

West Cumbria Spatial Master Plan

Energy, Technology and Nuclear: Working Paper 2

Prepared by Grant Thornton, Lumis and Quotec

Final Report (September 2006)

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Contents

	Page
Part A: Nuclear and energy sector	
1	Introduction
2	Decommissioning Supply Chain
3	Research and Development
4	Waste repository/ waste disposal
5	New Nuclear Build
Part B: Technology and non-nuclear industries	
6	Technology background
7	Need for diversification
8	Technology Trends
9	Relevant Technologies
10	Suggested Initiatives
11	Way forward
12	Annex

Part A: Nuclear and energy sector

1 Introduction

1.1 Background

Part A of this report has been prepared by Lumis with the support of Grant Thornton, and focuses on specialist input into energy related issues associated with the West Cumbria sub-region¹. The main focus has been on assessing the nuclear-related infrastructure and opportunities and in particular opportunities associated with Sellafield decommissioning. Compared with many other parts of the UK, the region has relatively little other energy related economic activity and resource. For example, although there are a small number of wind farms along the coast we did not see this as a major opportunity given that the wind resource has been largely exploited and the presence of the national park naturally curtailed wind development in a large part of the region. Overall, the region is a net energy importer and this position is likely to remain unchanged. Other than perhaps nuclear power generation, it is unlikely that there will be major opportunities in the broader energy sector.

For this study Lumis have relied on a number of information sources:

- Reports written, or commissioned, by members of the Strategic Forum or other external bodies.
- Meetings held with key stakeholders including the NDA, BNG, UKAEA, West Lakes Renaissance, Nexia Solutions, NWDA and West Lakes Research Institute.
- Discussions with other parties active in the region who were able to bring valuable insight based on their experience elsewhere, these include Fluor and Battelle.
- Lumis's own prior knowledge of the energy and nuclear sectors

In conducting our work we found that there are still quite a number of unresolved issues that could have a significant bearing on the baseline nuclear position and, depending on their ultimate outcome, could even provide substantial upside to the current position. There are four unresolved, nuclear-related issues that could have a direct impact on the region; these are:

- The sale of British Nuclear Group – Financial Advisors have been appointed and the sales process is ongoing,. As part of the transaction, the NDA have indicated that will enter into a 5 year management contract with the successful party to run the Sellafield site. The identity of the successful bidder, their track-record at other nuclear installations and the final conditions of the sale and purchase agreement will together have an influence on the future direction of the Sellafield site.
- The outcome of the government's energy review – the government published their report in July and have now entered a period of further consultation which will be completed around the turn of 2007. Two issues covered in the energy review are of particular interest to West Cumbria.

¹ This Working Paper was original completed in September 2006 as part of input into the development of the West Cumbria Spatial Masterplan. It was subsequently updated to in August 2007 to include any relevant updated policy statements.

- The NDA's study of UK civil Uranium and Plutonium stocks – we understand that this study is now underway and that it should be completed by spring 2007. The purpose of this study is to make recommendations to government on how the UK's stocks of Uranium and Plutonium should be treated and specifically to determine if some of this material, currently classified as waste, could be used productively. The outcome of this review could have major implications for the Sellafield site.
- The future of THORP and the Sellafield MOx facility – BNG is in the process of assessing the world market for additional reprocessing and fuel fabrication business for these facilities. Depending on the outcome of this marketing and sales effort, which we expect to be completed in late 2007, a case could be made to government and the nuclear regulator to extend the life of these assets beyond 2012. If this were the case it would have a significant impact on the baseline position at Sellafield and would mean that decommissioning of some of the sites major operational assets would be deferred.
- Although we have made reference to these unresolved issues in our report, we have concentrated on the current base assumptions rather than attempt to speculate on uncertain outcomes. Given that the entire baseline position could be affected by some of these issues and given that they could well be resolved in the next 6 to 12 months we would recommend that our conclusions and recommendations are re-visited to ensure that they are appropriate given the final outcome of these issues.

1.2 Baseline Position

1.2.1 Overview

The West Cumbrian economy has been in decline since the 1990s though it has experienced a period of relative stability between 1996 and 2003. Recent data analysis (CRED September 2005) indicates that further net job losses over the last couple of years. The September 2005 issue of Cumbria Economic Bulletin reported that for the second bulletin period in a row, proposed job losses were in excess of new jobs being created (1,388 over 914). Job losses in the two years to September 2005 total 5,000. 75% of the reported job losses have occurred in manufacturing, with 55% of the manufacturing losses relating to the restructuring at Sellafield.

Within West Cumbria, 12,000 direct jobs and 2,630 indirect jobs are dependent upon the nuclear industry. This amounts to 22% of West Cumbria's workforce, and 47% of Copeland's. £200-£250m is spent each year with local suppliers and estimated £300m in employee spending power. It is estimated that Sellafield contributes 22% of Cumbrian GVA, 40% of West Cumbrian GVA. Without intervention, the shift to decommissioning is likely to lead to the replacement of high wage jobs within the industry with relatively low wage jobs in lower value added sectors.

1.2.2 Employment

The progressive run down in operations at Sellafield will have a major impact on the local employment market. The impact of the job losses will be mitigated by the fact that much of the decline in employment can, according to the Nuclear Decommissioning Authority (NDA) and BNG, be accommodated via retirements and natural staff turnover. The current age of the Sellafield workforce is 42 years with an average length of service of 15 years so this is a realistic suggestion. While this may appear to limit the impact, in so far as it will result in fewer forced redundancies than would otherwise be the case, the effect on economic activity and the loss of spending power will not be ameliorated. Furthermore, the availability of fewer future employment opportunities is likely to exacerbate the current trend whereby young people leave the area, perhaps to continue education, and tend not to return to work in the area.

Employment within Sellafield has clearly had a huge impact on local labour markets and while much analysis of the effect of Sellafield on the local economy focuses on beneficial impacts, it has produced some difficulties. For example, local business owners have to compete with Sellafield for staff and find it difficult to afford the wages and other benefits that the nuclear industry can offer. A local business owner recently indicated that all of his employees had submitted applications to work at Sellafield and that he simply could not compete with the wages they offered, even for staff without any official qualifications.

The declining level of labour demand is also likely to lead to lower wages which will further constrain the spending power of lower total employment levels. Sellafield's lifetime plan 2006 estimates a budget decline of £640m over the next 10 years with employment decline of 3000. This corresponds to a loss of £60m in wages.

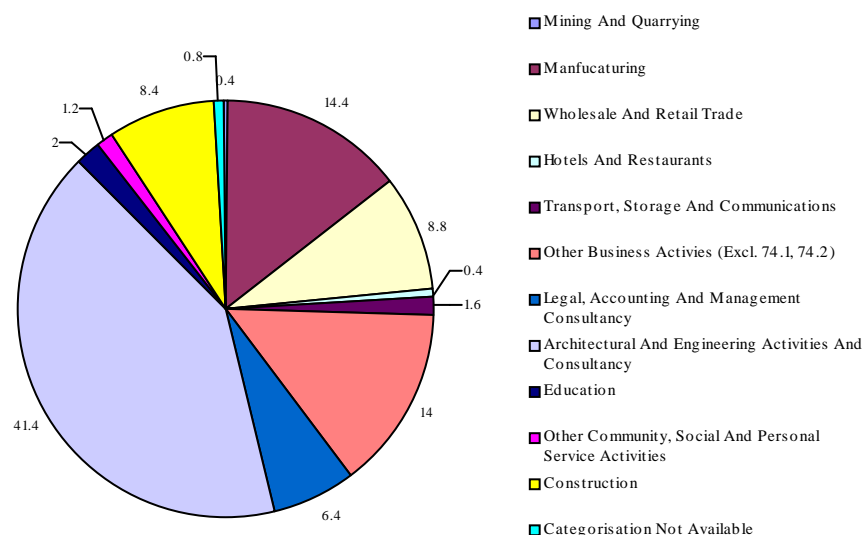
The recruitment drive at Sellafield has also suffered in the past due to perceptions of an industry in decline.

1.2.3 Supply chain

Businesses within West Cumbria are highly dependent upon the spending power derived from nuclear-related activities. This takes the form of both direct nuclear expenditure within the supply chain to procure products and services and the stimulus to local businesses from nuclear employees spending (their relatively high) earnings on goods and services.

Local companies have, over the years, developed specific expertise, skills and capacity to serve the nuclear industry. With the evolution to decommissioning underway, it is not clear the extent to which these companies will easily be able to adapt their businesses to serve different requirements partly as a result of decommissioning but also due to the change and reduction in spending power created by Sellafield employment. The local supply chain will need to realign itself to serve the new environment. Sellafield expenditure within the supply chain in 2004/5 in Cumbria amounted to over £100m (representing around 1/6th of total supply chain expenditure) .

Mapping the Regional Supply Chain, % share by Sub Sector



Source: *West Lakes Renaissance Database (reproduced from 'Mapping the Nuclear Supply Chain', ERM Economics July 2005)*

Within the region, four sub-sectors are of particular relevance for the nuclear industry. These are engineering and related technical consultancy, fabricated metals, machinery equipment and remediation services and collectively they supply much of the project management, design engineering and instrumentation services required.

The Sellafield site dominates regional nuclear demand, representing 83.6% of all spending within the Near Term Work Plans (NTWP).

Figure 1-1: NTWP Spend by Regional Sites

Site	Spend £m, NTWP Period (2005/06)	Spend £m, NTWP Period (2007/08)	Absolute Change £m over NTWP period	Percentage Change over NTWP period
Sellafield	1,016.90	994.8	-22.1	-2.8
Calder Hall	24.3	17.7	-6.6	-27.2
Drigg	19.3	16.7	-2.6	-13.5
Springfields	145.8	92.1	-53.7	-36.8
Capenhurst	25.5	8.5	-17	-66.8
Windscale	27.5	25.6	-1.9	-7
Total	Source: Mapping the	1,155.30	-103.9	-8.25%

Source: *Mapping the Nuclear Supply Chain, Final Review report. July 2005*

Although, over the long term, demand derived from the nuclear sector is projected to be worth around £38bn, there is an anticipated decline of around 8% in the period 2005-2008. The largest decline in terms of categories of expenditure is anticipated within commercial operations, waste and nuclear materials management, and support services. The NTWPs to 2008 do not reflect the increasing proportion of expenditure allocated to decommissioning within the LCBLs (life cycle baselines). Across the six sites, regional expenditure rises slightly from £1.26bn in 2005/06 to £1.28bn in 2006/07 before decreasing to £1.16bn in 2007/08 .

BNG's Sellafield procurement plan anticipates the increasing usage of a smaller number of suppliers acting as tier 2 suppliers. Although there is a decrease in overall expenditure over the medium term this does not necessarily imply decreased opportunities for the regional supply chain. The new opportunities offered by decommissioning, and changes in BNG procurement strategy, will result in increases in the value of services being carried out.

Figure 1-2: Supply chain

	2005 Estimated Supply Chain				2008 Estimated Supply Chain	
	NTWP 2005 Spend	% Supply Chain	Spend Supply Chain £M	Ntwp Spend 2008	% Supply Chain	Spend Supply Chain £M
Commercial Operations	359.3		50	179.6	310.5	53
Site Support	309.1		30	92.7	315.5	74
Waste And Nuclear Materials Management	276.2		42	116	241.7	60
New Build	122.8		73	89.6	130.8	75
Support Services	94.7		20	18.9	74	20
Decommissioning	56.2		67	37.7	51.4	90
Transition	19.5		14	2.7	12.8	14
Stakeholder Support	21.4		0	0	18.6	0
Total	1259.2		42.7	537.2	1155.3	60.9

Source: Mapping the Nuclear Supply Chain, Final Review report. July 2005

The largest increase in expenditure to 2008 is seen within site support (an increase of £140.7m), followed by decommissioning and waste and nuclear materials management categories

Sellafield - summary of main changes in expenditure 2005 - 2008 :

- The largest absolute falls in spending to 2008 are anticipated to be on 'Waste and Nuclear Materials Management' (£19.3 million) and 'Support Services' (£14.1 million).
- 'Site Support' is due to receive the largest increase in spending
- 'Commercial Operations', 'Site Support' and 'Waste and Nuclear Materials Management' the largest current areas of expenditure;
- Supply chain impacts of structural changes within the nuclear sector:
- BNG adoption of EU procurement rules will result in increased interest and competition for securing contracts. The movement to the new system will result in increases in the time taken to contract, impacting companies in the supply chain
- BNG and UKAEA aim to reduce the number of direct relationships they manage. The strategy is based on concentration of most service areas with a small number of tier 2 suppliers. The tier 2 suppliers will, in turn, be expected to integrate with tier 3 and tier 4 suppliers to deliver contract requirements.
- Changes in reporting requirements being driven by the NDA will increase demands on internal systems and require improvements in project and programme management systems (the Earned Value system). These developments will cascade down the supply chain.

- BNG will increasingly move towards e-commerce and has implemented procedures to reduce the burden for potential contractors, for example by removing the requirement for every tender to be supported with firm financial information.

A key issue for the region's companies is the extent to which they can adapt to ensure they retain market shares as competition increases and as the composition of demand changes. It has been suggested that one of the key factors indicating the extent to which companies may be able to adapt is their previous exposure to electronic procurement, contracting and project management systems. Evidence suggests that companies with lower exposure to these procedures and practices cannot adapt as quickly as those with higher exposure.

An increasing proportion of the work contracted by Sellafield is being let by competitive tendering procedures under European regulation. The new entrants are challenging the entrenched local business stock in serving the nuclear industry. The growth in competitive pressure is likely to continue which could have adverse impacts on businesses profit margins. The need for local business to respond to this threat could force them to become more competitive and, potentially, become a driver of future growth and economic regeneration.

1.3 The challenge

West Cumbria is starting from a relatively strong position. Today it is an acknowledged centre of excellence within the nuclear industry based on its long heritage of nuclear power development and operations which go back to the origins of the industry in the UK in the 1940's. The focal point of activity is around the Sellafield site and the facilities currently being operated or managed by the British Nuclear Group (BNG) and to a lesser extent the UKAEA. Key activities at Sellafield currently include:

- Nuclear fuel reprocessing (BNG)
- Storage of High, Intermediate and Low Level Waste from UK civil and military operations (BNG);
- Operation of the THORP and MOx facilities (BNG); and
- Preservation and decommissioning of older nuclear facilities including Windscale prototype AGR and Calder Hall Magnox reactor (BNG/UKAEA).

The challenge for the West Cumbria as a sub-region is how to respond to the impending shift of emphasis at Sellafield from being an operational nuclear site to becoming a site dominated by decommissioning activity. In making this transition, we consider the key challenges to be:

- Keeping West Cumbria as a nuclear centre of excellence whilst adapting to the changing emphasis from operations to decommissioning;
- Preservation of high quality jobs that the nuclear industry has traditionally provided for many decades in the area and whilst ensuring that sufficient numbers of suitably skilled people are available to respond to the future requirements at Sellafield;
Provision of appropriate business and support infrastructure to support the decommissioning activity at Sellafield;
- Capturing as much as possible of the value created decommissioning for the West Cumbria economy;

- Positioning West Cumbria to be a prime beneficiary of any future resurgence in the global nuclear industry; and
- Leveraging West Cumbria's strong reputation as a nuclear centre of excellence to create broader opportunities for region.

The challenges faced by West Cumbria and Sellafield are not unique. Comparison can be made with other major nuclear installations which have gone through similar transitions. Some of the best examples of this are at major US nuclear sites such as Hanford, Idaho and Savannah River. We believe that the experience of these sites in making this transition from operations to decommissioning is a good place to start in terms of assessing the issues that West Cumbria and Sellafield are likely to have to deal with, and, in defining some of the solutions and lessons learnt that can be transferred to addressing the particular situation in West Cumbria. It is also highly relevant that most, if not all, of the existing and potential industry participants in the Sellafield decommissioning process have extensive experience of operating in a similar environment in the US. For example, Fluor, CH2M Hill, Battelle, Washington Group are actively involved in the US nuclear decommissioning programme.

1.4 **A centre of nuclear excellence in West Cumbria**

What is a “nuclear centre of excellence”? To help us define what this could mean for West Cumbria, we think it is appropriate to look at, amongst other things, some of the US nuclear sites which are currently recognised to be (both a national and international context) centres of nuclear excellence. These sites have a number of common characteristics some of which could easily relate to West Cumbria going forward:

- A strong legacy in nuclear development (military and civil). Many of the US sites had a strong military nuclear role although institutions such as the Idaho National Laboratory has more of a civil nuclear heritage and was where many of the US's civilian nuclear reactor systems were developed. There are other similarities: some of these sites previously employed similar numbers to Sellafield (10,000) albeit the US sites tended cover huge geographical areas whereas Sellafield is highly concentrated by comparison. At these sites cessation of operations and the commencement of decommissioning acted as the “trigger” to make the difficult transition from an operational site to one where the emphasis is on clean-up;
- At some of these sites, a “cornerstone” national research and development facility was established by the Federal Government to use the highly skilled and qualified resource for other applications and to keep people from moving away from the area at a time when they were still needed and also to reduce the economic impact of decommissioning in the area. These laboratories today make up a network of National Laboratories in the US which still, in large-part rely on Federal Government funded research programmes;
- Private sector companies have been contracted to manage the decommissioning activities and run the government-owned laboratories on a commercial basis; this is referred to as a “GoCo” model or Government-owned, Commercially-operated. This is a similar model to that being adopted by the NDA at Sellafield, whereby the NDA retain ownership of the assets and liabilities and contract the management of these assets and liabilities to outside contractors who then manage them on their behalf;
- Strong partnerships are developed between the colleges and universities (local, national and international);
- The companies managing the US sites have, as part of their contractual obligations, a number of socio-economic performance objectives. These can include anything from

community support programmes, seed and venture capital provision for businesses within the region, to the provision of facilities for start-up companies. Great importance is placed by the contracting companies on their socio-economic performance and it appears that many go well beyond their contractual obligations to develop the local economy and work with the community.

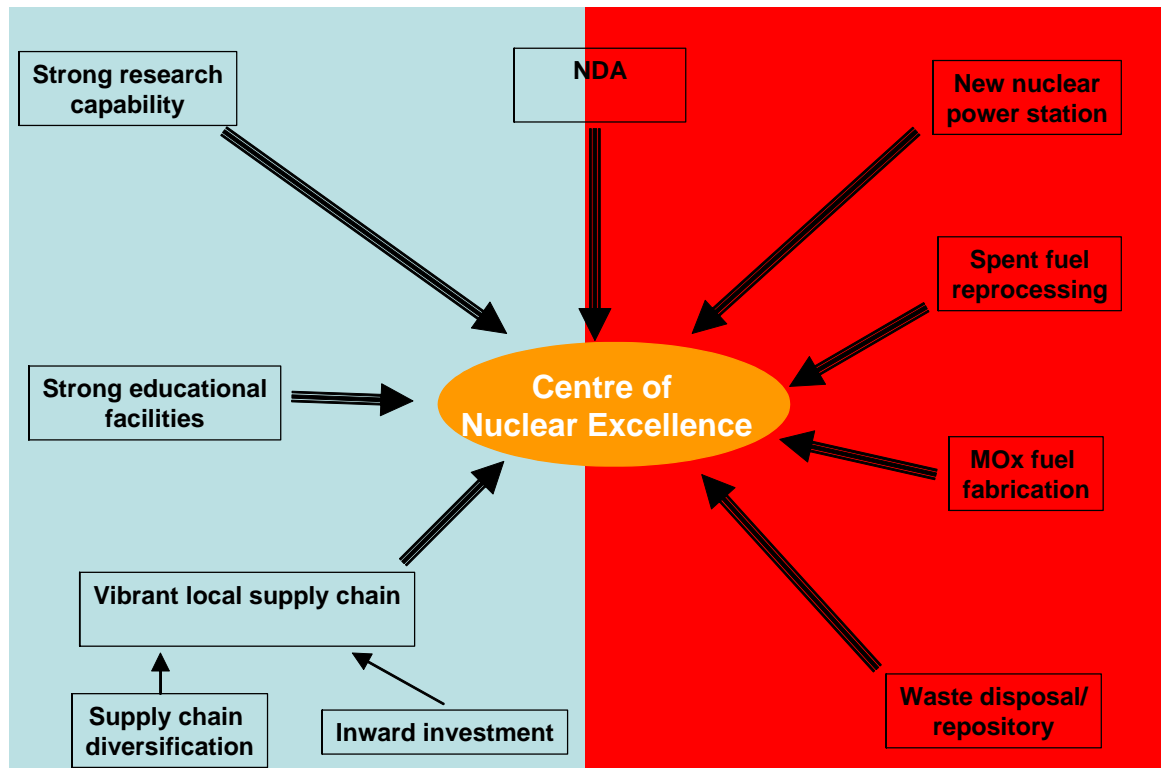
- All of these sites have been trying, over time, to reduce their reliance on government funding and to diversify the local economic base away from nuclear.
- Nuclear remains the area's core activity well after operations have ceased principally due to scale of the ongoing decommissioning and remediation activities.

There is some evidence that some the important building blocks, necessary for the future prosperity of the region, already exist in and around Sellafield:

- Sellafield is on the same scale as many of the US nuclear sites in terms of jobs and investment and has considerable momentum. Many new entrants will be automatically attracted to the region, attracted by the sheer scale of the decommissioning opportunity at Sellafield;
- Encouragement of the locally based infrastructure or supply chain to serve the local decommissioning market is underway, albeit at an embryonic stage;
- Education and training institutions to support the future activities at the Sellafield site either already exist or are planned;
- Research and development facilities exist or are planned including the potential for the UK's National Nuclear Laboratory to be sited at Sellafield;
- A strong emphasis is already being placed by the NDA and other stakeholders in the region on their socio-economic responsibilities. Traditionally the Sellafield site has been a major contributor to the local area;
- Much of the delivery infrastructure is already in place

The main challenge now is in identifying what else needs to be done to create a sustainable future for the West Cumbrian economy and its residents and in leveraging opportunities for the region.

A series of assets and activities will, together, constitute a strong and sustainable nuclear cluster or "nuclear centre of excellence" in West Cumbria.



Three categories of nuclear opportunity exist:

- I. Decommissioning opportunities at Sellafield. This is the single largest area of economic activity in the region for the foreseeable future.
- II. Other nuclear-related opportunities that are not directly associated with decommissioning. This includes the opportunity to site a new nuclear power station at Sellafield. Longer term, the location of a national radwaste repository (ILW/HLW/ spent fuel) will be considered. Because of the amount of the waste stored at Sellafield, it is inevitable that the region will be considered as a potential location.
- III. Life extension of some of the operating assets at Sellafield. As already noted, there is the potential for some assets (including THORP and the MOx facility) to remain operational for longer than the current baseline plan.

Within these three broad categories we have chosen to consider five specific opportunities as follows:

- Decommissioning supply chain
- Research and development
- Waste management, storage and disposal
- New nuclear build
- Fuel reprocessing and manufacture

2 Decommissioning Supply Chain

2.1 Background

West Cumbria has the opportunity to maximise the retention of economic value in the region from decommissioning activities. The high level of decommissioning expenditure in the region provides the opportunity for West Cumbria to grow the capacity and effectiveness of the local supply chain to enable it to succeed in the regional, national and international decommissioning and environmental clean up markets. Key to this will be the presence of companies and institutions located in West Cumbria with the capability to serve not only the local market but also operate nationally and internationally.

Significant effort has already been expended to strengthen the supply chain in the area. A Nuclear Opportunities Group (NOG) has been established to operate the Nuclear Opportunities Programme (NOP), a programme which is aimed at developing and co-ordinating economic development activities in the region. The NOG is chaired by West Lakes Renaissance's Nuclear Opportunities Manager and has membership as shown below:

- West Lakes Renaissance
- North West Development Agency
- Invest in Cumbria
- Government Office for the North West
- NDA
- British Nuclear Group
- UKAEA
- West Cumbria Development Agency
- West Cumbria Business Cluster
- West Lakes Research Institute
- Business Link Cumbria

The vision of the NOG is to establish West Cumbria as an internationally renowned centre for nuclear decommissioning and environmental services.

NOG members have made significant progress via a number of initiatives outlined in the NOG work plan over the past 2 years – principally supporting the location of NDA in West Cumbria, developing measures to support the existing supply chain (via the West Cumbria Supply Chain Project), and attracting inward investment.

The NOG (supported by consultants GENECON and White Young Green) is in the process of reviewing its activities and developing a 3 year strategy and action plan to facilitate the development of West Cumbria as a leading international location for nuclear decommissioning and environmental restoration services. The review addresses the NOG's strategic focus, current action plan and resources to assess whether it is on track to delivery its goals. The study includes a proposed updated 3 year action plan for the NOG. The review is a useful study of the current initiatives that are being implemented by the NOG partners, pulling together the various initiatives into one document and assessing the combined impact of these initiatives. It addresses weaknesses in the plan and makes proposals to strengthen the plan with the focus being to:

- Promote supply chain collaboration to win contracts within West Cumbria;
- Examine initiatives to encourage innovation and diversification; and

- Provide support to develop the export capability of the area, for example by encouraging new inward investors.

2.2 Development of the supply chain

We envisage supply chain development in four areas:

- Support to the existing local suppliers to improve their prospects of winning business in the new procurement systems that have been established by the NDA;
- Support to the existing local supplier base to develop the prospects of business expansion by accessing wider geographic markets and non-nuclear markets;
- Encouraging the development of new businesses in the area by exploiting local R&D activities; and
- Encouraging businesses to establish a presence in West Cumbria to serve the local market and to use this base to diversify into wider markets.

2.2.1 **Support to the existing local suppliers to improve their prospects of winning business in the new procurement systems that have been established by the NDA.**

A review of the local supply chain performed last year (Mapping the Nuclear Supply Chain ERM, WLR, NWDA, July 2005) emphasised the need for public sector support to help local businesses adapt to the new contracting methods; the primary concern being that local companies would lose market share to new entrants...this concern is still valid.

The ERM report surveyed 284 supply chain businesses and performed a gap analysis to map the capability of the regional supply chain against the requirements of the nuclear decommissioning programme. The main points highlighted were:

- Market information – many companies experience difficulties in translating the specific decommissioning requirements to their own sales prospects.
- Products & services – the supply chain is already providing decommissioning services to the industry and therefore there is, to some degree, a regional capability to provide such services in the future.
- Diversification – companies in West Cumbria have a greater dependence on the nuclear industry than would be found in the wider sample of companies. There is reluctance for some companies to diversify away from the nuclear industry.
- Procurement & management systems – the changing procurement procedures are causing major concerns in the supply chain, particularly for companies more exposed to the nuclear sector and for smaller companies.
- Technological capacity – many companies felt they had the technical capacity to respond to changing demands currently but this may become more of an issue over time, particularly further down the supply chain where responsibility for innovation becomes more devolved.
- Extra regional trade – companies pointed to the difficulties of operating in overseas markets. Eastern Europe was seen as an important potential market although such work is typically likely to be serviced by the overseas offices of the larger companies.
- Skills – a mixed picture emerges on the extent of skills capability, varying by sector, company size and tier in the supply chain but with particular problems being faced by smaller companies.

The ERM report identified 6 areas that could undermine the ability of the regional supply chain to participate fully in the more competitive market:

- Partnering - the ability to establish relationships with Tier 2 companies will be crucial to a strong presence in the market.
- Innovation – providing outcome based solutions will increasingly become a part of the scope of work and require innovative solutions
- Commercial management – suppliers will require to align their systems with the Tier 1 and Tier 2 contractors.
- Project management – the delivery of work programmes will have an increasing emphasis on project management and controls.
- Nuclear capability – increasing levels of skills training and re-skilling will be required.
- Business strategy & exporting – a need to increase awareness of companies to the opportunities and to support market entry.

The NOG review has reviewed how the local supply chain has adapted to changes in contracting and procurement methods since the establishment of the NDA and how the new contracting arrangements have impacted on the local supply chain. These findings indicate that:

- BNG's recent experience shows that new entrants have taken some of the market from local suppliers principally based on the quality of their bids.
- Tier 1 contractors report that local companies are less likely to request feedback after a failed tender than companies from outside the area.
- Business development agencies report a less mature attitude to collaborative approaches to win contracts than companies from outside the region.

The NDA now requires that Tier 1 contractors produce socio-economic plans for their sites outlining their approach to aiding economic development in the area. BNG's draft socio-economic plan for Sellafield shares the same vision as the NOG and commits to working with local and regional agencies to support self start businesses, provide coaching for local companies to meet NDA requirements, encourage entrepreneurial activity, to build socio-economic planning into major Tier 2 contracts and to establish a Nuclear Enterprise Zone to give local businesses access to surplus assets and resources at Sellafield.

The proposed NOG action plan contains a strategic objective to stabilise the existing local nuclear economy – actions to create a strong supply chain and an entrepreneurial workforce. The NOG study notes the good work (including the West Cumbria Supply Chain Project) that has already taken place in this area and proposes additional actions aimed at encouraging collaboration within the supply chain and improving the quality of tenders. These actions include:

- To deliver the current NOG action plan and provide dedicated advisory resources. In particular address developing relationships between Tier 1 and Tier 2 contractors.
- Extend the scope and lifetime of the West Cumbria Development Agency's supply chain SME project to enable more tailored services and to create and deliver new modules to address SME known weaknesses (i.e. in innovation, collaboration, bidding strategies, diversification, exporting).
- Review the potential for a Business 2 Business mentoring programme similar to that developed by the DTI in the oil & gas sector.

- All of these proposed actions appear appropriate. However, crucial to the success of delivering support to the local suppliers will be the amount of resource (financial and people) that is made available. We were not asked to evaluate whether the amount of resource required to deliver these supply chain support activities is sufficient, however we would comment that the size of this task must not be underestimated and additional funding will almost certainly be necessary to ensure that a high quality support service is provided to the local supply chain.

We are aware that in the past 12 – 18 months the budget to deliver supply chain support has been of the order £200 – 250k but that this will increase with the establishment of a project that is being launched by the NWDA. The NWDA is seeking to appoint a contractor to assist with the nuclear decommissioning supply chain with the aim of developing and enhancing existing businesses and encouraging new entrants/start-ups in order to create an internationally competitive nuclear decommissioning sector based in the North West. We expect that this project will build on the good work that has already been done under the West Cumbria Supply Chain Project although the details of the activities and work programme that will be supported by the NWDA project are not yet available and it therefore it is not clear how it will interface with NOG's action plan.

2.2.2 Support to the existing local suppliers to develop the prospects of business expansion by accessing wider geographic markets and non-nuclear markets.

A recent DTI study (Global Nuclear Decommissioning Opportunities – October 2005) assessed opportunities in the world nuclear decommissioning market and in the non nuclear decommissioning market.

At a national level, the NDA's plans indicate a UK civil decommissioning programme of some £70bn. The decommissioning of British Energy's nuclear fleet would add a further £10bn to the total and adding the Aldermaston site and other MOD facilities would further increase the total. These large sums of money highlight the opportunity for the West Cumbria region if it is able to develop itself as a recognised centre of decommissioning excellence.

The scale of opportunity increases again when the global nuclear reactor decommissioning market is considered. The study estimated a global market of some £300bn over the next 30 years, an average of £10bn per year. Additional global nuclear industry support infrastructure and defence decommissioning could add £150 billion, taking the total to £450bn.

The study also assessed the relative attractiveness of various markets to the UK supply chain – considering market criteria such as market size, timing, access, political/economic risk and the relative strengths of the UK to foreign companies. The ten most attractive decommissioning markets are UK, USA, France, Germany, Canada, Japan, Sweden, Russia, Spain and Ukraine. The study notes that:

- The demand for decommissioning services exceeds the capacity of the international supply chain and is therefore likely to lead to new entrants in addition to expansion of existing capacity.
- There is generally a low awareness by UK companies of the global market opportunities and that better provision of information is important to helping UK companies develop market entry strategies.
- SMEs considering exporting should look to alliances or partnering with UK or foreign companies already working in the target country as the best market entry route.
- There are shortages in certain skill areas which present opportunities for UK companies – for example, in the USA, shortages are reported in health physicists, nuclear engineers

and radio-chemists. It is important, however, that these shortages are not reduced via a “brain drain” from the UK and especially West Cumbria and that these Specialisms are retained in the region.

Although not mentioned specifically within the study, there are also substantial opportunities within Italy (which is decommissioning plants closed in the 1980's), India and China.

There are also opportunities in decommissioning in the non nuclear sector. The most attractive market areas (based on UK supply chain capability and market potential) are off-shore, fossil fuel and industrial. Project management, asbestos removal, chemical decontamination, general construction, conventional design, demolition and mechanical services are highlighted as areas where the nuclear supply chain can transfer capabilities into the non-nuclear market sectors. To assist West Cumbrian business to benefit from the opportunities that exist in the decommissioning and environmental restoration markets, further efforts should be made to bring the information into a local context. This would involve:

- Mapping local skills and capabilities onto the UK market requirements, opportunities in other countries and other non-nuclear markets.
- Devising market entry strategies for local businesses and providing support to these companies to implement these entry strategies.
- Proactively engaging with further potential inward investment companies to use West Cumbria as a base for further market diversification.

The challenge of reaching this vision is considerable and is unlikely to happen unaided. For example, some local suppliers (principally the SMEs) will need to go through a culture shift if they are to move away from a long engrained position of working predominately for only one customer (BNG, Sellafield) in one area.

The development of diversification opportunities into the national, international and non-nuclear markets is addressed in the proposed NOG action plan by the following:

- Developing and delivering an SME diversification training/support module.
- Promoting the take up of UKTI one-to-one export market assessments to local companies.
- Encouraging the West Cumbria Business Cluster to promote international opportunities and collaboration via hosting and participating in international events.
- Developing a list of potential organisations to attract as inward investors.
- Facilitating feasibility studies for potential “Big Idea” opportunities (e.g green ships, smelting)

We would expect that NWDA’s supply chain project (referred to above) should tackle these initiatives. Local suppliers would also be assisted by establishing development grants to support them in entering new markets.

2.2.3 Encourage the development of new businesses in the area by exploiting local R&D activities.

If West Cumbria is to develop as a centre of decommissioning and environmental clean up excellence then it will also be necessary that the region invests in developing its knowledge base.

To date there has been some successes in this vein – for example, the proposed establishment of “Nucleus”, developments at WLRI through its relationship with the University of Central Lancashire (UCLan), the proposed Dalton Institute West Cumbria facility and the NDA’s

support for a Chair of Epidemiology (in partnership with UCLan). In addition, the establishment of a National Nuclear Laboratory at Sellafield would be a major boost in the drive to increase the region's knowledge base.

An important element of supply chain growth depends upon the extent to which the knowledge base is exploited to commercialise the intellectual property that is developed within the region. The proposed NOG action plan highlights the need for greater activity to increase the amount of R&D in West Cumbria and to increase the rate of innovation within existing and new companies. The NOG action plan includes initiatives to:

- Work with NDA and BNG to promote greater innovation at company level.
- Increase the take-up of innovation reviews by local businesses - develop and deliver an innovation training/support module for local companies.
- Work with WLRI regarding areas of joint working in educational exports, innovation and R&D.
- Support the development of HEIs in West Cumbria and develop supply chain/HEI interactions.
- Review with the NDA the IPR opportunities now held by the NDA.

2.2.4 Encouraging businesses to establish a presence in West Cumbria to serve the local market and to use this base to diversify into wider markets.

There has been success in attracting business to establish a presence in West Cumbria – for example Fluor, CH2M Hill, Shaw International and RWE Nuken . The aim must now be to retain these businesses, attract others and encourage them to use West Cumbria as a base from which to support other decommissioning and environmental clean up markets throughout the world.

It is reasonable to expect that further businesses will, as a matter of course, decide to set up facilities in West Cumbria attracted by the high planned expenditure at Sellafield. More challenging will be the vision of these companies growing their West Cumbria businesses as a base from which to target external markets. However, West Cumbria has the opportunity and the potential to help inward investors towards this vision by providing:

- A high quality, knowledgeable workforce – supported by Sellafield decommissioning experiences.
- High quality training and higher education facilities – such as Nucleus, WLRI, Dalton Institute.
- Strong local R&D facilities and scientists – National Nuclear Laboratory, WLRI, Dalton Institute.
- A strong local supply chain that is willing and able to participate in collaborative ventures into new markets.
- Good infrastructure – transport, housing, leisure – to attract people to work and live in West Cumbria. We note that many people still appear commute into the region to work.

The achievement of the goal of the supply chain growing via inward investors selecting West Cumbria as a base for future expansion will be dependent upon the success of region in developing and providing the distinctive capabilities as outlined above. The development of these capabilities is discussed in other sections of this paper and in the working papers of other working groups.

Experience from Hanford, USA

The Hanford site in Washington State, USA, has number of parallels to the West Cumbria situation. From the 1940s to the late 1980s Hanford was an operational site producing plutonium before moving into the decommissioning/clean up phase.

We have had discussions with a representative from Fluor, the company which for the last ten years has had the contract to manage clean up activities at Hanford. Based on the Fluor experiences, the key messages and lessons for West Cumbria are:

- Despite best efforts, there has only been limited success in creating world class supply chain companies who have the ability to go on and serve other markets – the major successes that were given were in the areas of crane systems and construction.
- The Hanford area has been very successful in growing businesses that are unrelated to nuclear or clean up markets. These successes have been in “back office” businesses and warehouse/distribution businesses. One factor in this success has been that the local infrastructure – roads, river/barge, housing, amenities – was good and helped to attract businesses into the area.
- The tender specification for the Hanford site management role required interested companies to include an economic transition plan in their proposals. Although the winning bidder was not compelled to implement all aspects of its economic transition plan, Fluor took the view that a good economic transition plan was a unique selling point that helped to differentiate its proposal. Fluor also saw that successful implementation of the plan would improve its prospects of retaining the contract.
- Fluor’s economic transition plan seeks to leverage its corporate strength (Fluor’s business is much wider than nuclear clean up) to the benefit of the Hanford area. For example, it set up a construction engineering businesses in the Hanford area to serve the Hanford clean up project and to act as a central hub for Fluor Engineering throughout a range of other markets. Today, this construction engineering business has 50% of its income from Hanford work and 50% from other markets.
- Fluor extended the economic transition plan initiative by placing a similar requirement on its major Tier 2 suppliers. This was in a number of instances. For example, Lockheed Martin established an information processing and communications business at Hanford – this business’s income is now evenly split between Hanford and other markets.
- Fluor’s socio-economic intervention included the provision of consultants whose job it was to help local businesses in transitioning, start ups etc. Fluor also (jointly with Tier 2 suppliers) established a \$10m venture capital fund.

2.2.5 Recommendations

1. Supply Chain Development - the quality of the supply chain support programme will be crucial to a successful outcome. The increased funding that is being proposed by the NWDA supply chain project should be helpful provided the contract is awarded to a high quality, experienced contractor. We recommend that high profile “champions” are employed in the region to drive the various initiatives and that these champions should have demonstrated success in similar ventures.
2. Diversification - the DTI global nuclear decommissioning opportunities report is useful in highlighting the opportunities that exist in the decommissioning and environmental restoration markets. To assist West Cumbrian business in benefiting from these opportunities further efforts should be made to build on this work and on

the ERM Mapping the Nuclear Supply Chain work to bring the information into a local context. This should involve:

- Mapping local skills and capabilities onto market requirements in other countries and other non-nuclear markets.
 - Devising specific market entry strategies for local businesses and providing support to help these companies to implement these entry strategies.
 - Providing financial assistance to local businesses who wish to enter into new markets.
 - Proactively engaging with further potential inward investment companies to use West Cumbria as a base for further market diversification.
3. Procurement – the NDA is following EU procurement legislation in appointing Tier 1 contractors. There is a need to review the potential for compelling/encouraging socio-economic planning of major Tier 2 contractors. The aim of socio-economic activity is best directed at measures that support and enable the existing local suppliers to improve their performance such that they more frequently become “supplier of choice” rather than compelling the buyer to award minimum amounts of business to local contractors. The NDA has taken the lead in requiring a socio-economic element in its contract tendering procedures. The NDA should take steps to ensure that socio-economic requirements feature prominently in the tendering of major Tier 2 contracts.
 4. Knowledge and Communication - the local development agencies should consider developing twinning arrangements with other communities/ regions that have been through a similar experience – e.g. Hanford in the US. Such an arrangement would facilitate the flow of information between the communities and encourage sharing of best practice in regeneration activities.
 5. Delivery - the responsibility for delivering the NOG vision appears to be divided across a number of bodies. We recommend that consideration be given to restructuring such that a single organisation has the authority and accountability for delivery of the various initiatives that are associated with establishing a strong local supply chain and leveraging the overall decommissioning opportunity for the region

3 Research and Development

A vital component of a strong industry cluster is having a strong research and development base at its heart. R&D is a critical link between industry and academia and is vital for creating a climate of innovation and enterprise in a region; it is also one of the activities that make a particular location become recognised as a centre of excellence in a particular field. Nuclear is no exception, and vital to the long term success of West Cumbria as a nuclear centre of excellence will be how it attracts, develops and exploits its R&D capability.

West Cumbria already has some nuclear R&D capability which is mainly located at Sellafield. However it is probably fair to say that it doesn't match, at least in terms of recognition, some of the better known international nuclear centres of R&D in Europe and North America. The possibility of locating the UK's national nuclear laboratory (NNL) at Sellafield is of critical importance to the region and is the type of cornerstone knowledge asset that could transform the region and allow it to leverage opportunities associated with the global nuclear renaissance which is now underway.

3.1 National Nuclear Laboratory

3.1.1 Current Position

The Energy Review Report, published on 11 July 2006, makes reference to the potential establishment of a National Nuclear Laboratory:

“UK Research and Development capability will be critical to the nuclear clean-up programme going forward and may also become important to support other strategic initiatives such as new nuclear build in the future. While the market should provide much of the nuclear R&D that will be needed, government will want to establish in any transitional period that current key R&D capabilities are preserved and developed, potentially as part of a National Nuclear Laboratory. We will be carrying out some detailed work over the coming months to establish a way forward on this.”

The announcement in October 2006 for the BTC to form the National Nuclear Laboratory is an excellent opportunity. The creation of the NNL could enhance innovation, skills and enterprise through the creation of a hub around which R&D in the nuclear and energy sector is conducted.

One of the attractions of using the BTC is that many of the core facilities for the NNL have already been put in place. So far more than £200 million has been invested in the BTC facility and although further investment will be needed to fully commission the facility and create a fully-fledged NNL.

Government is also considering what the detailed operating model for the NNL should be – i.e. ownership, governance, funding, and facilities. Details of this should be announced later this year with implementation to follow possibly by the time of the completion of the BNG sale. Assuming that a positive decision is forthcoming for Sellafield, the real issue for the region is how to ensure that the presence of the NNL is leveraged to maximise the benefit of the region.

We believe that it is useful to consider international experience in creating world class nuclear R&D facilities. Two of the best examples we can find are at the Idaho and Hanford national laboratories in the US, both of which have a large nuclear R&D component.

3.1.2 **Case study 1: Idaho National Laboratory (INL) and the Centre for Advanced Energy Studies (CAES)**

INL employs 3,500 scientists with a remit to work with national and international governments, universities and industry partners to “discover new science and develop technologies that underpin the nation’s nuclear, renewable energy, national security and environmental missions.” INL has four main functions: It is designated as the US’s lead laboratory for nuclear energy research and development (in its 57 year history INL designed, constructed and operated 50 test reactors); it is a prime site for research for the Department of National and Homeland Security and in detection technologies to prevent nuclear proliferation and other weapons of mass destruction; it undertakes research, development and demonstration of energy and environmental technologies including energy efficiency, hydrogen, fossil fuels and alternative fuel transportation systems; and it conducts basic and applied scientific research in earth sciences, environmental engineering, biotechnology, materials etc.

In the nuclear field, which remains its core activity, INL’s activities include: development of the Generation IV nuclear technology (Gen IV was initiated by the US DOE in 2000 and is an internationally supported collaboration project to investigate commercial nuclear power technologies that can be deployed worldwide by 2030 or earlier. The Gen IV Forum currently has 10 members including the UK); analysis on nuclear plant operations and safety as well as nuclear licensing; spent fuel technology research and development; and supporting the US Nuclear 2010 programme, a government-industry partnership to evaluate and enable the deployment of new nuclear power stations in the US by 2010.

INL is operated by Battelle under a long term contract. Idaho National Laboratory has three major facilities: the Materials and Fuel Complex – this includes the hot fuel examination, fuel conditioning and fuel manufacturing facilities; the Zero-Power Physics Reactor; Fuel Assembly and storage Building and a new Space and Security Power Systems Facility; the Reactor Technology Complex – this is anchored by the Advanced Test Reactor, the complex also includes the Advanced Reactor-Critical Facility; Radiation Measurements Laboratory; Radiochemistry Laboratory; and the Safety and Tritium Applied Research Facility; and the Science and Technology Campus – this is anchored by the INL Research Centre and includes the High Temperature Electrolysis and materials laboratories and the new Centre for Advanced Energy Studies (CAES) – see below.

3.1.3 **Case study 2: Centre for Advanced Energy Studies (CAES)**

This was established in 2005 with a remit to advance energy research, technology and engineering education to meet the US’s future energy needs. CAES is a collaborative venture among the DOE, the State of Idaho, the Idaho University Consortium, Battelle Energy Alliance and Idaho National Laboratories. When completed in 2008, the CAES will be located in a 60,000 square foot building, at a cost of \$14 million. Initially the CAES programme will employ around 100 people. Although the focus will be nuclear, CAES will also address other energy areas including affordability, environmental impact, hydrogen, advanced fossil fuel generation and renewables. The goal of the CAES is to advanced energy-related research, education and training policy; develop a fully functional nuclear education and research user-facility by 2008; enhance Idaho and national nuclear educational opportunities; facilitate the collocation and collaboration of government-university-industry energy-related interests; and being a self-sustaining and internationally recognised advanced energy organisation by 2015. The CAES will be home to a number of discrete research, policy and education initiatives. Of particular interest when considering activities that could be carried out at a UK national nuclear laboratory located in Sellafield are the following:

Centre of Nuclear Fuels and Materials Research – includes Light Water Reactor (LWR) fuel performance evaluation, LWR core materials performance evaluation, LWR fuel safety evaluation, Gen IV fuel development, characterisation and testing, low-enrichment fuel

development and testing fuels and materials safety evaluation. Funding will come from government, private industry and universities.

Energy Policy Institute (EPI) – will have a primary mission to lead and inform a comprehensive national and international dialogue on nuclear energy. The EPI will be a “distributed institute” organised at two universities in the state of Idaho.

Education – the CAES will partner with the Idaho University Consortium and the National University Consortium to enhance nuclear education programmes. It is planned that a National Academy will be established at the CAES which will provide developmental opportunities for students, faculty and professionals throughout the international nuclear community. The CAES is also working with the Idaho University Consortium and the Idaho National Laboratories to implement a new degree in nuclear engineering.

Training – the CAES will be responsible for energy workforce development programmes for the nuclear industry and advanced energy sector generally.

3.1.4 Case study 3: Pacific Northwest National Laboratory (PNNL) at Hanford

The laboratory was formed in 1965 when Battelle (a not-for-profit charitable trust) won the contract to perform R&D for the Hanford site; Battelle now operate 5 other DOE laboratories under a “GoCo” model (Government-Owned, Commercially-Operate). As part of this study, the Grant Thornton/Lumis team met with a representative of Battelle who is leading their work related to Sellafield and in particular their relationship with Nexia Solutions. The PNNL is run independently of the other Hanford clean up projects. The initial work of the laboratory was to support the activities of the Hanford site so it was involved in environmental projects, nuclear fuel fabrication research and reactor design. From this initial, nuclear focused work, the expertise of the laboratory extended into environmental technology, health, energy, computer science and security. Increasingly the laboratory pursued more non-governmental projects. For example, it became involved in the early development of the use of lasers in compact discs.

Nuclear still remained at the heart of the laboratory. In the early 1970s the laboratory was awarded the contract to manage the Fast Flux Test Facility and continued operation of the last remaining reactor on the Hanford site until it shut in 1987. From the 1980s the nuclear programme moved more towards expansion of research into nuclear energy, health related applications and national security. During this time the laboratories developed vitrification, a process to turn hazardous waste and glass forming materials into glass (a process widely used throughout the nuclear industry today). In the mid 1980s the Pacific Northwest laboratory became one of the multi-programme laboratories in the US DOE’s national laboratory system – there are only 9 such laboratories in the US. These laboratories are intended to augment the US’s existing academic and industrial research facilities and address areas of national need such as environment, national security, energy, advanced materials etc. As an operator of the facility, Battelle have always placed great emphasis on supporting economic development and technology development and have striven to find ways of transferring government-funded research to private businesses. For example, at the US laboratories that they operate, Battelle allow scientists time to develop their own business ideas on a sabbatical basis, the laboratory also has very favourable IP clauses compared to other US government installations. Battelle have also created a \$150m venture capital fund aimed at helping leverage Intellectual Property created at their facilities.

Possible lessons that can be drawn for the UK NNL:

- The US laboratories have a solid platform of government-sponsored work which allows the substantial initial and ongoing investment in facilities to be made. On top of this they are encouraged by government to leverage these facilities to maximise income for

the laboratory over and above the government contracts. The US laboratories have an excellent track record of increasing their share of commercial R&D funding.

- Laboratories were established alongside large nuclear installations (commercial and military) to tap into the expertise at these sites. Some of the laboratories have been in operation for 40 years or more and have continued to maintain their success despite the run down of operations at the adjacent nuclear facilities.
- The US laboratories, without exception, have a broad role within the nuclear sector and in other sectors as well. For example, the Idaho National Laboratory is involved in R&D throughout the entire nuclear fuel cycle from fuel fabrication to new build to decommissioning and has a strong and growing presence in many other non-nuclear sectors as well. The key message is that there has been an active policy of diversification of the R&D base away from decommissioning.
- All of the laboratories are operated by the private sector under long term contracts with the federal government or agency. We suggest that this has contributed greatly to the highly commercial approach of these laboratories.
- The operators of the facilities work hard to assist the transfer of IP developed at the laboratory facilities to the external business community. Whilst the primary reason for the laboratory being to conduct government sponsored research, they all have a remit to encourage and assist technology transfer and to assist individuals and businesses commercialise the IP.
- The laboratories have adopted an international perspective. They aggressively collaborate with local, national and international universities, laboratories and businesses. Detailed information is made readily available on their web sites on research opportunities and programmes and there is throughout a strong external emphasis throughout

3.1.5 NNL role and remit

The vision for West Cumbria is that the NNL at Sellafield becomes the focal point for nuclear-related R&D in the UK and this in turn allows the region to grow as an international centre of nuclear excellence. If established on a sufficiently large scale, we would expect it to be one of the cornerstone investments and, as we have seen elsewhere, a world class R&D facility can, with the right direction and management, act as a catalyst for further economic growth opportunities.

In recent times, public sector funded nuclear R&D expenditure in the UK has been limited and perhaps it is unreasonable to expect the government will move to a high funding scenario in single step. The DTI website states that “publicly funded research into fission reactors began to decline with the privatisation of the electricity sector in 1990/91.” DTI (previously the Department of Energy) funding of nuclear research decreased from £164 million in 1989/90 to £17 million in 2001/02. All recent expenditure has been on fusion R&D rather than fission reactor R&D albeit the recent government energy review announcement suggests that R&D will be focused on clean-up and new build. Additional funding of research related to waste repositories (as recommended by CORWM) and into Generation IV reactors could expand the role of the NNL. We note that the government’s energy review statement on the NNL states that government still see that the private sector will have the greatest role in R&D provisions and government sees that it has only a transitional role to play. We would hope that the government remains heavily involved in UK nuclear R&D for a long period of time and that it fills funding gaps where there is no natural private sector involvement.

Ideally, the NNL's R&D activity should, at a minimum, cover the following:

- (i) Cleanup - Decommissioning and spent fuel management, treatment of radwastes, packaging of radwastes, handling/transport of radwastes, methods of disposal of ILW, HLW and spent fuel including deep geologic disposal.
- (ii) New nuclear reactor development – possibly via the future Gen IV programme and potentially a research programme to support new build (Gen III or IIIb)
- (iii) Support for the existing UK nuclear industry (Nexia currently do work to support the AGRs for British Energy) and BNG's operations at the Sellafield site (the principal activity of the BTC today)
- (iv) Over-time to expand its R&D base into other associated applications such as medical applications, detection technologies and Hydrogen economy technology development, environmental remediation

The impact that siting the NNL in West Cumbria will have will be a function of the scale, remit and funding underpinning it as well as the degree to which its presence in the region is then leveraged. The objective for the sub-region and its constituent stakeholders once the NNL has been established in the region will be to maximise its potential. over and above what the BTC/Nexia Solutions do currently.

Other research centres already in the UK provide a good example of how a National Nuclear Laboratory might work and the National Physics Laboratory (NPL) is one such model. The NPL is the UK's national standards laboratory, an internationally respected and independent centre of excellence in research, development and knowledge transfer in measurement and materials science. It maintains the nation's primary measurement standards - the heart of an infrastructure designed to ensure accuracy, consistency and innovation in physical measurement. It also carries out technology transfer functions and offers about 150 measurement and calibration services to a range of industrial and other customers mainly, but not exclusively, in the UK.

Between 1990 and 1995, the NPL had been operating as an Executive Agency of the Department of Trade and Industry (DTI). This policy was central to the reforms initiated by the Thatcher government and which were designed to apply to "executive" rather than policy functions within government. Agency status did indeed give NPL many of these management freedoms and devolved to it responsibilities which were suited to the management of a research laboratory. As an Agency the Laboratory made significant progress towards cost reductions and efficiency savings which were published in the NPL's Annual Reports.

At the same time, however, UK government was cutting back on its science and technology expenditure and was changing its priorities. As a result, the national budget devoted to the "National Measurement System" was dropping and in certain areas cuts of up to 30% were being made. Concentration on "core functions" meant that NPL had an overall staff of about 850 in the early 90s and was facing the prospect of tough times.

The government was considering privatising all their labs. The review options for NPL were finely balanced but eventually the decision was taken to convert it into a Government Owned, Contractor Operated facility. This was mainly because:

- there were legal complications to other privatisation options because the land on which the Laboratory was built was part of a Royal Park with restrictions on commercial use;

- it was felt that the Laboratory required a commercial independence from the industrial base it was designed to serve;
- the potential for significant income growth other than from government was relatively small so that a private sector company would hesitate in taking on the risk of full ownership;
- the government, having decided that it would always need a National standards laboratory, preferred to retain the sort of control and monitoring that came with public ownership and the certainty that NPL could never fail financially; and
- NPL's international partners might well have been less happy to cooperate fully with NPL if it was completely in the private sector.

The National Physical Laboratory became a Government Owned Contractor Operated laboratory in 1995. Since then the new management has trimmed costs and restructured the organisation. As a result some 150 more scientists are employed - an increase of about 20%. Serco operates the National Physical Laboratory a public private partnership with the UK Department of Trade and Industry. It won the retender in 2004 (£500mn contract over 10 years).

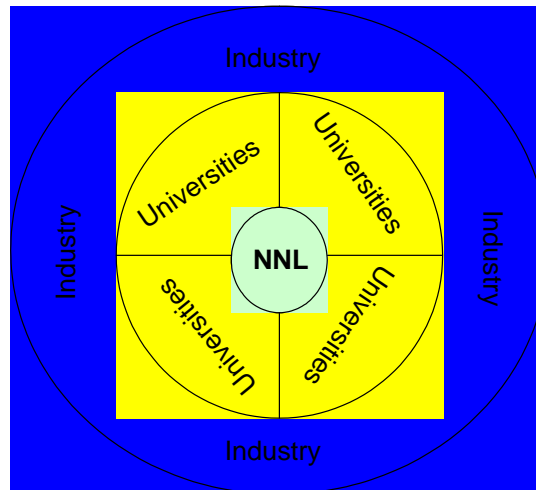
3.1.6 Maximising benefits of an NNL in West Cumbria

(i) National and international recognition as centre of nuclear excellence – this will depend on a number of factors:

- The role/remit of the NNL and the level of government support – currently the work done by Nexia Solutions at Sellafield is principally focused on supporting the current activities of BNG. It is quite an inward looking organisation with the exception of some limited external contract work for British Energy. To maximise its potential the NNL must conduct leading edge nuclear R&D and be able to attract funding from a range of sources over and above the support provided by central government. The more general research functions of the NNL would need to work alongside the ongoing support for BNG. Our view is that the NNL should be able to incorporate both of these roles simultaneously and should operate as one organisation and should not be split up into a government research lab and a commercial research lab.
- Strong commercial focus – in addition to applied research, the laboratory must be a commercially-oriented organisation which is seeking to leverage the IP it develops.

(ii) Retention and attraction of high quality, skilled jobs to West Cumbria – this will depend on the quality of the research conducted at the facility as well as the particular specialisms within the facility. The NNL should seek to attract scientists and technicians to West Cumbria.

(iii) Strong education and training – links should be forged between the NNL and the region's education and training facilities including the Dalton Institute and the Westlakes Research Institute. Some of the facilities of the NNL could be made available to local colleges and training institutions to allow practical experience to be developed. Some nuclear laboratories such as the CERN in Switzerland offer "Internships" at their facilities for students – these typically run 3-12 months; the NNL could offer a similar international programme. We also note that some facilities, notably the Westlakes Research Institute have facilities that are not at full capacity and these ought to be considered as potential "outside the fence" facilities for the NNL (see below). Strong links should also be created with a number of universities in the UK and internationally.



(iv) Commercial Exploitation – opportunities will exist to commercialise IP developed at the NNL and on the back of this to new businesses. This is the model which has been adopted at a number of US national laboratories (see PNNL case study). As we have seen elsewhere, positive intervention will be required to encourage commercial exploitation. There are many examples of how this can be done, including the provision of sabbaticals for employees to allow them the time to develop a business; assistance with facilities and other general business support; availability of venture capital and free or heavily subsidised use of the facilities at the laboratory for external companies who could not afford their own facilities. One of the issues we believe should be addressed is the accessibility of the NNL facilities to local companies and individuals. The Sellafield site is understandably a difficult site to access and we believe this will act as a deterrent to individuals and businesses who wish to access its facilities or have meetings with the NNL. Possible locations already exist within the immediate area for a satellite NNL centre including the West Lakes Science Park or the Sellafield visitor's centre which could be adapted to provide meeting facilities and light R&D and test facilities.

In the US, the private sector operator of the laboratory has been the prime mover in stimulating this entrepreneurial activity and we see no reason why a similar model could not be adopted at Sellafield.

3.1.7 Conclusions

Siting the UK NNL at Sellafield is one of the most important opportunities for the region. If properly funded and constituted it will become the cornerstone of a centre of nuclear excellence in West Cumbria and will provide substantial follow-on opportunities in the region in the nuclear sector and ideally help the region expand its technology base into related areas.

3.1.8 Recommended Actions

1. Role, Remit and Funding – the NNL must have a broad remit, receive a base of funding from central government that supports the investment in state of the art facilities and allows it to attract and retain the best people. It should have a dual role of supporting government nuclear research projects and working in collaboration with the private sector including its existing customers. The NNL should have a broad remit and cover the entire spectrum of nuclear R&D. Where appropriate, the

NNL should be encouraged to expand its technology base into associated areas such as environmental remediation and alternative energy research.

2. Management – we recommend that a GoCo model as has been adopted. We believe that this would maximise efficiency and best provide the appropriate commercial climate under which the laboratory should be run.
3. Facilities – in addition to the BTC, outside the fence facilities should be established to provide an easy interface between the laboratory and the private sector. This would help to overcome some of the access issues of the existing site on the Sellafield nuclear licensed site.
4. Intellectual Property and Commercialisation – where appropriate, IP developed at the laboratory should be made accessible to employees and external businesses to exploit and leverage. The operator of the laboratory should be given a mandate to encourage innovation and commercial exploitation of patents and inventions.

4 Waste repository/ waste disposal

4.1 Introduction

The West Cumbria region is the destination for majority of the UK's radioactive wastes; high level waste (HLW) and intermediate level waste at Sellafield and low level waste (LLW) at the Drigg site. The continued management and storage of these wastes will provide economic benefit to West Cumbria and enable the region to continue to develop world class expertise in this field.

The NDA's lifecycle plan for Sellafield assume that radioactive wastes will be treated, packaged and stored at Sellafield until ILW and HLW waste repositories are available in 2040 and 2075 respectively. The jobs profile for Sellafield does not include jobs that would be created in the construction and operation of the repository. Hence, if a waste repository were to be sited in West Cumbria, jobs, additional to those in the lifecycle plan, would be created.

4.2 ILW/HLW

4.2.1 National policy on radioactive waste disposal

The Committee on Radioactive Waste Management (CoRWM) is an independent body appointed by Government Ministers in England, Scotland, Northern Ireland and Wales to review the options for managing the UK's radioactive waste and recommend the option, or combination of options, that can provide a long-term (many thousands of years into the future) solution which protects people and the environment

CoRWM's priority is to recommend how to manage the wastes for which no long-term management strategy currently exists. These are wastes with high and intermediate levels of radioactivity which are now in storage or likely to arise over the next 100 or more years, and some low level waste which is unsuitable for disposal at the Drigg site in Cumbria.

In July this year CoRWM issued its final recommendations. The key elements of the recommendations are:

- In the long term, disposal of radioactive waste deep underground (geological disposal).
- Robust interim storage, in recognition of the fact that the process leading to the creation of suitable facilities for disposal may take several decades.
- An equal partnership between government and potential host communities based on a willingness to participate.
- The immediate creation of an oversight body to begin the process of implementation.

Although such a repository would not be operational for several decades there will be opportunities, in the nearer term, in R&D into aspects of geological disposal and interim storage and management of wastes.

4.2.2 CoRWM's recommendations

- Recommendation 1: Within the present state of knowledge, CoRWM considers geological disposal to be the best available approach for the long-term management of

all the material categorised as waste in the CoRWM inventory when compared with the risks associated with other methods of management. The aim should be to progress to disposal as soon as practicable, consistent with developing and maintaining public and stakeholder confidence.

- Recommendation 2: A robust programme of interim storage must play an integral part in the long-term management strategy. The uncertainties surrounding the implementation of geological disposal, including social and ethical concerns, lead CoRWM to recommend a continued commitment to the safe and secure management of wastes that is robust against the risk of delay or failure in the repository programme. Due regard should be paid to:
 - i. reviewing and ensuring security, particularly against terrorist attacks
 - ii. ensuring the longevity of the stores themselves
 - iii. prompt immobilisation of waste leading to passively safe waste forms
 - iv. minimising the need for repackaging of the wastes
 - v. the implications for transport of wastes.
- Recommendation 3: CoRWM recommends a flexible and staged decision-making process to implement the overall strategy, which includes a set of decision points providing for a review of progress, with an opportunity for re-evaluation before proceeding to the next stage.
- Recommendation 4: There should be a commitment to an intensified programme of research and development into the long-term safety of geological disposal aimed at reducing uncertainties at generic and site-specific levels, as well as into improved means for storing wastes in the longer term.
- Recommendation 5: The commitment to ensuring flexibility in decision making should leave open the possibility that other long-term management options (for example, borehole disposal) could emerge as practical alternatives. Developments in alternative management options should be actively pursued through monitoring of and/or participation in national or international R&D programmes.
- Recommendation 6: At the time of inviting host communities to participate in the implementation process, the inventory of material destined for disposal must be clearly defined. Any substantive increase to this inventory (for example creation of waste from a new programme of nuclear power stations, or receipt of waste from overseas) would require an additional step in the negotiation process with host communities to allow them to take a decision to accept or reject any additional waste.
- Recommendation 7: If a decision is taken to manage any uranium, spent nuclear fuel and plutonium as wastes, they should be immobilised for secure storage followed by geological disposal.
- Recommendation 8: In determining what reactor decommissioning wastes should be consigned for geological disposal, due regard should be paid to considering other available and publicly acceptable management options, including those that may arise from the low level waste review.
- Recommendation 9: There should be continuing public and stakeholder engagement, which will be essential to build trust and confidence in the proposed long-term management approach, including siting of facilities.

- Recommendation 10: Community involvement in any proposals for the siting of long-term radioactive waste facilities should be based on the principle of volunteerism, that is, an expressed willingness to participate.
- Recommendation 11: Willingness to participate should be supported by the provision of community packages that are designed both to facilitate participation in the short term and to ensure that a radioactive waste facility is acceptable to the host community in the long term. Participation should be based on the expectation that the well-being of the community will be enhanced.
- Recommendation 12: Community involvement should be achieved through the development of a partnership approach, based on an open and equal relationship between potential host communities and those responsible for implementation.
- Recommendation 13: Communities should have the right to withdraw from this process up to a pre-defined point.
- Recommendation 14: In order to ensure the legitimacy of the process, key decisions should be ratified by the appropriate democratically elected body/bodies.
- Recommendation 15: An independent body should be appointed to oversee the implementation process without delay.

Although such a repository would not be operational for several decades, in the nearer term there will be opportunities in R&D if CoRWM's recommendation 4 ("There should be a commitment to an intensified programme of research and development into the long-term safety of geological disposal aimed at reducing uncertainties at generic and site-specific levels, as well as into improved means for storing wastes in the longer term") is acted upon.

Position of the local councils

The position of the local councils on ILW/HLW repositories was stated in letters to CoRWM in May 2006 when Cumbria, Allerdale and Copeland councils responded to CoRWMs' draft recommendations. Their principal comments were:

- There should be a commitment by the UK Government to intensive R&D into all aspects of geological disposal, interim storage and other options not completely ruled out by CoRWM.
- Interim storage of ILW should be as close to the place of origin as possible. The councils are opposed to centralising ILW storage at Sellafield.
- The local councils are concerned that if one central repository (for HLW/ILW) is recommended it will be, by default, in West Cumbria.
- They support the concept of volunteerism by local communities.
- They support the principle of support for communities that bear the burden of nuclear waste facilities.

4.2.3 Waste Repository Sites

Nirex was set up in 1982 to implement a strategy for the safe disposal of LLW & ILW wastes.

In 2005 Nirex was made independent of the nuclear industry, in a move to boost transparency and accountability in the long-term management of radioactive waste. Nirex's objective is to carry out scientific, engineering and social science research to help develop safe and environmentally sound options for dealing with radioactive waste in the long term.

The most recent attempt to implement a deep geological repository to manage intermediate- and low-level wastes ended with a refusal in 1997 from the Secretary of State for the Environment to allow the construction of an underground Rock Characterisation Facility (RCF) close to the Sellafield works. The decision to focus the investigations at Sellafield in 1991 had followed a detailed decision-making process that started by considering which areas in Great Britain could potentially be used to site a deep geological repository (over 30% of the landmass) and sieving down from 537 sites sequentially to 204, 165, and on down to a short-list of 10 (+ 2 generic off-shore) sites that were evaluated in a multi-attribute decision analysis.

In June 2006 Nirex published an historic (compiled in the 1980s) short-list of sites that were possible locations for a radioactive waste repository (http://www.nirex.co.uk/index/iold_list.htm). There is currently no site selection exercise being undertaken in the UK. Nirex states that if and when a new site selection exercise is needed in the future, this historic list will not form the starting point of such a process. The scope of CoRWM's work does not include making recommendations on possible waste repository sites.

If a repository were to be located at a site other than Sellafield then there would have to be a major programme of transporting the Sellafield wastes to another site. This is likely to be unpopular with many communities affected by the movement of the wastes.

4.2.4 Waste repository costs

To give an indication of the cost of constructing and operating a deep geologic repository we refer to a NNC Ltd paper (Phased Deep Disposal – Costs CoRWM Document No: 683, September 2004) which estimated the cost of a phased deep geological disposal facility for ILW and LLW. The elements of the total cost (in 2001 money values) are shown in the table below:

	COST (MGBP)
Construction to First Waste Emplacement	1,023
Construction after First Waste Emplacement	806
Operational Costs	940
Care and Maintenance Costs	580
Closure	239
Subtotal of Construction, Operation & Closure Costs	3,588
Total all costs (including R&D, site investigation etc.)	6,248

Source: Phased Deep Disposal costs – CoRWM document No 683

The numbers above illustrate that a repository would generate significant economic value both in the construction and operations phases. A Nirex report (Cost estimate for a reference repository concept for UK high level waste/spent fuel – September 2005) estimated that around 250 permanent jobs would be created during a 36 year operating phase. This number would increase if the repository also was to accommodate ILW.

A report in Finland by Posiva Oy ("Into Olkiluoto Bedrock", Nov 2002) estimated that a spent fuel disposal repository in Finland would create jobs for around 200 people during the 10 year construction phase. On a larger scale the Nevada Alliance for Defence, Energy &

Business estimates that jobs would peak at 4,500 during the construction of the Yucca Mountain repository and that over 2,000 jobs would be created during the transportation and operations phase.

If a ILW/HLW/spent fuel repository were sited in West Cumbria then it would represent a significant source of employment for the sub-region. (Although this employment benefit is not likely to materialise for at least 20 years).

4.2.5 Community compensation

Much has been written about compensation measures for communities that host radioactive waste management facilities. A Nirex paper (Compensation in Radioactive Waste Management: Ethical issues in the treatment of host communities, May 2002) provides a survey of the types of issues that are raised by any attempt to identify appropriate compensation and considers issues such as calculation of compensation amounts and ethics.

A review of the compensation offered to host communities in countries such as Finland, Spain and Sweden – which already have operating ILW repositories – offers some ideas as to the type of compensation that could be obtained. Further examples are available from communities in the US and Canada that have hosted LLW repositories.

Compensation can take a number of forms but its general aim is to should ensure that the economic viability of the host community is maintained and enhanced and that property and business values are protected:

- community fund – to be invested as determined by the local community. In Belgium this has been an important aspect of community support with a wide variety of projects determined by the local community (ranging from job creation schemes to community centres)
- investment in local infrastructure – roads, rail, emergency services, hospital, schools, community services. The Eurajoki community in Finland negotiated the provision of a new old people's home as compensation for hosting a HLW repository
- reduced local taxation
- compensation for loss in housing values
- a Property Value Protection Programme has been established in Port Hope, Ontario to compensate property owners for any loss in property values associated with a LLW facility.
- compensation from loss of other business – e.g. tourism
- lump sum/up front compensation or compensation over a period of time. At the Hanford facility in the US, the local community receives income as each cubic metre of waste is received at the facility

Copeland Council has undertaken some work into potential forms of community benefit and at this time favours a form of endowment fund. Spending the fund and the interest from the fund would be controlled by Copeland Council and used to the benefit of the local community over many decades/generations.

4.3 LLW

4.3.1 Introduction

Currently the UK permanently disposes of almost all of its LLW at the LLW disposal facility located close to the village of Drigg. With the establishment of the NDA and its planned programme of decommissioning work, the 2004 UK Radioactive Waste Inventory indicates that about 2 million cubic metres of LLW could arise from existing nuclear and non-nuclear

activities over the next century, including that which will arise from the decommissioning and clean-up of the UK's older, publicly owned, civil nuclear sites.

There is concern that the Drigg facility does not have sufficient capacity to accommodate this volume of waste and DEFRA is in the midst of a public consultation process to develop a policy for the long term management of solid LLW (the deadline for responses to DEFRA's proposals was 31 May 2006).

Position of the local councils

The position of the local councils on LLW policy was stated in their response to the DEFRA consultation process in May 2006. Cumbria, Allerdale and Copeland councils' principal comments were:

- Concern that insufficient consideration is being given to a national v. regional solution to LLW storage. Local councils argue that there is only capacity at Drigg to 2008 and thereafter new vaults must be built. The councils argue that the construction of new vaults at Drigg should not be assumed.
- Drigg should not be used to accommodate waste from other UK nuclear sites.
- No increase in Drigg capacity should be sanctioned until agreement is reached regarding compensation measures for hosting a LLW disposal facility. The councils are disappointed that the consultation virtually omits the subject of compensation.
- The local community should have veto over importing LLW.

4.3.2 Impact on employment

The Lifetime Plan for the Drigg facility indicates approximately 80 jobs at the Drigg site until end of operations in 2050. These staffing requirements assume that Drigg operations are extended to 2050. A decision to limit the increase in Drigg capacity is likely to have only a small impact on employment in West Cumbria.

4.4 Summary and Conclusions

CoRWM has issued recommendations which conclude that a form of geologic disposal facility be considered as a disposal facility for the UK's ILW/HLW.

The issue of whether or not West Cumbria is host to an ILW/HLW repository may not be of immediate importance to the economic regeneration of West Cumbria. More important is that West Cumbria maximises the opportunities that may arise in terms of an R&D programme to support the UK's nuclear waste management strategy.

A decision to locate the National Nuclear Laboratory in West Cumbria will significantly enhance the prospects of the region to benefit from such an R&D programme. The business community in West Cumbria should maintain a close watch on the develop of an R&D programme and take early action to ensure that it is best positioned to benefit from the programme.

Given that the vast majority of the UK's ILW & HLW is already located at Sellafield, the local councils/community should develop a strategy to ensure that West Cumbria benefits to the maximum extent in the event that the region puts itself forward as a host for a ILW/HLW repository.

Recommended Actions

1. Leverage R&D - develop an understanding of the potential R&D opportunities (as recommended by CoRWM) that may be announced following a Government decision on the management of ILW/HLW so that West Cumbria businesses can be better positioned to benefit. Lobby for the maximum extent of the R&D activity to be provided by a West Cumbria based National Nuclear Laboratory.
2. Strategy Development - local councils should develop their strategy regarding their position as a potential repository (including an extension to the LLW repository) host community, taking into account:
 - local public attitudes
 - learning from other communities that host ILW repositories (in Spain, Sweden and Finland)
 - appropriate types and levels of community support that could be negotiated
 - Infrastructure requirements that would accompany a repository.

5 New Nuclear Build

5.1 Background

Whether new build nuclear takes place in the UK will be a political decision in the first place and then a commercial one by the developers of a project. The implications of the government's energy review will not be fully known within the timeframe of this assignment. Nevertheless, the Energy White Paper, published in May 2007 indicates government's strong support for nuclear power and new nuclear construction. The earlier Energy Review indicated that a major reform of the planning and regulatory system is needed in order to give the private sector greater confidence in the consenting process associated with new build.

Of particular relevance to the prospects of new build in West Cumbria is the April 2006 Jackson Consulting Report on the relative suitability of new build sites in the UK. The report only considered sites adjacent to nuclear power stations that are currently operating or have been decommissioned. Therefore, along with 14 UK other sites, Calder Hall at Sellafield was included in the assessment. Calder Hall received an "amber" ranking as a potential site for either a single or twin station and ranged behind 9 sites which received better than amber in at least one of the two categories. An amber ranking was described in the report as "the site is potentially feasible but has some important barriers to new reactor development that would need to be successfully overcome." In the case of Calder Hall the key barrier was the lack of transmission capability and the planning issues associated with achieving planning consent. The following extract from the report highlights the transmission issue: *"study published by Cumbria County Council in March 2006 estimated that the total grid connectivity costs for construction of an AP1000 at Calder Hall at Sellafield would be in the range from £66 million for a single AP1000 to £223 million for a twin AP1000 assuming that a new 80km transmission line would be built from Calder Hall to the grid connection at Carlisle. The cost of upgrading Calder Hall's single transmission circuit would be £66 million but the cost of installing a second circuit needed for a twin reactor would be much higher at £157 million (£223 million total). The cost escalation for a second transmission line is mainly due to the need to bury parts of the line underground."*

The Government has set out as part of its current nuclear consultation the potential for a further Strategic Site Assessment (SSA) of potential locations for new nuclear power stations. The SSA would be subject to further consultation. In light of these initial conclusions from the Jackson Study and in preparation for a SSA following the current round of consultation we would recommend the following actions:

The energy review report confirms our view that sites adjacent to existing nuclear power stations are the most obvious locations for new plants. We do not consider that this was intended to rule out Sellafield as a potential site for new build as it is a major existing nuclear licensed site. Government also stated that they expect to see an open and developed market for new build nuclear sites in the UK and will take steps to ensure this is the case if it does not happen. This statement is aimed at ensuring that British Energy, which controls all of the leading sites for new build, does not stand in the way of projects being developed in the future.

Although new build at Sellafield may not be a primary objective for the sub-region, at least on the same level as decommissioning, it is one of a small number of credible "transformational" nuclear-related development opportunities that exist for the region. Construction of a new power station at Sellafield would represent a substantial value

injection into the local economy during the construction phase followed by sustained employment for between 350 and 600 direct staff (depending on number of units built) for the operational lifetime of the plant (40-60 years) along with the associated spin-off benefits to the regional economy.

We are not aware of any existing plans to build a new nuclear plant at Sellafield. The last major investigation was in 1994 when BNFL conducted a detailed study into the feasibility of siting a new PWR at Sellafield. As a result of this exercise, a suitable site was identified adjacent to the existing Sellafield site. More recently, Environmental Resources Management (ERM) and Integrated Decision Management (IDM) were commissioned by Cumbria County Council, Copeland Borough council and West Lakes Renaissance to assess the implications of new nuclear build for Cumbria ; this report was published in March 2006. The main findings of this report were as follows:

- Sellafield is one of a relatively small number of potentially viable sites for nuclear new build in the UK (and the only one in Cumbria) but is not an optimal location compared to a small number of alternative sites. It would, however, be included in the top 5 or so sites in the UK.
- New transmission lines would need to be built to accommodate a new nuclear plant at Sellafield. Construction of a new transmission line would face considerable planning hurdles.
- New build would provide 7,000 person years of employment (but not all of this in West Cumbria). Once operational, a twin unit reactor would employ up to 600 people directly, with total job creation of around 1,000.
- An opportunity exists to build a Plutonium burning reactor as a means of processing the UK's inventory of civil plutonium stored at Sellafield.
- The construction and operation of nuclear new build in Cumbria would have a beneficial effect on the regional supply chain.

5.2 Sellafield attributes as a site for new build

Sellafield has a heritage as a site for operational and experimental nuclear reactors but differs from some of the other potential new build sites (but not Bradwell) in not having had an AGR. This means that more infrastructure would be required (e.g wire capacity) at Sellafield in comparison to some of the other sites. For example, it was the site for the UK's first commercial reactor, Calder Hall, which opened in 1956 and operated until 2005. The prototype Advanced Gas Reactor (AGR) was also sited at Sellafield and operated until 1981.

Sellafield has a number of positive attributes as a potential site for a new nuclear station.

5.2.1 Available land for new build and an existing licensed nuclear facility.

The 1994 BNFL study was predicated on replacing the Magnox power stations when they reached the end of their operations. Extensive research was conducted into a potential site and relevant documentation was produced. Although it is likely that much of this work would need to be repeated or updated to reflect today's environmental and planning standards, it is likely that Sellafield would still be considered to be a suitable site.

5.2.2 Supportive local community, skilled workforce and infrastructure.

The general presumption is that the only new build sites under consideration in the UK will be where there is an existing nuclear operating power station or where there is a substantial nuclear presence. The reasons for this are fairly obvious and include the likelihood that public opinion is going to be more favourable (or at least less opposed) than at a greenfield

site, there is a pre-existing workforce with relevant skills and the infrastructure will be in place (cooling water intakes and outflows, transmission, local subcontractors etc). Our working assumption is that, like many other communities which are heavily dependent on the presence of nuclear facilities, the surrounding population would be broadly supportive of new nuclear build on the site. This assumption would clearly need to be tested as it could be the case that there is less support for an operating nuclear power station compared to say some of the more traditional nuclear activities at Sellafield. It is also likely to be the case that the further away from the Sellafield site public opinion is tested, support for new build would decline as there would be less perceived economic benefits.

5.2.3 Site Ownership.

Sellafield is only one of a few suitable UK new build sites that is not owned by British Energy. As a result the new build site at Sellafield could be of interest to potential investors in new build such as EDF, RWE and EON. The Sellafield new build site is owned by the NDA. It would therefore be an issue for the NDA as to whether it would be willing to let a third party develop this site or whether they would consider using it themselves in the future. We are not aware of any ongoing discussions between the NDA and potential developers but think that it would be surprising if at least initial enquires had not been made of the NDA.

5.3 Sellafield Challenges

As a site for new build, Sellafield has two principal challenges

5.3.1 Transmission Infrastructure.

The Energy Review Report recognises that substantial upgrades will be required to the transmission system to allow new nuclear plants to be built and that many of these new units are larger than the AGRs and larger than the UK transmission system has been traditionally designed around. It also states that it expects developers to take the costs of upgrading the network and other transmission requirements into their site selection decision. For Sellafield, the main issues identified previously, when new build was being addressed in 1994, still exists today. The primary issue is the need to reinforce the transmission capability with a 400kV connection to Harker near Carlisle or Quernmore near Lancaster (see map below). A 1994 study by BNFL concluded that two double circuit 400kV lines would be required for two stations. BNFL concluded that planning permission for the southern route to Lancaster would unlikely to be granted because of the proximity to the National Park border. Using underground lines was considered but the cost was deemed to be prohibitive. The northern route, with a 70 km connection to Harker was felt to have a greater chance of gaining planning permission as a single new line might be able to use the existing transmission corridor and would also avoid the National Park. The costs of siting one line were estimated at £66 million and £233 million for 2 lines. These estimates are at least 10 years out of date and therefore unreliable and would need to be updated.

Under National Grid's shallow connection charging methodology, most of these costs would not be directly chargeable to the generator. Currently the generator would be required to provide security (in the form of a parent company guarantee, letter of credit or similar) for his pro rata share of any deeper reinforcement works required. Once the generator connects, this security requirement would disappear, replaced by the obligation to pay annual generator Transmission Network Use of System (TNUoS) charges which are paid by all transmission connected generators – these charges vary by zone with, generally speaking, costs being higher the further north one goes.

However this system is currently under review and the way in which this security amount is determined is likely to change as part of Ofgem's current Transmission Price Control Review. National Grid have proposed a mechanism which would see security amounts being determined as a percentage of a number of years' worth of generator TNUoS charges. Furthermore, post connection, generators would be obliged to continue to provide security in respect of a number of years' worth of generator TNUoS charges.

The result of these changes is that cost of connection is not likely to be a major barrier to a new nuclear power station, albeit that security requirements and ongoing TNUoS costs are likely to be higher than for a project further south. The main obstacles will be the time it takes to get planning consent for any new lines required. It should also be noted that, due to the large amount of new renewable generation with connection agreements in Scotland and northern England (which utilise capacity on the main transmission lines from Harker to Quernmore and south), it is likely that reinforcements beyond those envisaged by the BNFL study will be required in order to connect a new power station at Sellafield. Experience suggests that new overhead transmission lines are very difficult to consent as can be seen by the extensive time required to build the new North Yorkshire line and the current planning difficulties being encountered by the proposed new Beaulieu-Denny line in Scotland. Indeed the potential planning difficulties, combined with the high demands for capacity on the main north-south arteries, may mean that a subsea connection from Sellafield to some point further south (e.g. Stanah or the Merseyside area) is the most realistic option. However, unless a generator undertook to pay for a subsea connection itself, it would be for National Grid to determine the most cost effective route. They might determine that the potential cost savings would justify trying for the overland route despite the significant additional planning difficulties.

The first stage in appraising this issue would be to engage with National Grid to determine the project specific issues with a new connection of this size. Once plans for a new station were more advanced it would be advisable to make an early grid connection application so that this factor did not become an obstacle to project completion.

5.3.2 Transmission Network Use of System Charges

All things being equal a site would be preferred over another if it was in a location with lower generator Transmission Network Use Of System charges (TNUoS).

Transmission Network Use of System charges are levied on both generators and suppliers as the principal means by which National Grid recoups the costs of constructing and maintaining the transmission network. Generator TNUoS charges are determined with reference to a number of zones and currently vary from minus £9.1/kW/yr in the extreme south-west of England to plus £20.5/kW/yr in Northern Scotland. Sellafield is currently located within the Humber, Lancashire and SW Scotland zone which has charges of £5.6/kW/yr. This compares to Sizewell which is located in the Midlands and South-East zone with charges of £1.2/kW/yr and Hinkley which is located in the Wessex zone with charges of negative £5.1/kW/yr. To put this in context, for a nuclear generating plant running at 90% load factor, the current difference between Sizewell and Sellafield would be worth about £0.56/MWh. The difference between Sellafield and Hinkley would currently be worth up to £1.36/MWh. For comparison the total cost of a new nuclear power station is likely to be in the range £30 to 35/MWh.

Charges are generally higher when generation is high in relation to demand and the level of charges, together with the definition of the different zones, currently varies from year to year. It should therefore be borne in mind that the addition of a significant amount of new generation in an area can materially affect the zonal charge that applies.

5.4 New Nuclear Build Options for Sellafield

5.4.1 New Water Reactor to replace existing AGRs

Sellafield ranks below the best sites for new build in the UK which include Sizewell and Hinkley Point. We would expect that if new build takes place, these two sites will be developed before others are considered. Assuming that a strategy of replacing existing nuclear capacity as it closes is adopted where feasible and twin units are constructed at Sizewell and Hinkley Point amounting to 4,000 MW then additional capacity will only be required when the next wave of AGRs are decommissioned. At present, without life

extension, there are significant drops in nuclear capacity around 2010/11, 2014/15, and 2023 as shown below.

We would expect that life extension will be achieved at many, if not all, of these stations and the closure curve, above, would shift to the right by on average 5 years per station - with Dungeness B already having been granted a 10 year life extension. Therefore assuming 4,000 MW of new nuclear are commissioned at other sites to accommodate the closure of Hinkley Point B, Hunterston B, Heysham 1 and Hartlepool in the 2015-2020 window, then the second phase of new build will not be required to be on stream until 2020-2025 at the earliest. Assuming an 8 year development process (3 years planning and 5 years construction), the earliest time at which serious development of the second phase of plants would be required is in the 2012 and 2017 window.

Site selection for the second phase of AGR replacements will include sites that have a number of difficult issues associated with them (planning, transmission, land availability, distance from demand etc). We would expect Sellafield to be considered in this second wave and would probably rank in the top 3 or 4 sites in the UK but still facing some considerable issues especially around transmission.

Two issues could accelerate the timeframe for new build at Sellafield:

- Less capacity is built at Sizewell and Hinkley Point bringing forward consideration of other sites (however, we would expect Bradwell to be the next choice)
- An investor would like to advance new build on a non-British Energy site and is prepared to confront the particular difficulties associated with these alternative sites. Sellafield would probably be one of the preferred sites under this scenario.

5.4.2 Plutonium Burning Reactor

The NDA is studying options for dealing with approximately one hundred tonnes of plutonium that exist from the Magnox and AGR fuel reprocessing programmes. Stocks of UK civil plutonium are held under internationally agreed safeguards, but at present no final disposition route has been selected. For plutonium, the options include:

- Immobilisation through vitrification, ceramification, cementation or reprocessing into “disposal” MOX
- Re-use as MOX fuel or inert matrix fuel (IMF) in existing AGRs, PWRs or other LWRs
- Re-use as fuel in a plutonium burning fast-breeder reactor

If the policy of burning the plutonium in a reactor is the preferred route then the Sellafield site would be a natural location for this reactor (to minimise transport/ safety/ security issues). This will be a matter of national government policy and is outwith the control of the key stakeholders in West Cumbria.

5.4.3 Generation IV Reactor

Sellafield could be a site for a test reactor as part of the UK’s involvement in the Gen IV reactor development programme. Sellafield had been the site of experimental and test reactors in the past although it is many decades since the UK invested in a prototype reactor with this type of activity being more the domain of the US, China, Japan, Russia and South Africa.

5.5 Conclusions

New build nuclear at Sellafield site is a credible nuclear-related option and is one of a small handful of material non-decommissioning related opportunities that exist for the sub-region.

For a variety of reasons, new build is unlikely to be a very near term opportunity for West Cumbria. However it is likely to emerge as a possible option within a 10 year horizon and therefore the option should not be foreclosed.

West Cumbria should be looking longer term at supporting the research (via a National Nuclear Laboratory) into new generations of nuclear reactors which are expected to be commercially developed after 2020.

A new reactor fleet in the UK is an opportunity for West Cumbria even if a new reactor is not built in the region. It prolongs the life of the nuclear industry and will create opportunities in fuel fabrication, spent fuel management and possibly reprocessing all of which could have knock-on benefits within West Cumbria.

5.6 Recommendations

1. Protect Sellafield new build site option – ensure that land is not used for other purposes and potentially forecloses the new build options.
2. Update the Calder Hall/Sellafield new build site study² in preparation for DTI's Strategic Site Study,. This document would be targeted at potential investors and used for lobbying purposes;
3. Transmission - commission transmission options study (routes, costs and planning feasibility).
4. Information on Site - prepare a document outlining potential of new build at Sellafield and details of the site. This document would be targeted at potential investors and used for lobbying purposes.

Spent fuel reprocessing & MOx fuel fabrication

The Lifecycle Plan for Sellafield assumes that the thermal oxide fuel reprocessing facility (THORP) and the Sellafield MOx fuel fabrication facility (SMP) will cease operating in 2011 and 2016 respectively when the current order book is completed.

However the extended operation of these facilities has the potential to generate very significant revenues and employment for in West Cumbria.

- With the present plant capacity annual revenues of £500m - £600m are forecast if the plant is used to its capacity.
- There is also the prospect of expanding plant capacity to exploit the world situation where demand for reprocessing services exceeds supply.
- Keeping the facilities operational beyond 2011/ 2016 would safeguard a significant number of jobs (including support jobs) in West Cumbria (the Sellafield lifetime plan shows ~3,000 jobs associated with commercial operations).

² ERM

THORP ceased operation in April 2005 when it was discovered that a pipe fracture had caused radioactive liquid to escape into a secondary containment cell. The plant remains shutdown pending acceptance of the safety case by the Nuclear Installations Inspectorate before it can be restarted.

In June 2006 the NDA published the conclusions on the future disposition options to deal with its stock of Uranium and Plutonium. The study, conducted by the consultants ERM and IRM, “Uranium and Plutonium: Macro-Economic Study, contained the following relevant conclusions:

Most of the material, currently stored at Sellafield could either be considered an asset or a liability

Some of the Uranium stocks are immediately tradeable either as they are or after blending and the Plutonium stocks could be used as inputs to Mixed Oxide Fuel (MOX) fabrication. Processing to fuel could and use in a reactor could occur anywhere but the most likely location is the UK. This comprises the “bounding scenario” which assumes that the resulting fuel is used in a future UK nuclear electricity programme “of new, modern reactors with 60 year lifetime”. The NDA study estimates that this makes up a total of 12 GW of capacity and that this is followed by a 12 GW programme of fast breeder reactors which re-use the plutonium. Location of these third or fourth generation plants is not discussed and there are no specific reasons why they need to be at Sellafield or perhaps even in the UK.

The bounding scenario is one of three scenarios for the NDA to consider and wider consultation will take place on each of these options. One option “the waste bounding scenario” involves the treatment of all these materials as waste and is consistent with low uranium market prices and no long-term UK nuclear new build programme. The other scenario, “the Store bounding scenario” places all of the materials into long term storage but

The study does not make recommendations to the NDA and it remains uncertain what strategy will be chosen as there are many complex cost and risk issues associated with each.

A recent report by the Boston Consulting Group indicates that the economics of reprocessing spent nuclear fuel and recycling it via MOx fuel are such that it could be an attractive option (in combination with a repository) for solving the spent fuel management requirements in the US. The study shows that the economics of recycling followed by disposal of high level waste in Yucca Mountain is comparable to the economics of the targeted once-through U.S. fuel cycle, especially considering uncertainties that surround the nuclear fuel cycle, such as capital investment costs and uranium prices. The results of this report suggest that, with the prospect of a growing nuclear power generation sector and concerns regarding proliferation in certain countries, the global prospects for reprocessing/recycling may be on the rise.

Continued operations at THORP & SMP would make a significant difference to the Sellafield jobs profile as shown in the Sellafield Lifetime Plan and could have a negative impact on the accelerated clean-up programme at Sellafield. If THORP & SMP operations jobs were to continue then the resources could not be redeployed to clean-up activities. There would therefore be a requirement to attract new resources into West Cumbria – whilst this would benefit the local economy, BNG reports that it has had difficulties in the past in recruiting certain skill types for clean-up activities.

We understand that a decision on the future of THORP is required within 2 years otherwise it will become more difficult to restart the plant and an immediate investment of £5-10m will be needed to enhance effective operation and life of THORP.

The issue of the continued use of THORP & SMP is likely to be controversial. Any decision regarding future operations will be made by the UK Government and may be influenced by its wider energy policy.

Fuel reprocessing and fuel manufacture are significant “swing” issues in the economic future for West Cumbria. Keeping THORP & SMP operational will not only safeguard many jobs for at least 20 years but will also send important signals that Sellafield has a future as an operational site. This will be helpful in retaining well paid jobs and may be helpful in attracting people into the region.

Recommendations

1. Future of THORP and MOx - complete the review of future of the THORP & MOx facilities at Sellafield and present to Government.
2. Lobbying - decide whether to lobby Government for THORP & SMP businesses to continue beyond 2012.

Part B: Technology and non-nuclear industries

6 Technology background

Part B of this report has mainly been prepared by Quotec with the support of Grant Thornton. It focuses on technology and in particular non-nuclear technology, diversification and innovation issues.

6.1 West Cumbria industry sectors

The West Cumbrian economy has been in decline since the 1990s, though it has experience of relative stability between 1996 and 2002/03. Recent data analysis (CRED September 2005) indicates further net job losses over the last couple of years. The September 2005 issue of Cumbria Economic Bulletin reported that for the second bulletin period in a row, proposed job losses were in excess of new jobs being created (1,388 over 914). Job losses in the two years to September 2005 total 5,000. 75% of the reported job losses have occurred in manufacturing, with 55% of the manufacturing losses relating to the restructuring at Sellafield.

The growth in the corresponding period has had been more in the wholesale and distribution, and hotels and restaurants sectors rather than manufacturing. The economy is dependent upon a small number of large employers – key examples being BNG, Iggesund (paperboard) and Innovia Films, AlcanPackaging (packaging). A majority of these firms are externally owned, with key decisions taken outside of the region or country. A recent example is the announcement from Alcan of the closure in 2007 of the Workington plant, with manufacturing to be consolidated to two French plants instead.

Key factors behind that this widening gap in the sub-regional GVA and national averages are:

- The area's poor relative levels of new firm formation;
- The changing pattern of the industrial structure; and
- An increasing proportion of part-time employment.

6.2 Dominance of Nuclear

Within West Cumbria, 12,000 direct jobs and 2,630 indirect jobs are dependent upon the nuclear industry. This amounts to 22% of West Cumbria's workforce, and 47% of Copeland's. £200-£250m is spent each year with local suppliers and estimated £300m in employee spending power. It is estimated that Sellafield contributes 22% of Cumbrian GVA, 40% of West Cumbrian GVA. The shift to decommissioning is likely to lead to the replacement of high wage jobs within the industry with low wage jobs in lower value added sectors.

NDA have significant capacity in R&D, delivered primarily through Nexia Solutions as their research and technology arm. At Sellafield, Nexia Solutions operates the only facilities in the UK capable of carrying out research and development on highly active nuclear material.

Nexia operate the Technology Centre at Sellafield as a major R&D resource, with the facilities and IP generated owned by NDA. The Technology Centre includes high active cells, plutonium active laboratories, mixed oxide fuel development areas, low active and non-active laboratories, rig hall and the infrastructure to support over 300 technologists. Also in the sub-region, Nexia operate the Windscale Facility at Sellafield (which features a

large shielded facility and is used to support clean-up and active work) and their Off-Site Test Facility at Workington (covering all non-radioactive test rig work).

NDA are encouraging the development of the wider use of the Technology Centre and support, in principle, the NWDA's initiative to consider a US-type National Nuclear Laboratory. As the concept of a National Nuclear Laboratory is developed, it is expected that it will incorporate Nexia and the Technology Centre as part of a non-departmental public body, but this is dependent in part on Government policy decisions.

NDA have recently published their strategy document which encourages group companies to bring forward innovative ideas and confirms that innovation will be a

key factor in considering the award of competed contracts. It also recognises that, to date, R&D activities associated with decommissioning and clean-up in the UK have been carried out by nuclear operators, universities and specialist contractors with only limited collaboration and cross-fertilisation of ideas.

To address this, NDA intend to organise their R&D on a national basis, underpinned by a science and technology roadmap, and delivered against annual statements of R&D needs, risks and opportunities. The first statement identifies relevant challenges, to be addressed via a competitively tendered process.

6.3 Universities

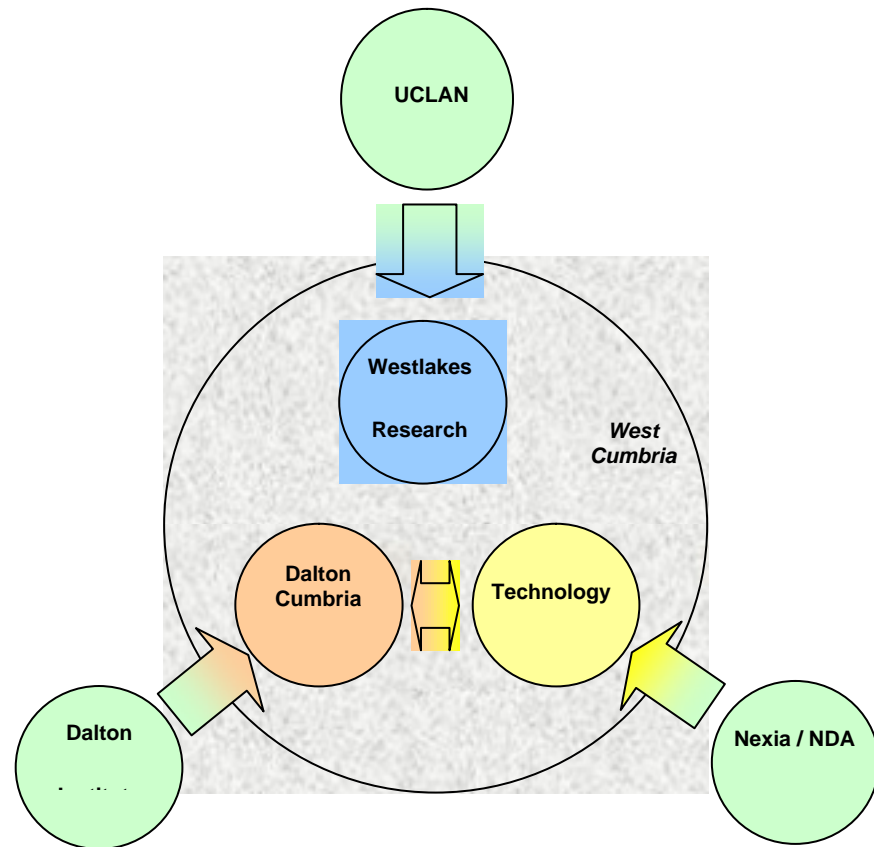
In the university sector, strengths in regional universities (including the University of Central Lancashire, the University of Lancaster, and the University of Manchester / Dalton Nuclear Institute) have been well characterised, but there is little university research capacity in the sub-region itself. The emerging University of Cumbria (and any future University of West Cumbria) is expected primarily to have a teaching remit, with relatively little IP-generating research.

The Dalton Nuclear Institute, launched in 2005, provides a focal point for the University of Manchester's nuclear research activities. Dalton collaborates with BNFL through two University Research Alliances (URA's) in the areas of radiochemistry and materials performance. Dalton also coordinates the Nuclear Technology Education Consortium (NTEC) of UK universities and research institutes (including Westlakes Research Institute), which aims to address the UK's nuclear skills shortage.

Westlakes Research Institute, now part of the University of Central Lancashire, has well-established teaching and research capabilities in environmental science, health and epidemiology. However most of its research is conducted under contract to commercial clients, with most of the associated IP in turn held by those clients.

The NDA and the University of Manchester have proposed that a Nuclear Institute should be established, based at the West Lakes Science and Technology Park. This new technology research facility, under the working title of the Dalton Cumbria Facility, would aim to complement the activities of the Westlakes Research Institute and contribute to the development of the Science Park.

Research Capacity (existing and developing)



7 Need for diversification

7.1 Background

West Cumbria has a particularly poor record in terms of the business start up rate. While numerous factors contribute to this, the opportunities and expenditure derived from Sellafield and the nuclear industry have been described as a "security blanket" or "comfort zone". One of the reasons given for the low start up rate is the fact that employment opportunities within the nuclear industry are comparatively attractive (in terms of earnings, security, type of work etc.). Unfortunately, this does not necessarily imply that start up numbers will increase significantly as employment opportunities decline within Sellafield, as developing an entrepreneurial culture will require more than a lack of alternative opportunity.

Inward investment again has tended to be more of the prospective nuclear supply chain and includes offices of larger companies. Attraction of inward investment in other innovative sectors has remained a challenge.

Enterprise needs the full mix of land, skilled labour, top management, investment funds and increasingly knowledge. West Cumbria does not as of now offer the diversified mix of the above requirements.

The primary issue for West Cumbria, in terms of non-nuclear innovation and technology, is the domination of the nuclear sector and the relatively low levels of R&D intensity outside of it. The successful exploitation of innovation and technology is likely to depend on a combination of maximising the potential of existing capacity and on capturing spin-out opportunities arising from nuclear technologies.

Decommissioning of Sellafield has highlighted risks of dependency on a single sector. It is essential that any future strategy and action plans make a pro-active, determined and long term effort to diversify the West Cumbrian economy. Diversification is recognised as a key determinant in the growth of any economy. The legacy from the nuclear industry provides a strong base to begin this process creating applications.

7.2 Historical Initiatives

Historical attempts to exploit technology from Sellafield for non-nuclear applications have met with limited success, but it is expected that the level of NDA investment will lead to significant future opportunities for spin-out activity. This activity should be informed by existing good practice elsewhere, from both inside and outside the nuclear sector (see case studies of MRC Technology, the Oxford Innovation System, Savannah River, Moulinex and Danone in the Annex).

Previous studies have considered the potential for sub-regional companies in the nuclear supply-chain to diversify into other sectors. A BNFL study identified historical activities to encourage diversification and grouped them into 3 broad categories:

- 'direct diversification' in which a company encourages the exploitation of technology, IPR and other assets to develop non core businesses;
- 'less direct diversification' in which a company supports employees in establishing new businesses and suppliers in developing new products and services for existing and new customers and markets; and

- ‘area diversification’ in which a company supports local regeneration and economic development initiatives.

BNFL’s support for these 3 categories of diversification has met with limited success. This is due in part to the low level of innovation which is characteristic of a local economy dominated by a major employer, but also to other regional economic factors and the limited number of alternative activities. BNFL identified a number of success factors for future diversification activities, based on their experience and other success stories, including:

- the use of strategic partnerships to ensure a commercial perspective in exploiting proprietary technologies;
- acceptance of a greater responsibility where firms are dominant employers within an area;
- taking early action ahead of restructuring and run down in employment;
- working through partnership with local authorities and other agencies to ensure initiatives are responsive to local need and opportunity;
- building on technological strengths and skills to attract new industries; and
- supporting a wide range of initiatives to create strength through diversity.

Amongst other recommendations, the BNFL study recommended the following actions:

- clarification of IPR ownership and a continued commitment by the NWDA and BNFL to continue to seek opportunities to exploit or transfer IPR outside the nuclear industry
- public agencies to continue to foster links between the NDA/BNFL and its industry clusters notably in technologies such as bioremediation and clean up
- to explore the feasibility of engaging a major partner organisation to assist in the commercial exploitation of technologies outside the nuclear industry (along the lines of QinetiQ / Carlyle Group – see Annex)

Since the study was completed, there has been little activity on IPR and on considering a commercial partner to assist with its exploitation. Whilst technology audit and brokerage are currently resource-constrained and moving forwards relatively slowly, some activities are ongoing, including:

- Westlakes Renaissance are undertaking a pilot project to support the nuclear supply chain (which NWDA has recently issued a tender to expand), which will have some diversification support.
- West Cumbria Development Agency has proposed a Technology Transfer project, to support nuclear sector employees in setting up spin-offs.
- Envirolink, the Northwest ETS cluster body, have also been active in introducing ETS companies to nuclear opportunities.

7.3 Venture Funds / Incubation

There have been a number of funds which have been available to companies in the sub-region, including the West Cumbrian Development Fund, BNFL Enterprise Ltd

and the Harris Knowledge Fund. Of particular interest is Westlakes Ventures, which was established with significant funding and with access to the Innovation Centre at Westlakes Science Park. The fund did successfully support some spin-outs, but did not generate sufficient income to sustain operations and is now dissolved.

Campus Ventures, at one time one of the biggest and most successful university incubators in the UK, established an incubator in Westlakes Science Park, with support from the NWDA. This provided managed workspace and support and advice to start-ups, with a particular focus on energy and environmental service industries. However in 2004 Campus Ventures was forced into administration after government auditors ruled that it was no longer eligible for grants from the European Regional Development Fund.

One general observation is that the low volume of spin-out opportunities available, combined with the typically low success rate of new ventures, makes it challenging for any venture fund / incubator to achieve the deal flow needed for success.

8 Technology Trends

8.1 Global Trends

According to the RAND Corporation, the world is in the midst of a multidisciplinary technology revolution that shows no sign of abating in the near- to mid-term future. By 2020, this revolution could bring important changes in economic development, health, environmental quality, and military power.

Advances in biotechnology, nanotechnology, materials technology, and information technology have been occurring at an accelerating pace, with the potential to bring about radical changes in all dimensions of life. The pace of these developments shows no sign of abating over the next 15 years, and it appears that their effects will be ever more remarkable. The technology of 2020 will integrate developments from multiple scientific disciplines in ways that could transform the quality of human life, extend the human lifespan, change the face of work and industry, and establish new economic and political powers on the global scene (see Annex for more information).

This convergence of technologies is expected to have a substantial impact on companies and markets in the future. Some convergent technologies are already hitting the marketplace, for example optical microelectromechanical systems (MEMS). The traditional barriers between industry sectors are likely to be eroded or restructured, with new industry boundaries emerging. Any proposed initiatives in West Cumbria should take account of this and consider potential opportunities in convergent technologies.

8.2 European Framework Programmes

The Framework Programmes (FPs) are the European Union's main instruments for funding research and development. FP7 will be fully operational as of 1 January 2007 and bundles all research-related EU initiatives together under a common roof.

The broad objectives of FP7 have been grouped into four categories: Cooperation, Ideas, People and Capacities. For each type of objective, there is a specific programme corresponding to the main areas of EU research policy.

Key themes under the Cooperation specific programme will include:

- Health
- Food, agriculture and biotechnology
- Information and communication technologies.
- Nanosciences, nanotechnologies, materials and new production technologies
- Energy
- Environment (including climate change)
- Transport (including aeronautics)
- Socio-economic sciences and the humanities
- Security and Space

Importantly, the Specific Programme on 'People' provides support to researchers, supporting their career development and mobility by means of an expansion of the existing 'Marie Curie' exchange programme. This mechanism could be exploited in order to attract researchers to the sub-region and particularly to any cornerstone research facility that is developed.

The specific programme on 'Capacities' will focus on improving research capacities throughout Europe. The main actions include support to research infrastructures, research for the benefit of SMEs, regional research-driven clusters, help for convergence regions to unlock their full research potential, 'Science in Society' (activities aimed at strengthening the link between science and society in general) and horizontal activities of international cooperation. Again this programme could be exploited to the benefit of the sub-region.

8.3 The UK DTI Technology Programme

The DTI's Technology Strategy initially encompassed six medium term strategies in Key Technology Areas, which were launched in April 2006. Subsequently, as the DTI's Energy Review has continued, Energy has been added as a seventh priority area. The strategies, developed in consultation with business, provide a technology focus and create a dialogue for taking forward activity in areas where UK business can succeed. The strategies build on the Technology Strategy Board's Call to Action document published in November 2005 and highlight the key technology priorities to enable the development of the UK's position.

There are elements of all seven Key Technology Areas which may be relevant to the sub-region e.g.

Advanced Materials

- Materials for energy production and distribution (re conventional and sustainable energies)
- Materials in the development of sensors and diagnostic technologies
- Multifunctional materials, including damage tolerant, self-diagnostic, self-healing materials

Information and Communication Technologies

- 'Key developments in telecommunications' and 'Information Security' (re any remote monitoring capability)

Electronics and Photonics

- Advances in sensor technology for security, and 'Environmentally, electronic and photonic technologies will provide solutions to climate and pollution monitoring.'

Sustainable Production and Consumption

- Resource efficiency, waste and pollution
- Water and wastewater (including desalination technologies)

Design Engineering and Advanced Manufacturing

- Design, simulation and modelling, validation and advanced engineering research
- Advanced manufacturing technologies and processes (including robotics)

Bioscience and Healthcare

- Improved diagnostic and therapeutic equipment and techniques (with possible relevance to epidemiology and other healthcare science strengths)

Emerging Energy Technologies

- Low Carbon Energy Technologies- includes support for a relatively broad portfolio of low carbon technologies, addressing a range of renewable technologies including hydrogen and fuel cell technologies.

The priorities for the Autumn 2006 and Spring 2007 Collaborative R&D competitions under the Technology Programme have now been announced and are included in the Annex, along with further details on the Technology Programme itself.

The Technology Programme also includes regional support in the following areas:

- Regional support for Technology Programme Implementation, including support for capital programmes and specialist demonstrator facilities
- Regions as Partners in the Technology Programme, particularly for projects showing relevance to regional objectives
- National-regional collaborations, including regional support for projects such as:
 - i. Astraea unmanned aerial vehicle project
 - ii. Materials Knowledge Transfer Network

DTI data on spending on the Technology Programme by region or sub-region is not currently available. However regional development agencies may be able to access this data via the Regional Innovation Liaison Group.

8.4 The UK Foresight Programme

The UK Government Foresight programme aims to provide challenging visions of the future, to ensure effective strategies now. The current round of Foresight, launched in April 2002, operates through a fluid, rolling programme that looks at 3 or 4 areas at any one time. The starting point for a project area is either: a key issue where science holds the promise of solutions; or, an area of cutting edge science where the potential applications and technologies have yet to be considered and articulated. Particular topics since 2002 are:

- Cognitive Systems
- Flood and Coastal Defence
- Brain Science, Addiction and Drugs
- Cybertrust and Crime Prevention
- Exploiting the Electromagnetic Spectrum
- The Detection and Identification of Infectious Diseases
- Tackling Obesities: Future Choices

Prior to 2002 Foresight generated reports in a wide number of technical areas and in cross cutting issues. Particular priorities to come out of the earlier rounds of Foresight included nanotechnology, information technology, Biotechnology, sensors (in all forms) energy technologies and materials technology.

8.5 NWDA Strategy

At a regional level, the NWDA Regional Economic Strategy identifies two transformational actions which are of particular relevance to the sub-region, namely the development of cluster programmes in priority areas, and the development of an integrated economic plan for West Cumbria (with Cumbria Vision & West Cumbria Task Force tasked with delivery).

NWDA has identified 6 key sectoral areas:

- Biomedical: biotechnology, pharmaceuticals and medical devices
- Energy and Environmental Technologies
- Advanced Engineering and Materials: Chemicals, Aerospace, Automotive, Advanced Flexible Materials
- Food and Drink
- Digital and Creative Industries
- Business and Professional Services

Of particular relevance are the Energy and Environmental Technologies sectors. In April 2006 NWDA produced the 'Northwest Nuclear' report, which included a recommendation to help companies to diversify out of the nuclear sector.

The NorthWest Science Strategy, in addition to the references to Renewable Energy mentioned above, also considers Environmental Technologies. The report tasks the North West Environmental Alliance with becoming a world leader in key areas of environmental science and technology, and with transferring knowledge and technology to the regional sector. The report suggests an early focus on environmental modelling and monitoring, and also covers Cleaner Technologies and Regeneration.

9 Relevant Technologies

Analysis of sub-regional capabilities (through discussion with stakeholders, review of previous studies and a structured brainstorming activity) identified the following potential technology opportunities:

- Environmental sciences
- Geological / hydrological services
- Air pollution / atmospheric dispersion modelling
- Marine and freshwater quality monitoring
- Radiological emissions
- Waste management
- Healthcare sciences
- Radiation genetics
- DNA / plasma sampling
- Epidemiology
- Population monitoring
- Occupational health and medical statistics
- Sickness absence
- Non-nuclear decommissioning and remediation
- Automation and robotics
- Remote monitoring
- Remote working capacity
- Future energy technologies (fuel cells / hydrogen generation / renewables)
- Fabrication capability for a highly controlled environment
- Industrial processing capability
- Security
- Industrial safety
- Risk assessment
- Concrete technologies
- Nanotechnology toxicology

In order to establish the most relevant areas for West Cumbria to capitalise on, a set of transparent criteria are needed. These should relate to the market opportunity and the strengths of the sub-region, taking account of possible future strategic developments.

In addition, cluster development is promoted by the DTI and is widely seen as a powerful way of enabling economic development and regeneration (see Annex). DTI have identified three key factors in the development of successful clusters:

- Functioning networks and partnerships
- A strong innovation base
- A strong skills base

Taking these into account, the five proposed assessment criteria for technology themes for the sub-region are:

- Market (e.g. opportunities, access)
- Skills Base
- Innovation Base (e.g. knowledge, IP, R&D activity)
- Infrastructure (e.g. regional strengths, existing networks and partnerships)
- Strategic Need (considering the value of longer-term opportunities and developments)

An initial mapping of the identified technologies against these criteria is given in the figure below.

	Market	Skills Base	Innovation Base	Infrastructure	Strategic Need
Non-nuclear decommissioning and	✓✓	✓✓	✓	✓	✓
Automation and robotics	✓*	✓✓	✓		✓
Remote monitoring	✓*	✓✓	✓		✓
Remote working	✓	✓*		✓*	✓
Future energy technologies	✓		✓		✓
Fabrication capability for a highly controlled environment	✓*	✓			
Industrial processing		✓✓			
Security	✓*	✓			
Industrial safety	✓*	✓			
Risk assessment	✓*	✓			
Concrete technologies	✓*	✓	✓*		
Nanotechnology toxicology	✓*	✓	✓	✓	✓✓

This mapping identifies a number of areas where further research might identify additional opportunities which the sub-region should consider. However, on the basis that any technology opportunity which provides a positive or strong positive correlation against two of the assessment criteria should be given priority, the five themes which have the most potential for West Cumbria are as follows:

1. Non-nuclear decommissioning and remediation
 - To focus on:

- Offshore installations
- Fossil power generation plants
- Military facilities (e.g. Derwent Forest project)
- To capitalise on NWDA RES identification of environmental technologies as potential transformational project for the region.
- To build on established support mechanisms, such as Envirolink Northwest and the Technology Partnership Initiative
- To build links to national networks e.g. IPMnet Knowledge Transfer Network
- The UK market for the assessment and remediation of contaminated land alone was £942M in 2004 (a 20% increase from 2000), and real term growth of 19% is anticipated between 2004 and 2009. The broader market for environmental technologies in the UK is ca. £15BN and is set to grow to £21BN by 2010. High growth rates are predicted in many sub-sectors, particularly waste management, contaminated land remediation, environmental impact assessment and renewable energy as well as the sustainable use of resources (including water) .
- The Nuclear Opportunities Group have also identified Non-Nuclear Decommissioning and Environmental Restoration as priority themes, estimating a global market for environmental restoration of £515bn. They also identify the potential for the UK to develop a long term UK green ship recycling industry, with an interesting opportunity for West Cumbria to develop this as a specialist sector using its existing port infrastructure. However this would be subject to high investment, planning and public concerns, and there is a lack of the necessary dry dock capacity in the sub-region.
- A joint report by NIA and Optimat identifies the same opportunities for the UK as a whole, with the same ranking of priorities.

2. Future energy

- To focus on energy storage technologies which are relevant to the ‘always on’ nature of nuclear electricity generation. These are likely to relate to hydrogen and fuel cells, and could build on previous research into uranium as a fuel cell catalyst.
- To consider diversification opportunities from any National Nuclear Laboratory or other ‘cornerstone’ research centre
- To capitalise on the NWDA Science Strategy identification of renewable energy as a major opportunity for the Northwest
- To capitalise on incentives for renewable energy arising from the Energy Review e.g. the Environmental Transformation Fund
- To complement the recently announced Joule Centre for Energy Research, the Northwest’s first centre for the development of sustainable energy technologies. It is a £10m centre, funded by the NWDA, which will pioneer low-carbon technologies, including new wave, tidal and micro-hydro technologies. Its research will also focus on developing a host of new ‘smart’ technologies aimed at improving energy efficiency in the home and for industry.

- To recognise a recent ADAS report which identified the North West as the region best placed to adopt and harness renewable technologies, focussing on wind energy in the sub-region.
- To consider the practice of the British Columbia Energy Technologies Cluster in promoting and developing capabilities in fuel cells and hydrogen technologies, including the Hydrogen Highway promotional initiative . (see annex, item 21.)

3. Remote monitoring and handling

- Based on expertise in remote sensing and robotics in controlled environments.
- Would require robust and high-speed/capacity telecommunications links.
- Possibly to consider inventory tools and systems develop in nuclear sector.

4. Remote working

- To promote remote working, recognising the number of relatively high-income remote workers who are based in the sub-region
- To support state-of-the-art communications infrastructure development, including wireless provision where appropriate
- To provide financial incentives for individuals and organisations to be based in the sub-region, accompanied by appropriate marketing and training provision
- Supported by the NWDA Digital Industries cluster, reflecting the acknowledgement in the September 2005 ICT strategy that the North West is below its target for people working or learning from home.
- To consider the Yorkshire Forward ICT cluster approach through Digital Yorkshire, which provides support to a range of geographical and sectoral business networks.
- To capitalise on the related profile given by the planned Whitehaven digital TV switchover.

5. Nanotechnology toxicology

- Based on strengths in healthcare sciences and dispersion modelling of atmospheric particulates (including those at Westlakes Research Institute)
- Applied to the dispersion of nanoparticles in the human body and their potential effects
- Capitalising on a background of growing concerns over potential health problems associated with nanoparticles in consumer products .

10 Suggested Initiatives

10.1 Introduction

Previous studies have identified a range of possible enabling activities, to provide cross-cutting support which could underpin all of the technology themes identified above. Key factors in the success of these enablers include:

- The need for a broad range of mechanisms to support and promote the generation of new products/processes and companies, through providing incentives and addressing barriers.
- The need for long-term support and patience from sponsoring bodies, in order to achieve sustainable outcomes.

The Nuclear Opportunities Group report has pointed to mechanisms that should be considered against four topic areas i.e.

- Supply Chain
 - WCBC development
 - Teaming Up programmes
 - Mentoring of smaller companies
- Innovation
 - IPR review of former BNG Intellectual Property
 - West Cumbria Technology Transfer project concept
 - Area based economic development
 - Increasing business start-ups
 - BNG Skills Audit
 - Wider infrastructure to support cluster development
 - West Cumbria International Conference Centre
- Diversification
 - Encourage spin-outs through developing a ‘Technology Transfer’ support model’
 - Dowry contracts to underpin start-ups

Underlying the success of many of these mechanisms is the need to promote links to Knowledge Intensive Organisations (KIOs), who have an important role in generating IP and skills to underpin the innovation process (see Annex). Successful examples on leveraging links to KIOs in commercialising IP include MRC Technology and the ‘Oxford Innovation System’ (see Annex).

One approach to promoting such links is to improve access to funding for collaborative R&D, either nationally (through the DTI Technology Programme – see Annex) or regionally (following the example of the Yorkshire Forward Industrial Research and Development Award for Large Companies – see Annex).

DTI Energy Group could be lobbied by West Cumbria for more support for decommissioning research, but they may argue that this is already in place through the NDA. More specifically, the DTI Technology Programme could be lobbied for support for a Knowledge Transfer Network in the nuclear supply chain, for collaborative R&D funding for technology spin-outs from nuclear, and for support to help local companies access grants through the technology programme. The sub-region could also benefit from EU or DTI support for diversification, taking advantage of the People and Capacities programme under FP7.

10.2 Initiatives

Taking into account the priority technology themes identified above, along with the infrastructural enablers that will be needed to deliver them, the following initiatives are proposed:

10.2.1 Diversification Agency for Nuclear

The Agency would consider both existing IP within BNFL and any IP arising from NDA decommissioning activities, and would be assigned exclusive rights for non-nuclear applications, in order to really capitalise on the wealth of technologies developed in the nuclear sector. It would identify, characterise and exploit these non-core or diversification opportunities. Its scope would extend beyond Sellafield, to include other sites including Culham, but the Agency would be based in West Cumbria.

Successful models for commercial exploitation of IP arising from the science base can be seen in Isis Innovation in Oxford and in MRC Technology (see case studies in Annex). These examples point to the benefit of having sophisticated investment and business management in place from the outset. The Agency could achieve this by operating in strategic partnership with a commercial organization, which would provide the necessary private sector funding and management capability (see Annex for QinetiQ case study). This would allow the Agency to work towards becoming a self-sustaining organization, with flotation providing an exit route for public investment, possibly within 5 years.

The development of the Agency would be supported by an initial audit of IP in the nuclear sector, in order to identify opportunities for IP exploitation via the most appropriate mechanisms e.g. spin-out, licensing, out-sourcing, joint ventures. Although these exploitation routes would vary from case to case, the Agency would work closely with the NWDA to create high value knowledge-based employment and enterprises in the sub-region.

10.2.2 Technology and Innovation Centre

The Technology and Innovation Centre would provide resources (in terms of access to specialist facilities, equipment, staff and funding) to support high-growth SMEs in the sub-region.

The Centre would focus on the technology themes identified in this study ie

- Non-Nuclear Decommissioning and Restoration (recognising the potential for a stand-alone ‘Centre for Environmental Restoration’)
- Future Energy
- Remote Monitoring and Handling
- Nanotechnology Toxicology

Further research, including more detailed technology foresighting and forecasting, could identify and define other technology themes which the Centre should address.

Whilst maintaining these areas of technology focus, the Centre would remain accessible to all high-growth SMEs in West Cumbria. In order to promote this accessibility, the Centre would require the development of an Access fund, providing financial support for SMEs in accessing services and facilities provided by the Centre (see Annex for details of the National Biomanufacturing Centre Access Fund).

The Centre would need to work closely with other bodies, including the National Nuclear Laboratory, Westlakes Research Institute and neighbouring Universities, in order to minimise duplication and to complement their activities. The Technium network in Wales (see Annex) highlights the need to work in close partnership with the science base in order to maintain leading-edge capabilities and to deliver specialist academic support to SMEs. A close partnership would also be needed with the Nuclear Diversification Agency, which could licence relevant IP to the Centre.

10.2.3 National Nuclear Laboratory Diversification Unit

The proposed National Nuclear Laboratory should also address the diversification agenda, through the formation of a Diversification Unit. This Unit would ensure that the laboratory maintained an element of diversification in its scope, and would work closely with the Nuclear Diversification Agency to enable the exploitation of non-core opportunities.

The Unit would capture spin-off opportunities, and would link to the Technology and Innovation Centre to support and develop these. It would also seek to maximize NNL spend in the local non-nuclear supply chain.

The Unit could usefully draw on the model of the Pacific Northwest National Laboratory (PNNL) in the US. PNNL is a successful example of a government-owned commercially-operated laboratory, which has expanded from initial nuclear-focused work to address environmental technology, health, energy, advanced materials, computer science and national security. The operator of the site, Battelle, place emphasis on supporting economic development and technology development, with the aim of transferring government-funded research into private businesses.

One operating model for the Centre would be as a government-owned but commercially-operated (GOCO) body, following examples such as the National Physical Laboratory, the National Biomanufacturing Centre, or ULAEA. Under this arrangement, the management of the Centre would be tendered to organisations with strong interests and capabilities in the relevant technology areas.

10.2.4 High Growth Company Support Programme

This programme would provide a range of support mechanisms to all high-growth companies in West Cumbria, in order to promote the development of the sub-regional economy and the diversification of the supply chain. It would be complementary to the Technology and Innovation Centre (which could deliver some elements of the programme), providing incentives and addressing existing barriers to successful company growth.

10.3 Case Studies

10.3.1 UK AEA

UKAEA Culham undertook a successful exercise to look at underlying skills and potential applications. This identified expertise associated with gyrotrons, which was considered more closely to identify underlying expertise in high power microwave technology. Potential applications in microwave oven technologies were then considered.

The development of the programme would be informed by an initial audit of the skills of the sub-regional workforce. This would consider in detail the skills sets and possible

applications, going beyond usual assessments and considering underlying functional skills (see UK AEA case study).

The range of activities for innovation support provided under the programme would include:

- Training in business skills
- Provision of mentoring and networks, providing peer support e.g. 'First Tuesday' meetings
- Guaranteeing initial revenue for start-ups ('dowry' funding)
- Incentives for staff to venture out from comfort blanket of nuclear funding e.g. 'commercial sabbaticals' (building on the New Horizons scheme and Technology Transfer project)
- Support for accessing collaborative R&D funding (from DTI Technology programme or by establishing model similar to Yorkshire Forward large company grants)

10.3.2 Airbus

A workshop was held in Toulouse, France, to identify potential interactions between the aerospace and tourism/leisure sectors. It was supported by the regional development authority, using funds from the EU to support employment generation.

Tourism/leisure delegates submitted their unmet needs ahead of the workshop e.g. 'how can we prevent the surrounds of swimming pools becoming slippery and dangerous?', 'how can we prevent delays in boarding aircraft caused by too much hand luggage?

Aerospace scientists were given notice of the problems, which ran into several hundred, and invited to put forward outline solutions ahead of the workshop. The workshop was divided up according to groups of common interest problems and was followed by more intensive brainstorming on the best ideas.

The outputs included several new and successful products and some start up companies.

- Support for accessing FP7 funding (possibly following OneNorthEast's programme for support for access to FP6)
- Remote working support, via financial incentives, training and marketing, and with support for communications infrastructure development

In addition to innovation support, the programme would also provide support for diversification, including:

- Local to local
 - Facilitate interactions between sectors e.g. nuclear to leisure / farming
 - Use pre-planned workshops with pre-identified topics of interest (see Airbus case study). A successful outcome is likely to be dependent on obtaining an appropriate level of resource to ensure sufficient pre-planning, as well as ensuring an appropriate mix of delegates.
 - Provide management advice and client support including one-to-one support for new diversification market/feasibility studies.
- Local to outside region

- To include the provision of incentives to ensure that companies remain in region

The programme would seek to leverage DTI and EU support for diversification, recognizing that as part of FP7 there may be relevant funding programmes under ‘People and Capacities’.

The programme would be delivered by a team of high-quality industry / cluster specialists, with expertise relevant to the sub-regional supply chain. This team would combine elements of the Manufacturing Advisory Service and the Technology Promoters scheme, but operating with a sector focus. They would have a brief to consider international markets and sources of funding, reflecting the fact that high level suppliers to the nuclear industry in West Cumbria are international in their activity, but the local supply chain is not.

11 Way forward

In order to implement the initiatives identified above, the following immediate next steps are recommended.

11.1 Nuclear Diversification Agency Feasibility Study

- To undertake a study into the feasibility of a Nuclear Diversification Agency, to consider the scope, method of operation and mechanism needed.
- To consider existing models, including MRC Technology and QinetiQ.
- To investigate best practice in promoting diversification in the remit of other national laboratories (to include the US Pacific Northwest National Laboratory)
- To consider how this could be applied to the proposed National Nuclear Laboratory.

11.2 Audit of IP developed in the Nuclear Sector

- To conduct an audit of IP developed in the nuclear sector, particularly that held at Sellafield
- To consider the most appropriate routes for exploitation
- To focus on diversification opportunities that can benefit the long term sustainability of businesses in the sub-region.

11.3 Technology and Innovation Centre Scoping Study

- To undertake a study into the feasibility of a Technology and Centre, to consider the scope, method of operation and mechanism needed
- To undertake more detailed assessments of potential technology themes
- To consider existing models, including Technium.

11.4 Developing a Technology and Innovation Strategy and Culture

- To examine the costs and benefits of promoting an Innovation Culture in the sub-region looking at models in other UK regions and the US
- To develop ideas for a Nuclear Technology Knowledge Transfer Network to take forward technology roadmap development for the sector and to influence the national technology strategy and collaborative R&D programme
- To develop a wider technology strategy appropriate to the sub-region.

11.5 High Growth Company Support Programme Scoping Study

- To consider in more detail best practice across all the proposed support mechanisms
- To use this best practice to develop a set of initiatives for the sub-region.

11.6 Skills Audit

- In support of the High Growth Company Support Programme, to carry out an audit of skills held by the sub-regional workforce (with particular emphasis on Sellafield), to identify the underlying functional skill sets
- To consider how these underlying skills could be applied to support diversification.

11.7 Pilot Diversification Workshop

- To carry out a pilot diversification workshop, to focus on one theme (probably tourism)
- To assess the outputs and impact and consider applicability to other sectors.

12 Annex

12.1 Cluster Development

In recent years ‘cluster’ thinking has become one of the most influential concepts in local and regional development practice and research, providing a useful framework for policy makers. Clusters are often considered an attractive economic development strategy as they can encourage the creation of new companies, new products and new employment opportunities in high skilled, high wage type jobs. Indeed the cluster concept has become a powerful economic development and regeneration tool in the UK since the publication of the Competitiveness White Paper in 1998, where explicit reference was made to the potential role that clusters play in fostering both national and region competitiveness.

In the UK, the DTI has led work in recent years on how best to establish effective mechanisms for cluster development, publishing “A Practical Guide to Cluster Development” as an evidence-based guide targeted at those engaged in the delivery of cluster policy at the local level. It is intended to provide a valuable ‘What Works’ information source.

The DTI’s Guide defines a number of critical success factors that are favourable for the growth of clusters. It homes in particularly on three specific factors:

1. The presence of functioning networks and partnerships that generate formal and informal flows of knowledge and information;
2. A strong innovation base, with supporting R&D activities where appropriate - with innovation being a key driver of cluster development; and
3. The presence of a strong skills base – that provides a range of appropriate skills and abilities.

The DTI identifies an important role in the cluster development process played by factors such as an adequate physical infrastructure, the presence of large firms, a strong entrepreneurial culture and access to sources of finance for business start up and growth.

12.2 The Innovation Process

Innovation is the generic term for the successful development of a new idea – a new product or service, or the production and bringing to market of that new product or service. An important area in the study of innovation is concerned with understanding the nature of the innovation process – what innovation is and how it is delivered. This in turn requires an understanding of the actors involved, and what motivates them.

Innovations can be broadly classed as institutional innovation or technological innovation. The former describes improvements in the way that institutions operate or the creation of entirely new organisations. Technological innovation involves changes which can be measured directly, analysed and characterised. Technological innovation can occur in products and processes.

There are varying degrees of innovation described as incremental, radical and disruptive. An incremental innovation is a small change, a minor improvement along the lines for which the product or process is currently valued. A radical innovation is a dramatic improvement along those same lines, while a disruptive innovation represents a transition to a new technology or

a new paradigm. A disruptive innovation often results in changing the way that people think about the product, process or institution, and in developing new characteristics that are subsequently expected by users.

Technological innovations are often considered to follow a general progression from research, through development to full commercialisation and eventual obsolescence. The core process by which this occurs is sometimes referred to as the ‘innovation cycle’. This process is comprised of several steps: basic research, applied research, experimental development, commercialisation and diffusion. However, this does not imply that each innovation must go through each of these steps or that the steps occur sequentially. Each stage influences the other stages and different stages can often coexist with one another.

Under the Frascati Manual Definition of R&D (as used by HM Government)

R&D is defined in terms of research and experimental development. Research is further divided into basic and applied research. R&D covers the following related activities:

Basic Research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.

Applied Research is also original investigation undertaken in order to acquire new knowledge, but directed primarily towards a specific practical aim or objective.

Experimental Development is systematic work, drawing on existing knowledge gained from research and/or practical experience, that is directed to producing new materials, products and devices; to installing new processes, systems and services; or to improving substantially those already produced or installed which will lead to an extension of knowledge.

Commercialisation generally requires further injections of finance and acceptance in the market, as well as responding to the reactions of existing firms, technologies and customers.

Diffusion signifies ultimate acceptance of the innovation as it spreads into industry.

The difficulties in making the transition from applied research to a product/process, in the market, have been called the ‘Valley of Death’. At this stage the project is often too uncertain or small scale to attract major investment from, for example, venture capitalists and therefore relies on seed money, often from Government matching funds, university development programmes or so-called business angel investors. This is a particularly challenging stage in developing a technological innovation.

There are many individual and institutional players involved in innovation. The three primary actors are considered to be the Government, industry and universities, and each of them has unique motivations and limitations to their involvement.

Universities – Universities provide two main inputs to the innovation cycle: basic and applied research and human capital. University research does not implicitly lead to innovation although it does make a contribution to the innovation process. Much more is required than simply increased research in order to turn a new invention or discovery into a commercially attractive innovation. Universities are one node in an interconnected network of innovation players.

Industry – Once the individual technologies and components are assembled into a new product/process, then a key step is the demonstration of the viability and functionality of the product/process. Whilst universities are focused upon research, industry is focused upon

product or service development. In practice this means that the majority of demonstration work is conducted in industry. Businesses around the world are changing the way that they conduct research and development. For a mixture of commercial and business reasons, companies are cutting back their corporate laboratories and building collaborative research programmes with other partners in both industry and universities. Industry seeks to identify research, from the science base or elsewhere, which it can then develop to create a commercially viable product or service.

Government – The principle motivation for Government intervention to promote innovation is the importance of innovation and R&D in maintaining high and stable economic growth. The key traditional role for Government has been as the sponsor of university research, leaving the development and commercialisation of new ideas to the private sector. The second role of Government (or more precisely the legal system) has been to provide a framework of intellectual property rights that ensure that innovators can receive sufficient returns from the commercial development of ideas. Governments also have a role in providing traceability for measurements and underpinning the development of standards for trade.

12.3 The Triple Helix Model

The Triple Helix model considers the increasing importance of the interactions between government, industry and universities in the innovation process. As companies become more technologically advanced, their activities in research and training can become more university-like. Equally universities increasingly take an entrepreneurial approach and are more open to considering other sources that can contribute to the creation of new knowledge. At the same time government can be seen to be moving away from its historical regulatory role and towards addressing market failures and supporting entrepreneurship.

12.4 The Open Innovation Model

Open Innovation is a concept put forward by Henry Chesbrough, moving away from an internally oriented and centralised approach to R&D. Rather than relying entirely on internal ideas in order to deliver new products and processes, the open innovation approach makes use of both internal and external sources of ideas, allowing companies to find the most appropriate business model.

12.5 Non-Cumbria Spin-Out Case Studies

Walsh Scientific

Walsh Scientific is a successful spin-out from UK AEA at Culham, providing diagnostic services to the fusion site. It has benefited from the high international standing of fusion research at Culham, with the demands of plasma diagnostics near the edge of current technical capabilities. This gives the company the opportunity to identify, develop and prove new diagnostic concepts.

Walsh have collaborated with Culham on the development of a “next generation” laser diagnostic system that will take the understanding of plasma physics to a higher level. The company is now expanding operations to laser diagnostics and consultancy projects at some of the world’s leading research laboratories, particularly in the field of high-temperature plasma diagnostics. They are also applying their experience to other markets through the development of a range of optical products such as radiation tolerant optics for the fission industry.

Innoval Technology

Innoval Technology is a materials consultancy formed as a buy-out from Alcan’s Banbury Research Centre, specialising in light metal applications and providing technical expertise, contract research, analytical and testing services.

They have capabilities in modelling – computer simulation and software development, for process engineering, process stages or entire factories – with parallels to areas of expertise in West Cumbria.

The success of Innoval benefited strongly from a guaranteed initial workload from their parent organisation.

12.6 National Biomanufacturing Facility

The National Biomanufacturing Facility (NBC) aims to help biotech SMEs to develop and manufacture a wide variety of novel biopharmaceutical medicines for early phase clinical trials. The NBC is intended to address a perceived market failure, where the volume of manufacture required by biotech SMEs is very small and not commercially viable for contract manufacturing organisations (CMOs) to provide.

Ultimately, the NBC aims to generate increased wealth and employment opportunities for the local area, by attracting new companies as well as providing assistance for local companies to develop their own business.

The £30m facility has training and education as a secondary focus, with the operator intending to employ 10 staff per year, providing them with hands-on specialist training. It is intended that these staff will become candidates for employment for the SMEs accessing the NBC.

In scoping the facility, the NWDA identified the need for an access fund, and just under £3m has been made available to assist qualifying SMEs (particularly in the local area) to purchase services from the Centre.

Over the lifetime of the initiative the NBC expects to support around 90 companies, and the Gross Value Added of the initiative is expected to exceed £100m, primarily in terms of growth of the companies involved.

12.7 Technium

The Technium network offers the optimum environment to enable knowledge-based start-up and spin-out companies to realise their potential. Technium includes a network of state-of-the-art facilities across Wales served by the latest information technology and fibre optic bandwidth capabilities. Inside the facilities, companies are supported by a team of business and technical support staff and have access to specialist laboratory facilities and communal networking areas. Strong partnerships forged between Technium and local Centres of Research Excellence provide specialist academic support for research & development projects.

The Technium network includes facilities addressing performance engineering, digital technologies, sustainable technologies and optoelectronics. The Technium concept was set up to drive enterprise and innovation in Wales, and it achieves this through:

- adopting a unified, integrated approach to business and technical support for its tenant companies.
- encouraging a partnership approach between the public sector, academia and the private sector towards supporting its companies.
- working with early stage companies to overcome the typical barriers to success.
- nurturing potentially successful businesses capable of strong growth and improves the climate for enterprise in Wales.

- encouraging businesses in Wales to become more competitive by developing and adopting leading-edge technologies, product and process innovation.
- providing more opportunities for Welsh-based companies and overseas investors looking to establish R&D projects.

12.8 QinetiQ

QinetiQ is one of the largest science and technology organizations in Europe. The company was created in 2001 when the Ministry of Defence (MoD) divided and partly privatised the activities of the Defence Evaluation & Research Agency. QinetiQ competes on the world stage, providing services, consultancy advice and test facilities to both the MoD and commercial customers.

In 2002, the MoD selected Carlyle as a strategic partner to further grow the business, and in 2003, Carlyle acquired an equity interest in QinetiQ as part of a Public Private Partnership transaction (with the MoD retaining a majority stake in the company). In February 2006 QinetiQ was listed on the London Stock Exchange with a market capitalisation of £1.3 billion.

QinetiQ's plan is to develop its non-MoD business by commercialising technologies first developed for the defence industry into applications for a much broader range of sectors. It aims to form partnerships and joint ventures with companies who share the same views on the importance of technology and who bring an extra competitive edge to joint projects.

QinetiQ's strategic partnership with the Carlyle Group has been a key feature in its success to date. Carlyle group have brought the professionalism, commercial experience and funding support that have allowed QinetiQ diversify away from its mono-customer culture.

12.9 The Oxford Innovation System

The success of IP commercialisation and entrepreneurship in Oxford is attributable to the 'Oxford Innovation System'. This provides the resources (IP, people and financial) and supports the entrepreneurial flair needed to achieve success.

There are expert teams in place throughout the system to help entrepreneurs, from having or identifying a good idea, to getting it patented and then licensing that patent or starting a business. Partners in the innovation system include:

- Isis Innovation Ltd - the technology transfer company of the university, arranging patents and license agreements and setting up spin-out companies. Isis now files one patent application a week on average, has assisted in the formation of more than 40 spin-out companies, negotiated over 200 licence and option agreements, and managed over 100 consulting contracts for University researchers. It also operates the Oxford Innovation Society (a club which fosters links between business and the academic community) and the Isis Angels Network (which provides a vehicle for the introduction of private individuals and companies with potential interest in investing in spin-out companies from the University of Oxford).
- Begbroke Science Park – with world class university scientists working alongside industry colleagues to produce the next generation of innovative technologies.
- Oxford Science Park - providing flexible space and more for young and established companies alike.

- Oxfordshire Bioscience Network - a unique public-private partnership promoting biotechnology business and research enterprise across Oxfordshire, providing a range of services to facilitate networking and communication.
- UK Bioinformatics Forum - a joint venture between Oxford Brookes University, Oxford University and the Oxfordshire Bioscience Network encouraging bioinformaticians and other scientists to aspire to industrial and academic excellence in informatics.
- University Departments - the fundamental and applied research in Oxford University's departments is world-renowned.
- Oxford Science Enterprise Centre [OxSEC]- based at Oxford University's Saïd Business School, OxSEC encourages entrepreneurship in the University's science and technology communities. The centre provides training and support for early stage businesses and new ventures, giving scientists the vision and skills to deal with the reality of business.

12.10 MRC Technology

MRC Technology (MRCT) undertakes commercialisation activities on behalf of the MRC, translating scientific discoveries and inventions into technologies and products with a clear healthcare benefit. It does this through the development and commercialisation of know-how and intellectual property (IP) arising from research within MRC-funded Units and Institutes. All IP which arises from employment with the MRC is owned by the MRC, and all income generated by MRCT goes back to MRC to support further research.

MRCT has experienced staff, from both academia and industry, whose combined knowledge is applied in determining commercialisation strategy. MRCT files patents on behalf of the MRC, manages the patent portfolio and negotiates licensing agreements with industrial partners.

MRCT also has applied research laboratory facilities where it incubates start-up companies and works with pharmaceutical and biotechnology companies on collaborative research programmes. Unlike other technology transfer organisations, these facilities allow it to engage in applied, translational, research and development of early stage intellectual property coming from MRC units.

MRC technologies and inventions often have clear commercial potential but are too immature to attract industrial or investor partners. To facilitate projects such as these, MRC has established a Development Gap Fund (DGF) with £4.5 million of funds committed over a three year period. The DGF uses revenues from previous successful commercial activities. It is 'pre-seed' money, operating at the earliest possible stage of technology transfer and is intended to strengthen new patent filings or to assist in the generation of patent filings for commercially interesting ideas.

MRCT experience has identified a number of success factors in commercialisation, including:

- the importance of support for technology transfer and the need for earmarked funding and specialist staff.
- recognition that basic research of high scientific merit is not a separate category from work with high commercial potential.
- the need for a flexible approach, with the minimum of rules and bureaucratic procedures.

- effective management of potential conflicts of interest.
- sophisticated investment and business management from the outset.

12.11 Savannah River

The downsizing of the US's nuclear industry has affected many isolated communities. Economic development organisations have been set up to promote diversification of these local economies.

The Savannah River Regional Diversification Initiative (SRRDI) was established to help cope with the impact of downsizing the Savannah River Site through regional planning and economic diversification. The SRRDI aimed to create an environment suitable for technology-based start-ups and business expansion, as well as attracting new investment and ventures to the area.

SRRDI has also created a venture capital fund, a Proposal Development Centre, a Challenge Fund for technology development and a small business research and development programme. SRRDI has been successful in attracting a new Bridgestone-Firestone tyre assembly plant and a new SKF ball bearing plant to its Aiken County Industrial Park with support from the State of Carolina and has helped create 3,860 new jobs.

12.12 Moulinex – Managing Large Scale Restructuring

In 2001, Moulinex employed 10,000 people worldwide, including 4,500 employees in France's lower Normandy region. Moulinex was a successful company, built up by its founder, Jean Mantelet, whose small household appliance inventions proved hugely popular.

After the founder's death in 1991, the company continued to grow but also started to accumulate debts and to develop problems with shareholders. In September 2001, Moulinex filed for bankruptcy and was subsequently bought by a competitor, resulting in 3,000 redundancies. After serious social upheavals (including strikes, factory sit-ins, and arson threats), the government appointed a representative to oversee the economic and social revitalisation of the lower Normandy region.

This novel arrangement combined both economic and social elements, and also took into account the impact of changes on subcontractors. In terms of social responsibility, a redundancy agreement was signed by all but one of Moulinex's trade unions, providing a number of measures above the legal requirements.

In relation to economic regeneration, in 2002 a regional development agreement was signed by the State, by the regional council and by the three French regions. By 2005, 90% of the budget provided had been allocated for site reassignment, support for job creation, and attracting new activities.

The redeployment of employees, as well as the implementation of the various social measures, were entirely paid for by the public authorities. The regional development plan, including site reassignment and the creation of 2,300 new jobs, was funded by the state and the lower Normandy region, which financed 40% and 60% respectively.

[Taken from European Foundation for the Improvement of Living and Working Conditions, European Monitoring Centre on Change, Case Study 2005]

12.13 Danone – Managing Large-Scale Restructuring

Danone is a major European food manufacturer which aims to keep social responsibility as a core value. After a series of acquisitions, in 2001 Danone identified overcapacity and loss of competitiveness in its biscuit manufacturing division and initiated a restructuring process.

This process would require significant workforce reductions and factory closures across several European countries.

After an initial leak to the press, Danone put emphasis on keeping the restructuring process open and transparent, making public announcements well ahead of any action. They set out a restructuring plan which outlined the principles and course of action to be followed in all factories concerned. Local negotiations with worker representatives and trade unions were then organised for each site affected by a closure or restructuring. A key part of their strategy was to redeploy laid-off workers and to reindustrialise the areas where the company closed down manufacturing sites. This included minimum redeployment of 80% of redundant staff, and offsetting job losses by contributing to greater job creation in the areas where sites were closed down.

The distinguishing features of the restructuring project were therefore the policy of goodwill that Danone adopted, combined with the early announcement of its decision to restructure, prior to the closure of the sites, and its subsequent management of these sites.

[Taken from European Foundation for the Improvement of Living and Working Conditions, European Monitoring Centre on Change, Case Study 2005]

12.14 **Rover**

Following a long history of British ownership, in both the public and private sectors, the car manufacturer Rover was purchased by BMW in 1994. In spite of heavy investment by BMW, the business was broken up in 2000 and MG Rover was launched by Phoenix Venture Holdings.

After continuing losses, the company eventually went into administration and was purchased by Nanjing Automotive, who pledged to retain some car production in the UK. Recently they have confirmed further investment in the Longbridge plant to assemble a new model, starting in 2007.

During this process, public sector support has focused on four areas:

1. Support for individuals

- Early interviews for state benefits advice
- Skills assessment interviews and individual training plans
- Training provision
- Help in starting a new business
- A 'Manufacturing Recruitment and Skills Matching' service

2. Support for suppliers

- Supplier hotline
- Wage replacement scheme
- Deferral of HMRC payments
- Transition loan fund

- Financial advice
 - 'Company Training Plans'
3. Support for the communities most affected
 - Residents support line (focusing on debt counselling)
 4. Support for longer-term redevelopment of the regional economy
 - Plans to redevelop the Longbridge site to provide alternative employment

Total government support across these mechanisms is estimated at £175m, and is claimed to have helped over 4,400 former employees back into work and helped save over 2,500 jobs in the supply chain.

12.15 Economic Diversification Assistance Program

One-industry towns in Northern Ontario are eligible for a financial helping hand to diversify their economies. A new provincial fund, the Economic Diversification Assistance Program, will invest in projects that bring about new economic activity. The program is administered by the Northern Ontario Heritage Fund. Communities eligible include those with 30 per cent or more of their workforce employed in one economic sector, and has lost at least 10 per cent of its workforce in a given industry or has experienced hardship due to a major economic disruption over the last five years. Projects will be funded up to \$5 million maximum for any one project.

12.16 Framework Programme 7 (FP7)

The Framework Programme (FP) is the European Union's main instrument for funding research and development. FPs have been implemented since 1984 and cover a period of five years with the last year of one FP and the first year of the following FP overlapping. The current FP is FP6, which will be running up to the end of 2006.

FP7 will be fully operational as of 1 January 2007 and will expire in 2013. It is designed to build on the achievements of its predecessor towards the creation of the European Research Area, and carry it further towards the development of the knowledge economy and society in Europe. The indicative budget for FP7 is €53bn, including €2.7bn for Euratom nuclear research and training activities.

FP7 bundles all research-related EU initiatives together under a common roof. It is one of the main initiatives linked to the Lisbon agenda for European growth and competitiveness; along with a new Competitiveness and Innovation Framework Programme (CIP), Education and Training programmes, and Structural and Cohesion Funds for regional convergence and competitiveness. It is also a key pillar for the European Research Area (ERA).

FP7 aims for simplified instruments and procedures for funding and participation. Collaborative research will be based around broad research themes, rather than instruments, with much continuity from FP6 as well as the addition of two new topics, space and security.

The broad objectives of FP7 have been grouped into four categories: Cooperation, Ideas, People and Capacities. For each type of objective, there is a specific programme corresponding to the main areas of EU research policy. All specific programmes work together to promote and encourage the creation of European poles of (scientific) excellence.

Cooperation

The specific programme on 'Cooperation' supports all types of research activities carried out by different research bodies in trans-national cooperation. Eligible actions range from collaborative research projects and the creation of networks to the establishment of European Technology Platforms and the coordination of non-EU research programmes. International

cooperation with non-EU countries is also included. Accounting for over half FP7's total budget, the 'Cooperation' Programme aims to gain or consolidate leadership in key scientific and technology areas.

The programme will be sub-divided into nine distinct themes. Each one will be operationally autonomous while at the same time ensuring coherence within the Cooperation Programme and allowing for joint activities cutting across different themes, through, for example, joint calls.

- Health
- Food, agriculture and biotechnology
- Information and communication technologies. See also FP7 on IST
- Nanosciences, nanotechnologies, materials and new production technologies
- Energy
- Environment (including climate change)
- Transport (including aeronautics)
- Socio-economic sciences and the humanities
- Security and Space

Ideas

The specific programme for 'Ideas' aims to support frontier research at the existing borders of knowledge, carried out by individual teams in all scientific and technological fields, including engineering, socioeconomic sciences and the humanities. The investigator-driven programme will be carried out by an independent European Research Council (ERC) to stimulate creativity, excellence and the discovery of radical, new knowledge.

People

The Specific Programme on 'People' provides support to researchers, supporting their career development and mobility by means of an expansion of the existing 'Marie Curie' exchange programme. These actions will be reinforced and refocused on key aspects of skills and career development, while also strengthening the links with national research systems. The overall aim is to strengthen, qualitatively and quantitatively, human resources in the European research sector.

Capacities

The specific programme on 'Capacities' will focus on improving research capacities throughout Europe. The main actions include support to research infrastructures, research for the benefit of SMEs, regional research-driven clusters, help for convergence regions to unlock their full research potential, 'Science in Society' (activities aimed at strengthening the link between science and society in general) and horizontal activities of international cooperation.

In addition, there will also be a Specific Programme for non-nuclear research carried out directly by the Joint Research Centre (JRC).

12.17 DTI Strategy

The UK Department of Trade and Industry, working with the Technology Strategy Board (set up in 2005), aims to promote world-class science & technology and support UK business success.

Between 1997 and 2007, the UK Government Science Budget (spent mainly in universities and public sector research institutes) will have doubled to £3.3 billion. In July 2004, the government published its ten-year framework for Science & Innovation with the aim of

raising the UK's total private and public sector in research and development, from 1.9% to 2.5% of GDP by 2014.

The Technology Programme is a key part of the government's Science and Innovation Investment Framework - £370 million over three years (2005-2008) to support companies with medium to long-term investments in technology (see Technology Strategy Board report April 2006, Developing UK Capability). Areas given high priority are:

Advanced Materials

Two particular priorities are materials to support developments in energy supply and distribution, and materials for sensing and diagnostics. Materials modelling particularly for scale and lifecycle analysis are also prioritised.

Bioscience and Healthcare

While the US is recognised as being the global leader, the UK has the largest and most mature bioscience industry in Europe, based on world leading research in life sciences and related measurement sciences. UK strengths are in the early identification and targeted treatment of disease, having the leading bio-pharmaceutical sector in Europe and in the capability to develop biosciences for wider business applications, outside the healthcare field in energy, biorenewable feedstocks for industry, the water industry, food processing and environmental remediation.

Design Engineering and Advanced Manufacturing

the UK retains a strong capability in the fields of precision engineering, high value process manufacture and in the design of buildings and other structures, intelligent process control, advanced jointing technologies, and the development of special surfaces and other properties using nanotechnology.

Electronics and Photonics

40% of Europe's independent electronic design houses are in the UK. The demand is for improved functionality of electronic products in ever smaller dimensions and for sensors and sensor systems especially for the modern built environment, vehicles, consumer durables, healthcare and security devices. In novel areas, such as organic electronics, the strength of UK research has led to a whole new industry developing around plastic electronics, which has the capacity to transform the markets for displays and radio frequency identification, which in turn will transform supply chain management.

Information and Communication Technologies

UK strengths include the ability to collect, transmit, store and analyse large amounts of data in a secure environment. This ICT capacity is complemented by innovative financial, business and retail services which have the capacity to exploit this potential globally. Modelling and simulation have become increasingly important for manufacturing and service industries. UK strengths in high performance and grid computing offer opportunities for exploitation in aerospace and defence, healthcare, transport logistics and financial services.

Sustainable Production and Consumption

There is considerable upward pressure on energy and raw material prices, coupled with growing concerns about the environmental consequences. Four key areas for the UK are: energy efficiency; resource efficiency and the management of waste; technologies to promote a sustainable food chain; and technologies for the water industry.

Emerging Energy Technologies

The recent Energy Review (The Energy Challenge – July 2006, DTI) provides some guidance on priority for technology development, particularly in low carbon fuels and energy

saving/combined heat and power. Micro-generation, carbon sequestration, cleaner coal technologies, energy storage and energy distribution are all discussed and considered as priorities for development, as is smart metering.

12.18 DTI Collaborative Research and Development Priorities

The DTI Technology Strategy Board (TSB) have agreed the following priorities to be included in the Autumn 2006 and Spring 2007 Collaborative R&D competitions (the list for Spring is not exhaustive) and it is expected that those towards the top of the list to be called earlier. No funding amounts have yet been allocated.

Sustainable Production and Consumption: Moving Towards the Zero Emissions Enterprise - A challenge to business to reduce their diverse negative environmental impacts. (Defra BREW funding)

Emerging Energy Technologies: Low Carbon Energy Technologies (DTI Energy Group funded)

Bioscience and Healthcare: Technologies for the Development and Manufacture of Biopharmaceuticals

Advanced Materials: Lightweight Materials and Structures

Network Security Innovation Platform: The Human Machine Interface in Network Security (Feasibility Studies)

Electronics and Photonics: Plastic Electronics - Deposition and Patterning of Complex Multiple Thin Film Layers of Functional Electronic Materials

Emerging Energy Technologies: Oil & Gas Technologies

Design Engineering and Advanced Manufacturing: Design Simulation and Modelling for Sustainability, Competitiveness and Quality of Life

Electronics and Photonics: Sensors and Imaging for medical, security and environmental applications

More details are available from <http://www.dti.gov.uk/innovation/tech-priorities-uk/competitions-for-funding/page32764.html>

12.19 Yorkshire Forward Industrial Research and Development Award for Large Companies

The Yorkshire Forward Industrial Research and Development Award for Large Companies is a new scheme approved by the European Union that will lead to £18.5 million of new investment.

The main aim of the scheme is to encourage large companies in Yorkshire and Humber to carry out new research and development with commercial potential.

The aim for this grant support is to encourage growth, strengthen competitiveness and boost employment in the region.

It will provide awards to support industrial research and pre-competitive development projects, or a combination of these which are carried out by large companies in the region. Applicants need to consider how their project fits with the distinction between industrial

research and pre-competitive development as different levels of grant support apply to each (official definitions and other funding conditions are provided).

Grants are available up to the European Commission State Aid maximum rates shown in the table below. These limits are based on total project costs, including all other sources of public funding, and are set at 50% for Industrial Research and 25% for Pre-Competitive Development.

To receive support under this scheme projects must:

- Have a total project value of between £500,000 and £2 million
- Last for 18 months
- Be business-led, with the main applicant being a large company with a base in Yorkshire and Humber. (Large companies that plan to move to Yorkshire and Humber may also apply, but will not be sent an Offer Letter until they have a base in the region.)

12.20 Global Technology Trends

The RAND Corporation identified 56 illustrative technology applications that might possibly be developed and implemented by 2020. Of these, the researchers selected for further analysis 16 applications scoring highest in a net assessment combining technical feasibility on a commercial basis, potential marketability, and, most important, the number of societal sectors influenced:

1. Cheap solar energy
2. Rural wireless communications
3. Genetically modified crops
4. Filters and catalysts for water purification
5. Cheap housing for adaptable shelter and energy
6. Rapid assays to detect specific biological substances
7. Green manufacturing
8. Ubiquitous radio-frequency identification tagging of products and people
9. Hybrid vehicles
10. Drug delivery targeted to specific tumours or pathogens
11. Improved diagnostic and surgical methods
12. Quantum-mechanical cryptography for secure information transfer
13. Communication devices for ubiquitous information access
14. Pervasive sensors
15. Tissue engineering
16. Computers embedded in clothing or other wearable items

Most of the 16 illustrative technology applications listed above draw from multiple technologies, e.g., biotechnology, nanotechnology, materials and information technologies. The combined effect of further technology development and implementation will be significant, changing lives around the globe

Because of variations in science and technology (S&T) capacities and in the institutional, human, and physical capacities relevant to implementing technology applications, the global technology revolution will play out differently across nations.

If the advanced countries are to stay ahead in their capacity to implement technology applications, they will need to make continuing efforts to ensure that laws, public opinion, investment in R&D, and education and literacy are drivers for, and not barriers to, technology implementation.

Several of the illustrative applications will trigger strong reactions and opinions over religious, environmental, or social concerns (including privacy). These reactions could differ dramatically across countries and thus contribute to the international variation in technology implementation.

12.21 British Columbia Energy Technologies Cluster

Leading Edge BC was established in 2003 as a not-for-profit marketing organization dedicated to ensuring that BC is globally recognized as a premier destination for technology enterprise by investors, entrepreneurs, site selectors and potential technology recruits.

An industry-led partnership with the Provincial Government, Leading Edge BC aims to raise the profile and awareness of BC technology-based opportunities with the goal of increasing the overall technology investment and contributing to BC's economy through employment and innovation.

Leading Edge BC invites partnerships with business and technology associations and organizations, municipal governments and regional organizations throughout the province.

Building on a leading global competence in fuel cells, hydrogen and natural gas vehicle technologies, BC's energy technologies cluster now offers exciting opportunities for a range of technologies in: biofuels & biodiesel, biomass, waste-to-energy, solar, wind, geothermal, wave, tidal, smart energy and energy management systems.

Though the fuel cell sub-sector plays a significant role, a 2004 BC Columbia Power Technology Industry Survey by KPMG found it to account for only 20% of companies surveyed. Others fell under different power sources, such as natural gas, or under different elements of the industry supply chain, such as energy management, energy storage, distribution, transportation, monitoring and control, fuel processing, and power conditioning.

While the majority of companies are in the start-up stage, total revenues of respondents were over \$600 million and were predicted to be over \$1 billion by end 2005, confirming the growing demand for power technology products. The established players accounted for 69% of total revenues reported.

74% of total sales in 2002 were outside Canada, and 31% were outside North America. R&D expenditures totalled \$175 million for 2002, with three respondents accounting for 67% per cent of total R&D expenditures reported. Respondent companies employed approximately 3,000 people.

The investment potential of BC's energy technologies cluster is well recognized by many of the world's leading multinational companies. Companies within BC's cluster have been the recipient of significant international inward investment and development partnerships by leading firms such as Mitsubishi, Ford, General Motors, Daimler Chrysler, BOC, BP, Shell Hydrogen, BASF and Duke Energy amongst others.

In Canada, British Columbia has been the most successful province in raising venture capital financing for energy technologies over the period 1996-Q3 2004.

12.22 Bibliography

Key Reports and studies reviewed

Genecon report for WLR

Mapping the nuclear supply chain (final report), ERM, 2005 (Study for West Lakes Renaissance and NRDA)

The objective of the project is to map the capability of the regional supply chain against the requirements of the short and long term decommissioning programme for Sellafield, Calder Hall, Drigg, Windscale, Capenhurst and Springfields in order to:

- identify gaps in the current supply chain;
- enable businesses to identify opportunities for development and investment;
- identify opportunities for targeted inward investments; and
- identify skills needs and the regional capability to provide training.
- An in depth study – lots of meetings (with supply chain, BNG, UKAEA), interviews and an email survey.

Issues/changes impacting the supply chain:

- move to T1, T2, T3 structure, and new procurement & performance management processes, fewer T2 level contracts
- BNG “make or buy” policy
- the extent to which regional companies can retain market share as competition is increased. Necessary skills are: e procurement, contracting & project management systems.
- Identified areas where local supply chain performance could be undermined - i.e. a gap assessment.
- Report proposes a “Nuclear Supply Chain Alliance” to co-ordinate the activities that promote supply chain excellence for regional companies.
- Report identifies a Supply Chain Development Plan that is to be delivered by the Alliance via a range of specialist delivery partners
- Action plan has 19 suggested development areas (all good ideas), prioritised and with a lead body suggested

Action plan includes the initiative of “internationalisation” i.e. export opportunities, export support programme. The ERM study identified a low level of export activity in the regional supply chain and recognises the need to increase awareness of export opportunities and to facilitate market entry.

Sellafield Lifecycle Baseline – 2005/06

Jobs reduction

- 2005 = 13,000 (including sub-contractors)
- 2015 = 10,000
- 2025 = 6,000
- 2035 = 4,000

- Impact is immediate – no “grace” period.
- Largest impact in 1st ten years is “sub contract” and “professional” category (highest paid)
- Professional 30% reduction
- Skilled, 10% reduction
- Sub contract, 50% reduction
- Overall, 30% reduction
- Thorp closure – 2011, current contracts completed.
- SMP closure – 2011?

Sellafield Socio-Economic Plan 2006/07

- Recognises that “Cumbria has the potential to be a world leader in nuclear clean-up and Sellafield has a major role as an economic engine to enable this objective”
- West Cumbria/ Sellafield has a history of secure and well paid employment; this has suppressed entrepreneurial activity.
- “The intellectual and physical assets at Sellafield are the kernel of the future economy of West Cumbria”
- Sellafield will work with local and regional agencies on four themes:
- Education, training and skills – support to self-start businesses, provide coaching for local supply chain to meet NDA needs, support local graduates in start ups.
- Encourage entrepreneurial activity – some success in the past, key is to identify spin-out opportunities, provide incubators, Unsolicited Innovation Proposal, Programme R&D Announcements (list the decommissioning challenges and encourage private sector to offer solutions.
- Diversification - build socio-economic planning requirement into major tier 2 contracts,
- Nuclear Enterprise Zone – allow regional businesses (start-ups, spin-offs) access to surplus assets and resources at Sellafield.

Response to DEFRA public consultation process on LLW management (Allerdale, Copeland, Cumbria Councils – May 2006)

- Drigg capacity exhausted by 2008.
- Concern that insufficient consideration is being given to the national v. regional solution to LLW storage.
- Drigg should not be used to accommodate waste from other UK nuclear sites.
- No increase in capacity until agreement is reached re compensation measures for the LLW presence. Disappointed that consultation virtually omits this subject.
- Local community should have veto over importing LLW.

[Note – job impact. Will peak at 350 plus in next few years (plutonium contaminated material recovery operations) then drop to ~80 (including sub-contractors) until end of operations in 2050. This on the assumption that Drigg is extended to give capacity until 2050.

Response to CoRWM public consultation process on ILW/ HLW (Cumbria, Copeland & Allerdale Councils, May 2006)

- Commitment by UK Government to intensive R&D into all aspects of geological disposal, interim storage and other options not completely ruled out by CORWM.
- Interim storage of ILW – should be as close to place of origin as possible.
- Concerned that if one central repository is recommended it will be by default in West Cumbria.
- Opposed to centralising ILW storage at Sellafield.
- Fully support the concept of volunteerism.

Diversification opportunities at BNFL and in the local economy (final report), ERM and Environmental Council (Part of BNFL National Stakeholder Dialogue)

- Outlines BNFL's (now BNG) diversification policy and success. Assesses a number of diversification, technology transfer and incentive initiatives conducted by BNFL over a number of years.
- Relevant diversification projects included Uranium catalyst fuel cells, Xenon and Krypton production, energy storage, instrumentation and robotics spin-offs, Fluorine generation equipment technology, Joint Nanotechnology JV with EMI and Sensors JV with Anglia Water.
- These projects and ventures had very mixed success and a number failed to materialise. The report concluded that "BNFL has been involved in numerous ventures, few of which have created diversification opportunities which have succeeded commercially."
- Main reason for failure cited as: BNFL's focus on core business, limited applicability of nuclear technology to other industries (IPR usually flows in other direction)
- Report mentions the establishment of the BNFL Technology Centre in 2004 which at the time was not yet fully operational. The Centre aim as to offer an integrated research and technology complex with laboratories, conference facilities dedicated to chemical and engineering development and to be host to 300 residential technologists. Primarily dedicated to nuclear research, the centre may also generate new commercial ventures. [BTC/Nexia Solutions)
- BNFL instituted the "New Horizons" scheme at the time when THORP was scaling back to offer employees leaving the company basic advice and training relating to starting up a business.
- The report refers to BNFL Enterprises Ltd which was established in 1995 with a £2.5m fund to invest in related ventures. Between 1995 and 2004 it only invested a portion of the fund in 8 ventures. It appears that there was a limit of good projects. Report mentions other initiatives: Cumbria Trust, Cumbria Inward investment Agency, Harris Knowledge Fund, Westlakes Science Park and the West Cumbria Development Fund as other sources of assistance.
- The report also stated that the successor companies on the Sellafield site were unlikely to fulfil these wider development and diversification roles unless part of their remit and highlighted the loss of BNFL as a "paternalistic" procurer of services.

Actions suggested by report:

- Ascertain ownership of IPR between NDA and other parties
- Public agencies (including NWDA) foster links between NDA/BNF and its industry clusters in technologies such as bioremediation and clean-up
- Explore the feasibility of engaging a major partner organisation to assist in the commercial exploitation of technologies outside the nuclear industry.

A skills needs assessment of the nuclear industry (Executive Summary), Cogent, 2006

- Essentially a “here and now” snapshot of skill needs in the industry.
- Main technology drivers for the nuclear industry are: clean-up and decommissioning technologies, waste disposal and enhanced reactor technology.

Emerging issues from Cogent’s skills needs assessment:

- Innovation – need for a nuclear technology centre and a nuclear laboratory
- Management and leadership – need for more project management skills and more emphasis going forward in project-based working
- Skills gap – over 70% of employers report skills gaps but in particular disciplines rather than universal.
- Recruitment – industry has issues attracting people and has difficult demographics.
- The conclusions based on “as is” scenario – skill needs would be different under a “renaissance” scenario which includes new build, waste disposal facilities, life extension, national research demand etc.

BNG skills strategy

- Purpose to address skills issues as Sellafield moves from owner/operator to site contractor. Operating assumptions based on 206 Life Time Plan
- Highlights a number of risks including loss of key skills during period of uncertainty, key skills in demand elsewhere in the nuclear industry and shortages of a national pool of skills could drain resource from Sellafield. This issue was re-enforced by Steven Morgan of BNG in the course of our discussions regarding the future of the site.
- BNG site to establish a site strategic training board by April 2006 to provide management direction and oversight on the skills challenges.

Northwest nuclear, a strategic approach to the nuclear sector in the region, NRDA, 2005 Sellafield socio-economic plan 2006/07, NDA/BNG, 2006

- Identifies a vision – a world-class region of excellence in nuclear technology through demonstrable achievement in decommissioning, radioactive waste management, nuclear energy generation and research & development.
- The region is the northwest, not just West Cumbria.

Identifies 6 action themes:

- Strategic relations- maintain/ strengthen relationships with Government bodies (NDA, DTI, DEFRA) and develop new relationships in areas related to waste management and nuclear submarine procurement.
- Attracting investment – continue to support/encourage inward investments and relocations (NDA, Fluor etc) and seek to attract companies from outside of nuclear sector. Support the development of a National Nuclear Laboratory.
- Skills & research – support a National Nuclear Academy in West Cumbria (Nucleus) to address issues around skills needs. Likewise Dalton Institute & National Nuclear Laboratory will support higher level skills shortages.
- Supporting supply chains: build on existing support programmes (Business Link). Develop programmes to support issues raised by changes in NDA supply chains. Assist SMEs in decommissioning export markets and non-nuclear markets.
- Enterprise & Innovation – support people who wish to start up their own businesses as they leave Sellafield. Support innovation of nuclear technologies into new markets.
- Influence infrastructure – improved transport required.

- Actions listed for each theme together with suggested lead organisations. Actions appear good/ well founded. Suggest a bigger push on diversification initiatives (export and non-nuclear sectors) – learning from US?

Nuclear Opportunities Group – 2006/09 Strategic Action Plan, Genecon/WYG for West Lakes Renaissance, June 2006.

- A very useful report that has pulled together various previous work re-retraining & supply chain and also make some recommendations on the role for the Nuclear Opportunities group. The report also considers a wider economic context.
- Purpose of study is a plan to facilitate the development of West Cumbria as a leading international location for nuclear decommissioning and environmental restoration.

Nuclear and radiological skills study, report of the nuclear skills group (part 1), DTI, 2002

- Identified a National skill shortage “hot spots” in certain disciplines (e.g. safety case production and radiological protection) and growing skills shortage in next 15 years even without new build.
- Concluded that Postgraduate education and apprentice training “are also in a fragile state, raising concerns about future workforce development”.

Potential New Build in Cumbria (final report), ERM, 2006 (report for Cumbria County Council, Allerdale Borough Council and West Lakes Renaissance)

- Sellafield is one of a number of potentially viable sites for nuclear new build in the UK (and the only one in Cumbria)
- It is not commercially optimal as it would require a lengthy connection across West Cumbria (cost and planning issues) and would incur relatively high grid charges which reflect demand is required in the South of England.
- New build would provide 7,000 person years of employment. Once operational a twin reactor would employ around 600 people directly, with total job creation of around 1,000
- The report touched upon the opportunity to build a reactor which would burn Mox fuel as a means of processing the UK’s inventory of civil plutonium stored at Sellafield. If a policy decision were to be made to follow the Mox route, Sellafield would be the preferred site.
- Sellafield could also be a site for a prototype Pebble Bed Modular Reactor (PBMR) under development in South Africa. This possibility is likely to be diminished with the recent sale of Westinghouse to Toshiba.
- The report concluded that “a new build project phased to produce power around 2016 would have a small but measurable beneficial effect in the context of the overall job losses”

Other

- NWDA Regional Economic Strategy 2006
- To provide the regional priorities and context
- NWDA / Northwestscience ‘science strategy englandsnorthwest’ 2002
- To view regional strategies to identify diversification strategies
- Project Corus (Workington) Steering Group Report, July 2005
- To regional economic provide context
- Wealth and Job Creation Opportunities in the Cumbrian Energy Sector, Cumbria Inward Investment Agency, June 2003
- To identify diversification opportunities

- Technology Strategy – a national regional partnership (presentation by Pam Alexander, Chief Executive SEEDA, 26 April 2006 from DTI Technology Programme website)
- Key Technology Areas, Technology Strategy Board, April 2006
- To identify the national technology priorities for the UK
- Science and Innovation Framework - HM TREASURY DTI Innovation report
- To identify national Strategies

Allerdale and Copeland Labour Market Profiles, Nomis Official Labour Market Statistics, March 2006