Our nuclear renaissance:
before the lights go out

IBM®

1

How can **nuclear power** help meet the demand for **fast, sustained, secure and optimised low-carbon energy production,** in a market suffering fierce competition for resources, people and plant?

Part of a series of papers on IBM Smarter Energy

Time is running out for Britain's energy. Based on current capacity, **demand could outstrip supply as early as 2016.** At the same time, Britain is committed to an **80 per cent reduction in greenhouse gas emissions by 2050** – and almost half of Britain's current CO_2 emissions **stem from electricity generation.**

How can we meet the demand for fast, sustained, secure and optimised low-carbon energy production, in a market suffering fierce competition for resources, people and plant?

By designing and building facilities that aim to operate in an instrumented, interconnected and intelligent way from the start, and doing so in a smart way.

Based on current capacity, demand for energy could outstrip supply in Britain as early as 2016. At the same time, at least a quarter of Britain's electricity generating capacity will need to be replaced in the next ten years.

If the country's energy needs are going to be met in the long term, we will have to act quickly to address the situation now. We need to create a revitalised energy network that is available and secure, with consistent supply. And we need to make the most of our energy capacity.

Nuclear power will be a crucial element of the future energy mix. The UK's Low Carbon Transition Plan specifies that "around 40 per cent of electricity will be from low-carbon sources, from renewables, nuclear and clean coal"[1] by 2020.

Nuclear power produces less than two per cent of the emissions released by coal to generate the same amount of electricity. Increasing the proportion of electricity generated by nuclear power – currently around 13 per cent – could help the UK meet its long-term carbon reduction targets and maintain secure supply.

For this to be achieved, the UK needs to start the new-build programme now. By 2025, all but one of the UK's current ten nuclear power stations (representing 19 operating reactors) are due to be closed down as they reach the end of their planned working lives. It takes up to ten years to design, build and commission a new nuclear power station and costs can run into the billions. The first new nuclear plant in the UK is likely to be built by EDF Energy at Hinkley Point in Somerset and be in full commercial operation by 2018.[2] The company plans to build four new nuclear reactors in the UK, subject to the right framework being in place, with first concrete on the first plant expected to be poured in 2013. This means a possible short-term energy gap as demand overcomes supply, with the long-term picture remaining unclear.

Once this new nuclear generating capacity is up and running, it must take its place as a core part of the UK's generation capacity. This means it has to be safe, available, secure and operating efficiently at all times. It will also have to share the stage with more partners than ever and cope with more sources offering unpredictable supply, including distributed renewables, imported/exported power, next generation gas, micro-generation and more.

40%
of the UK's electricity will come from low-carbon sources by 2020

Then there are the skills and resources to consider. It has been nearly 20 years since the last major nuclear plant build in the UK and a generation of engineers with experience in this specialised arena is now hitting retirement age. Building new nuclear facilities is only part of the story; they need to be maintained and operate at highest possible efficiency. The fact that around 30 countries worldwide are

engaged in this nuclear renaissance with over 200 stations envisaged only adds to the pressure: competition for resources could be fierce and supply chains may be constrained.

In this changing energy landscape, we must make the most of our energy supply, from design to build, from operation to delivery. For nuclear power generation, this means optimising facilities both in terms of the complex operational aspects involved and the interaction of the plant with the electricity markets.

13%
of the UK's energy supply currently comes from nuclear power

SMARTER DESIGN

What do we need to do in order for nuclear power to help meet the demand for speedy, sustained, secure and optimised low-carbon energy production?

Design facilities that operate in an instrumented, interconnected and intelligent way from the start, and do so in a smart way. They must comply with appropriate construction standards and operating regulations as well as planning for decommissioning from the start. Safety and security considerations must be integral to the design. And they must be seen to be in order to maintain public acceptance.

In the decades since the last major nuclear plant build, the world has become more instrumented, interconnected and intelligent. For example, IBM's enhanced business systems provide rapid in-depth analysis, with intelligent Product Lifecycle Management tools. These have allowed industries that have been developing in the past decades, such as Aerospace & Defence, Oil & Gas, Automotive and Construction, to fine-tune plans to enhance end-to-end financial performance right from the start.[3] Intelligent Product Lifecycle Management tools are designed to be used throughout the Design, Build, Operate and Maintain cycle to input information once and use it many times; minimise risk in new plant design and construction, especially where multiple parties are involved and complex data is handed between them many times; and transfer complete and accurate information to plant operations seamlessly, from the day of commissioning forward. The latest IT architecture and systems help to share information efficiently and securely with everyone involved in designing a new plant, as well as those building, supplying, operating, maintaining and regulating them. And they can help all stakeholders do so safely, to specification and to schedule.

Smarter design helps the data needed in both the operational and decommissioning phases of a plant's lifecycle to be anticipated during design and construction. Rapid and detailed analysis and modelling of data could also be used to assess what impact any changes to the project programme might have on the financial performance.

High Performance Computing (HPC) solutions can help drive intelligence deep into the nuclear design process, optimising design, minimising maintenance and extending plant lives from the start. IBM's expertise in extreme computational power can help transform the way complex tasks – such as reactor design – are carried out. Right now, IBM HPC solutions are already used by nuclear facilities in the UK, France and the United States.[4]

By 2025, all but one of the UK's current **ten nuclear power stations are due to be closed** down as they reach the end of their planned working lives.

Nuclear facilities should also be designed to be smart. The essential ingredients for smart operations can be built in at the front of the lifecycle rather than retrofitted, as happened with the first and second generation plants.

Tomorrow's nuclear power supply must benefit from intelligent tools that help get new capacity on-stream fast. Greater monitoring and measurement has the potential to capture real-time data allowing faster response times and decision-making across the plant. New, minimally manned, plant operation methodologies could be developed by automating businesses processes and knowledge capture, bringing cost advantages as well as increasing operational effectiveness.

Well-designed and integrated technologies will support smart, safe operation and maintenance throughout the life of the asset.

SMARTER BUILD

To bring a new nuclear fleet on-stream quickly, you need to build smart and create a smart organisation and programme that will deliver better results.

This means establishing the right supply chain for the build at the right time and place, offering the right quantity and quality of service, as well as ensuring safety and security throughout the build phase.

Bringing in effective IT systems – and the right service companies – in support of the supply chain should be an integral part of the process. For example, virtualisation can be used before construction begins in order to help anticipate any problems, from bottlenecks to potential safety issues, and to keep the supply chain moving.

IBM's Business Analytics and Optimisation (BAO) solutions are designed to address complex problems such as the scheduling of construction and planned turnarounds where many parties are involved, each dependent on each other and operating under constraints imposed by their wider business environment. This helps to ensure the build isn't delayed by unforeseen glitches in the schedule and allows the right level of time and cost contingency to be built in, so the programme remains on course despite the inevitable problems which occur in large and complex projects such as these.

Asset management tools and techniques can be introduced in order to help manage the vast amount of equipment and inventory involved in the construction, and support a seamless hand-over from construction to operation. IBM has employed RFID-based tracking solutions within the nuclear and oil & gas industry to track both people and critical equipment to support safety and security.

IBM designs and integrates smart plant monitoring and management systems to help achieve this, supported by digital infrastructure. Intuitive human-machine interfaces provide operators, supervisors and managers with an ability to run plants safely and efficiently.

For example, IBM can create 3D simulations of complex performance and operational processes, integrating project planning with rehearsals for construction, maintenance and operational activities. Such simulations have already been used to assist a US nuclear generator plan and execute a

New nuclear: building opportunities

Critical success factors across the new nuclear lifecycle

- **Ensure safety and security at all times.**
- **Establish appropriate consortia models, eg commercial, contractual, project.**
- **Build an effective new delivery organisation, business processes, target operating model, culture and systems.**
- **Find the right technology at the right sites using the right partners.**
- **Manage overall programme financials, funding and key risks.**
- **Develop detailed financing models and a business case.**
- **Manage public relations, communications, consultation and change management.**
- **Establish the information and application architecture to support the programme.**
- **Ensure documents and records are accurately kept, accessible and maintained for the life of the asset.**
- **Assess the right skill and resource needs as well as current capabilities.**
- **Locate and retain key staff.**
- **Record skills and experience of an ageing workforce and transfer skills and experience to new generation of staff.**

complex plant life extension activity during a planned outage.[5] Interconnected solutions of this sort are the key to building a smarter supply network, underpinned by effective data capture, i.e. capture data once and re-use it often. This is vital to the maintenance of "digital plant", which must track critical data over a 70-year Design, Build, Operate and Maintain cycle.

13%
of the UK's energy supply currently comes from nuclear power

SMART OPERATION

Taking a smarter approach to the design and build of the new nuclear fleet could set the stage for smarter operations and maintenance in the long term. This will help keep both plant and systems consistent, secure, reliable and available and it could improve the economic return on the asset throughout its life.

This is as important for public perception as it is for financial stability. Events such as the 2008 oil price shock, the Russia-Ukraine pipeline dispute and restrictions on winter gas supplies in the UK have highlighted energy supply vulnerabilities, and people are becoming more aware of the potential impact than ever.

Maximising return on investment once a new plant is up and running means being able to guarantee safety and operational efficiency, with zero downtime for unplanned maintenance throughout the life of the asset.

Smart operations help achieve these goals. For example, power stations – and nuclear in particular – face significant security risks. IBM has worked with border agencies, defence organisations and building facilities managers to develop a range of smart security and surveillance technologies which both help to detect and to anticipate issues. These include biometric and video recognition/interpretation systems, site and perimeter incursion monitoring, digital defence systems to protect digital assets from hacking or malicious damage, as well as staff location awareness and detection solutions linked to radiation exposure monitoring.

IBM solutions enable virtual simulation for training and operational management, as well as fleet-wide performance management based on integrated and trusted data. These help improve decision-making, business processes, agility, flexibility, capability and best practices across the fleet.

IBM systems can monitor operations in real time in order to detect and resolve any adverse trends or potential faults, allowing for remote maintenance that can keep engineers away from danger. By integrating intelligent monitoring devices within a comprehensive asset database, IBM's Enterprise Asset Management (EAM) solutions can share data between plants and help prevent similar incidents from occurring elsewhere in the fleet. Safety and quality are critical in the industry – IBM EAM's solutions are already used by companies around the world to enable work to be undertaken in a controlled, safe and efficient manner by the right people, at the right time using the right materials.

There is no good time for expensive, critical assets to be offline. It is a question of choosing the "least bad" time and minimising the impact

Creating the **next generation of new nuclear capacity** demands a tight focus on **efficiency, flexibility and stability of supply.**

of maintenance turnarounds. Smarter scheduled maintenance takes the system offline for the minimum of time – at the optimal time – in order to minimise impacts on supply and the bottom line. IBM's Asset Management services leverage experiences from industries facing similar challenges to apply planning and optimisation solutions.

All the above data can then be used in Advanced Collaborative Environments – as deployed within the oil industry – in which multidisciplinary teams monitor a number of facilities (oil platforms, nuclear power stations, etc) remotely in a highly visual, centralised operations centre. By integrating and analysing business and engineering data from different facilities, operators can gain unique operational insight, identify examples of best practice and improve decision-making processes.

This approach allows teams to keep an eye on issues that might otherwise fall between the cracks. It also makes the most of increasingly scarce, highly skilled nuclear engineering resources. Combined, these smarter operations will help to keep power flowing through both anticipated and unexpected maintenance and operational downtime.

Finally across the enterprise, energy generation virtualisation can provide intelligent supply management, with distributed generation, energy storage and load control, all managed in a single environment. IBM is working with utilities to implement operational and maintenance solutions which span multiple generation technologies – nuclear, wind, hydro, gas, clean coal – and which are designed to deal with all the physical assets within one management system.

If nuclear power is to enjoy the renaissance that many argue it deserves, it will need to be designed, built, operated, maintained and decommissioned in a smarter way in order to achieve a smarter approach to energy.

Creating the next generation of new nuclear capacity demands a tight focus on efficiency, flexibility and stability of supply. A smarter approach can help meet the challenges more efficiently and effectively.

WHERE NEXT?

Adding a stable and reliable nuclear fleet to the country's energy mix is only going to grow in importance in the years ahead. The balance between electricity demand and energy generation capacity in the UK is likely to shift in the next decade, with the underlying trend in domestic consumption pointing upwards, influenced in part by the ongoing changes to our lifestyles.

For example, energy demand could increase by as much as 25 per cent if half the UK's vehicles were electrically powered. Countries with high levels of highly variable wind generation are already experiencing issues relating to the provision of power when the wind isn't blowing and the use of excess production when it is. This future will soon be a reality for the UK given the rate of expansion of offshore wind production. We need to ensure that any new supply will be able to meet the changing demands now and in years to come.

IBM is prepared to play a key role in this nuclear renaissance, from new builds to the revitalisation of existing nuclear assets, with solutions designed to extend the life of power plants. Through-life solutions have been designed to support developers and energy generation businesses at every stage of the nuclear new-build journey, from design and construction, through operation and maintenance, to final decommissioning.

And with UK energy consumption now at around 400 terawatt hours a year and the prospect of long-term demand increases, making the most of both new and existing infrastructure is going to be critical.

Adding a **stable and reliable nuclear fleet** to the country's energy mix is only going to **grow in importance** in the years ahead.

IBM Contacts

Steve Hornsby
Partner and Nuclear Industry Leader,
IBM Global Business Services
steve.p.hornsby@uk.ibm.com

Jon Bentley
Partner and Smarter Energy Leader,
IBM Global Business Services
jon.z.bentley@uk.ibm.com

References

1. “UK at forefront of a low carbon economic revolution”. UK Department of Energy and Climate Change (DECC) Press Release. 15 July 2009. http://www.decc.gov.uk/en/content/cms/news/pn081/pn081.aspx

2. “Delivering the UK’s Nuclear Renaissance – Vincent de Rivaz speech at Unite conference”. EDF Group Press Release. 24 Mar 2010. http://www.edfenergy.com/media-centre/press-news/Delivering-the-UKs-Nuclear-Renaissance-Vincent-de-Rivaz-speech-at-Unite-conference.shtml

3. “Smarter Nuclear in the UK: An IBM Point of View”. Steve Hornsby, Nick Archer and Loh Koon Tan. IBM. December 2009.

4 “Smarter Nuclear in the UK: An IBM Point of View”. op cit.

5. “Leading-edge data analytics and visualization enable breakthrough science on Argonne’s Blue Gene/P”. Argonne National Laboratory press release. 10 April 2009.

Part of a series of papers on IBM Smarter Energy

To read other papers in this series visit www.ibm.com/think/uk/energy

IBM United Kingdom Limited
76 Upper Ground
South Bank
London
SE1 9PZ

The IBM home page can be found on the internet at ibm.com

EUW03010

Recycled fibre content 50% post consumer waste, 25% pre consumer waste and 25% virgin fibre.