections below use the SCP framework to show the resource flows through the supply chains of two example sectors in the Resource and Energy Analysis program (REAP) modelling system (the full set includes food, shelter, transport, products, services, public services, energy and waste).

In the two sectors that follow, covering food and shelter, policy options and levers are currently under development in the REAP modelling system. There are also many economic and social implications of these policy options to be followed up in the Strategy for a One Planet Economy research programme.

The analysis follows as closely as possible the SCP framework diagram in Figure 2: the data has been drawn at the UK level from the REAP system and appears in summary input-output tables. This serves as a start, although it loses the detail of the full 123 sector accounts; when there are full UK physical input-output tables, a larger version would be feasible. There are also unresolved questions where the national accounts show different results to industry studies – so the reports below are at this stage an illustration of what is to be followed up.

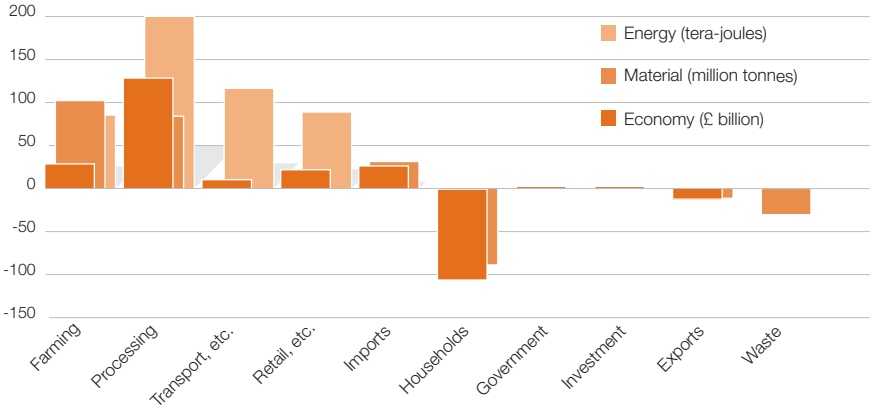


Fig 3 **Provisional resource flows in food and farming**

Sustainable food and farming

The UK food chain, from farming to waste disposal, involves very large resource flows, including economic, material and energy (Figure 3). The largest economic activity is at the secondary stage of food processing, and nearly all of this goes direct to households. Catering and other value-added operations are also larger than primary production in agriculture.

In material terms, agriculture produces nearly 90m tonnes a year, food and drink processing throughput is 80m tonnes a year, and food-related imports total 34m tonnes to primary or food manufacturing sectors. About 9m tonnes of controlled waste comes from food processing, and 3.3m tonnes from catering. Households then consume about half a tonne per person, a further 100kg which goes to waste, plus a further 60kg of food and drink packaging or containers.

The UK is 60 per cent self-sufficient by material flow for all foods, and 75 per cent for domestic varieties such as potatoes. Imports are therefore a minority share by weight, but generally involve the longer distance and higher value-added items.

Current food and farming policy

There are many layers to this complex and controversial policy agenda. At the international trade level, the World Trade Organization Doha Round of trade talks was unresolved at the end of 2005. EU member states, the US and other developed countries are maintaining for the moment

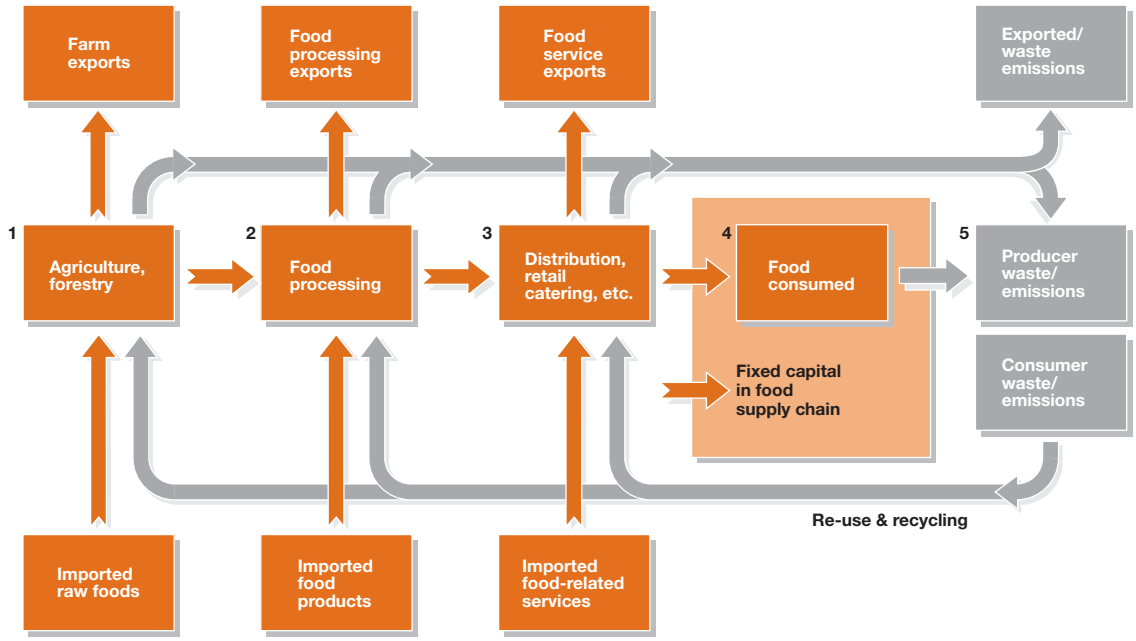


Fig 4 **Food and farming resource flows and policy options**

the structures of farm subsidies and import tariffs which restrict the global trade in food and favour the larger intensive producers. Meanwhile, the EU Common Agricultural Policy (CAP) reforms have now shifted the farm subsidy regime from production quotas to whole farm payments, including environmental criteria.

The UK sustainable food and farming strategy aspires towards an integration of rural economic development, public health and efficient food production. It advised that farming could be separated into intensive and extensive areas of production across the UK.[3] Recent research shows how the distribution of food is responsible for more than a quarter of all freight travel.[4]

In much of the crowded UK there is competition between urban and rural land-uses: 14 per cent of the land area is subject to Green Belt policy where land values should be stable, but in reality are pressured by other quasi-farm uses such as horse stabling and garden centres. Even in rural areas, agriculture as such comprises less than 5 per cent of the economy.

Factors of change

The majority of UK residents have enough food, so future trends are more concerned with food quality, diets, sources, production methods and distribution. These are some of the key factors to be modelled in the REAP system:

> *Imported percentage*: the trend towards imported foods is set to continue, and the shake-out of UK agriculture and CAP reform may well accelerate this process.

> *Vegetarian percentage*: this affects the balance between energy intensive meat-based food (32 per cent by weight) and others. Further spread of vegetarian diets would see overall reductions in Ecological Footprint, as well as possible health benefits.

> *Organic production percentage*: at present this covers 0.6 per cent of food volume by weight, but has been increasing by 15 per cent per year over the last decade. There are different opinions on whether this trend will continue or level off.

> *Chemical intensity*: the inputs by weight of chemical fertilisers and pesticides have increased dramatically in the last 50 years, and this is the majority of the energy and material inputs to farming.

> *Packaging percentage*: food packaging by weight has increased only slowly, but more rapid is the shift from low-energy re-useable packaging to higher-energy disposable material.

> *Food waste fraction and composting percentage*: there is limited re-use of food for animal feed from institutional catering. Current levels of food waste composting are a fraction of 1 per cent, but the regional waste strategy contains objectives to increase this fraction.

These policy options and levers are shown on the food SCP framework in Figure 4.

3 Defra, 2003
4 Defra, 2005

Towards sustainable food and farming

The current globalised, high-energy, fossil fuel-based food sector, instrumental in the trade balance between rich and poor countries, will need to change in a One Planet Economy if the overall impacts are to be cut by a factor of four. These are some of the main opportunities ahead for policy, producers and consumers:

> *Consumer demand and preference*: This is likely to be as much "push" from food scares, dietary concerns and possibly health insurance companies, as "pull" from simple consumer preference. The turning point may be when retail chains realise there is more profit in higher-value, high-quality niche products, than in the conventional approach to volume sales.

> *Food technology and supply chains*: production technology is likely to enable greater quality and diversity through ICT-based precision methods. There is also growing awareness of natural growing cycles and use of natural genetic capital in medicinal and material sciences. There may be legal developments such as law suits against producers of unhealthy food. The big unresolved question concerns genetically modified food (GM), whether it's regarded as a hazard or contribution to a sustainable food system.

> *Food markets and subsidies*: The vital key to this structural shift towards a sustainable agriculture system is the economic management of food markets and subsidies. The current CAP reforms have leaned towards environmental

priorities, but the overall effect may be to encourage large-scale intensive production to be imported.

> *Global trade and international development*: at the same time as re-thinking regional and local production, it is crucial that the benefits to the developing world of basic food production are not lost. A strategic convergence programme would help to diversify production in the developing world, and to move away from the current monoculture of cash-crops which are so vulnerable to commodity prices and extreme weather events.

> *Land markets and land management*: farm land values are likely to increase along with pressures for other uses, and the CAP environmental objectives aim to encourage niche foods and higher value production.

Built environment

The shelter or "built environment" sector shows an opposite case to the food sector – instead of immediate consumption, it concerns the accumulation of material and financial "stocks", and their operation in use. There are three main categories:

> housing of all types, sizes, ages and ownership;

> other buildings – commercial, industrial and public sector; and

> other infrastructure – civil engineering, transport, drainage, etc.

The general shape of the supply chain can be seen in Figure 5. The minerals and aggregates sector has a material production throughput of 180m tonnes a year, and secondary manufacturing of building materials and components had a material production of 56m tonnes. The construction sector is classed as a service industry, and not in the national material accounts. However, industry studies show a total material requirement of 420m tonnes, of which only 360m were incorporated into construction products – the remainder becoming waste (mostly quarrying waste).[5]

The energy in production shows the dominance of the building materials sectors, the largest being the cement and steel industries. This totals 197 terra joules (TJ), compared with 41 TJ in construction itself and 21 TJ in construction minerals and aggregates. As regards the operation of the buildings in use, heating and power in all UK buildings generates 51 per cent of the total energy demand and CO_2 emissions.

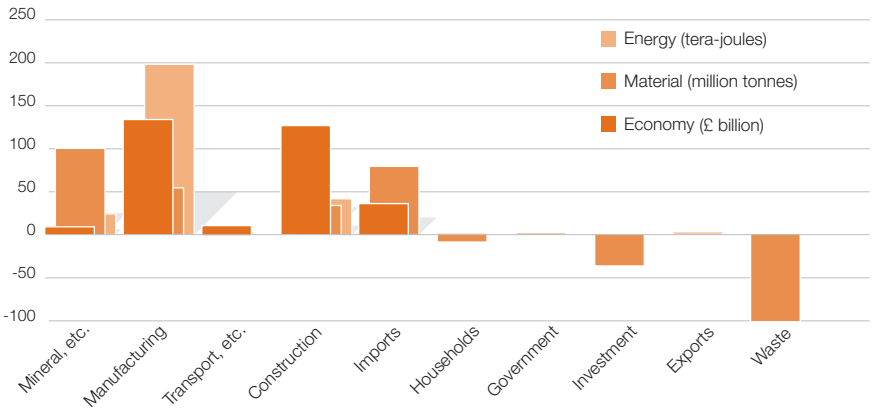


Fig 5 **Provisional resource flows in the built environment**

Energy in housing is classed under "private households" as consumption, but energy used in other buildings is found under the production sector accounts.

In each of the building types there are distinct stock-flow effects. The addition to the building stock is 1-2 per cent per year, but the demolition of the older stock is a tiny fraction of this. At these rates it would take more than 1,000 years to replace the average house which is built to a notional 60-80 year design life standard. This uncertainty about lifespan is crucial to the balance of construction impacts with energy-in-use impacts. To make real progress in reducing the built environment Environmental Footprint over the next few decades, new buildings will be a minor component compared with the existing building stock and its profligate demand for energy.

For demonstration buildings it appears possible to achieve ultra-low energy usage, at 1-2 per cent extra capital cost, which is more than offset by lower energy bills. However, for the mainstream industry there are many barriers and disincentives to investment in efficiency. The situation is more difficult with the existing building stock, where conditions, age, type and ownership are all different. Hence there is a need for new kinds of organisations and financial packages to help bridge the gap.

Future trends and drivers

Most parts of the UK are under increasing pressure for new housing: this is mainly due to forecast population growth of 3.5 per cent per decade, and a household size which is on average 2.4 to 2.1 people. This is a challenge for meeting the Ecological Footprint targets:

> Construction of 200,000 dwellings a year will consume massive amounts of materials and energy, wherever it is done.

> However, the new dwellings have the potential to be much more efficient in energy and water than the existing stock: there is technological potential to reduce external resource demands almost to zero at a small added capital cost.

> Concentration of new construction in urban areas will tend to generate more reclamation and demolition waste than the equivalent in a greenfield location, and higher densities tend towards multi-storey buildings which are more energy and material intensive for the same floorspace.

> The social and economic effects of regeneration, and their effects on affluence and consumer spending habits, will be much more significant than the transport effects of urban concentration, and possibly than the direct energy requirements of the new housing.

Factors of change

These are some of the key factors which can be modelled in the REAP system, as shown on the resource flow framework (Figure 6):

> household floorspace per person in both existing and new housing, driven by the natural aspirations for space. The outward spread of urban development is then constrained by planning policy in the UK;

> the stock turnover itself, as a proportion of existing stock, and the rate of demolition of older dwellings;

> household energy efficiency per unit of floorspace for new and existing dwellings. This is based on a composite measure of energy demand as the sum of end-uses such as heating and lighting, and shares of energy fuels;

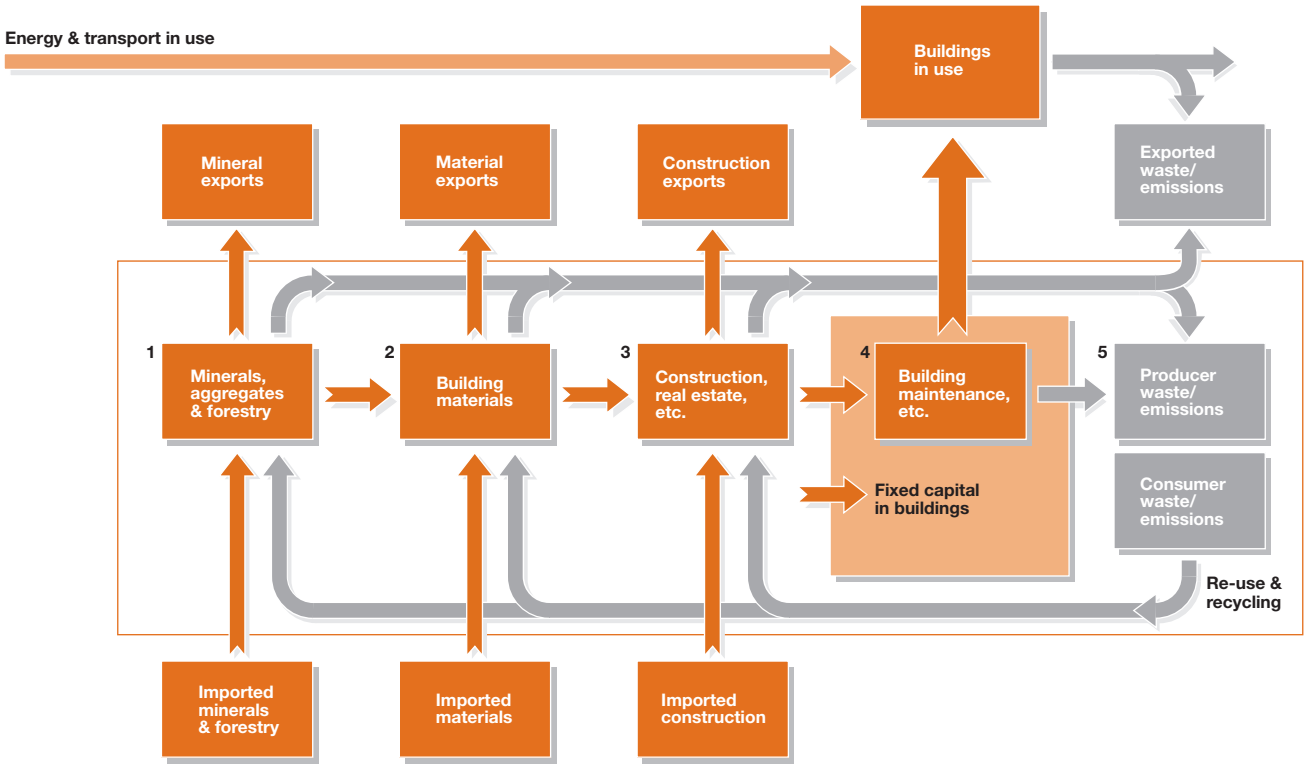


Fig 6 **Built environment resource flows**

> household material efficiency per floorspace. This applies to new construction, the volume of materials used per unit floorspace, and the Ecological Footprint intensity of those materials. Again, this is on a highly averaged level;
> waste arisings and material lifecycle. How much bulk material stays in the system or comes out as waste, and how much of the waste then re-enters the system;
> commercial and public service buildings need a similar range of units to housing above. The difference is that they are not related to population in the same way, but rather to economic growth and economic structure, and the intensity of floorspace per unit of economic activity.

Towards a sustainable built environment

This challenging agenda applies on many levels and sectors, but the reality is that the construction industry supply chain is known, not unreasonably, for inertia and conservatism. The concept of sustainable construction is emerging as a policy agenda, a business approach and a marketing label. Beyond the rhetoric, it is likely to involve increased pressure from regulation, supply chain pressures, tax and subsidy incentives, and public procurement.

In each of these the Ecological Budget UK data can help distinguish facts from aspiration, and short-term gains from long-term effects:

> increased eco-efficiency and reduced materials intensity per unit of floorspace;
> reduced primary inputs, and increased recycling and secondary use;
> zero-waste construction and demolition practices;
> integrated materials management systems;
> public procurement and market development initiatives;
> economic and institutional arrangements to provide finance and other incentives for sustainable construction; and
> regional spatial strategies, urban regeneration, and the balance of new build with rehabilitation.

One of the parallel projects to the Ecological Budget UK is the Eco-Region North West project, which has focused on the construction and built environment sectors. This has developed an Eco-Benchmark system for assessing the resource flow performance (material flow analysis and Ecological Footprint) of construction and buildings in use. Another offshoot is the West Midlands Sustainable Communities project, which is comparing the pros and cons of new build versus rehabilitation in the context of economic and community regeneration.

Conclusions

Over the past 100 years, supply chains have become more and more complex, with thousands of materials and components going into final products sourced from hundreds of countries. While not providing a complete and detailed supply chain of every product, Ecological Budget UK has helped with an understanding of the general pattern of key supply chains in the activity sectors of food, construction, transport and so-on.

More important, it has linked the material and energy requirements of supply chains with their economic output in the context of national and regional targets for SCP. As identified in the chapter, the social welfare that can be derived from a given product is another important dimension of the SCP debate. In future, it is hoped that further developments in the Ecological Budget UK data will contribute to more detailed analyses of sectors, firms, products, technologies and consumer choices. This will add to the evidence base on the fundamental structure of production and consumption systems, and help point the way towards a One Planet Economy.

5 Smith, R.A., Kersey, J.R. & Griffiths, P.J., 2002, *Mass Balance of the Construction Industry*, Viridis.

7 The future

This chapter highlights what the Ecological Budget UK project has achieved, and the main results so far. This is but a start, and there are many questions to follow up – regional and local policy, industrial supply chains, taxation and international trade; questions that will be addressed by the One Planet Economy Network Strategy.

Sustainable consumption and production targets

The overall messages from the results in this report now become very clear:

- The Footprint measure shows that consumption by UK residents is using up the Earth's resources at several times their per capita share.
- As a service-led economy we are now *exporting our environmental impacts*, by importing goods from overseas, even while the UK becomes cleaner and greener.
- The UK government's long-term target for a 60 per cent reduction in climate emissions translates into a long-term goal of a 75 per cent cut in resource use – i.e. *a Factor Four increase in resource efficiency*.
- Such resource efficiency improvement can be both cause and effect of economic *growth and competitiveness*.
- This can be achieved through the principle of *'market transformation'*. We interpret this as environmental sustainability combined with technological, economic, organisational and social change.

Only when the UK economy is clearly moving on this strategic path towards a Factor Four step change can the challenge of the UK Sustainable Development Strategy 2005 be taken up. This will move us towards a real One Planet Economy – an economic system of production and consumption which respects environmental limits, while being financially and socially sustainable.

The concept of the One Planet Economy was referred to in the UK Sustainable Development Strategy, but not defined, measured or otherwise followed up at that point. This is the cue for the Ecological Budget UK.

Towards a One Planet Economy

These are the principles behind the proposals for moving the UK towards a One Planet Economy:

- The first principle is *'integrated asset management'* covering economic, social and environmental capitals and risks – in other words, that the UK economy should manage itself as intelligently as any other large complex organisation.
- The national accounts and fiscal budgeting systems should support integrated asset management, with the *'triple bottom line'* approach to comprehensive accounting for all forms of capital – economic, social and environmental.
- This leads to the *'polluter pays precautionary principle'* – i.e. that users of environmental services should pay for the risk or damage caused, locally or globally. While this idea is not new, the issue here is applying it either to producers, intermediaries or consumers.
- This should be followed through on an *integrated supply chain principle*, i.e. by tracking material and energy resources from cradle to grave, and from supply sides to demand sides.
- This adds up to a full *'market transformation'* programme in each sector, for low impact technologies and sustainable consumption patterns.
- Such a programme should be *financially viable,* aiming at net gains in both national and individual costs and benefits.
- Such a programme should also be *socially responsible*, aiming towards equalising the differences between social groups, between regions, and between the UK and the developing world.
- To implement this requires a practical *'business case'* to be developed for each economic sector: each policy level: each product type, and so on.

The contribution of Ecological Budget UK

The Ecological Budget UK first phase results, and the Resource and Energy Program (REAP) toolkit, provide an essential contribution to the UK policy evidence base. Following the launch of the phase 1 results, a five year programme of research and development is now taking shape. This includes, firstly, a contribution to the *evidence base* for the One Planet Economy:

- national *material/energy accounts* and budget implications, to be shown alongside the fiscal and monetary budget, on an annual basis;
- a full breakdown of *direct, external, embedded and induced* impacts of economic activity, using CO_2, material flow analysis, Ecological Footprint Analysis and other appropriate measures;
- an investigation of key supply chains (e.g. construction, chemicals) for their total environmental costs and benefits on a lifecycle/risk management basis;
- an investigation of critical policy options (e.g. nuclear power) for the total environmental costs and benefits on a life cycle/risk management basis.

Following on, there is great potential for the Ecological Budget UK project to demonstrate the applications to the One Planet Economy, in the national and regional government policy process, for example:

- developing medium-long term *market transformation* strategies for key sectors of consumption and production, e.g. construction, chemicals, etc.
- exploring the *fiscal policies and programmes* needed to facilitate this market transformation, including taxation or other charges. This can be demonstrated in the form of an alternative Comprehensive Spending Review;
- identifying the *potential for public procurement* and other investment in clean technologies. This uses the public sector trading potential to its full effect, as an instrument of public policy;
- investigating the *potential for international development* policy, using economic partnerships and other instruments;
- exploring the contributions of *regional and devolved administrations*; local authorities: and other agencies of government, e.g. in health and education.

Thirdly, there is an urgent need to *enhance and mobilise capacity* – for innovation, learning, participation and new forms of networking. At a simple local level, if people can network with their neighbours enough to share car journeys, then traffic congestion could be cut at a stroke. At a national economy level, if industries can find a user for their by-products in advance, then our waste problems could be a thing of the past.

Such examples represent the 'network' strand of the One Planet Economy Network (OPEN) Strategy, deliberately framed as a network and process, because it is much too diverse and complex to be organised by one group, or completed at one point in time. A start has been made at the regional level by the SCPNet forum, and this needs to be extended to other levels in the public sector, private sector and civic sectors.

Next steps

Ecological Budget UK has set out the beginning of a longer-term programme of research and development. Our understanding of the flows of materials and energy through the UK demands much more detailed investigation if we are serious about moving the UK towards a One Planet Economy.

As the follow on to the Ecological Budget UK, the OPEN Strategy has been launched. This is outlined in the full reports on www.ecologicalbudget.org.uk.

The OPEN Strategy, to summarise the above, is arranged in three parallel streams:

- *building the evidence base:* accounting and analysis of UK consumption and production;
- *building the applications:* applying this evidence to the challenge of achieving the One Planet Economy in consumption and production;
- *building the capacity:* promoting networks in order to mobilize the potential of public, private and civic sectors.

Ecological Budget UK is the most significant step to date in understanding how the decisions we take every day affect the environment around us. It is an essential step in creating a platform to enable us to move from the current UK 'three planet economy' to a One Planet Economy.

Appendix: Project scope and methods

The aim of the Ecological Budget UK is to provide a complete set of resource accounts of the UK, broken down by devolved country and region. Ecological Budget UK also provides CO_2 and Ecological Footprint accounts which, in addition to tracking regions, measure the impact of every UK local authority. Below is a list of what these accounts include, and necessary work for the future.

Resource accounts

- The Ecological Budget UK resource accounts have established the tonnes of materials and products which are produced, imported, exported, added to stock and consumed by the UK's devolved countries and regions.
- The Ecological Budget UK resource accounts bring together a number of useful measures such as Domestic Material Consumption (DMC) and Domestic Material Input (DMI). These are used by national government to understand material flows in the UK.
- The Ecological Budget UK method organises the tonnes of resources used in the UK economy into 123 industrial production sectors, according to the Standard Industrial Classification. This breakdown makes it possible to identify resource-greedy production sectors. Tonnes of resources are also disaggregated into 82 "final demand" or consumption categories covering private households, government (local and national), exports and capital investment. This makes it possible to identify resource-greedy consumption categories.
- The resource accounts adhere to Eurostat standards and trade classifications. Eurostat is the European Union government office that coordinates and standardises EU statistics. This means Ecological Budget UK results fit into the statistical classifications of other EU countries.
- The Ecological Budget UK project has provided a baseline measurement of resource consumption. Coupled with future resource accounts, we will be able to reliably measure changes in resource consumption from year to year. Ecological Budget UK is compatible with the UK Office for National Statistics' (ONS) top-level indicator on resource consumption, which tracks from 1970 to present day.
- Ecological Budget UK is based on the ONS Economic Accounts – the UK Blue Book. This makes it possible to benchmark each sector in terms of resource productivity – material flow per unit of economic output.
- The Ecological Budget UK provides an initial understanding of the "upstream" and "downstream" environmental impacts of industrial sectors. It does this by mapping interactions between industries, showing which sectors use resources from which others.

CO_2 emissions

- Ecological Budget UK has constructed a new indicator for carbon dioxide that includes emissions embodied in imports, extending current CO_2 accounts that measure only emissions from production ("territorial emissions").
- To achieve this, Ecological Budget UK used a monetary input-output table that tracks the flow of money through the UK economy. For further information see the Resource and Energy Analysis Program (REAP) reports at www.ecologicalbudget.org.uk.
- Therefore, Ecological Budget UK takes into account direct and "embedded" CO_2 emissions – those emissions released during a product's entire lifecycle – whereas "direct" emissions relate only to those produced during the use of the product. By combining the resource accounts with the CO_2 emissions, we can understand the relative emissions impact per tonne of different materials and products.
- CO_2 emissions from consumption have been calculated for every region and local authority area in the UK. These can be compared with territorial emissions. Ecological Budget UK has also determined emissions from consumption of 54 socio-economic groups using the ACORN classification.

Ecological Footprint accounts

> Taking the Global Footprint Network's Ecological Footprint standard, Ecological Budget UK has broken the Footprint down into a detailed profile (70 categories) of household consumption. For the first time, a standard and comparable Footprint analysis has been provided for every region and local authority in the UK. This is calculated statistically from the average household expenditure of social types, and their distribution by local authority, and is available free of charge at www.sei.se/reap.

Policy

> The REAP software was developed as a part of Ecological Budget UK, making it possible to access the datasets in detail, and project different resource use and CO_2 emissions scenarios into the future.

> REAP gives national, devolved country, regional and local authorities the opportunity to explore the effectiveness of policy decisions. For more information, visit www.sei.se/reap.

> Ecological Budget UK has helped the West Midlands and North East regions identify policy issues and develop alternative scenarios for the future.

> Ecological Budget UK has made a significant contribution to the Sustainable Production and Consumption network – SCPNet (www.scpnet.org.uk), developing an evidence base for SCP policy development in the devolved countries and English regions.

> The datasets and the REAP tool will enable quantitative assessment of policy choices in economic and spatial development, especially at the regional level. In particular this feeds into strategies in transport, housing, energy and waste management.

Contact details

Established in 1999, the Centre for Urban & Regional Ecology (CURE) carries out multidisciplinary research in three inter-related programme areas:

> Sustainable City-Regions;
> Landscape Impacts & Futures;
> Land Restoration & Management.

The common theme is the organisation and interaction of complex communities, both natural and human, at various scales from the local to the European. The research is underpinned by an advanced technical capability for spatial analysis, modelling and visualisation.

Contact
CURE
School of Planning & Landscape
University of Manchester,
Manchester M13 9PL
Tel: 0161 275 6920/38
www.art.man.ac.uk/PLANNING/cure/

SEI is an independent, international research institute specialising in sustainable development and environment issues. It works at local, national, regional and global policy levels. SEI has been engaged in major environment and development issues for a quarter of a century and has become established as a leading expert on the subject of Sustainable Consumption within Europe and especially the UK. Working closely with the European Environment Agency as well as national, regional and local governments, has ensured that the research is applied, relevant and timely. The Sustainable Consumption (SC) Group contributes to the overall SEI mission statement by bridging the gap between science and the policy arena.

Contact
SEI
University of York
Heslington
York YO10 5DD
Tel: 01904 432 897
www.regionalsustainability.org

Established in 1961, WWF works to conserve endangered species, protect threatened habitats and address global threats, seeking long-term solutions that benefit both people and nature. WWF is committed to exploring alternative lifestyles based around sustainable consumption; this is a vital task which requires us to understand and measure the global environmental impact of our everyday decisions and actions. We also need to know where change is most beneficial and most needed – whether at a policy, economic, business or personal level. WWF's Ecological Footprint Programme has been developed to meet this need, providing all levels of government with the information and tools they need to make informed decisions, and developing models and case studies to demonstrate footprint strategies in action.

Contact
WWF-UK
Footprint Programme
Panda House
Weyside Park
Godalming
Surrey GU7 1XR.
Tel: 01483 426444
www.wwf.org.uk

www.ecologicalbudget.org.uk

Partners

Biffaward Programme on Sustainable Resource Use

Funded by:

Objectives This report forms part of the Biffaward Programme on Sustainable Resource Use. The aim of this programme is to provide accessible, well-researched information about the flows of different resources through the UK economy based either singly, or on a combination of regions, material streams or industry sectors.

Background Information about material resource flows through the UK economy is of fundamental importance to the cost-effective management of resource flows, especially at the stage when the resources become 'waste'.

In order to maximise the Programme's full potential, data will be generated and classified in ways that are both consistent with each other, and with the methodologies of the other generators of resource flow/waste management data.

In addition to the projects having their own means of dissemination to their own constituencies, their data and information will be gathered together in a common format to facilitate policy making at corporate, regional and national levels.

More than 30 different mass balance projects have been funded by Biffaward. For more information on the Mass Balance UK programme please visit **www.massbalance.org**

The mission of WWF is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity
- ensuring that the use of renewable resources is sustainable
- promoting the reduction of pollution and wasteful consumption

www.wwf.org.uk

for a living planet®

WWF-UK

Panda House, Weyside Park
Godalming, Surrey GU7 1XR
t: +44 (0)1483 426444
f: +44 (0)1483 426409