Current and Future Demand for Skills
in the Science Based Industries

England

Sector Skills Assessment

2011

Chemicals
Pharmaceuticals
Bioscience
Polymers
Petroleum
Oil & Gas
Nuclear

Delivering Skills for Science Based Industries

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1.0 Prologue

This Sector Skills Assessment for ***England*** *is part of a suite of five covering the four nations, together with a main UK wide report reviewing the sector by industry. While each report has been designed to be self-contained and comprehensive in its own right, the complete assessment is formed from the five documents and should be viewed together.*

The year 2010 marked a change in government and the political drivers of the skills system. With a lower emphasis on skills intervention and a shift in philosophy to the choices of individuals and employers on skills, comes a conversely strong emphasis on high quality research that translates to the skills solutions, information, advice and guidance required to inform decisions; decisions that will be made by employers, employees and 'stakeholders' such as qualification awarding bodies, funding bodies, providers of education and training, and (not least) policy developers in government itself.

Nationally and globally the recession continues to dominate. Working through, as it has since 2008, from Banking to Manufacturing, the latest test to the economy will be in the contraction of the public sector over the next four years and the extent to which the private sector can grow to absorb capacity shed by the public sector. Skills for growth are therefore a strategic imperative.

The UK position of skills development in an evermore connected global economy remain as before. In this context, skills contributions to energy, clean water, food, health, a low carbon economy, sustainable development and advanced manufacturing bring both a social and a technological dimension to skills development. This places high importance on the supply and demand for skills in science (physical science and bioscience) and engineering, and the translation of research and innovation into solutions.

There is not a subsector of the Cogent footprint that is either untouched by or driven by this complex set of environmental drivers in play during 2010. This is illustrated in Table 1.0.1 for each of the sectors active in England.

Table 1.0.1 Strategic Contribution of Skills in Cogent Sectors in England

Sector	Strategic Position
Bioscience	R&D, health, low carbon, sustainable development
Pharmaceuticals	R&D, health, advanced manufacturing
Chemicals	advanced manufacturing, strategic supply chain manufacturing
Polymers	strategic supply chain manufacturing, advanced manufacturing (composites)
Petroleum	energy (fuels), transport infrastructure
Oil & Gas	energy (fuels), raw materials (manufacturing), energy security
Nuclear	energy (electricity), low carbon, energy security

These sectors are diverse in both their markets and their skills drivers but they are united by the underpinning science: all deploy molecular transformations to achieve their products. The most critical occupations that define these industries are those that require knowledge and application in science, engineering, and regulatory affairs. These are manifest in the managerial, professional, technical and associated professional and craft occupations mainly. Cogent research consequently focuses on these occupations.

The following sections explore in increasing depth the sector, its industries, the evidence base and the Cogent research strategy. Where it has not been possible or appropriate to include a full account of research findings, the Appendices contain further information and a full bibliography of recent skills publications by Cogent.

The UK has the 6th largest economy in the world, and 4th in the OECD, but its recovery from the recession that began in 2008, will depend *inter alia* on strong growth in the manufacturing sector, not least the Cogent industries. This is central not only to the immediate contribution to industrial activity, employment and wealth creation, but also to the longer term goal of rebalancing the economy with respect to the financial sector. The Cogent sector in England is an attractive target for investment and development, and one which can maintain a competitive edge through its use of intellectual capital.

Finally, this Sector Skills Assessment is published in December 2010. The previous Sector Skills Assessment was published in February 2010. There is consequently some degree of overlap in the coverage of these two publications. While Cogent has sought to keep this to minimum and report new primary research and customized national data, the latest Skills Oracle (see later) does not become available until January 2011.

1.1 Chemicals – a strategic asset

UK Chemical firms are required to offset the lower labour and raw material costs of the emerging markets in Asia and Eastern Europe by adding value to commodities, using lean manufacturing techniques and developing supply chain efficiencies. Mergers and acquisitions are being used to reposition companies to remain competitive, although bulk transport costs limit the distance over which chemicals can be reasonably transported, and in turn the degree of consolidation possible.

Increasingly, rapidly developing economies are exploiting their growing strength to attack traditional high value markets in the UK, Europe and the USA. Nevertheless, PricewaterhouseCooper predicts firms, such as pharmaceuticals, close to world class academic institutions, will remain strong; an analysis that suggests that UK based firms should remain resilient even while they cope with the expiry of patents and the fragmentation of the industry caused by the rise of niche, targeted, therapies.

1.2 Nuclear – secure, low carbon electricity

Nuclear Electricity Generation in 2010 stands on the verge of the largest change of all of the Cogent industries. Against an on-going decommissioning programme which will see the UK capacity fall from 10 GWe to 1 GWe, three private consortia have proposed investment which would result in the construction of 16 GWe of new capacity. This amounts to a major collaborative, privately financed, infrastructure project with a huge demand for high level science and technology skills. Planning to underpin it took a specific step forward in October 2010 with the coalition government's identification of 8 potential sites in its revised draft National Policy Statement. In response to this national proposal, Cogent produced in 2009 an in-depth report, *Power People* (2009), which remains the starting point for an assessment of the industry today. Shortly afterwards it published *Next Generation* (2010), an assessment of the skills impact of a thirteen year building programme based on 6 reactor pairs. Next Generation included an initial risk register that identified where, at this point, skills shortages would pose a particular threat. These included, amongst others, project management, high integrity welding and safety case authoring.

1.3 Bioscience – a new industrial revolution

Alongside the established industries, the Cogent footprint also contains the burgeoning Biotechnology sub-sector. In August 2010 Cogent took on responsibility for the Life Sciences sector from Semta. Both SSCs will continue to work closely together to meet the need the needs of employers in their footprints, and are currently arranging a series of meetings with stakeholder groups across the UK to agree new operational arrangements in each nation, and make arrangements for the handover of existing projects, where appropriate. The new arrangements will build on Cogent's existing remit for the Pharmaceutical Industry and provides the Life Sciences sector with 'one voice' to speak clearly to Government and Academia on skills issues.

International statistics for biotechnology confirm the dominance of health. In contrast, there is a paucity of data for industry and primary production to demonstrate significant commercial penetration. Small businesses dominate the landscape of biotechnology and outsourcing of specialist services is prevalent. There is evidence of continued growth in medical biotechnology and rapid development of parts of industrial biotechnology, e.g. speciality chemicals (supply chain to the pharmaceuticals industry) and steady development on others (e.g. energy, environment, materials); and slow development in agricultural biotechnology.
The latest biotechnology data for the United Kingdom confirm that the United Kingdom has a major global profile in medical biotechnology. The data demonstrate that the bioeconomy is dominated by health. The proportion of companies in medical biotechnology that are SMEs is extremely high at 99%, while the proportion of companies in medical biotechnology with fewer than 50 employees is also high at 90%. Total employment in medical biotechnology is estimated to be of the order of 24,000. Industrial biotechnology was recorded in the National Strategic Skills Audit (UKCES 2010b) as one of six strategic advanced manufacturing sub-sectors for their importance in the supply chain of numerous established sectors, and for their potential contribution to a low-carbon economy.

1.4 The workforce today

As would be expected in a sector reliant on science and technology, the Cogent Workforce is generally highly qualified workforce. Table 1.0.1 shows the distribution of qualifications across the Cogent industries, and in comparison with the UK as a whole.

Table 1.0.1 Workforce Qualifications

	Level of highest qualification held						
	S/NVQ 4 +	S/NVQ 3	Trade Apprenticeships	S/NVQ 2	Below S/NVQ 2	No qualifications	**total**
Oil and Gas	46%	19%	12%	12%	8%	4%	100%
Petroleum	26%	19%	5%	22%	16%	13%	100%
Nuclear*	38%	33%	5%	20%	3%	1%	100%
Chemicals	47%	14%	6%	14%	12%	7%	100%
Pharmaceuticals	58%	15%	3%	11%	8%	5%	100%
Polymers	20%	17%	8%	19%	23%	13%	100%
Cogent	**38%**	**18%**	**6%**	**16%**	**13%**	**8%**	**100%**
UK	**32%**	**17%**	**5%**	**17%**	**14%**	**15%**	**100%**

The Pharmaceutical sector shows the highest fraction at NVQ level 4 and above, although this may underestimate the actual level because of the inadequacy of Standard Industry Codes in Pharmaceutical research and development. In contrast, Polymers and Petroleum employ a large number of staff with qualifications below NVQ level 2, and have the largest fraction with no qualifications at all.

The 2006 Leitch Review set a goal for the UK to reach the OECD upper quartile for skills attainment by 2020. Targets derived from this recommendation provide the benchmark for the UK Commission for Employment and Skills annual assessment of UK skills, jobs and productivity, Ambition 2020. [1,2] Table 1.0.2 shows the 2020 target together with the current UK and current Cogent levels.

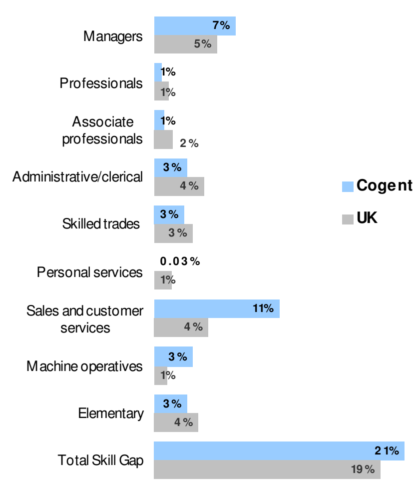
Table 1.0.2 Ambition 2020

Highest Qualification	Target 2020	UK (current)	Cogent (current)
Level 4	40%	28%	38%
Level 3	28%	17%	24%
Level 2	20%	17%	17%

The occupational distribution of the Cogent Sector workforce is given in figure 1.0.1 which reflects the expected demand for Managers, Professionals and Process Operators . In broad terms, this is repeated across the industries with some variation in for Professional and Sales depending on the nature of the industry.

Across the sector the existing integrated skills gap is slightly higher than the UK average, with particularly high levels amongst Managers and Sales and Customer services. The latter reflects the requirement for a combination of marketing skills and customer focus together with a high degree of technical knowledge.

Figure 1.0.1 Occupational Distributions



Ambition 2020 cites a link between the proportion of workers trained and the Gross Value Added such that a 5% increase in the number former results in a 4% increase in the latter. The gearing between training and productivity must be, in part, a function of the character of the industry. If taken at face value, at least, this would imply that raising the proportion of Cogent employees trained from 52% to 60% would generate an additional Gross Value Added of £4bn.

Cogent industries are well placed to support the UK economy in its recovery, and in any event form a critical part of the industrial supply chain. Driven by technology and science, high level skills have always been the life blood of the sector. This is only further emphasised by the economic necessities and technological opportunities that present themselves in 2010.

[1] Ambition 2020: World Class Skills and Jobs for the UK, July 2010

[2] Prosperity for all in the global economy - World Class Skills: The Leitch Review of Skills, December 2006

2.0 National Policy Overview

Education and skills are devolved issues for the four nations of the UK. In England, skills policy in 2010 has undergone significant change since the General Election in May 2010 when the new Conservative-Liberal Democrat coalition government came to power. At the time of writing, it is still not clear what the new government's policy will be on skills and which organisations and structures will remain in the new learning and skills environment, but some policy 'signals' are emerging.

For the past decade, England has pursued a regional skills policy. A national policy framework has been set by Government departments such as the Department for Business, Innovation and Skills and the Department for Children, Schools and Families, based on meeting Public Service Agreement targets. This framework has also been informed by regional statements of priorities expressed through documents such as the Regional Economic Strategy (RES) and articulated through regional boards such as Regional Skills and Employment Boards (ESBs) and Regional Skills Partnerships (RSPs). Funding for skills has been agreed nationally, and then disseminated primarily through the regional network of the Learning and Skills Council (now the Skills Funding Agency since April 2010).

Within each of the 9 regions that make up England, skills policy has been set by the Regional Development Agency (RDA) and Skills Funding Agency working through an ESB or RSP that brings together other regional partners such as Job Centre Plus, Business link, Sub-regional economic partners, and others including SSCs and provider representatives. Each region through the RDA has agreed a number of 'Priority Sectors' which have been the recipient of additional/specialist support and funding streams. These complement the national skills funding streams available across England, which are not targeted at particular sectors, but instead focus on skills levels.

There have been a number of high-profile national funding streams for England such as Train to Gain. This was primarily aimed at raising the level of skills within the workforce population to at least level 2 and 3, rather than targeting specific sectoral priorities. Train to Gain was very widely publicised and very well taken up – particularly in sectors that have lower-skill entry levels, and it enabled a significant amount of individuals in work to achieve a first level 2 or 3 qualification. However, the amount of public money spent on Train to Gain and questions of 'additionality', 'deadweight' and 'value for money' were raised by a number of bodies including the National Audit Office and the Department for Innovation, Universities and Skills select committee. A version of Train to Gain funding – The Sector Compact – has been rolled out through selected Sector Skills Councils since 2009. This has enabled SSCs like Cogent, to add a sectoral dimension on to Train to Gain, through directing funding to their sector industries.

In October 2009, the Government's Skills White paper announced the creation of a new Joint Investment Scheme (now re-named Joint Investment Programme – JIP) that would be open to SSCs and a small number of standard setting bodies to bid into. JIP was partly designed to address some of the criticisms that had been levelled at Train to Gain by restricting the fund to a defined, 'ring-fenced' pot, prioritising it at sectors as well as skills that were genuinely in demand by the UK economy, and bringing in a requirement for a 50% employer match. For the SFA, JIP also represented an opportunity to pilot 'demand-led' commissioning of provision, and for SSCs, the first real opportunity to 'direct' national funding to SSC-approved provision, for example through the work of National Skills Academies. The JIP programme has survived the change of government and the first provision is rolling out from September 2010. It is anticipated the principle of employer–match funding will continue to be important in any new government funding for skills, and that JIP itself will also be re-worked into a new programme (Growth Innovation Fund –GIF) that will continue to target relatively small amounts of public funding (compared to Train to Gain) at strategically important sectors such as advanced manufacturing, life sciences, aerospace and green technologies.

The establishment of the new coalition government in summer 2010 has created some of the most significant changes in the organisational and policy landscape in England for several years. The new government is supportive of the sectoral agenda, but not the regional one, and RDAs along with other regional planning bodies such as regional SFA, Regional Government offices, and their partnership structures such as RSPs and ESBs, are being wound down. Instead the government has created a Regional Growth Fund worth £1.4bn that local and regional public/private partnerships can bid into, to drive job creation, innovation and upskilling in their local economies. New Local Enterprise Partnerships (LEPs) are also being established to promote and support local business.

At the same time, there is likely to be a relaxation of national skills policy drivers within England, as the coalition government is ideologically opposed to the 'interventionist' approach to qualifications and skills development and regulation operated by the previous government. The coalition government appears to be in favour of a more 'free-market' approach to skills with employers and learners being empowered to become 'informed consumers of learning'. Regulation, such as overly-bureaucratic oversight of FE colleges for example, will be relaxed, and it seems likely that the role of SSCs will increasingly focus on standard setting , and driving employer buy-in and investment in, skills; to deliver a more self-regulated 'market approach' to sector skills development, in partnership with regulatory bodies, professional bodies and Trade Associations. The importance of apprenticeships – particularly in providing vocational progression pathways is also emphasised.

In addition, the fiscal crisis of 2008 is still being felt in the reduction of public spending which has seen a number of education arms length bodies being disbanded, with others including the UKCES, still under review. The Comprehensive Spending Review of October 2010, saw a reduction of approximately one-third in the departmental budget of BIS, and the implications of this both for the future funding of Sector Skills Councils, and prioritisation of sector investment, are still unknown. It seems likely however, that the world of 2011 will see significant reductions in education and skills budgets as a whole; and an increased need for SSCs to prioritise their industry sector interventions and to increase significantly the amount of employer investment that can be leveraged into workforce development provision.

3.0 Research Strategy and Products

3.1 Research Strategy

The advanced manufacturing industries in the Cogent footprint cover a diverse set of sectors which, although bound by a common reliance on science and molecular transformation, differ significantly in their economic and skills drivers and the extent to which national data provides sufficient evidence to sustain skills gap analysis and future skills projections.

The research approach employs best use of national data where it exists combined with primary research to fill gaps and to penetrate more deeply than national data. Apart from the annual Sector Skills Assessment (this report), there are four main categories of output:

- **Factsheets**
  (by Industry and Region)
- **Skills Oracle**
  (annual report of primary research)
- **FutureSkills**
  (annual report of primary in-depth research and future scenarios on skills)
- **Hard-to-Reach Sectors**
  (sectors of complexity by size, location etc)

Table 3.1.1 illustrates the sectors in the first column and the Cogent perspective of segmentation of subsectors in the second column. For the most part the sectors are mutually exclusive although their supply chains may intermingle. In this way Pharmaceuticals is largely distinct from Chemicals but Chemicals is a significant supply chain to Pharmaceuticals. Bioscience is an exception. From 2010 Bioscience is a new sector to the Cogent footprint. Bioscience is cross-cutting with Medical Biotechnology sitting closely with Pharmaceuticals while Industrial Biotechnology sits closely with Chemicals.

The third column illustrates the extent of national data coverage (by Standard Industry Classification). This shows clearly the lack of national data coverage for three highly strategic sectors (politically, economically, strategically and technologically) and a number of additional specialist segments. The three strategic sector gaps left by national data are: 1 – the absence of Nuclear (Power Plant Operation; Power Plant Decommissioning; Power Plant Construction; Defence – Propulsion and Deterrence); 2 – the limited coverage of Pharmaceuticals (given the large proportion of R&D functions outside manufacturing in this sector); and 3 – the limited coverage of bioscience industries as distinct from the specific coverage of research in biotechnology.

Table 3.1.1 shows how the four research outputs have been deployed to ensure full coverage. In particular, the in-depth research of those sectors that are politically, economically, strategically and technologically of high priority is mapped out in the short term. In this way, for example, Nuclear has been covered by both Skills Oracle and FutureSkills leading to internationally recognised reports throughout 2009 and 2010; and this will continue through 2011, as the priority shifts to include skills for growth in the cross-cutting area of Bioscience.

Table 3.1.1 Sector Segmentation and Research Coverage

Sector	Segmentation	SIC fit		Fact Sheet	Skills Oracle	Future Skills	Hard-to Reach Research
Nuclear*	NPP Operation			2011			2010 intern'l project
	NPP Decommissioning						
	NPP New Build						
	Defence						
	Fuel Processing						
Bioscience	Pharmaceuticals						
	Medical Biotechnology			2010	2011		2011
	Industrial Biotechnology				2010	2010	2011
Chemicals	Industrial Chemicals						
	Consumer Chemicals						
Polymers	Processing						
	Packaging						2012
	Sign Making						2012
Petroleum	Forecourts Retail						2011
	Storage and Distribution						
	Refining (Downstream O&G)						Commercial
Oil& Gas	Extraction (Upstream O&G)						2011

*NPP = Nuclear Power Plant

Legend

- Good coverage
- Coverage as indicated
- SIC only - not covered

3.2 Research Products

3.2.1 Factsheets[3]

These are data sheets distilling national data (e.g. ABI, LFS, NESS, ASHE), primary research by Cogent, and secondary data sources (e.g. government, trade, and international data). There are factsheets by industry (six), by region (thirteen) and by nation (four).

3.2.2 Skills Oracle[4]

Skills Oracle is a means by which employers can avoid survey fatigue yet get a useful and quick turn around in return for investing information with Cogent. At the same time the aggregated and anonymised analysis allows Cogent to generate the body of evidence and substantiate the voice of employers to policy makers and funders of qualifications. Building year on year, Skills Oracle, in conjunction with other sources of intelligence, establishes how well the sector is positioned to secure the skills it requires. But most importantly, it helps inform and shape action for the future; the evidence of demand and the evidence of progress.

Skills Oracle is a major contribution by knowledgeable employer experts – usually HR managers or equivalent with an authoritative voice on skills and training for all employees on their site. It is hosted annually by electronic means.

The survey combines regular quantitative measures with qualitative capture of opinion and future perspectives. Skills Oracle concentrates on the heart of the science-based industries – the employment and training of people with skills in science and engineering. Skills Oracle is therefore a focused survey of those sector and segments that employ such skills.
Cogent likens Skills Oracle to a skills 'ftse' of the top employers of skills, and thereby a barometer of the picture generally. The outputs from Skills Oracle are an overarching annual report. Although less robust, but still useful qualitatively, are the individual sector reports that are also published. A confidential company benchmarked version of the sector reports are provided to all respondents.

3.2.3 FutureSkills

FutureSkills is the collective output for the in-depth research projects that are prioritized for a given sector in any given year. The output is typically a detailed report arising out of major primary research in a sector, including employer and stakeholder consultation. The reports are often peer reviewed, formally launched, and followed by dissemination, evaluation and feedback. Examples of such reports included in this SSA are the Nuclear Series and the Bioscience series.

Nuclear series:

- Power People (2009)[5]
- Next Generation (2010)[6]
- SouthWest Nuclear Workforce[7]

Bioscience series:

- BioVision (2010)[8]
- Biotechnology (2010)[9]

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3 http://www.cogent-ssc.com/research/regionsindustry.php
4 http://www.cogent-ssc.com/research/Oracle.php
5 http://www.cogent-ssc.com/research/renaissance_i.php
6 http://www.cogent-ssc.com/research/renaissanceII.php
7 http://www.cogent-ssc.com/research/Publications/SouthWestNuclearWorkforce.pdf
8 http://www.cogent-ssc.com/research/Publications/BioVision.pdf
9 http://www.cogent-ssc.com/research/Publications/SEMTA_COGENT_report.pdf

3.2.4 Hard-to-Reach Sectors

This product is new for 2010-11 and addresses special research to cover gaps in intelligence due (usually) to hard-to-reach sectors. Hard-to-reach status may be due to the nature of the employer base (e.g.SMEs), or the complexity of the research (e.g. international collaborations). Current activities in this area include international research collaborations in Nuclear across the OECD and planned research of petroleum retail and bioscience SMEs.

3.3 Research Drivers

The research strategy considers PESTEL factors (see elsewhere in this SSA) in order to prioritise resources and workstreams in a given year. The Cogent footprint covers some of the most strategic science-based sectors in the UK economy. The industries range from the strategic (Nuclear) to the world-leading (Pharmaceuticals); many are incubators of new technologies (Chemicals – Industrial Biotechnology, Plastics - Composites) that will refresh and renew the sector in the future; others generate wealth and support our self-sufficiency in energy fuels (Oil & Gas and Petroleum). All have the deployment of higher level and technical skills at the heart of their business.

The research and intelligence reported in this SSA illustrates how the they have been driven in large part by both gaps in information and the strategic and political UK priorities, especially those sectors for which major in-depth research has been conducted and collaborations established.

3.4 Quality Assurance, Control

For major reports, a system of peer review is deployed[10] (or expert panel review drawing from Cogent Advisory Councils), and general evaluation and feedback captured.[11] These together with the Cogent Research Charter,[12] internal proofing and auditing protocols apply.

All major publications are accompanied by a web-published technical annex, giving details of the methodology and rationale.

3.5 Dissemination and Evaluation

All major publications are accompanied by an appropriate dissemination strategy. This usually entails national dissemination, often entails a launch event and can include international dissemination. The dissemination is usually accompanied by a feedback questioannaire on impact. The feedback analysis is web-published.[13]

3.6 Operationalising LMI

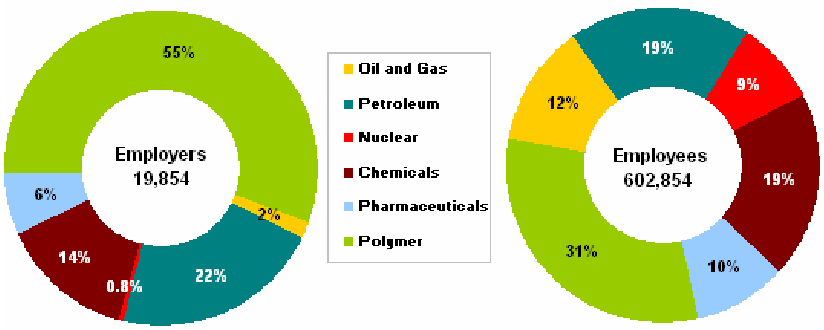
The various outputs inform the development of the business strategy, the action plans for the four nations and form the evidence base for development of standards (including NOS) and qualifications. Often this will require further tailored research. These and the resrecah putputs in themselves are received by the various industry Advisory Council administered by Cogent (Chemicals, Life Sciences, Pharmaceuticals, Nuclear, Polymers, Downstream Oil& Gas). The evidence is also used to support project development and the business plans of the two National Skills Academies (process Industries and Nuclear).

[10] For example http://www.cogent-ssc.com/research/Publications/Technical_Annex.pdf
[11] http://www.cogent-ssc.com/research/surveys.php
[12] http://www.cogent-ssc.com/research/Publications/Research_Charter.pdf
[13] http://www.cogent-ssc.com/research/surveys.php

4.0 The Integrated Sector

Figure 4.0.1 shows the distribution of companies and staff across the Cogent industries. The largest single area is Polymers with 31% of the workforce followed by chemicals and petroleum. Polymers also account for the majority of employers in the sector. The Nuclear sector is significant at this point because while it currently supports 9% of the workforce, this may change significantly if the likely new build programme in implemented.

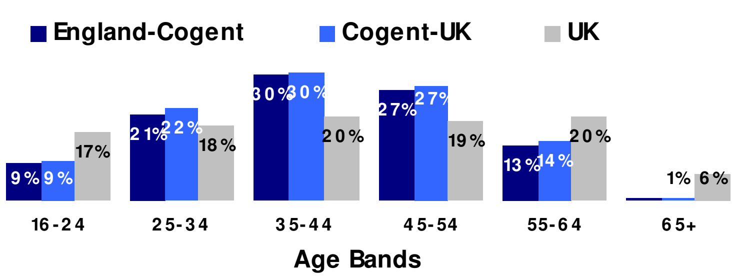
Figure 4.0.1 Employers and Employees



(Source: England Factsheet, Cogent 2010)

The age profile of the Cogent workforce in England is shown in figure 4.0.2. In common with the sector in the UK, the distribution is less evenly spread than the workforce generally, with a broad but clear maximum between 35 and 54 years. This is consistent with sectors that rely largely on higher (and older) levels of skill from the education supply.

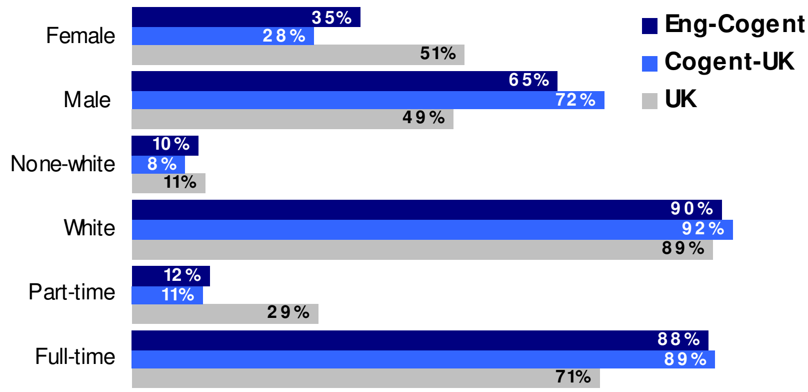
Figure 4.0.2 Age Profile



(Source: England Factsheet, Cogent 2010)

Figure 4.0.3 illustrates the workforce distribution in terms of gender, ethnicity and employment type (full time or part time). Overall the profile follows the broad characteristics of the Cogent sector; the workforce is overwhelmingly white, male and in full time employment. In fact, these characteristics are slightly stronger in the case of England than the sector generally. Notably the ratio of males to females is significantly different from the UK generally, showing a continuation (albeit with some weakening) of an historical trend in these industries.

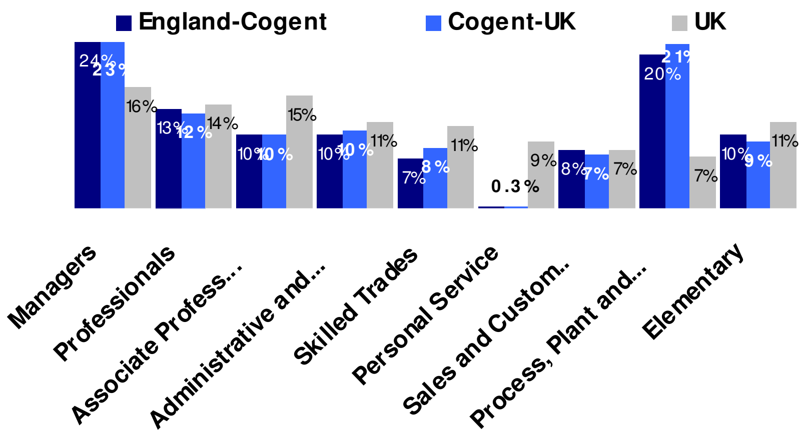
Figure 4.0.3 Workforce Distribution



(Source: England Factsheet, Cogent 2010)

Figure 4.0.4 shows the sector in England with higher proportions of professionals and process operatives than Cogent-UK and the UK generally. This is in line with expectation for a manufacturing profile although there is significant variation by sector.

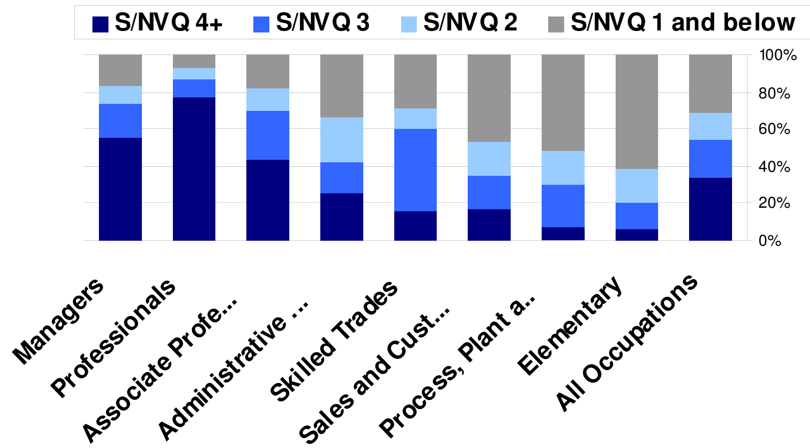
Figure 4.0.4 Occupational Distribution



(Source: England Factsheet, Cogent 2010)

Figure 4.0.5 shows the proportion of highest level qualification by occupation. Analysis in conjunction with Skills Oracle data (Main UK report, section 5.2), suggests that the three most highly skilled occupations are also those, in a UK context, with the greatest turnover and net increase in recruitment: management, professional and technical; these also correspond – again according to Skills Oracle – to the occupations that are hardest to fill.

Figure 4.0.5 Occupational Distribution



(Source: England Factsheet, Cogent 2010)

4.1 Skills Oracle Summary

Skills Oracle is essentially an online project surveying, over time, a significant and consistent sample of science and engineering employers. It is therefore not intended to cover all sectors or segments (retail forecourts being an example that is not in scope).

When used in conjunction with other sources of intelligence, and with national data, Skills Oracle is a powerful addition to the quantitative and qualitative evidence base on skills, training, qualifications, and the employer perspective.

The survey is not yet sufficiently large to resolve differences between nations, so the following UK integrated data is cited as a guide to the key issues for employers in England as elsewhere.

- Annual average company turnover in employment is approximately 15%.
- Professional scientists and engineers vacancies that are ‘hard to fill’ are reported by 57% of employers.
- Annual training budgets average was £930 per employee. In addition to this companies may incur additional cost such as travel, subsistence, internal training and mentoring, the maintenance cost of training facilities as well as maintaining productivity during training.
- Employers were satisfied with the coverage of qualifications across the sector. Satisfaction ratings were highest for ‘Academic’ qualifications, ‘Competence Based’ qualifications and ‘Flexibility’ of provision.
- Health, Safety and Environment (HSE) training was the most frequently reported training undertaken, when viewed across both internal and external training requirements. Companies tend to resource externally for specialist training, such as, ‘Professional’, ‘Technical’ and ‘Health, Safety and Environment’.
- ‘Private Training’ providers are used by 94% of employers; 80% use ‘FE’ providers; and 51% use ‘HE’ providers.
- For private training providers, satisfaction levels tended to be extremely high (ranging between 76% and 97%) in all areas of; ‘Cost’, ‘Relevance’,

'Flexibility', 'Location' and 'Quality' of provision. This reflects the highly tailored provision offer by private training providers.

- The satisfaction ratings for FE and HE were also very high (ranging between 60% and 85%), with the lower of these ratings referring to relevance, flexibility and location of provision. This suggests 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.

- The majority of employers (83% and 78% respectively) place a high level of importance on the supply of Apprentices and Graduates to their workforce (8% of the skills supply recruited were Apprentices; 11% of the skills supply recruited were Graduates).

- Most employers (81% and 74% respectively) invest in 'Competence Based' and 'Technical' training of the existing workforce, with 64% of employers investing in 'Professional/Higher Level' training.

- Skills gaps and shortages were reported by 83% of employers to had some, or significant impact.

- Competence-based skills needs are reported by 65% of employers report have increased in the 12 months preceding the survey; 72% of employers expected the demand for both competence-based and management level skills to increase in the 12 months following the survey.

- Looking ahead, Cogent employers were split in concluding that the economic situation for their businesses would 'improve' (39%), 'remain static' (26%), or 'worsen' (26%) within the year (8% of employers were undecided).

- Most Cogent employers predicted 'no significant change' in employment in the short term (2 years ahead).

- Securing funding, improving access to training courses and encouraging young people into the sector, are viewed by Cogent employers as the highest priorities for a Sector Skills Council.

5.0 Sectors Selected In-depth

5.1 Nuclear

The beginning of the second decade of the century is a pivotal time for nuclear skills in the UK. Within the civil sector, there is very high aspiration from the utilities and vendors to construct new capacity, set against a rapidly increasing demand for low carbon electricity. Defence nuclear capability similarly has a large programme of planned construction and on-going operations. This confluence of nuclear activity has nevertheless formed at a time of considerable financial uncertainty. If the highest aspirations of the two sectors are realised, there will be an unprecedented peak in demand for nuclear skills. On the other hand, even in the most conservative scenario there remains an on-going demand for decommissioning and operational skills. At the time of writing, the most recent influences on the long-term prospects are government's policy statements in the form of a revised draft National Policy Statement (NPS)[14] for nuclear, listing eight sites as potential locations for civil new build, and the Strategic Defence and Security Review (SDSR)[15] which was assumes the continuation of the Astute attack submarine programme but a delay to the Vanguard deterrent platform replacement.

The Cogent assessment of skills needs for the nuclear industry has been made in a series of reports under the title of 'Renaissance'. The first of these, *Power People*[16], was published in September 2009 and described the existing civil nuclear estate, with an overview of the findings included in the 2009 Sector Skills Assessment (SSA). Since then, Cogent has published *Next Generation: Skills for Nuclear New Build*[17] and prepared a report on the defence sector to be published as 'Assurance'[18]. Some of the information presented in the 2009 SSA covering current work in generation, fuel processing and decommissioning, is repeated here since it describes the single largest nuclear activity in the UK at the time of reporting. This report extends the field of view to include civil nuclear new build and the Submarine Enterprise programme.

5.1.1 Civil Nuclear Sector

<u>The existing estate</u>

At its peak, nuclear power in the UK provided over a quarter of the total electricity generation in the UK. Today, the industry is on the cusp of a renaissance in new build that will see a transition between the old and the new generation of power stations. It is therefore paramount that the UK retains the skills it already has and develops the skills it needs to meet the requirements of a sector that is likely to grow over the next few years.

The civil nuclear industry today provides employment for 44,000 people[16]. 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

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14 Revised Draft National Policy Statement for Nuclear Power Generation (EN-6) Vol1 and 2

15 Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review, Cm 7948, October 2010

16 Power People: The Civil Nuclear Workforce 2009 – 2025, Cogent 2009

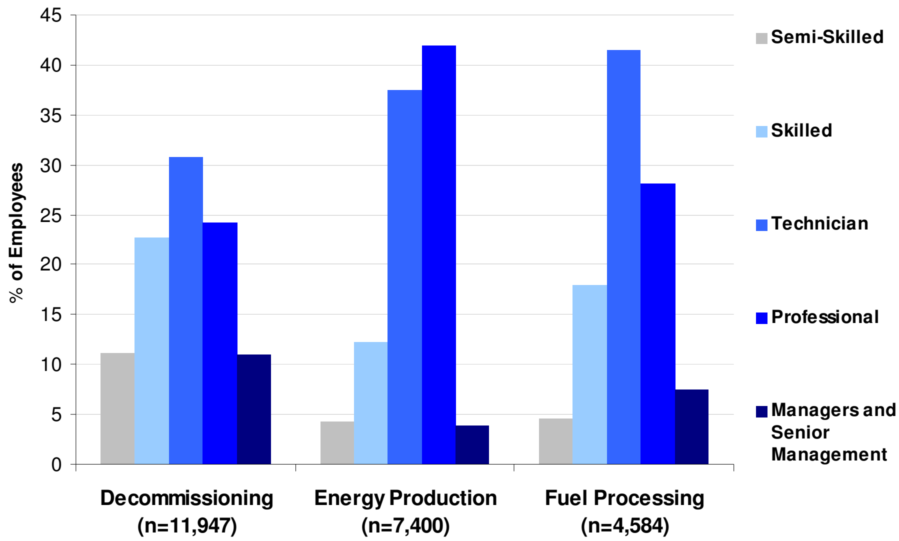
17 Next Generation: Skills for New Build Nuclear, Cogent 2010

18 Assurance: Skills for Nuclear Defence, to be published December 2010

South East of England (9%) are the next largest in employment. The North East of England, the East of England and North England 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, with the combined Technical, Professional and Senior Management skill levels typically close to, or in excess of, 70% in any of the sectors. Figure 5.1.1 shows the distribution of skill levels across the sectors.

Figure 5.1.1 Occupational Skill level of Civil Nuclear Workforce (excl. Supply Chain)



(Source: Power People: Civil Nuclear Workforce 2009-2025, Cogent 2009)

Future prospects

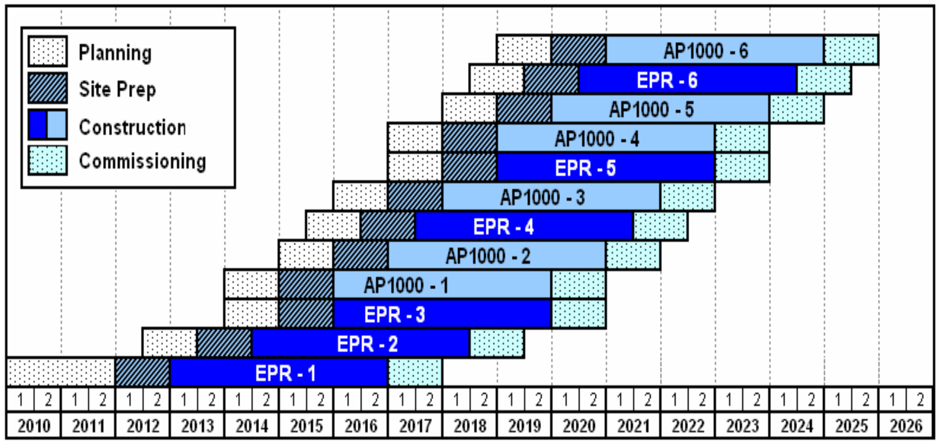
The decommissioning timescale for the existing AGR fleet will result in a loss of 10 GWe capacity in the period to 2025. In response, and in line with government policy of a mixed low carbon electricity economy, three private sector consortia[19] have stated their intent to deliver up to 16 GWe by 2025. New build on this scale would create thousands of new jobs and training opportunities in construction, advanced manufacture, engineering construction, regulation, nuclear operations, power generation, and plant maintenance.[20] It is in this context that a 'next generation' scenario has been framed. The scenario assumes no significant alteration to the timeline projected by the Office for Nuclear Development[21] for first new nuclear generation, and that the UK is expected to supply most of the skills required.

19 GDF Suez, Iberdrola, Scottish and Southern; EDF; Horizon Nuclear Power (RWE and E-ON)

20 Employment figures used are generally quoted in full-time equivalents (fte). This will give the lowest possible estimate of the number of jobs. Mobility in the workforce and fractionation of fte will return a multiple of the fte calculation.

21 Department of Energy and Climate Change.

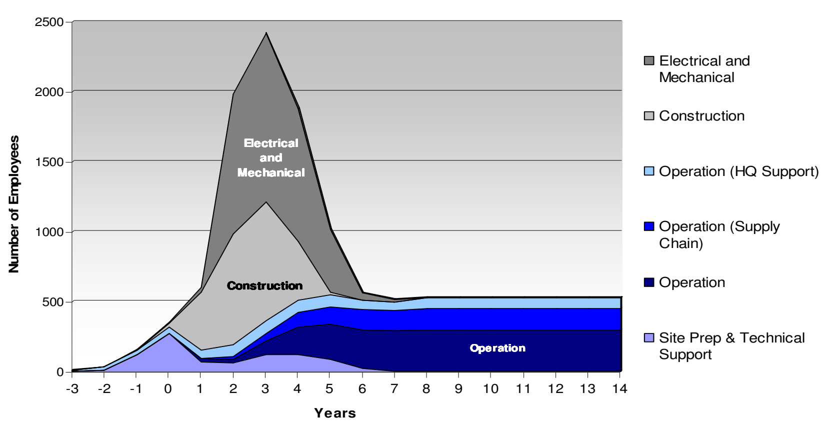
Figure 5.1.2 Indicative 16 GWe New Build Scenario (Timeline for 12 Units)



(Source: Next Generation: Skills for New Build Nuclear, Cogent 2010)

The assessment made in '*Next Generation'* examined the workforce required to build 6 stations by deploying 12 Pressurised Water Reactor units to generate up to 16 GWe, finishing *circa* 2025.[22] The station build profile modelled in Figure 5.1.2 comprises six 'EPR'[23] and six 'AP1000'[24] reactors. The timeline accommodates an 'early-starter' profile for the EPR design followed by the AP1000, with an average five years to achieve a fully commissioned single unit. The basis of the model was an industry informed profile for a single unit (figure 5.1.3) that could be scaled accordingly. With the long projection to 2025, it is estimated that the figures are accurate to a precision of 20% (alternative scenarios have also been analysed http://www.cogent-ssc.com/research/renaissanceII.php but show only small differences in the overall effect on the workforce).

Figure 5.1.3 Single Pressurised Water Reactor (PWR) Workforce Level

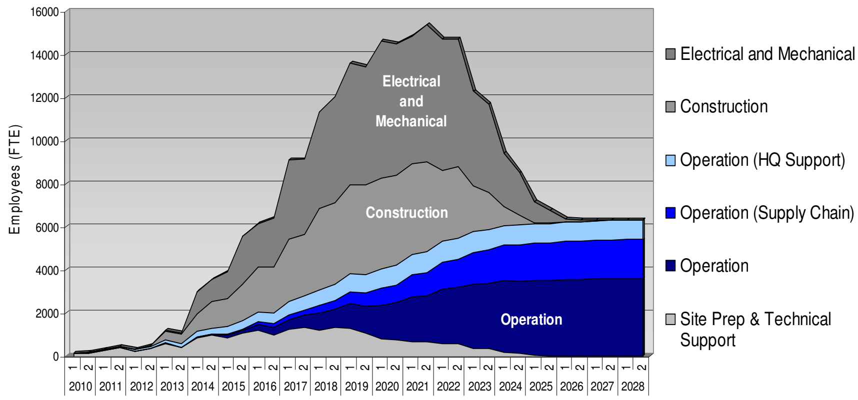


(Source: Next Generation: Skills for New Build Nuclear, Cogent 2010)

Employment of the order of 110,000-140,000 *person years* is predicted, based on full-time equivalents totalled each year for every year. This gives an average 10,000 jobs *per year.* Headcounts will be considerably higher, especially for construction.

[22] No inference is intended that new build will cease after this timeframe, or that new build should be aimed at a predetermined capacity ceiling. The market will decide what it can bear.
[23] The Pressurised Water Reactor design of the vendor company Areva
[24] The Pressurised Water Reactor design of the vendor company Westinghouse

Figure 5.1.4 Integrated Workforce (6 twin unit stations - 16 GWe)



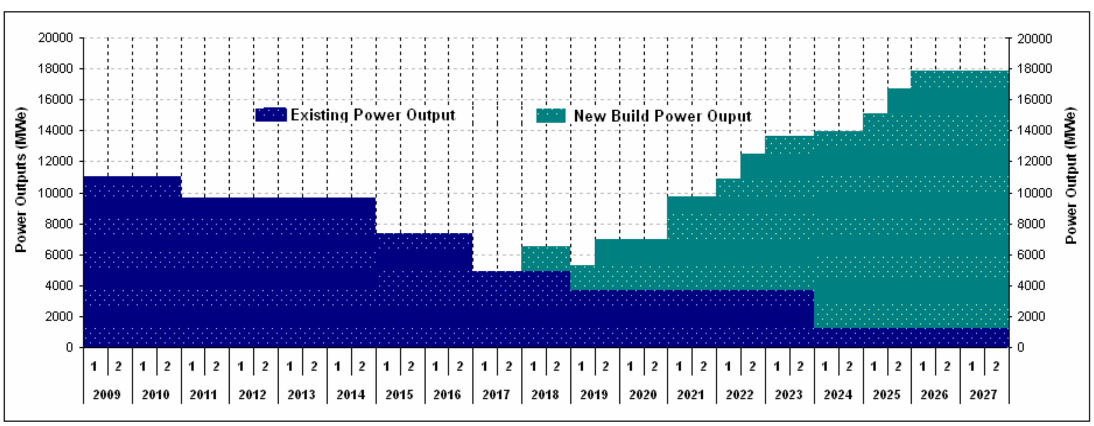
(Source: Next Generation: Skills for New Build Nuclear, Cogent 2010)

Figure 5.1.4 shows the effect of scaling up the single unit of figure 5.1.3 along the profile of figure 5.1.2 to represent the integrated workforce over the entire build programme.

Stretching or compressing the new nuclear timeline affects the predicted peak employment and the degree to which the construction and manufacturing workforces can cycle through various build projects. For the scenario, a main total employment peak of 14,000 full-time equivalents *circa* 2021 is predicted. This figure provides an indication of the racking up of skilled demand over the next decade and has implications for the supply of skills from education and training, and for transition planning of existing skills in the industry. The peak is driven by the significant overlap in the separate new build projects with seven units under various stages of construction between 2019 and 2021.

The sum of the separate sector maxima, albeit at different points in time, amount to 18,000, comprising 12,000 for Construction, 5,000 for Operations and 1,000 in Manufacture.

Figure 5.1.5 Power Output forecast for 12 units



(Source: Next Generation: Skills for New Build Nuclear, Cogent 2010)

Before new generating capacity is fully commissioned, existing generating capacity, according to current lifetime plans, continues to decline (figure 5.1.5). A low of 5 GWe generation provided by nuclear in 2017 is predicted before a gradual increase to a combined peak of approximately 17 GWe is established by the end of the scenario timeframe *circa* 2025. This illustrates the potential for workforce transition planning across the old and the new power stations. However, the age profile of the established workforces will reduce this facility over this period. Further, the operation of the existing estate will require on-going support, including a degree of new construction itself, as successful and safe operation in this area is a prerequisite for future development.

While no reference has been made in this work to the locations of new build[25], at site level the model for the component reactor unit can be applied to single, twin, and triple-unit stations as required. By way of example, employment in the manufacture, construction and operation of a twin-unit station will be 21,200 person years over six years.

During a new build project, Construction will comprise 60% of the workforce, Operations 25% and Manufacture 15%. Construction and Manufacturing are secured early and persist for as long as the supply chain is engaged in the project, while the Operations workforce is a more permanent entity for the estimated 40-year operating lifetime[26] of a station, and beyond to decommissioning. It is in Manufacturing where employment in the global supply chain will have greatest share. It is anticipated that for employment in Construction and Operations the UK can realize the employment requirements from a combination of retaining existing skills and growing the skills that are required. A summary of workforce metrics is given in table 5.1.1.

The demand for skills in each sector requires careful planning due to the significant number of people required across a range of skills and occupations. This will be compounded by nuclear awareness and safety training requirements associated with working under a regulated nuclear site license from the outset of construction. Further, long induction periods are required for some critical skills due to the high levels of education, training and experience to produce the highest levels of workmanship, quality assurance, and competence. The projected levels of demand will not only risk the supply of <u>critical</u> skills for capability, but will also emphasize the demand for skills capacity through 'new blood', drawn from all levels of the education and training supply, as well as transitioning expertise from sectors with oversupply (*e.g.* existing nuclear operations as they progress to decommissioning).

Capacity issues identified are:

- shortage of demand information
- workforce mobility
- supply of apprentices, scientists and engineers
- age profile of existing workforce
- long induction periods for experience competing demand for experienced
- people from national and international projects.

Capability issues identified are:

- nuclear awareness, behaviour and culture
- suitable qualification and experience.

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[25] The draft National Policy Statement for Nuclear listed the following as potential sites for new build: Bradwell, Hartlepool, Heysham, Hinkley Point, Oldbury, Sellafield, Sizewell and Wylfa.

[26] Recognising that operating lifetimes of new nuclear power stations could be around 60 years

Table 5.1.1 New Nuclear Workforce Metrics

16 GWe (new)	6 Twin-Unit Stations	Station (twin unit)	Construction[a] (twin unit)	Manufacture (twin unit)	Operation (twin unit)
Person years %	110,000 - 140,000	21,200	13,000 60%	3,200 15%	5,000 [b] 25%
Timeframe of build	13 years	6 years	6 years	6 years	6 years
Employment – pn yrs per GWe	6,000	7,571 [c]	4,643[c]	1,143[c]	1,786[c]
Employment - fte p.a. (aver.)	10,000[d]	3,533[d]	2,167[d]	533[d]	833[d]
Skill Levels			25% L2 60% L3 15% L4+	15-30% L2 30-40% L3 20-40% L4+	10% L2 [e] 40% L3 [e] 45% L4+ [e]
Workforce Split			40% Civil 45% Mechanical & Electrical 15% Management & Supervision	10% Civil 30% Major Nuclear 40% Balance of Nuclear island 20% Balance of Plant	60% Nuclear Operator 30% Supply Chain 10% Utility HQ etc
Other	18,000 combined peak employment of sectors (peaks at different times)		12,000 peak employment 2021 UK supply (most)	1,000[f] Peak employment UK supply (mostly)	5,000 peak employment 2026 UK supply

a Here 'Construction' includes site preparation and electrical and mechanical jobs; **b** thereafter 1,000 fte pa for 60 years or 60,000 person years; **c** uses a hypothetical EPR+AP1000 station; **d** 'Person Years' divided by 'Timeframe'; **e** based on nuclear operator data; **f** estimated contribution to peak from sector that is highly globalised.

(Source: Next Generation: Skills for New Build Nuclear, Cogent 2010)

In addition to the capacity and capability assessment, a risk register has been created to identify the most critical skills required for the first new build across the progressive stages of Design and Planning, Manufacture, Engineering Construction, Operation. At the time of writing, the most at-risk skills are identified as:

- Project Management
- Safety Case Authoring
- High Integrity Welding
- Control and Instrumentation
- Planners and Estimators
- Geotechnical Engineering
- Non-destructive Engineering
- Manufacturing Engineering (Mechanical Electrical, Production, Chemicals)
- Design Engineering (Mechanical Electrical, Production, Chemicals)
- Regulators

5.1.2 Defence

In common with its civil counterpart, the strongest determining factor as to the overall shape of the defence nuclear programme is government policy. Beyond current operations, there is a need to define future military requirements and to manage the supply of nuclear skills accordingly.

Nuclear defence operations are coterminous with the Royal Navy submarine fleet, and have two strands; propulsion and the UK independent nuclear deterrent. The Submarine Enterprise Programme comprises the following four high level activities and the associated oversight function:

- the continuation of existing long and short term overhaul programmes of the operational submarine fleet
- decommissioning of submarines coming out of service
- construction of the Astute 'Hunter Killer' SSN[27] class
- conception, design and construction of a successor SSBN[28] launch platform for Trident

<u>Operations and Decommissioning</u>

Continued operational effectiveness and reliability requires, in additional to in-service maintenance and Operational Docking Periods, a schedule for planned large-scale replacement of key components and the upgrading of systems to reflect on-going technological advances. In addition, the first generation of pressurised water reactors (PWR1), and all but the latest core design of the PWR2 successor, require its replacement of the nuclear fuel during the submarine lifetime. At the end of its service life, the submarine is prepared for long term storage afloat (known as defuel, de-equip and lay-up preparation).

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[27] SSN – NATO designation, Ship Submersible Nuclear: Submarines with nuclear primary propulsion systems and conventional weapons

[28] SSBN – NATO designation, Ship Submersible Ballistic Nuclear: Submarines with nuclear primary propulsion systems and ballistic nuclear weapons (in addition to conventional weapons)

SSN Class

The Astute class is the latest to be produced in the UK, and was designed as the replacement for the Swiftsure and Trafalgar classes It is capable of a range of functions from surveillance to surface warfare and anti-submarine operations. Nuclear propulsion allows for wide geographical deployment with minimal risk of detection. The boats carry conventional weapons, but represent the state-of-the-art in terms of instrumentation and indeed crew facilities.

HMS Astute, was launched in November 2009. The second, third (Table 5.1.2) fourth boats are now under construction, and the fifth is in its initial build stage. Long lead time components for a sixth Astute class submarine were ordered in March 2010. On the basis of the Strategic Defence and Security Review (SDSR), *Securing Britain in an Age of Uncertainty*[15] published on 19 October 2010 it is assumed that the construction of all seven boats will be completed, even under a reduced defence budget.

Table 5.1.2 Astute Class build status – November 2010

Boat	**SSN**	**Status November 2010**[29]
1	Astute	Sea Trials
2	Ambush	Launch scheduled for 16 December 2010
3	Artful	Outfitting
4	Audacious	Under Construction
5	TBC	Initial build
6	TBC	Long lead time items ordered
7	TBC	Planned[30]

(Source: Cogent unpublished 2010)

It is also worth noting that, with the facility for the Astute design to accommodate nuclear-armed Tomahawk cruise missiles, there is potentially some overlap with the deterrent platform.

SSBN Class

The UK nuclear deterrent operates according to a philosophy of 'calculated ambiguity', which makes use of submarines to make the launch point extremely difficult to track. The strategy uses the principle of Continuous At Sea Deterrence (CASD), which has operated since the introduction of the Polaris system in 1968. By having an operational nuclear launch platform constantly available, it is also judged that the escalatory risk of sailing a submarine as a response to an increased threat is avoided. In practice the policy is executed by a flotilla of (currently) four vessels arranged such that one submarine is on operational patrol while the remainder are in different states of pre and post patrol preparation and maintenance.

HMS Vengeance, the fourth and last of the Vanguard class SSBN submarines, was launched in 1998. The 2006 defence white paper, *The Future of the United Kingdom's Nuclear Deterrent*[31], concluded that by 2024 there would be an insufficient number of SSBNs in operation to continue the posture of CASD. It also judged that the interval from detailed concept work to first patrol would be about 17 years, based on the experience of designing, manufacturing and deploying the existing submarine based deterrent. Within the SDSR, the coalition government announced its intention to delay the progress of the replacement programme through the procurement review process, reserving a final decision until 2016, potentially leaving a gap between the build programmes of the Astute and the Vanguard successor.

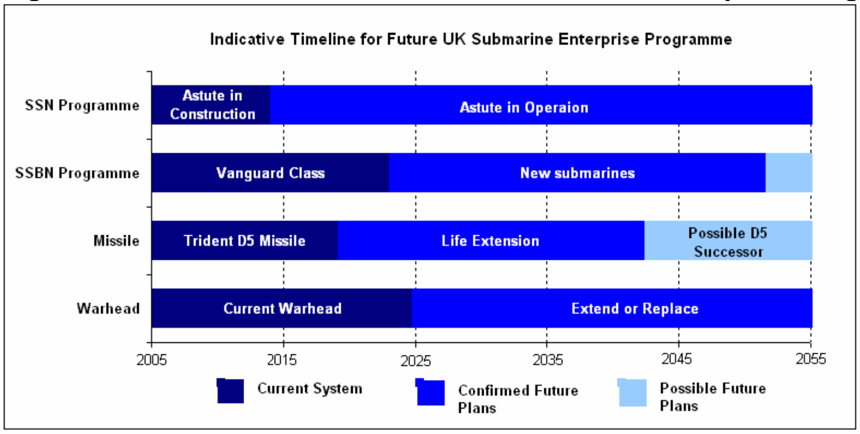
[29] BAE Systems News Release 263/2010, 1 November 2010
[30] SDSR (footnote 15) indicates the continuation of the plan to produce 7 Astute submarines
[31] Defence White Paper – The Future of the United Kingdom's Nuclear Deterrent, Cm 6994, December 2006

Since the early stages of the Astute programme, it has been acknowledged that the recruitment and retention of skills greatly benefits from a steady ‘production line’ of submarines. This point was made explicit in the 2006 white paper,

> *“There are also risks that, in the event of a significant gap between the end of design work on the Astute-class conventional role nuclear submarines and the start of detailed design work on new SSBNs, some of the difficulties experienced on the Astute programme would be repeated because of the loss of key design skills.”*

Future skills’ planning has since been strongly influenced by this recognition. This may have some impact on the maintenance of skills and training provision in the interval.

Figure 5.1.6 Indicative timeline for the Submarine Enterprise Programme



(Source: Cogent unpublished 2010)

An indicative timeline for the submarine programme is shown in figure 5.1.6. This shows the broad order of events planned to maintain a consistent demand for nuclear skills consistent with defence policy requirements. Delays in procurement, or more significant changes to defence policy, will necessarily change the timeline and the associated skills demand.

International Context

Some gauge of the positioning of the UK fleet within the NATO alliance can be made by comparison with the French and US nuclear fleets. All three nations operate both SSN attack submarines and SSBN deterrent platforms.

France

In late 2006, the French Defence Ministry awarded initial contracts with the intention of procuring six Barracuda class SSN submarines, a similar number to the Astute fleet. The first of the class will be delivered in 2017 with subsequent boats due to delivered at two year intervals, a rate also comparable with that of the Astute fleet. These will replace the existing Rubis class (four boats) and Amethyst (two boats).

Unlike the UK, the French nuclear deterrent is distributed across both air and marine launch platforms, with SSBN submarines accounting for around 80% of the arsenal. Le Triomphant, the most recent boat, was received by the French Navy in September 2010. It is estimated that the French nuclear defence budget is 9.5 - 10% of the national total, compared to 5 – 6% in the UK.

USA

The United States submarine fleet is considerably larger than those of the French and UK. Fifty-three SSN boats[32] operate from three classes: Los Angeles – 43, Seawolf – 3, Virginia -7. Five further Virginia class submarines are in construction.

The total US deterrence programme also employs air and land launched systems, although the submarine fleet forms the largest single component hosted by fourteen boats of the Ohio class[33]. Each submarine can carry 24 Trident II D5 missiles

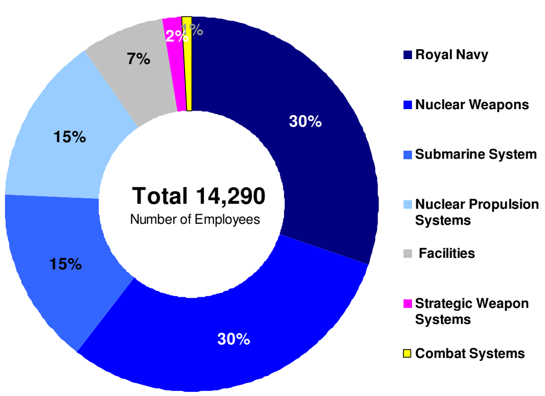
The Defence Workforce Today

A report on the skills demand in the defence sector is being prepared by Cogent, based on data collated by Deloitte, and will be published in Q4 2010. To maintain portability, the data were recorded against the same set of job contexts devised by Cogent for the Power People and Next Generation analyses, and a comparison between the two sectors is included in the Assurance report. Since publication will be subject to Ministry of Defence approval, we give here only a broad overall picture of the industry.

In 2010 the total Defence nuclear workforce comprises over 14000 personnel. For comparison, the directly employed civil workforce totals around 23,500. Although smaller, the demand for nuclear skills in defence forms a very significant fraction of the UK total. While a direct correspondence does not exist in all areas, the level, broad competences required and job appeal put many aspects on the same footing, at least outside of the Royal Navy (where the military bottom-fed entry and progression routes apply).

Figure 5.1.7 shows the breakdown of the current defence nuclear workforce (construction and operations) by functional workgroup. Propulsion and Weapons form nearly half (45%) of the total, with the Royal Navy constituting 30%.

Figure 5.1.7 Defence Nuclear Workforce 2010



(Source: Cogent unpublished, 2010)

Figure 5.1.8 segregates the same total workforce against job contexts, which allows an initial comparison with the civil sector. Energy production (for nuclear propulsion), Maintenance and Scientific and Technical Support form the largest specialisms and collectively amount to over half of the total complement.

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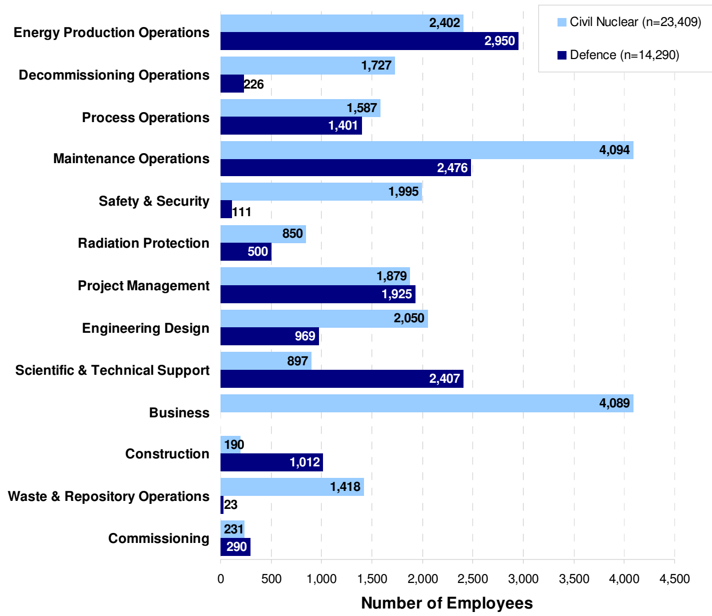
[32] United States Navy Fact File, Attack Submarine - SSN

[33] United States Navy Fact File Fleet Ballistic Missile Submarines - SSBN

Figure 5.1.8 Nuclear Workforce – Job Context Comparison 2010



(Source: Cogent unpublished, 2010)

Indeed, it is notable that that, currently, more people are employed in the energy production in defence than the civil sector. However, a civil sector new build programme on the scale assumed by the industry would double the long-term operational demand.

The role of the defence nuclear industry in on-going construction of the Astute class is represented in the large project management cohort which is at an equivalent level to the civil sector, but a larger proportion of the defence total. A further defence job context which is notably high, in both absolute and percentage terms, is Scientific and Technical support. This is associated particularly with weapons maintenance and development, and also reactor production. Skill levels in these areas are weighted towards Practitioner and Expert levels (corresponding approximately to level 2-3 and level 3-4).

Defence skills planning has, to date, assumed relatively stable demand and supply levels arising from a regular drumbeat of submarine construction. This assumption is vulnerable to two factors: competitive demand from a civil new build programme and changes in government policy driven by cost or deterrence policy. At the end of 2010 both factors look likely to have an impact at some level.

On-going LMI research will be vital in monitoring and refining the analysis in the light of the inevitable developments within the Defence and Civil constituencies.

5.1.3 Skills Summary

- Highly regulated, safety critical sector.
- Stable skills demand for Decommissioning.
- Stable skills demand for Defence.
- Significant increased demand for skills for nuclear Power Generation dependent on extent of private sector utility adoption of new build.
- Most at risk skills in the short term are skills in the supply chain for new construction.
- Most UK construction supply chain has lost nuclear capability and experience in skills for nuclear pointing to benefit of Nuclear Skills Passport.
- Training in nuclear safety culture and behaviour required as top up to existing training.
- Scenarios for new build developed and applied at national and regional level.
- Transition planning of skills from old to new estate is a priority for operating workforce.
- Long periods required to achieve suitable experience and qualification.
- Dependency on secure supply of science and engineering skills.

5.2 Bioscience

It has taken bioscientists less than half a century from first resolving the structure of biologically produced DNA in 1953 to map the complete human genome by the year 2000. Merely a decade on, bespoke synthetic DNA in a functioning bacterial genome was reported in the spring of 2010.

With the ability to genetically control and amend natural systems to produce materials, there are immense implications for the penetration of biotechnology across traditional industries whose products are essentially molecular – pharmaceuticals or chemicals, for example. In the future these industries will increasingly become life science industries whose products are essentially bio-molecular, and they will contribute to a growing bioeconomy in the UK; a bioeconomy that promises energy sufficiency, environmental sustainability, health benefits, and long-term economic growth.

With such potential at stake, it is not surprising that all UK governments identify life science as a priority sector.[34,35,36,37] This makes skills for growth in the UK bioeconomy a strategic priority for Cogent. Growth in biotechnology foreshadows a shift in skills across sectors. In particular, biotechnologies bring research and development closer to production and manufacturing. This will drive: the need to review the higher level skills required by employers from the Further and Higher

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[34] *Life Sciences Blueprint,* BIS 2009; *Life Sciences 2020: Delivering the Blueprint,* BIS 2009*; Maximising UK Opportunities from Industrial Biotechnology in a Low Carbon Economy*, A report to government by the Industrial Biotechnology Innovation and Growth Team, BIS 2009; *Strength and Opportunity: The landscape of the medical technology, medical biotechnology and industrial biotechnology enterprises in the UK,* BIS/UKTI/DoH 2009
[35] *Life Sciences – Key Sector Report,* Scottish Government 2009
[36] *Economic Renewal: A New Direction,* Welsh Assembly Government 2010
[37] *Life Sciences – Sector Profile*, Invest Northern Ireland 2010.

Education system, the skills and knowledge required by employees, a greater interdisciplinary awareness across the workforce, and models of future demand.

The bioeconomy is underpinned by biotechnologies which cut across sectors – red, white, green and blue biotechnologies, for example. Today the greatest impact for the UK is in medical or red biotechnology in health. Here the UK has a world-leading position, strengthened and sustained by the proximity of the research-intensive pharmaceuticals industry. The same technologies underpin white or industrial biotechnology and in which there is some evidence of commercial activity by the speciality chemicals sector.

Medical and industrial biotechnology are the main focus of Cogent research because they sit firmly in the footprint of Cogent industries. For completeness, agricultural and marine biotechnology etc. are included in the broader scope. Biotechnology companies in the supply chain to sectors can both increase productivity and add value. These are typically small-to-medium high-tech enterprises with a strong emphasis on research.

The continued penetration of traditional sectors by bioscience will depend on economic, technological, social and policy factors such as:

- the rate of scientific advance and technological diffusion
- intellectual property and ownership
- private investment and access to capital
- the public purse and a shrinking tax base from an ageing population
- policy positions on regulation, business, health, research and education
- public acceptance of technological advance
- the rate of skills shift from the traditional to the biotechnological
- the supply of highly skilled scientists, technicians and senior managers.

The impact of biotechnology on skills extends beyond those employed directly in the gene-based sciences, to supporting research and development and business functions of a biotechnology company or the supply chain. In this regard, a multidisciplinary set of skills in science, especially chemical, biological, genetics, statistical and modeling is important. Furthermore, many of those employed in supporting roles (e.g. marketing, technical sales, regulatory affairs) and who may not be specialised in some of these sciences, will require a broad awareness as appropriate to their industry.

5.2.1 Historical and Scientific Context

The chemical structure of the double helix was first deciphered in the 1950's by Watson, Crick, Wilkins and Franklin. From the knowledge of the structure of Deoxyribose Nucleic Acid (DNA), it was subsequently deduced that within the 'rungs' of a helical 'ladder' which holds the double helix together was written the four-letter - A,C,T and G - 'alphabet' of bioscience. In fact, the nucleotide base-pairs that make up the rungs are the scribes of the four-letter language, or blueprint, of all living systems.

In less than half a century since the structure of DNA was resolved in1953,[38] the complete human genome was mapped by the year 2000. The year 2010 marked a new era for bioscience when it was reported that bespoke synthetic DNA could replace natural bacterial DNA.[39]

[38] Watson JD, Crick FH (April 1953), *Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid"*, Nature 171 (4356): 737-738.
[39] Artificial life' breakthrough announced by scientists, BBC, May 2010. http://www.bbc.co.uk/news/10132762

With the ability to manipulate DNA, the technological appliance of bioscience, i.e. biotechnology, is potentially immense.

5.2.2 Research Literature

A number of preliminary studies have broadly reviewed skills in this area (Cogent 2010[40,41] and 2009,[42] Semta 2010,[43] Cogent/Semta 2010,[44] ABPI 2008,[45] UKCES 2010[46]. A common undercurrent is a dichotomy on skills: the industries are clear on the skills they require; but they are unclear on the demand for those skills. In general, these reports explore, the:

- clarity on skills required
- lack of clarity on skill demand
- dominance of the pharmaceuticals and chemicals sector in terms of skills data
- pace of technological development and how skills demand can outstrip supply
- hard-to-fill vacancies (scientific and technical)
- dependence on a secure supply of scientistsand engineers
- increasing concentration of R&D in the UK
- change in the nature of manufacturing
- stability of employment overall
- substantial replacement demand from the rise of medical biotechnology.

Representative recommendations from these studies include:

- deeper skills intelligence on the sector
- improved information advice and guidance
- greater opportunities for work experience
- development of training and qualifications for technicians
- employer-recognised graduate employability standards
- overcoming skills barriers for small businesses
- development and deployment of standards and qualifications for the workforce.

One higher level skills project has been piloted in the area of biopharmaceuticals.47

National data sources allow a degree of skills penetration, but only for sectors that are covered by standard industry classifications (SIC07). The SIC07 codes relevant to the life sciences are shown in table 5.2.1. The codes sit across the footprints of both Cogent and Semta. This illustrates the challenge in resolving the required skills and workforce information for the biotechnology sector as distinct from a traditional industry, or as distinct from generic cross-sectoral classifications such as research and development.

[40] *BioVision – Skills for Growth in the UK Bioeconomy,* Cogent 2010. http://www.cogent-ssc.com/research/Publications/BioVision.pdf

[41] Labour Market Survey – Life Sciences Pharmaceuticals, Biotechnology and Medical Devices, Cogent and Semta 2010, http://www.cogent-ssc.com/research/Publications/SEMTA_COGENT_report.pdf

[42] Life Sciences and Pharmaceuticals, Cogent, 2009. http://www.cogent-ssc.com/research/Publications/LSPReport.pdf

[43] *Skills and the Future of Advanced Manufacturing',* Semta 2010; *Science Industries (Bioscience) Sector Skills Assessment*, Semta 2010.

[44] *Labour Market Survey of the Life Sciences, Pharmaceuticals and Biotechnology and Medical Devices Sector',* Cogent/Semta 2010. *http://www.cogent-ssc.com/research/latest_publications.php*

[45] *Skills Needs for Biomedical Research – Creating Pools of Talent to Win the Innovation Race*, ABPI 2008; *Science Higher Education in 2015 and Beyond – Call for Evidence,* ABPI 2008.

[46] *Strategic Skills Needs in the Bio-medical Sector*, UKCES 2010.

[47] University of Reading (2009) *South East Universities Biopharma Skills Consortium Project*

Table 5.2.1 Bioscience-related Standard Industry Classifications (SIC07)

2110 - Manufacture of basic pharmaceutical products
2120 - Manufacture of pharmaceutical preparations
3250 - Manufacture of medical and dental instruments and supplies
7211 - Research and experimental development on biotechnology
7219 - Other research and experimental development on natural sciences and engineering

It is noted that the statistics for biotechnology (SIC07:7211) would appear to vastly under-represent the industry by comparison with recent research (see section 5.2.6).

5.2.3 Defining Bioscience and Biotechnology

The scope of bioscience and biotechnology used for this report encompasses industries that use science and technology that rely on biological processes. An industry such as pharmaceuticals is within scope as many of its products, nowadays, are biopharmaceuticals (biologically produced drugs) or involve bioprocessing at intermediate stages. The chemicals industry, on the other hand, has long been using biotechnology to produce industrial enzymes and detergents. In the food industry fermentation, is the most recognizable biotechnology.

This report adheres to the following definitions.

Biotechnology: *any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use.*

Medical biotechnology: *any biotechnology involving the discovery, development and manufacture of biopharmaceuticals and therapeutics (including devices that rely on action via pharmacological, chemical, immunological or metabolic processes).*

Examples include biologics (vaccines and antibodies), bioinformatics, diagnostics, regenerative medicines and therapeutics (gene and stem-cell based).

Industrial biotechnology: *biotechnology in which materials, chemicals or energy are produced by biological processes.*

Examples include chemicals, pharmaceutical intermediates, biofuels, bioplastics, enzymes, bioremediation, bioleaching and bioweapons.

Four colours of biotechnology – red, white, blue and green – are widely cited to distinguish between applications in, respectively, health, industry, and the marine and agricultural fields of primary production respectively.

5.2.4 The Bioeconomy of 2010

Biotechnology offers solutions for the health and resource issues facing the world. According to OECD, the global population is expected to exceed 8 billion within two decades, raising demand for health services, for energy, for food, for water, for shelter and for raw materials.[48]

Based on conservative estimates of the penetration of biotechnology in health (80% of pharmaceuticals), in industry (35% of chemicals), and in primary production (50%), a recent report, *The Bioeconomy to 2030'* (OECD 2009), has predicted the global bioeconomy will, by 2030, contribute 2.7% of OECD GDP - a GVA of $1.062 trillion. The growth predictions rely, *inter alia*, on technology transfer of bioscience; an area in which the UK is strong with both the public and private sectors making significant

[48] *The Bioeconomy to 2030,* OECD 2009.

contributions. Directly and indirectly, the public sector contributes to the bioeconomy through research council funding, through the National Health Service which purchases drugs, treatments and services from the private sector, and through the funding of education in science. This includes the infrastructure of Higher Education which secures the supply of people with highly developed knowledge and employable skills in natural sciences, biosciences, process engineering and the relevant technologies.

Small businesses in the supply chain to large industries are a feature of the bioeconomy. These are businesses founded on bioscience that uses high-technology platforms to bring significant added value and productivity. Skills intensity goes hand-in-hand with this business profile, making skills an important element for sustained growth.
Biotechnology is already used in primary production, industry and health (figure 5.2.1). The main uses are:

- in *primary production* for breeding of animals and plants with designed traits
- in *industry* for the bioproduction of chemicals, plastics, enzymes and biofuels
- in *health* for biologics, biopharmaceuticals, and diagnostics.

As the markets for biotechnology are well known, the correspondingly affected workforces are also well known: in the UK the sectors are process industries (800,000 employees),[49] food and drink (500,000 employees),[50] health (2 million employees),[51] environment, agriculture, marine etc.[52] What is less predictable is the degree to which biotechnology will compete with or replace the traditional supply chains in these sectors, and the change in the profile of skills, especially scientists, technicians and senior managers, that would be induced.

In most economies, commercial development and employment in red biotechnology vastly outstrips that of all other biotechnologies. There are, nevertheless, a growing number of examples of white biotechnology reaching commercial maturity.

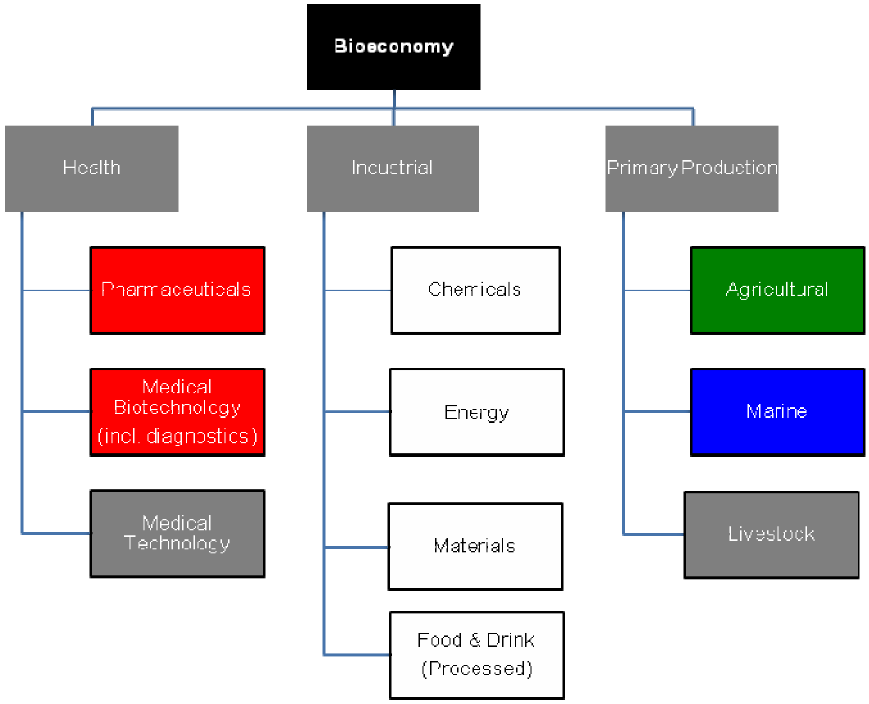
Surprisingly, in view of the dominance of red biotechnology in the bioeconomy of 2010, it is white biotechnology that holds the greater economic promise in the long term to 2030 (OECD 2009). It is conservatively predicted that industrial biotechnology could contribute 39% of OECD GVA in biotechnology by 2030, compared to 36% from primary production and 25% from health. This may suggest that current private sector investment in research and development for industrial biotechnology is out of line with market opportunities, notwithstanding other limitations such as the policy and regulatory environment.

Regardless of the 'colour' of a biotechnology, the most important and universal technology platforms concern genetic information and genetic modification. Platform technologies are a major determinant of the skills shift, sitting close as they do, to both research and application.

The most mature and widespread technology platforms are: genomics, genetic modification, DNA sequencing, gene synthesis, and bioinformatics. Although mature in terms of application, these technologies continue to advance in sophistication, bringing increased added value and raising productivity. They will continue to be complemented and extended by further emerging technologies (modified enzyme manufacture, for example) for the foreseeable future. Those of potential that are currently arriving at, or are close to market already are: RNA interference, metabolics, proteomics, and synthetic biology.

[49] Cogent http://www.cogent-ssc.com/research/
[50] Improve http://www.improveltd.co.uk/
[51] Skills for Health http://www.skillsforhealth.org.uk/
[52] Lantra http://www.lantra.co.uk/

Figure 5.2.1 The Bioeconomy



(Source: BioVision, Cogent 2010)

5.2.5 International Biotechnology

International statistics on biotechnology are complicated by variation in national collection and collation methodologies.[53] In addition, some statistics can be biased by data for large companies with only a small share of economic activity attributable to biotechnology. It is also noted that the OECD data preceded the new UK statistics developed by BIS. (Analysis of this data is included elsewhere in this report, e.g. table 5.2.5).

By many measures the United States is by far the leading nation in biotechnology (table 5.2.2). There are 3,300 biotechnology enterprises in the US. Employment levels are 1.3 million in biotechnology R&D with 50,000 employed directly in R&D activities. Excluding the UK, the European Union collectively hosts in excess of 3,300 enterprises with the largest nation states by this measure being France (824), Spain (659) and Germany (587). In France 237,000 are employed in biotechnology R&D firms, 50,000 are employed in biotechnology activity, 25,000 in R&D activity generally and 14,000 in biotechnology R&D.

On average, 67% of enterprises in a country are of size less than 50 employees – the SME category, or smaller. Where comparable international data exist (six OECD countries), biotechnology-related employment has a 12% share of total employment, but the share of biotechnology employment in biotechnology R&D firms is higher, as would be expected, at 18% (based on four countries).

Applications in health dominate statistics on the share of: firms (45%), employment (60%), R&D expenditure (77%), and sales (57%). Table 5.2.3 gives the details for selected OECD data.

[53] *Biotechnology Statistics*, OECD 2009.

Patent activity for biotechnology gives an important indication of innovation. Human genome activity is attributed to a surge of biotechnology patent applications in the late 1990s. The current decade has seen applications fall as a proportion of all patent applications, partly due to tightening of regulation on patenting of genetic materials. Today, the country average is 6.5% of all patent applications. In 2006, the United States contributed 42 % of PCT patent applications in biotechnology. Germany and Japan contributed 7% each. The UK contributed 5% of applications and made a total of 1,264 biotechnology PCT patents in the period 2004-2006; fourth in country activity behind the United States (11,474), Japan (3,720) and Germany (2,106).

Clinical trials can also be used as an indicator of innovation and of the development pipeline of future products. In the 20-year period from 1989 to 2009, 138 biotherapies received marketing approval across the world. Of these approvals, 66% were accounted for by firms based in the United States. Of the firms owning the approved biotherapy, 41% differed in name from those that developed the product. This is a symptom of outsourcing of biotechnology services, and mergers and acquisitions activity – often involving the major pharmaceutical companies.

As measured at end of December 2007, there were 703 registered clinical trials of new biomolecular entities. The UK is found to be second only to the United States by this measure. In this connection, the UK was responsible for 10% of all trials; the United States 55%.

With the exception of government R&D budgets for energy, there is an extreme paucity of internationally comparable data for industrial biotechnology.

Similarly, internationally comparable statistics in primary production relate largely to field trials for genetically modified crops with targeted traits. Not-for-profit sectors (*e.g.* government research institutes, universities and private non-profit organizations) dominate this activity. This suggests that this biotechnology is still in a pre-competitive phase. Pest resistance, herbicide tolerance and agronomic traits (harsh environments) are the most common activities. Like many countries, other than Canada and the United States, the activity of the UK is small. For example, between 2006 and 2008, the UK recorded four field trials. In comparison, for the same period, Germany recorded 28, France 52, and Spain 218. By contrast, the United States and Canada recorded 3,924 and 2,102, respectively.

Drawing from the international statistics, table 5.2.4 summarises the main commercial activities in biotechnology and identifies the growth potential. This illustrates: continued growth in medical biotechnology; rapid development of parts of industrial biotechnology, e.g. speciality chemicals (supply chain to the pharmaceuticals industry); steady development of others, e.g. energy, environment, materials; and slow development in agricultural biotechnology.

In summary, international statistics for biotechnology confirm the dominance of health but there is a paucity of data for industry and primary production to demonstrate significant commercial penetration. Small businesses dominate the landscape of biotechnology and outsourcing of specialist services is prevalent. Typically 12% of employment in a biotechnology company will be directly in a biotechnology activity.

Table 5.2.2 Biotechnology Employment and Enterprises (OECD 2009)

Employment[1]	US	France	Korea	Canada	Germany
Total (n=)	1,300,000	237,000	130,000	86,000	Not avail
Biotechnology (n=)		50,000	15,000	13,000	14,000
R&D (n=)	150,000	25,000			
Biotechnology R&D (n=)		14,000	7,500	7,000	7,000

Enterprises	US	EU[2]	OECD	France	Germany
Biotechnology (n=)	3,301	3,337		824	587
Dedicated Biotechnology R&D	83% (n=2,744)	62% (n=2,075)	58%[3]	56% (n=461)	84% (n=496)
Proportion Biotechnology R&D with <50 employees	77% (n=2,528)		63%[2]	67% (n=556)	

1. Figures round down to nearest hundred
2. Figure for 15 countries
3. Figure for 10 countries

(Source: BioVision, Cogent 2010)

Table 5.2.3 Biotechnology Applications (%) (OECD 2009)

Biotechnology		Enterprises[1]	R&D Expenditure[2]	Sales[2]	Employment[3]
Health	Medical	45	77	57	60
Industrial	Processing	6	1.5		3
	Environmental	8	2		4
	Food & Drink	11	4	15	9
	Industry subtotal	*25*	*7.5*		*16*
Primary Production	Agriculture		6	8	6
Other[4]	Bioinformatics	5	1.2		2
	Natural Resources	2	0.6		1
	Not specified	13	7		14

1. Based on data of 11 countries
2. Based on data of five countries
3. Based on data of six countries
4. OECD statistics do not distinguish the biotechnology application for firms in the service sector. It is possible that many of the firms reported under ‘other’ include platform technology firms that are active in Health.

(Source: BioVision, Cogent 2010)

Table 5.2.4 Biotechnology Growth Sectors

	Biotechnology		Examples	Commercial Growth by 2015
Health				
Medical Biotechnology	Diagnostics		Immunological and genetic tests, bioinformatics/pharmacogenetics linked to personalised medicine, preventative medicine	Rapid - in vitro Steady - in vivo
	Biopharmaceuticals		Biologics and therapeutics – chiral drugs, monoclonal antibodies, vaccines, hormones, enzymes, proteins	Steady
Industrial				
Industrial Biotechnology	Chemicals (Processing)		Bulk and speciality - enzymes, detergents, solvents, amino acids, vitamins, biopolymers, organics and pharmaceutical precursors	Steady Rapid – pharmaceutical precursors
	Materials (Processing)		Bioplastics, (from biopolymers), biopolymers (polysaccharides/s polyesters, polyamides/nylons, polyurethanes)	Steady
	Energy		Biofuels - biogas, bioethanol, biodiesel from crops, biomass, biodiesel from recovered oils	Steady
	Environment		Bioremediation - sewage, industrial waste (heavy metals), agriculture (chemical) Biosensors – environmental monitoring	Slow to steady
	Resource Extraction		Bioleaching (metals from ores), enhanced oil extraction	Slow
	Food and Drink		Fermentation and brewing	Established
Primary Production				
Agricultural, Marine, etc Biotechnology	Crops	Traits	Herbicide tolerance, pest resistance, environmental resistance, yields, quality, propagation	Steady to rapid
		Diagnostics	Disease diagnosis and control	Slow
	Forestry	Traits	Propagation, pest resistance, lignin yield (for paper)	Slow to steady
	Livestock	Traits	Quality, infection resistance	Slow to steady
		Propagation	Cloning to preserve designer traits	Slow to steady
		Biologics	Biopharmaceuticals (from milk)	Slow to steady
		Diagnostics	Disease diagnosis and control	Slow
		Therapeutics	Growth hormone, parasite and infection control	Slow

(Source: BioVision, Cogent 2010)

5.2.6 UK Biotechnology

The OECD 2009 biotechnology report preceded the creation of the UK's Bioscience & Health Technology Database from which the annual UK reports on the sector will in future be drawn. The UK database underpinned the publication of two government-sponsored reports in 2009: *Strength and Opportunity*[54] and *Maximising UK Opportunities from Industrial Biotechnology in a Low Carbon Economy*.[55]

The former, in particular, goes a long way to address the paucity of robust biotechnology statistics for the UK. The data excludes the major pharmaceutical and chemical companies that would otherwise swamp the statistics. Medical technology is also included in this publication, although medical technology, in contrast to biotechnology, includes replacement body parts, dental implants, assistive devices and MR scanners. Table 5.2.5 summarises the latest biotechnology statistics for the UK. The data confirm that the UK has a major global profile in medical biotechnology.

The proportion of companies in medical biotechnology that are SMEs is extremely high at 99%, while the proportion of companies in medical biotechnology with fewer than 50 employees is also high at 90%. Total employment in medical biotechnology is estimated to be of the order of 24,000. Research and development makes up a major component of business activity being performed by 57% of all companies. This rises to 86% for companies classified as development enterprises. Many companies are young, 5% are less than two years old, and the majority have been formed within the decade.

Manufacturing applies to a sizeable 27% of the companies, although it is not clear where the manufacturing is located. The main products from the medical biotechnology sector are small-molecule biologics and specialist services such as DNA sequencing or contract research. Although the perception of medical biotechnology is that it focuses on developing biologics (biologically derived molecules); in fact, small molecule drugs and specialist services (such as DNA sequencing) <u>each</u> account for 41% of the total turnover of £4.2 billion.

There is a healthy pipeline of products; indeed, the most well stocked medical biotechnology pipeline in the European Union. Of growing importance are biologics in the therapeutic protein and antibody categories.

As measured by employment, six regions of England together with Scotland and Wales may be identified as clusters. In the case of industrial biotechnology, development is slow at present but the potential remains for significant economic impact, indeed more than medical biotechnology by OECD estimations. Industrial biotechnology was recorded in the *National Strategic Skills Audit* (UKCES 2010)[56] as one of six strategic advanced manufacturing sub-sectors for their importance in the supply chain of numerous established sectors, and for their potential contribution to a low-carbon economy. Here the paucity of precise skills information was noted due to their nascent state.

More generally, science and engineering professional and technical roles are highlighted with an emphasis on breadth and depth of knowledge and the importance of vocational pathways. From an analysis of Working Futures data (UKCES, 2008),[57] the shift to technical and professional scientists in the economy generally was noted with a net demand for 2007-2017 as follows:

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[54] *Strength and Opportunity: The landscape of the medical technology, medical biotechnology and industrial biotechnology enterprises in the UK,* BIS/UKTI/DoH 2009

[55] *Maximising UK Opportunities from Industrial Biotechnology in a Low Carbon Economy*, A report to government by the Industrial Biotechnology Innovation and Growth Team, BIS 2009

[56] *Skills for Jobs today and Tomorrow, The National Strategic Skills Audit for England 2010*, UKCES 2010.

- science and technology professionals 514,000 (expansion demand of 192,000)
- science and technology associate professional 206,000 (expansion demand of 40,000)

This section on biotechnology prospects illustrates that it is timely to research skills futures scenarios to quantify the skills shift as biotechnology penetrates further in both the chemical and pharmaceutical industries.

5.2.7 The UK Pharmaceuticals and Medical Biotechnology Industries

The Medical Biotechnology and Pharmaceuticals sectors are interdependent. Both are industries that produce molecular entities. The former does this exclusively using bioprocesses, the latter does this using both bioprocesses and chemical processes. This sets them apart from medical technology where the ultimate product is normally equipment or a physically manufactured product such as a replacement body part. While 41% of revenue in medical biotechnology comes from small molecule drugs, most of these are probably manufactured by supply chain companies.

Traditional pharmaceuticals in the UK has been holding up against a number of forces: the patent 'cliff edge', the impact of generics, and the slow off-shoring of manufacturing. But its research base in the UK has been resilient - a point illustrated by the high skills profile (see section 6.2). It remains the fourth largest exporter in Europe and invests £4.3 billion (in 2008) in research and development in the UK. As the resource intensity of research and development and the long lead-times for regulatory approvals exerts a toll on the industry, the Medical Biotechnology sector has provided some solutions with specialist research services, reduced risk, increased productivity and rapid technology diffusion. The large unified market in the National Health Service and the quality of research and development in the higher education system are important factors in the resilience of pharmaceuticals to hold up in the UK.

Cogent recently published a 2010 Pharmaceuticals and Medical Biotechnology industry factsheet.[58] This brings together the latest data on medical biotechnology with national data, including skills data (see also appropriate previous industry section). This illustrates the combined employment profile of 73,000 (employment split 60:40, pharmaceuticals:medical biotechnology),1,500 employers (employer split 30:70 pharmaceuticals: medical biotechnology). The 44,000 employed by pharmaceuticals (according to national statistics) may well under estimate the true picture as companies that are not primarily manufacturers are not included. In this combined picture of a bioeconomy segment, the South East and East of England stand out, each with almost a fifth of the combined employment and employers. Overall England, Scotland, Wales and Northern Ireland are host to 80%, 10%, 8%, and 2% of employment.

In contrast to the broad employment statistics, Scotland is home to the second largest life sciences cluster in the UK and one of the most sizeable in Europe. It has an established network of over 40 pharmaceutical clinical trial support and contract research organisations.

[58] http://www.cogent-ssc.com/research/Publications/factsheets/Pharmaceuticals_and_Medical_Biotechnology.pdf

Table 5.2.5 Statistical profile of UK Biotechnology (BIS/UKTI/DoH 2009)

UK Biotechnology	Medical	Bioolgics[1]	Specialist Services	Industrial[2]
Turnover (% total)	£4.2bn	£1.7bn (41%) small molecules	£1.7bn (41%)	£230m
Enterprises (% total)	777	144 small molecules 154 biologics (38%)	448 (58%)	64
Employment (% total)	24,000	10,250 (43%)	13,500 (56%)	1,600
Size (by employee)	90% (<50) 99% (SMEs)			98% (SMEs)
Proportion R&D	57% (86% for development enterprises)			66%
Proportion Manufacturing	27% (n=209)			50%
Main products	Small molecules (part of biologics) Specialist services			Specialist services Environmental Biofuels Pharmaceutical intermediates Food and Drink
Product pipeline	245 (Clinical Trials) 447 (Drug candidates)			
Company age	17% <3yrs 42% 4-9 yrs 41% 10+ yrs			10% <3 yrs 46% 4-9 yrs 44% 10 + yrs
Growth segments	Antibodies Therapeutic proteins			
Geography (by employment)	England E England SE England NW Scotland England SW England London England YH Wales			England NE Wales England London England YH England SE Scotland

1. 'Biologics' groups together bioderived molecules - small molecules, antibodies, vaccines, therapeutic proteins, nucleotides etc
2. 'Industry' groups together Specialist Services, Environemntal, Biofuels, Pharmaceutical Intermediates, Food and Drink, Speciality/Fine Chemicals, Commodity Chemicals

(Source: BioVision, Cogent 2010)

The effect of medical biotechnology, however, on skills is already apparent, if not fully quantified. National data on skills are available only for the pharmaceuticals sector. As shown in section 6.2, the high level of skills requirement relative to the wider economy is apparent with 55% of the skills makeup at S/NVQ level 4 and higher. Although comparable data for medical biotechnology is absent, an even more intensive skill profile would not be unexpected given the statistical reviews above. Moreover, given the fact that the UK profile is most in R&D, the proportion of employment in biotechnology activities will be high.

5.2.8 The UK Chemicals and Industrial Biotechnology Industries

Cogent recently published a 2010 chemicals industry factsheet.[59] (See also the appropriate previous section). This brings together industry estimates with national data, including skills data, for the industry. The profile is one of 140,000 employees and 3,100 employers. The North West region of England stands out as a major concentration of employment (22% of employees), followed by Yorkshire and Humber (11%). These regions are joined by the South East when concentration of enterprise is accounted for (12%, 15% and 12% respectively). Overall, England, Scotland, Wales and Northern Ireland are host to 83%, 8%, 7%, and 2% of UK employment. The impact of new processing techniques could therefore have major consequences for the skills requirements of this industry and for its geography.

Section 5.2.2 reviewed the impact that industrial biotechnology could have on the chemicals industry, including skills. In addition, a small but authoritative survey of 61 respondents (including 20 from the speciality chemicals segment) has shown evidence of uptake of biotechnology by the larger chemical companies, with almost half making use of bio-processing at some stage in manufacturing (CIKTN/BIS 2008).[60] Extracted from this source, figure 5.2.2 shows the range of industrial biotechnology processes already in action and the industry perception of the future.

Noting the proximity of biotechnology to research and development, the chemicals industry invests £540 million in research and development in the UK per year.

Although, in general, the rate of industrial biotechnology uptake is weaker for Chemicals than for Pharmaceuticals, visibility on skills in biotechnology is just as difficult to disentangle from the statistics.

5.2.9 A Skills Taxonomy

From the evidence presented it is clear that biotechnology is a technological driver of skills across several sectors. All sectors, nevertheless, share a degree of the same bioscience, the same biotechnology, and the same skills. This is captured by figure 5.2.3, which illustrates a skills matrix of activities and job contexts for the life science industries.

The template comprises three general activity silos – research and development, manufacturing, and commercial services. Within each activity silo are nested families of job contexts which themselves depend on the biotechnology involved. Large, vertically integrated companies will encompass all three silos of activity. But, if the direction already taken by the medical biotechnology and pharmaceuticals sector is a portent of change to come in other sectors, then there will be increasing out-sourcing to small businesses providing biotechnology services in research and development - genetically modified organisms, contract biosynthesis etc. - and activity across the matrix will be populated in specialisms across one or two silos per company, e.g. research and development with technical services.

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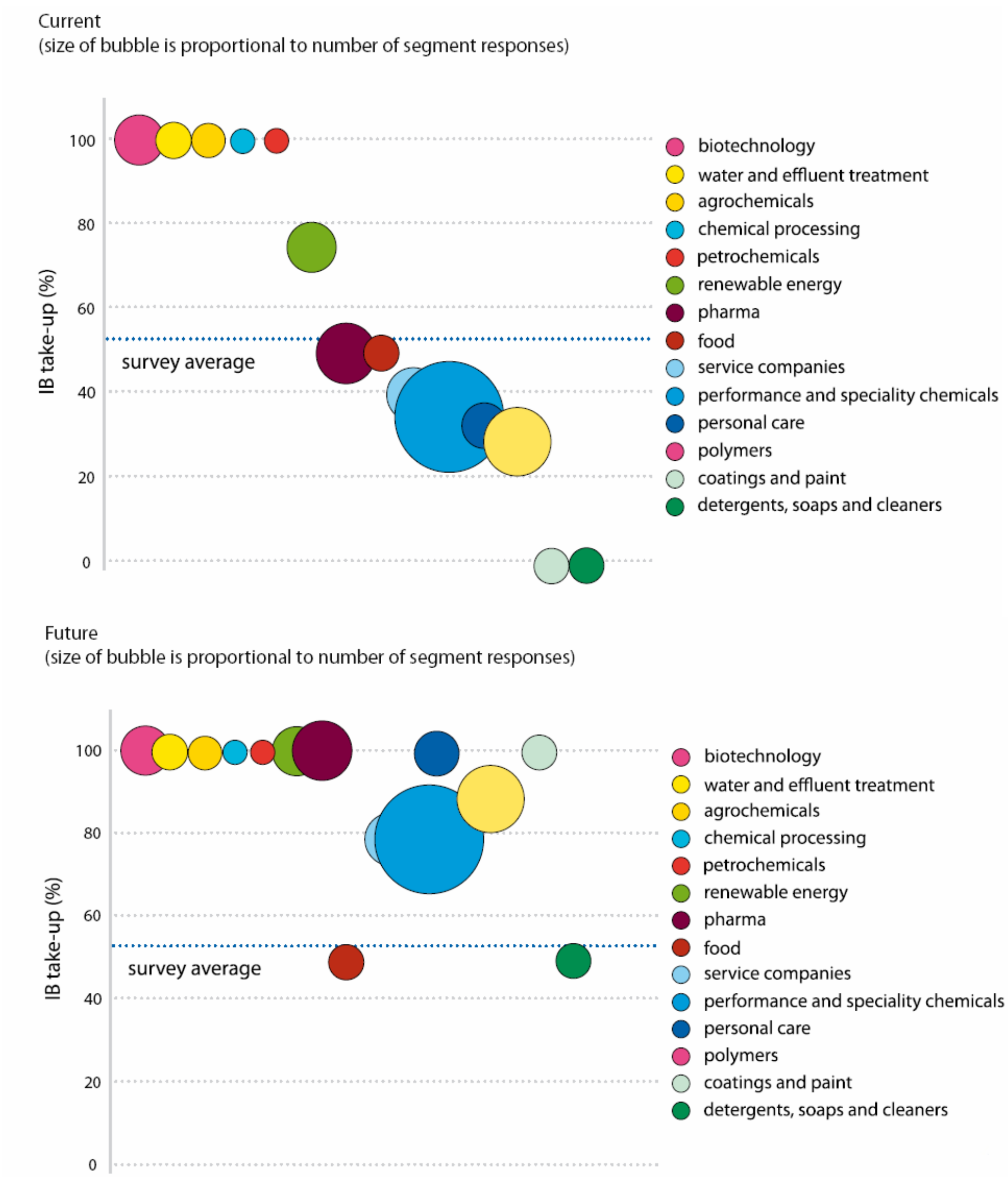
[59] http://www.cogent-ssc.com/research/Publications/factsheets/Chemicals.pdf

[60] *Industrial Biotechnology in the Chemicals and Chemistry-using Industries in the UK: Follow-up Survey to assess Barriers to Implementation and Opportunities for Growth'*, CIKTN/BIS 2008.

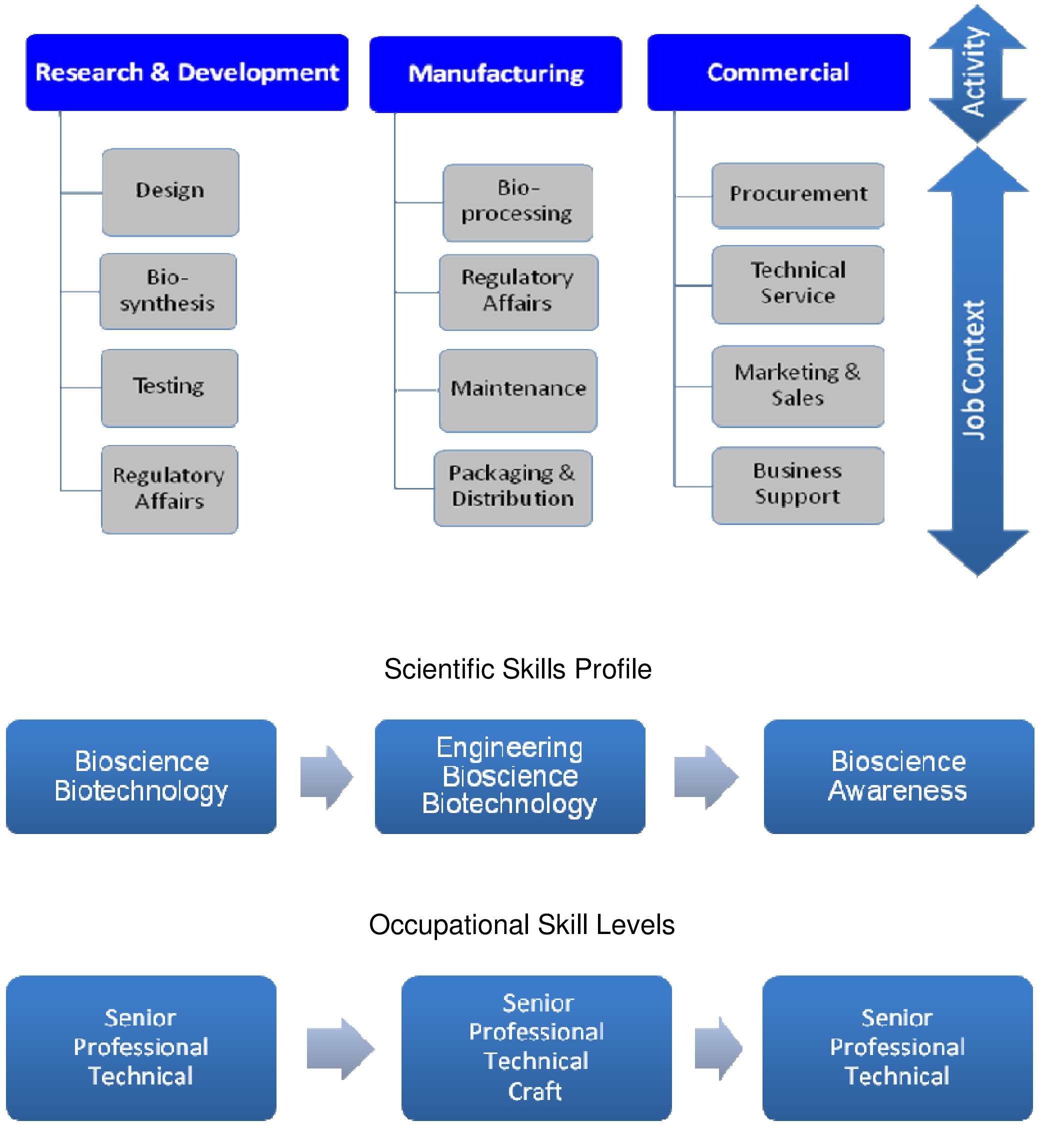
Such a template can be used to structure skills research, to categorise job roles and to support standards and qualifications development. The context for standards development, for example, will change with the industry, such that regulatory affairs in medical biotechnology may involve highly stringent clinical, legal and ethical regulation, whereas in industrial biotechnology, the focus of regulation may shift more to safety, environmental and health in the chemicals sector, or there may be additional standards for food production.

Figure 5.2.2 Current and Future UK uptake of Industrial Biotechnology (CIKTN/BIS 2008)



(Source: BioVision, Cogent 2010)

Figure 5.2.3 A Taxonomic Skills Template for Bioscience
Life Science Industries – from R&D to Commercialisation



(Source: BioVision, Cogent 2010)

5.2.10 Skills Summary

- Medical biotechnology is a significant sector that is not fully captured by UK national data sources.
- The UK is a major global force in the Life Sciences industries.
- Higher level skills dominate the industry.
- The large SME sector in medical biotechnology constitute a symbiotic business position opposite the big pharmaceuticals companies, with mergers and acquisitions common place.
- The supply of R&D skills from the higher education is critical to retaining the UK global position.
- The skills needs of big pharmaceutical companies are well documented but there is lack of clarity on demand.
- The pace of technological development will require the UK to ensure the supply of chemical and biological science graduates with good analytical and practical skills.
- R& D position of UK in chemical and biological science and applied to medical biotechnology must be sustained by research councils.
- Significant potential for industrial biotechnology in chemicals industry.

5.3 Life Science Industries – A Labour Market Survey

During 2009 Cogent and Semta collaborated on research covering the life science industries. The research report, based on 380 interviews from a sample base of 3,028 companies was published in February 2010. The respondent sample represented 24,000 staff across England (80% of companies), Scotland (13%), Wales (4%) and Northern Ireland (2%).

Full details of the research findings and the methodology were published during 2010.[61] The research focused primarily on:

- Establishment and workforce details
- Recruitment issues
- Workforce skills
- Training and development

The research is one of the most comprehensive yet undertaken in skills in these sectors. The sample of 380 respondent organisations has given a reasonable level of confidence in the findings reported, with the usual caveats when examining sub-group samples smaller than 100. Employer skill priorities and plans for action for the sector. This section reviews some of the findings.

5.3.1 Employers

The sample covered three types of company: pharmaceuticals (excluding R&D), medical devices and research (including biotechnology and pharmaceuticals). Cogent's interest rests across the first and the third; Semta's interest rests across the second and the third.

By employment 76% (18,384 employees) of the sample rests in the Cogent footprint; and by company/site 53% (203). The distribution by site and employment shows the normal inverse correlation between employment field and employer size (figure 5.3.1).

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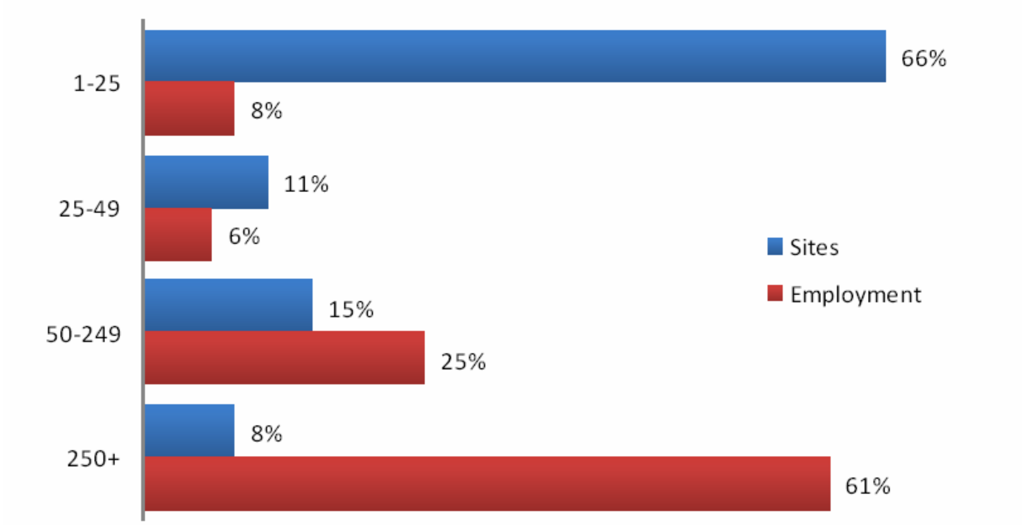
[61] http://www.cogent-ssc.com/research/Publications/SEMTA_COGENT_report.pdf

Figure 5.3.1 Sample by Sites and Employment



Biotechnology
Of these life science companies, 15% deployed biotechnology. This represents 18% of employment overall. In the pharmaceuticals and R&D sectors a higher incidence of biotechnology was recorded at 19% and 22% respectively.

University Spin-Outs
Overall 11% of companies had their origin as a university spin out. This proportion rose to 22% in the R&D sector.

5.3.2 Occupations

A slightly reduced sample (94% of respondents; 356 companies; 19,326 employees) were able to respond to this query.

A high proportion of senior management was recorded (22%); this is in character with national data for these sectors. When combined with professional scientists, technologists and engineers, 55% of employment was found to reside in these occupational groups (10,000 employed from the sample). A correspondingly low level of employment of elementary skills was also recorded (1%).

Just under two-fifths of those employed were female, with the five largest proportions, in decreasing order, being: administrative (66%), sales (53%) technical (44%), professional (35%), and management (33%) occupations.

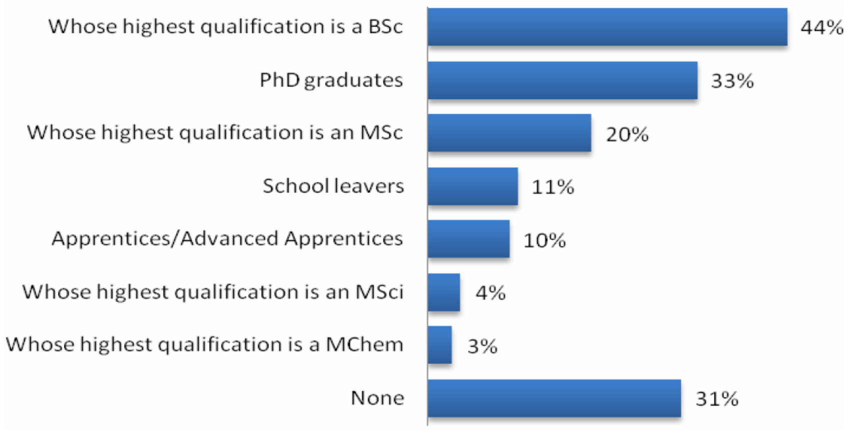
Research and Development
Across all occupations 29% of employment is in an R&D function, with the expected highest proportion of professional occupations (59%) being deployed in this category; 38% of managerial staff were deployed in this category.

5.3.3 Recruitment

Employment appeared to be stable, with 48% of all companies having similar levels of employment to the previous year; almost a third had increased recruitment; less than a fifth had reduced employment. The smaller companies are those most likely to have the same levels of employment.

Many companies (48%) had recruited within the year. The larger companies were the most likely to have been active in this area.

Figure 5.3.2 Recruitment – Skill Levels (base: 181)



Qualifications

Recruitment tended to be at the higher end of the skills spectrum. This is in keeping with the high levels of R&D recorded by the sample.(figure 5.3.2) When analysed by R&D company, recruitment of staff with qualifications at degree, masters and doctorate levels was, naturally, much higher at 65%, 38% and 62% respectively.

Relevant Work Experience

At least two-thirds of recruits were deemed to have relevant work experience. This figure rises in proportion to the qualification level, so that 94% of those of masters level.

Overseas Recruitment

Almost one-third of recruitment is of overseas personnel or students from overseas.

Hard-to-Fill Vacancies

Although sample size did not prove robust for this query, the data qualitatively suggests that professional and technical occupations of R&D in large companies experience this problem to the greatest degree.

5.3.4 Workforce Skills

Skills Gaps

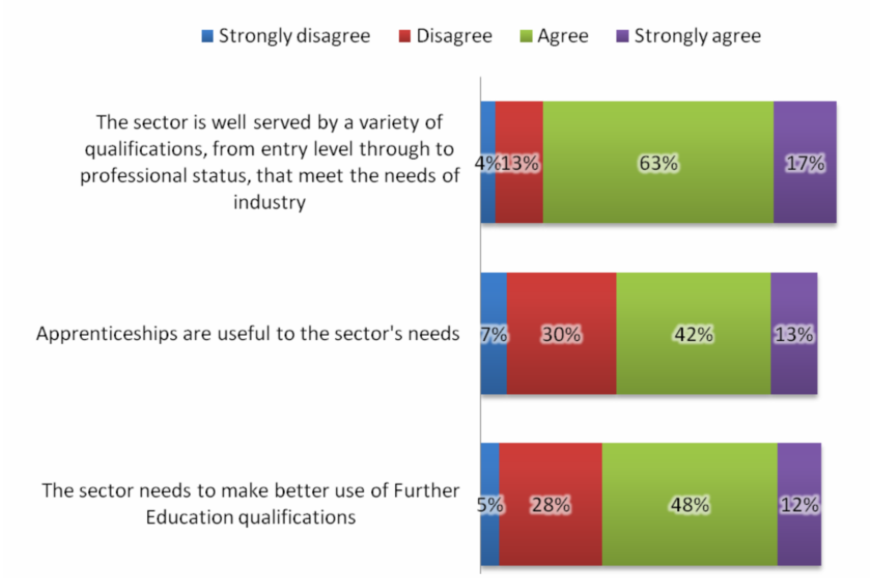
Skills gaps required to meet business objectives were reported by one in seven of employers; down from almost a third of employers since 2006. In line with the hard-to-fill enquiries, the gaps are most evident at the higher level occupations.

On a qualitative basis the most pronounced skills gap in science is chemistry, with pharmacology/toxicology also being cited.

Qualifications Supply

The majority of employers (79%; base: 380) declared their sector well-served by qualifications from entry to professional levels, but more than half suggested that they needed to make better use of vocational pathways. Figure 5.3.3 illustrates.

Figure 5.3.3 Qualifications



(base: 380)

<u>Drivers of Change of Skills</u>
New products, new technologies, new equipment or compliance issues are the most quoted reasons for changes in skills needs. Almost three-quarters (72%; base: 351) of employers anticipated that their existing workforces would need to acquire <u>both</u> new skills and new knowledge to continue to meet business objectives; less so for small employers (58%).

<u>Training</u>
On average 61% of employers (base: 390) have arranged or funded off-the-job training within the year; this being consistent across all three sectors. This rises to 84% for the larger companies. The pattern is similar for on-the-job training, with the corresponding statistic being 68% overall. This leaves one quarter of all companies that have undertaken no training within the year.

The average external spend on training is close to £21k (base: 94). When factored by employee, this averages to less than £645k per employee but there is a wide variation by sector and an abruptly 'stepped' variation of average spend per company by size category: from £122k for the large employers (250+ employees), to £44k for the medium-to-large employers (50-249 employees), to £9k and £8k for the small employers (5-49 and 1-4 employees, respectively).

The Pharmaceutical and R&D sectors on average spend almost four times as much than Medical Devices.

Most companies (58%; base: 294) expect levels of spend on training to remain fairly static in the coming year.

Training tends to focus more on the higher occupational levels as shown by table 5.3.1)

Table 5.3.1 Training by Occupation (%) (base: 294)

	On-the-job only	Off-the-job only	Both	Don't Know	Neither
Managers and Senior Staff	23	16	40	1	20
Professional Engineers, Scientists and Technologists Occupations	23	12	52	1	12
Associate professional and technical occupations	21	14	49	2	13
Skilled trades occupations	21	6	45	5	23
Process, plant and machine operatives	28	4	34	7	27
Sales and customer services occupations	33	12	33	2	20
Administrative and secretarial Occupations	27	8	34	5	26
Elementary occupations	27	9	23	2	39
Personal service occupations	19	4	19	19	41

In-house training is common (81% of those training), followed by commercial training providers (47%; base: 294). This tends to be due to expertise and experience. The Skills Oracle survey (section 5.2) found similar but probed more deeply to show that the job-specific training was the main focus, and that where technical and professional training with qualifications was required, that providers (FE or HE) were used.

Ratings for providers of training or qualification followed the Skills Oracle pattern also. Cost and time to train are the most quoted barriers to training. This is a pattern that is consistent across the economy generally.

Just over a quarter of the sample accessed funding for training activities, mainly for vocationally orientated courses. The incidence tended to be highest for R&D (35%; base: 83) and increases in line with company size (45% for companies of 250+ employees). Many companies had difficulty identifying access to qualification funding.

5.3.5 Skills Priorities

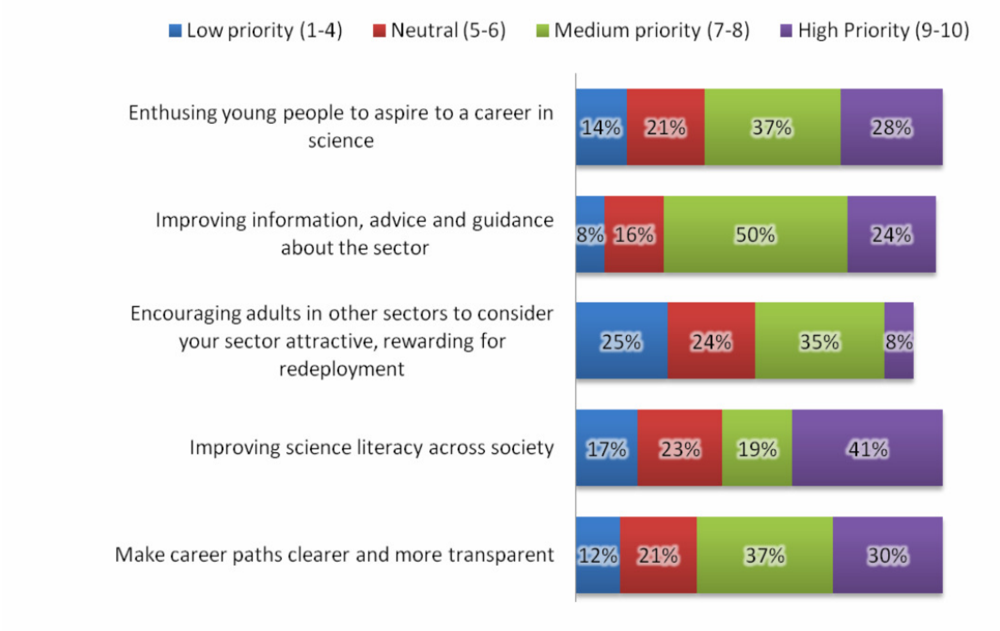
When asked to rate the objective of skills in their company from the restricted list of objectives below, employers prioritised the objectives as follows (base: 380):

- Achieve a top quality workforce (73%)
- Improve employer engagement and investment in skills (55%)
- Enhance leadership and entrepreneurship (53%)
- Improve sector image (44%)

When restricted to a single choice, ‘achieving a top quality workforce’ was more than twice as popular as any other at 38%. The aims feeding this priority are the development of training and qualifications that are more relevant to the employer need, and working with the education system to equip a higher number of people with the right vocational and practical skills as well as academic science.

Closing the skills gap in this context by increasing the supply of quality people and for practical skills to be championed from the education system featured prominently. Figure 5.3.4 discloses all priorities.

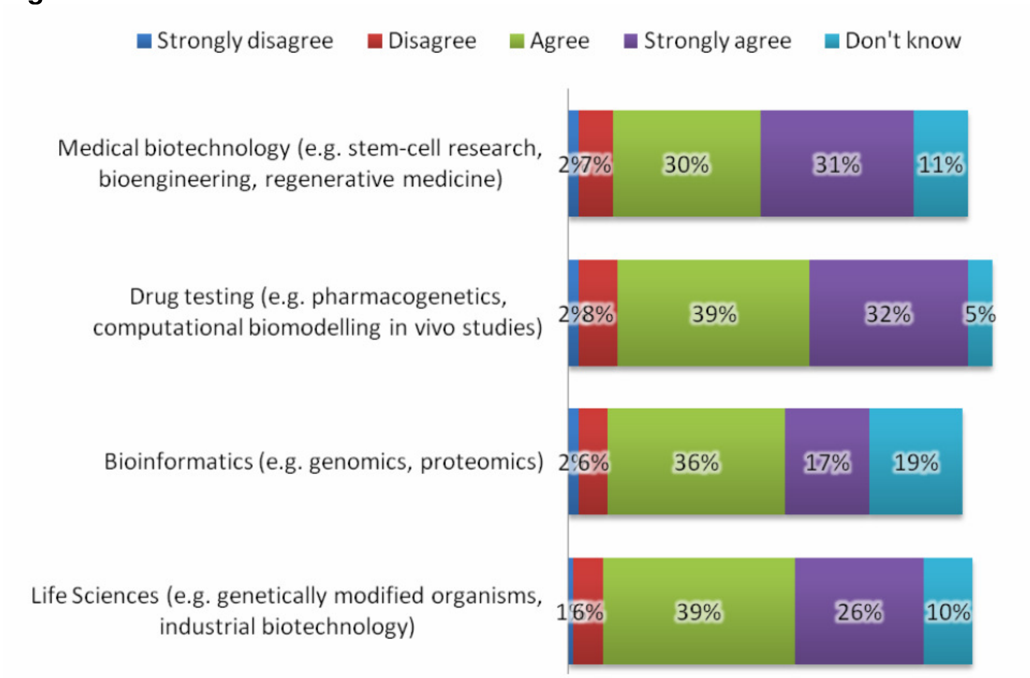
Figure 5.3.4 Priorities in Achieving a Top Quality Workforce (base: 146)

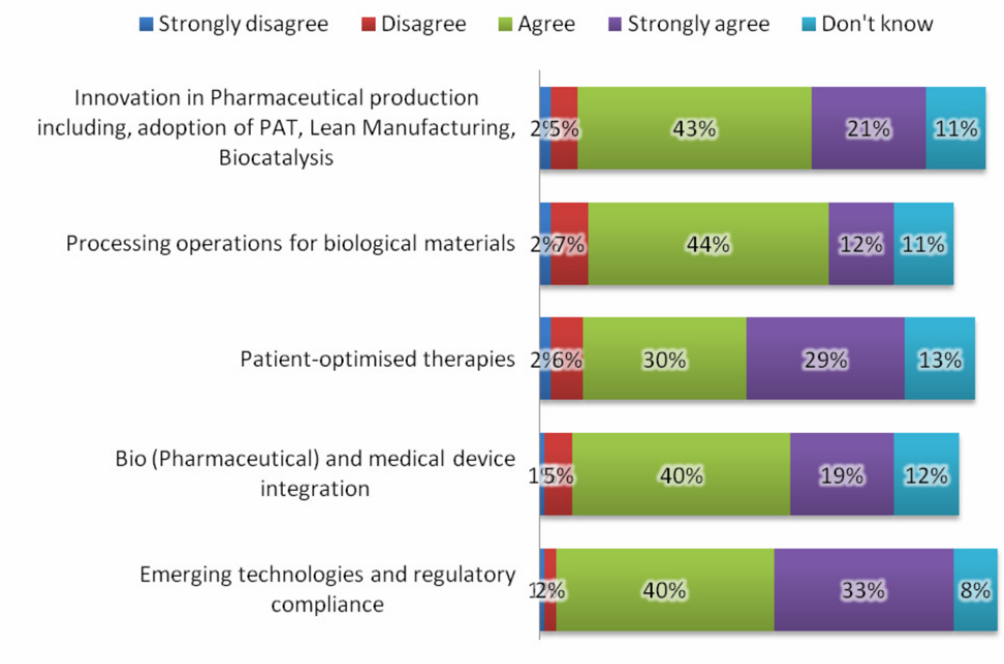


5.3.6 Science and the Future of the Pharmaceuticals Sector

Pharmaceutical companies were asked to indicate the extent to which they agreed with a number of propositions about the future of the sector. The sample base in this sub-group was 84. In all cases there was overwhelming agreement of the importance of the future developments in science and engineering. The responses are catalogued in figure 5.3.5.

Figure 5.3.5 Future Advances in Science and the Pharmaceuticals Sector





5.3.7 Skills Summary

- A high proportion of senior management and professional occupations.
- A significant element of R&D qualifications associated with professional occupations.
- Employment has been stable and largely independent of economic downturn.
- Significant overseas recruitment in R&D skills.
- Skills gaps are most evident in the higher skilled levels.
- Hard-to-fill vacancies are also mostly experienced at professional and technical level.
- Skills gaps in the supply from education include chemistry, pharmacology and toxicology.
- Education provision, in the main, serves the sector well but better use could be made of vocational pathways.
- Spend on training appears low by UK benchmarks but the measure is company dependent and fails to capture investment in training facilities.
- R&D intensive companies spend four times as much on workforce development.
- Achieving a top quality workforce is the most sought after outcome of training.

6.0 Sectors Industry by Industry

Cogent industries in England cover of the order of 85% of UK employment across the sector. The reader is therefore referred to the detailed skills analysis by industry that is provided in the UK-wide SSA. The summaries only are reproduced

6.1 Chemicals

- A strategic infrastructure in manufacturing and raw materials supply supporting most other UK manufacturing.
- Strategic to UK supply of chemicals that are not readily imported due to hazards associated with storage and transport.
- Safety critical sector; highly regulated.
- A major UK industrial sector.
- An energy intensive sector.
- High levels of skills from operator through technical, professional and management.
- Technical and professional occupations are most hard-to-fill.
- Economic downturn has reduced output in short-term.
- Requires supply of science and engineering skills.
- Impact of emerging technologies could drive shift in skills needs higher more interdisciplinary, more bioscience.

6.2 Pharmaceuticals

- Strategically important sector.
- There is a large demand for Professionals, Managers and Operators in the sector.
- There is a concentration of Research Institutions in the south east which may change with fragmentation following the development of biologics, for example.
- There is demand for technical up-skilling.
- There is competition from low-wage economies.
- Rapid change transfer of new technologies will be a key driver of skills
- There is demand for science, technology, engineering and mathematics (STEM) graduates, and especially for the highest skills in chemical and biological sciences.

6.3 Polymers

- Polymers is a critical UK supply chain to manufacturing.
- The industry is dominated by SMEs.

- A high demand for process operators is evident from the workforce make up.

- Job specific training is of highest priority for employers, making training for process operatives a high compounded priority.

- Levels of external spend on training are lower than UK norms and lower than other manufacturing sectors and may be a reflection of the SME dominance of the sector and the lower level of regulation compared to other manufacturing sectors.

- The supply of Apprentices and Graduates is articulated by some employers as an important to the sector.

- Employment turnover can be high.

- There is demand for technical, leadership and management skills.

- Training provision tends to be catered for by private providers, with much specialist provision from the HE and FE having shrunk in recent decades.

- There is an important high technology role in the area of composites.

- There is a need to attract more young people to the sector

- Current provision in FE and HE is very limited.

6.4 Petroleum

- A major revenue earning industry for the UK.

- The industry provides a secure supply of fuels for the UK.

- The industry is crucial source of raw materials for large parts of the manufacturing manufacturing sector, e.g. Chemicals, Pharmaceuticals, Polymers and Petroleum industries.

- The proximity of the ‘downstream’ Petroleum and Petrochemicals industry is a major geographical determinant of induced skills demand.

- Production may have peaked but current levels of production continue to obviate significant import requirements.

- A safety critical sector; highly regulated.

- Public perception of the industry critical currently due to recent global incidents.

- Assuring quality and skills in the supply chain is just as important as it is in the asset-holding company.

- Large demand for technical and engineering skills.

- Future demand for skills to support new extraction technologies.

- Large proportion of workforce in professional and managerial levels.

- Many of the high level skills are in demand globally.

6.5 Oil and Gas

- A major revenue earning industry for the UK.

- The industry provides a secure supply of fuels for the UK.

- The industry is crucial source of raw materials for large parts of the manufacturing manufacturing sector, e.g. Chemicals, Pharmaceuticals, Polymers and Petroleum industries.

- The proximity of the ‘downstream’ Petroleum and Petrochemicals industry is a major geographical determinant of induced skills demand.

- Production may have peaked but current levels of production continue to obviate significant import requirements.

- A safety critical sector; highly regulated.

- Public perception of the industry critical currently due to recent global incidents.

- Assuring quality and skills in the supply chain is just as important as it is in the asset-holding company.

- Large demand for technical and engineering skills.

- Future demand for skills to support new extraction technologies.

- Large proportion of workforce in professional and managerial levels.

- Many of the high level skills are in demand globally.

6.6 Nuclear

- A politically orientated sector with a future linked to private and public investment.

- A highly regulated, safety critical sector.

- Private sector investment in new build will be a major determinant of future skills demand.

- Long term stable and predictable demand for skills in Decommissioning which will be largest subsector workforce for the foreseeable future.

- The future of Fuel Processing capacity and capability depends on: a) the global demand for fuel manufacture; and b) future policy decisions on the reprocessing of waste.

- The UK is at the forefront of Western European new build ambitions in Civil Nuclear.

- Models of future workforce demand have been developed – potentially equivalent to three London Olympics projects.

- If new build programmes proceed, there will be an immediate need for skills in the manufacturing, engineering construction and construction supply chains.

- New build activity, if significant could induce skills shortages in and the sustainability of the Decommissioning sector.

- Major skills shortages are projected from both primary research and lessons learnt from new build projects in western Europe; these are commonly in the areas of nuclear safety and quality assurance in the supply chain, and points to a requirement for standards and training to be developed.

- Critical at-risk skills have been identified across construction, engineering construction and operation of new nuclear power plants.

- General skills demand for the supply of engineering, science and some specialist science professionals.

7.0 Projected Demand (Working Futures)

7.1 Projected Demand by Sector

Working Futures projections have been taken at the highest level SIC as an approximation for each sector. While the Working Futures[62] data preceded the onset of the recession, its projections a decade ahead normally sit outside the variations of general economic fluctuations. In the case of the current global recession the data is yet to be reassessed and is used here as the best data available to inform a conservative analysis. It is also noted that the Working Futures analysis uses LFS and ABI base data which under-represents the footprint overall (see earlier section) by as much as 50% when supply chain and sectors outside national data are accounted for.

Figure 7.1.1 shows a decline for the manufacturing sectors overall – historically this is a well established trend with a shift in employment across the UK from manufacturing to services. However, segmentation shows that the trend is not uniform.

In total, an employment requirement of an additional 91,400 personnel is projected. Allowing for uncertainty and a conservative estimate of an additional 50% for the direct supply chain and uncoded sectors, suggests of the order of 91,400 – 137,000 new personnel are required in total by 2017.

7.2 Projected Demand by Occupation and Sector

When analysed by occupation, the greatest net requirement is for occupations related to science or engineering. Figure 7.2.1 shows the details overall. Selecting the occupations that centre on skills in science and engineering, there is a net requirement for:

- managers of 21,900
- professionals of 9,100
- associated professionals of 12,000
- machine operatives of 13,700
- skilled trades of 7,350

These are the occupations which focus on the application of knowledge and skills in science or engineering and make up 64,000, or the majority of the total new employment requirement. Allowing for uncertainty and incomplete coverage of national data, a conservative estimate of approximately 96,000 new personnel is projected for science or engineering-related occupations by 2017.

7.3 Projected Population of Science-related Occupations

Figure 7.3.1 shows the projected population trend of occupations within the standard occupational classifications, noting that the volumes would require scaling by a conservative factor of 1.5 to represent the sector overall. Of particular note are:

- the increase in the population of corporate managers
  - scaled estimate of population 57,900 - 86,900 by 2017

- the stable population of science and technology professionals
  - scaled estimate of population 18,000 – 27,000 by 2017

- the fairly stable population of science and technology associate professionals
  - scaled estimate of population 10,200 – 15,300 by 2017

[62] *Working Futures 2007-2017,* UK Commission for employment and Skills, 2008.

- the decline in the population of process operatives
  - scaled estimate population of 30,600 – 45,900 by 2017

- the decline in the population of skilled trades (Mechanical/Electrical)
  - scaled estimate of population 19,800 – 29,800 by 2017.

Managers are by far the most populus occupation. The steepest decline is predicted in the process operative occupation. This is shadowed by skilled trades. Although the decline is most steep for process operatives, the occupation will nonetheless remain substantial and have a net requirement due to replacement demand

7.4 Skills Shortages and Skills Gaps

It should be noted that due to the small projected numbers, relative to the UK base data, the error in projection may be significant and the projections are most useful qualitatively for trends.

Gaps will continue to emerge across all occupations driven in the main by technology, regulation and compliance.

Of the 96,000 new personnel required in science and engineering-related occupations, apportionment, across the priority occupation gives requirements of:

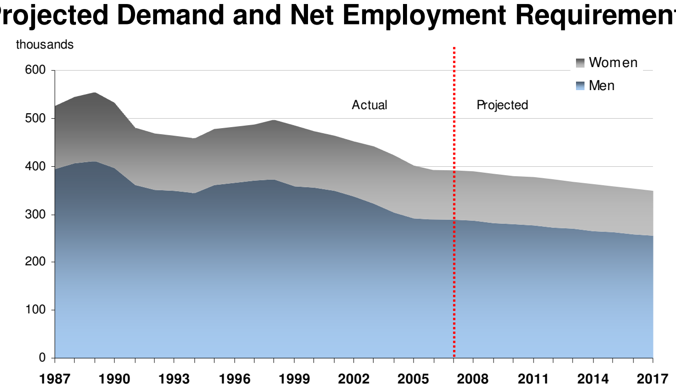
- managers – 32,800
- professionals – 13,700
- associated professionals – 17,900
- machine operatives – 20,600
- skilled trades – 11,000

For managers the main entry routes are either by internal progression or transfer from the economy generally. These occupations are therefore not limited by the supply from the education system.

For professionals the main entry route is either graduate recruitment or transfer from the economy generally.

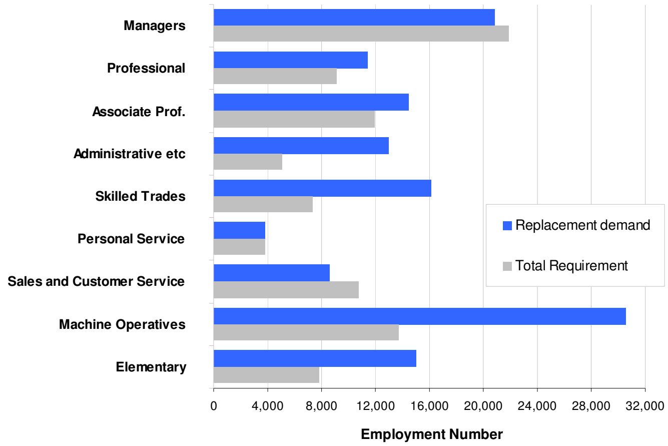
For the occupations of associated professional, process operatives and skilled trades, there is a combined requirement for 49,500 by 2017 (projected from 2007). It is in these occupations that apprenticeship and technician training are most relevant.

Figure 7.1.1 Projected Demand and Net Employment Requirement 1986-2017



(Source: Working Futures2008; excludes Nuclear, Bioscience)

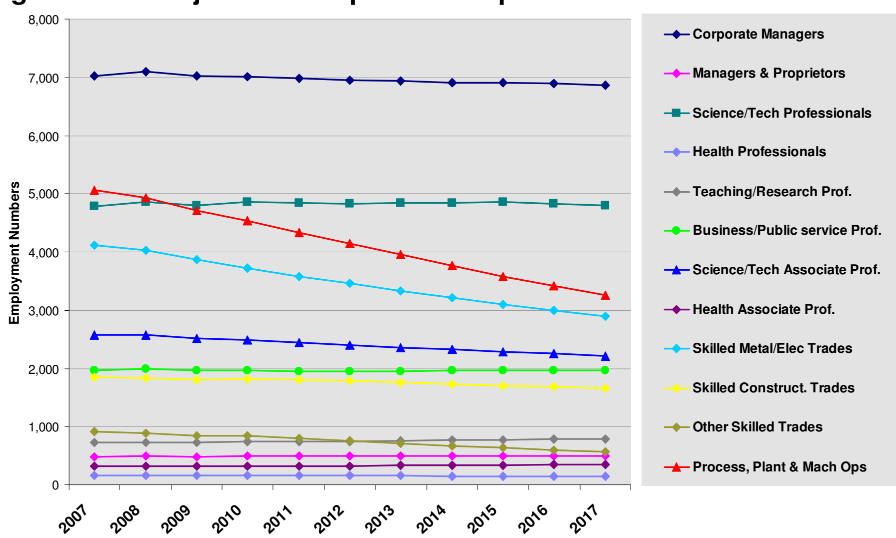
Figure 7.2.1 Projected Demand by Occupation and Sector 2007-2017



(Source: Working Futures2008; excludes Nuclear, Bioscience)

Notes
Replacement Demand = Retirements + Occupational Mobility + Migration
Net requirement = Expansion Demand + Replacement Demand

Figure 7.3.1 Projected Occupational Populations 2007-2017



(Source: Working Futures 2008; excludes, Bioscience)

7.5 Summary
The following apply for the year 2017.

- Positive recruitments are projected for most occupations.

- Science-related occupations comprise majority of the workforce demand by 2017.

- Occupations at technical and professional levels comprise the majority of demand for science-related occupations.

- A net positive recruitment requirement of 91,400 – 137,000 is projected by 2017.

- A net positive recruitment demand of approximately 96,000 in science-related occupations is projected by 2017:
    - managers – 32,800
    - professionals – 13,700
    - associated professionals – 17,900
    - machine operatives – 20,600
    - skilled trades – 11,000

- For most of the science-related occupations the population projection is fairly stable, with the exception of process operatives for which a population decline is projected. For the priority occupations the following trends are projected:
    - corporate managers – stable
    - science professional/associated professional - stable
    - process plant and machine operatives - decline
    - skilled trades - decline

- For the priority occupations the following populations are projected**:**
    - 57,900 - 86,900 corporate managers
    - 28,200- 42,300 science professionals/associated professionals
    - 30,600 – 45,900 process plant and machine operatives
    - 19,800 -29,800 skilled trades.

- Skills gaps are most likely to be driven by technology, regulation and compliance and will require new standards as well as facilitative actions on development of suitable provision for education and training.

- For those occupations dependent on apprentice programmes for new intake, the technical, process operative and skilled trade occupations share a combined requirement of 49,500 by 2017 (projected from 2007).

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The National Skills Academy NUCLEAR

The National Skills Academy PROCESS INDUSTRIES

The strategic skills alliance for the Science-based Industries