Energy and Material Efficiency

... in a nutshell

Low carbon | Materials processing

UNIVERSITY OF CAMBRIDGE

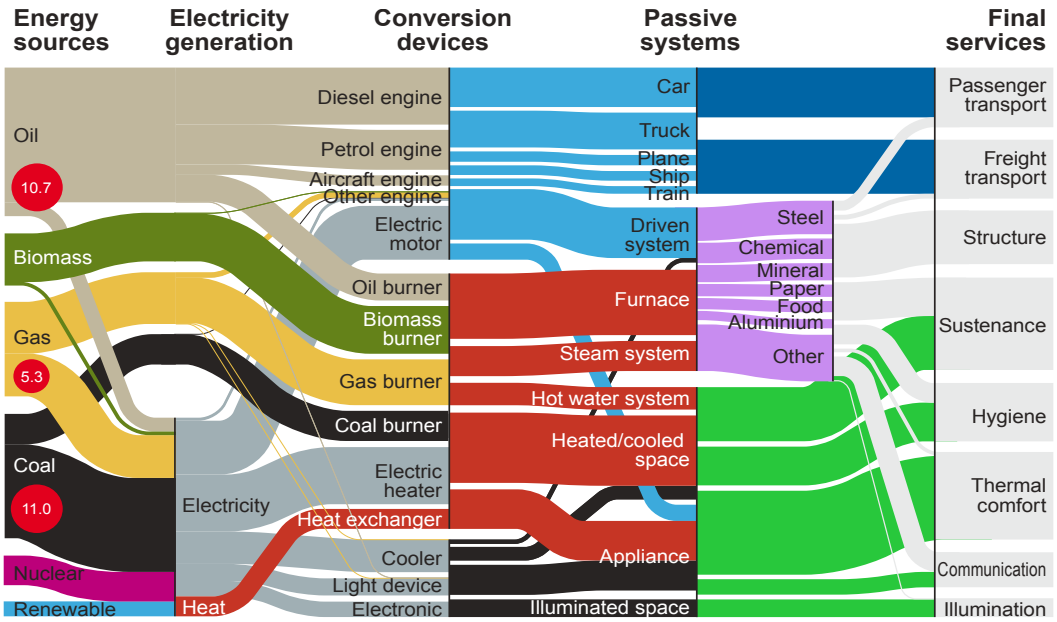
energy efficiency

The root cause of global warming is growth in energy use, and the key counter-measure is to reduce demand.

To understand global energy use we have developed a series of world maps showing the flow of energy from fuels to services.

In the map below, the width of the lines is proportional to energy use, and losses are not shown. What's new about our maps is that they show the flow of energy through technologies, not economic sectors.

- The theoretical limit is that we could save 95% of current energy to deliver the services we use. In practice we estimate that the achievable saving is nearer to 75%.
- Renewable sources are currently small contributors to the global flow. Increasing the contribution of renewables is difficult due to limited land availability. Nuclear energy supplies 6% of global demand.
- The devices that convert energy are highly developed, but the greatest losses occur when we use energy at a high temperature in cool applications, e.g. burning gas to heat houses, and through poor matching of devices to their applications.
- The greatest energy savings would occur through better design of "passive systems" to provide more final services for each unit of useful energy. Heating and cooling energy is required in houses only because of their imperfect insulation, and most fuel used in vehicles is required to propel the vehicle, not its contents.
- Technical solutions for energy efficient cars and houses are known, and their implementation depends on motivation. For industry, many systems are already highly optimised, so the biggest opportunity is material efficiency.



From fuel to service: tracing the global flow of energy through society

Global energy demand in 2005 total = 475 EJ

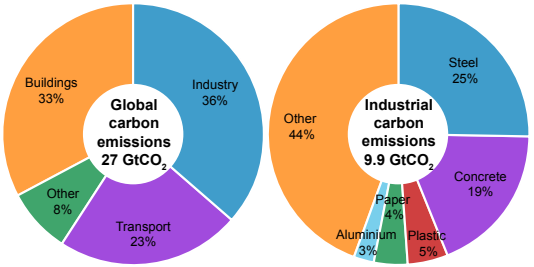
Global carbon emissions in 2005 total = 27 Gt CO_2

JM Cullen and JM Allwood
Energy Policy 38 (2010) 75–81

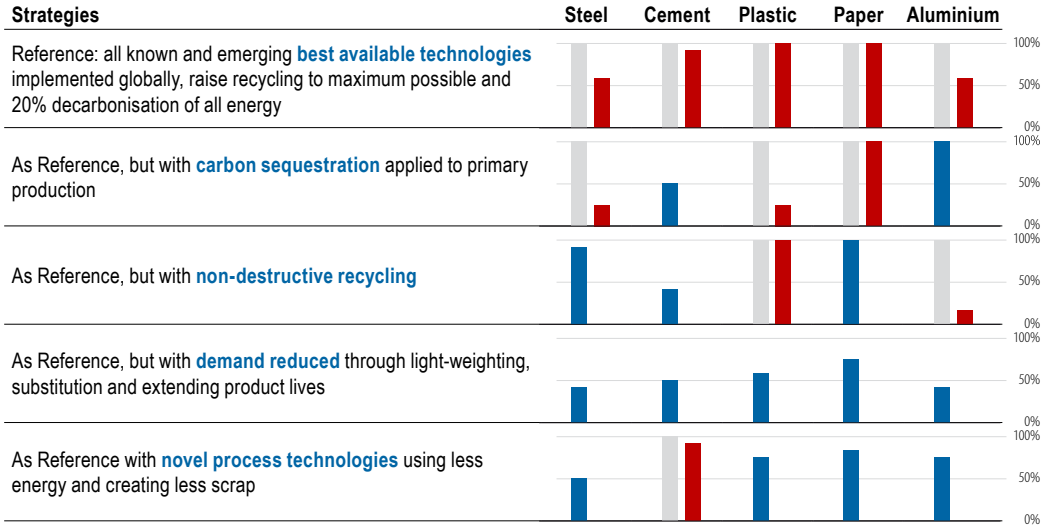
material efficiency

How can industry cut global emissions by 50% in 2050, when demand for products is expected at least to double?

We have predicted 2050 emissions for five key materials under various future strategies. The blue bar shows how extensively the strategy must be implemented to reach the 2050 target. If 100% implementation is insufficient, the red bar shows the excess emissions relative to the target.



Global CO_2 emissions in 2006 from energy and processes



The primary materials industry can only lobby for strategies that allow continued output growth. However, the analysis shows that these will not give the required cut in emissions. Instead, Material Efficiency—delivering required services with less primary production—could allow greater cuts, at lower cost:

- We already have enough global capacity for primary materials production even as demand grows, but must increase the capacity of production from scrap by up to four times.
- We can reduce our demand for primary materials by (i) doubling the service life of products (ii) reducing the amount of material used in each application and (iii) substituting other materials. In each case, loss of revenue from materials sales could be compensated by new business models.
- Many components at end of life could be re-used with "non destructive recycling". This could be applied immediately to steel girders from used buildings, used aluminium car wheels, building cladding and window frames.
- Asset values in primary materials production are high, giving high inertia to change. However, many improvement opportunities exist, for instance through better coupling of heating and cooling cycles in metals production.

what do we do?

We are developing and extending our maps of global energy flow, to help prioritise opportunities for future efficiency. In parallel, we are developing bottom up studies of energy and carbon efficiency. For instance we are working with Unilever to support business strategy development for emissions reduction in response to growing stakeholder interest.

energy efficiency

WellMet2050, a five year £1.5m programme, aims to identify and validate all means to halve global carbon emissions from the production of steel and aluminium goods while demand doubles. We are evaluating all existing options for carbon emissions reduction, as well as options for material efficiency and radical reductions in energy requirements via new process routes. The work combines economic and physical modelling, technology development and demonstration, and continuous dialogue with a large consortium built around a portfolio of case studies.

WellMet 2050

We are developing novel materials processing technologies, focusing on the non-destructive reuse of materials. These include development of un-photocopying to remove toner print from office paper, supported by Xerox, cold bonding of aluminium scrap, and an array of techniques for flexibly forming and re-forming sheet metal.

Non destructive recycling

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