Enabling the Transition to a Green Economy: Government and business working together

The Transition for the Chemicals Industry

HM Government

Sector overview

The chemicals sector's annual sales were £55bn in 2009; it accounted for 12% of all manufacturing and 22% of UK manufacturing exports, with a consistent trade surplus (exports exceeding imports) and circa 90% of companies exporting[1].

The sector employs almost 170,000 people, with a labour productivity more than double the UK average[1].

The sector contributed to a total of £5bn R&D investment in 2009, accounting for 32% of all business R&D in the UK[1].

There are chemical companies across the UK, with key clusters in the North East, North West, Yorkshire and Humber regions.

The sector is one of the most energy intensive sectors, accounting for 22% of total UK industrial energy consumption. At £4bn p.a., energy is one of its biggest costs and for some companies it represents 30% of their total costs and up to 70% of their variable costs.

A recent report identified that, in 2007, chemistry research impacted on the operations of 15 downstream industries, supported 5.1 million jobs, and directly contributed £222bn to the UK's GDP.

The chemicals sector territorial greenhouse gas (GHG) emissions[2] in 2008 were 8.8 million tonnes (2% of UK territorial emissions). GHG emissions associated with the chemicals sector on a production basis[3] are 22 million tonnes of CO_2e, representing 3% of UK producer GHG emissions.

1 Source: ONS ABS and BERD data – figures include pharmaceutical manufacture
2 Territorial emissions refers to emissions from UK territory
3 Producer impacts refers to impacts associated with the activities of UK citizens. The emissions relating to electricity consumption have been allocated to the user and include impacts from international aviation and shipping and some activities of UK citizens abroad.

Working together as an industry

The UK chemicals sector acted early and has already implemented low-cost options like high efficiency drives to abate overall greenhouse gas (GHG) emissions. For example, Combined Heat and Power (CHP) is a process that captures and utilises the heat that is a by-product of energy production. It has been adopted by most intensive chemical operators where there is sufficient heat demand. The sector has improved its energy efficiency by 35% since 1990 through improvements to chemical processes and plants, generation and efficient use of heat and power and energy management; GHG emissions were reduced by 70% over the same period.

Building on this, the sector acknowledges that further reductions in its GHG emissions could be achieved through greater materials efficiency, increased recycling and the development of new step change process technologies and newer carbon abatement approaches such as carbon capture and storage (CCS), renewable heat and electricity.

The sector has come together to form the Industrial Biotechnology Leadership Forum in order to ensure that the UK is able to capitalise on the green and growth benefits that industrial biotechnology presents to the chemicals sector in terms of greening production processes, switching to renewable bio-based feedstocks and making the new green products required by other sectors to allow them to transition to the green economy.

The global context

Total shipments of chemicals was worth almost $3,500bn in 2009 – with the US, China and Japan as the major producers. The UK is traditionally the sixth largest producer globally and third in Europe after Germany and France.

The products of the chemicals sector are globally traded with over 80% of the chemicals produced in the UK exported and two-thirds of the

chemicals used in the UK imported. The level of exports exceeded the level of imports within the EU in 2010 (£27bn vs. £22bn) with more than 50% more exports to the rest of the world than imports in 2010 (£29bn vs. £13bn).

Due to the high energy usage of the chemicals industry, increases in energy costs brought about by EU and domestic climate change and energy policies have the potential to impact on the international competitiveness of the UK chemicals sector if international competitors do not incur similar costs.

Innovation

The chemicals sector uses fossil fuels not only as an energy source, producing GHG emissions, but also as a raw material for the manufacture of sophisticated products, some of which also generate GHG during and at the end of their lifetime. As a result of commercial and environmental pressures, the chemicals sector was an early mover in terms of reducing its carbon, energy and environmental footprints, often in advance of regulation.

Notwithstanding the actions already undertaken by the chemicals sector to reduce its carbon and environmental footprint, it is looking towards new breakthrough technologies that could further reduce its footprint and increase the industry's net abatement potential. However, the breadth of products, processes and technologies[4] used across the sector means that there is no single roadmap or game-changing technology that will provide the solution to greening the chemical sector. Rather, the adoption of some or all of the opportunities outlined below will provide the means to further green the sector.

Biocatalysis

The application of biocatalysis (using natural catalysts to transform organic compounds) to the chemicals sector is a significant opportunity that would enable chemical companies to produce new green products and processes. A World Wildlife Fund[5] report concluded that the full climate change mitigation potential of industrial biotechnology, and specifically biocatalysis, ranges between 1 billion and 2.5 billion tonnes of CO_2e per year by 2030.

For example, UK company Johnson Matthey's new APICO catalyst is used industrially to synthesise methanol, a valuable chemical intermediate whose use as an energy feedstock is increasing. Resource efficiency benefits stem from reduced plant start up time, longer catalyst life and fewer by-products.[6]

Renewable feedstocks

The UK chemicals sector is already starting to adapt to a green economy by increasingly producing chemicals and materials using renewable feedstocks. This includes using biomass rather than petrochemicals and using carbon locked in municipal waste as a feedstock.

Advanced recycling technologies

Chemical companies are increasingly looking at advanced recovery and recycling technologies as a means to reduce their environmental impact. The hydrocarbons locked within used and disposed of plastics and polymers can be viewed as potential sources of chemical building blocks and companies are working to develop ways of unlocking these. Recycled polymers can be produced through a process of de-polymerisation, where the polymers are 'broken down' into their constituent monomers, for subsequent formation into new, recycled polymers.

Electrochemistry

Electrochemistry is another area being explored. Fundamentally, electrochemistry is concerned with inter-converting electrical and chemical energy. It is an area of science that is critical to the storage of intermittent renewable energy sources, batteries for the next generation of electric cars, the clean production of hydrogen, solar cells with greater efficiency and sensors for use in research of biological systems and healthcare.

4 The UK chemical sector synthesises in the order of 30,000 chemicals

5 http://biofuelsandclimate.files.wordpress.com/2009/03/wwf-biotech.pdf

6 http://www.cia.org.uk/Low_carbon_brochure_final2LR.pdf

Carbon Capture and Storage

Carbon Capture and Storage (CCS) is an emerging technology that would enable GHGs to be captured as they are produced and transported into deep underground structures, thereby reducing GHG emissions. An International Council of Chemical Associations (ICCA) commissioned report[7] in 2009 estimated that CCS in the chemicals sector could have a possible abatement potential of around 420 million tonnes of CO_2e. However, cost (between £30 and £150 per tonne of CO_2 abated[8]) and economies of scale could hinder smaller industrial scale applications, and as a result the industry is considering the potential for a cooperative or network approach to industrial CCS, and the European Commission is funding work in this area[9].

Energy efficiency

The chemicals sector is one of the most energy intensive sectors, where energy is often used directly in the production processes, accounting for 22% of total UK industrial energy consumption. At £4bn p.a., energy is one of its biggest costs and for some companies it represents 30% of their total costs and up to 70% of their variable costs.

The EU chemicals industry is the most energy efficient compared to other areas in the world. However, a substantial increase in energy efficiency is dependent on technological breakthroughs[10]. Examples include efficient motor systems that drive machinery, CHP, alternative energy sources (photovoltaic, fuel cells), improved energy storage, and the optimization of catalysts.

The 2009 ICCA commissioned report[11] estimated that energy efficiency savings of circa 1,100 million tonnes of CO_2e were possible by 2030.

Resource efficiency

The nature of the chemicals sector as it has developed over the last 150 years means that one person's 'waste' is often seen as another person's feedstock. This approach to resource efficiency reduces the need for raw materials, and has led to the creation of clusters of chemical companies that are integrated and reliant on the 'waste' products from each other. However, there are still opportunities for further increasing recycling and water management at all stages of the supply chain[12]. Defra evidence estimated a potential savings opportunity of £4.4bn in 2009 through no and low cost measures to tackle waste (largely through plastics and rubber recycling) in the chemicals and non-metallic minerals sector[13].

As mineral resources become rarer, the sector faces risks associated with security of materials supply as many raw materials, such as rare earth elements, are sourced outside the UK. Research by Defra has identified that future resource risks for the UK economy of relevance to the chemicals sector may include palm oil, phosphorus, lithium, cobalt and tin[14]. The sector and Government are working together to identify ways to manage this risk.

Nevertheless, in the future the chemicals sector will be producing chemicals using less energy and resources: resources that will be increasingly sustainable and renewable, with reduced emissions and reduced environmental impact.

7 http://www.icca-chem.org/ICCADocs/ICCA_A4_LR.pdf
8 http://downloads.theccc.org.uk.s3.amazonaws.com/pdfs/CCC_final_report_issue2.pdf
9 http://ec.europa.eu/clima/funding/ner300/000001/index_en.htm
10 Ecorys study in progress - The competitiveness of European Companies and Resource Efficiency
11 http://www.icca-chem.org/ICCADocs/ICCA_A4_LR.pdf
12 Ecorys study in progress - The competitiveness of European Companies and Resource Efficiency
13 The Further Benefits of Resource Efficiency, Defra March 2011
14 Review of the Future Resource Risks Faced by UK Business and an Assessment of Future Viability, Defra December 2010.

Lifecycle approach

As the world economy moves towards a greener future, all current and new manufacturing sectors will require greener products. The chemicals sector, being at the base of the majority of manufacturing sectors, will provide the new green solutions to enable these sectors to become green themselves, and can use its influence to encourage them to do so.

The chemicals sector therefore has a key role in the transition to a green economy as a solution provider and developer of the low-carbon and greener products and building blocks required by other sectors.

To quantify this potential, an independent report by McKinsey and Co for the ICCA in 2009 took a whole-lifecycle approach to assess the role the outputs of the chemicals sector made in reducing emissions in the sectors that use chemicals.

The ICCA found that, by looking at a full carbon life-cycle approach, for every unit of GHG emitted by the chemicals sector, the products of the chemicals sector enabled GHG savings 2-3 times greater than their own emissions – a figure that could rise to a ratio of 4 to 1 under the right conditions. This equates to a maximum saving of 5.2 bn tonnes of CO_2e.

The ICCA work identified a series of opportunities where the chemicals sector could contribute to wider GHG savings through the development of new green products in downstream sectors. These include insulating foams in buildings, agrochemicals, lighting, plastic packaging, automotive plastics, low-temperature detergents, engine efficiency, synthetic textiles, and marine antifouling coatings.

The fuel consumed by the marine shipping industry is reduced significantly through the use of chemical-based antifouling coatings that also protect ships from corrosion. This minimises drag and it was estimated that the average fuel consumption of ships without antifouling coatings would be 29% higher. After taking into consideration the production footprint of the coatings and average coating lifetime of 12 years, the net abatement volume was estimated to be around 190 million tonnes of CO_2e by 2030 for global shipping.

Leasing and management services

The UK Chemicals Stakeholder Forum is exploring the potential for growth in chemical management services and chemical leasing. These business models have the potential to optimise the use of chemicals, save energy, encourage recovery and recycling, enable better use of technical expertise, and create a stronger relationship between the manufacturers and users. These business models are not widely established yet in the UK, but could make an important contribution to the green economy.

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