cogent | Skills for Science Based Industries

Sector Skills Assessment

February 2010

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1 Introduction and Scope

1.1 The Science-based Industries

Cogent is the Sector Skills Council (SSC) for industries that range from the strategic (Nuclear) to the world-leading (Pharmaceuticals); many are incubators of new technologies (Chemicals, Polymers,) that will refresh and renew the sector in the future; others generate wealth and support our self-sufficiency in energy fuels (Oil & Gas, Petroleum). All have the deployment of higher level and technical skills at the heart of their business.

In the global market, the UK must position itself as a high-skill, high-value economy, characteristics which naturally perfuse these industries. The industries translate science and engineering into value-added products. The workforce has historically been highly skilled and shows an increasing trend in this direction, with technological developments being a strong determinant of the skills requirement.

1.2 Scope

This report provides an overview of the current and future skills demands for the sector, the drivers for change, the skills required for 2020, the regional variations that exist, and the actions that will support the skills developments the sector will require. The data that underpins our analysis is derived from a number of Cogent sources, notably;

- *Industry Factsheets*[1]
- *Sector Skills Agreement*[2]
- *Skills for Science Industries*[3]
- *Power People: The Civil Nuclear Workforce*[4]
- *Next Generation: Skills for New Build Nuclear*[5]
- *HE at a Glance*[6]
- *Technically Higher- Securing Skills for Science and Innovation*[7]

More specifically, this document represents Cogent's sectoral contribution to the National Strategic Skills Audit of the UK Commission for Employment & Skills (UKCES), the primary aim being to provide the co-ordinated and consistent intelligence required to understand current and future skill needs in England. The methodology includes: identifying key drivers of change; trends; current and emerging strategic needs; and priorities for action. While the analysis pertains to the Cogent sector across the UK, it should be read in conjunction with the accompanying nations reports which provide separate information for each of England, Scotland, Wales and Northern Ireland. Cogent submitted its Summary Sector Skills Assessment to UKCES in December 2009, as well as contributing to the New Industry New Jobs Cluster reports for Advanced Manufacturing, Low Carbon Industries, Engineering Construction and leading the Life Sciences & Pharmaceuticals report, all of which form parts of the input for the National Strategic Skills Audit.

Particular attention is drawn to the extensive new primary LMI section entitled "Skills Oracle", which was not available for the summary report released in November 2009.

[1] Cogent, 2007 - http://www.cogent-ssc.com/research/regionsindustry.php

[2] *Sector Skills Agreement, Cogent 2006* - http://www.cogent-ssc.com/research/SSA_publications_Index.php

[3] *Skills for Science Industries* , Cogent 2008 - http://skillsreport.cogent-ssc.com/Cogent_Skillsreport.pdf

[4] *Power People: The Civil Nuclear Workforce 2009 – 2025, Cogent 2009* - http://www.cogent-ssc.com/research/Publications/NuclearReportPowerPeople.pdf

[5] Next Generation: Skills for New Build Nuclear, to be published February 2010

[6] *HE at a Glance*, Cogent 2008 - http://www.cogent-ssc.com/research/Publications/publications/HE_at_a_glance.pdf

[7] *Technically Higher*, Cogent (Higher Level Skills Strategy)- http://www.cogent-ssc.com/Higher_level_skills/Publications/EmergingHigher.pdf

1.3 Cogent Research Plan

Research fulfils a primary and strategic function at the core of Cogent's Strategy and Business Plan and forms the evidence base for Cogent planning and operations. The information provided in this Sector Skills Assessment document represents a snapshot of recent sector data and analysis, but should be seen in the context of an on-going research programme. This is predicated on four complementary strands

- Factsheets – key region and industry data
- Skills Oracle – the employer perspective
- Future skills – predictive analysis
- Impact Matrix - an assessment of research effectiveness

1.3.1 Factsheets

Factsheets have proven to be a popular research product with industry and stakeholder organisations since their development in 2007. Three series of factsheets cover:

- Industries
- Regions
- Education Supply and Employment Destination

Historically, these have primarily used national data, but increasingly this will be enriched with Cogent's own primary LMI. The Factsheets will be published annually on a rolling programme. In 2010, the Industry Factsheets will be refreshed, then in 2011 the Regions and Nations Factsheets, and so on biennially. The Education Supply and Employment Destination factsheets will be refreshed in the same years as the Industry ones.

1.3.2 Skills Oracle

This project is a major innovation in securing the regular authoritative voice of the sector on skills. Skills Oracle takes two forms – The *Oracle Expert Panel* and the *Oracle Community*. It provides individual confidential reports to contributing employers, in addition to generating the key LMI that will furnish annual "State of the Nations" reports. Analysis derived from this initiative is presented in section 4 below.

1.3.3 Future Skills

Future Skills is a sequence of in-depth, employer-reviewed, reports, published each year, assessing the shape of skills to come within a specific industry or key technology. Beginning in 2008 this was *Skills for Science Industries 2008-2023*, followed in 2009 by *Renaissance I: The Civil Nuclear Industry 2009-2025*. In 2010, in addition to three further peer reviewed nuclear reports, the future challenges and opportunities for Industrial Biotechnology will be reviewed, as well as *Renaissance II: Next Generation Skills for Nuclear New Build*.

Such scenario planning complements the analysis of current skill supply and demand by assessing the technological, political or other developments that could cause a significant shift from trend. It also serves to identify completely novel developments that are seen to add value to existing industry. Industrial Biotechnology is a good example of such a paradigm shift within the footprint.

1.3.4 The Impact Matrix

The Impact Matrix evaluates the impact of research work both as a process and as an output - especially for published reports – and is an essential aspect of the research strategy. Every major piece of research activates the Impact Matrix. This ensures that work is quality assured, endorsed by the sector, enhanced with each cycle, and valued by the sector and, more widely, by the stakeholder community. The *Impact Matrix* includes:

- The Cogent Research Charter
- Peer Review
- A Dissemination strategy
- Post publication assessment (closed and open survey)

1.3.5 Publications

All of the Cogent research publications can be accessed on the main Cogent website at: www.cogent-ssc.com/research

1.4 The World of Skills

1.4.1 National and International Context for the Cogent Sector

Cogent sector industries add value through skills-intensive products that support the infrastructure of modern society itself - energy, health, transport and materials. But the intellectual property, the generation of new scientific knowledge and, crucially, the skills and innovation to apply cutting edge solutions to today's problems, are the core assets that will sustain these UK industries on a global platform.

If ever there was a period in economic history when the finite supply of global resources was most acutely felt, it is today. We have reached a stage when the advances of science, digital communications, transport and engineering have raised the interdependence of humanity in all parts of the globe. In arriving at this juncture, the pace of economic and social advance has been driven, in the more advanced economies, by coupling success through consumption, with socialisation through regulation. But we will threaten the very sustainability of our industries and our society if we have consumption without the investment to make ourselves more efficient, innovative, flexible, self-sufficient, responsible, and indeed, more skilled. From oil to pharmaceuticals, all of the sectors within the Cogent footprint are concerned with using science to add value. Through science and engineering we have unlocked value and functional sophistication from carbon in its various forms, and from non-carbon-based material in the case of the Nuclear sector. From chemical sources we have created pharmaceutical and biotechnological advances with valuable practical applications. It is the in-common skills around chemical transformation, separation science, molecular processing and physical containment that link the Cogent footprint.

Oil connects a significant part of the sector – as it connects a significant part of the world economy - primarily because we are intensively dependent on it both as a source of energy and as a raw material. Through oil, the carbon economy has shaped our civilisation. The majority of oil, 70%, is used for energy and energy fuels (petrochemicals); half of the rest is converted to chemicals, plastics and pharmaceuticals. The knowledge of those working in the Cogent sector will be vital to meeting the world's challenges relating to carbon, to ensure the future sustainability of our economy. It is knowledge with skilled application and transfer to commercial advantage and wealth creation that has earned the science-using industries in the Cogent sector their strategic platform.

Altogether these are world-leading industries built on UK strengths in research and development in science and engineering, technological innovation and a highly trained and experienced workforce. But a highly skilled workforce is, or will be, expensive in any part of the world, so it is the leading-edge know-how that will sustain competitive advantage throughout the global skills race. The fact that all six Cogent sectors appear in the top 13 of the Department for Business, Enterprise and Regulatory Reform Scorecard (2007), showing Gross Value Added to the economy, testifies to their economic value.

Skills and education are an investment in which the individual, the state and the employer reap a return in the longer term. The higher the skill levels, the higher that return. For an individual the benefit of higher skills can be an earnings premium of as much as £400,000 in a lifetime. Most employers recognise the return to the business and accept a responsibility for a greater share of the cost as the vocational value of training is enhanced.

A generation ago, the ICI conglomerate was the bellwether of the UK economy. In the same era, energy production was a nationalised industry while much of petrochemicals was the domain of a handful of oil companies. In that era, these all-encompassing organisations could manage the whole 'skills pipeline' for their workforce. Today, break-up and privatisation within these industries has brought sector renewal and an expansion of enterprises. For example, the largest private sector business by far in the UK in 2007 was a chemicals/ petrochemicals/ plastics manufacturer with just under 14,000 staff, sales of £19bn and profits of £1.5bn. The free market has consequently delivered a process sector with flexible, profitable businesses. With historically greater financial risk for privatised utilities, nuclear power generation has relied on the state to support its on-going safe operation, at least until recently. With a new contribution to be made to low carbon electricity generation, the economics have made private investment more attractive.

Overall, a downside of the sector's recent history has generally been a reduced 'skills horizon' for a given employer. This risks a gradual decline in skills investment and a skills macromanagement void – that is, until the Sector Skills Councils and attendant National Skills Academies evolved.

Through Cogent and its two sister National Skills Academies, NSAN and NSAPI, and the industry-owned Oil and Gas academy (OPITO), there has emerged the means for an overview of labour market skills intelligence, a national voice for employers skills needs, the development of skills products and services and the operational aspects of skills development and accreditation with employers and learning providers.

Together Cogent and the academies will grow the skills premium for the sector with the sector.

From the formation of the Polytechnics in the Wilson era, through the expansion and deregulation in the Thatcher era and the subsequent further expansion in the Blair era, we have seen a massive widening of participation in education, to the extent that almost 40% of young people experience some form of higher education.

However, this success in education supply has been overshadowed by the attendant re-branding of Polytechnics as Universities, with many gradually losing their primary employer and workforce focus.

For the Cogent sector, the somewhat freer market in higher education has come at the expense of provision in STEM (science technology engineering and mathematics) and, in particular, a gap in provision of STEM linked to workforce development.

Investment in skills is not just a matter of economic prosperity; it also concerns social justice. Skills embody an opportunity for individuals and businesses to improve their prospects, to contribute to improved business performance and national Gross Domestic Product, and to add to the national stock of skills. Education through the workplace can release billions of pounds of latent value to the economy. This is a skills revolution that promises to be as profound and wide-reaching as was the industrial revolution that led to the birth of the Cogent industries in the first place – for example from cotton trade to textile mills to dyes to chemicals.

Skills have a role to play in:

- Increased productivity
- Energy-efficient growth
- Clean processing
- Knowledge creation
- Innovation in the application of science, engineering and technology
- Digital innovation

In France and Germany, substantial proportions of level 3 and higher qualifications are vocational. In the UK, the majority of the widening participation in qualifications has been in full-time, first-time courses for young people prior to employment. Those established in employment, typically of age thirty or more, tend to assimilate skills informally and without recognition through qualifications. Unfortunately, relatively few gain a qualification above the level attained when they entered employment, and there is a lack of clear routes to vocational qualifications.

We support expansion of vocational qualifications in the workplace through our skills products. Our industry-led accreditation schemes, and our frameworks for qualifications and apprenticeships, offer a continuum of quality-assured provision for the development of skills at technical, associated professional, and management levels.

The challenge of skills for sustainability in the sector is as monumental as the legacy opportunity it presents to government, to industries and their supply chain.

These challenges and opportunities are:

- A globally mobile workforce in some sectors
- A STEM-reliant skills set that is in high demand from other sectors
- A workforce sector served and united by a Sector Skills family
- A fragmented sector with the skills chain unbundled across many employers
- Informal skills that are developed on-the-job but not widely accredited
- A traditional skills infrastructure that has withered
- Training that is seen as employment cost rather than skills investment
- A safety-critical sector requiring skills for compliance
- An ageing workforce in which today's modal peak will exceed retirement within a decade
- A workforce with latent skills capacity
- Global businesses with global outreach
- Industries that add value to carbon when demand for carbon-based energy and materials are on the verge of exceeding supply
- A need to meet the energy requirements of the UK given current issues around energy balance and security
- A requirement for new phases of pharmaceutical and biotechnological work as a number of important drug patents expire

The reward of success in this skills challenge is deeper than economic prosperity alone; workforce development opportunity linked to skills qualifications are also about fairness, quality of life and opportunity for all.

The price of failure is a second-rate social and economic infrastructure.

1.5 The world of Skills – the Public Policy Context

1.5.1 English Skills Policy

English skills policy, as developed by the Department for Business, Innovation & Skills and its precursor departments, has moved over the past few years to review the balance between public and private funding of skills. The Government has expressed its clear intention to focus on getting young people ready for the labour market, on basic skills for existing workers, and on any areas of market failure. In return for this, the Government increasingly expects employers and individuals to meet the cost of acquiring intermediate and higher level skills, since these are the levels where clear economic benefits can be seen to accrue directly to the individuals and firms.

The Government is also committed to changing funding systems to ensure that they are led by demand from learners and employers – checked against robust labour market intelligence – rather than by the need to meet provider wishes or inaccurate quotas.

To meet these aims, a number of English policies have been announced, including Skills Accounts to give more choice and control by individuals over their learning, and a strong programme of vocational qualifications reform meaning that only the qualifications really relevant to employers – as determined by their SSCs – attract public funding. To give these policies time to make a difference, the Government has postponed the time at which it will review the potential statutory right to access training, from 2010 to 2014.

The economy has moved on from the context in which the Government wrote "World Class Skills" in 2007, and the focus of recent skills policies such as "Skills for Growth" (November 2009), "Going for Growth" (January 2010), and "Building Britain's Future" (July 2009) have been on targeting scarcer Government resources on those areas of the economy most likely to contribute to growth out of recession.

More sector-specific skills policies have included "New Industries, New Jobs", "Jobs of the Future", the "Low Carbon Industrial Strategy" and the "Life Sciences Blueprint" (all published in 2009). The Cogent sector finds itself at the heart of all of these strategies, as emerging technologies and the higher level skills to use them, are harnessed for economic growth.

1.5.2 Scottish Skills Policy

While taking account of the Leitch review's focus on the economically important skills of the UK, Scottish policy also concentrates on a drive to improve basic and generic skills. It remains focused on the needs of individuals, but a stronger role for employers acting through their SSCs is envisaged – as long as they understand properly the Scottish policy context. This role extends to ensuring that,

> *"…employers have a say in the design and development of learning at all levels and in all settings, not just in vocational qualifications".*
>
> (Skills for Scotland: A Lifelong Skills Strategy, Scottish Government, 2007)

To deliver upon the skills policy, the Scottish Government has undertaken some significant institutional changes, creating Skills Development Scotland (SDS) and bringing together the following four partner organisations to deliver comprehensive information, advice and guidance for careers and learning as well as support for skills development:

- Careers Scotland
- Scottish University for Industry
- Key skills elements from Scottish Enterprise
- Key skills elements from Highlands and Islands Enterprise

The Skills Development Scotland Operating Plan 2008-09 contained the following key elements, crucial to the Sector Skills Council approach in Scotland:

"Individual Development – developing a distinctively Scottish approach to skills acquisition; developing a coherent funding support system and promoting equal access and participation in learning.

Economic Pull – stimulating increased demand for skills from employers both public and private; improving the utilisation of skills in the workplace; understanding current and projected demands for skills to help meet future skills needs; and challenging employers, learning providers, awarding bodies and others to use the Scottish Credit and Qualifications Framework.

Cohesive structures – simplifying structures, funding and provision to make it easier for people to access the learning and training they need."

1.5.3 Welsh Skills Policy

The main foundation for current Welsh skills policy was set out on "Skills that Work for Wales", published by the Welsh Assembly Government in 2008. The main policy focus is on re-aligning the balance of public and private sector responsibilities so that people pay where they derive most benefit, and the skills funding policy is being developed to formalise this.

To ensure learning opportunities match economic need, the Sector Priorities Fund has been established to fund training providers to deliver the strategic priorities identified through Sector Skills Agreements. All new vocational qualifications and units are required to reflect the Sector Qualifications Strategies developed by the respective Sector Skills Councils.

In a particularly strong move towards work-related learning at higher levels, the Higher Education Funding Council for Wales is brokering arrangements with Universities to develop provision according to needs identified by Sector Skills Councils.

1.5.4 Northern Ireland Skills Policy

The Northern Ireland administration published "Success through Skills" in 2006 (updated in 2008) in response to the UK-wide Leitch review and in the light of the Irish Government's own Skills Strategy, which reached many of the same conclusions as Lord Leitch's. The strategy contains the agreement to move towards demand-led skills funding, with SSCs having an integral role in approving appropriate vocational qualifications, although the details of the systemic changes to make this happen are still being developed. The Northern Ireland administration is keen on the local dimension of skills provision, and is looking to SSCs and Workforce Development Forums to identify skills needs at sectoral and local levels respectively.

1.5.5 Low Carbon Policy

The Government has placed a strong emphasis on the need for development of new skills for a low-carbon economy. It is expected that the economy will be transformed over the coming years to a point where all jobs will require some aspect of "Green Skills". This is likely to be driven by legislative requirements and consumer pressure, as much as the economic necessity forced by rising prices of energy and commodities.

'Green jobs' (working specifically in industries providing low carbon and environmental goods and services); 'Green Skills' (required in all sectors, but demonstrating an awareness of environmental issues); and sustainability are significant and growing aspects of public policy-making, and it appears that the economic impact of sustainability skills is currently particularly well-recognised by Government departments across the UK. Recent relevant publications include:

- "New Industry, New Jobs" (BERR, April 2009)
- "The UK Low Carbon Transition Plan" – (DECC, July 2009)
- "Jobs of the Future" – (BIS & DWP, Sep 2009)
- "One Wales, One Planet" (Welsh Assembly Govt, May 2009)
- "Achieving a Low-Carbon Future: A Strategy for Scotland" (Scottish Govt, 2007)
- "Sustainable Development Strategy for Northern Ireland" (DARD Northern Ireland, Feb 2008)

This is clearly of particular interest to Cogent given the nature of the industries. Accordingly, the analysis through this document, the above-mentioned cluster reports, and our wider work reflects this priority.

1.5.6 Partner Relationships

Cogent has good working relationships with the Department for Business, Innovation and Skills, the Department of Energy and Climate Change, the Devolved Administrations, Regional Development Agencies and a range of other partner organisations in each of the four nations of the UK, to ensure appropriate delivery of our Strategy and Action Plan.

1.5.7 Requirement for Systemic Change

In the context of this policy environment, SSCs still need the appropriate mechanisms to drive change, and in order to deliver the promises of the policies discussed in this section, there still needs to be substantial change to the funding and delivery mechanisms in all four nations of the UK.

The systems for public funding of learning still provide incentives for learning providers to maximise their income by increasing learner numbers according to determined unit prices, rather than to concentrate on meeting the needs of strategically important industries.

In order for SSCs and employers properly to play their roles in delivering skills policy, we believe that the following changes need to be made:

- We need to see explicit requirements for public funding agencies to show the connection between the intelligence from SSCs representing employer demand and their funding decisions.
- Commissioning of vocational training and workforce development needs to have sufficient mechanisms and incentives to ensure that the identified priorities from SSCs and employers are responded to by providers.

- We need to see mechanisms whereby employers can hold to account the public funding agencies that commit and spend money in their name.

We are hopeful that the National Strategic Skills Audit, of which this document is a constituent part, will improve the responsiveness of the supply-side to employers' needs, but we believe that this is only likely to happen when there is a more direct connection between expressed needs and delivery."

2 Science-based Industries

The Cogent industries are knowledge and skills intensive, relying particularly on technical, process and higher level skills. Despite a decrease in the total workforce requirement in recent years, replacement demand is sufficient to ensure there is a net demand for skills. Furthermore, a specific expansion in higher level and multi-disciplinary skills is noted as industry responds to technological developments and a drive to a more sustainable industry.

This section reviews the key features of the sector, by industry, as it exists today.

2.1 Chemicals

2.1.1 Headline Statistics [2,8,9,10,]

- *£1.25tn sales globally p.a.*
- *60% growth globally in last decade*
- *£60bn UK sales value*
- *£43bn UK exports*
- *£6.5bn UK trade surplus*
- *Third in Europe and fifth globally amongst OECD value added per employee*
- *92% of UK Chemicals output was exported in 2004*
- *12% of value added in manufacturing, equivalent to 1.5% of GDP.*
- *92% of UK chemicals output exported in 2004*
- *200,000 employees (2007)*

The Chemical Industry is one of the largest manufacturing industries in the UK and has had one of the highest growth rates. According to the Annual Business Inquiry survey of 2009, there are 2,619 chemical companies. The industry deals with heavy, bulky, volatile and hazardous materials that are difficult to transport. As a result, chemicals manufacturing has proved resilient to off-shoring and has grown in the UK around the supply of raw materials (for example, North Sea Oil) or the end user – other manufacturers, including upstream chemicals manufacturing. In addition to the bulk chemical sub-sector, low volume, high value, fine and speciality chemicals form an important part of the industry. Given the range product types, the economic strength of the industry overall is, predictably, not homogenous. Nevertheless, diversity has been able to provide a degree of resilience to the industry as a whole.

Mergers, acquisitions and out-sourcing have fragmented the sector and expanded its supply chain. This may have resulted in a significant under-assessment of the sector by national data. The degree of fragmentation is illustrated by the fact that at 2009 there were only four Chemicals companies listed in the FTSE 350 index.[11] It does, however, host one of the largest private-sector companies in the UK (Ineos). Accordingly, the industry has a relatively high proportion of medium-sized enterprises when compared to other European countries.

Turnover has shown significant growth since 2005, reaching £42.69bn in 2007 (excluding Pharmaceuticals and Paints).[12] Over the last decade the industry grew more than five times faster than the average for all industry driven by productivity increases. A Gross Value Added (GVA) of £8.48bn equates to an average GVA per employee of £77,017, compared with a national average of £31,419.

In recent decades the industry has become less R&D intensive, with the exception of Pharmaceuticals which is a sub-sector (in terms of SIC classification). When Pharmaceutical R&D is stripped out, the R&D investment of the top UK

[8] Cogent Chemicals Industry Factsheet, 2007 - http://www.cogent-ssc.com/research/Publications/factsheets/Chemicals_Factsheet_AW_Chemicals_Factsheet.pdf
[9] Cogent Industry Trend data, 2008 - http://www.cogent-ssc.com/research/Publications/publications/ABI_TRENDS.pdf
[10] Cogent Regional Factsheets, 2007 - http://www.cogent-ssc.com/research/regionsindustry.php

[11] The Future of UK Manufacturing: Sector Analysis – Chemicals, Price Waterhouse Coopers, 2009.
[12] Annual Business Inquiry, 2009

Chemicals companies (£10bn, 2007) is on a par with Aerospace and Defence but is swamped by Pharmaceuticals (£50bn, 2007), the UK R&D lead sector in terms of absolute spend and rate of increase in the last five years. R&D investment by Chemicals in the UK totals more than £21bn each year. R&D expenditure is predominantly (83%) funded by the industry itself. The industry (excluding Pharmaceuticals and Paints) in the UK employs approximately 109,000 people directly[12] and up to five times[13] this number indirectly. Despite a statistical decline in employment over a decade, the value of the sector and productivity has risen inexorably. The Cogent Sector Skills Agreement (SSA) research into the Chemicals industry[10] highlighted, in particular, the age profile and skills shortages and gaps in the large technical workforce of process operators, technicians and skilled trades that account for over 70% of the overall workforce.

The SSA process also revealed:

- a poor understanding of career pathways and opportunities
- a lack of skills and knowledge required for process improvements.
- a need for an increase in Technical Apprentices
- a lack of standard benchmarking of competence across companies
- sporadic demand for contract support due to shutdowns and turnarounds
- health, safety and productivity risks with contractor skills and knowledge.

Age of workforce	16-24	7%
	25-34	20%
	35-44	25%
	45-54	30%
	55+	18%
Ethnicity	White	95%
	Non-white	5%
Gender	Female	27%
	Male	73%

Figure 2: Chemicals Demographics[14]

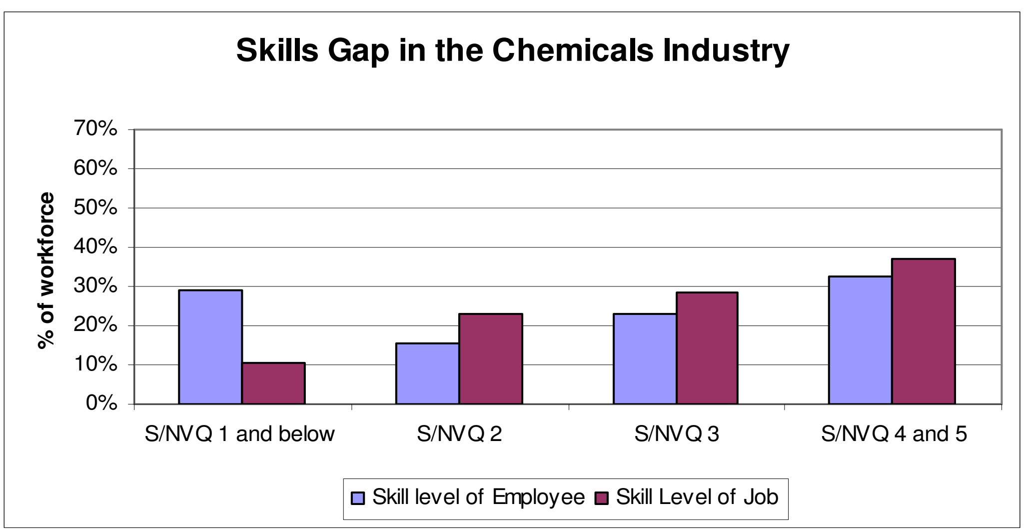

Figure 1 : Chemicals Skills Gap[14]

[13] The Chemical Industries Association

[14] Labour Force Survey January 2006-December 2006

2.2 Pharmaceuticals

2.2.1 Headline Statistics[15]

- *the UK Pharmaceuticals Industry is fourth globally in world trade balance.*
- *the Pharmaceuticals industry accounts for 1% of UK GVA*
- *UK Pharmaceuticals Exports (2006) £14.6 billion*
- *UK spend on medicines as a proportion of GDP: 0.94%*
- *UK sales share of the world's top 100 prescription medicines (2003): 20%*
- *UK market share of new medicines (2003): 17%*
- *Pharmaceutical R&D expenditure in the UK (2005) : £3,308 million*
- *R&D accounted for 34.2% of sales in the UK Pharmaceuticals industry (2004)*
- *UK has 2 corporations in the global top ten with a 10.5% global market share*

The Pharmaceutical industry in the UK employs between 68,000 and 73,000 people in 600 companies. The industry produces a range of products, from antibiotics to the contraceptive pill, and continues to pioneer new treatments for many serious and life-threatening diseases. In short, this is an industry that enhances and, in some cases prolongs, many lives round the world. The industry has an annual turnover of £15.68bn[16], with a GVA of £7.45bn. The average GVA per employee is £109, 530, compared to the UK average of £31, 419.

Total turnover in the Pharmaceuticals industry has increased by £6.4 billion since 1998 (not indexed). GVA in the industry has significantly increased. Total employment in the Pharmaceuticals industry has remained comparatively stable over the decade but peaked a few years ago.

The expiry of drug patents has had a large effect on the profits of drug companies, a development which has combined with the emerging field of biologics (discussed further in section 3.2) to generate a new landscape for pharmaceuticals.

Age of workforce	16-24	8%
	25-34	28%
	35-44	33%
	45-54	23%
	55+	8%
Ethnicity	White	92%
	Non-white	8%
Gender	Female	44%
	Male	56%

Figure 3: Pharmaceuticals Demographics[14]

15 Source Association of the British Pharmaceutical Industry

16 ABI 2005 – released Nov 2006, available through ONS

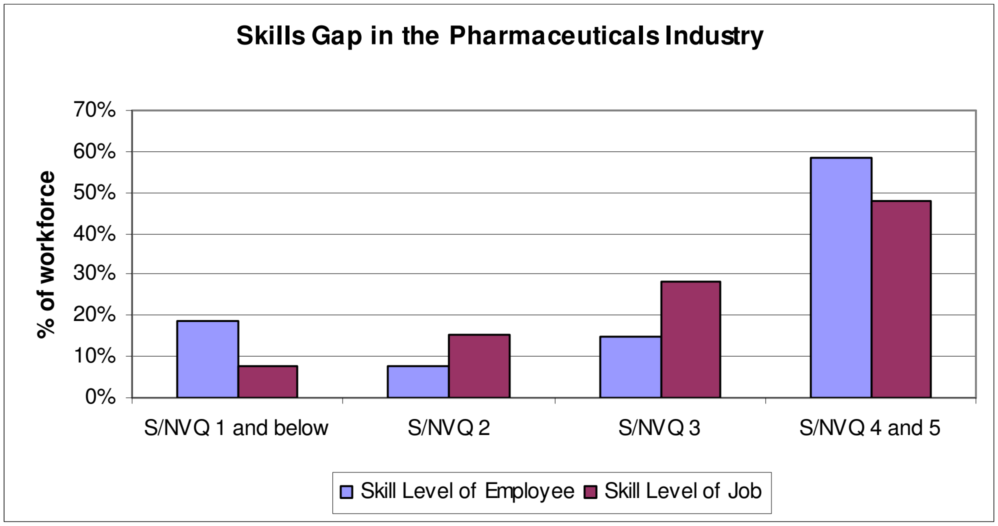

Figure 4: The Pharmaceuticals Skills Gap[14]

2.3 Nuclear

2.3.1 Headline Statistics [4]

- *10 Nuclear Power plants currently operating*
- *11 GWe capacity (2009)*
- *15-20% total National Grid supply*
- *24,000 people directly employed*
- *20,000 people employed in the supply chain*
- *16 GWe proposed for operation by 2025*
- *9,000 people employed in the defence sector*
- *New build activity from 2012*
- *Tens of thousands of jobs in new build supply chain*

There is a major gap in national data concerning the Nuclear sector, including defence, caused in part by a lack of relevant SIC codes for the industry. Cogent research during 2009 and 2010 addresses this gap not just for the sector but also its extensive engineering supply chain. Currently, civil nuclear power is overwhelmingly the largest component of low carbon electricity – zero at the point of generation – and recognized by government as an important contribution to the UK energy mix, along with renewable sources and energy conservation[17]. Furthermore, it is the only low-carbon alternative with demonstrated generating capacity to match, if not exceed, that of traditional fossil fuels on a station-for-station basis. The existing nuclear generating fleet contributes 11 GWe to the national grid, corresponding to around 18% of the peak demand level. In fact, as a stable base load supply, the nuclear contribution increases during periods of reduced demand when (mainly) coal-fired stations are taken off-line. However, as the ageing Advanced Gas Cooled Reactor (AGR) fleet is decommissioned, an energy gap threatens to open up eliminating up to 70% of the UK's low carbon electricity. In the absence of a new build programme, only one nuclear powered electricity station (Sizewell B) will continue to operate after 2025. In late 2009 there is a strong expectation of new nuclear build, underpinned by facilitative actions already taken by Government and a desire by three consortia to construct at least 16 GWe of new generating capacity by 2025. Around 1,000 workers per year will be required for the planning, construction, maintenance, operation and regulation that will take place over a thirteen-year period at least[5]. These will be mainly in construction (at least 60%) and operation (up to 25%). Cogent is currently engaged in an extensive review of the nuclear skills demand for new nuclear, published under the 'Renaissance' series title.[4] This research has analysed the projected civil nuclear workforce from 2009 to 2025.

[17] Meeting the Energy Challenge: A White Paper on Energy, HMG, 2008;

Today the industry employs 44,000 personnel, of whom 24,000 are employed directly by the operators. And of those, Decommissioning (12,000) is the largest sector, followed by Electricity Generation (7,500) and Fuel Processing (4,500). Importantly, the workforce is older than, and retires earlier than, the UK in general. Up to 70% of the current workforce will retire by 2025, the vast majority of whom will be from the technical, professional and senior management skill levels that dominate this safety critical industry. This injects a significant replacement demand for the sector on top of the new demand from new build. In addition to the civil nuclear industry, a fleet of nuclear–powered submarines, including the new Astute class, and the Trident programme is operated and maintained by the Ministry of Defence. The defence workforce is of the order of 9,000. Since the data for this chart is taken from the Labour Force Survey 2006, it does not include the projected demand for new building of power stations. More information on the latest position regarding the nuclear sector is given in section 5 below.

Age of workforce	16-24	6%
	25-34	28%
	35-44	35%
	45-54	21%
	55+	10%
Ethnicity	White	96%
	Non-white	4%
Gender	Female	18%
	Male	82%

Figure 5: Nuclear Demographics[14]

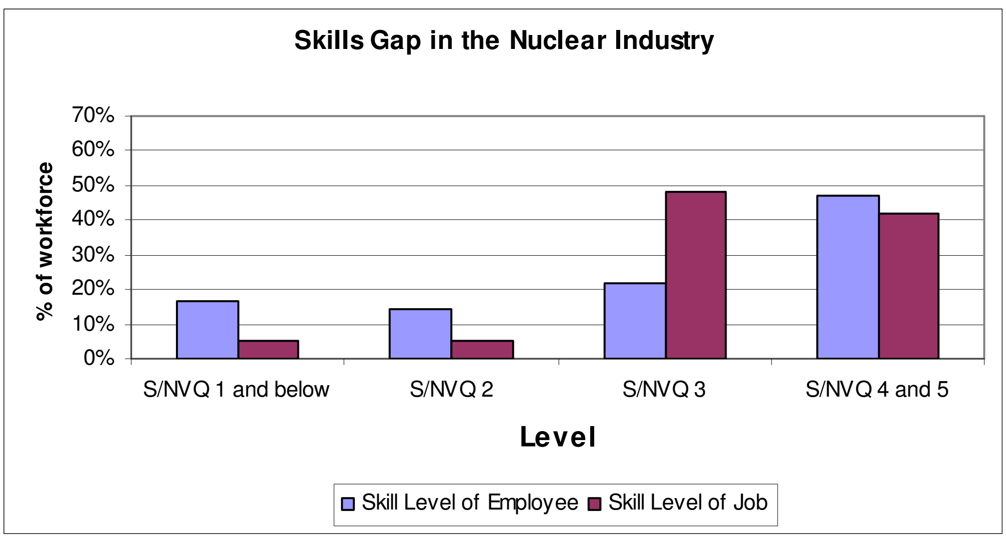

Figure 6: Nuclear Skills Gap[14]

2.4 Oil and Gas

2.4.1 Headline Statistics

- *UK ranked 11th globally for crude oil production*
- *total offshore crude oil production in the UK is 70.07 million tonnes*
- *UK consumes 2 million barrels of oil per day*
- *total UK natural gas production equals 84.18 bn m*^{3}
- *supplied 97% of oil UK oil demand and 73% of gas demand in 2007*[18]
- *UK (GVA) of all production and manufacturing industries.*
- *Oil and Gas together met >70% of UK primary energy demand in 2008.*

The UK Oil and Gas extraction industry (also referred to as the upstream) covers the exploration, extraction and initial processing of North Sea oil and gas (hydrocarbons) from around the UK, both onshore and offshore. The centre of activity for oil and gas extraction is off the coast of Aberdeen, Scotland. Hydrocarbons are produced in other areas of the UK such as the southern North Sea, from around offshore Humberside to Norfolk and Suffolk, and offshore Liverpool and Morecambe Bays. The majority of these offshore sites have landfall sites around the coast for further distribution or processing. Others off-load from the offshore facility to small tankers that transport the cargo to various onshore terminals for onward transmission. The principal onshore production area is in Poole, Dorset where the reservoir of hydrocarbons is literally under Poole Harbour but produced onshore in an environmentally sound method. There are several other lesser known onshore fields.

The UK Continental Shelf (UKCS) is facing significant challenges as the province matures. Many existing large producing fields are declining and discoveries are becoming fewer and smaller. In future, the industry's ability to compete will depend critically on rapid and continual improvement in performance. This, in turn, will depend on greater collaboration to ensure this performance can be delivered with the resources available. Technological advances will be crucial to enable effective and economic exploitation of other oil and gas reserves that were previously considered too difficult to access. Nevertheless, the UK still has substantial recoverable reserves of oil and gas potentially exceeding the amount already produced, albeit considerably fragmented.

The industry employs approximately 30,000 people in direct oil and gas extraction. More widely the industry itself estimates the sector to include 600 employers and a supply chain workforce of close to 300,000 in 500 companies. It also employs a large proportion of mechanical engineers. Turnover is less than for Chemicals but GVA is closely linked to the price of oil and is consequently the highest in the Cogent 'footprint' at an average of £725,000 per employee.

Age of workforce	16-24	5%
	25-34	22%
	35-44	25%
	45-54	30%
	55+	18%
Ethnicity	White	99%
	Non-white	1%
Gender:	Female	21%
	Male	79%

Figure 7: Oil & Gas Demographics[14]

[18] Oil and Gas UK 2009 economic report - http://www.oilandgas.org.uk/issues/economic/overview.cfm

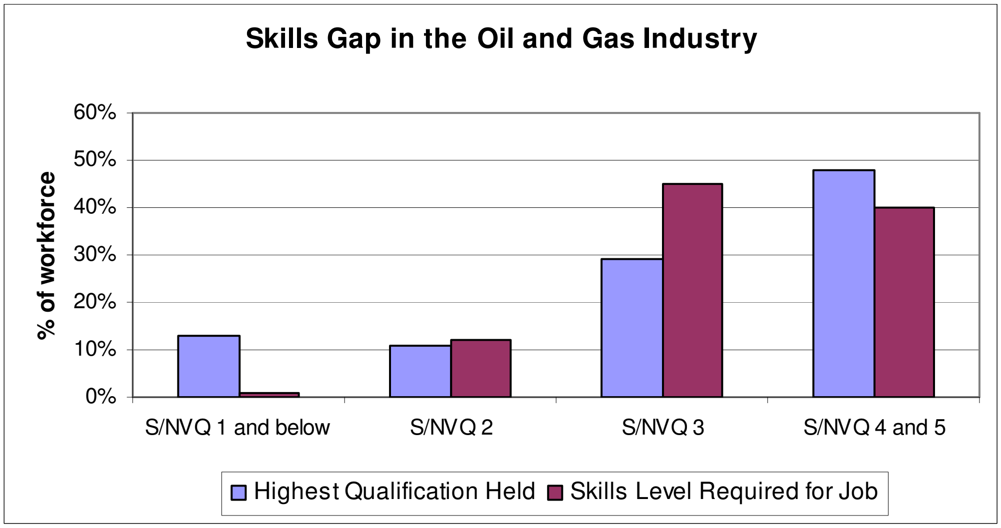

Figure 8: Oil & Gas Skills Gap[14]

2.5 Petroleum

2.5.1 Headline Statistics [19]

- *The UK has the fourth largest total refining capacity in the EU.*
- *0.5% of UK GVA*
- *9 Refineries, with numerous sites spread across the UK coast*
- *Refinery throughput (2006) equates to 82 million tonnes of oil equivalent.*
- *Refining Capacity equates to 1.8 million barrels per day*
- *Gross sales (2005): £6bn*
- *Fuel sales (2006): 50 bn litres*
- *Petrol sales (2006): 50%, Diesel sales (2006): 50%*
- *Around 130 million litres of petrol and diesel are sold in the UK each day to an estimated 5 million customers*
- *UK filling stations (2006): 9382 (annual reduction c.600 sites)*
- *Supermarket filling stations (2006): 1,191 (13% share of filling stations)*
- *Fuel use by road passenger vehicles has increased by 72% since 1970*
- *Average CO_2 emissions from new cars are 11% lower than in 1995*

The Petroleum Industry (also referred to as 'downstream' oil) in the UK employs approximately 120,000 people in 7,000 companies[20] (200 companies excluding forecourt retail). The Industry includes the stabilising, refining and manufacturing of Petroleum, as well as storage, blending and distribution. Retail sale of automotive fuel also forms a large part of this sector. The main products of the downstream sector are transport fuels (aviation fuel, diesel and unleaded petrol), for which the market in the UK amounts to about 50 million tonnes per year. The commercial market includes industrial transport (cars, trucks, buses, and trains), marine (marine diesel for ships) and agriculture (tractors etc), as well as public services and military vehicles.

The Industry has the largest turnover in the Cogent group, with an annual turnover of £52.78bn[21] (£31.01bn for refined petroleum products and £21.77bn for the retail sale of automotive fuel. This is significantly affected by taxation.) GVA tends to be much reduced due to the weighting of the low-margin retail sales of petroleum and diesel. Average GVA of £3.88bn (£1.64bn for refined petroleum products and £2.24bn for the retail sale of automotive fuel). This equates to an average GVA per employee of £55,486 compared to the UK average of £31, 419. However, the GVA for 'refined petroleum products' is £126,308 and is linked to the price of oil.

[19] Source: UK Petroleum Industry Association (UKPIA) Statistical Review 2009 & 2007 & UK Energy Sector Indicators 2007

[20] Figures including Forecourt Retail

[21] ABI 2005 – released Nov 2006, available through ONS

Total turnover in the Petroleum industry has increased by £18.6 billion (not indexed). This comprises: an increase of £5.9bn in refined petroleum products and coke oven products; a 12.7bn increase in petroleum retail since 1998. GVA in the industry has significantly increased. Total employment has decreased since 1998.

Age of workforce	16-24	7%
	25-34	11%
	35-44	37%
	45-54	32%
	55+	13%
Ethnicity	White	94%
	Non-white	6%
Gender	Female	24%
	Male	76%

Figure 9: Petroleum Demographics[14]

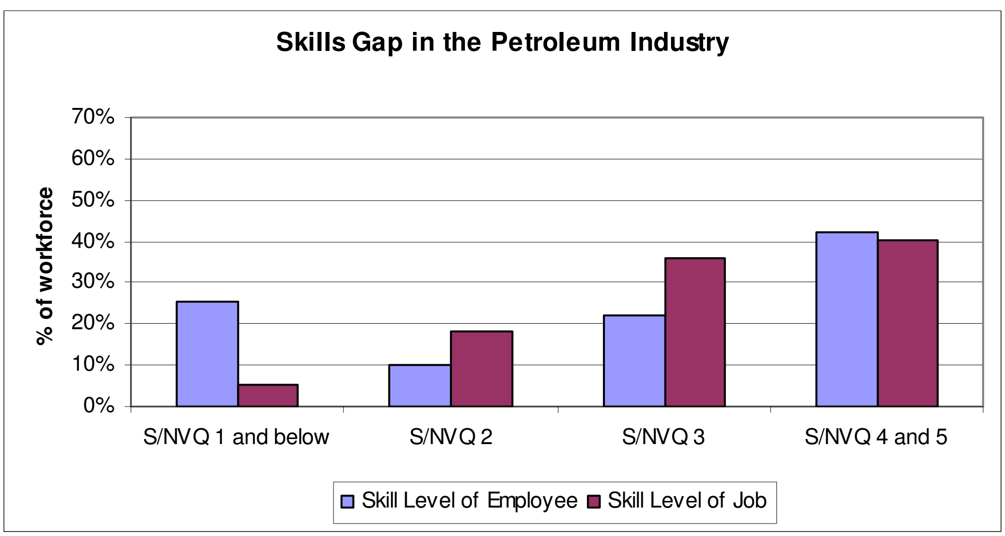

Figure 10: Petroleum Skills Gap[14]

2.6 Polymers

2.6.1 Headline Statistics[22]

- *The UK is one of the top 5 Plastics Processing countries in the EU*
- *Sales in the Plastics industry account for 2.1% of UK GDP*
- *The UK's Plastics Processors consume 4.8 million tonnes of material*
- *Packaging accounts for 36% of consumption*
- *The UK produces 2.5 million tonnes of plastics per annum*
- *In 2004 the average hourly wage in the UK and US was 22.9 USD compared to China at 1 USD*
- *The Composites industry is buoyant with a predicted growth of 4% per annum*

The Polymer industry comprises four discrete processing areas: Plastics processing, Rubber processing, Polymer Composites processing and Sign-making. Over 7,500 companies operate within the sector employing some 286,000 employees. This figure rises to approximately 400,000 employees when secondary operations are taken into consideration.

The industry is extremely dynamic, being subject to many changes and opportunities arising from technological change, development of new materials and processing technology; not least, the development of new products and changes in response to consumer requirements.

The Industry has an annual turnover of £19.76bn[21], with a GVA of £7.31bn. This equates to an average GVA per employee of £37,102 compared to the UK average of £31,419. Total turnover in the Polymers industry has remained stable since 1998 (not indexed). Gross Value Added in the industry has also remained stable.

Total employment in the Polymer industry has decreased since 1998.

Age of workforce:	16-24	10%
	25-34	22%
	35-44	27%
	45-54	25%
	55+	16%
Ethnicity:	White	94%
	Non-white	6%
Gender:	Female	21%
	Male	79%

Figure 12: Polymers Demographics[14]

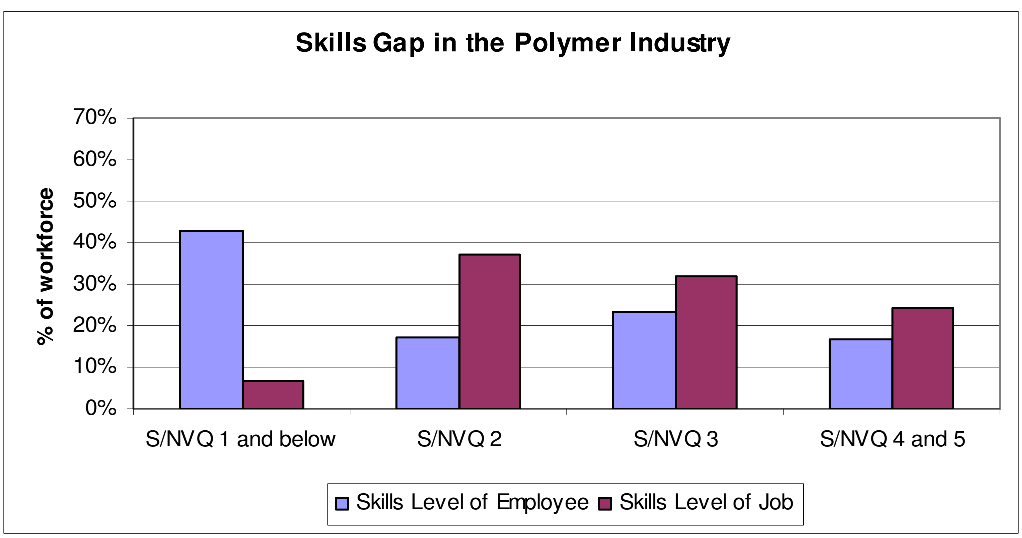

Figure 11: Polymers Skills Gap[14]

[22] Source: British Plastics Association www.bpf.co.uk

3 Skills Supply

3.1 The Requirements for STEM Skills

A reliable supply of skilled scientists and engineers is fundamental to the innovation on which the future success of Cogent industries is based. The following discussion reflects the subject origin and destination of higher level skills. These have a particular role to play in the safety regulated scientific industries, but also exist alongside a significant vocational skill set. Data describing the latter is not currently available in a form readily amenable to this type of analysis, and is not addressed further here. However, the Skills Oracle survey (section 4) does report employer views on the full range of skill levels, and identifies useful areas for intervention.

For higher level skills, data supplied by the Higher Education Statistics Agency (HESA) gives a measure of the stock and flow of STEM graduates and, in turn, the health of the skill supply in this area. (The 'Science' category used STEM in this context includes some Biological Sciences).

The data presented below are derived from two 2007/2008 HESA publications 'Students in Higher Education Institutions' and 'Destination of Leavers from Higher Education Institutions'. Further data on the STEM graduate destinations are presented in Cogent's recent publication "Technically Higher: Securing Skills for Science and Innovation" [23]

3.2 STEM Student Population

In 2008, around 246,000 full and part-time STEM students were studying at degree and postgraduate level in the UK (Figure13). This is a slight decrease (5%) from the previous years' figures. However, the overall number of students studying in the STEM subject area has increased by 3.4% since 2002/2003 (Figure 13). Notably, this expansion is not reflected evenly across all subject areas. For example: there has been a decrease in those studying electronic and electrical engineering (19%), production and manufacturing engineering (38%), microbiology (19.5%), Genetics (22%), and physical, terrestrial and geographical sciences (35%); and an increase of 47% in the total number of students studying Mathematics.

Between 2006/2007 – 2007/2008 there was a slight increase (1%) in the number of full time undergraduate STEM students, while in the same year there was considerable decline (49%) in the part-time postgraduate STEM student population.

[23] http://www.cogent-ssc.com/Higher_level_skills/Publications/AnnexBrochure.pdf

STEM Subjects	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	Change in numbers 02/03-07/08	% Change 02/03-07/08
Biology	24,410	25,400	26,290	27,075	27,580	26,360	1,950	8.0%
Genetics	2,695	2,680	2,550	2,290	2,240	2,099	-596	-22.1%
Microbiology	4,195	4,340	4,470	4,370	4,880	3,375	-820	-19.5%
Molecular biology, biophysics & biochemistry	9,280	9,805	9,600	9,945	10,460	10,314	1,034	11.1%
Chemistry	19,015	18,525	18,520	18,375	19,585	18,815	-200	-1.1%
Materials science	435	505	545	630	650	618	183	42.0%
Physics	12,830	13,360	14,610	15,035	14,935	14,870	2,040	15.9%
Geology	6,735	7,730	8,310	8,790	9,145	8,325	1,590	23.6%
Physical & terrestrial geographical & environmental	21,830	21,655	20,500	20,615	20,530	14,512	-7,318	-33.5%
Mathematics	20,120	24,025	25,555	26,935	28,590	29,621	9,501	47.2%
Statistics	3,940	3,620	3,445	3,598	3,550	3,435	-505	-12.8%
General engineering	18,990	20,695	21,380	21,035	21,665	19,921	931	4.9%
Civil engineering	16,325	17,860	19,750	19,830	22,115	22,895	6,570	40.2%
Mechanical engineering	21,070	20,790	21,215	21,955	22,600	22,991	1,921	9.1%
Electronic & electrical engineering	37,440	35,650	34,590	32,795	32,345	30,341	-7,099	-19.0%
Production & manufacturing engineering	9,885	9,225	7,980	7,255	6,850	6,055	-3,830	-38.7%
Chemical, process & energy engineering	5,585	5,780	6,080	6,215	6,845	7,714	2,129	38.1%
Materials technology not otherwise specified	2,990	3,065	3,215	3,110	2,935	2,741	-249	-8.3%
Industrial biotechnology	135	90	55	130	205	1,024	889	658.7%
Total	237,905	244,800	248,660	249,983	257,705	246,026	8,121	3.4%

Figure 13: STEM Student Trend 2002/2003-2007/2008

Note: The HESA student trend data presented above covers students registered for first degree, postgraduate, other undergraduate degrees, and contains all United Kingdom (UK) other European Union (EU) and Non EU domiciled students reported to HESA for the reporting period 1 August 2002 to 31 July 2008.

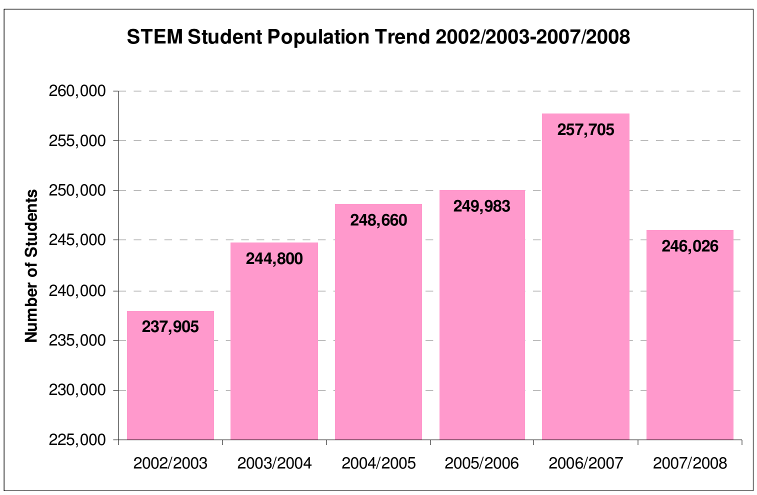

Figure 14: STEM Student Population Trend

3.3 Gender Balance

Female students make up about one-third (32%) of the STEM total. Within engineering and technology the proportion of female students is lowest at 12%; it rises in mathematics to 37%, in physical sciences to 41%, and forms the majority in the biological sciences, at 64%. Within the Cogent sector (Figure15), the balance varies between industries; ranging from 27% in polymers to 51% in chemicals and 55% in pharmaceuticals.

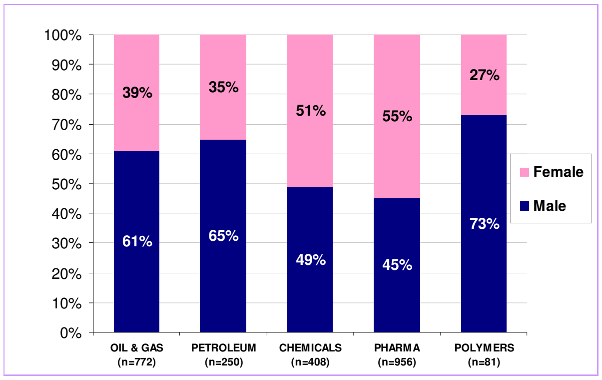

Figure 15: Gender Balance of Graduates Entering Employment in Cogent Industries 2007/2008

3.4 Industrial Destination of STEM Graduates

Almost 3300 (weighted)[24] graduates (STEM and non-STEM) entered employment within the Cogent footprint in 2007/2008. Figure 16 shows how these were divided amongst the industries.

Together, the chemical and pharmaceutical industries are the largest (56%) recruiters of graduates in the sector, with the Oil and Gas industry also recruiting a large (31%) proportion.

In contrast, the Polymer industry is the lowest direct recruiter, but this may in part be explained by the declared classification of much of the industry's high level research as chemical.

The Cogent sector employs around 4% of the total UK STEM supply graduating in any one year. These in turn form just over a third (36%) of graduates employed across the sector, although this varies from industry to industry (Figure17)

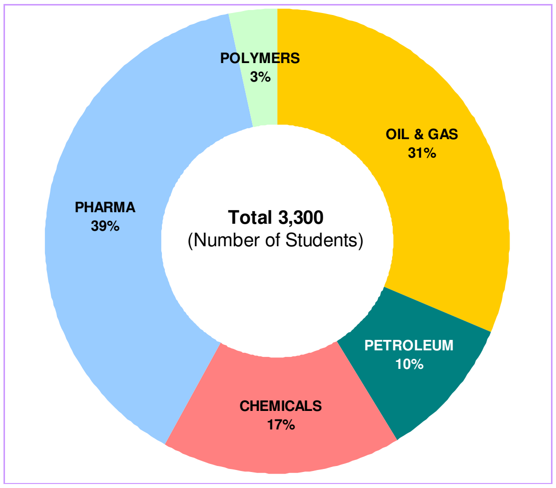

Figure 16: Destination of ALL Graduates entering Cogent Industries in 2007/2008 (weighted)

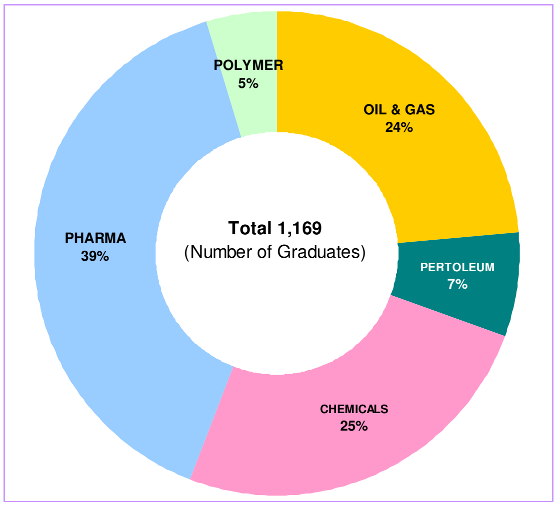

Figure 17: Destination of STEM Graduates Entering Cogent Industries 2007/2008 (weighted)

Note: HESA data for 2007/2008 underestimates the number of graduates entering the oil and gas, nuclear, petroleum and chemicals industry due to the SIC code separation and change from SIC2003 to SIC 2007. Consequently, 2007/2008 figures in destination of STEM graduates entering employment to Cogent industries are likely to be underestimated by around 300.

[24] Destination data is obtained from surveys of recent graduates, which have a typical response rate of 75%. Numbers qualified as 'weighted' have been extrapolated to give a reasonable estimate by dividing by 0.75

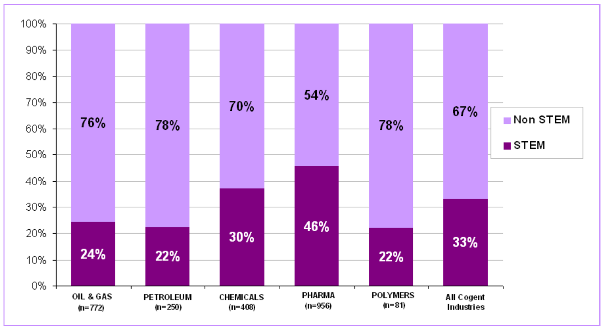

Figure 18: Proportion of STEM Graduates Entering Employment in Cogent Industries

As may be expected, the flow of STEM graduates into the Cogent sector is dominated by those having studied chemistry, followed by mechanical engineering and electronic & electrical engineering graduates. STEM graduates are in highest demand in pharmaceuticals (Figure18).

The dominant subject areas supplying the Cogent energy industries are: mechanical engineering; geology; electronic & electrical engineering; chemical, process & energy engineering subject areas. The Cogent manufacturing industries draw from chemistry; pharmacology, toxicology and pharmacy.

A comprehensive sectoral breakdown of destination by subject is presented in *Technically Higher*[23]

3.5 Occupational Destination of STEM Graduates

Nearly half of STEM graduates enter professional occupations, and of this group over half again have entered engineering professions. The charts below (figures 19 and 20) provide an overview of the main occupational groups that graduates entered employment into and, for the largest occupational category – professional - a breakdown by more detailed occupational group. For Cogent industries, a proportionately higher fraction of STEM graduates (69%) enter professional occupations than graduates as a whole (49%).

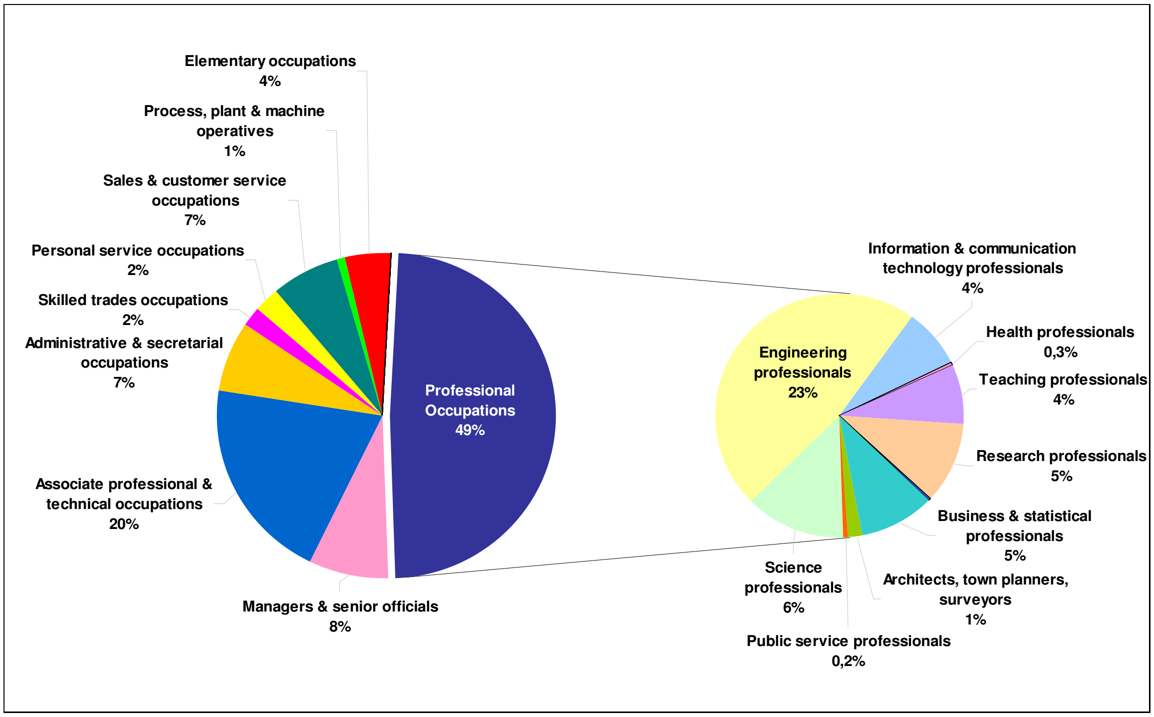

Figure 19: Destination of STEM Graduates by Occupation 2007/2008

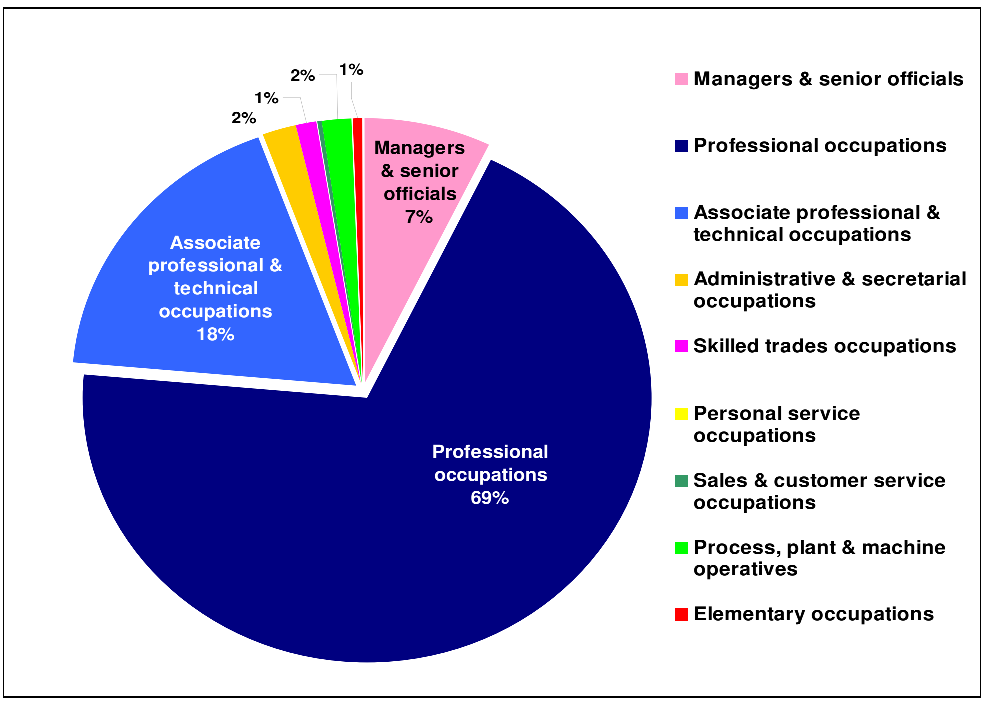

Figure 20: Occupational Destination of STEM Graduates Entering Employment in Cogent Industries 2007/2008

3.6 Trend in STEM Graduates Entering Cogent Industries

Trend data show graduate recruitment to the sector as being consistently around 1,700 weighted per annum in employment, most notable in the slow decline in graduate employment in the combined chemical and pharmaceuticals sector. In contrast, there has been an increase (30%) in STEM graduates entering the oil and gas industry over the same period.

Figure 21 shows STEM graduate levels in Cogent industries between 2002/03 and 2006/07. (The changes in classification for 2007/08 prevent a meaningful comparison and have therefore been omitted in this case.)

Tables presented in the "Technically Higher: Securing Skills for Science and Innovation" show the distribution of the 'first destinations' of 2007 graduates in relevant STEM subject area, by Cogent-relevant sector of employment and occupational destination by 2008 in the UK.

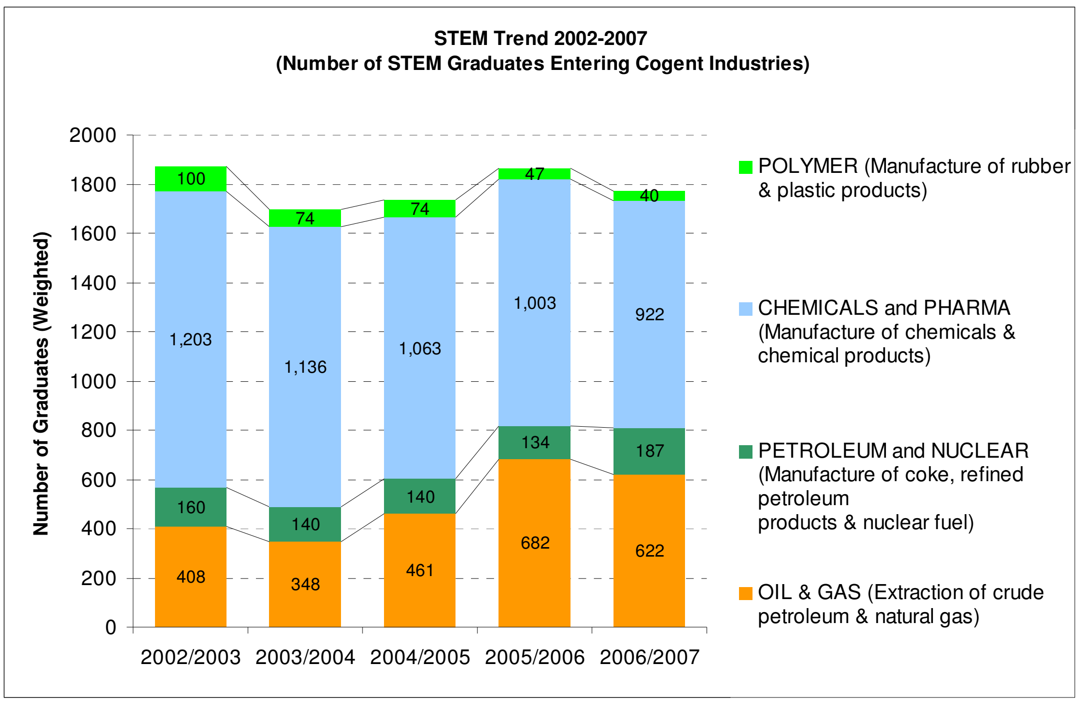

Figure 21: Trend in STEM graduates Entering Cogent Industries 2002/03-2006/07 (weighted)

3.7 Overview

In summary, the total number of STEM graduates is not the limiting factor in the filling Cogent industry STEM posts. Rather, the challenge is to attract graduates to posts in Cogent industries.

4 Skills Oracle[25]

4.1 Primary Labour Market Intelligence

During 2009 Cogent implemented 'Skills Oracle'. Skills Oracle is a primary LMI development leading to:

- A skills 'FTSE' - an index that is a barometer of skills in the sector
- A skills benchmark - a collective measure against which employers can assess their skills position in relation to other companies
- A skills voice - a report of measures and opinions, supported by a body of evidence from a substantial and consistent expert panel of employers.

Skills Oracle works through an electronically distributed employer panel returning annual measures to an online survey. A full Skills Oracle report will be published later in the year on an industry-by-industry basis. Some preliminary results, mainly at sector level, are reported herewith.

The electronic survey was live during quarter 4 of 2009.

4.2 Industry and Employment

A 40% return delivered respondents from 69 sites of companies across five sectors – Chemicals, Pharmaceuticals, Polymers, Petroleum and Nuclear. The companies represent a wider network of 280 industrial sites across the UK. The same companies are part of a global network of 920 sites worldwide. The UK sites collectively employ 40,000 people and 420,000 people worldwide. By this employee measure, the survey represents of the order of 7% of the 550,000 employees in the 5 Cogent sectors responding to the survey. The measure also underlines the global reach of these sectors, as reflected in the 1:9 ratio of UK: worldwide employment. On average, each site employs 580 people, with a maximum of 10,000 and a minimum of 10. Several companies operate multiple sites; the average employment per company is 6,600, while the maximum employed is 100,000.

4.3 Recruitment and Staff Turnover

Employment tends to be direct and full-time with the main routes into the sector being 'Mature Entrants', 'Apprentices', 'Graduates' and 'Agency'. Between 40% and 60% of employers reported recruitment in these categories. Across all sectors, 54% of employers reported dependence on contractors for routine operations. In the Chemicals, Pharmaceuticals and Petroleum sectors this dependence was reported by 75-80% of respondents. The incidence of recruitment of migrants was low (2% of recruitment) and was predominantly in the Polymers sector.

In total for the sites surveyed, staff turnover (combined inflow and outflow) was of the order of 4,000, while at least 7,000 were induced contractor employment. The proportion of those employed directly suggests an annual sector turnover of 10% in employment. (The contractor group, while noted has been excluded from all subsequent data processing). Analysis of the entrants and leavers by occupation gives a profile of the in-demand occupations. In this way, there was a significant net increase in: (a) 'Professional Science and Engineering' occupations; and (b) 'Craft and Technical' occupations. In both cases, the entry levels were double the departure levels. Occupations such as 'Managers', 'Commercial and Marketing', and 'Administrative and Secretarial', indicated stable profiles, but 'Production and Operations' occupations indicated a significant decline.

Vacancies for Professional Scientists and Engineers were reported by 57% of employers as the most 'hard to fill', a clear 27% majority over those expressing the contrary opinion. Craft and Technical was the only other occupational category that came close to being labelled as 'hard to fill', with all other occupations being reported, on balance, as not hard to fill.

The outflow of employment was recorded in categories of 'Retirement', 'Redundancies' and 'Other'. Most employers listed 'other' as the main departure route for employees (55%), followed by redundancies (28% of employees quoted) and retirement (17% of employers quoted).

[25] Most data are rounded

Overall, a net inflow of employment was recorded of the order of 0.6% of the employment represented by the sample of employers. Both this and the inflow and outflow by occupation do, however, require detailed analysis at industry level. This will be reported through the national Skills Oracle report for 2010.

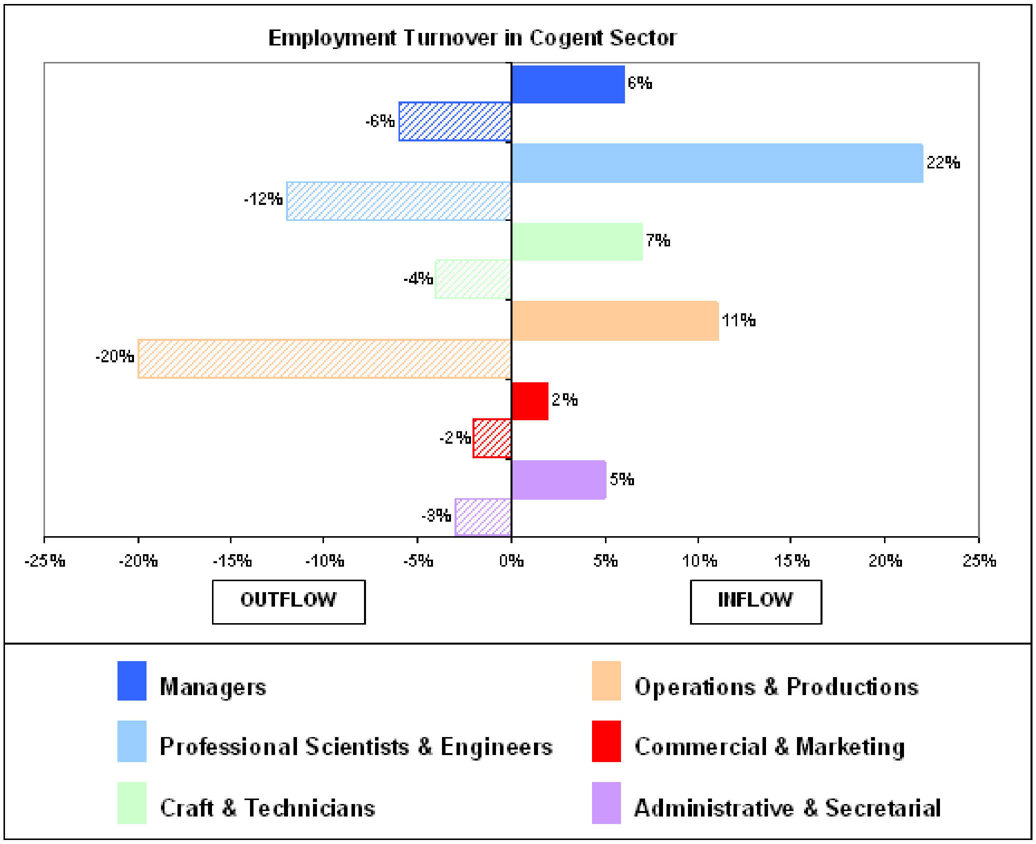

Figure 22: Employment Turnover in Cogent Sector

4.4 Training Budgets

The vast majority (92%) of companies in the sample administer training budgets. Of those that reported training budgets, the average was just over £300,000 with a maximum reported of £3,000,000. Of the budget maxima by industry, the lowest quoted for an individual site was £500,000. When Nuclear - the industry with the highest reported training budget - is stripped out, the headline average for top training budgets drops to around £1,000,000.

Correspondingly, the average without Nuclear becomes of the order of £200,000. Despite the recession, most (55%) reported that their budgets would remain similar in the coming year. A substantial proportion (25%) expected training budgets to be cut. For the sector, the average annual spend on training per employee is £850.[26] The average training budgets per industry per employee for the sample are charted below.

4.5 Qualifications – the Employers View

In general, employers were satisfied with the supply of qualifications across the sector. Satisfaction ratings were highest for 'Academic' qualifications; 'Competence-based' qualifications and 'Flexibility' of provision (respectively 40%, 32% and 28% majorities over the contrary opinion). But ratings were lower for the use of 'Apprenticeships' and the 'Accessibility' of provision (21% and 15% majority opinions, respectively). Despite these majorities, the proportion of employers that disagreed was of the order of 20% or higher suggesting scope for further SSC action, particularly in, awareness raising, and development of flexible and accessible provision.

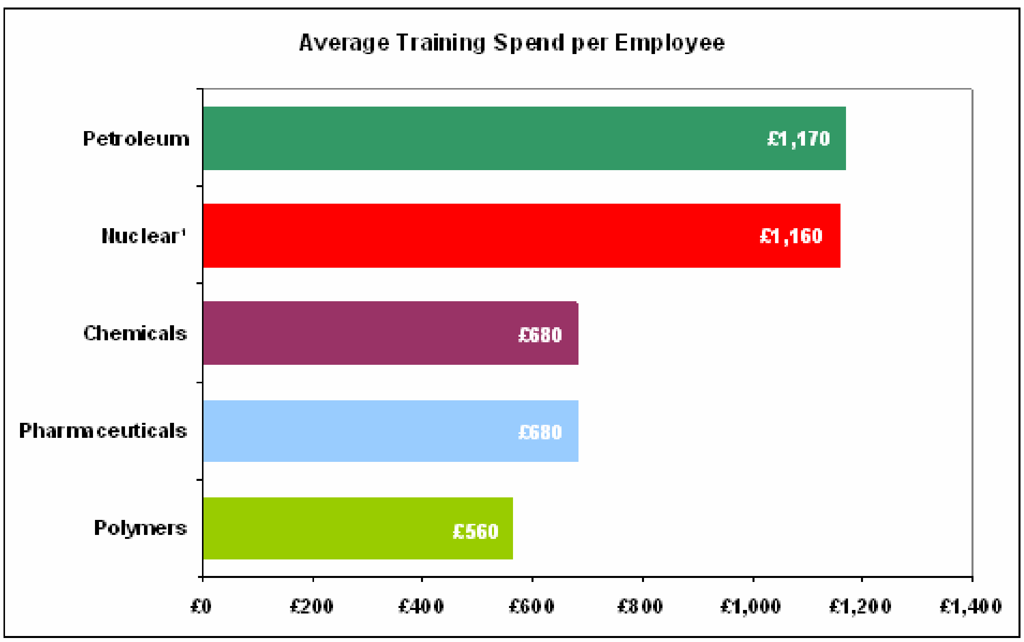

Figure 23: Average Training Spend per Employee

Note: Figures in above chart do not include the cost of time out of employment to train.

¹ Nuclear: Based on the average of; the *company average training spend* & *the site average training spend* to give one training spend figure.

[26] Based on 580 average employees per site and an average training budget of £490k per site.

4.6 Training

Safety, Health and Environment (SHE) was the most frequently reported training undertaken, when viewed across both internal and external training requirements. Companies tended to resource externally for specialist training needs (SHE, 70%; Technical, 70%; Professional 75%). When training needs are more directly related to a job, training tends to be internally resourced (‘Job Specific’, 90%; ‘SHE’, 86%; ‘Competence’, 62%).

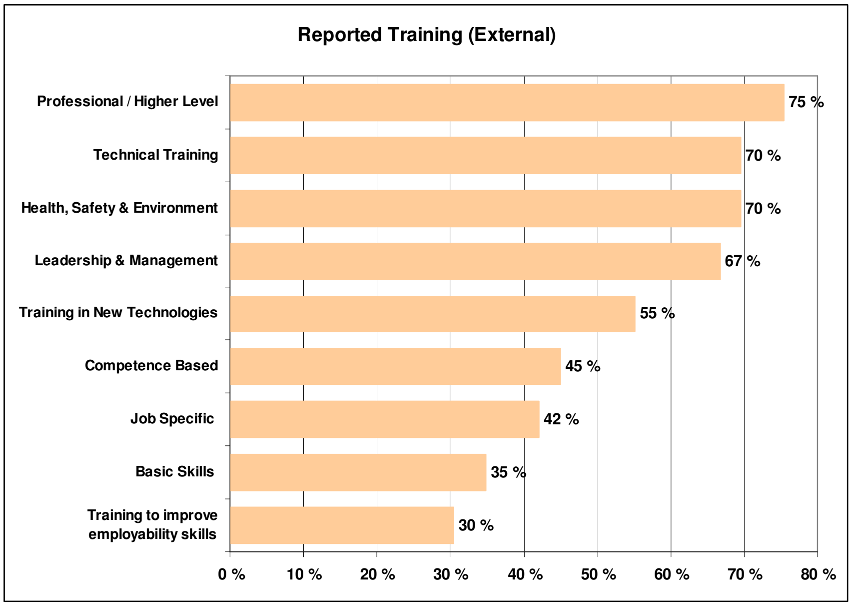

Figure 24: Reported Training (external)

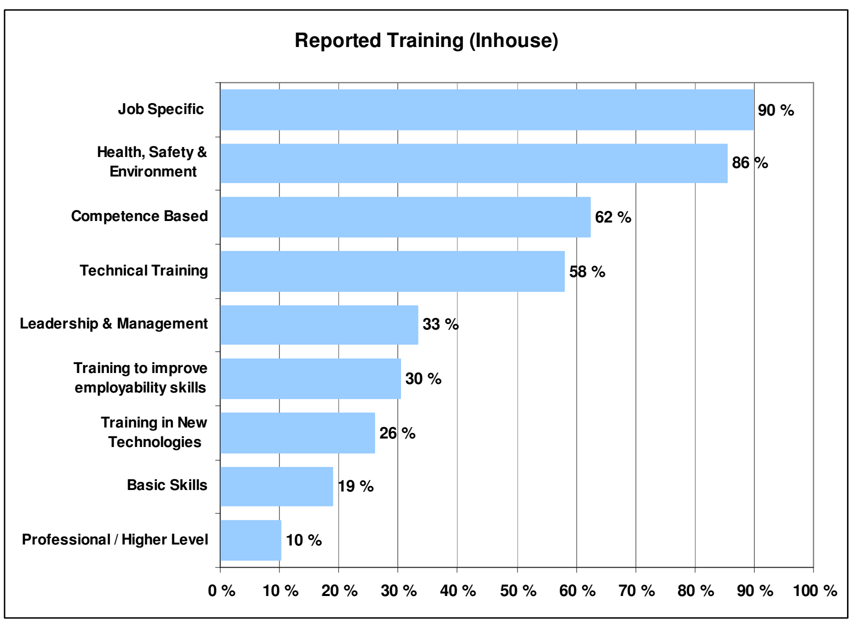

Figure 25: Reported Training (in house)

4.7 Providers of Education and Training

For workforce development, employers made use of a range of private and public providers. The frequency of the use of providers is: private sector (94% of employers), FE sector (80% of employers), HE Sector (51% of employers).

Satisfaction ratings with each type of provider was measured for 'Cost, 'Relevance' of provision, 'Flexibility' of provision, 'Location' of provision, and the 'Quality' of those delivering education or training. For private training providers, satisfaction levels tended to be extremely high in all areas, ranging from the lowest of 76% satisfied (on Cost) to the highest level of satisfaction of 97% (on Quality). In the main, this reflects the highly tailored provision that private training providers must produce in order to secure a business offer. The ratings for the public sector in FE and HE were also high, with all satisfaction levels between 60% and 85%.

The lowest of these ratings referred to relevance, flexibility and location. This portrays the constraints of qualification provision in a training context, as well as geographical coverage. The results suggest that while employers value such provision, there is scope for FE and HE to innovate in flexible and accessible provision, and that there is a role for the Sector Skills Council in facilitating this.

4.8 Education Supply

Employer expectations of the skills presented by 'School Leavers', 'Apprentices' and 'Graduates' was captured. For School Leavers, basic skills in literacy, ICT and numeracy are most relevant to employers. Most (43%) were neither satisfied nor dissatisfied, although a sizeable 19% expressed levels of dissatisfaction, while 38% expressed satisfaction.

All industry sectors placed a high level of importance on Apprentices, with a rating by 83% of employers. Industry returns in this connection ranged from as high as unanimous (100% of employers) in the Nuclear sector, to 57% of employers in the Pharmaceuticals sector. Employers expressed clear levels of satisfaction in many of the categories detailing what may be expected from an Apprentice. In priority order, employers valued 'Industry Awareness' followed, in equal measure, by 'Technical Skills', 'Practical Skills' and 'Employability Skills' .

The majority of industry sectors (78%) placed a high level of importance on Graduates. Employers also placed high priority on expectations from graduates in 'Practical Skills' and 'Industry Awareness'. High levels of expectation were attached to literacy, numeracy and IT skills. While employers apparently placed lower priority on core subject knowledge, when read in conjunction with general satisfaction ratings on STEM, it is clear that employers expect the high levels of subject knowledge but would wish to see improvements in practical skills. In this connection, 82% of employers were satisfied or very satisfied with STEM subject skills, while only 3% were not. Further, expectation ratings on 'Employability' and 'Innovation' reached majority status (37% and 24%, respectively) for graduates only.

4.9 Workforce Development

The degree of workforce development for the 'Existing Workforce' and the supply of 'School Leavers', 'Apprentices' and 'Graduates' was assessed for the skills categories of 'Basic', 'Competence', 'Technical' and 'Professional'. Competence and Technical training of the existing workforce was reported by a large proportion of employers (81% and 74%, respectively), while 64% also invested in the professional and higher level skills of the workforce. Technical training was the most prevalent training reported across all categories of employment, with 51% and 54% of employers also engaging in technical training for Apprentices and Graduates.

4.10 Skills Gaps, Shortages and Future Skills Needs

In the year past, a significant majority of employers indicated that skills gaps and shortages had had either 'some impact' or a 'significant impact' on business performance. This impact was reported by 83% of employers for the existing workforce, and by 72% of employers for new recruits.

Between 94% and 97% of employers stated that their skills needs had either, remained 'constant', or had 'increased' relative to the previous year. This was highlighted for the employment areas of 'Competence', 'Technical', and 'Leadership and Management', where requirements had increased during the current year. This was reported by 65%, 58% and 54% of employers in each area, respectively. Looking a year ahead, the same areas remained relevant but with an expectancy of a continued increase in the skills development required. This was reported by 72%, 66% and 72% of employers respectively.

4.11 Skills and the Economy

Almost a third of employers (29%) reported preparing to extend into new technologies to maintain business performance. The nature of the new technologies and the skill requirements will be the subject of follow-up interviews.

Unsurprisingly, 95% of employers reported that the general economy had 'some impact' or a 'significant impact' on their businesses. However, for two industry sectors with considerable and unique internal economic drivers (Nuclear and Pharmaceuticals), the impact was rated at a lesser degree of severity.

Looking ahead, employers were split in considering that the economic situation for their businesses would 'improve' (39%), 'remain static' (26%), or 'worsen' (26%) in the year ahead. This contrasts with the view of the same employers that the economy generally was expected to improve in the same period. This could be due, either to a perceived lag in industrial economic activity as the general economy picks up; or, it may arise as a result of the greater insight into their own sectors that employers undoubtedly have. In either case, the general conclusion is continuing uncertainty of the economy in the sector.

Given the lack of consensus about the future economic situation for businesses, most employers predicted no significant change in employment in the short term (2 years ahead) across the following categories: 'Process Operator', 'Technicians', 'Scientists and Engineers' and 'Management and Leadership'. However, the distribution of responses does indicate divergence in employment patterns by industry, which will be the subject of the national report on 'Skills Oracle' to the industries.

4.12 What Employers Want from a Sector Skills Council

From a defined list of SSC activities, employers were asked to select those they considered would be most beneficial to their businesses and industry. This gives, in effect, a popularity chart of the skills activities of the SSC that employers endorse. The chart below shows the relative popularity of each activity. The three most popular employer endorsements on skills activism were: 'securing funding' (for skills in the sector), as voted by 72% of employers; 'improving access to training provision' (62%), and 'attraction of young people' to the sector (61%).

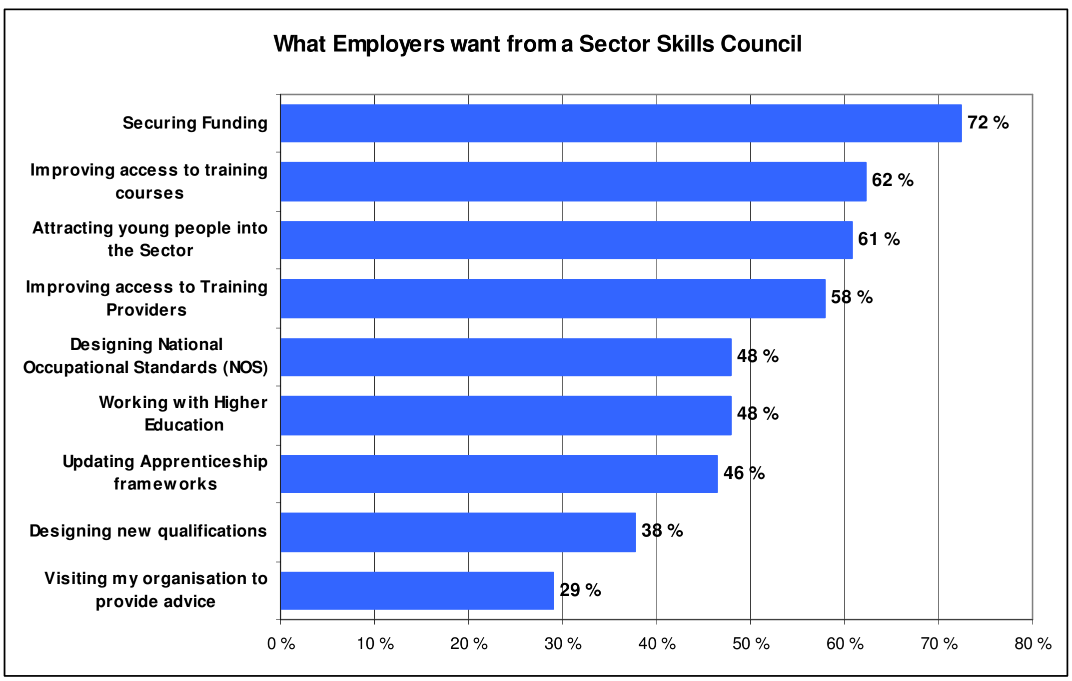

Figure 26: What Employers Want from an SSC

5 In-depth – The Civil Nuclear Industry

5.1 In-depth Reports

As a complement to the overarching biennial review of the sector industries described earlier, Cogent has embarked on an annual programme of in-depth reports analysing key strategic areas within the sector. These will react both to emerging events within existing industries and to the development of new technologies that have the potential to contribute to the sector.

5.2 *Power People* Report

By 2009, the civil nuclear industry in the UK was poised for a step change in its evolution. While the programme of decommissioning the aging AGR fleet continued, national and international controls on greenhouse gas emissions, and the need to improve energy security, greatly renewed interest in the nuclear contribution to a mixed energy economy. In response, Government primed a regulatory and planning framework to engage with utility companies and consortia interested in contributing to a new build programme. This initially resulted in interest in the privately funded construction of 12 GWe of new generating capacity, a level roughly equivalent to the output of the existing fleet. By the end of 2009, the publicly stated ambitions of three consortia lifted the potential output from new build nuclear sources to 16 GWe.

While the UK retains a considerable legacy of nuclear skills, now employed primarily in operations and decommissioning, there has been no new civil nuclear power plant construction since the completion of Sizewell B in 1995. Given the size and demographics of the sector, the delivery of a new build programme of this scale will be a challenge. Following a request from the Nuclear Development Forum[27], Cogent began an in-depth study of the civil and defence components of the UK nuclear industry to be published in four parts under the collective title *Renaissance Nuclear Skills*. The first, *Power People: The Civil Nuclear Workforce 2009 – 2025,* was published in September 2009. Further reports, *Next Generation: Skills for New Build Nuclear, Assurance: Skills for Nuclear Defence* and *Illuminations: Future Skills for Nuclear* will be published during the first half of 2010.

With electricity generation associated with 24% of global man-made CO_2 emissions[28], a nuclear renaissance offers a low-carbon, high-energy density solution to sustainable economic and social development. *Power People* demonstrated that investment in skills today is vital to sustain the UK nuclear industry and to ensure that UK skills share in the rewards of the global nuclear markets of tomorrow.

5.3 The Position of Skills

Skills are an essential part of the solution for a nuclear sector on the cusp of renaissance. Yet these are transition years in which the industry's decisions on skills will define the sector for decades to come. In this transitional term, it is therefore crucial that the skills and productivity of the workforce demonstrate early potential of UK capability.

The *Power People* analysis is the first stage in a process that leads to training and skills interventions to prevent predicted skills gaps arising and to ensure that the industry has a sustainable skills base, and is in a position to take advantage of the new build opportunities.

The research addresses a major gap in national data and provides the evidence base for the authoritative voice on skills needs. Three skills drivers are analysed: an ageing workforce driving replacement demand; a shift in skills to decommissioning; and demand for skills to operate a new fleet of nuclear power stations. While the sector may have been aware (anecdotally) of these drivers, the defining contribution of *Power People* is in the robustness of the figures, the in-depth primary data and the peer-reviewed analysis. This will feed the subsequent reports in the "Renaissance" series that will carry recommendations.

For the civil nuclear workforce, the skills legacy is a positive position from which to grow. Throughout Electricity Generation, Decommissioning or Fuel Processing, the workforce has current capability. This is a resource to be nurtured for a secure and

[27] The NDF is formed from representatives from Government, key industry stakeholders, skills bodies and trade unions, and chaired by the Secretary of State for Energy and Climate Change

[28] The Economics of Climate Change. The Stern Review, Nicholas Stern, Cabinet Office HM Treasury, Cambridge University Press, 2007.

sustainable energy future for the UK, for UK employment, and for UK PLC globally.

In contrast to the wide range of econometric data collected nationally for various economic sectors, there is a paucity of discrete national and international data that does justice to the labour market of the civil nuclear industry. This places great emphasis on the primary labour market research reported in this "Renaissance" series. *Power People*, provides the most comprehensive industry-wide evidence to-date of skills in the civil nuclear industry of any nuclear-generating country, together with an outlook on the shape of skills to come.

A skills classification system, applied to labour market returns from all the operating companies, allowed the workforce to be mapped by region, nation, skill level, age, sector, and job context.

5.4 Employment

The civil nuclear industry today provides employment for 44,000 people. Of these, 24,000 are employed directly by the nuclear operators across three sectors – Electricity Generation, Decommissioning, and Fuel Processing. The remainder is employed in the direct supply chain to the nuclear industry. The sectors are split across both public and private ownership, with the latter being prevalent in Electricity Generation. Of the 24,000 employed directly by the nuclear operating companies, Decommissioning (12,000) is by far the largest sector, followed by Electricity Generation (7,500) and Fuel Processing (4,500).

The North West of England has the largest employment, with 53% of the workforce overall, comprising 14% of Electricity Generation, 62% of Decommissioning and 73% of Fuel Processing. The South West of England (12%), Scotland (11%) and the South East of England (9%) are the next largest in employment. The North East of England, the East of England and North Wales have a 3% share, each, of the national employment of the sector. However, much of this picture will change within the decade.

The skill levels of the workforce are high, as would be expected for a safety critical industry. The combined Technical, Professional and Senior Management skill levels are typically close to, or in excess of, 70% in any of the sectors.

The core job contexts of Energy Production Operations, Decommissioning Operations, Processing Operations and Maintenance Operations, make up 43% of the workforce. In balance, supporting and value-adding job contexts, such as Project Management, Engineering Design, Safety and Security, and Business make up the bulk of the remaining employment (42%).

A general Reactor model was developed using historical data. Each unit creates operating employment for up to 500 people. At least 350 are employed on site, with up to a further 150 employed elsewhere in the company. (Refinement of the Reactor model, including sensitivity to the two most likely new build designs, will form part of the second report in this "Renaissance" series).

5.5 Future Demand

Future demand for skills depends on the model adopted for Decommissioning and New Build Nuclear. The former is the largely predictable shift from Electricity Generation to Decommissioning associated with the ageing Advanced Gas Reactor (AGR) fleet; the latter is, to some extent, opaque and was analysed using a Replacement Generating Capacity scenario of 12 GWe at 2025 and lifetime extensions to existing fleet. Without new build, the workforce is set to decline by 58% by 2025 (Figure 27) with new build at Replacement Generating Capacity, the model projects new demand for 4,600 jobs in the Electricity Generating sector by 2025 with a sizeable impact on the supply chain as well. The workforce is older than, and retires earlier than, the UK workforce in general. This lends a considerable level of complexity, urgency and flexibility to skills planning. The profile acts most harshly on the higher skilled and more experienced parts of the workforce. Here, up to 70% of current employees will retire by 2025 (Figure 28). The age profile is the main determinant in the Replacement Generating Capacity scenario, driving a general skills gap of up to 14,000 by 2025. This converts to an industry requirement of the order of 1,000 new recruits per year, mainly as new apprentices and graduates. However, the new build driver of demand will draw in suitably experienced personnel from other sectors and possibly globally. (The exact skills complexion of this will be the subject of subsequent reports in this "Renaissance" series).

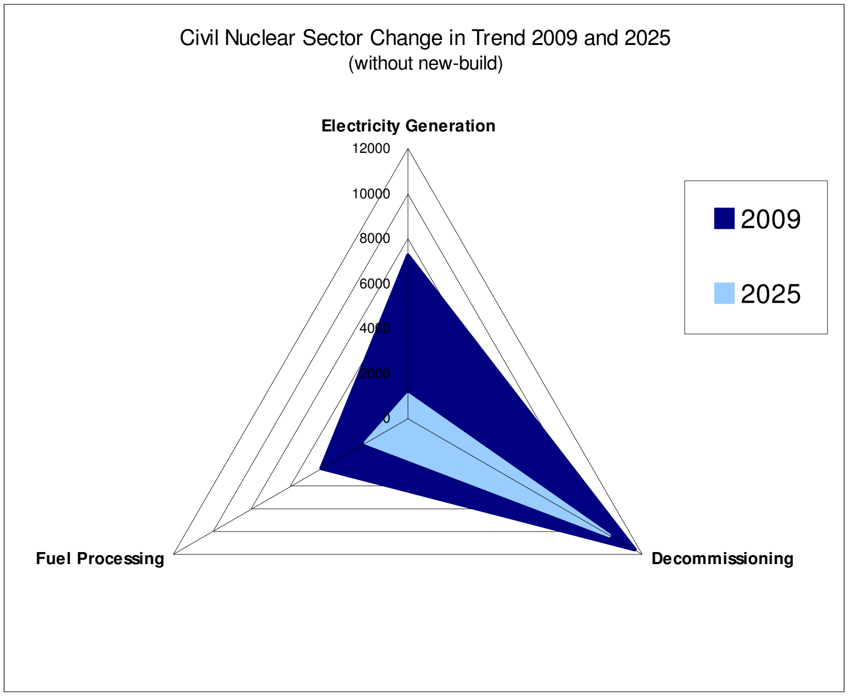

Figure 27: Civil Nuclear Sector Change in Trend 2009 & 2025

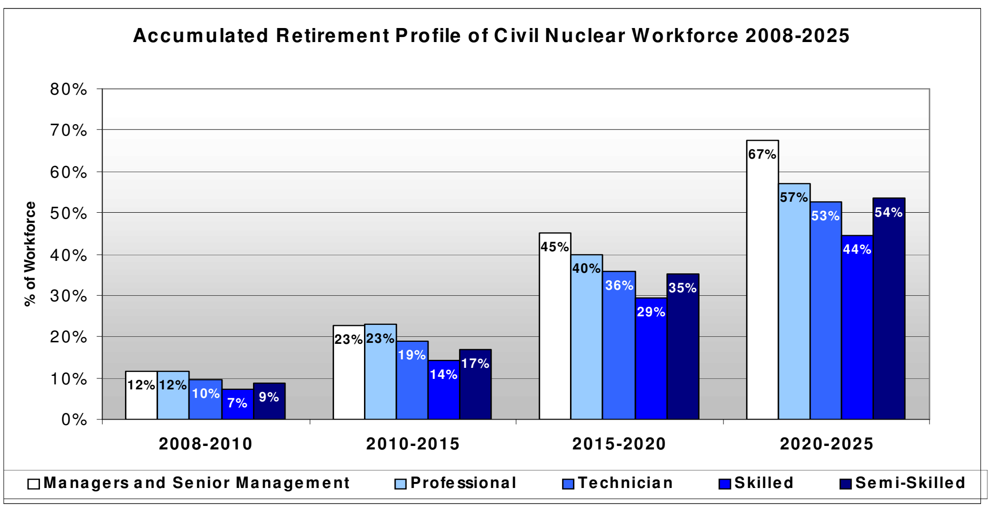

Figure 28: Accumulated Retirement Profile of Civil Nuclear Workforce

The year 2015 appears to be a watershed year for skills. At this point many of the drivers of skills converge. By 2015, the retirement profile of the nuclear workforce begins to diverge significantly from that of the UK workforce; by 2015, the decommissioning of the old fleet will have taken hold; and, by 2015, recruitment and training for the new fleet must begin if the first are to commence operations from 2017.

The skills demand will follow the change in landscape by sector. This will be: stable numbers in Decommissioning; decline in old Electricity Generation followed by expansion of new Electricity Generation; and, finally, decline in Fuel Processing. The most striking demand statistic is the demand without new build. In this case, regardless of scenario, the UK faces a reduction of 90% in the workforce employed in nuclear Electricity Generation.

At the macro level, the skills challenge will be in managing skills supply and skills transitions.

There will be locations where 'old' and 'new' generation nuclear may crossover. The regions concerned will hold nuclear-literate workforces and communities. But the skills involved in new-generation operations will have changed, with new technologies, new processes, new practices, new regulations and new owners. Up to six regions may have both new and old capacity side-by-side: the South West of England (Hinkley Point, Oldbury), the East of England (Sizewell, Bradwell), the South East of England (Dungeness)[29], North Wales (Wylfa), the North West of England (Sellafield, Copeland, Heysham, Braystones), and the North East of England (Hartlepool). As the regional futures become clearer, drill-down research will be required to inform the development of local skills strategies.

5.6 Future Strategies

The skills compass points to the development of strategies on: general public awareness and confidence in a sector in renewal; perceptions of employment opportunity, advancement and prestige to attract new blood to the sector; reskilling and upskilling for mobility and retention of valued skills within the industry; and, on-site training opportunities and accessible specialist facilities (e.g. reactor simulators) linked to the industry and the colleges and universities involved in skills supply and training. Cogent Sector Skills Council and the National Skills Academy for Nuclear, working with industry, will take a leading role in ensuring these strategies are driven forward and that the skills products (below) continue to develop and evolve to remain capable of embracing these developments.

- Future Skills
- Career Pathways
- Nuclear Skills Passport
- Nuclear Industry Training Framework (an integral part of the Skills Passport)

Cogent will enhance its work with other strategic nuclear industry bodies,[30] government[31], and wider sectors[32] for new build construction, for the benefit of the industry and to ensure that skills are a solution to a secure and self-sufficient, low-carbon energy supply of the future. Employers must continue to invest in skills – not just for today but also for the new industry of tomorrow.

In addition to the substantive publication, the research and narrative of *Power People* has been used to inform contributions to the Low Carbon Cluster report and the Engineering Construction Cluster report, both commissioned by the UK Commission for Employment and Skills.

The enhancement of the UK's nuclear skills capacity and capability is a critical component of the national energy policy, reflected in both Government action and the active attention of the select committees of the interested departments. The skills interventions, and the structures that support and verify them, will be the engine that drives the UK nuclear renaissance.

[29] Dungeness was not included in the government's draft Nuclear National Policy Statement published in November 2009. Consultation on the NPS, however, will continue until 22nd February 2010

[30] The Nuclear Decommissioning Authority, the Nuclear Industry Association

[31] The Office for Nuclear Development, the Department of Energy and Climate Change, the Department for Business, Innovation and Skills

[32] Construction Skills, The Engineering Construction Industry Training Board

6 Skills Scenarios

6.1 Drivers of Change – Established Industries

6.1.1 Economy [33]

Looking to the future, all industries across the Cogent sector face, or will face, the impact of the current economic climate. It is therefore imperative that incentives to invest in training are promoted for resilience and sustainability.

The intensity of the recession that began in 2008 is clearly articulated by Cogent employers, but taking a view across all Cogent sectors the impact is varied, with some resilient stories of note amongst the more general downbeat mood in the economy. This variance will feed through to skills and employment in the short and medium terms, with some employers sustaining business, some rationalising and some growing to fill the gaps.

Manufacturers supplying essential consumer and healthcare products (sub-sectors of chemical, pharmaceutical and polymers) have been withstanding the economic downturn. Companies involved in the supply chain to other manufacturers and more expensive consumer products (sub-sectors of chemicals and polymers) have been experiencing a harsher economic climate. Sectors of strategic and infrastructural significance (oil & gas, refining and nuclear) are affected also by policy and regulatory drivers and global demand. In the case of the latter, this has had a positive effect on perceived future employment prospects, particularly for nuclear new build that will be sustained well into the next decade.

6.1.2 Chemicals

The most affected areas are those supplying the construction and automotive sectors. Sub-sectors still doing well include agrochemicals and supply to pharmaceutical companies. Parts of the sector that supply chemicals and packaging for food and drink manufacturers are withstanding the general downturn. Production of soaps, detergents, cosmetics and toiletries also continue to do relatively well. However, paints and other industrial markets have noted a marked decline, linked to the slowdown in the housing market.

6.1.3 Pharmaceuticals

The rise of generic drugs (post patent lifetime) and contract manufacturing had already preceded the recession. It could be argued that these trends will continue to exert a stronger influence on the future of the industry than the latest recession. However, many small and medium pharmaceutical companies are riding the recession to date. The move into biological molecules (Biologics) is potentially an innovation and growth area with a horizon stretching beyond this recession.

6.1.4 Polymers

The brunt of the recession has been borne by polymer employers more than any other Cogent industry. Evidence across the EU illustrates that polymer industry activity and migration can be an economic barometer of major manufacturing capacity. A number of large multi-national polymer companies are reviewing their UK options. The smaller indigenous companies, perhaps with local or specialist niche markets, and a nimbleness to innovate are faring a little better.

6.1.5 Nuclear

To date there is no evidence that the recession is having a significant effect on skills in the nuclear industry. The expected nuclear new build is a process that will take place over more than ten years, with substantial lead-in times for equipment. Indeed, substantial investment in new stations is expected to begin around 2012– someway after the expected depth of the current recession. In any case, the first cheques are likely to be written by major international utilities, with strong capability to invest despite the current market conditions.

6.1.6 Oil & Gas

The effects of the recession combined with the global banking crisis are causing the oil and gas industry to act urgently to ensure continued new investment in the UK Continental Shelf reserves to enhance extract and extend the lifetime of the fields.

6.1.7 Petroleum (refining and retail)

The general economic downturn has affected demand for fuels, but there is a threshold level at which decline in demand will bottom out, given the demand for transport from all sectors beyond that of industrial and business. One major oil company has announced a 10% reduction in its UK workforce in a cost cutting exercise. Other companies in the supply chain are reducing

[33] Cogent, Contribution to Alliance of SSCs *"The impact of the economic downturn on business and skills in England"*, May 2009, and Cogent, *"Recession Piece for England"*, April 2009

staffing levels resulting in a downturn of services to major installations in the UK. Most large companies are now recruiting on a conservative basis. A number of oil distribution companies and authorised distributors have been affected by the downturn in the supply of petroleum products, especially with the high cost of diesel as haulage contractors cut back on their purchase of fuel.

6.2 Emerging Technologies

The proximity of the science base to its application in the Cogent industries, allows technological change to have a rapid impact, which can then be exploited to respond to commercial and societal expectations. The emergence of new technologies is both a commercial necessity to maintain competitive advantage, and an opportunity to add to the value chain through increased functionality, or decreased costs and environmental impact. At the end of the first decade of the twenty-first century, a number of developments point the way to changes in the Cogent sector in Life sciences and Pharmaceuticals, Industrial Biotechnology, Composites and Plastic electronics.

This section of the report summarises on-going Cogent work in the skills analysis for emerging technologies. As described in the introduction, the Future Skills strand of the research programme will produce an in-depth report each year on a significant area within the footprint. The following discussion reflects the development of the analysis to date; which is to say that equal weight has not been given to each technology.

In some cases, notably in the advanced manufacturing areas of composites and plastic electronics, emerging technologies exist as major cross-sector activities where it is the combination of advanced materials and manufacturing that provides the functional advantage. In these areas Cogent and SEMTA are developing a partnership to deal with the skills issues that arise.

An issue of particular significance for emerging technologies is that of the transition to a low carbon economy. There is merit in addressing the common themes of the low carbon technologies, and Cogent recently contributed to the Low Carbon SSC cluster report[34]. In this discussion, however, the potential benefits are addressed within the technology areas, where the particular attributes can be identified in context.

6.2.1 Life Sciences and Pharmaceuticals

Life Sciences and Pharmaceuticals are strategic sectors in which the UK is a world leader. The Pharmaceutical industry invests more in R&D than any other business sector. And that investment is increasingly in the area of Medical Biotechnology. The NHS, the dominant UK 'client', is one of the most mature and advanced healthcare services in the world. Covering the entirety of the UK population, its healthcare network, its skilled resource of healthcare scientists, its clinicians, and its vast patient databases, constitute a powerful offer on clinical trials and the development of new medical biotechnologies. Further, the public sector, through the NHS and Higher Education, is the main provider and investor in specialist skills supply, scientific research, and the main purchaser of healthcare solutions.

Altogether, these sectors, if nurtured and facilitated, can become high-tech drivers of economic growth, provided the sectors can find new, collaborative ways forward and source the new high-tech skills in the right place at the right time.

The development and future for skills in these sectors have been recently addressed in a detailed future skills review[35] completed for the UKCES in December 2009 by Cogent, SEMTA and Skills for Health.

[34] Low Carbon Cluster Report to UKCES, December 2009

[35] Life Sciences and Pharmaceuticals Cluster Report to UKCES, December 2009

a) Insight - the Industry Today[36,37,38,39, 40,41]

i) Econometrics

- £52.5bn R&D spend by Pharmaceuticals & Biotechnology companies globally (2007)
- 98 of the 178 Pharmaceuticals & Biotechnology companies are US-based (2008)
- UK largest share (15 of 60) in European Pharmaceuticals & Biotechnology (2008)
- UK sales in 2007 for Pharmaceuticals increased by 4.7%
- Global sales in 2007 for Pharmaceuticals increased by 9.4%
- R&D accounted for 15.9% of UK sales in 2007
- Eight of the 25 top global R&D investors are pharmaceutical companies (2008)
- Two of the top eight Pharmaceutical R&D companies are UK firms (2008)
- Two UK companies spent 89% of the sector total, and 37% of the UK850 [42] (2008)
- 30 Pharmaceuticals & Biotechnology companies in the R&D UK850 (2008)
- £7.9 billion invested in Pharmaceutical & Biotechnology R&D by 130 UK firms (2008)
- Pharmaceuticals & Biotechnology accounts for 37% of total R&D spend in UK (2008)
- Five companies account for 77% of investment in R&D by firms from the UK850 (2008)
- 56 Foreign-owned Pharmaceuticals & Biotechnology companies in the UK850 (2008)
- UK Pharmaceuticals Exports (2006) £14.6 bn
- UK spend on medicines as a proportion of GDP: 0.94% (2006)
- The Pharmaceuticals industry accounts for 1% of UK GVA (2006)
- UK sales share of the world's top 100 prescription medicines (2003): 20%
- UK market share of new medicines (2003): 17%
- The Pharmaceuticals & Biotechnology sector was the largest contributor to R&D in both the UK850 and the G1400[43] in 2007.

The picture of the industry today is one of a large, skills intensive, workforce contributing significant added value per employee. But R&D costs are rising faster than sales, reflecting the highly safety regulated environment in which the transfer to market takes place. This suggests that investment in R&D alone will not produce the innovative products required to sustain the industry at today's levels.

The Industry in 2006 had an annual turnover of £15.68 bn, with a Gross Value Added (GVA) of £7.45 bn. This equates to an average GVA *per* employee of £109,000 compared to the UK average of £31,419. The turnover has increased by £6.4 bn since 1998. GVA in the industry has also increased significantly in the same period. Pharmaceutical companies in the UK spent £7.9 bn on R&D in 2007 – an investment of around £20m every day. Well over a third of all UK industry-supported R&D comes from the pharmaceutical industry. The Association of British Pharmaceutical Industries note that of the major medicines sold in the UK, around half were developed in British laboratories. Analysis of the UK top 850 R&D companies in the UK shows Pharmaceuticals as the number-one investor (Figure 30). [46]

[37] Cogent Pharmaceuticals Industry Factsheet, 2007 - http://www.cogent-ssc.com/research/Publications/factsheets/Pharmaceuticals_Factsheet.pdf (Also, Appendix 2)
[38] Cogent Industry Trend data, 2008 - http://www.cogent-ssc.com/research/Publications/publications/ABI_TRENDS.pdf
[39] Cogent Regional Factsheets, 2007 - http://www.cogent-ssc.com/research/regionsindustry.php
[40] Cogent Sector Skills Agreements 2007, http://www.cogent-ssc.com/research/SSA_publications_Index.php
[41] The R&D Scoreboard 2008, Pharmaceuticals and Biotechnology, Sector Summaries, HM Government
[42] The top 850 companies for R&D expenditure in the UK
[43] The top 1400 companies for R&D expenditure in the world

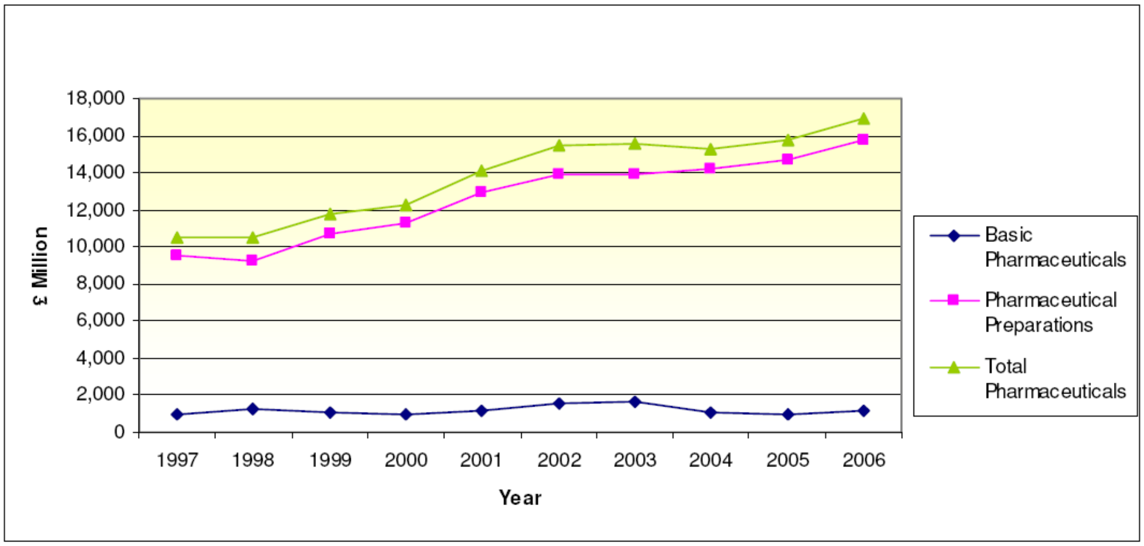

Figure 29: Turnover for the Pharmaceuticals Industry 1997-2006[44]

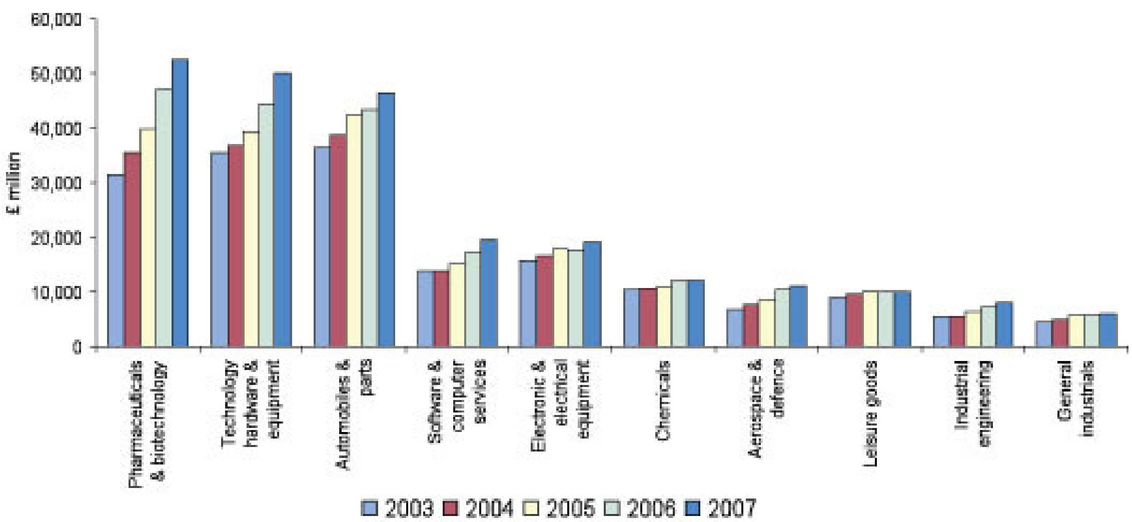

Figure 30: R&D Growth[45]

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[44] Annual Business Inquiry 2006
[45] R&D Scoreboard, Dept for Business Innovation & Skills, 2009

ii) The Workforce and the Geography

The Pharmaceutical Industry in the UK currently employs approximately 70,000 people in 600 companies. Around 28,000 of these are employed in R&D activities. Total employment has remained stable since 1998. Both LFS and ABI sources indicate the workforce is characterized by a dominant proportion of senior management/professional skills (almost 50% at Level 4 and above) and a significant proportion of supporting technical skills (up to 35% at Level 3).[8,] In comparison to most manufacturing sectors, the industry has a large proportion of female staff - 44%. This is not untypical, though, for employment in healthcare sectors.[8,] Regions of high concentration in the industry are the South East, the North West, and the East of England. These regions employ, respectively, 24%, 21% and 12% of the total workforce). Data for each UK region and nation are published by Cogent.[39]

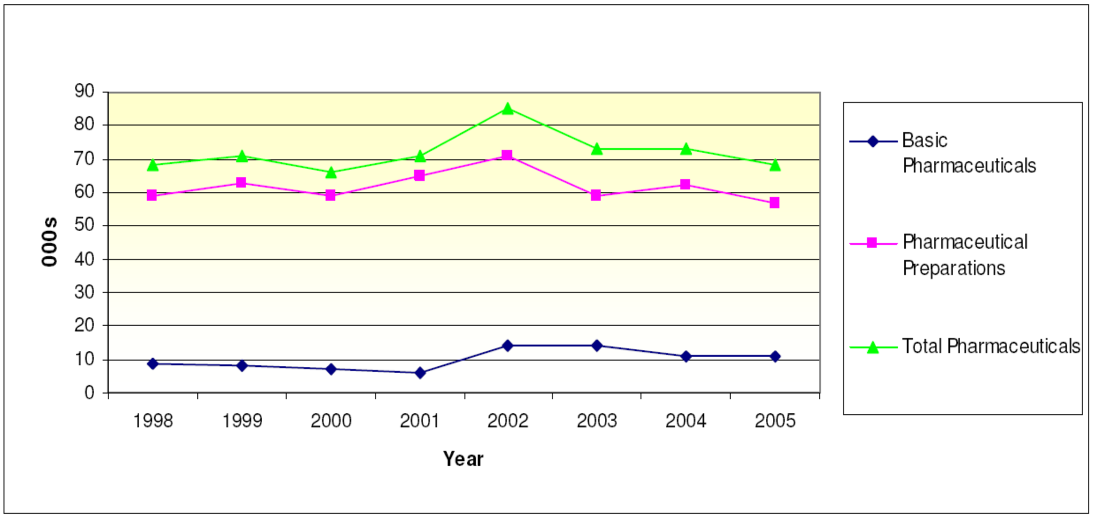

Figure 31: Employment in the Pharmaceutical Industry 1995-2005[16]

iii) Skills

In 2006/07 Cogent carried out its Sector Skills Agreement research into the Chemicals and Pharmaceuticals industry.[40] The research found that, *inter alia*, technical skills were at a premium. Skills gaps were reported for Management and Leadership, Business Improvement Techniques and upskilling according to the Cogent Industry 'Gold Standard'. A need for large numbers of Apprentices was also identified. Standards and qualifications have since been developed and the formation of the National Skills Academy for the Process Industries was announced in 2008 to raise demand and deliver training through accredited providers.[46] Independently, but also consistent with this, the SEMTA *Bioscience SSA* of 2006,[47] which also included the Pharmaceuticals sectors, reported skills gaps at management level (including researchers and scientists) scientific and technical levels. In the case of 'hard-to-fill' vacancies, the most commonly cited scientific and technical skills in short supply were chemical, biological and medical sciences. These findings correspond very closely to those reported by Association of British Pharmaceutical Industry (see below).

In terms of the supply of skills from HE, the Association of British Pharmaceutical Industry, the Bioscience Industry Association, and the Biosciences Federation have conducted surveys.[48]

[46] http://www.process.nsacademy.co.uk/

[47] *Bioscience Sector Skill Agreement,* Semta, 2006, http://www.semta.org.uk/employers/science/about_sector_skills_agreements/bioscience_ssa.aspx

[48] *Sustaining the Skills Pipeline in the Pharmaceuticals and Biopharmaceuticals Industries*, the Association of British Pharmaceutical Industry, 2005; *In vivo Sciences in the UK: Sustaining the Supply of Skills in the 21st Century*; the Association of British Pharmaceutical Industry, the Biosciences Federation, 2007; *Skills needs for Biomedical Research*, the Association of British Pharmaceutical Industry, 2008.

Key findings are skills shortages amongst potential recruits, including the following:

- Core practical skills: concerns over - competency in basic laboratory skills; paucity of placements; practical science in schools
- Mathematical skills: concerns over - post-16 level mathematics knowledge; understanding of statistics; qualitative analytical techniques, numeracy
- First degree graduates: concerns over mathematical capability; practical skills; application of scientific and mathematical knowledge; variability in subject discipline
- Skills gaps in disciplines at a range of educational levels across R&D and Manufacturing.

Some of the most at risk areas are:

- Biosciences

  Pharmacology, Physiology, Biotechnology, Biopharmaceuticals, Drug Metabolism, Toxicology, Pathology, Pharmacokinetics and Pharmacodynamics

- Chemical Sciences

  Analytical Chemistry, Physical Chemistry, Synthetic Organic Chemistry, Computational Chemistry

- Engineering

  Chemical Engineering, Process Engineering, Mechanical Engineering, Electrical Engineering

- Mathematics and Information Technology

  Statistics, Informatics

b) Foresight - the Industry by 2020

The existing business model in Pharmaceuticals is not sustainable. Innovation is required to respond to rapidly changing demand and technological opportunity. Set against this, costs remain high because of investment in skills, capital equipment for research and plant that are essential. And the position is further compounded by the inability of the market to sustain current price margins.

Biotechnology offers the innovation required for targeted markets with reduced risk and accelerated product pipelines. Biologics, pharmaceuticals produced by micro-organisms rather than synthetic chemistry, will produce the product candidates with high molecular specificity; bioinformatics will help filter the most propitious candidates; and therapeutics will be modelled using dynamic virtual biosystems powered by a highly advanced systems biology capability so that only the most efficacious drug candidates are offered for clinical trials. Overall, the increased efficacy reduces risk and development costs. The more focused approach on the client means a greater degree of technical service support and engagement with the healthcare provider will be required.

There is already evidence of the commercial restructuring. Increasing mergers and acquisitions mark the end of the vertically integrated company and a shift to sourcing new expertise, innovative processes and intellectual property. Patent activity suggests that biologics is already taking hold.

The ‘factory of the future’ will mostly involve discovery (R&D), experimental scale-up, and the process-intensive manufacture of biological APIs (therapeutic proteins, monoclonal antibodies, recombinant DNA etc). Discovery will be the business of small, science-driven biotech companies (~10 employees). The UK research base for biologics is second only that of the USA, and should assure a future for the discovery end of bio-pharma. Products will be of low volume, *e.g.*1-2 litres of fermentation liquor.

Scale-up and process-intensive manufacturing will be out-sourced to contractor manufacturers who will receive such products from a broad array of small discovery companies.

Regulatory trends, “personalized” therapy for the individual patient; and cheaper medicines will drive much leaner, real time product release, and flexible manufacturing as the medicines are made and packed to order.

In response to the new technologies, the complexion of higher level skills will change with increasing inter-disciplinarity and the development of manufacturing processes will stimulate a requirement for significant workforce development. Historically, this has been an industry that has shown stable employment for decades. This section assesses the effect of change on the size of the workforce and the skills of that workforce.

Working Futures[49]

The Working Futures report predicts demand for pharmaceuticals to continue to rise with an ageing and wealthy population but it does recognize strain on healthcare budgets with the prescription system increasingly using generic drugs and encouraging self-medication (over the counter drugs). In the longer term positive replacement demands are reported – of the order of one-third in the decade 2007-2017.

i) The Factory of the Future

A recent scenario workshop convened by Cogent and which included Seta and the ABPI, considered the skills development that will be needed for the workforce of the future in UK Pharmaceuticals manufacturing.

- *All Manufacturing Sectors*

Employee Skills Passports recommended to record training and development. This will facilitate change and skills retention of skills during a transition period for the sector.

- *Discovery Companies*

BIT/PAC (Business Improvement Techniques/ Performance and Competitiveness)

BIT/PAChas a role for the small business as the discovery businesses matures. They are predominantly staffed by PhD-level scientists and owner/entrepreneurs, many with limited overall business experience.

Laboratory technicians: The discovery companies recruit mostly from academia (PhD scientists), and these scientists do all the experimental work. Much more of the routine work could be done by suitably qualified lab technicians supervised by the scientists.

- Contract Manufacturers

Manufacturing disciplines are highly relevant to this part of the supply chain envisaged for the future. A site will have 150-180 employees (4 shifts). As in current Big Pharma, the majority of the employees will be Operators, but will be very highly skilled and educated.

Operators: Very highly skilled, some graduates (Level 3, 4 or even 5). Will need to be in-depth problem solvers, able to set up, and start up a production batch run, interrogate process information in real time, understand the underlying science (chemistry, biochemistry, chemical engineering, sterile engineering). Products will frequently change as experimental materials are sent in from the labs of the discovery companies. The operators will also need to do some maintenance work. They will also be adept in IT (interrogation and maintenance).

Fitters: Traditional fitters will be required but only a minimum. Currently they are a substantial part of the workforce.

Electricians: Minimum number.

Process Expert (Level 4 or 5): Chemical engineer, able to reconfigure processes for different products.

Quality Assurance and Quality (Level 3): Finished products require analysis. To what extent QA and QC will be integrated into the Operators' job is not clear.

Stockroom and Warehouse: Minimum inventory and product (products made to order, real time release. Biological raw materials and products may require special conditions (cold store) and may have short shelf life.

- Filling and Packing: This will be a machine-driven environment requiring traditional skill sets (Level 2 operators). But packing to order in a more automated, high-speed process will demand better technical skills (including routine maintenance) to minimise over- and under-fill and cost control. Lean manufacturing will be essential because of cost and time pressures. However, compared to the new Contract Manufacturing environment (above), the jobs will continue to be repetitive in nature. Business Improvement Techniques/6 Sigma/Lean skills and training will be the norm. Qualified persons (Level 4 or 5) will be needed, as at present.

ii) Workforce Stock and the Flow Predictions

In 2008 Cogent published its first estimates of 'stock and flow' of employment in its sector. With 'stock' corresponding to current and projected levels of employment in the sector, the main outflow was taken as retirement and the main inflow was taken as new blood to the sector from university graduates, apprentices etc (taking other flows as static and small in proportion to these two). While the analysis covered all industries, the process is re-worked in this study taking account of the latest scenarios for the

[49] *Working Futures 2007- 2017,* the UK Commission for Employment and Skills

pharmaceuticals sector. Figure 32 portrays the workforce stock of 70,000 with 73% of employment in technical or higher occupations – outstripping all other sectors in the proportion of higher level skills employed. Stock projections for the industry are dependent on the future scenario.

This analysis uses a scenario in line with Working Futures, which projects sustained employment to 2020 and a significant net replacement demand of up to one-third of the 2007 workforce per decade due to age and market change. Two dominant factors are considered to affect stock demand in this study: emerging technologies and their effect on R&D (Skills Shortages) a shift in manufacturing to the more nimble 'factory of the future' (Skills Gaps). The first, emerging technologies, will potentially re-focus research and will sustain higher level skills demand overall. However, the composition of higher level skills will change in a manner beyond the scope of this preliminary research. Mergers and acquisitions, alliances and collaborations will bring a new workforce, new expertise and new dimensions on skills, especially in biotechnology into the sector. This will be the area of skills shortages in recruitment for a new type of workforce. The second, the factory of the future, will raise workforce development demand. Employees will be required to know and be experienced in more of the business value chain than just a single drug product. This will be the area of skills gaps in the workforce.

In general, skills inflation is predicted for the dynamic decade ahead. The postgraduate proportion of professional occupations will increase; the technical occupations will require more graduate skills (e.g. Foundation Degree level) and other occupations will shift to Higher Apprentice level.

A replacement demand of one-third per decade is estimated to correspond to approximately 27,000 by 2020. The higher level occupational requirement is estimated to be 60% of this range (16,000); the technical occupations 25% (7,000); and, the process occupations 10% (2,700). An estimate of the current flow of graduates into the Cogent sector can be found through HESA destination analysis.[50]

In 2008, HESA data suggests that graduate intake is 1,300 (weighted relative to HESA return rate). It is also noted that the science and engineering intake by the industry is a very small fraction of the total produced annually by HE, thereby indicating that simply increasing the numbers of students in these subjects, when there is distinct vocational demand, is a weak lever to direct supply to the industry.

It is also noted that the regions of domicile of graduates do not precisely match the regional clusters although the South East and North West are prominent. This is more a reflection of the location of the provision than the employment.

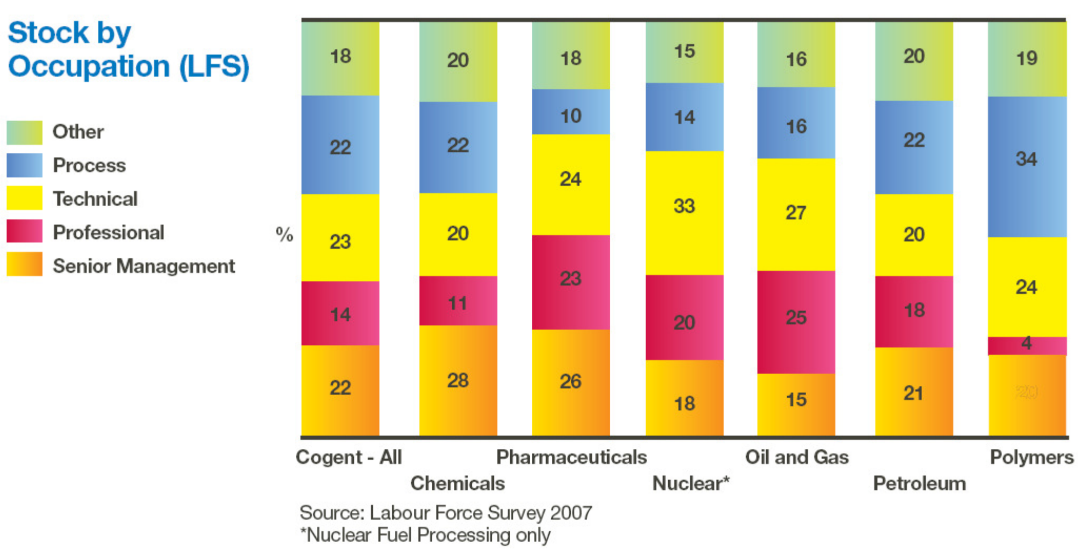

Figure 32: Stock by Occupation[10]

[50] Higher Education in the Cogent Sector at a Glance, Cogent SSC, 2007
http://www.cogent-ssc.com/research/Publications/publications/HE_at_a_glance.pdf

Figure 34 illustrates the scientific graduate intake for the Pharmaceutical industry. Chemical and Biological Sciences dominate with a combined 51% of the scientific cohort. Pharmacology, Toxicology and Molecular Sciences are closely related to these two disciplines and make up a further 21%. When disaggregated from the subject categories, the subject titles show the breadth of science and engineering required by the industry. The projected graduate supply at today's rate would supply 15,600 of the predicted 16,000 replacement demand. However, the overall statistics may well disguise a shortage within the science disciplines that are reported as hard-to-fill.

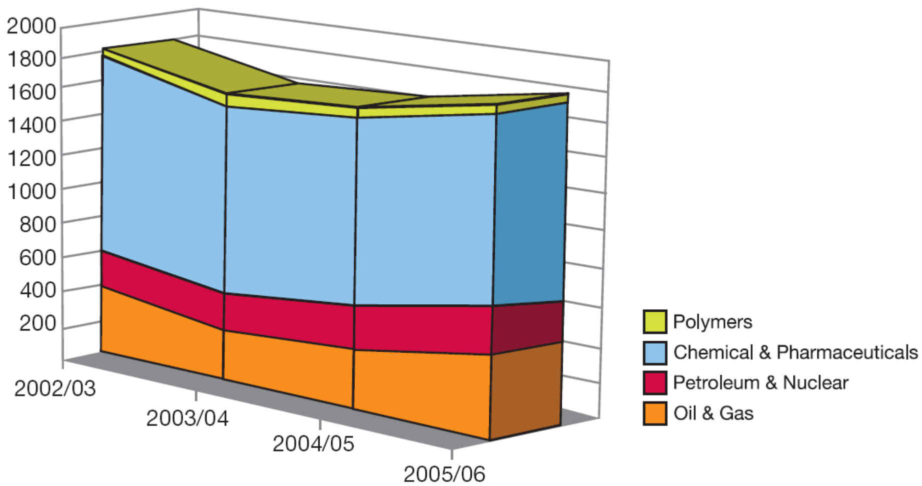

Figure 33: STEM Graduate Flow (HESA 2007), Cogent SIC (2005/06)' [51]

Scientific Employment	Scientists % intake 2008	Graduates %intake 2008	Supply by 2020
Chemical Sciences[1]	28	13	2,000
Biological Sciences[2]	23	11	1,700
Pharmacology &Toxicology[3]	15	7	1,000
Molecular Science[4]	6	3	500
Engineering[5]	5	2	300
Mathematical Sciences[6]	4	2	300
Subjects allied to Medicine[7]	3	1.5	230
Physical Sciences[8]	2	1	150
Total	86%	41%	6,180

Figure 34: Pharmaceuticals Industry Graduate Supply (SIC03 24.41, 24.42)[53]

Notes
1. Including: Medicinal Chemistry, Analytical Chemistry, Biological Chemistry, Pharmaceutical Chemistry
2. Including: Microbiology, Genetics, Applied Biology, Applied Biological Sciences, Animal Science, Physiology
3. Including Pharmacy
4. Including: Molecular and Applied Molecular Biology, Biophysics, Biochemistry
5. Including: General Engineering, Chemical, Process and Energy Engineering, Mechanical Engineering
6. Including Statistics
7. Including Clinical Medicine
8. Excluding Chemical Sciences

[51] *Higher Education and the Cogent Workforce,* Cogent SSC, 2008, http://www.cogent-ssc.com/research/Publications/factsheets/HE_Factsheet.pdf

The data suggest that the industry generally sources what it needs regarding graduates' skills, but that there are some hard-to-fill scientific disciplines that are the foundation of future growth. It is noted that 25% of the overall graduate intake goes, at least initially, into lower occupational levels. The focal point of graduate skills is therefore one of graduate workforce development and CPD in a fast-changing industry. There is a paucity of comparable data for vocational routes to the industry making analysis less precise for the technical and process occupations. A general analysis by Cogent SSC in 2008 explored the age profile at these levels and the inflow *via* apprenticeships and vocational qualifications.

Large skills gaps were measured, with supply predicted to be insufficient to meet replacement demand. Apportioning the data to the Pharmaceuticals sector gives a shortage of 4,000-5,000 or up to 50% of the predicted replacement demand for technicians and process operators. It was further predicted that this deficit would increase significantly in the next decade. This coincides with the known lowest point in 16-18 year-olds in the general population. For the technical and process occupations, regardless of shortages, there will certainly be significant levels of skills gaps. This is to be expected for a fast-changing sector. The influx of large volumes of newly skilled people will bring with it demand for workforce development in a strategic sector where the UK has a prime position and one that should be protected through skills investment. Taking account of the biotechnology scenarios above, it is emphasized that roles will change gradually within 5 years and significantly within 10 years.

iii) Future Labour Market Research

Labour Market Research is in progress with the industry including the Skills Oracle[52] (Cogent, Dec 2009), the Bioscience Skills Balance Sheet (Cogent, SEMTA, Dec 2009) and Scenarios for Industrial Biotechnology (Cogent, 2010).

c) Summary and Skills Implications - Pharmaceuticals

The UK has a world-leading Pharmaceuticals Industry which, by most econometric measures, has an impressive impact for the UK economy. The industry is sustained by access to a supply of highly skilled graduates and postgraduates, quality research from Higher Education, a large 'client' National Health Service, and the proximity of a significant supply-chain Chemical industry.

The Pharmaceuticals industry employs 70,000 people in the development and manufacture of drugs. Over 70% of the employment is at the technical and professional levels.

Regional concentrations are in the North West and the South East of England which together make up 45% of employment. The East of England is a further cluster region comprising 12% of the industry's employment. The industry will be entering a phase of prolonged change. Anticipating skills demand and developing robust data to underpin the preliminary analysis of this paper is a priority. An employer-validated scenario planning study should be undertaken and reported within a year.

The study should use the model developed by Cogent with the Nuclear industry and the Office for Nuclear Development (DECC) and be overseen by the Office for Life Science (BIS) and report to the Skills Forum. For a timeline to 2020 the scenarios should research what new skills are required, by when and develop a stakeholder action plan. The industry creates at least 1,000 new jobs per year for UK graduates, 45% of which are in sciences – mostly chemical and biological. Up to 30% of the science intake comprises small numbers (1-2% each) of highly specialized subject areas across life sciences and engineering, so that overall the profile of skills sourced each year by the industry is highly interdisciplinary, 60% graduate, and 40% postgraduate. While some posts are recorded as hard-to-fill, and surveys indicate skills gaps with the intake, in general the graduate level of recruitment may be just sufficient to meet the projected need but should be monitored. Also, vacancies may be increasingly hard to fill (and should be monitored). If there is a general step to increasing postgraduate intake, competition for these critical skills will be more intense. Industry and career awareness programmes have a role to play here. Replacement demand in the technical and process occupations may be acute and routes to sourcing new supply will have to be addressed, perhaps through targeted and supported Apprenticeships. An industry reliant on higher level skills requires a significant and competent technical workforce to support both research and manufacturing. Recruitment data in this area is less robust, but from the age profile, shortages up to 50% of replacement demand are predicted for the technical and process occupations if the industry is to retain

[52] http://www.cogent-ssc.com/research/Oracle.php

today's employment levels. Robust vocational destination schemes should be developed to monitor a critical part of the workforce.

The large turnover in people and the pace of technological change will drive a massive need for workforce development, especially in the biotechnologies with which the Pharmaceutical industries are engaging. Targeted Technical Foundation Degrees, Higher Apprentices and Technical Masters in the fields of Biotechnology and Bioscience should be supported, developed and delivered to the workforce. This could provide a continuous higher upskilling 'seam'.

With so much technology-driven change in the system, there will be massive demand for workforce development - both reskilling, upskilling. The education system in science and engineering is well geared for supply, but vocational provision that caters for employer demand is comparatively weak. At the technical and higher levels, part-time provision for employers has shrunk drastically since the demise of the Polytechnic system in the early 1990's. Establishing a new network of Technical Foundation Degree providers in the priority regions could address this. With provision limited, the industry itself has developed a good training record but the scope of training required in future may become unsustainable. Accordingly, the industry would require reliable and accredited sources of training and education, a more mixed curriculum across the technical, the commercial and the regulatory, and a skills funding mechanism that recognizes the shared value of skills to the individual and the business. In a new departure for growth, the local and regional economy, and the strategic position of the industry, should be factors for consideration of support.

Given the pace of change, overcoming inertia to reskill is a key consideration. A 'Bio Primer' series in Industrial Biotechnology and Industrial Bioscience should be developed with industry and for industry. And specialist learning modules should be built around this series. The Sector Skills Councils should commission these, industry should inform/resource the development, the National Skills Academies should drive demand and deliver the modules through accredited training providers.

The period to 2015 will be one of gradual change; that to 2020 may hold significant change. The old economic model based on high R&D investment, patent protection, and high-margin manufacturing will be challenged. The high-cost high-value equation will no longer sustain the business model for either the industry or its health sector clients.

The skills mix in the future is likely to be higher, wider and more interdisciplinary. Research will be more niche, innovative, project-driven and reliant on new technology platforms. In manufacturing, the factory of the future will be more flexible and responsive to technological innovation and a new client relationship. On the whole, for sustainability, there needs to be significant 'ventures' with Higher Education and with the Health sector so that timelines and costs for discovery, approval and efficacy are reduced. Reform in the NHS is required to facilitate this. The strategic role of the Office for Life Sciences is an excellent start. In general, this scenario portends a shift towards a value-added technical service for the industry. There will be significant skills inflation in the sector; technical occupations will require a higher proportion of graduate skills, while the professional occupations will become increasingly postgraduate relative to today.

Exploiting inter-disciplinarity has been a feature of the Pharmaceutical industry. But this trend will intensify in the future as all discernable advances are at the interfaces of the sciences - and particularly at the interface between chemistry and molecular biology in this industry. Acquiring these skills will generate new challenges for employers, especially in those areas that are already recognized as hard-to-fill. The market for postgraduate skills will be more competitive as the pool is smaller and more sought after. Employers will have to offer attractive and fulfilling career opportunities. There may be scope for Masters preparation/conversion for those considering a career in the Pharmaceuticals industry

Life Sciences and Pharmaceuticals is a strategically important sector. The future for Pharmaceuticals is predicted as stable but dynamic: stable in employment but, within that employment, a shift in skills is required to support new biotechnology-driven products and services. The changes and skills developments must be embraced by the industry and facilitated by Government for the sector to be well-placed to retain its global premier status.

6.2.2 Industrial Biotechnology

a) Background to the Sector and Main Drivers

Historically the development of the use of biotechnology has been in the food and drink, pharmaceutical and biological intermediary sectors, where the production of biologically based products (e.g. beer, vaccines and enzymes) have made full use of processes which have been researched and developed in the biological sciences.

The key market sector to date for the use of Industrial Biotechnology (IB) has been in the pharmaceuticals and other health care products (vaccines) sectors, having developed from their strong links with life science R&D. Advances in the use of molecular biology, genomics and microbiology made in the 70s, 80s and 90s have led to the increased use of biotechnology in large scale biological production of products such as synthetic insulin, human growth factor and clotting agents. Leading on from this, it has been recognised that the technology lends itself to the manufacture of chemical products and in particular products that rely on the use of oil as their stock material.

In addition, the drive for higher efficiency and reduction in carbon emissions IB offers a genuine viable alternative for the manufacture of such products. Key candidates include the manufacture of biofuels from arable feedstocks, bio-pesticides and industrial cleaning chemicals. This is not a disruptive technology, the markets remain the same as those the traditionally produced for the use of the chemicals and fuels process industries. Therefore, the focus for the research and development of IB has moved from the bioscience based industries, such as pharmaceuticals, to chemical manufacturing. Whilst the end usage of the products will remain the same, the processes used to manufacture them are still being developed, hence the need for further R&D in this sector.

Globally the technology has received significant attention and investment and yet its full potential has yet to be fully realised. The barriers to IB's adoption by the chemical sector remain significant with lessons to be learnt as to public perceptions of biotechnology, as illustrated through the case of Genetically Modified (GM) crops must be learnt to avoid any such public rejection of the use of the technology by consumers.

Estimates of the global IB market to 2025 vary from £150bn to £350bn with the UK potential being in the order of £4bn to £12bn. The latter corresponds to up to 20% of the UK sales value of chemicals today.

In summary, whilst the potential for the expansion of biotechnology R&D into the chemicals sector is evolving, the take up of the technology in the chemicals sector so far is at best limited. In fact, in recent decades the chemicals industry has become much less R&D intensive, with exception of Pharmaceuticals sub-sector. Even so, R&D investment in the chemicals manufacturing sector still totals more than £21bn each year in the UK.

The European Technology Platform for Sustainable Chemistry (SusChem), through the development of a Strategic Research Agenda has identified the major areas of research that needed to be developed to ensure that IB becomes a significant contributor to future bio-based economies. The research needs to focus on three main areas, biomass, bioprocesses and bioproducts, including bio-energy.

b) Contribution to the Low Carbon Economy

Chemicals is one of the highest industrial users of energy and is reliant on security of supply of its main feed-stocks – oil and gas - and the stability of that market.

IB has the potential to lower the carbon footprint of the industry through biocatalytical processes and to reduce environmental impact by using aqueous chemistries. In short, IB offers a route to sustainable development for the sector. But IB requires the chemicals sector to innovate through new technology based on bioscience.

c) Adoption of IB in the Chemicals Industry

IB is relevant to all the main subsectors of chemicals – Commodity Chemicals, Speciality Chemicals, and Fine Chemicals – but especially to Speciality and Fine Chemicals. In these sub-sectors not only is the impact already visible but the pace of penetration is predicted to accelerate.

A number of examples of IB in chemical manufacturing are already apparent in the UK:

- Manufacture of S-Chloropropionic Acid (Avecia)
- Enzymatic Synthesis of Acrylic Acid (Ciba/BASF)
- Enzymatic Catalysed Synthesis of Polyesters (Baxenden Chemicals)

The Chemical Innovation Knowledge Transfer Network recently surveyed the sector on the awareness of IB. Key findings were that at least 33% of the sample were already using IB with a further 13% considering its use. Larger companies tended to be the main users but there was evidence of IB in all sizes of company in the sample.

The main areas perceived for application of IB in the near future were:

- Chemicals manufacture
- Polymer manufacture

- Biofuels manufacture
- Algae oil production
- Anaerobic digestion
- Enzyme production (detergents)
- Bioremediation
- Fermentation processes
- Oil extraction (food and cosmetics)

The results of the survey provide clear evidence of the growing take-up of IB. The early users are in renewable energies (biofuels, fermentation and effluent treatment). The main barriers to IB uptake were quoted as: lack of awareness, knowledge, technology transfer, expertise and experience. In addition, high risk and investment costs were cited. It was concluded that IB is a targeted activity for chemicals, relevant to up to half of the sector.

d) Current Skills

The adoption of industrial biotechnology into the chemical manufacturing environment will lead to an increase in demand for skills related to the technology as businesses across the sector seek to make greater use of IB to replace existing chemistry based products and develop new bio-based ones.

With the priority that government is now assigning to IB and the traditional strength that the UK has in this area, the successful development of this technology will depend on the skills pipeline and technology transfer with HE, public and private sectors working together closely to ensure that skills do not become a critical roadblock to the adoption of the technology across a wider range of industrial sectors. As with other advanced technology areas the focus is on higher level skills to meet the requirement of this area (PhDs and MScs with a specialism in industrial biotechnology). Whilst the technology has become well established within both the Pharmaceutical and Biotechnology sectors the use of the technology is still in its infancy in the chemicals sector and as such there is a requirement for R&D personnel in these areas to develop new skill sets.

With the global recession and climate change featuring at the top of political agendas the drive for IB to become a tangible reality is intensifying and so the demand for higher skilled employees conversant in the technology and the R&D of the technology will continue to increase significantly in the coming years.

A 2008 survey by the Department for Business, Innovation and Skills) BIS (IB – GT, November, 2008) suggested that the numbers of employees in the Chemicals industries with the required biological sciences training was very small at the time, with the result that IB R&D in the sector was extremely limited.

The response to this has been seen in the research funding from the Biology and Bioscience Research Council (BBSRC) in the areas of significance to biotechnology for industry (REF BBSRC report – Oct 2009). These include targeted priority studentships in Bioprocessing, Masters Training Grants (MTGs) in IB and Bioprocessing and Industrial CASE Studentships, which allow greater involvement from the private sector in PhD research programmes.

The BIS survey (IB – GT, November, 2008) cited a lack of expertise as the most important barrier to companies looking to use and develop IB but also amongst existing IB users who stated they had problems recruiting people with the right skill sets.

In 2007 Cogent carried out its Sector Skills Agreement (SSA) research into the Chemicals industry. This highlighted, in particular, the age profile and skills shortages and gaps in the large technical workforce of process operators, technicians and skilled trades that account for over 70% of the overall workforce.

The SSA process also revealed, among other things:

- A lack of skills and knowledge required for process improvements.
- A requirement for a rise in Technical Apprentices

To enable IB to take hold requires a new skills set for the chemicals sector. The skills shortages and gaps will depend on the state of the industry today, the diffusion and translation of innovation, and the success of skills supply to make the science happen. The following section reviews this position.

e) Future Skills

For the chemicals industry, Cogent has undertaken some scenario projections using the Working Futures forecasts to 2017. The projection forecasts a substantial net replacement demand of up to one-third of the 2007 Chemicals workforce due to age and market change, partly driven by IB. Taking account of all factors, it is estimated that by 2017, the chemicals workforce (excluding petrochemicals, paints and pharmaceuticals) may employ 100,000 people, of which 33,000 will be new employees sourced from the supply in education and training. These new jobs will be in technical and process operations (42% or 14,000 apprentices etc) and professional grades (39% or 13,000 graduates etc). It is estimated that approximately 50% of these jobs will require some knowledge of industrial biotechnology.

The complexion of the technical and professional occupations will change towards greater inter-disciplinarity.

To some extent the trends will follow what is now established in the Bio-pharmaceuticals sector, with growth in discovery companies, followed by mergers and acquisitions.

This will be particularly relevant to the chemicals industry to prime the innovation pipeline with the knowledge, skills and Intellectual Property Rights (IPR) in an industry in which R&D has lapsed relative to other high-value sectors.

The change in manufacturing processes will induce increased skills gaps and stimulate a requirement for significant workforce development, especially in the large technical and process operator workforces. There is a strong need to develop and retain highly skilled individuals who work at the chemistry-biology-engineering interface to lead the next generation of innovation as well to act as industry leaders for the future.

The section below summarises the main issues that have been highlighted in discussions around the industry:

- With the focus on the R&D of IB products in the chemical sector the need will be for higher level skills, namely first degrees, MScs and PhDs in the relevant subject areas
- Graduates and post graduates will also need to have multidisciplinary experience where ever possible as industrial biotechnology crosses the boundaries between such areas as biology, genetics, microbiology, chemistry and chemical engineering.
- With the emphasis on applied research, work experience will provide practical working skills for graduates and post graduates alike.
- Technicians capable of running the equipment associated with the development of the technology e.g. Biofermentation pilot plants
- New Product Development (NPD) and project management skills to provide the ability to generate products from the research being done on IB.
- Team working skills to ensure that research can work effectively with bioprocess engineers in the scaling up of bench top product to commercial scales
- Researchers with the skills to move seamlessly backwards and forwards across the interface between chemistry and the biosciences to enable them to develop biochemical/chemical products using biological feedstock and processes.

f) Supply-side Issues

Employment in Industrial Biotechnology will be predominately in Chemicals. For graduate intake as a whole in the chemicals sector, 75% are employed (at least initially) in the technical/associated professional levels or higher. Across the Cogent sectors the flow of science graduates is dominated by chemistry graduates, with almost 350 entering from this discipline alone in 2006, mainly into the chemicals and pharmaceuticals sectors. Of note, is the fact that these industries also recruited a further 100 biologists in 2006. These industries were also the largest recruiters of graduates across the sector (70%), see Figure 35. The Cogent estimates of employment stock and flow across the sectors, based on Working Futures projections, suggests that intake to the chemicals sector is likely to be about 1,800 graduates per year. These recruitment levels suggest a 25% shortfall in graduate intake to the sector to achieve the 13,000 higher level skills demand by 2017. This, however, needs to be confirmed by further consultation with the industry. Analysis of the remaining workforce is equally important in this field due to the high proportion of technical occupations supporting the business. It is estimated that 14,000 replacement posts in technical and process operations are required. In this area, large skills gaps are apparent, with supply being insufficient to meet replacement demand. It is also predicted that this deficit will increase substantially in the period to 2017.

These projections will create demand for the replacement skills in industrial biotechnology and workforce development in Industrial Biotechnology.

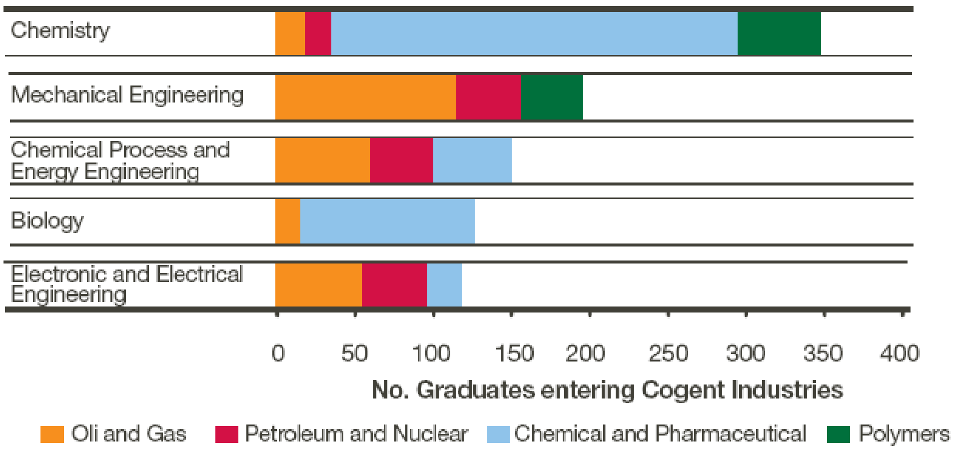

Figure 35: Number of Graduates Entering Cogent Sectors

The table below shows the trend number of first year undergraduates in the subjects relevant to IB, and is taken an indication of the number of graduates that are likely to be available for employment. The numbers of students taking relevant biological science and chemistry degrees had been declining, but in recent years the numbers have recovered. Only a limited number of students are enrolled on courses specifically on Industrial Biotechnology. One of the factors that the industry has to tackle is how to attract graduates in the science subjects that are needed into the sector. In the case of technicians, many have previously been trained through HNC/D programmes. Between 2002/3 and 2005/6, the number of students undertaking HNDs in Chemistry almost halved (starting at just under 100). In this connection, Cogent is working on creating a flexible, work-based Technical Foundation Degree Framework within which Chemicals and Bioscience are key sectoral strands. The chemicals strand is aimed at laboratory technicians and is being led by Manchester Metropolitan University while the University of Kent is leading in the bioscience strand. These workforce frameworks are aimed at upskilling existing staff in technical roles.

This project is an important test of employer demand for HE provision in workforce development and the co-funding model for learning through work.

g) IPR and Global Competition for Skills

Global competition will remain intense and it has been noted[53] that there exists the possibility that the R&D associated with IB will in itself become a marketable asset for the UK economy. It has been suggested that these global pressures have the potential to result in "a war for talent" as the global players scour the world for key personnel with the right skills and experience sets resulting in intensive competition for R&D scientists.

h) UK Strengths in IB

As a location, the UK has a number of potential advantages for an IB future: a large domestic demand for sustainable materials; a sophisticated and mature consumer market; good global trading links; strong regional clusters; a strong science and engineering base in the HE community; and, one of the strongest global R&D capabilities in biotechnology.

	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
Relevant Biological Sciences	13750	12725	12350	12785	12955	13015
Chemistry	3825	3640	3485	3895	3890	4095
Industrial Biotechnology	50	35	20	20	25	0

Figure 36: First year Full-time First Degree Students by Subject of Study in 2002/03 – 2007/8

[53] BERR IB2025 report, (May 2009), p35

Current R&D centres of excellence in industrial biotechnology largely reside in universities throughout UK (IB-IGT report Feb 2009) and will remain so for the foreseeable future as chemical sector companies develop collaborative partnerships with them and their own R&D capability to embrace the new technology.

6.2.2 Composites

Energy conservation and low-carbon policies of governments throughout the world will stimulate global demand for more versatile, lightweight, low-cost and energy-saving products.

The hallmark weight reduction and structural strength of composite materials will help reduce the fuel consumption of a variety of vehicles and machines that incorporate these materials.

This scenario, combined with the international reputation of the UK for engineering and design, makes for the potential to become a global leader in the sector.

a) Background and Main Drivers

Composites are mixtures of two or more discrete materials, which together form a material with superior physical properties. Advanced composites, including Polymer Matrix Composites, Metal-Matrix Composites and Fibre-Reinforced Polymers offer numerous applications, primarily because an extensive range of fibres, resins and metals can be developed to bespoke design and mechanical demand. In particular, carbon fibre, with its low density and high strength can be combined with a polymer/resin to yield a composite that can be moulded. Key features of such composites are:

- low density
- high mechanical strength
- moulding versatility
- low maintenance
- corrosion resistance

It is through these features that composites offer potential in replacing metals for many applications. This can: reduce production times and costs (moulding rather than forging and machining), increase lifetimes (reduced susceptibility to corrosion), increase performance (lower inertia due to low density). The significant energy savings both in production and operation means composites find application in many sectors such as

- Automotive
- Aerospace
- Marine
- Construction
- Domestic Appliances
- Medical Devices
- Turbines

The UK polymer industry is a major part of the supply chain network supporting UK capacity in these sectors. It is often found in clustered in regions with such manufacturing capacity, such as in the East and West Midlands. Engineered composite materials must be formed to shape. The matrix material can be introduced to the reinforcement material before or after the reinforcement material is placed into the mould cavity or onto the mould surface. The matrix material experiences a melding event, after which the part shape is essentially set. Depending upon the nature of the matrix material, this melding event can occur in various ways, such as chemical polymerization or solidification from the melted state. This level of versatility lends composites many cross-sector uses. According to BIS[54], estimates of the future value of the UK Composite market in the Construction and Automotive sectors, is at least £20bn, while the UK market for composite wind turbine blades will be worth in excess of £5bn. Composites is also a fast-growing export sector. Growth will be driven mainly by the big user industries – chiefly Aerospace and Renewable Energies, where the material's lightness and high mechanical strength find application in the manufacture of aircraft wings and fuselage, and in wind turbines. With a few global companies dominating this market (*e.g.* British Aerospace, Airbus, Boeing, Rolls Royce etc), the skills in the supply chain are critical alongside technology transfer. Competition in skills for this emerging sector will therefore be global as well. The deployment of composites in the automotive sector currently lags that of the Aerospace sector. However, as is the case with Aerospace, the dynamics of the large volume car manufacturing is global and competition for skills will, accordingly, also be global.

While the Marine industry would also benefit from composites technologies, it is widely

[54] Department for Business Innovation and Skills, http://interactive.bis.gov.uk/advancedmanufacturing/annex-case-studies/composite-materials/

predicted that this sector will be the last to be penetrated by the technology.

Composites process technology is closely related to that of the Polymer and Plastics industry. This is a highly diverse sector, comprising many enterprises in the supply chain to end-product manufacturers, especially those in the front line of advanced manufacturing e.g. automotive, aerospace and engineering construction. Over 7,500 companies operate within the sector employing some 286,000 employees. The industry has an annual turnover of £19.76bn, with a GVA of £7.31bn. These nationally derived measures are spread across the many process industries in the sector that operate at various levels. Within this large population, the Composites sector is the highest value-adding part of the sector.

b) Current Skills

National data include the polymer composites sector within what is a large and diverse UK industry. The occupational distribution of the polymers and plastics workforce illustrates that the sector in general is a mature one relying on process technology rather than new science. Accordingly, the dominant occupations are managers (20%) and process operators (35%). Furthermore, only 1,000 (0.3%) of employees are employed in R&D capacity.[55] Composites are an exception to this trend.

The Composites industries require researchers, innovators, technologists, designers and highly-skilled processing technicians with skills in the areas of structural design and modelling, manufacture, assembly, stress engineering, disposal, and maintenance, repair and overhaul. This will require innovation in process technology, materials technology and accelerated diffusion and translation to capacity and capability in the polymers industry and the manufacturing sectors.

The UK has several HE centres of excellence in Materials Technology, including Composites. In line with this, Composites is receiving significant government R&D funding (£64m over an 8-year period[56]). However, public sector R&D will come under scrutiny with the rising public deficit. Yet this is a highly applied research field and one in which a return on investment is highly tangible.

Although the investment required to develop new and emerging technologies and upskill/re-skill the workforce are high, global competition could place at risk the capability of the UK if such investment were not forthcoming. In Europe, there has been major investment in the development of composite technology centres and clusters for the provision of composites skills training for both employees and graduates.[57] The UK has recently responded to this in forming its own such centre.

Given that composites is a rapidly growing technology, there is a critical need for upskilling of the existing workforces, both within the polymer industry itself and the manufacturing industries that fabricate and make use of the composites. The supply chain to these industries is critical, and it is here that the most demanding challenges are faced in increasing SME commitment to and involvement in training.

As with the other emerging technologies, Composites development will draw also from a multidisciplinary range of graduates and postgraduates along with a secure supply of technicians if the UK is to compete internationally.

c) Future Skills

Clearly, there is a significant potential increase in demand for a workforce with a range of skills relating to composite manufacture and usage.

However, there are real concerns that industries will struggle to meet their existing business requirements, let alone future growth as a result of the skills shortages and gaps that could exist in Composites.[58] In response to this, the Government has published (late 2009) a cross-sector UK Composite strategy. This scopes ways to raise the awareness of the capabilities of composite materials, and the steps that are necessary to help improve the UK's capacity to produce composite structures cost effectively at the speed and volume required by key markets crucial to the UK's economic future.[59] This strategy takes account of the cross-sector skills relevance of both Cogent and SEMTA.

Future skills requirements have been identified by the National Composites Network as:[60] Short Term: processing techniques of hand laminating, infusion (vacuum forming) and pre-

[55] *Skills for Science Industries,* Cogent 2008; R&D in UK Business, 2006

[56] UKTI website http://www.entrepreneurs.gov.uk/gep/6101/en-GB.html

[57] NCN Polymer Composites Sector – UK Skills paper 2009

[58] NCN 2009, Polymer Composites Sector – UK Skills report

[59] BIS Advanced Manufacturing website 2009

[60] NCN 2009, Polymer Composites Sector – UK Skills report

impregnation lay-up, need training support; Medium Term: the more advanced industries will have to be trained for automation, whereas the lower tech companies will adopt infusion/ pre-impregnation; and, Long Term: All industries will have to adopt automation processes and the skills associated with that.

In response to the growing demand for skills developments in Composites, Cogent has proposed an extension to the remit of the National Skills Academy for the Process Industries to include composites (section 7.3.4).

In this way, an existing skills network can deliver the skills needs of a new sector Regardless of the outcome of the proposal, a new, high level, strategic employers group is being formed to lead on a national skills strategy for the industry.

This group, the Composites Employers Skills Group, will be jointly managed by SEMTA and Cogent in accordance with their new partnership agreement and supported by NCN & BIS. Key workstreams will include workforce development, 14-19 and higher education.

c) Supply-side Issues

Composites provision naturally sits with Materials in Higher Education. Much undergraduate provision in this area, as is the case with Polymer Technology, has eroded. Indeed, the formerly strong part-time provision, e.g. in HNC, has declined rapidly over the last decade, thereby limiting access to training for workforce development purposes. In contrast, the UK has a strong postgraduate focus on Composite materials. Such departments draw in graduate chemists, physicists and biologists with appropriate skills, to work closely with and alongside engineers and mathematicians to provide the range of interdisciplinary skills required for innovation and technological progress required.

A prime focus for many of these institutions is collaboration between academia, industry in knowledge transfer partnerships. But there remains a gap in strategic manufacturing research to support the supply chain for materials processing. As demand for composites rises, the supply of the postgraduate specialist skills will be at a high premium in the emerging industry.

To support this activity, a highly qualified technical support workforce will be essential. It is in this case that there is a serious risk of a gap in provision. In this regard, *Working Higher* is an initiative involving Cogent, HEIs and the Higher Education Funding Council for England (HEFCE) to set up a Foundation Degree Framework to address this risk in general across the Cogent footprint.[61]

Working Higher is designed to be a solution to workforce development needs by creating a flexible, work-based Technical Foundation Degree Framework of which Polymers/Composites is a key sectoral strand being led by London Metropolitan University. The flexible provision for learning through work, provided by *Working Higher*, will allow employers to better manage workforce development, will widen access for those in employment without prior HE experience and enhance employability for the future workforce. Links with centres of expertise in Composites are under development.

d) Geography[62]

As previously mentioned, the polymer sector is a major part of the supply chain supporting Composites capability for the manufacturing industries. It is found in clustered in regions with such manufacturing capacity, such as the West and East Midlands, as well as in the traditional chemicals industry concentrations of North West England.

To date the approach to tackling the shortage of trained employees has emerged regionally, driven by some Regional Development Agencies. Examples of these initiatives include the development of a Composite Technician award (SEEDA), development of South West Composite Gateway (SWDA), proposal for a regional Composite Centre (EEDA), creation of a dedicated MSc in Composites Materials at Bolton University (NWDA). In Wales there are also developments which will impact of skills provision in the UK as a whole, the Welsh Composites Centre (Welsh Assembly) and the proposal for an applied knowledge hub for advanced materials and manufacturing systems in North Wales.

[61] *Working Higher* is a £3m Higher Education Funding Council for England (HEFCE) funded collaboration between Cogent, the University of Hull and the Higher Education Academy Physical Science Centre.

[62] Cogent Regional Factsheets, 2007 - http://www.cogent-ssc.com/research/regionsindustry.php

English Region	Employees	% Workforce In England
North West	26,500	17%
Yorks & the Humber	18,800	12%
North East	10,500	7%
East Midlands	21,800	14%
West Midlands	21,000	13%
East of England	19,200	12%
South East	19,200	12%
London	6,500	4%
South West	13,800	9%
Total England	157,300	100%

Figure 37: Employment in the Polymer Sector in England

6.2.3 Plastic Electronics

a) Background to the Sector and Main Drivers

Cogent has an interest in the emerging Plastic Electronics market from its footprint in the polymer industry. The field is so new, however, that technology transfer still has a way to go before it emerges as an established industry. This section is therefore concise in noting the relevance, rather than explaining the skills in depth.

The term plastic electronics, also known as printed electronics is used to describe electronics based on semi-conducting organic polymer materials.

The technology means that diodes and transistors can be printed on flexible plastic substrates using inks made up of semi-conductive organic polymers. These polymers can be solution-based, enabling them to be printed using inkjet or other printing techniques onto flexible or rigid surfaces. The different component layers that make up the electronic device or circuits can be added one by one to the substrate. The basic flexible substrates commonly used in plastic electronics are manufactured polymers such as polyethylene terephthalate (PET, used in plastic bottles) or polycarbonate (PC). Plastic electronics is a nascent sector, very much at the start of its development, but with a recognised potential for growth in which the UK could play a leading part.

It is unlikely that plastic electronics will completely replace silicon electronics and the more mature inorganic semi-conductor industry, because of the latter's technical and performance characteristics Plastic electronics does have a number of advantages for certain types of products where a compliant surface or where thinness and weight are major design requirements. There are strong possibilities that a new range of products and markets will be developed and in this sense it is a disruptive technology, with products opening up new markets. There will be some competition in current electronics markets, for example in the electronic book market where a number of companies from across the work are entering the market, but based on rigid LCD displays

Estimates of the size of this market vary, since take-up of the products is dependent on a number of factors, including the growth of products for the low-carbon economy.

Unlike traditional semi-conductors, which need to be made at high-temperatures in clean rooms, plastic electronics can be printed at low (room) temperature, so the energy used in production is much less[63]. Xerox has recently announced that they have developed a new silver ink that has a melting point of just 140 degrees[64]. In addition, the device processing stage uses materials more efficiently[65].

Plastic electronics devices are lighter, because they are printed on a low density organic film substrate, therefore in any applications where they are used, less energy will be consumed, both in terms of fuel for transport and in packaging requirements.

The Organic/Polymer Light Emitting Diodes (OLEDs and P-OLEDs) technology is very energy efficient and can be used in ultra-thin lighting displays that will operate at lower voltages than LCDs (liquid crystal displays). Furthermore, they are capable of generating light and do not require the manufacture of additional backlights or filters.

b) Skills Requirements

The current skills used in the sector are mainly those of Research and Development.

The development and short term needs of the sector require teams of individuals with multidisciplinary awareness to realise the products that the technology makes possible.

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[63] BBC website, 3rd January 2007 http://news.bbc.co.uk/1/hi/technology/6227455.stm
[64] Xerox news website 27th October 2009 http://www.xerox.com
[65] Plastic Electronics: A UK Strategy for Success. http://www.berr.gov.uk/files/file53890.pdf

Examples of possible applications are:

Energy efficient lighting	**Smart fabrics and intelligent textiles**
• Lighting, signage, displays • Organic/Polymer Light Emitting Diodes (OLEDs and P-OLEDs)	• **Wearable displays** • **Illuminated safety clothing** • Novel fashion items and clothing that build on the UK's reputation for design
Flexible displays • Large format displays – public information, retail and advertising • Roll up displays • Posters and retail 'shelf edge' displays • Electronic paper • E-readers – light, flexible with less glare and more robust against accidental damage than rigid readers**.**	**Sensors** • Medical sensors can be embedded in dressings, bio-sensors • Intelligent packaging for the pharmaceutical and food industries – labels that change colour if food items go outside their recommended temperature range or shelf life • low cost electronic radio-frequency identification (RFID) tags • Sensors in laminates and coatings
Photovoltaic cells • Large scale to feed into grid • Off grid solutions including self charging mobile phones and laptops. • transparent wafer-thin batteries	**Flexible electronic circuitry** • Disposable electronics, consumer throwaway • Hand held and mobile equipment

The main skills needed for these multidisciplinary teams are:

- electronic engineering, optics and nanotechnology
- printing and ink technology
- materials science – thin films and coatings
- chemistry
- physics.

It is important to realise that, at this stage of the development of the technology, the design, testing and diagnostics software for plastic electronics has not yet been fully developed.

As products are developed in the laboratory and go into production, there will be a greater need for technicians who will be involved in testing, prototyping, design implementation and optimisation of products and manufacturing processes. As the markets develop, these will be needed in increasing numbers within the next 3-5 years.

There is, consequently, a need to develop technicians' skills, where they need to have multidisciplinary awareness of materials science or chemistry, and be able to apply their skills over a range of activities.

6.3 Demography

Reviewing the information from the Labour Force Survey/Institute for Employment Research figures for 2002-08 gives some insight into the recent demographic trends of the Cogent workforce[66]:

In general employment has declined and productivity enhanced. The overall level of employment in the Cogent sector has fallen over the period by 14%, at a time when the UK economy as a whole saw a 3% employment increase. This experience is common with other manufacturing-related sectors. However, these

[66] LFS/IER 2008, Provided via UKCES Almanac

figures require further analysis in the light of the following:

1. The use of SIC codes in the LFS/IER data removes most of the nuclear workforce; and this is an area with significant expected employment growth.
2. There has been a trend towards outsourcing to the supply chain, suggesting that there may be under-counted employment that sits within other SIC codes.
3. Recent Working Futures figures have predicted that this level of decline will not continue in some sectors, meaning that a reconciliation of the figures would be helpful to shed light on required skills and training needs.
4. There will clearly be significant replacement demand to maintain a viable workforce, even set against the picture of an overall absolute reduction in numbers.
5. A high proportion of this loss of employment has been at the lower end of the age range, with the number of those between 19-24 years old falling by 33% while the number of those aged over 60 has risen 62%. This clearly raises serious concerns over the need to replace the relatively higher proportion of people who will be retiring in the next few years, while recent recruitment of young people has been lower.
6. There is some evidence to show that the Cogent workforce is becoming slightly more representative of the UK workforce as a whole than previously was the case. The proportion of the workforce that is female has risen from 26% to 29%, at a time when the female proportion of the overall UK workforce increased by only 0.25%. The proportion of those from ethnic minorities has risen slightly to 7%, a little behind the proportion of the UK workforce, at 9% in 2008.

6.4 Skills Equilibrium

The guidance for this Sector Skills Assessment specifies that the possibility of a low skills equilibrium in the sector is appraised. As set out throughout this document, the Cogent sector is dominated by highly-skilled occupations. There is also evidence of high performance working practices as evidenced in skills scorecards of the former Sector Skills Development Agency. In the Cogent sector, the historical position has been the contrary while the trend driven by emerging technologies will be to further skills inflation in high-tech sectors.

Many of these industries are also highly regulated (for example, by the HSE) as they involve hazardous materials and processes. Regulation tends to act as a positive lever to maintain high levels of skills, in order to demonstrate competence. Since the productivity, competitiveness and survival of sector companies are based on the need for high skills, and this has been evidenced copiously in previous SSAs and in all recent skills reports for the sector, there has never been any evidence of a low skills equilibrium in the sector, and there is nothing in the current analysis to suggest that one should be expected.

7 Actions

7.1 Big Tickets

Following the Sector Skills Agreements published by Cogent in 2007, the adoption of 'Big Ticket' actions has driven the approach to addressing key needs of the sector. This approach remains appropriate - although the details of the actions have been amended over time - and consists of the following:

7.1.1 Industry Skills Standards and Qualifications[67]

Cogent is developing a suite of qualifications that underpin our competency-based Gold Standards and Job Contexts to enable acquisition and recognition of competence to National Standards for key roles in the sectors. The 'Gold Standard' includes Technical Competence, Business Improvement, Compliance and Functional and Behavioural skills (FAB skills).

7.1.2 Apprentices[68]

Apprentices continue to be a major strand of Cogent's work and represent a highly-respected system of training and education.
Apprenticeships provide the vital supply of skilled employees for the future with the right skills to meet the future sector needs

7.1.3 Future Skills[69]

Cogent's Future Skills research programme provides the evidence and essential intelligence to inform Cogent's strategy and programme of activity, as well as, providing employers with the trend data to support their own workforce planning. Increasingly futures work forms a significant part of this.

7.1.4 Careers Pathways[70]

This is a sector-wide web-based initiative, welcomed both by employers and stakeholders alike and has attracted thousands of users over the past two years. It is playing an important part in securing the talents industry needs now and in the future.

[67] http://www.cogent-ssc.com/education_and_qualifications/index.php
[68] http://www.cogent-ssc.com/education_and_qualifications/Apprenticeships.php
[69] http://www.cogent-ssc.com/research/index.php
[70] http://www.cogent-careers.com/

7.1.5 Skills Benchmarking[71]

This Big Ticket is underpinned by an IT platform which provides the all-important employer benchmarking against the Cogent standards and job roles, as well as a web-based skills match product which allows individual assessment against the Gold Standard competences Cogent is setting the standard for skills in the Sector and developing the tools to allow companies to assess their performance.

7.2 Higher Level Skills Actions

While national vocations standards and qualifications are developed by Cogent (see 7.1.1), development of higher level qualifications involves partnerships and collaborations as described below.

The high profile industries of the Cogent footprint are substantially skills intensive, with emphasis on the development and delivery of science, innovation, intellectual and capital knowledge. Many of the industries rely heavily on the subject areas of science, technology, engineering and mathematics (STEM), where employees are recruited and trained at a high level, particularly those partaking in, and entering from, further and higher education.

Over recent years, focus and intensity has turned to these higher level skills needs. The nature of the industries demands high levels of knowledge and skills in STEM subjects combined with an increasing need to deliver management, leadership and innovation skills, particularly to address the emerging technology markets.

In order to meet the current and future high level skills needs, Cogent has engaged with employers, higher education and policy makers to improve ways of working and funding skills opportunities. Cogent published the higher level skills strategy "Technically Higher" in December 2009. This coincided with three Government white papers, "New Industry, New Jobs", "Higher Ambitions" and "Skills for Growth", which detail the future of higher education, particularly in association with employers and emerging technology areas.

Challenges remain in the high level skills areas, particularly in STEM and workforce development. Through the development and establishment successful partnerships of employers with higher education, a number of significant projects within

[71] http://www.cogent-competence.com/

the Cogent footprint have begun. Of key importance to Cogent are “Working Higher” and the regional Higher Level Skills Partnership projects currently in operation.

7.2.1 Working Higher

Direct action has been taken through Cogent’s Foundation Degree Framework, Working Higher.[72] This is a £3m HEFCE-funded collaboration between Cogent, the University of Hull and the Higher Education Academy Physical Science Centre, designed to be a solution to workforce development needs by creating a flexible, work-based Technical Foundation Degree Framework for the chemical, polymer, petroleum, bioscience and nuclear industries.

The work-based Foundation Degrees will be developed in partnership with a University consortium, employers and the secondment of industry champions from the sector to HE to ensure the development is fit for demand.

The universities chosen to deliver the Working Higher project are:

- Petrochemical Industry - University of Hull
- Nuclear Industry - Universities of Portsmouth and Central Lancashire
- Chemical Industry - Manchester Metropolitan University
- Polymers Industry - London Metropolitan University
- Biosciences/Pharmaceutical Industry - University of Kent

This project is an important test of employer demand for HE provision in workforce development and the co-funding model for learning through work

7.2.2 Higher Level Skills Partnerships

Cogent has also been heavily involved in the North West and North East regions, through the HEFCE and RDA funded regional Pathfinder projects. In both regions, skills assessments have been used to direct funding to priority areas, where providers have been active in helping to reduce the skills gaps identified. Employers in the Cogent footprint have been engaged in a number of projects across these regions, helping to co-fund suitable development and up-skill staff on the programmes developed. In the North West, activity has focused on the areas of Biomedical, Advanced Manufacturing/Engineering and Energy and Environmental Technologies. This partnership with North West Universities Association (NWUA) has allowed Cogent to direct and draw down in the region of £500,000 for providers for developments in the Cogent sector. A number of projects have been awarded directly for the benefit of the Cogent sectors.

In the North East Region, Cogent has been working with the NE Higher Level Skills Pathfinder to support the development and pilot of a Higher Level Apprenticeship Scheme for the NE Energy sector with Newcastle College, and Redcar and Cleveland College. This project began in January 2009, and produced a research report from employers in the energy sector in the region. This project has also secured some initial funding for the colleges to begin developing the scheme, which will be taken forward in 2010.

In addition to these projects, Cogent has established itself as a leader in the UK higher level skills and STEM arenas. As such, Cogent has a wide array of partnerships with industry and higher education, and with other external bodies, including Government departments, professional bodies and councils and with the Higher Education STEM Programme based at the University of Birmingham.

Cogent is also taking a lead on HE STEM activity for other SSCs with a STEM footprint. Through this partnership, Cogent will begin to address strategy areas including Graduate Benchmark statements for industry, employability skills, etc and to improve ways of working and consistency across SSCs, STEM activity, Government and employers.

[72] http://www.cogent-ssc.com/Higher_level_skills/Working_higher.php

7.3 National Skills Academies – Delivering Skills Solutions

7.3.1 The National Skills Academy Value Chain

A critical success factor for meeting the skills challenge is delivering training in the right format, in the right place and at the right time, for both the employer and the learner. After building a detailed case, and following several years of in-depth lobbying, planning and consultation, Cogent and employers were successful with their bids into the Learning & Skills Council's tendering round for the National Skills Academy Process Industries and the National Skills Academy for Nuclear.

Cogent works in partnership with its two National Skills Academies to ensure that strategic skills solutions articulated by employers are delivered on the ground through a network of approved providers. Cogent has a close and synergistic relationship with the academies in order to develop and quality assure vocational training that is valued and used by every company they represent. This relationship is represented in the value chain below.

Cogent's focus is towards the left side of the value chain – developing strategic skills action plans, considering future business environments and the implications on skills, as well as setting standards and representing the employer voice. At the other end of the value chain the National Skills Academies engage with employers and then commission and deliver skills solutions, products and services to meet their needs. Their focus is on gearing up the delivery and uptake of qualifications by employees in the sector.

7.3.2 National Skills Academy Nuclear [73]

The National Skills Academy for Nuclear is an employer-led organisation established to ensure that the UK nuclear industry and its supply chain has the skilled, competent and safe workforce it needs to deal with the current and future UK nuclear programme, including all sub sectors: defence, decommissioning, operations, fuel cycle, waste management and more recently new nuclear build.

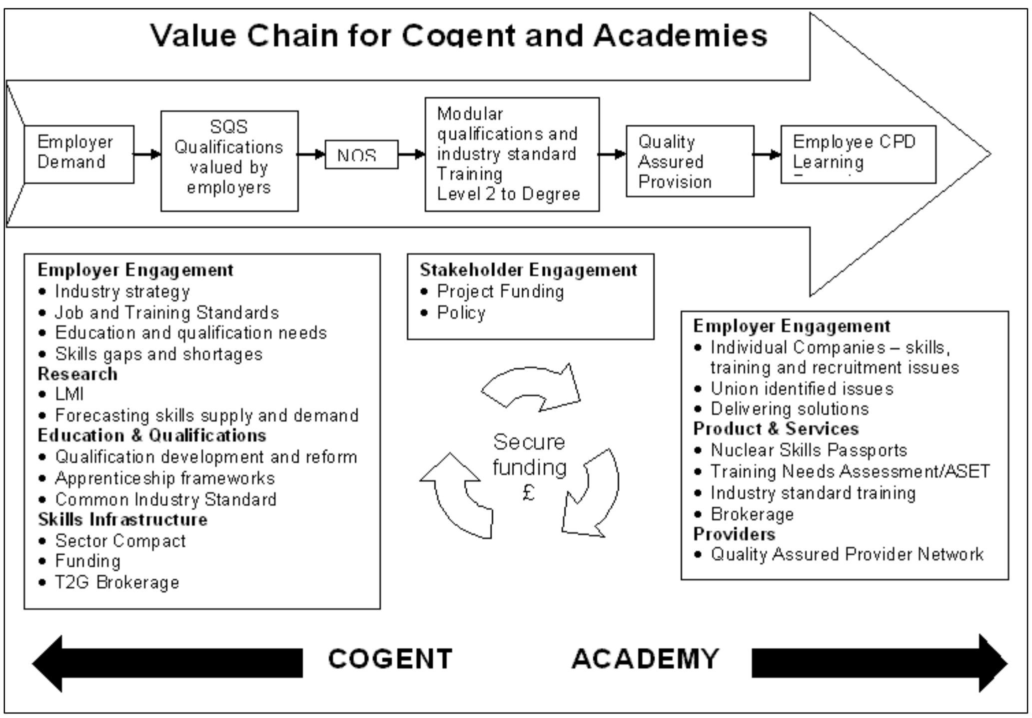

Figure 38: Value Chain for Cogent and Academies

[73] http://www.nuclear.nsacademy.co.uk/

Delivering Excellence in Nuclear Skills

The Skills Academy has established a high quality training provider network that is tasked with delivering excellence in nuclear skills. The provider network has been developed to encompass a range of high quality provision covering the whole of the UK. This network delivers programmes at all levels from vocational and technical training to post graduate study. The high quality provider network comprises of organisations in the following categories:

- Quality Assured: FE and Private Training Providers
- Employer Assured Training Providers
- Employer Nominated Providers
- Higher Education Associate Members

The Skills Academy is now rolling out a number of products across the sector including:

- Energy Foresight Interactive Learning Resources
- The Award for Nuclear Industry Awareness
- NVQs in Decommissioning and Radiation Protection
- The Community Apprenticeship Programme
- Foundation Degrees
- Bursary Awards
- The Nuclear Skills Passport
    - from 2010 highlighted as highly desirable in tenders
    - used to implement the Nuclear Industry Training Framework
    - vehicle for the introduction of the triple entry bar standard for workers in the nuclear sector. The triple entry bar standard consists of the Basic Common Induction Standard, Basic Nuclear Industry Context and Basic Nuclear Industry Behaviours.

Under Development

- Certificate of Nuclear Professionalism

The Skills Academy has also played a key role in a number of exciting capital build projects, which will provide world-class facilities, including:

- **ENERGUS**: the £20m Northwest flagship skills delivery centre in Cumbria
- **The Energy Centre** a new training delivery centre at Bridgwater College with a key focus on new build
- **Engineering Centre** at North Highland College

7.3.3 National Skills Academy Process Industries [74]

The National Skills Academy for the Process Industries provides national leadership in training provision; moving employees up towards world-class skills standards for every role at every level. The process industries produce hundreds of essentials from biofuels and plastics, through to rubber, synthetic fibres for clothing, pharmaceuticals and chemicals which transform, strengthen and make safe many end-user products. The process industries which include chemicals, pharmaceutical and polymers manufacturing have a combined turnover of £67.1 billion and a Gross Value Added in excess of £23 billion, which is over 15% of total UK manufacturing GVA.[75] Skills development is vital to meet the future needs of UK process and science-based businesses, which are operating in a highly competitive global marketplace.

NSAPI is based on a hub and spoke operating model. A small centre provides leadership and accreditation while a network of public and private training centres around the UK will deliver the skills training. The Academy defines and accredits regional provision, based on Cogent-defined standards which sit within a national framework. In this way, training accredited in the South East will be recognized in the North West.

Through the activity above, NSAPI:

- delivers high quality training based on world class standards;
- builds networks with a range of existing learning providers, so that new approaches and higher standards are shared across the sector and with other SSCs, and benefit both employees and employers;
- provides leading edge teaching in a modern learning environment;
- establishes centres of innovation aimed at shaping training programmes to meet the sectors' needs;
- is flexible, working closely with employers;
- is part of the formal education system;

[74] http://www.process.nsacademy.co.uk/
[75] http://www.cogent-ssc.com/cogent_family/NSAPI.php

- delivers to SMEs through regional clusters.

7.3.4 NSAPI – Extension Bid [76]

At the time of writing (January 2010) Cogent and NSAPI have submitted an Expression of Interest into the LSC's fifth round of tendering for National Skills Academies. The submission was centred on an extension to the remit of NSAPI to incorporate Emerging Process Technologies of industrial and also of pharmaceutical biotechnology and composite technology into the footprint. This will enable the Chemical, Pharmaceutical, Petroleum and Polymer industries to innovate and harness the application of emerging technologies to drive new developments and stimulate future markets, which in turn will depend on the upskilling of the workforce. The extension would bring skills for the following areas within the Cogent/NSAPI remit:

Composites

- Composites manufacturing
- Composites supply chain
- Composites recycling.

"White" Industrial Biotechnology

- Biotransformations to make speciality and effect chemicals, such as flavours and fragrances
- Bioethanol development and biorefining (production)
- Biological fermentation processes for manufacture of e.g. PHB (Polyhydroxybutyrate)
- Polymer based "smart materials" development

"Red" Medical Biotechnology

- Biopharmaceuticals
- Genetically modified organisms' use in drug applications
- Stem cell developments
- Immunodiagnostic systems

"Green" Environmental Biotechnology

- Waste recovery
- Waste management – use of microbial cultures to breakdown pollutants

Industrial Biotechnology can also be applied in other industries, such as agriculture, food applications and marine. Since many of these sub-sectors can be linked with other sectoral bodies, the approach to this bid is one of collaboration and partnership. The Academy will therefore seek to work with Cogent, SEMTA, Improve and their related Academies and partners to develop expertise that has relevance to multiple sectors. The proposals support the recommendations of the Government's Industrial Biotechnology – Innovation and Growth team

7.3.5 OPITO – The Oil & Gas Academy.[77]

OPITO is a Skills Academy (not an LSC-supported National Skills Academy) for the upstream Oil & Gas industry. It is fully funded by Industry and has its UK base in Aberdeen.

OPITO was endorsed by Alex Salmond MSP, First Minister for Scotland, and Malcolm Wicks MP, the then UK Energy Minister, at its launch in December 2007. The creation of the organisation was driven by employers and trade unions in the Oil and Gas industry as it sought to address its skills and workforce challenges. This development recognises the role of skills in an industry that makes a significant contribution to energy production in the UK and ensures UK skills and qualifications support UK interests in the global Oil and Gas markets.

Cogent retains a 10% shareholding in the new Academy as well as two Director positions. The Oil and Gas industry maintains its relationship with Cogent through membership, and both organisations will continue to work effectively together for the benefit of the Oil and Gas industry.

Board members of OPITO are drawn from:-

- UK Offshore Operators Association (Oil & Gas UK)
- Inter Union Offshore Oil Liaison Committee (IUOOC/ Unite)
- Offshore Contractor Association (OCA)
- International Association of Drilling Contractors (IADC - North Sea Chapter)

76 http://www.berr.gov.uk/files/file51144.pdf

77 http://www.opito.com/index.php?option=com_content&task=view&id=1&Itemid=2

- Well Service Contractor Association (WSCA)
- Inter-Union Offshore Oil Committee(IUOOC/Unite)
- Health and Safety Executive
- Department for Education and Employment advisors
- OPITO business includes:
- Development and maintenance of Emergency Response Standards
- Approval of training delivery (56 global training centres in 18 countries)
- Petroleum Open Learning
- Workforce Competence and Technical Standards and Qualifications
- Management of the Upstream Modern Apprenticeship Scheme (500 Apprentices)
- Oil Industry Workforce Skills Development (data gathering and analysis; design and implementation of skills interventions).

OPITO works very successfully internationally exporting its Industry Standards to more than 22 countries across the globe.

7.3.6 National Skills Academies – Future

The role of the Academies in Cogent's sector will increase in importance as we see their maturing influence over the delivery of learning provision for the industries with which they have direct contact.

We also expect that they will increasingly support Cogent in providing Labour Market Intelligence for our sector, such as the information we have been able to provide through this Sector Skills Assessment.