Smarter Nuclear in the UK
An IBM Point of View
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UK Energy Context - The Energy Challenge

In the coming decade, the UK faces a significant energy challenge. In the UK, even if as currently forecast, demand remains roughly constant, a significant proportion (approximately 25%) of current UK electricity generation capacity - mainly old coal and much of the existing UK nuclear fleet - is due to be decommissioned. If half of Britain’s passenger cars were powered by electricity, then this would increase electricity demand by a further 26%. The UK therefore needs to make a significant investment in new generating capacity to meet the forecast demand.

Globally, electricity demand is forecast to double in the next 25 years. Thus the required UK new build programme (of some 43 GW) will be within the context of worldwide competitive market. Currently within the nuclear industry alone, 53 new reactors are under construction, 136 being planned and a further 200 proposed. Over 30 countries worldwide are building or planning to progress a new build programme. The OECD’s Nuclear Energy Agency estimates an average of twelve stations will be initiated per year until 2030, rising to fifty four per year.

The type of generation constructed is also important. The UK is committed to challenging legally-binding carbon emissions targets - a reduction of 34% against 1990 levels by 2020 with a further target of 80% reduction by 2050. In addition, there are concerns regarding the security of supply of some sources of fuel, such as gas.

Ofgem estimate that an investment of the order of £200Bn will be required in the next 10-15 years to provide secure energy supplies and meet carbon targets.¹

The UK government has also recently published the National Policy Statement (NPS) for Energy¹ which sets out the need for UK investment in new energy infrastructure. In the NPS the government “concluded that there is a significant need for new major energy infrastructure” and that “new nuclear power should be free to contribute as much as possible towards meeting the need for 25 GW of new non-renewable capacity”.

The UK Government is clearly supportive of industry plans to bring a significant quantity of new nuclear power to market in the UK. In the past few years the UK Government has taken active steps to facilitate new nuclear build programmes in the UK, by:

- **Streamlining the planning process** to improve certainty around timing of key approvals and consents by forming the Infrastructure Planning Commission.

- **Amending the regulatory process** with the introduction of Generic Design Assessment and Strategic Site Assessment processes.

- **Clarifying waste disposal and decommissioning** through the introduction of the Funded Decommissioning Programme, the Nuclear Liabilities Financing Assurance Board, and plans to establish a fixed price for waste disposal.

However, it is equally clear that they expect the Electricity Industry to take the lead in bringing proposals to market and shoulder the majority of the risk for each project, including funding the design, construction, operation and eventual decommissioning of each nuclear power station.

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¹ Ofgem Project Discovery - Energy Market Scenarios - October 2009 - www.ofgem.gov.uk/Markets/WhIMkts/Discovery/Documents1/Discovery_Scenarios_ConDoc_FINAL.pdf

The Challenges facing Nuclear Developers

The situation described above is forcing companies to restructure the way they build and operate generation assets. They face a wide range of challenges to a successful profitable outcome. Some key issues that need to be overcome include:

### Building an effective delivery organisation and programme

- Ensuring safety and security at all times
- Establishing the appropriate consortia models - commercial, contractual, project
- Building an effective new delivery organisation, business processes, target operating model, culture and systems
- Determining what technology at what sites using which partners
- Managing overall programme financials, funding and key risks
- Developing the detailed financing models and business case
- Managing Public Relations, communications, consultation and change management
- Establishing the information and application architecture to support the programme
- Ensuring documents and records are accurately kept, accessible and maintained for life of asset
- Resources
  - Assessing skill & resource needs and current capabilities
  - Locating and retaining key staff
  - Recording skills and experience of an aging workforce
  - Transferring skills and experience to new generation of staff

### Delivering the new power station to appropriate standards on time and to budget

#### Design & Consents - Completing design and obtaining regulatory approval in a timely fashion

- Managing design change and control of design data across a complex supply chain
- Designing for ease of construction, operation, maintenance and decommissioning
- Effectively managing interaction with regulators and general public
- Answering regulatory questions in a timely fashion

#### Delivery - Ensuring construction meets required quality standards, whilst minimising cost and time

- Securing scarce resources and components in a competitive global market at optimum cost
- Optimising construction programme and dealing with issues and changes
- Control of construction and manufacturing quality
- Modelling risks and scenarios

### Ensuring maximum financial return from safe power station operation

#### Operation - Ensuring that the plant is designed and built for safe operation and to maximise uptime

- Ensuring that operational experience is built into plant and component design
- Optimising and simulating operational processes, such as refuelling, during design
- Integrating engineering, design and business data to optimise operational performance

#### Maintenance - Eliminating unplanned downtime, whilst minimising cost to maintain the fleet

- Ensuring access to design information for the life of the power station
- Accurately diagnosing of asset condition and forecasting failures to optimise planned outages and reduce unplanned downtime
- Incentivising supply chain from design stage onwards to achieve zero unplanned downtime and ensure availability of spare parts for life
- Simulating and optimising maintenance processes during design

### Decommissioning – Proving decommissioning processes to minimise Funded Decommissioning Programme (FDP) contributions

- Simulating and optimising decommissioning activities during design
- Demonstrate that decommissioning processes have been developed to minimise the cost and risk of decommissioning and thereby minimise FDP contributions
A Smarter Planet

Since the last UK new build programme at Sizewell, technology has advanced significantly enabling new approaches to a range of problems. Our world is becoming:

**Instrumented**

We now have the ability to measure, sense and see the exact condition of almost everything. Sensors can be found in nearly everything from simple infra-red motion detectors in security systems, to sophisticated sensors in engineering equipment, and even CCTV footage. In addition we also measure business performance in ever increasing detail.

**Interconnected**

These sensors and business systems can now be interconnected more easily than ever before enabling the data to be integrated and transmitted long distances in real-time, removing geographic and organisational barriers to sharing data. Engineering data can be combined with business and commercial data to give a business-wide perspective.

**Intelligent**

By combining the data with modern analytical techniques, we now have the ability to make better decisions. We can now analyse the growing volume of data in real-time, combined with improved algorithms to identify trends & patterns, and reporting tools to present data in useful formats.

Implications for UK New Nuclear Programme

IBM has been a provider of IT and industry solutions to the Energy and Utilities industry for over thirty years. We are the largest service provider to utilities and counts the top ten utilities as clients. IBM’s vision is to help power generation companies develop, manage and optimize a diverse energy portfolio — including nuclear and renewable energy as well as more efficient fossil generation, and a smart grid.

Within the nuclear sector, we have delivered solutions for over twenty nuclear organisations around the world. We have established a Centre of Excellence for Nuclear Power at La Gaude in France, and are investing in a sister facility in Shanghai, China.

By applying the developments described above to the issues faced by new nuclear build programmes, we can be smarter about how we build and operate these critical assets.

- “Smarter designs to build a smarter plant”
- “Smarter delivery to get on-stream fast”
- “Smarter operation to maximise safe production”
- “Smarter maintenance to keep plant & systems secure, reliable and available”

IBM’s advanced solutions and thought leadership support improved design, construction, supply, safety and operation of power plants. We can help decrease the risk and cost of new and complex capital-intensive construction projects, decrease schedules, and facilitate operational excellence.
Smarter Design to Build a Smarter Plant

- IBM clients in the Nuclear, Oil & Gas and Aerospace & Defence sectors are using the latest Product Lifecycle Management (PLM) tools to support simulation and visualisation of critical engineering and operational events to eliminate risks, prove designs and minimise costs.

- Enhanced business systems enable rapid and detailed analysis, modelling and optimisation of proposed changes to the project programme and the impact on the financial performance.

- Design and integration of smart plant monitoring and management systems, and associated digital infrastructure, with intuitive human-computer-interfaces and integrated analytics for operation, safety and maintenance.

- By automation of business processes and knowledge capture, we can develop new, minimally manned plant operation methodologies.

- High performance computing, advanced computational methods, and complex visualization techniques can assist in optimising design, minimising maintenance and extending plant lives.

- In the United States, IBM is working with major corporations to assess, detect and resolve vulnerabilities in IT systems design to ensure IT security and reliability from day one.

HPC Analysis of Material Aging and Design Optimisation

IBM High Performance Computing facilities are being used in collaboration with EDF Group and US national laboratories in the analysis and optimisation of nuclear reactors.

High Performance Computing can also be used to reduce cycle times for complex numerical analysis such as finite element analysis and material aging assessments.
Smarter Delivery to Get On-Stream Fast

- Using the latest IT architecture and systems to efficiently and securely share information amongst the eco-system of stakeholders designing, building, supplying, operating, maintaining and regulating the plants to deliver plants safely, to specification and to schedule - using experiences in the Aerospace and Defence sector.

- Create and maintain the “digital plant” using “intelligent Plant Lifecycle Management” tools alongside the physical plant for the 70 year design, build, operate and maintain cycle to “input information once and use it many times”; minimize risk in new plant design and construction; and seamlessly transfer complete and accurate information to plant operations, from the day of commissioning forward.

- Leveraging our experiences and knowledge of the UK nuclear supply chain, we can support design, delivery and monitoring of the capital programme and supply chain to assure delivery in a constrained and competitive global market and provide early identification of major issues and leverage economies of scale across multiple plants worldwide.

- Use proven techniques to assist rapid development and implementation of new business organisation structure, processes, systems and the associated infrastructure to improve control and reduce business risk.

3D Simulation of Complex Activities to optimise design for ease of Construction, Operation, Maintenance and Decommissioning

Integrate project planning with rehearsal and simulation of complex construction, maintenance and operational activities to optimise design.

Simulate and optimise maintenance and operational processes to minimise risks and reduce outage durations.
Smarter Operation to Maximise Safe Production

- Use virtual reality and simulation for training and operational management.
- We can provide fleet-wide performance management based on integrated and trusted information to improve decision-making, business processes, agility, flexibility, capability and best practices across the portfolio.
- Building on our experience from the oil and gas industry, we can perform multi-level optimisation to increase operational availability, efficiency and performance - in real-time, at unit level or fleet level - based on analysis and integration of operational, business process and external variables.
- We can address “skills shortage” through increased knowledge capture and process automation and using tools and techniques to increase employee retention, improve recruiting, and enhance learning and training.
- We can monitor IT systems in real-time to detect and resolve vulnerabilities and threats.

Address Skills Shortages using modern tools and techniques

Innovative new approaches to identifying and locating scarce skills and experience.

Document, record and make available knowledge via web 2.0 tools.

Recent work with INPO has highlighted the potential value of modern virtual reality and simulation techniques to enhance and optimise training programmes.
Smarter Maintenance to Keep Plant and Systems Secure, Reliable and Available

- We can integrate intelligent devices with Enterprise Asset Management solutions to enable true Condition Based Maintenance. Deploy advanced prognostics to identify patterns and forecast potential failures, which enables optimised maintenance regimes to minimise whole-life cost.

- By integrating business and engineering data from each station we can develop fleet-wide best practices, and improve decision making by optimising access to scarce highly skilled resources. For example, moving towards an Advanced Collaborative Environment such as those use by oil and gas companies for their upstream assets.

- We can improve physical and cyber security and safety through biometric and video recognition / interpretation, site and perimeter incursion monitoring and staff location awareness and detection solutions linked to radiation exposure monitoring.

- We can provide the reliable and secure data infrastructure to underpin the operations, by deployment of advanced system architectures such as the IBM Solution Architecture for Energy and Utilities (SAFE).

- Develop long term procurement strategies to incentivise suppliers to minimise downtime, and reduce the risk of long-term component obsolescence.

Use Advanced Collaborative Environments to improve decision making and optimise usage of scarce technical resources

Integrate business and engineering data using on and off plant teams supported by advanced analytics to optimise business decision making.
Authors

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