

Q10

Issue 10



Adapting to a carbon constrained economy

This is the tenth in a series of Quickstarts on Design for Sustainability (D4S) with Plastics. It focuses on opportunities and strategies to reduce carbon impacts using plastic products, through two approaches: by reducing greenhouse gas emissions associated with the product's total life cycle; and by using plastics to deliver carbon-efficient solutions such as insulation. Regulations are being introduced world-wide to restrict emissions of carbon dioxide (CO₂) and other greenhouse gases to the atmosphere and this will drive demand for more products with improved energy efficiency and lower emissions¹.

In this Quickstart:

- Plastics and the carbon cycle
- Climate change
- Plastics delivering solutions and benefits
- Design strategies to reduce greenhouse gas emissions
- Greenhouse impacts of recovery and disposal
- Understanding and communicating carbon impacts

PVC window frames have good insulating properties. (Image of the Mount Buller fire tower, Victoria, supplied by the Department of Sustainability and Environment)

Design for Sustainability
with Plastics

Quickstart



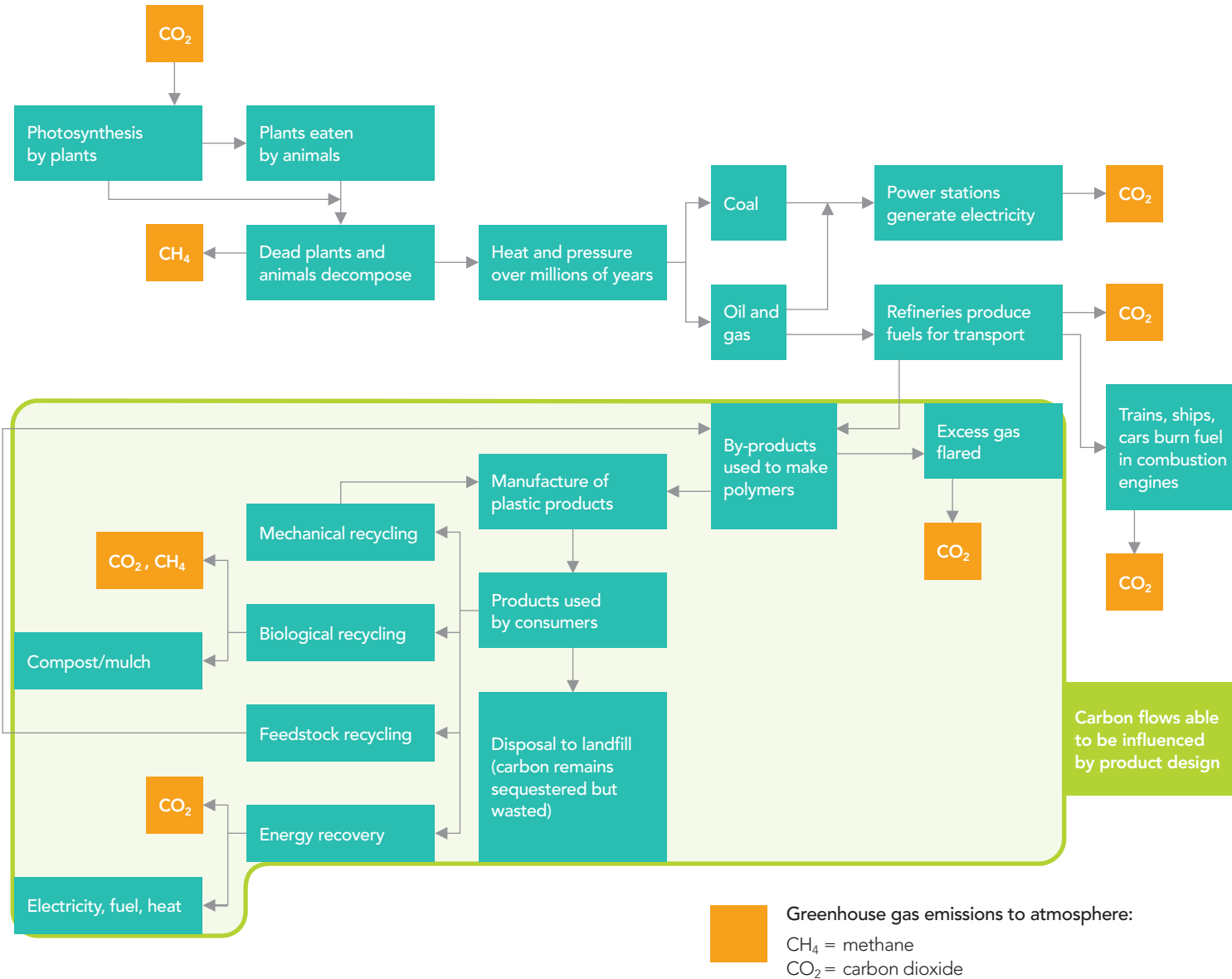
Plastics and the carbon cycle

Carbon atoms are continuously recycled through the physical environment. This is called the 'carbon cycle'. When the carbon cycle is in balance the CO₂ generated through natural and industrial processes is absorbed through carbon 'sinks'. These sinks include: sedimentary rocks; marine sediments; oceans; fossil fuels such as coal, petroleum and natural gas; living plants and organic material in soils. Since the industrial revolution, CO₂ emissions resulting from human activities have started to exceed levels that can be absorbed through natural carbon sinks, and this in turn is contributing to an enhanced 'greenhouse effect'.

Plastics are manufactured primarily from oil and gas that formed over millions of years from the fossilised remains of plants and animals. Unlike coal and transport fuels, which release CO₂ back into the atmosphere when burned to generate energy, most plastic products continue to retain the carbon originally sequestered in the oil or gas². A simplified interpretation of the carbon flows associated with plastics is shown in Figure 1.

Designers and manufacturers can reduce CO₂ emissions associated with plastic products through strategies that improve efficiencies in production and recyclability at end of life (see page 5).

Figure 1: Carbon flows associated with plastics





*Insulating concrete forms help to reduce energy consumption over the life of a building.
(Image supplied by Polyfoam Australia)*

The consensus of scientific opinion is that 'human-induced climate change is happening, will intensify if greenhouse gas emissions continue to increase, and could impose large costs on human civilisation'³.

Climate change

Greenhouse gases include water vapour, CO₂, methane, nitrous oxide and ozone, although CO₂ is used as the common reference point (referred to as CO₂-equivalent or CO₂-e). As these gases build up in the atmosphere they contribute to an 'enhanced greenhouse effect' by absorbing and reflecting heat.

The concentration of CO₂ in the atmosphere increased from about 280 ppm (parts per million) in 1750 to 383 ppm in 2007⁴. The build-up in greenhouse gases in the atmosphere has contributed to a rise in average global temperatures and other climatic impacts such as reduced rainfall in countries such as Australia⁵.

Plastics delivering solutions and benefits

Every stage of the plastics life cycle requires energy for production or transport, and contributes to total greenhouse emissions. The plastics industry globally uses approximately 4% of the world's annual consumption of oil and gas⁶. Approximately half of the carbon atoms in the original hydrocarbon feedstock remains locked (sequestered) in the plastics after manufacture. However, because most plastics are manufactured from fossil fuels they will also release some CO₂ if combusted, for example in an energy recovery facility.

Most plastic products use less energy and generate lower greenhouse gas emissions over their life cycle than equivalent products made from other materials⁷. This is because they generally require less energy to manufacture and many plastic products save significant amounts of energy during their use phase (particularly plastic components in cars, plastic insulation and plastic packaging).

One study concluded that the substitution of all plastics consumed in Europe with alternative materials would increase energy use by approximately 26% and greenhouse gas emissions by 56%⁸.

The plastics industry is also helping to reduce greenhouse gas emissions by delivering solutions to a wide range of industry sectors. For every unit of greenhouse gases emitted directly and indirectly by the plastics and chemicals industry, 2-3 units are saved via the products and technologies provided to other industries and consumers—such as building insulation materials, agrochemicals, lighting and plastics used in piping. Plastic insulation alone was estimated to reduce global greenhouse emissions by 2.4 GtCO₂-e globally in 2005⁹.



Making a product from recycled plastics generates less greenhouse gas emissions than manufacturing the same product from virgin material

Australian research has demonstrated that recycling of plastic packaging, rather than sending it to landfill, significantly reduces energy consumption and greenhouse emissions¹⁰.

Greenhouse impacts of recovery and disposal strategies

This is due to the avoided energy use and greenhouse emissions from the manufacture of virgin materials when these are replaced by recycled materials.

Other recovery technologies such as feedstock recycling, which converts polymers back into monomers (the chemical building blocks used to make polymers) or hydrocarbons, need to be evaluated to determine their overall environmental impact.

Not all of the available technologies generate a net reduction in energy use or greenhouse gas emissions¹¹ although they may have other benefits such as diversion of waste from landfill. Mechanical recycling is preferable because it allows plastics to go through multiple cycles, retaining the value of the material and the 'embodied energy' used to manufacture it. Plastics are too valuable to use only once and then waste, so products need to be designed for end of life recovery¹².

Understanding and communicating carbon impacts

Life cycle assessment (LCA) is a scientifically rigorous method for the calculation of environmental impacts over the complete life cycle of a product or service (see Quickstart 8). Depending on the objective of the study, it is possible to undertake a streamlined LCA which only focuses on energy and greenhouse gas emissions.

If the results of the LCA are intended for publication or communication to external organisations, international standards for transparency and peer review need to be followed¹³. The Australian Competition and Consumer Commission (ACCC) is also developing a guide to carbon offset claims¹⁴.



In 2008 Ant Packaging became Australia's first accredited 'carbon neutral' plastics factory¹⁵. The company manufactures plastic bottles for the cosmetics, homeopathic and other industries. (Image supplied by Ant Packaging)

Design strategies to reduce greenhouse gas emissions using plastic products

- 1** Use less material. This will reduce greenhouse emissions throughout the life cycle (during polymerisation, product manufacture, transport, and disposal or recovery).
- 2** Use plastics rather than heavier alternative materials if they meet functional and commercial requirements.
- 3** Design products to be as durable as possible. This will extend the product's life and delay the need for repair or replacement with a new product.
- 4** Design with specific end of life recovery in mind, for example by promoting continuous recycling.
- 5** Use renewable energy, for example by purchasing certified GreenPower¹⁶ from an energy provider.
- 6** Maximise efficiencies in the supply chain, for example by sourcing materials from energy-efficient manufacturers and using lower impact transport modes.
- 7** Purchase 'carbon credits' to offset the greenhouse gas emissions associated with a product or business. The money paid to organisations offering carbon credits is used to fund projects such as infrastructure for renewable energy or tree planting to increase sequestration in carbon sinks.
- 8** Consider different business models, for example replacing a product with a service (see Quickstart 12).

The aim of the Quickstart series is to promote the design of products and services that are sustainable—that is, products and services that contribute to social progress and economic growth, as well as providing ecological benefit, throughout their life cycle. The sustainability of a product is largely locked in at the design phase, which is why D4S is so important.

The Quickstarts are written for practitioners at every stage of the plastics product chain, including designers, polymer suppliers, product manufacturers, brand owners, specifiers and recyclers. The series also supports the implementation of PACIA's Sustainability Leadership Framework (2008), which promotes a whole-of-life approach to product innovation and stewardship and the need for step-change 'transformations' in material and resource use.



Designers and manufacturers can reduce their carbon footprint by purchasing renewable energy from sources such as wind power. Wind turbine blades are manufactured from fibre-reinforced plastic. (Image supplied by Sustainability Victoria)

The Quickstart series is part of the 'Design for Sustainability with Plastics' program managed by a collaborative partnership between Sustainability Victoria and PACIA. The Quickstart series can be downloaded from www.pacia.org.au.

Further information

Australian Government
Department of Climate Change
(for information on regulations,
climate change science, carbon offsets,
and programs for business and community):
www.climatechange.gov.au

Carbon Offset Guide Australia
(a partnership between EPA Victoria and RMIT):
www.carbonoffsetguide.com.au

ACCC
(carbon offsets and the Trade Practices Act):
www.accc.gov.au/content/index.phtml/itemId/807902

International Council of Chemical Associations
(report on *Innovations for greenhouse gas
emission reductions*):
www.pacia.org.au/Content/media-6.07.2009-1.aspx

PACIA
(for information on life cycle management,
D4S, plastics recycling and sustainability):
www.pacia.org.au

Sustainability Victoria
(to download a range of D4S resources):
www.sustainability.vic.gov.au

Footnotes

- 1 Australian governments are also supporting innovation in energy efficient products and services through higher minimum standards and investments in education and training – see www.coag.gov.au/coag_meeting_outcomes/2009-04-30/docs/National_strategy_energy_efficiency.pdf.
- 2 Carbon 'sequestration' refers to the capture and long term storage of carbon dioxide from the atmosphere in forests, soil, oceans etc.
- 3 *Garnaut climate change review: final report*, Commonwealth of Australia, 2008.
- 4 *Garnaut review*, Ibid, p. 33.
- 5 *Garnaut review*, Ibid. pp. 121–152.
- 6 Plastics Europe, www.plasticseurope.org/Content/Default.asp?PageID=974.
- 7 GUA, 2005, *The contribution of plastic products to resource efficiency*, Plastics Europe, Vienna, www.resbrasil.com.br/upload/Plastics_GUA_LCA_completo_2_0105.pdf; International Council of Chemical Associations (ICCA), 2009, *Innovations for greenhouse gas emission reductions*, www.pacia.org.au/Content/media-6.07.2009-1.aspx.
- 8 GUA, Ibid, p. 153.
- 9 ICCA, Ibid, p. 31.
- 10 Grant T. et al, 2001, *Stage 2 report for life cycle assessment for paper and packaging waste management scenarios for Victoria*, EcoRecycle Victoria, Melbourne.
- 11 Delgado C. et al, 2007, *Assessment of the environmental advantages and drawbacks of existing and emerging polymers recovery processes*, European Commission, Luxembourg, <http://ftp.jrc.es/EURdoc/eur22939en.pdf>.

12 PACIA, 2009, *Sustainable plastics recovery*, www.pacia.org.au/Content/SustainablePlasticsRecovery.aspx.

13 Standards Australia and Standards New Zealand, 1998, *AS/NZS ISO 14040:1998 Environmental management—life cycle assessment—principles and framework*.

14 ACCC, www.accc.gov.au/content/index.phtml/itemId/807902.

15 See www.antpackaging.com.au/flex/australias_first_carbon_neutral_plastics_factory/53/1.

16 GreenPower is a government accreditation program for renewable energy from sources such as hydro, wind power and biomass which produce no net greenhouse gas emissions. Households and businesses can purchase renewable energy from their energy provider. See www.greenpower.gov.au.

Publication details

Quickstart: Design for Sustainability with Plastics was prepared by Helen Lewis Research for Sustainability Victoria and the Plastics and Chemicals Industries Association (PACIA) with input and advice from practitioners and others involved in the sector.

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