

Britain's chemical and chemistry-using industries

# STRATEGY FOR DELIVERING CHEMISTRY-FUELLED GROWTH OF THE UK ECONOMY



CHEMISTRY AT WORK



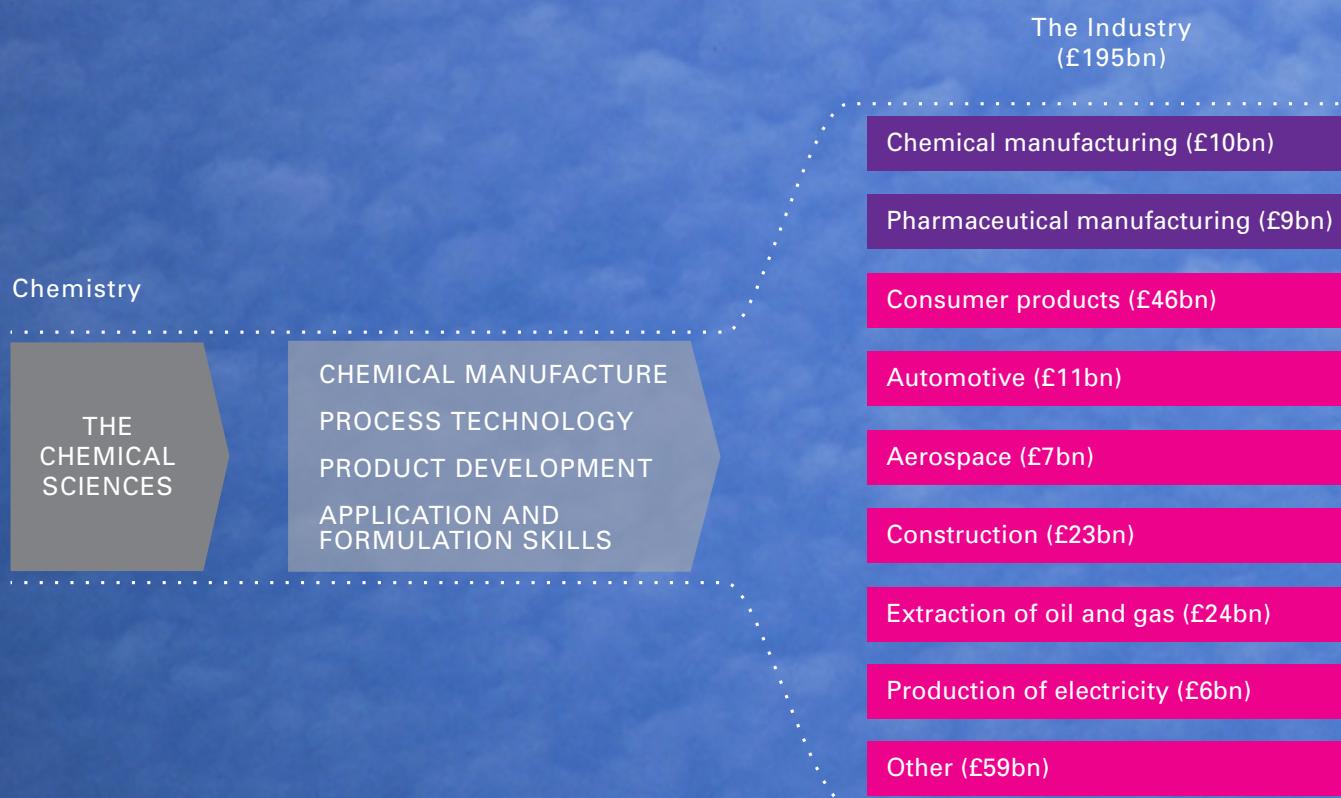
**CHEMISTRY  
GROWTH  
STRATEGY  
GROUP**

## VISION

'By 2030, the UK chemical industry will have further reinforced its position as the country's leading manufacturing exporter and enabled the chemistry-using industries to increase their Gross Value Added<sup>1</sup> contribution to the UK economy by 50%, from £195 billion to £300 billion.

*Secure and competitive energy and feedstock, accelerated innovation and strengthened supply chains will be critical in realising this vision.'*

### THE CONTRIBUTION OF THE CHEMISTRY-USING INDUSTRIES TO THE UK ECONOMY



Source: ONS Annual Business Survey 15/11/2012

<sup>1</sup> Gross Value Added (GVA) is total sales less purchased raw material and services.

The chemicals sector is at the very foundation of the UK's manufacturing industries and is behind a wide variety of products, ranging from lightweight polymers, through to medicines, clean drinking water and even the food we eat. It is a multi-billion pound industry that has significant exports and employs people in high-value and highly skilled jobs.

The UK has a vibrant and competitive chemicals industry and has an important role to play in the transition to a low carbon economy. Therefore I'd like to thank the Chemistry Growth Strategy Group for bringing the sector together to produce this clear strategic vision for the sector.

The Government's Industrial Strategy sets out an approach which looks 10, 20, 30 years into the future to how Government supports sectors and this industry-led strategy is an important contribution to the Government's overall approach to industrial strategy.

By taking this new, long-term approach, and working in partnership with business, we can give greater confidence for investment and growth - something that the whole country will benefit from.

The vision in the strategy sets out a compelling case for action from both industry and government to secure and build upon our competitive advantage in the global chemicals market and deliver the growth and business opportunities identified in this report.

I am therefore keen to work with industry to deliver this strategic vision for the benefit of the chemicals industry and UK economy as a whole.



*Rt Hon Michael Fallon MP,  
Minister of State  
for Business and  
Enterprise*

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# INTRODUCTION

Chemistry is the bedrock of manufacturing. Strong competitive chemical industries underpin all great manufacturing nations in the developed world because chemicals and materials are the essential component on which manufacturing is built. By 2030, the world population will be 8.3 billion, 60% of the world's population will live in urban areas, there will be 2 billion cars on the road and 50% more primary energy needed. These huge challenges cannot be met without embracing the chemical and chemistry-using industries. The UK's industrial recovery and growth, and our nation's ability to respond to these challenges depends on nurturing and sustaining a differentiated chemical industry.

The success of all the UK's established growth sectors – including aerospace, agri-tech, automotive and life sciences – will be dependent on chemistry, often delivered through competitive supply chains with SMEs at the heart in providing essential manufacturing, service and design links.

The global economic downturn has severely impacted the chemical and chemistry-using companies in the UK like many others across manufacturing. However, with the right leadership and the appropriate support from Government,

these businesses have a crucial role to play as a strong innovation and growth driver for the economy. Failure to act cohesively now will result in risking a huge opportunity loss.

Although Government already has an array of initiatives and investments that will contribute to a successful outcome, much needs to be done if UK chemistry is to deliver its full potential for economic growth and 'greening' the economy. Larger parts of our industry need to become more globally competitive and the fragmentation within and across industries needs to be more nationally cohesive. In this respect, it is essential that the industry builds on existing infrastructure and integration to remain globally competitive. Special attention is also needed to address the national skills deficit in the natural and engineering sciences.

As the facts and figures in this report set out, despite the downturn in the global economy, chemical producers and users in the UK remain very strong and valuable contributors to the national economy and to society. Recognising that great progress has already been made in the development of a national industrial strategy and more balanced vision of the future, the Chemistry Growth Strategy

Group was formed by business leaders to make a difference. We believe that it is possible to do more. Consideration of the current landscape and several scenarios for the future led to clear consensus on our priorities and recommendations. We believe that the interests of the nation can best be served by the formation of a Chemistry Growth Partnership for the UK, to take these forward. Leading manufacturers and users of chemicals will work with Government to deliver a manufacturing renaissance.

We present the strategy here, and look forward to delivering chemistry-enabled growth for the UK.



*Keith Wiggins  
(Chair, Chemistry  
Growth Strategy  
Group)*



*Graeme Armstrong  
(Chair, Chemistry  
Innovation)*

The UK needs chemical and chemistry-using businesses. The entire UK manufacturing sector relies on chemistry to generate £600 billion of annual aggregate sales to the economy. The chemical sector itself has an annual turnover of £60 billion, sustains 500,000 jobs throughout the country and is consistently the UK's biggest manufacturing contributor to the national balance of payments, posting an annual £5 billion trade surplus.

Despite these impressive statistics, our industry faces some fundamental challenges if it is to prosper and grow. Responding to these challenges, the Chemistry Growth Strategy Group (CGSG) was formed to identify priorities and recommendations that will accelerate national economic growth. This group of senior industrialists has consulted and collaborated with many key stakeholders leading to a collective vision:

**'By 2030, the UK chemical industry will have further reinforced its position as the country's leading manufacturing exporter and enabled the chemistry-using industries to increase their Gross Value Added contribution to the UK economy by 50%, from £195 billion to £300 billion. Secure and competitive energy and feedstock, accelerated innovation and strengthened supply chains will be critical in realising this vision.'**

To achieve this ambition, the CGSG proposes the establishment of a joint industry/Government Chemistry Growth Partnership (CGP), that will build on the vision set out in this strategy and help the industry achieve the potential growth opportunities that have been identified. Initially it will target three critical priorities:

- **Securing competitive UK energy and feedstock supplies**

The CGP will work with appropriate Government departments and other stakeholders on policies to ensure that

both energy and feedstocks (the raw materials for chemical manufacturing) are available, affordable and environmentally optimal. In particular, the CGP will support the urgent exploitation of the UK's unconventional gas sources, including proof of commercial viability by 2014.

- **Accelerating innovation**

The CGSG endorses the establishment of an open-access Innovation Centre for the formulation of chemical products. The CGP will work with Government to explore the business case for this Centre and will subsequently promote usage of the Centre to exploit the UK's leadership in formulated product design and manufacturing, driving maximum benefit from the Centre's world-class expertise, technology, equipment and skills. It is envisaged that the proposed Centre will complement the already established centres for Sustainable Chemistry, Industrial Biotechnology and Materials located in the Centre for Process Innovation which is part of the High Value Manufacturing Catapult initiative, as well as the innovation programme established by the Chemistry Innovation Knowledge Transfer Network.

Industry will be encouraged to leverage links with the Continuous Manufacturing and Crystallisation Centre (CMAC) in Scotland. The CGP will also encourage industry to optimise UK and European public funding to drive innovation.

- **Rebuilding UK Chemistry Supply Chains**

The CGP will work with Government and industry to refill the UK's hollowed-out chemistry supply chains, with particular focus on UK SMEs to serve down-stream industries. In recent years, economic considerations have led many key manufacturing sectors to buy their chemical technology and products from overseas. Whilst the market place through imports to the UK has responded to this challenge in many areas, supporting the redevelopment of the UK's base of

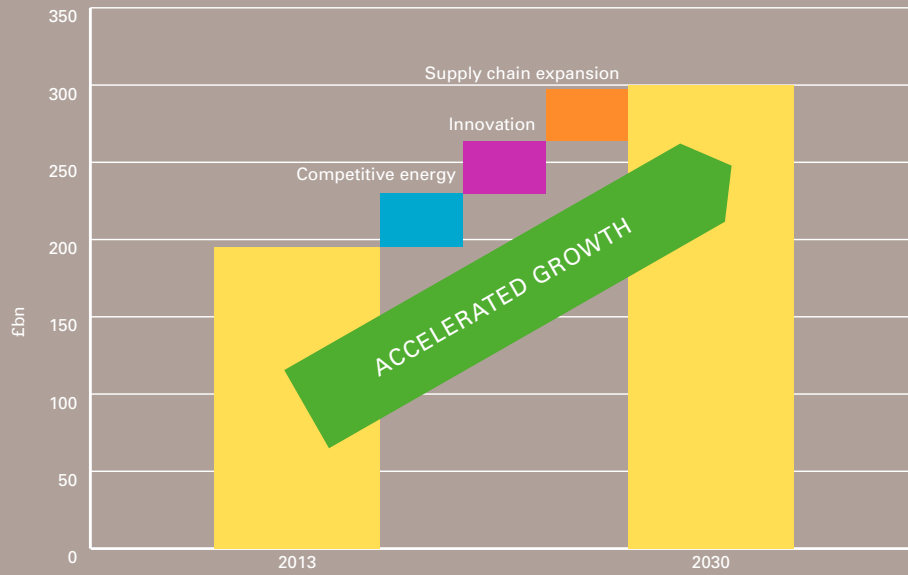
SMEs will help to address key supply chain weaknesses through their agility, innovativeness and connectivity – hence delivering a substantial contribution to the UK economy and balance of payments. Central to success here will be reinforcing industrial clustering and infrastructure to effect economies of scale and greater efficiency and productivity through greater integration. There are also opportunities to attract foreign direct investment (FDI) into the UK which will help to fill gaps in UK supply chains.

The CGP will also provide strategic leadership to mobilise and utilise the wider community of the chemical and chemistry-using industries in pursuit of these three priorities. A focus on six key enabling areas will provide further support. These are:

- Enhancing the contribution of chemically enabled climate change solutions for growth sectors in existing UK supply chains.
- Promoting and leveraging existing Government initiatives across a whole range of activities and helping to contribute to new ones for the future.
- Working with Government to ensure enhanced export promotion programmes and effective trade agreements.
- Working through trade associations and other stakeholders to deliver a regulatory culture and climate that supports sustainable growth and business investment.
- Bringing industry and the financial community together to strengthen their understanding of each other's business requirements; and ensuring better signposting to and navigation of available Government and private sector funding initiatives.
- Securing the right people in terms of a competent, diverse and sustainable workforce.

# CHEMISTRY GROWTH TIMELINE

VALUE CREATION IN THE SUPPLY CHAIN



The value creation will be from the chemical sciences utilising competitive energy.

The value capture will be spread across the chemical and chemistry-using industries in accelerated innovation and rebuilding the UK value chains across the chemical and chemistry-using industries.

# RECOMMENDATIONS

## Our platform for growth

The CGSG recognises the benefits of the Government's many activities to support UK chemistry: especially the establishment of the Office of Unconventional Gas and Oil, the Technology Strategy Board's Catapult Centres, Knowledge Transfer Networks, Sector Skills Councils, Research Councils and other funding initiatives.

Essential to chemistry's ability to deliver its growth potential for the UK economy are: secure supplies of competitive 'clean' energy and feedstocks for chemical manufacturing; support to accelerate innovation from concept to commercial use; and, action to reverse the hollowing-out of the UK's chemistry supply chains by rebuilding them from within. A

number of additional recommendations also serve as enablers to growth.

CGSG therefore calls for joint industry/ Government action to establish a **Chemistry Growth Partnership** that will oversee and ensure the development of an action plan to drive the implementation of this report's recommendations.

Priorities		The CGP will work with the relevant stakeholders to:
Securing competitive energy and feedstocks	1.	Support appropriate policies to enable safe exploitation of unconventional gas, sustainable use of biofuels, and optimal use of waste resources.
	2.	Enable the industry to undertake projects to provide further proof of commercial viability of shale gas by 2014, to enable commercial flows by 2017. This should include working with local communities on fracking issues and benefits.
	3.	Explore the potential to increase support for research into technically and economically viable options for carbon capture and storage, and preferably usage on an industrial scale.
	4.	Support the continuing development of renewable resources through industrial biotechnology and synthetic biology.
Accelerating innovation	5.	Endorse the establishment of a world-class open-access Innovation Centre for advanced formulated product design and manufacture and the CGP will work with Government to explore the business case for this Centre (as proposed by the Technology Strategy Board's Formulation Special Interest Group).
	6.	Guide and encourage industry to fully leverage the suite of Innovation Centres covering synthesis, industrial biotechnology, chemicals for photovoltaics, materials and advanced formulation. Encourage industry to engage with the UK research base, especially with Research Council Centres and Institutes (e.g. the EPSRC UK Catalyst Hub), drawing on the research and training expertise available.
Rebuilding UK Chemistry Supply Chains	7.	Ensure chemistry-intensive SMEs fully leverage business support available from initiatives such as the Advanced Manufacturing Supply Chain initiative and the new national Manufacturing Advisory Service, and the established Scottish Manufacturing Advisory Service.
	8.	Encourage major chemical and chemistry-using companies to strengthen business relationships with UK suppliers and customers, as well as exploring new foreign direct investment opportunities.

## RECOMMENDATIONS (cont.)

Enablers		
Climate change solutions	9.	Enhance the contribution of chemistry and biotechnology-enabled climate change solutions to growth sectors of the UK economy; incentivise and increase uptake of existing energy efficiency measures by these sectors, recognising their importance as a cost-effective lever to reduce carbon emissions across the UK economy.
	10.	Identify which technologies and innovations are likely to help reduce emissions and optimise heat use across the sector. Ensure the right framework and incentives for the adoption of energy efficient and low-carbon technologies to reduce the chemical industry's own emissions; stimulate R&D programmes and facilitate new technologies prior to commercialisation with a focus on the whole-life cycle.
Leveraging Government initiatives	11.	Act as a focal point to improve SMEs' awareness of and ability to navigate existing support and networking initiatives.
Trade	12.	Pursue national export promotion campaigns, targeting high-value sectors and markets.
	13.	Continue to push for rapid conclusion of a free trade agreement between EU and USA to remove nuisance taxes on chemical shipments.
Regulation	14.	Respect and support the work of trade associations and others helping to create a regulatory climate and culture that strengthens international competitiveness and delivers growth while addressing social and environmental responsibilities.
Finance and funding	15.	Bring industry, especially SMEs, and the financial community together, to strengthen their understanding of each other's business requirements and establish greater clarity on lending risk, investor benefits and product/business cycles.
Skills	16.	Engage with wider society and school children in particular to address perceptions of the industry through programmes such as See Inside Manufacturing, Children Challenging Industry and the Catalyst Science Discovery Centre.
	17.	Address the specific need for more professionally accredited technicians and apprentices through an employer-owned, demand-led system facilitated by the sector coming together around a bid to develop a Science Industry Partnership (SIP).
	18.	Promote training and qualifications that meet robust and professionally verified standards including the 'Cogent gold standard' as a brand for excellence in chemistry skills.
	19.	Reinforce and strengthen improvements in higher level graduate, masters and post graduate level training, accredited by the appropriate professional organisations.



## The global landscape

The current macroeconomic shift is unprecedented in modern times. Since the global economic downturn of 2008-2010, the world has had to recognise and deal with some new norms. The volatility of both financial and political systems around the world is increasing. Energy security and economic issues prevail, with increasing urgency around climate change and the nuclear debate. Greater complexity is making the global regulation and trade environment more difficult to navigate. A marked 'flight East' has taken place in Western manufacturing and finance sectors.

Our planet is expected to be home to some 9 billion people by 2050, with 7 out of every 10 living in cities. Pressure on resources – especially energy, food and water – is already evident. In this situation, chemistry is central to making life liveable and business growth attainable. Chemistry will extend the life of materials and products, lower their carbon intensity, enable more reuse and recycling of critical elements, and reduce the energy intensity of transportation, buildings and domestic and industrial equipment.

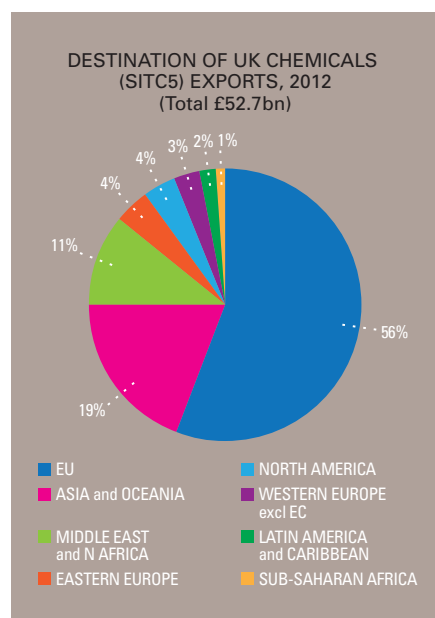
## Changing places

The UK's relative position in the global economy has changed. Developing countries are now competing throughout the value chain. This is threatening the UK's existing position. If the UK stands still, there is a danger we will be left behind.

The Government's response to this is its Industrial Strategy, setting out a long-term, whole-Government approach to supporting business. This core economic policy will provide long-term clarity and confidence to encourage businesses to invest and grow in the UK. The Industrial Strategy's spectrum approach to supporting sectors will fully recognise that a strong and innovative chemicals sector is an important – even critical – requirement

for driving growth.

The importance of the European Union as a market for UK manufacturers cannot be over stated. As the UK's number one manufacturing exporter, over 50% of those exports go to Europe. On-going uncertainty over our membership of the Union is not helpful for trade and investment decision-making. Respecting the democratic process, we hope the debate and decision can be concluded as quickly as possible.



## UK chemistry's vital contribution

The UK economy today depends heavily on its chemistry-related strengths. These include an abundance of natural gas, including potential for local unconventional gas; a world-class science and innovation base; superior product formulation and marketing skills, and skills in difficult and complex process technologies; and more.

Chemistry-using industries currently generate over £600 billion of sales and £195 billion in gross value added (GVA) from UK-manufactured output.<sup>2</sup> Chemical and pharmaceutical companies are the nation's top manufacturing exporters, and among the top ten in the world, with a £6 billion trade surplus: GlaxoSmithKline alone exported £2.3 billion worth of pharma products from the UK in 2010, and spends more than £40 million a year on chemicals from UK supply chains.

In fact, for any industrial sector with

a manufacturing component, chemistry is vital. In the UK, these sectors include aerospace, automotive, construction, energy generation and supply, life sciences, consumer products and chemicals manufacturing – identified in 2010 by UK Government as priorities for growth. Of the eight great technologies that the Government is funding to propel the UK to growth, six are chemistry based.

Chemistry and chemical products currently underpin a significant share of the UK economy. In 2011, chemicals and pharmaceuticals accounted for 12.3% of manufacturing value added, or 1.4% of gross value added in the economy. In addition, chemical companies use a wide range of services (e.g. distribution, plant and building construction and maintenance, IT, accounting and legal services, contract research, advertising). And many downstream manufacturing operations are dependent on chemical inputs in their products and/or processes.

Chemistry's contribution to the UK's economic growth happens regionally. Regional growth opportunities – particularly for SMEs – are embedded in the four chemical clusters around the UK.

Growth in chemicals creates job and growth opportunities for customer industries and support services. For every direct job in the chemical sector, at least three are supported in purchased services and supply chains.

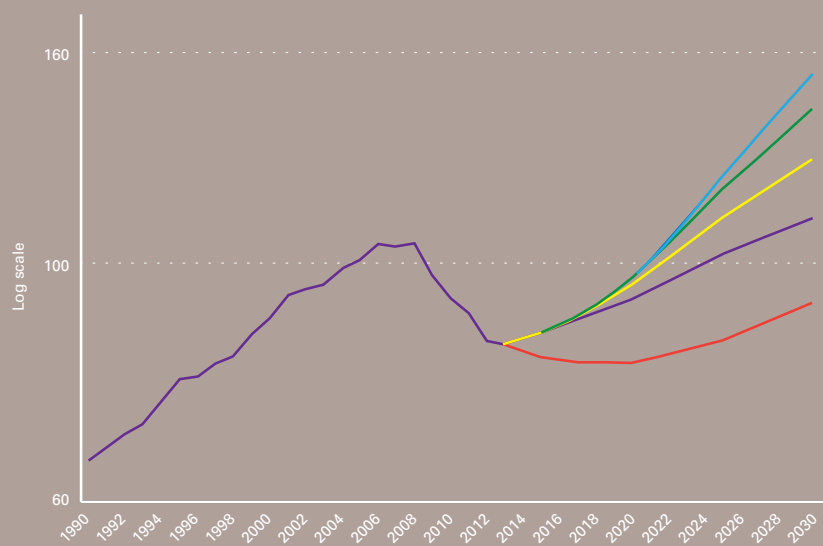
## SMEs – vital to UK economy and UK chemistry<sup>3</sup>

- 99.7% of UK companies are SMEs.
- SMEs employ 53% of UK workforce, represent 44% of turnover and 50% of value added.
- In chemicals (including pharmaceuticals), 95.6% of UK companies are SMEs employing 42% of the total workforce, accounting for 29% of turnover and 23% of value added.
- SMEs tend to be highly innovative.

<sup>2</sup> Chemistry Innovation Knowledge Transfer Network, A strategy for Innovation in the UK chemistry-using industries, June 2013.

<sup>3</sup> Eurostat Economic Data, 2010.

PROJECTED INDEX OF VALUE ADDED, UK CHEMICALS INCLUDING PHARMACEUTICALS, 2009=100



2030 added value in 2011 prices and annual growth 2013-2030 for

- Basic chems contract 10% pa to 2025: £18bn/0.5% pa
- Base (Oxford Economics): £22bn/1.7% pa
- With generic improvement: £25bn/2.5% pa
- + Innovation boost: £28bn/3.1% pa
- + Unconventional gas boost: £31bn/3.6% pa

This graph shows the projected growth of chemicals GVA based on different scenarios and demonstrates how a combination of generic improvements, innovation and the exploitation of shale gas can increase the chemical industry's GVA to £31 billion by 2030.

chemicals. These include renewable feedstocks and feedstocks from waste; industrial biotechnology; new developments in advanced materials, especially for transport; battery technologies; and opportunities in advanced product formulation, at which the UK excels.

Yet higher average growth of up to 3.6% a year (increasing GVA to £31 billion by 2030) is feasible if the UK successfully exploits its indigenous unconventional gas resources. Shale gas in the USA has led to a wave of massive new investment: the American Chemistry Council has calculated that the reopening of mothballed plant and new capacity builds will add at least 15% cumulative growth in overall US chemicals output over the next 5 years. In the UK, the modest impact of shale gas to date shows that potential additional growth in the chemical sector from existing capacity is considerable. Nevertheless, in order to capitalise on this potential, and as highlighted by the Royal Society and the Royal Academy of Engineering review<sup>5</sup> of hydraulic fracturing, operational best practices must be followed to ensure the health, safety and environmental risks are managed effectively.

However, it is important to recognise there is also the possibility of further contraction. Present UK policies on climate change are ambitious. The complexity of the UK's finely balanced energy markets and continuing emphasis on costly renewable energy brings associated risks. Together, these factors are leading to higher energy prices and cost disadvantage relative to EU or global competitors. Companies with plant capacity across Europe have allocated manufacturing to sites outside the UK. One consequence of which is the weakening of UK chemistry supply chains. For example, INEOS ChlorVinyls is now the sole manufacturer of chlorine in the UK. The nation's overall production of chemicals and pharmaceuticals fell by 5% in 2012, partly owing to a shift of pharmaceuticals output to lower-cost regions of the world, and partly because of fluctuating demand for bulk organics leading to a big drop in chemicals output. Other data for 2012 show the UK's

### Future scenarios – projected contribution of chemistry to the UK economy to 2030<sup>4</sup>

In a baseline scenario, based on a continuation of current policy and economic conditions, UK producers work to counter the impacts of: increasing competitive threats to bulk chemicals manufacturing from the Middle East; a rejuvenated USA with its liberation of shale gas; and continuing emphasis on costly renewable energy at home. In this scenario, chemistry's contribution to the economy makes a modest recovery with an average 1.7% annual growth rate from 2013 to 2030, leading to a GVA of £22 billion (a real increase of £3 billion) by 2030.

Adding some 'generic' improvements to the scenario could improve that chemicals growth rate to 2.5%, and so add

a further £3 billion to GVA by 2030. The UK Government has already recognised the need for many of these improvements in The Path to Strong Sustainable and Balanced Growth. Such improvements must ensure that secure and competitive supplies of energy and chemical feedstocks (raw materials) and a level playing field on climate policy costs are in place. This means exempting most of the UK's energy-intensive manufacturing from climate policy costs, or providing compensation, over relevant investment horizons to retain a global level playing field. Other feasible improvements include adjusting regulatory regimes, raising the quality of the UK's technology workforce, and giving SMEs the stable supportive environment they need to thrive.

An estimated 3.1% growth per year (increasing GVA by a further £3 billion to £28 billion by 2030) could be achieved if a boost is provided specifically to UK innovation efforts. Chemistry Innovation has identified a range of innovation opportunities with the potential to create multi-billion pound new markets for UK

<sup>4</sup> Oxford Economics, The UK Chemicals Outlook to 2030, December 2012.

<sup>5</sup> Royal Society, Shale Gas Extraction Final Report, June 2012.

chemicals imports have risen faster than exports, reducing the traditional surplus in chemicals and pharmaceuticals from around £500 million per month to around £300 million per month.<sup>6</sup>

The CGSG therefore concludes that the UK now has a short-term but compelling opportunity to take decisive action to liberate natural resources and set long-term policy that supports growth and investment.

### Strategic intent

We live in times of rapid change and exceptional opportunity for the chemicals and chemistry-using sectors in the UK. These sectors welcome the Government's position: to rebalance the economy, and to form industrial policy that supports the competitiveness and rebuilding of UK manufacturing for the long-term. UK chemistry can make an exceptional contribution to building up the supply chains that have been diminished, and to national growth through delivering ambitious targets.

The CGSG was formed to identify priorities and recommendations that will accelerate national economic growth through the chemical and chemistry-using industries. Consultation and collaboration with key stakeholders and associated industry bodies has led to a collective vision:

**'By 2030, the UK chemical industry will have further reinforced its position as the country's leading manufacturing exporter and enabled the chemistry-using industries to increase their Gross Value Added contribution to the UK economy by 50%, from £195 billion to £300 billion. Secure and competitive energy and feedstock, accelerated innovation and strengthened supply chains will be critical in realising this vision.'**

To achieve this goal, the CGSG proposes the establishment of a joint industry/Government Chemistry Growth Partnership (CGP), that will build on the vision set out in this strategy and help the

industry achieve the growth opportunities it highlights. Initially the CGP will target three priority outcomes:

- Securing competitive energy and feedstock supplies
- Accelerating innovation
- Rebuilding UK chemistry supply chains.

The CGP will also provide strategic leadership to mobilise and utilise the wider community of the chemical and chemistry-using industries in pursuit of these three priority outcomes. Action by the CGP will additionally focus on six key underpinning areas:

- Enhancing the contribution of chemically-enabled climate change solutions for UK growth sectors.
- Promoting and leveraging existing Government initiatives.
- Ensuring effective trade agreements and export programmes.
- Respecting and supporting the role of trade associations in forming the regulatory climate.
- Strengthening the mutual understanding of the SME and financial communities, and improving awareness and navigation of Government funding initiatives.
- Securing the right people in terms of a competent, diverse and sustainable workforce.

The CGP recognises that the success of its work depends crucially on the expertise, experience and motivation of the UK chemistry workforce and its various representative bodies. Its mission will therefore include efforts, from primary school level upwards, to inspire students and young people to follow careers in chemistry. It will also encourage greater take-up of the Sector Skills Councils' existing programmes, and the activities of professional organisations and others, to broaden and deepen the nation's chemistry-related skill base.

<sup>6</sup> Royal Society of Chemistry, 2012 Chemical Industry Review, January 2013.

## SECURING COMPETITIVE ENERGY AND FEEDSTOCKS

## ACCELERATING INNOVATION

## REBUILDING UK CHEMISTRY SUPPLY CHAINS

### A. Securing competitive energy and feedstocks

Chemistry provides the key enablers for renewable energy, low emission transportation, energy efficient homes and businesses, and sustainable agriculture. It is at the heart of the UK's development of a 'green economy'.

Parts of the chemical and chemistry-using industries are energy intensive. However, for every tonne of carbon emitted, they save 2 tonnes, as evidenced by a July 2009 McKinsey report 'Innovations for Greenhouse Gas Reductions – A life cycle quantification of carbon abatement solutions enabled by the chemical industry'. To be successful, manufacturers need competitive and secure supplies of energy and feedstocks (raw materials). This means striking an affordable balance in the energy mix between natural gas, clean coal, new nuclear and renewable sources. And

manufacturers also need a level playing field with respect to climate policy costs. It is therefore important that Government's assessments of the competitive implications of new proposals for energy and climate policies take into account the cumulative impact of existing measures.

New sources of feedstock can make a significant contribution to both growth and 'greening' of the economy:

- Although quantification of recoverable reserves is not yet available, the UK potential for unconventional gas could be equivalent to twice that of North Sea (conventional) gas – reducing dependence on imported gas and improving the business case for investment in UK chemical capacity.
- Biofuels and waste recycling also offer sources of feedstock and a route to lower carbon emissions from production, for example: mechanical recycling of plastics uses 25-60% less energy than that required to produce primary polymers as feedstocks.
- With carbon capture there is potential to reuse and generate value from CO<sub>2</sub> emissions by converting them into hydrocarbons. Much greater research is urgently required on the potential for commercialisation.

US experience of shale gas shows that the community benefits from developing such resources can be significant. The establishment of the new UK Office of Unconventional Gas and Oil is a good step towards ensuring UK communities gain as much as possible from any shale gas development in their area, while protecting the environment and safeguarding the public. Shale gas can also be a valuable chemical feedstock, as well as a cheaper energy source.

The current US debate about a possible ban on exporting Liquefied Natural Gas (LNG) made from shale gas illustrates the ongoing uncertainty and changes in the global landscape. UK policies need to ensure UK companies stay competitive; encouraging the liberation of indigenous natural resources will reduce or eliminate dependence on imported energy or feedstocks.

Using more fossil fuels in the form of unconventional gas for power generation

### Example: INEOS Bio – innovation for sustainability

INEOS Bio was formed in 2008 as part of the INEOS group of companies, to build and operate industrial scale facilities for turning waste and non-food crop biomass into advance biofuels and renewable power, using INEOS's proprietary bioenergy technology.

The technology turns biomass wastes to bioethanol by a process of gasification and conversion. When the bioethanol is burnt, it returns carbon dioxide to the atmosphere which was taken out as the biomass grew. This is quite different from burning traditional petrol, which releases carbon dioxide into the atmosphere from carbon that has been stored in oil for a much longer time.

The first INEOS Bio facility in Florida, USA, brings to commercial reality the fruits of a pilot project which began in 2000. By 2003, when a gasifier was added to the pilot plant, it became a fully integrated gasification-fermentation-distillation demonstration facility. With the establishment of INEOS Bio five years later, work started on the design and engineering for an industrial scale plant which broke ground in 2011. Investment in the project exceeds \$130 million. During the project development phase, 400 direct and indirect jobs were created.



With its advanced thermochemical and biochemical bioethanol technology, INEOS Bio is aiming to contribute significant growth to the European and North American bioethanol market, while supporting more sustainable communities and transportation.

*'The chemical industry's ability to underpin sustained growth in UK manufacturing is increasingly determined by the need for competitive and secure supplies of energy and feedstocks. The safe exploitation of unconventional gas is central to that supply and will also provide an essential bridge to a longer term UK energy mix that includes nuclear and renewables.'*

**Tom Crotty, Director, INEOS**

### Example: Oxford Catalysts – unlocking the commercial potential of synthetic fuels or chemicals from shale-gas and from biomass

Oxford Catalysts is an SME that spun out of the University of Oxford at the end of 2005 with two platform catalyst technologies focused in the area of clean energy and clean fuels. The company completed an Initial Public Offering (IPO) on the AIM Market of the London Stock Exchange in April 2006, raising £15 million and enabling it quickly to set up its own laboratories and begin to focus on developing its catalysts for the first targeted applications. Whilst seeking out and working with clients with specific commercial targets for its technology, the company identified, and ultimately, in 2008, acquired, a US spin-out company called Velocys, which was developing an impressive portfolio of microchannel reactor technology, and thus provided a perfect platform to exploit the type of highly active catalyst enabled by the Oxford Catalysts technology. Today, commercial roll-out of Oxford Catalysts' Fischer-Tropsch reactors and active catalyst has begun. The reactors produce synthetic crude oil from a feed of synthesis gas (a mixture of carbon monoxide and hydrogen). Together with its delivery partners the company offers a complete gas-to-liquids solution, producing ultra-clean diesel. In April 2013, Ventech Engineers International placed an order worth \$8 million for Oxford Catalysts' Fischer-Tropsch reactors – sufficient for a plant producing around 1,400 barrels per day of liquid products. The company has been able to raise further funds in the UK markets amounting to a total of over £55 million since the IPO, the latest, an oversubscribed placing in January 2013 worth £30 million to support commercialisation activities.

The technology was first demonstrated in the Austrian eco-town of Güssing, where the town's heat and power is produced from a woodchip gasifier. The Oxford Catalysts trial unit took a slip-stream off the gasifier output as its feed, and ran for over a year producing synthetic crude oil. This successful demonstration has led to significant commercial interest in the technology and the two most advanced projects serve as important exemplars of the technology's potential. First, Solena Fuels,

who are to build a municipal waste-to-fuels plant to supply British Airways with jet fuel at London City Airport by 2015, has specified Oxford Catalysts' Fischer-Tropsch technology for the project. Secondly, in the USA, the company has been selected to provide Fischer-Tropsch technology for a gas-to-liquids plant for Calumet Specialty Products Partners L.P., who will use shale gas as an input to produce ultra-high quality specialty products (lubricants and waxes). The economics of the project are regarded as highly attractive – a conclusion that should raise interest here in the UK as we move towards exploiting our shale gas reserves.



*'Oxford Catalysts is excited to be commercialising its breakthrough technology. Smaller scale Gas-to-Liquids (GTL) based on our innovative microchannel reactors and highly-active catalysts open up the GTL market to the majority of energy and specialty chemicals companies, allowing them to convert undervalued natural gas and waste biomass into valuable liquid transportation fuels and chemicals.'*

**Susan Robertson, Chief Financial Officer, Oxford Catalysts**

is, in our view, not inconsistent with greening the economy, because gas is the cleanest burning fossil fuel. The positive impact of replacing coal (and oil) with gas for electricity production is therefore significant. Gas also has capital and operating cost advantages for power generation. And it offers a flexible complement to intermittent renewables.

In the medium term, revenues from the use of UK unconventional gas can help pay for growth in renewables and important future technologies such as the 'hydrogen economy'. Support is needed for the production and safe handling of hydrogen, and to advance current research into different materials that could be used for efficient hydrogen storage and fuel cell technology. The CGSG supports the work of the Government to look at the commercial challenges for this market that could help shape the direction of this area.

Moving forwards, the establishment of a Chemistry Growth Partnership will have several actions related to energy.

**The CGP will work with Government and industry stakeholders to:**

1. Support appropriate policies to enable safe exploitation of unconventional gas, sustainable use of biofuels, and optimal use of waste resources.
2. Enable the industry to undertake projects to provide further proof of commercial viability of shale gas by 2014, to enable commercial flows by 2017. This should include working with local communities on fracking issues and benefits.
3. Explore the potential to increase support for research into technically and economically viable options for carbon capture and storage, and usage on an industrial scale.
4. Support the continuing development of renewable resources through industrial biotechnology and synthetic biology.

## B. Accelerating innovation

Innovation is the conversion of science, technology and know-how into commercial value, which drives economic growth. It can involve technology developed in one

part of the world, implemented in another for sale in yet another. Commercial value is derived from sales of new products, operation of new manufacturing processes, licensed income through

process development and application in this country and use overseas and/or implementation of an alternative business model.

Innovation is critical to growing the UK economy. An important task for the CGSG was to prioritise the areas with the greatest potential for growth, and highlight what is needed to accelerate innovations in these areas to exploit these growth opportunities.

In the analysis completed by Chemistry Innovation, three areas emerged as priorities: raw materials for the 21st century; smart manufacturing processes; and design for functionality. The scale of each area's contribution was assessed within the 2013 Chemistry Innovation Strategy.

- **Raw materials:** The potential longer term benefits of using biomass or waste as raw materials reach £8 billion. There is also potential for using new technologies to replace scarce metals, as defined in the Industrial Biotechnology Innovation and Growth Team Report<sup>8</sup>.
- **Smart manufacturing processes:** Scalable, flexible and more resource-efficient processes offer considerable potential benefits in both chemicals and industrial biotechnology. In the UK, this opportunity is estimated at £10 billion.
- **Design for functionality:** A further £10 billion opportunity is identified for formulated products with designed-in functionality. Currently, the formulated products market in the UK is worth about £180 billion a year, and the UK is recognised as a strong player globally. That advantage needs to be better coordinated and developed, to enable growth in both domestic and global markets. A conservative estimate of the potential benefit of intervention on materials chemistry (to create substitutes for materials currently imported) stands at £5 billion. Chemical products designed for a 'circular economy' offer additional potential: about £1 billion is currently achievable through design for waste management and recycling, and this figure could grow up to tenfold by 2020.

### Example: Catapult Centres – accelerating innovation

The UK Government, through the Technology Strategy Board, has established a series of Catapult Centres. These centres give businesses access to equipment and expertise that would otherwise be out of reach, as well as opportunities to conduct their own proprietary R&D. Catapults also help businesses to access new funding streams and point them towards the potential of emerging technologies.

Companies working with a Catapult Centre can:

- Trial new approaches to designing and manufacturing products, at reduced risk and cost
- Take new knowledge from Technology Readiness Level (TRL)<sup>7</sup> 3 towards Level 7-8
- Avoid capital investment until an unequivocal case can be made
- Leverage funding for medium to long-term (and high risk) R&D through collaboration with other companies on common, pre-competitive problems

The High Value Manufacturing Catapult was the first Catapult to be established. It comprises seven centres, one of which is the Centre for Process Innovation (CPI). The CPI has attracted Government investment for many of its facilities, which include:

- Industrial biotechnology
- Smart chemistry
- Thermal technologies
- Printable electronics
- Anaerobic digestion
- Sustainable engineering



# CATAPULT

<sup>7</sup> Technology Strategy Board, High Value Manufacturing Strategy 2012-2015, May 2012.

<sup>8</sup> Industrial Biotechnology Innovation and Growth Team, IB 2025 Maximising UK Opportunities from Industrial Biotechnology in a Low Carbon Economy, May 2009.

*'Johnson Matthey welcomes this Strategy and a potential Chemistry Growth Partnership, which will be critical in further strengthening relationships between the UK's Chemical and Automotive Sectors and throughout the entire value chain.'*

**David Prest, Managing Director Johnson Matthey Emission Control Technologies**

Some important interventions in innovation have already started (see Appendix A). There has also been progress (notably in Scotland) on efforts to connect SMEs more with universities and the Catapult Centres, to generate innovations that solve real-life problems and promote growth.

All these and other recent developments will make a positive difference, but not necessarily enough to meet the specific chemistry needs of the other sector strategies consulted as part of this work (see Appendix B).

The proposed Centre for Advanced Formulation, it is envisaged, will complement the established centres for sustainable chemistry, industrial biotechnology and materials located in the Centre for Process Innovation, which is part of the High Value Manufacturing Catapult, and also the innovation programme established by Chemistry Innovation.

The CGP will work with Government and industry stakeholders to:

- Endorse the establishment of a world-class open-access innovation centre for advanced formulated product design and manufacture, and the CGP will work with Government to develop the business case for this Centre (as proposed by the Technology Strategy Board's Formulation Special Interest Group).
- Guide and encourage industry to fully leverage the suite of Innovation Centres covering synthesis, industrial biotechnology, chemicals for photovoltaics, materials and advanced formulation. Encourage industry to engage with the UK research base, especially with Research Council Centres and Institutes (e.g. the EPSRC UK Catalyst Hub), drawing on the research and training expertise available.

### C. Rebuilding UK chemistry supply chains

The UK chemical and chemistry-using industry already has a strong infrastructure in place which will enable the rebuilding of UK supply chains – ethylene pipe lines, freight lines and ports in addition to sites like Wilton, Runcorn and Humberside give the UK a strategic advantage.

Over the past decade, however, a previously more integrated chemical industry with many raw material products manufactured here, has seen elements no longer made in the UK through restructuring based on commercial decisions. Whilst the market place through imports to the UK has responded to this challenge in many areas, supporting the redevelopment of the UK's base of SMEs will help to address key supply chain weaknesses. This has resulted in key chemical building blocks no longer manufactured in the UK or the country limited to sole supplier status for a number of key products.

More recently, however, there has been a noticeable trend among large chemistry-using companies (e.g. in pharmaceuticals) to rethink the East-West balance of their manufacturing. Influencing factors here include the growing costs of doing business in Asia,

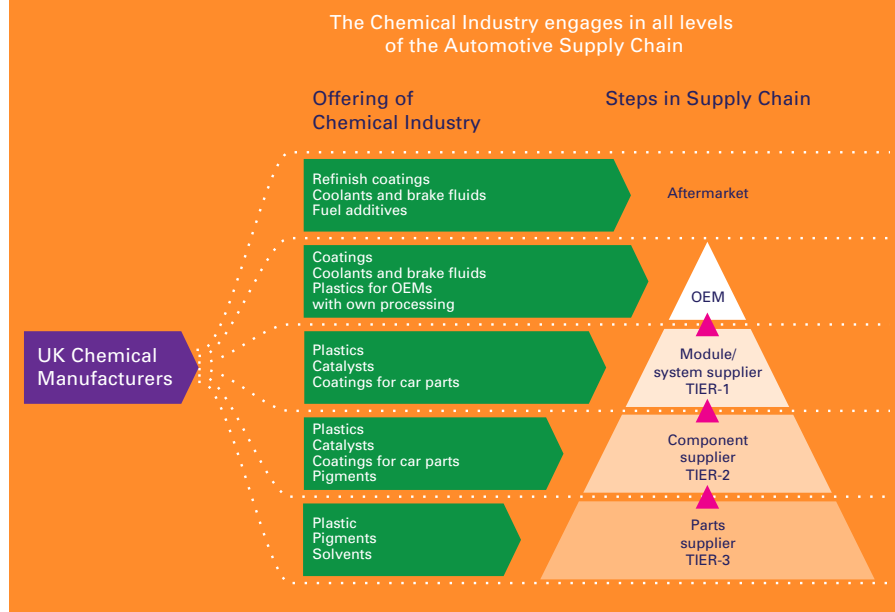
as well as regulatory and quality issues.

The aerospace industry alone bought about £220 million worth of chemicals and plastic products in 2010; converting imports to in-country sourced products would make a significant contribution to the UK economy. Including embedded chemistry in other components would take this value much higher. Similar signs are being given by the automotive and other priority industries.

There are also opportunities to attract foreign direct investment (FDI) into the UK. This will help to fill gaps in UK supply chains and further improve its competitiveness in the global market place – as evidenced by our Fenix Fluor case study.

Ensuring a thriving community of SMEs will be particularly important for filling in the UK's hollowed-out chemistry supply chains. SMEs are less likely than the majors to move their operations, jobs, and tax payments to another country when times are hard. They are generally agile, innovative and well-connected to academic and other centres of excellence. They also need to be recognised as less resilient to downturns than the majors are, and often in need of support to build their business growth skills.

Local Enterprise Partnerships have an



### Example: Fenix Fluor

In October 2012, Mexichem Fluor signed the agreement to form a new company, Fenix Fluor Ltd, a joint venture between Mexichem UK Limited and AGC Chemicals Europe Limited.

This was a multi-million dollar investment, signalling confidence in the UK chemicals industry from both Mexico (Mexichem Fluor) and Japan (AGC Chemicals).

Based at Mexichem Fluor's Rocksavage site in Runcorn, UK, Fenix Fluor manufactures R-22 (chlorodifluoromethane), a key raw material in the production of fluoropolymers used in the automotive, aerospace and construction industry. Mexichem Fluor chose to pursue this investment to secure the integrity of a long term asset, and to retain leadership status in the manufacture of quality R-22.

Its construction supported a number of UK suppliers, with the gas compression packages supplied by a firm in Great Yarmouth, the industrial refrigeration packages by a firm in Dartford and the plant control computer was made in Leicester. During construction, around 70 contractors were employed on site and around 20 permanent staff are now employed by the enterprise.

But for the broader chemicals industry, the formation of Fenix Fluor has a more significant impact. Fenix Fluor is the only



Business and Enterprise Minister, Michael Fallon, MP opens the new Fenix Fluor Manufacturing facility at Mexichem Fluor, Runcorn. The plant provides key raw materials for use in the automotive, aerospace and construction industry.

producer of R-22 in the UK. Its formation strengthens what was a fragile UK supply chain for the production of fluoropolymers by providing a market for HF, chloroform and sulphuric acid, and a stable and local supply of R-22 to the plastics industry.

Significantly, the companies that manufacture the feedstocks for R-22 are based on the same site as Fenix Fluor, Rocksavage in Runcorn. This includes HF, made by Mexichem Fluor, chloroform from INEOS ChlorVinyl, and sulphuric acid from INEOS Enterprises. The chloroform is supplied with chlorine produced by INEOS Chlor which is also on the Runcorn site. These plants are the only assets that manufacture these chemicals in the UK, therefore Fenix Fluor will help to ensure their future survival.

Fenix Fluor produces R-22 of the highest purity and is therefore able to produce higher purity TFE. This will provide a stable and local supply to AGC Chemicals which is the only PTFE plant in the UK (and also based in the North West). The plant will be fully loaded via sales to global PTFE manufacturers.

Without R-22 production in the UK, demand for HF, chloroform, sulphuric acid, and chlorine would all reduce. This would force these assets to seek markets further afield. The transport of finished products into Europe and beyond adds additional cost and this ultimately puts pressure back on the producer's profits as they attempt to absorb this cost in order to remain competitive with the end user. As the balance between UK-based consumption vs sales abroad shifts more to sales abroad, profit margins continue to be squeezed. Continued erosion of the UK manufacturing base can and has ultimately led to closures.

Without a UK-based R-22 supply, AGC's PTFE manufacture facility at Hillhouse would be forced into an R-22 import position adding cost to their raw material again putting pressure on profit margins.

The competitive nature of today's global market means that only the fittest manufacturers will survive. For the survival of the UK chemicals sector it is essential that a thriving UK-based supply chain exists producing and consuming raw materials with a strong level of UK consumption to form the backbone of a healthy export sector. Without this UK base the supply chain will potentially begin to unravel as individual blocks from the supply chain fail. Given the fragile and integrated nature of the overall supply chain losing one single block could have very significant consequences.

*'A key element of Mexichem's vision is to ensure the economic viability of our chemical operations through creation of vertically integrated and highly utilised supply chains. This co-investment by Mexichem and Asahi Glass in the UK is a prime example of putting that vision into practice and one that must be replicated throughout the UK chemical industry to generate a critical mass of integrated and diverse chemical production chains.'*

**Dave Smith, Business Director, Mexichem Fluor**



important role to play, connecting industry and local authorities to agree priorities for investment in local roads, buildings and facilities. For SMEs especially, this is a significant lever to stimulate growth and maximise business effectiveness.

The CGP will work with Government and industry stakeholders to:

7. Ensure chemistry-intensive SMEs fully leverage business support available from initiatives such as the Advanced Manufacturing Supply Chain initiative, the new national Manufacturing Advisory Service, and the established Scottish Manufacturing Advisory Service.
8. Encourage major chemical and chemistry-using companies to strengthen business relationships with UK suppliers and customers, as well as exploring new foreign direct investment opportunities.

### Example: GlaxoSmithKline (GSK): on-shoring strengthens UK content in supply chains

GSK is a global healthcare company. The mission is to improve the quality of human life by enabling people to do more, feel better and live longer. GSK has three primary areas of business – Pharmaceuticals, Vaccines and Consumer Healthcare. Within the Supply Chain and Global Manufacturing, GSK has 87 sites in 34 countries manufacturing pharmaceuticals, vaccines and consumer healthcare products. Seventy four of these sites are the responsibility of Global Manufacturing and Supply (GMS) with more than 27,000 people involved in the manufacture and supply of our pharmaceutical and healthcare products. A further 13 Sites are operated by our vaccines business.

Each year, the company manufactures more than 4 billion packs of medicines which are sold in more than 150 countries; 1 billion tubes of toothpaste; and 1 billion servings of Horlicks, Lucozade and Ribena.

More than £1 billion is spent each year on global manufacturing procurement – sourcing more than 5,000 raw materials and packaging components and active pharmaceutical ingredients (APIs) from a global supply base. More than £40 million is spent on chemicals from the UK supply chains.

GSK's success to date has been built on increasing demand for healthcare around the world, a continuous improvement mindset, a strong base of intellectual property, and the availability of highly skilled life science staff.

Looking forward to 2020, GSK has announced a series of investments of more than £500 million in the UK, creating up to 1,000 new jobs, plus wider construction and supply chain benefits. This has been made possible by the introduction of new patent box rules in the UK (10% corporation tax) and transformed the way in which GSK views the UK as a location for new investment. Medicines of the future will be not only discovered but also made in the UK.

*'The support provided through the Patent Box has transformed how the world views the UK in terms of a location to not only discover but subsequently manufacture new innovative medicines, creating fantastic investment opportunities for the whole of the pharmaceutical industry. This is an exciting time for the pharmaceutical supply chain in the UK.'*

**Dave Tudor, Vice President, Primary Supply Chain, GlaxoSmithKline**



CLIMATE CHANGE SOLUTIONS  
GOVERNMENT INITIATIVES  
TRADE  
REGULATION  
FINANCE  
SKILLS

## A. Climate change solutions

A global carbon framework and increased use of chemical climate change solutions across industrial sectors could see average energy use by the EU chemical industry rise by 22% to 2030. However, if the right frameworks exist to harness energy efficiency and carbon reduction opportunities, there is scope to reduce carbon emissions in the chemical sector by a total of 30% by 2030.

Increased take up of existing climate change solutions in the chemical and chemistry-using industries will not only enhance environmental performance. It could also increase the growth rate for EU chemicals demand to 2.5% per year (cf. 1.5% growth rate in GDP). This includes solutions ranging from buildings and homes, to renewable energy, to transport, to agriculture. Growth in chemicals demand from the energy sector alone could exceed 3% per year.

The CGSG welcomes the Government's recent Heat Strategy, and specifically the commitment to closer working with companies themselves and their sector associations, in order to understand more about how heat is used in each sector (including chemicals) and how it can be decarbonised.

This will allow the chemical industries and Government to come to an agreed position about the technologies and innovations likely to do most for decarbonisation in this sector, and about where Government, industry and academia could focus their efforts to achieve a smooth transition to a long-term low-carbon future for heat-intensive industries in the UK.

The CGSG therefore supports the proposal to work with Government to develop a 'roadmap' for this sector, focusing on those parts of the sector that represent the greatest CO<sub>2</sub> emissions and use the greatest amount of heat.

## Example: Chemistry addressing climate change – Kingspan

Since it was founded in the late 1960s as a small engineering business, UK-based Kingspan has grown into a leading international provider of sustainable products for the construction industry. The company provides a range of products, from insulated boards and insulated composite panels to renewable energy systems and raised access floors. Kingspan's goal is to help reduce the impact buildings have on the environment throughout their lifecycle. Its projects range from evolutionary chemical and structural improvements in its product range, to more fundamental changes in materials and building envelope solutions.

In April 2013 Kingspan was formally recognised as a Superbrand – a benchmark across the world for quality, high performance and innovation,<sup>10</sup> which enable it to provide global solutions for the construction of lower energy and lower carbon buildings.

Kingspan's Insulated Panels company has also blazed a trail by becoming one of the first two in the UK to access funding from the UK Green Investment Bank, to improve energy efficiency at its own manufacturing site at Holywell, North Wales. Kingspan plans to achieve net zero energy by 2020.



*'UK-headquartered Kingspan Insulation's commitment to quality, performance and innovation is, through the help of chemistry, delivering global solutions for the construction of lower energy and lower carbon buildings.'*

**Peter Wilson, Managing Director, Kingspan Insulation**

<sup>10</sup> Consumer Superbrands, Official Results 2013, April 2013.

The CGP will work with Government and industry stakeholders to:

9. Enhance the contribution of chemically and biotechnology-enabled climate change solutions to growth sectors of the UK economy; incentivise and increase uptake of existing energy efficiency measures by these sectors, recognising their importance as a cost-effective lever to reduce carbon emissions across the UK economy.
10. Identify which technologies and innovations are likely to help reduce emissions and optimise heat use across the sector. Ensure the right framework and incentives for the adoption of energy efficient and low-carbon technologies to reduce the chemical industry's own emissions; stimulate R&D programmes and facilitate new technologies prior to commercialisation with a focus on the whole-life cycle.

### B. Leveraging Government initiatives

The Government has several initiatives in place to support and encourage chemical and chemistry-using companies, particularly SMEs. These range from R&D funding for industry and academia available from the Technology Strategy Board and Research Councils, to financing schemes such as the Business Bank, Green Investment Bank, and Enterprise Finance Guarantee Scheme (see Appendix A for details of these and a representative sample of other initiatives with the greatest relevance to this sector). These are delivering considerable benefit to a large number of companies, through funding and networking opportunities.

The CGSG has identified that a significant number of potential users of these initiatives still lack awareness about them. Better signposting to what is available, easier navigation among the various types of initiative, and a filtering mechanism to better match specific company needs to the right initiatives would help to considerably strengthen the SME contribution to UK chemistry.

The CGP will work with Government and industry stakeholders to:

11. Act as a focal point to improve

### Example: Nottingham Eco House – zero carbon domestic environment

BASF has built a low carbon, energy efficient demonstration house at the University of Nottingham. The house incorporates a range of energy efficient chemistry-based products and solutions, all of which are now generally available. They include innovative insulation foams, admixtures for concrete, pigments for heat management and phase change materials.

Several features of the house's construction contribute to environmental performance. Various types of rigid polyurethane foam insulation were chosen because of its high insulation factor and outstanding airtightness. The concrete for the foundations contains a formulated admixture which reduces the demand for natural fine aggregates, thereby lowering the carbon footprint.

The external walls and roof are protected by a topcoat product based on plastisols (suspensions of PVC particles). This product is designed for outdoor use in demanding environments for excellent UV resistance and a high degree of corrosion protection. It also achieves maximum solar reflectance through the appropriate choice of pigments.

The phase change materials, such as BASF's Micronal®, are designed to absorb heat, store it and release it at a later date. The plasterboard contains microscopically small polymer capsules with an embedded wax storage medium. When the temperature rises, the wax melts and the phase-change material absorbs heat. When the temperature drops, the wax solidifies and heat is emitted. These materials can be integrated invisibly into the most diverse of construction materials.



Nottingham Eco House.

*'Chemistry is at the heart of the UK's developing "green economy", providing key enablers for energy efficient construction, renewable energy, low emission transportation and a sustainable primary production sector.'*

**Torben Jensen, Senior Vice President, Business Centre North, BASF**

**SMEs' awareness of and ability to navigate existing support and networking initiatives.**

### C. Trade

Global business opportunities for growth outweigh those in the UK by a large margin: in 2011, for example, UK domestic demand for chemicals and pharmaceuticals

was less than 2% of global demand. Also in 2011, £53 billion sales value of chemical, man-made polymer and pharmaceutical manufacturing was exported from the UK. This income stream sustains 150,000 direct jobs, plus more than 300,000 jobs in distribution and other industrial and commercial support services, local community services and in the public

sector. However, UK companies can be hindered from competing properly in global supply chains by inadequate or unenforced international trading agreements.

At the same time, it is important to remember that the European Union is a significant trading partner for the UK. Many UK companies feed into the supply chains of companies based on the continent and vice versa. It is worth noting that Germany's most important trading partner is now the UK, and vice versa. UK exports to Germany are growing faster than German imports to the UK. There is a vital growth opportunity here, not to be missed.

Currently, the USA is the UK's largest non-EU trading partner for chemicals. Two-way trade between the UK and the USA in non-pharmaceutical chemical products amounts to more than £20 billion, and extracts £180 million per year from industry in customs duties. On products that attract EU import duty, the rate can be as high as 5.5%. Nuisance taxes severely impact the profitability – and hence long term future – of UK chemistry.

Every 1% increase in chemical and pharmaceutical exports, or a similar decrease through import substitution, equates to £500 million of UK-generated sales, or the safeguarding/creation of 4,500 jobs within and around the UK chemicals supply chain. More sector-focused promotion campaigns targeted at significant international opportunities, particularly in high-growth emerging markets, are needed to support UK companies.

**The CGP will work with Government and industry stakeholders to:**

- 12. Pursue national export promotion campaigns, targeting high-value sectors and markets.**
- 13. Continue to push for rapid conclusion of a free trade agreement between EU and USA to remove nuisance taxes on chemical shipments.**

#### **D. Regulation**

The UK's strengths in innovation and R&D, formulation and other aspects of chemistry are well known and well documented. Foreign companies choose to buy chemicals in the UK because they

can expect reliability, quality, service, responsiveness and local knowledge. A regulatory environment is needed that will give more encouragement to companies seeking to avail of these strengths to set up business in the UK.

**The CGP will work with Government and industry stakeholders to:**

- 14. Respect and support the work of trade associations and others helping to create a regulatory climate and culture that strengthen international competitiveness and delivers growth while addressing social and environmental responsibilities.**

#### **E. Finance and funding**

The CGSG survey of industry needs found that, broadly speaking, most established chemical companies with healthy balance sheets do not face significant barriers to accessing finance for new projects. However, SMEs and start-up companies experience significant problems when trying to access finance on reasonable terms. The main barriers quoted are lack of management history and weak or non-existent security against debt-based models of finance.

SMEs are the backbone of chemical and manufacturing industries. However, traditional banks are not targeting risk-based investment, or fund requests less than £5-7 million; and personal guarantees are still usually required from SME directors before investments are allowed.

The Government, under the auspices of the Business Bank, is also considering which advice services can be brought together, how they can be consolidated and where a consolidated service will sit.

In addition, the Government has already increased the supply of finance to lenders through the Funding for Lending scheme; helped businesses access bank finance by providing guarantees through the Enterprise Finance Guarantee scheme; and stimulated new non-bank finance through the Business-Finance Partnership.

Progress should be enabled by the planned £10 billion Business Bank, the Business Growth Fund, and the Green Investment Bank. But SMEs need better communication and guidance in how to

access the available funding and advice effectively.

As the majority of the sector's financing needs are related to capital expenditure, the Government's £2.6 billion Regional Growth Fund is a positive step towards meeting those needs. The current round of the Advanced Manufacturing Supply Chain Initiative will help further; however, no plans have been announced yet for a fifth round.

**The CGP will work with Government and industry stakeholders to:**

- 15. Bring industry, especially SMEs, and the financial community together, to strengthen their understanding of each other's business requirements and establish greater clarity on lending risk, investor benefits and product/business cycles.**

#### **F. People make the difference**

The chemical sciences, encompassing chemistry and chemical engineering, are a crucial component of our world-leading science base, a key driver for the UK growth agenda. Collectively, this sector is a vital component in the Government's growth agenda, in creating jobs and in the move towards a knowledge-based, high-tech economy.

A skilled, technical workforce is critical to a successful UK chemical sector: every 1% increase in the number of employees trained is associated with an increase in productivity of 0.6%, worth £162 million to the chemical sector GVA.

The chemical sector invests heavily in skills, with a strong track record in recruiting graduates and apprentices through robust schemes. However, the workforce is ageing and businesses looking out to 2030 will require a new range of skills to embrace new technology, innovation and the very best manufacturing practices to drive growth.

Cogent, the Sector Skills Council for the science industries including chemicals, and the professional organisations, notably the Royal Society of Chemistry (RSC) and Institution of Chemical Engineers (IChemE), operate a range of schemes and activities that address various aspects of this skills agenda and we urge on-going cooperation between these bodies to

## ACKNOWLEDGEMENTS

ensure that the 2030 skill base is fit for purpose. More specifically, the CGP will work with Government and industry stakeholders to:

16. Engage with wider society and school children in particular to address perceptions of the industry through programmes such as See Inside Manufacturing, Children Challenging Industry and the Catalyst Science Discovery Centre.
17. Address the specific need for more professionally accredited technicians and apprentices through an employer-owned, demand-led system facilitated by the sector coming together around a bid to develop a Science Industry Partnership (SIP) - see Appendix D for details on the full scope of the SIP.
18. Promote training and qualifications that meet robust and professionally verified standards including the 'Cogent gold standard' as a brand for excellence in chemistry skills.
19. Reinforce and strengthen improvements in higher level graduate, masters and post graduate level training needs, accredited by the appropriate professional organisations.

In delivering this strategy we should like to thank members of the Chemistry Growth Strategy Group (CGSG) and support teams for their invaluable leadership and commitment to the task. CGSG members are:

**Keith Wiggins**, Chairman, Chemistry Growth Strategy Group  
**Graeme Armstrong**, Executive Committee, Research, Development & Innovation, Akzo Nobel Limited, Chair of Chemistry Innovation and Royal Society of Chemistry representative voice  
**Dr Will Barton**, Senior Consultant, Oxford Catalysts Limited, and Technology Strategy Board  
**Dr Tony Bastock OBE**, Managing Director, Contract Chemicals Ltd  
**Paul Booth OBE**, European Director Government Policy, SABIC UK Petrochemicals Limited, President, Society of Chemical Industry and Chair, North East of England Process Industries Cluster  
**Sandra Breene**, President, European Consumer Care, Croda plc  
**Alistair Conn**, Site Manager, Syngenta UK Ltd  
**Tom Crotty**, Director, INEOS Limited and Chair, Cogent  
**Torben Jensen**, Senior Vice President, Business Centre North, BASF plc  
**Mark Kenrick**, Chief Executive Officer, Lotte Chemical UK Ltd  
**Dr David Prest**, Managing Director, Johnson Matthey plc, Emission Control Technologies  
**Ian Shott CBE**, Managing Partner, Shott Trinova LLP, Technology Strategy Board, and Institution of Chemical Engineers representative voice  
**Harry Swan**, Managing Director, Thomas Swan & Co Ltd  
**Dave Tudor**, Vice President, Primary Supply Chain, GlaxoSmithKline plc  
**Adrian Whitfield**, Chief Executive, Synthomer plc

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Chemical Industries Association (CIA)  
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Chemicals Northwest (CNW)  
Chemistry Innovation (CI)  
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Cogent, the Sector Skills Council  
Confederation of British Industry (CBI)  
Fenix Fluor  
Prof Sir Mike Gregory CBE, Head of Institute for Manufacturing  
Humber Chemical Focus (HCF)  
INEOS Bio  
Institution of Chemical Engineers (IChemE)  
Kingspan Insulation  
Members of the Allied Industries Association (AIA)  
North East of England Process Industry Cluster (NEPIC)  
Oxford Economics  
Prof Richard Parry Jones CBE, Co-chairman, Automotive Council  
Mike Pitts, Technology Strategy Board  
Royal Society of Chemistry (RSC)  
Society of Chemical Industry (SCI)  
Technology Strategy Board (TSB)  
UK Trade and Investment  
Your Connected Future (YCF)

## APPENDIX A: CURRENT GOVERNMENT-SUPPORTED INITIATIVES

### **Advanced Manufacturing Supply Chain Initiative:**

Partnership between Birmingham City Council, Department for Business, Innovation and Skills and the Technology Strategy Board in a £125 million national project to address market failures, improve manufacturing supply chain competitiveness, and attract new manufacturers to Birmingham.

### **Biotechnology and Biological Sciences Research Council (BBSRC):**

providing £35 million of funding for research and commercialisation of industrial biotechnology and bioenergy.

**Business Bank:** A Government-backed bank aiming to attract private sector funding in order to support, when fully operational, up to £10 billion of new and additional business lending.

**Business Growth Fund:** A £300 million scheme, to invest in new and established lending channels that are best able to meet four key objectives: increasing the number of debt finance markets available to SMEs; mobilising new funding from private sector sources to support lending to SMEs; channelling finance to SMEs in an effective, appropriate and responsible manner; and expanding the total amount and/or types of debt funding available to SMEs.

### **Centre for Process Innovation, Teesside:**

Part of the High Value Manufacturing Catapult.

### **Chemistry Innovation Knowledge Transfer Network:**

Delivers programmes relating to several of the key intervention areas.

### **Employer Ownership of Skills:**

A competitive fund open to employers to invest in their current and future workforce in England. Employers are invited to develop proposals that raise skills, create jobs, and drive enterprise and economic growth. Government will invest in projects in which employers are also prepared to commit their own funds in order to make better use of combined resources.

### **Engineering and Physical Sciences Research Council (EPSRC):**

Primary funder of chemical and chemistry-focused research in the UK. It has a current portfolio of approximately: £600 million invested in supporting research that addresses materials and chemicals innovation; £100 million for innovation in energy supply and feedstocks; and £345 million for researching innovative manufacturing processes.

EPSRC initiatives include a £60 million fund for impact acceleration to improve industrial collaboration and foster greater entrepreneurship.

- Centres for Innovative Manufacturing, maximising the impact of innovative research for the UK, supporting existing and new industries, opening up markets in growth areas.
- Centres for Doctoral Training and Industrial Doctorate Centres, providing related skills and training for current and future needs.

### **EPSRC Grand Challenges:**

In 2010 three themes were selected as being of strategic importance to the UK – 100% efficient synthesis (known as 'Dial a Molecule'), directed assembly of extended structures with targeted properties, and utilising CO<sub>2</sub> in synthesis to transform the chemicals industry. Networks have now been established in all three themes with industry as well as academic input, and some outstanding proposals have been generated.

**EPSRC UK Catalysis Hub:** Catalyst technology is critical to the UK chemical industry, and to address environmental issues. The EPSRC-funded Catalysis Hub aims to build on the UK's catalysis expertise in both academia and industry, focusing on fundamental science that has an impact on UK industry and the UK economy. Launched in January 2013 with EPSRC investment of £13 million over a 5-year period.

**Green Investment Bank:** With £3 billion of UK Government money to invest in sustainable projects, is dedicated to the mission of accelerating the UK's transition to a greener economy through sound investment in UK green infrastructure projects.

### **Knowledge Centre for Materials Chemistry (KCMC):**

A virtual centre of expertise providing multi-disciplinary research and innovative knowledge transfer based on world class capabilities in applied materials chemistry. The KCMC is a single point of contact for companies in applied materials chemistry at Bolton, Liverpool and Manchester Universities and the Science and Technology Facilities Council (STFC) at Daresbury.

**MAS:** Originally launched by Government in 2002 to improve the competitiveness of manufacturing firms in England by providing hands-on specialist manufacturing advice locally, particularly to SMEs. A new national MAS was launched in January 2012, in

which local MAS advisors are complemented for the first time by a national team of sectoral specialists. They support supply chain developments in key advanced manufacturing sectors including aerospace, automotive, civil nuclear, offshore wind, food and drink, marine, pharmaceuticals and rail.

**Materials Innovation Factory (MIF):** Co-founded by the University of Liverpool and Unilever, the MIF facility will provide an unparalleled suite of open-access, state-of-the-art equipment and internationally-leading academic expertise. Due to open in 2015, the MIF will be where industry and academia can innovate together within a shared environment.

### **Networks in Industrial Biotechnology and Bioenergy:**

BBSRC, EPSRC and the Technology Strategy Board are investing £15 million in cross-disciplinary, community-building networks to support industrial biotechnology and bioenergy. These networks will underpin the development of a sustainable UK bioeconomy with potential to maintain future energy security, create innovative bio-based products and increase the efficiency of a wide range of manufacturing processes.

**See Inside Manufacturing:** A joint programme between Department for Business, Innovation and Skills and industry designed to update the perception of manufacturing in strategic sectors.

**Talent Retention Scheme:** An online scheme set up by a group of senior industry leaders in the Skills and Jobs Retention Group at the request of the Secretary of State for Business, Innovation and Skills. It provides an easy-to-access route for skilled people looking for jobs in the advanced manufacturing and engineering sectors. This industry-led, sector-focused programme helps to prevent the loss of key talent overseas.

**Technology Strategy Board (TSB):** Is running a £5 million competition to fund feasibility projects and collaborative R&D focused on developing and manufacturing high-value formulated products for a range of chemistry-using industries.

**TSB's Catapult programme of technology and innovation centres:** Represents £1 billion investment to build a bridge between the UK's world-leading science base and business. Includes the Centre for Process Innovation, which is part of the High Value Manufacturing Catapult initiative.

## APPENDIX B: UK PRIORITY GROWTH SECTORS' CHEMISTRY NEEDS

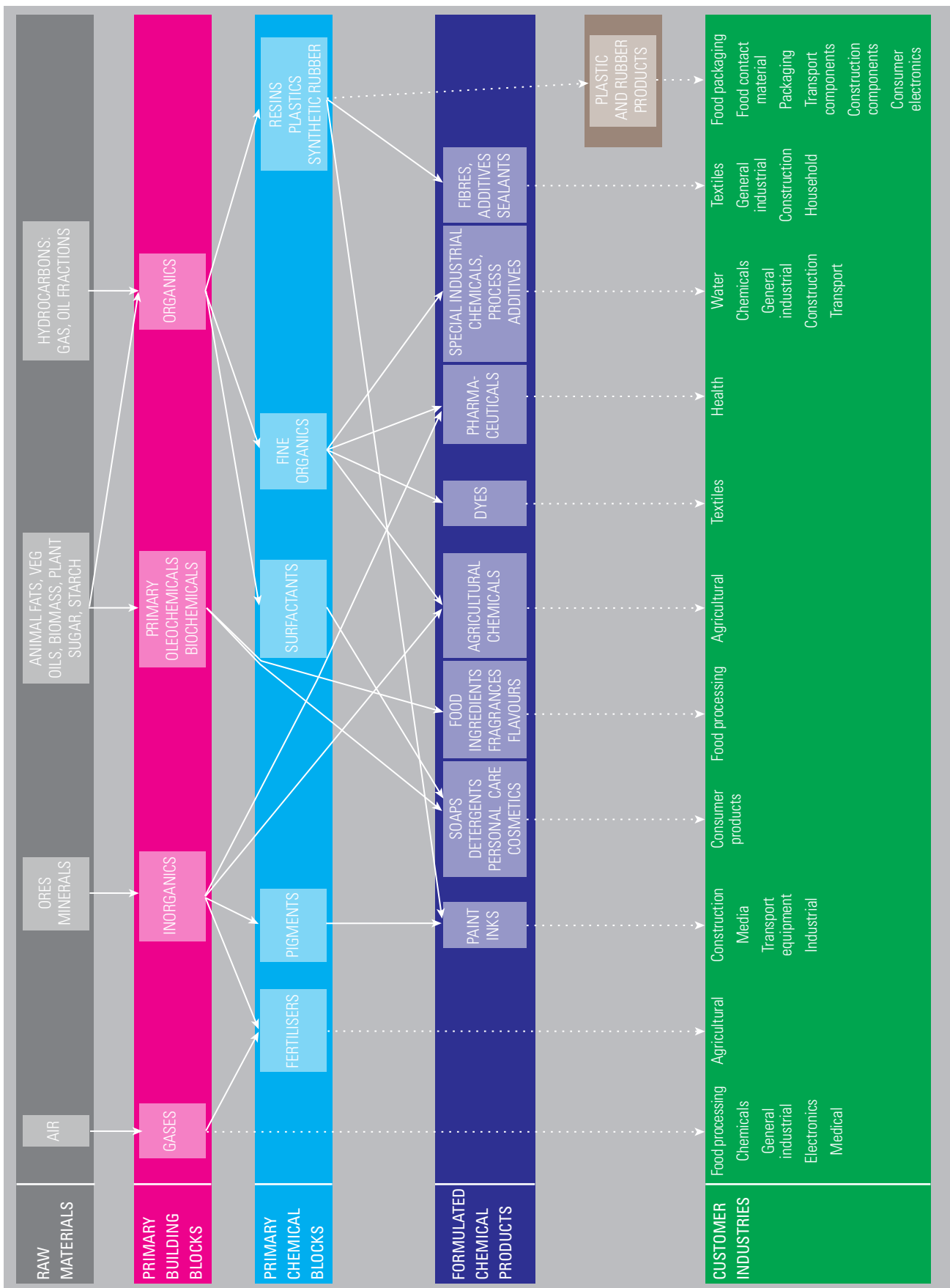
INDUSTRY	Innovation opportunities and challenges addressed through application of chemistry
AEROSPACE	Lighter materials for structure, interior and engines
	Sealants and adhesives to facilitate assembly and disassembly
	Coatings and flame retardants to protect the structure and passenger
	Lubricants and additives to enhance engine efficiency
	Bio-based fuels to increase renewable content
	More capable electronics for better control and flight management
	Lighter electronics and displays to enhance the passenger experience
AUTOMOTIVE	Lightweight materials for body, drive train and trim
	Polymer based composites with natural and synthetic fibre reinforcement
	Coatings to protect and to enhance aesthetics
	Lubricants and additives for efficient running engines
	Bio-based fuels and alternative energy drives: battery, fuel cell, solar
	Electronics for engine and journey management and a better user experience
	Design for end-of-life recyclability
	Catalysts for enhanced vehicle emissions control
CONSTRUCTION	Materials for fast and sustainable construction
	Coatings with basic and added functionality
	High performance insulation materials
	Thermal management materials and systems
	Low energy, longer life lighting
	Recycling and full utilisation of waste materials
	In-situ energy generation and storage systems
	Control systems for building and environment management
ENERGY GENERATION AND SUPPLY	Chemical formulations for enhanced oil recovery
	Fracturing fluids for shale gas extraction
	Carbon capture technology for clean burn of fossil fuels
	Bio-based fuels
	Materials for wind turbine structures
	Functional materials for photovoltaic cells
	Decommissioning technologies for nuclear power
	Energy storage and release capability

## APPENDIX B (cont.)

LIFE SCIENCES	Pharmaceutical actives, chemically and biologically derived
	Antibiotics for difficult-to-treat infections
	Regenerative medicine to enable organ and limb replacement
	Better diagnostics to target treatments where most effective
	Systems enabling care and diagnostics in the home
	Nutraceuticals for improved wellbeing
FOOD	Agrochemicals for safe intensification and crop protection
	Animal feeds for nutrition and welfare
	Ingredients allowing robust food processing and extended shelf-life
	Ingredients offering added nutritional value
	Flavourings and additives naturally based and naturally processed
	Novel food processing solutions and product reformulation which meets demand and is acceptable to consumers
	Packaging to increase shelf life and to support delivery of a safe and more sustainable food chain
HOME AND PERSONAL CARE	New functionality offered to consumers
	Natural, bio-derived ingredients, for greener products
	Formulation of new products using pre-registered ingredients
	New ingredients such as nanomaterials, giving novel effects
	Increased speed-to-market through formulated products
	Science-based formulation design capability
	New technologies for reproducible manufacturing of formulated products
CHEMICAL MANUFACTURING	Technology enabling production with high atom efficiency and minimum waste
	Scalable and flexible manufacturing processes close to supply or market
	Increased use of bio-based feedstocks
	More complete utilisation of feedstock with reduced waste
	Using recovered and recycled materials as feedstocks
	Deploying alternatives to catalysts that use scarce metals
	Upgrading chemical processes to increase efficiency
	Reducing the use of energy and water in chemicals manufacture
	Utilising bio-based transformation processes
	Encouraging cross industry collaboration for mutual benefit



Examples of supply chain links associated with the chemical industry



## APPENDIX D: AN INDUSTRIAL PARTNERSHIP FOR SKILLS

Through the Government Employer Ownership of Skills investment, companies have been invited to form Industrial Partnerships to deliver on the skills needed for growth. In the Chemical and Life-Science sector, GSK has submitted a bid on behalf of some 30 employers to form a Science Industry Partnership.

The **Science Industry Partnership** presents a unique opportunity to address the sector skills challenges. The Partnership will sit across the scientific areas highlighted above – chemical, chemistry-using, materials, industrial biotech and life sciences. This will need strong employer leadership, as well as effective collaboration between the sector skills body (Cogent), the professional organisations representing the chemical sciences (the Royal Society of Chemistry and the Institution of Chemical Engineers), the Society of Chemical Industry, and the representative trade bodies for the sector, led by the Chemical Industries Association.

The employer-led partnership will provide a vehicle to map out the skills agenda and deliver the skills that underpin the chemicals and chemistry-using growth strategy. It will:

- Challenge current skills arrangements and the status quo.
- Direct Government skills funding to the growth agenda.
- Look to the future to address the impact of new technologies on the skills needed.

The areas currently identified within the Science Industry Partnership bid include the following:

**Careers** – building on, and bringing together, the range of activities being undertaken by the contributing organisations to ensure a coherent approach to supporting employer involvement in advice and guidance in



*Richard Davies of Essar Oil (UK) is a former apprentice and now a Mechanical Inspector.*

science careers to schools, colleges and universities.

**Traineeships** – a new programme preparing school leavers for the world of work providing work experience, essential knowledge of the sector and work readiness.

**SMART Apprenticeships** – Apprenticeship standards set at an industry level for occupations but with flexible delivery around the employer and the role requirements increasing diversity and up-take, and properly accredited by the appropriate professional organisations.

**Industry Graduates** – promoting further an integrated undergraduate experience embracing knowledge, skills and work experience, and promoting best practice for the involvement of industry advisory panels in university curriculum development.

**Workforce Development** – promoting the acquisition of new skills in the workforce, embracing new technologies and best practice and promoting a technician workforce leading to professional registration.

**Modular Masters** – new Masters programmes to address gaps and drive technology transfer such as IB and Formulation.

In delivering the chemical industry growth strategy a number of skills challenges will need to be addressed:

**Attracting New Talent:** The sector continues to under-recruit to meet future projected demand. The sector needs 33,000 apprentices and 37,000 graduates by 2020 yet projected in-take is only 21,000 and 18,000 respectively<sup>11</sup>. With structural changes across the industry and offshoring of ownership there are fewer large blue chip companies leading the skills pipeline. The sector needs a more robust and fit for purpose talent pipeline through:

- Communicating and building ownership amongst employers for the skills gaps.
- Collaboration between the bodies active in STEM careers, including Government, and supporting good practice (e.g. the See Inside Manufacturing initiative of the Department for Business, Innovation and Skills).
- Supporting the direct work of employers into schools.
- Promoting schemes that attract mature entrants to the sector.

**STEM Skills:** The numbers of students studying STEM subjects is increasing which is positive news; however, employers continue to criticise the lack of mathematical and practical skills in many school and college students. This can be addressed through:

- The introduction of Traineeships as an entry path to Apprenticeships and work.
- Sector Apprenticeships to include criteria regarding maths and English attainment.
- Professional Body accreditation of the outputs of learning and training programmes.

**Existing Workforce:** The continual advances in technology are leaving the existing workforce behind. Provision is based on current skills requirements; trainers are equipped to deliver today's technicians not the technicians of the future. There is a critical need to up-skill the current workforce. Ways to address this are to promote:

- Workforce development through the uptake of training programmes that link directly to job/occupation competence defined by the Gold Standard and RSciTech/EngTech registration by the Professional Bodies.
- Continuous Professional Development (CPD) of our scientists and engineers.
- Programmes that encourage returners to the workforce.

<sup>11</sup> Cogent Research, 2013.



### Personal care

- Shower gel:** propylene glycol
- Shampoo:** sodium lauryl sulfate
- Body lotion:** hexylene glycol
- Moisuriser:** cetyl alcohol



### Food

- Food colouring:** titanium dioxide
- Food trays:** low-density polyethylene
- Fertilizers:** ammonium nitrate
- Packaging:** polyethylene terephthalate
- Preservative:** methylcyclopropene



### Automotive

- Coatings:** methyl methacrylate
- Airbags:** sodium azide
- Bumpers:** polypropylene
- Headlamp lenses:** polycarbonate
- Tyres:** solution-styrene-butadiene rubber
- Screenwash:** ethylene-glycol
- Fuel tanks:** high-density polyethylene
- Fuel additive:** 2,4-Dimethyl-6-tert-butylphenol
- Emission control:** catalysts

### Medical

- Hip replacement cement:** polymethyl methacrylate
- Non-latex gloves:** nitrile butadiene rubber
- Antiseptic wipes:** benzalkonium chloride
- Sedative:** benzodiazepine
- Eye drops:** chloramphenicol
- Dentures:** polymethyl methacrylate
- Cough medicine:** dextromethorphan



## CHEMISTRY AT WORK



### Construction

- PVC doors and windows:** polyvinyl chloride
- Paint:** titanium dioxide
- Insulation:** expanded polystyrene
- Perspex:** polymethyl methacrylate
- Safety hats:** acrylonitrile butadiene styrene
- Pipes:** high-density polyethylene
- Low voltage insulation:** low-density polyethylene



### Transport

- Seat fabrics:** polyamide
- Coatings:** methyl methacrylate
- Fuel tanks:** high-density polyethylene
- Fuel additive:** 2,4-Dimethyl-6-tert-butylphenol
- Doors and frames:** carbon fibre



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