CHEMICAL INDUSTRIES ASSOCIATION

The chemical industry:

delivering a low carbon future 24 hours a day

Responsible Care

How we are delivering the low carbon economy 24 hours a day

Chemicals are essential to modern healthy living and are also vital to delivering a low carbon economy.

We are doing this by continuously reducing our own greenhouse gas (GHG) emissions and helping others to reduce their emissions by using chemical products and technologies. Many of these solutions are produced in the UK.

UK and EU strategies to reduce GHG emissions need to recognise the role we play if the chemical industry's contribution to the low carbon economy is to be maintained and enhanced.

Chemicals are essential to modern living

The products of the chemical and pharmaceutical industry are essential to modern healthy living. Our products are used to make all of our consumer goods from computers, cars and clothes to detergents, fuels and construction materials.

We are also contributing to a low carbon economy by reducing our own emissions and helping others to reduce theirs.

Reducing our own emissions

The global chemical industry already has a good track record for reducing its GHG emissions and is committed to continually improving. For example: UK chemical industry energy efficiency has improved by 35% in the past 20 years and we have reduced our GHG emissions by 70% over the same period.

Helping others to reduce their emissions

A recent independent report has found that: for every tonne of GHG emitted by the global chemical industry its products and technologies enable over 2 tonnes of GHG emissions savings. Without these savings there would have been up to 11% more emissions of GHGs in 2005.

The top chemical industry products that enable these carbon savings include: building insulation, fertilisers and crop protection, lightweight components for cars and planes, low temperature detergents, biofuels and materials for wind turbines.

These chemical products and technologies are all made in the UK, supporting low carbon jobs and generating UK exports. In future, their increased use can further reduce our GHG emissions whilst "greening the economy".

In fact, the McKinsey report shows that by 2030, with the right policies under a global framework, the GHG emissions savings enabled by the chemical industry could increase to over 4 tonnes for every 1 tonne of chemical industry emissions.

We need, though, the right policy framework

Until a global climate change agreement is implemented, UK and EU governments need to take a balanced view to maintain a level playing field for energy intensive businesses. This is critical to the continued contribution of the chemical sector to the UK economy and UK GHG reductions.

Delivering low carbon solutions

Chemical products for vehicles save 230 million tonnes of GHGs. Emissions can be reduced through lighter plastic parts which reduce a car's weight, better tyres, and petrol/diesel additives that improve energy efficiency.

230
million tonnes
of GHGs saved

100
million tonnes
of GHGs saved

The chemical industry enables larger rotor blades on wind turbines and more efficient solar panels, essential for the development of cost effective renewables and saving 100 million tonnes of GHGs.

Insulation foams in buildings save 2,400 million tonnes of GHGs. This is 233 times more than the emissions from manufacture. It is also four times the entire annual emissions of the UK.

2,400
million tonnes
of GHGs saved

An independent study by **McKinsey and Company** confirms the global chemical industry's emissions savings contribution

The chemical industry is the first sector to use a lifecycle assessment of its products to evaluate how it can optimise its contribution to the global reduction in GHG emissions.

The independent report by McKinsey and Company was commissioned by the International Council of Chemical Associations (ICCA). McKinsey and Company is a global management consultancy firm and are advisors to the world's leading businesses, governments, and institutions. A critical review of the report was conducted by the Oko Institute, a renowned environmental research group, independent of McKinsey and the ICCA.

The McKinsey report examines how the emissions of the global chemical industry and the savings we enable may change in the future, and then makes a series of recommendations on how policy can help to optimise overall GHG reduction.

The study presents carbon lifecycle assessments for the use of chemical products in over 100 applications including insulation, wind turbines and solar panels.

The lifecycle GHGs emitted and saved by each application are compared with those of the next best non-chemical alternative to assess its gross emissions savings.

Modern compact fluorescent lamps are more effective and longer lasting, and save 700 million tonnes of GHGs.

700
million tonnes
of GHGs saved

Chemical fertilisers and crop protection products save 1,600 million tonnes of GHGs and help increase food production whilst reducing the need for land-use change.

1,600
million tonnes
of GHGs saved

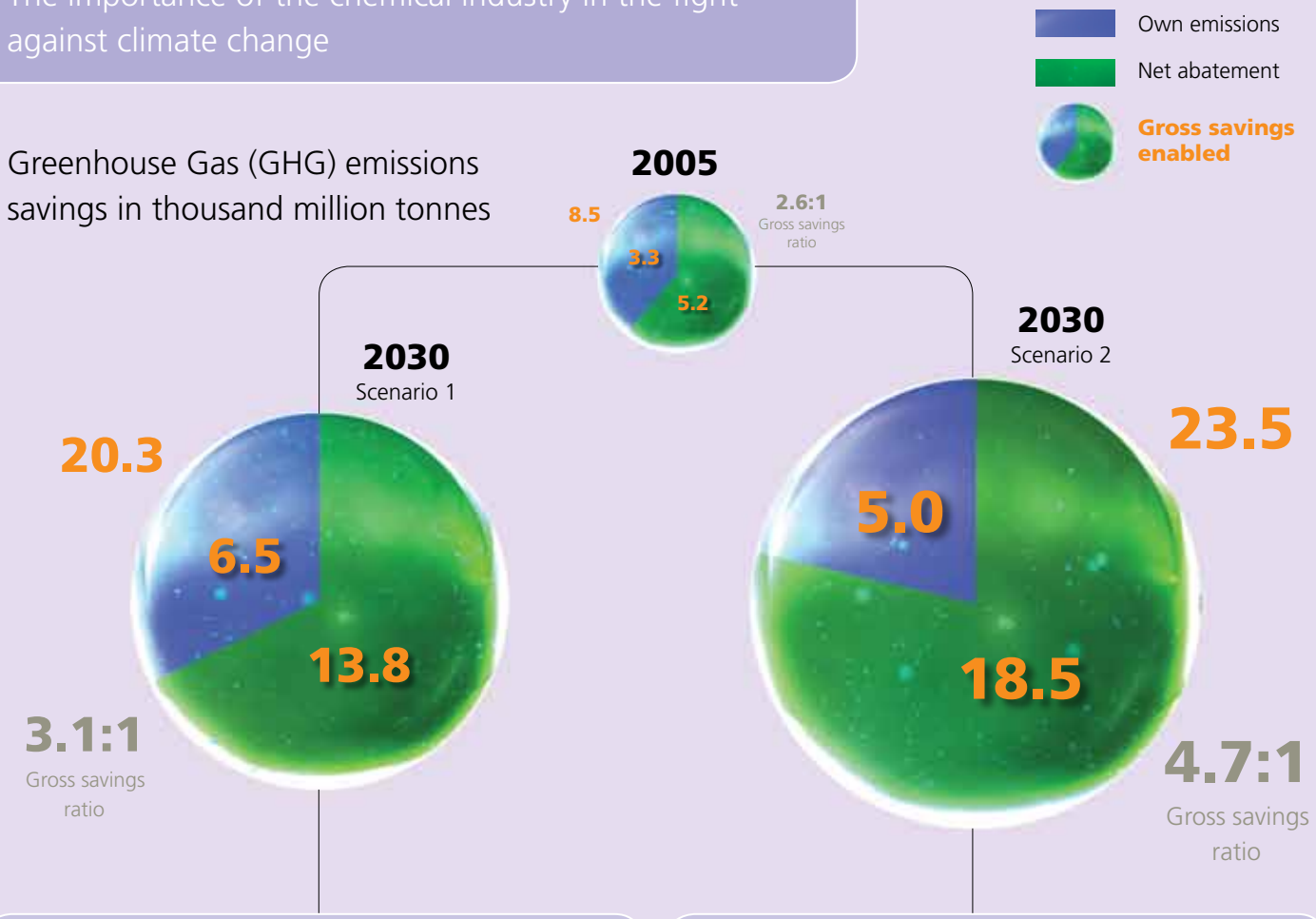
The McKinsey report explores two different scenarios for 2030:

Scenario 1 is the "business as usual case" whereby the UK and EU continue with their existing and planned carbon reduction programmes but that there is no global agreement to reduce GHG emissions.

This means that manufacturers in big industrial nations such as the USA, China, India and Brazil do not have to pay the costs of carbon emissions in the way that UK and EU manufacturers do.

Scenario 2 looks at what will happen if there is a fair, workable and implemented global agreement to reduce GHG emissions.

This means that all manufacturers across the globe will all face carbon emission constraints.



Scenario 1: No global agreement

By 2030 the worldwide demand for chemicals is predicted to double. Without a global agreement the emissions of GHGs by the chemical industry are also likely to double. This is despite most of the extra production being done in more efficient chemical plants because there will be a shift in production to coal based economies such as China and India.

Without the right policies under a global framework there will not be sufficient incentive for coal-based economies to implement expensive carbon capture and storage technology.

The relocation of energy intensive industries away from carbon constrained economies is known as "carbon leakage" because ultimately global carbon emissions are not reduced, simply moved or leaked elsewhere.

Growth in the use of GHG saving chemical products could mean that the industry will save up to 3.1 tonnes of GHG for every 1 tonne of its own emissions: a relatively marginal improvement on 2.6 tonnes in 2005.

Scenario 2: Global agreement

In this second scenario there is also around a doubling in worldwide chemicals demand but slightly stronger than in scenario 1 due to increased use of GHG saving products.

However, there is a larger improvement in chemical industry GHG efficiency and our own GHG emissions rise by only 50%. This is because all economies have implemented measures to improve carbon efficiency including high cost options such as carbon capture and storage.

Nonetheless, the share of chemical industry global emissions rises to 15% in 2030 compared to 7% in 2005. This is despite the chemical sector using all the carbon efficiency measures that McKinsey expect to be available. In order to reduce this share it is clear that more step-change technologies are needed in the chemical sector.

The wider use of GHG saving chemical applications means that the products of the chemical industry will save up to 4.7 tonnes of GHG for every 1 tonne of own emissions: a strong improvement from 2.6 tonnes in 2005.

This means the chemical sector contributes up to 12% of the global savings over and above the projection in scenario 1.

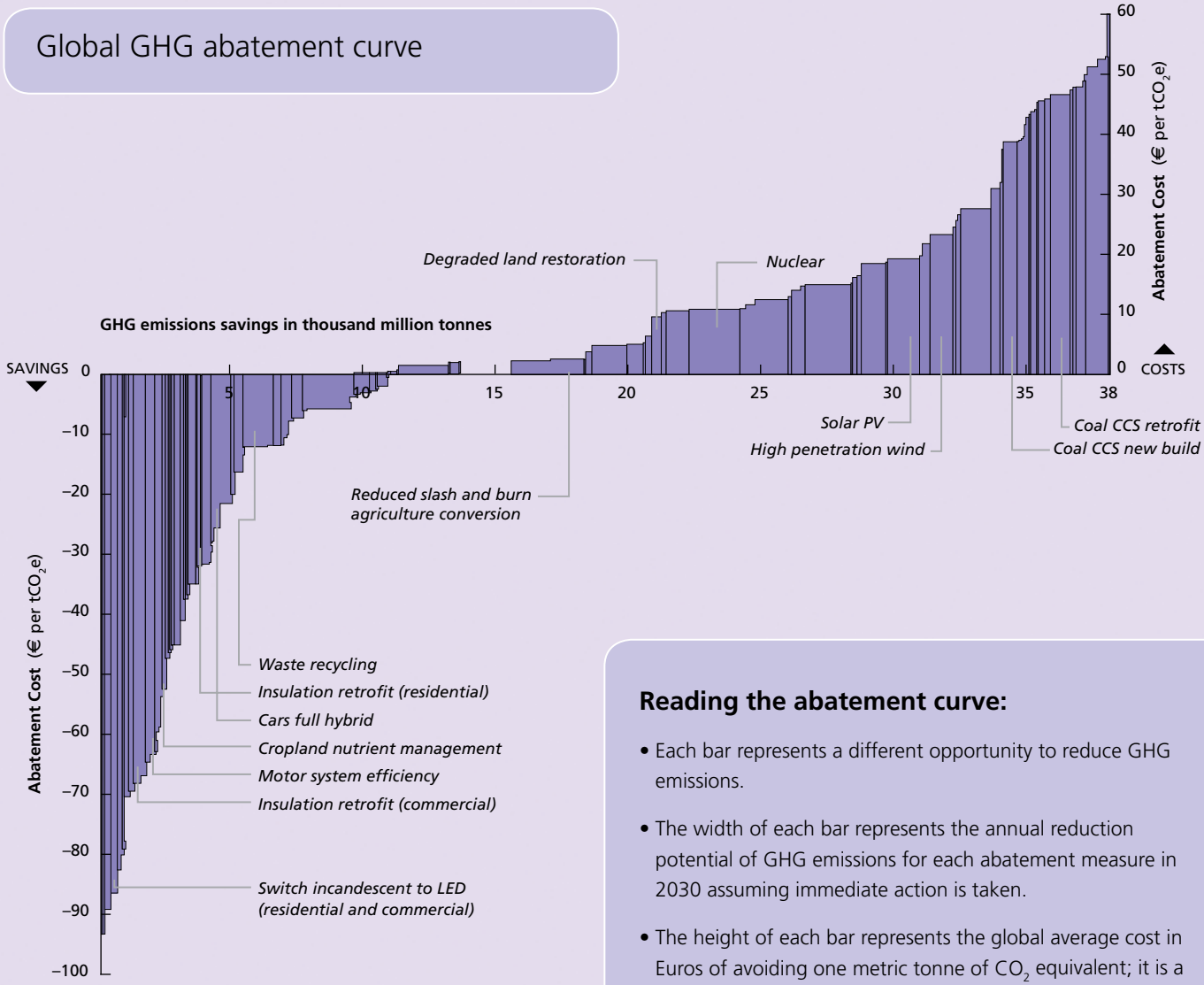
Insulation remains the chemical application that enables the most savings but the contributions of solar power, biofuels, wind power and carbon capture and storage become more important.

Policy recommendations

These projections demonstrate the value of taking a lifecycle approach to policy design within a global carbon framework. We recommend the government considers the following principles and UK-specific proposals when designing policy:

1) A global carbon framework which covers all regions and sectors
2) Focus on the largest, most effective and lowest cost opportunities for GHG reduction including energy efficiency
3) Support for the development and implementation of new step-change technologies
4) Provide incentives for faster action by rewarding "early movers" that proactively reduce their carbon footprint
5) Support the development of the most effective and sustainable use of available feedstocks and energy
6) Development of waste policy that promotes the most efficient and sustainable, disposable, recovery and recycling options allied to existing government initiatives
7) The introduction of a technology cooperation mechanism between the developed and developing world as this could benefit both technology owners and receivers and also support a level playing field.

Global GHG abatement curve



Note: This abatement curve is based on a 4% interest rate, depreciation over life time of the equipment and products used.

Source: Global GHG Abatement Cost Curve v2.0, McKinsey and Company

Reading the abatement curve:

- Each bar represents a different opportunity to reduce GHG emissions.
- The width of each bar represents the annual reduction potential of GHG emissions for each abatement measure in 2030 assuming immediate action is taken.
- The height of each bar represents the global average cost in Euros of avoiding one metric tonne of CO_2 equivalent; it is a weighted average figure over both regions and time.
- The graph is ordered from left to right from the lowest cost to the highest cost abatement opportunities. Bars below the line indicate net financial savings over the lifetime of the measures.

In the home

233:1 = Emissions savings ratios

Case study one: 233:1 Insulation

Buildings account for around 27% of CO_2 emissions in the UK. Improving their energy efficiency is one of the most effective ways of tackling GHG emissions.

In Norfolk the Dow Chemical Company manufactures Floormate™ 300-A, an advanced insulation board that allows households and businesses to save over 230 times the GHG emissions than it takes to make.

Floormate™ 300-A starts as foam polystyrene. In a process called extrusion Styrofoam is created from the polystyrene. This process creates a material with an unrivalled set of properties: low thermal conductivity, high compressive strength and low water absorption – which make it efficient, strong and durable enough to suit a wide range of uses in homes and businesses – for instance it can be used in unwaterproofed areas and under heavy concrete floor slabs – a revolution for the construction industry.

A house in the Cotswolds achieved an astonishing 90% energy saving compared to the average house by using Floormate™ and other insulating products.

- one year's production of chemical insulation will enable 2.4 billion tonnes of CO_2 to be saved over its lifetime, equivalent to four times the annual GHG emissions of the UK.

Case study two: 2.7:1 PVC windows

Windows and doors in homes and commercial properties are responsible for a large proportion of heat loss which equals lots of preventable GHG emissions. Installation of high-rated energy efficient windows and doors will significantly reduce energy bills and the carbon footprint of the property.

The vast proportion of top-rated windows (BFRC 'A' rating) are manufactured from PVC.

A carbon lifecycle comparison between a typical PVC window unit and one made from aluminium or wood shows that over the life of the window, emissions from the PVC window are nearly three times lower, contrary to the common belief that a man-made plastic must be more carbon intensive.

Within the UK, INEOS ChlorVinyls are the only manufacturer of PVC, which is produced at their site in Runcorn, Cheshire. In the past five years, the site has invested in excess of £200M in state-of-the-art processing technology which requires 12% less energy – equivalent to a carbon saving of 85MtCO_2e every year.

Some other GHG saving products in the household:

- **20:1** Lighting with compact fluorescent lamps (CFL)
- **9:1** Low temperature detergents
- **2.6:1** Synthetic textiles – replace cotton with polyester which has lower own emissions and is harder wearing
- **2.3:1** Domestic polymer piping (replacing other materials)
- **2.2:1** Use of enzymes to increase the life of bread
- **1.9:1** Easy-care finishing for cottonware (easy iron)
- **1.8:1** Polymers replacing traditional packaging
- **1.8:1** Clothing – replacing cotton with nylon
- **1.5:1** Polymer use in large houseware items (e.g.: waste bins)
- **1:1** Fridge insulation
- **1:1** Use of polymers in carpeting

Transport

Case study three: 51:1 Fuel-saving tyres

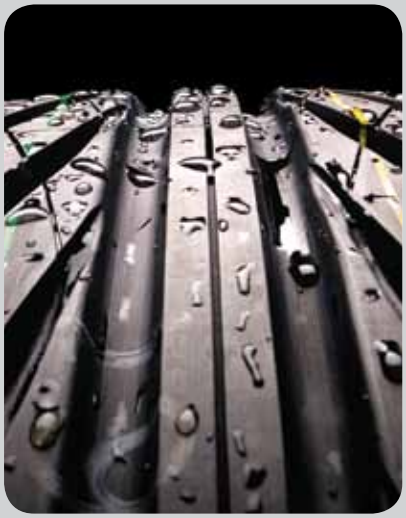
The growth in the number of vehicles worldwide has been spectacular. There are estimated to be 850 million today and, with numbers expected to reach 1.5 billion by 2030, the rapid development of sustainable vehicles is essential. This means reducing emissions, improving safety performance and reducing road noise in affordable motorcars, vans and lorries. Tyres are part of this development.

A modern tyre has to offer the best trade-off between: fuel saving (environmental performance and cost), safety (increased grip, particularly in wet conditions) and longevity (cost, environmental impact).

Fuel saving is achieved by reducing the rolling resistance of a tyre: the portion of the engine's energy lost as heat by the tyre. Rolling resistance can be reduced by using science to optimise the internal structure, the tread pattern and the rubber compound of the tyre.

Since the invention of the motorcar there has been continuous improvement in the rolling resistance of tyres. The big improvement came in the 1990s when silica was used to modify the rubber used in tyres. Using synthetic rubbers it was possible for scientists to structure the polymers (large molecules made of a string of identical small molecules called monomers) in new ways.

This advanced synthetic rubber is known as solution-styrene-butadiene rubber (s-SBR). In the UK, Polimeri Europa manufacture and research ever more advanced s-SBR for low rolling resistance tyres at its site at Grangemouth in Scotland.



Some other GHG saving products for transport:

71:1 Lightweight aeroplane components

21:1 Fuel and lubricant additives for engine efficiency

20:1 Antifouling coatings for shipping

2.9:1 Lightweight polymers for vehicles

1:1 Use of more synthetic rubber to replace natural rubber in tyres

Agriculture

Case study four: 6.2:1 Farming – synthetic fertilizer and crop protection

Production of our major crops more than doubled between the 1950s and 2000 to keep pace with the growing world population. With the global population set to reach 9 billion people by 2050, food production will need to be 70% higher than today. The challenge is to do this as far as possible on our existing farmland to avoid further erosion of established forests.

Forests and permanent grasslands store hundreds of tonnes of carbon per hectare. We need to grow more from less, and agricultural productivity is the key to a sustainable future.

Crop protection

Crop protection chemicals are one of the critical modern technologies that have helped to raise yields. Without effective crop protection food production would be 40% lower. Weeds compete with crops for sunlight, nutrients and water.

Herbicides offer a practical and convenient alternative to ploughing and manual weeding practices. Use of herbicides reduces the considerable energy needed for mechanical tillage, but also delivers benefits in maintaining soil moisture levels, minimising soil erosion and increasing organic matter stored in soil.

Some crop protection chemicals have beneficial effects on plants beyond their ability to control pests. Syngenta's product Amistar™, the world's leading fungicide, boosts yields and grain quality in cereals through maintaining leaf greening for longer as well as offering broad spectrum protection against many diseases. It is also known to increase the nitrogen use efficiency of the crop.

Amistar™ was invented in the UK and is also manufactured here. It highlights the potential for UK developed and manufactured chemical technologies to play a key role in safeguarding food production and the environment by enhancing production on existing land.

Synthetic fertiliser

Currently, 49% of the world's population is dependent on the use of nitrogen fertiliser in agriculture for its survival. The sustainable, scientific and targeted use of nitrogen fertiliser have increased yield dramatically over the last few decades and avoids the destruction of forest for farmland and the associated release of fixed carbon from the vegetation and the soil.

GrowHow is the UK's only manufacturer of ammonium nitrate (AN) fertilizer and the ammonia and nitric acid inputs used to make it. It is also the country's largest industrial consumer of gas. Gas is used to heat its processes and it is also the most efficient ingredient for making ammonia. GrowHow has sought to drive down emissions both from its manufacturing process and by limiting the emissions from the use of its fertiliser products.

GrowHow has made significant investments in improving the efficiency of its ammonia production. It also captures and reuses what $C0_2$ it can for, amongst other things, to help grow tomatoes.

In 2010 GrowHow is also implementing the latest catalyst technology to reduce its emissions of nitrous oxide (N_2O) from its nitric acid process (N_2O is a GHG with 310 times the global warming potential of CO_2). A £9 million project will reduce manufacturing emissions by over 1.3 million tonnes of $C0_2$ every year. The project will make its ammonium nitrate fertiliser amongst the most GHG efficient made in Europe.

Through the development of an easy to use soil sampling test for farmers, GrowHow has led the way in driving forward the sustainable, scientific and targeted use of nitrogen fertiliser. This has helped to maximise food production and minimise excessive and unnecessary emissions from the soil.

Energy

Some GHG saving products for energy:

231:1 **Use of foam coating in district heating**

123:1 **Wind turbine blade materials**

5.3:1 **Trichlorosilane use in solar cells**

4:1 **Biofuel replacing gasoline**

From waste to energy

A £52 million bioethanol plant is set to be built in the North East of England. The 30 million litre waste to bioethanol plant – the first of its kind in Europe – is being built by INEOS Bio and could be operational by 2012, should government incentives come on stream in time.

Based at the INEOS Seal Sands site in the Tees Valley, it will convert 100,000 tonnes annually of biodegradable household and commercial waste into 24,000 tonnes of zero carbon road transport fuel and three megawatts (MW) of renewable electricity for homes and industry per year.

The new plant will help create 350 construction jobs and over 40 permanent skilled roles, and by 2015 could be expanded into a larger integrated biorefinery, combining advanced bioenergy production with advanced waste treatment.

INEOS said the biorefinery would help meet the UK's renewable energy targets for 2020. Under the Renewable Energy Directive, the UK has to obtain 15% of energy from renewable sources by 2020. Latest statistics show the UK reached 3% by 2009.

Funding to help support the project has come from the Department of Energy and Climate Change (DECC) and the north east region.

The plant will use the company's advanced BioEnergy Process Technology, which uses anaerobic digestion to convert gases derived directly from biomass into bioethanol. This bioethanol production is integrated with combined heat and power generation.

Future innovations

Case study five: 51:1 Future innovations

The capacity of the chemical industry to reduce society's carbon footprint is not limited to fine tuning existing solutions. The chemical industry also has a vital role to play in developing innovative products and technologies of the future. This section highlights how one UK chemical company, Johnson Matthey, is providing solutions for today and working to develop the next generation of products and technologies.

Enhancing energy efficiency

Innovative catalysts, materials and technologies can play a huge role in helping to reduce GHG emissions by improving the efficiency of chemical processes. For example:

Catalysts for methanol production – 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.

APICO, Johnson Matthey's revolutionary new methanol synthesis catalyst.

Jet engine efficiency – Over the last decade, jet engine efficiency has been improved by higher temperature running. Advanced materials have helped enable this by protecting the engine turbine blades from this heat by electroplating a thin layer of platinum onto the blade. Johnson Matthey already supplies an electroplating compound, known as Q-Salt, but their scientists are already working on the next generation technology, Q+™. Q+™ promises to give the same protection for approximately 20% less platinum, while generating efficiency improvements for the product in manufacture, as well as in use.

Fuel Cells – Johnson Matthey's fuel cell technologies tackle energy efficiency from a different angle. Fuel cells generate clean electricity by electrochemically combining a fuel – usually hydrogen – and air. They are efficient, quiet and emit no CO_2 or regulated pollutants. Fuel cells can power all sorts of devices from cars and buses to laptops, mobile phones and buildings in which the by-product heat can also be used to provide heating or cooling. Fuel cell technologies are already being used in a number of areas but plug-in hybrid cars, which combine fuel cells with batteries that can be recharged from the mains, could well become the first major automotive application.

Renewables

Substituting fossil fuels with sustainable, renewable alternatives has obvious benefits for GHG emissions and stimulates the need for a range of new chemical processes. For example:

Renewable feedstocks – Johnson Matthey's scientists and engineers have developed ways to make ethyl acetate, an industrial solvent, from bioethanol, and identified a way of using a waste product of biodiesel manufacture, glycerine, to make propylene glycol. Propylene glycol is used in products as diverse as moisturizers and antifreeze.

Second generation biofuels – One of the problems with traditional biofuels such as biodiesel and bioethanol is their poor compatibility with vehicles such as airplanes. Johnson Matthey is using new catalyst technology to upgrade second generation biofuels, such as algae oil into conventional jet fuels in a single step.

The hydrogen challenge – The ultimate dream is to harness renewable energy to generate hydrogen. This presents exciting opportunities for the chemical industry. In one collaboration, Johnson Matthey's researchers have worked on an iron rich compound which, when heated to over 1000°C by concentrated solar energy, could split water to make carbon free hydrogen.

Action on abatement

Where emissions cannot be avoided, innovative chemical processes can offer an alternative solution. For example:

Nitrous oxide – Despite its popular name of 'laughing gas', nitrous oxide (N_2O) is no joke as every tonne emitted has the same global warming potential as 310 tonnes of CO_2. Nitric acid is used around the world as an ingredient for fertilisers, polymers and explosives, but during its production, a side reaction leads to the formation of small amounts of N_2O. Johnson Matthey has commercialised a catalyst technology, Amoxis, which converts this N_2O to harmless nitrogen and oxygen. Amoxis has so far abated emissions equivalent to over 18 million tonnes of CO_2 (nearly the entire emissions of the UK chemical sector).

Man holding up large circular gauze, woven from rhodium-platinum wire for use as a catalyst in the commercial production of nitric acid by the oxidation of ammonia. This photograph is the copyright of Johnson Matthey plc.

Methane – Methane is another key target for abatement as it has a global warming potential around 21 times worse than CO_2. These emissions account for 1.5% of all man-made GHG emissions so coal mines are the focus of a number of technology developments, including one by Johnson Matthey that looks to use catalysts to convert the methane into less harmful CO_2.

Carbon dioxide – The world will not be weaned off its fossil fuel diet in the short term so there is growing interest in carbon capture and storage (CCS) technologies which collect CO_2 from power stations and industry sites and lock it in geological reservoirs. Many of these new technologies use hydrogen obtained from fossil fuels to generate electricity efficiently while capturing and sequestering the CO_2 by-product. Johnson Matthey is applying commercial catalysts and process technology to early demonstration units, while developing a portfolio of R&D projects that address the challenges set by next generation CCS concepts.

Breakthrough innovations in the area of the industry's own emissions could come from:

- Continued process and catalyst improvements and process intensifications;
- The use of renewables as ingredients for chemicals (white biotechnology), including key building block raw materials from biomass;
- Advanced recovery and recycling technologies.

Innovations to enable savings by others:

- Conductive polymers for printable electronics to make simple electronic devices more efficient;
- Reverse osmosis membranes for more efficient water desalination;
- Materials for advanced solar cells which may increase solar power penetration by making it more cost effective;
- Materials for advanced fuel cells to reduce costs and improve durability;
- Materials for high-performance power storage devices, such as advanced lithium-ion and nickel-hydride batteries and capacitors, which will lead to drastic performance improvements and cost reductions.

Delivering low carbon solutions 24 hours a day

In this document we have set out how, here in the UK, the chemical industry is already delivering the climate change solutions that are helping to reduce our GHG emissions. The McKinsey report underlines how we can play a crucial role in delivering the UK's low carbon future.

The UK chemical industry and its employees are continuously striving to improve our own emissions performance and we passionately believe in producing the climate change solutions which can contribute to both the UK's low carbon transition and a broad-based UK economic recovery.

It is painfully apparent that, if we are to sustain and grow this contribution, we need to see an improvement in the UK business environment for energy intensive sectors like chemicals which operate in global markets. The current outlook is not good: a recent independent study for employers and trade unions[1] shows that as governments both develop targets and regulations without anything similar globally, the resulting policies will double UK energy prices by 2020.

The fight against climate change is one that needs to be fought and one to which we contribute. In the absence of a global inclusive climate change agreement, it is vital that the UK acts quickly to mitigate the impact of these increased energy and carbon costs on the sectors that are most exposed.

We hope the recommendations we make in this brochure will help to assist effective policy design. This will ensure we remain, in the UK, a vibrant and innovative industry delivering low carbon solutions.

Steve Elliott, Chief Executive
Chemical Industries Association

The Chemical Industries Association is the organisation that represents chemical businesses throughout the UK. Our activities are split between lobbying and provision of advice and services. Our policy agendas stretch across the economy and competitiveness; our products and the way we work; health, safety and environment and employment issues.

Responsible Care

[1] The Cumulative Impact of Climate Change Policies on UK Energy Intensive Industries – Are Policies Effectively Focussed? A report by Waters Wye Associates for the Energy Intensive Users Group (EIUG) and Trades Union Congress (TUC) on the vulnerability of intensive industries to massive unilateral increases in UK energy and carbon costs.

Chemical businesses in the UK are a **£60 billion** industry.

Every working day, our sector adds **£30 million** to our country's balance of trade.

The jobs of **600,000** workers in the UK depend on chemical businesses.

Workers in chemical businesses earn on average **40% more** than other parts of manufacturing.

Delivering low carbon solutions 24 hours a day

The chemical industry today delivers society savings of 2 tonnes of greenhouse gas for every 1 tonne that we emit in our production processes.

By 2030, with the right policy framework, this could rise to 4 tonnes of society savings for every 1 tonne we emit.

Email your support for our work to lowcarbon24@cia.org.uk

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