Innovate UK

Directory of projects

Nuclear Innovation Showcase
Collaboration Nation

Collaboration Nation

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Introduction

The UK's nuclear industry is undergoing a long awaited resurgence. Significant steps have been taken to secure investment in the construction of new nuclear power stations and R&D support has been committed to evaluate new technologies, including small modular reactors. This, combined with our legacy waste and decommissioning commitments creates a significant opportunity for innovative businesses in the UK to play a major role in both domestic and global markets.

Since 2012, Innovate UK, Engineering and Physical Sciences Research Council (EPSRC), Department of Energy & Climate Change (DECC) and the Nuclear Decommissioning Authority (NDA) have co-funded a portfolio of projects totalling around £50 million which has focused on developing an innovative and sustainable UK supply chain. We have been delighted to support a wide range of highly innovative projects, from drones to robotic spiders and technology transfer from sectors including Formula 1 and fisheries!

More importantly, we have engaged with companies who are completely new to the sector, bringing radical solutions to existing problems as well as connecting innovative SMEs with established nuclear suppliers.

This directory provides a summary of collaborative R&D projects funded in our 2012 supply chain competition and feasibility studies from our 2014 programme. We present their technology, project highlights and their proposed steps towards commercialisation. This will enable potential collaborators, investors and customers to connect with the companies involved and the exciting technologies they are developing.

Derek Allen

Lead Technologist, Energy, Innovate UK

EPSRC
Engineering and Physical Sciences Research Council

NDA
Nuclear Decommissioning Authority

Department of Energy & Climate Change

2014 Feasibility Studies

Arvia Technology Limited

An investigation into the use of the Arvia Technology in treating radioactive organically contaminated resins

This project investigated the use of the Arvia technology to treat radioactive organically contaminated resins, as well as another nuclear waste called squeezate. A big part of this project involved developing a new adsorbent which offered increased performance.

What was the business need that motivated the project?

There is a global market for the treatment of stored organically contaminated resins after they were found to be unstable. Consequently, nuclear sites that had stored these resins need to find solutions to transfer the radioactivity onto more stable resins for reconditioning and safe storage. If successful, the Arvia process could provide a treatment step required for such a solution. There are over 1200 cubic metres of resin stored across 20 sites in the UK alone with an estimated value of £600 million, represents a viable business proposition for Arvia.

What innovative approach did you take to address the challenge?

Arvia's innovative organic destruction allowed a cost effective treatment of the resins, and this innovation is proprietary to Arvia. This project also investigated the treatment of another nuclear waste, squeezate, which is combination of sweat and oils from nuclear decommissioning protective suits.

What are the expected benefits to industry?

A successful feasibility study will allow Arvia to roll out its treatment process across the nuclear sites as a solution to an ongoing problem. A similar approach will be taken for the treatment of squeezate.

What are the next steps towards commercialisation?

There are discussions with the nuclear industry regarding extensive trials of active resin treatment on their sites. Genuine interest in the treatment of squeezate has been shown by Sellafield, and discussions are ongoing regarding active trials on their site.

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Arvia Technology Limited

Submersible treatment of pond waters

The project involved the design of a submersible treatment unit as a solution to legacy ponds at Sellafield.

What was the business need that motivated the project?

Sellafield hosts most of the UK's radioactive waste, including radioactive material in water filled ponds designed to keep heat generating materials cool and a barrier to activity. These open air ponds store first generation Magnox waste, as well as nuclear fuel pile storage and contain millions of litres of contaminated water which poses the highest UK nuclear hazard. Arvia has developed a highly innovative process for the destruction of radioactive liquid organic waste through its patented technology which represents a potential solution.

What innovative approach did you take to address the challenge?

Building a submersible treatment unit to remove organics from pond water without creating an imbalance to the water content.

What are the expected benefits to industry?

This is a novel solution for the treatment of legacy ponds and could potentially overcome current storage issues associated with legacy ponds at Sellafield.

What are the next steps towards commercialisation?

Further development work in collaboration with industrial partners such as Sellafield to deploy full scale plant.

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Barrnon Limited

Feasibility - pre-industrial research of horizontal sludge dredge

The development of a remotely controlled horizontal dredge powered by a prime mover to collect hazardous sludge for reprocessing from ponds and lagoons at nuclear decommissioning sites.

What was the business need that motivated the project?

Large quantities of radioactive sludge held in water filled tanks require removal from nuclear decommissioning sites. Inability to remove this material efficiently was holding back the decommissioning process. Therefore a system capable of clearing this material was urgently required.

What innovative approach did you take to address the challenge?

Barrnon developed a fluidising head to extract sludge from an aqueous environment. The design was based loosely on Barrnons experience in the marine industry seeking to develop dredges for the collection of cockles.

What are the expected benefits to industry?

The dredge designed by Barrnon has advanced the collection of sludge from decommissioning ponds and lagoons providing an appreciable reduction in decommissioning timescales.

What are the next steps towards commercialisation?

By adapting the basic head design into a vertical series head, a vertically operated tool has been developed enabling a wide variety of sludges to be removed from skips and confined areas quickly and efficiently. We have formed an alliance with tier 2 companies to introduce the technology to decommissioning sites across the world.

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Create Technologies Limited

SeeSnake

Partner organisation
O C Robotics

The project combined the N-Visage™ radiation mapping technology with snake arm manipulators to enable accurate radiological characterisation of nuclear plants which are problematic to access by conventional means.

What was the business need that motivated the project?

The project has enabled a step change in capability for both partners. Createc's intention is to extend the range of N-Visage options so that we have a solution for every nuclear characterisation challenge. For OC Robotics, this project has enabled real-time 3D mapping and contamination analysis when combined with the Lasersnake technology will enable a snake arm system to undertake the full range of activities required to dismantle contaminated metalwork. The combined system would be a remarkably powerful, generic tool for nuclear decommissioning.

What innovative approach did you take to address the challenge?

The innovation lies in the level of integration of the two technologies. The project investigated utilising the snake-arm mechanism as part of the N-Visage™ scanning system; this required the development of a reusable snake-arm control interface for third-party sensors and systems.

What are the expected benefits to industry?

The ability to determine the location and size of radiation sources in difficult to access areas, with high levels of radiation and contamination is a significant technical challenge and is fundamental to the planning stage of projects and liability estimates. SeeSnake is a step forward in obtaining this data.

What are the next steps towards commercialisation?

We hope to prove the technology at Sellafield with the LaserSnake project through deployment using the Active Demonstrators Programme. Fukushima continues to be the most prominent short-term application of the SeeSnake concept. This is also an opportunity to create a hand-held instrument based on the SeeSnake sensor package.

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Energy Process Developments Limited

Study of the feasibility of setting up and operating a pilot-scale nuclear molten salt reactor (MSR) demonstration

The Energy Process Development (EPD) feasibility report, released July 2015, concludes funding, not science/R&D, is key for immediate innovative MSR design implementation. A review of six valid designs pointed to Moltex Energy's Stable Salt Reactor for immediate UK investment.

What was the business need that motivated the project?

A global market valued at a trillion dollars is estimated for new nuclear build including innovative fission technology. Potential UK entrants for innovative technology are well placed if there are appropriate investments by government and industry. Ultimately Molten Salt Reactors may emerge as dominant because they are safe and can be engineered to be a potential low cost option. This feasibility study was directed towards informing all interested parties of this. Without defined business plans for routes to market, this study was directed towards long-term public good rather than to short-term gains.

What innovative approach did you take to address the challenge?

From inception, industry-standard nuclear reactors were solid-fuelled. To introduce liquid-fuelled reactor technology to interested parties is itself innovative. Otherwise, standard engineering procedures were used to review molten salt reactor designs that were available for implementation. The team's maxim: "if facts change, we change our minds" – truly innovative, surely no?

What are the expected benefits to industry?

During the study period, established nuclear industry were found to be largely averse to new liquid-fuelled reactor technology. There have been rapid changes here, coincidental with this feasibility study. UK government recently announced £250 million of new funding for nuclear R&D, a proportion of which will be allocated to small modular reactors, a category that includes the MSR.

What are the next steps towards commercialisation?

UK government is undertaking a techno-economic appraisal of designs for a Small Modular Reactor to be completed in 2016. The feasibility study team has aligned with Moltex Energy LLP which has provided one of the submitted designs. This can be a first step. There are other possibilities under consideration.

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Ferroday Limited

Interoperability for ultrasonic NDT data

Used an information model standardised in ISO 10303-235 for the digital representation of product and process details and the results of inspections for defects by three different ultrasonic detection methods.

What was the business need that motivated the project?

To demonstrate the scope and flexibility of the International Standard developed by Ferroday Ltd and to obtain realistic use-cases to demonstrate new software that implements the Standard.

What are the expected benefits to industry?

Easier communication and integration of data between different software systems, independence of data representation from proprietary software, conservation of data for comparison with future inspections, quality control and quality assurance of the digital data representation.

What are the next steps towards commercialisation?

Complete a new version of the ISO standard based on the lessons learned in the study, complete the development of the software, trial the use of the software and the models in commercial applications.

What innovative approach did you take to address the challenge?

Developed views of the standard model to capture the details of the products, the inspection processes and results for three use-cases. Developed new web based software to manage the model views and the input of the results. Developed web based tutorials and help methods to assist the understanding of the model and the software.

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Fiberstone Products Limited

Feasibility study to develop DEnsification processing of a Ceramic MAtrix composite material for Nuclear waste containment (DECMAN)

Partner organisation
The University of Cambridge

The aim of the project was to determine whether the porosity of Fiberstone composite material could be reduced using mechanical squeeze casting and vacuum technology. Computer modelling was developed to predict the porosity and permeability of the material and compared with empirical measurements.

What was the business need that motivated the project?

The competition identified waste management and storage as one if its central themes. The decommissioning market is estimated to be worth £50 billion pa by 2020, with between 82 and 145 reactors being retired by 2030. There is a clear demand for nuclear waste containment vessels that satisfy a range of demanding requirements at relatively low cost. FIBERSTONE™ composites already have a demonstrable track record of satisfying the demands of toughness, strength, chemical and physical inertness in a range of onerous industrial applications. In order to be considered for nuclear waste containers it was important to reduce its porosity and permeability. The company identified that the subsequent improvements would open up a new market for the product.

What innovative approach did you take to address the challenge?

We decided to look at the possibility of reducing porosity by using external squeezing and vacuum to remove gases trapped in the FIBERSTONE™ material. We also examined changes to the Fiberstone material itself. The measurements were used to develop a computer model to better understand the porosity and permeability of the material.

What are the expected benefits to industry?

Assuming the project was successful, FIBERSTONE™ could be used as a lower cost replacement of existing storage systems for long term safe storage of low and intermediate radioactive waste streams.

What are the next steps towards commercialisation?

Further work is required using coatings to reduce permeable porosity. One of the technologies studied in the feasibility study will be developed further to speed up production of parts and improve cost competitiveness.

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Forth Engineering Limited

Development of a robotic spider for remote characterisation and retrievals

Partner organisation
The University of Manchester

Development of a hydraulically powered robotic spider equipped with powerful grippers and cutting tools which will be able to manoeuvre around legacy ponds on Sellafield and assist in the Nuclear Decommissioning programme.

What was the business need that motivated the project?

The aim was to develop a working Remotely-Operated Vehicle (ROV) that could manoeuvre itself across the difficult harsh terrain of a legacy pond. Existing ROV's such as tracked vehicles have proved ineffective and so having a hydraulically powered "spider" which can "tip-toe" over difficult terrain and be powerful enough to grip and cut items such as scaffold poles was our objective.

What innovative approach did you take to address the challenge?

We used the vast knowledge of hydraulics we have within our company and through the use of a knowledge transfer partnership brought in a post doctorate in Robotics, Mecatronics,and Computer Science which has enabled the innovative approach we are developing to address the challenge.

What are the expected benefits to industry?

The benefits are that the legacy ponds should be able to be tidied up in a safe, effective manner. The process will be carried out remotely and should aid in the decommissioning programme.

What are the next steps towards commercialisation?

Developmemt of the prototype will continue, and we will seek to demonstrate the spider to all interested parties over the course of the next 12-18 months either on-site or at our own deep recovery facility.

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GeoRoc Limited

Large-scale hot-isostatic pressing of waste forms for the treatment of Magnox sludge and other wastes

The project produced a commercial scale proof-of-concept for the immobilisation of Sellafield sludges using Hot-Isostatic Pressing (HIPing). This solution provides a safer, more durable wasteform and a 12-fold reduction in waste volume over the baseline method.

What was the business need that motivated the project?

To develop the business case for Hot-Isostatic Pressing of radioactive wastes at Sellafield it is necessary to demonstrate the technology can be applied at an appropriate scale. This project allowed GeoRoc Limited to prove that HIPing is a commercially relevant technology worthy of further investigation. The success of this project has opened access to an international market potentially worth billions, while the technology proposed also has the ability to realise large savings to the UK tax-payer if adopted.

What innovative approach did you take to address the challenge?

To achieve the project aims in the most cost effective manner, innovative working practises were utilised. This involved the use of numerous process experts and pilot facilities. GeoRoc Limited also developed advanced canister and wasteform process technology to achieve success.

What are the expected benefits to industry?

The ability to produce at least a 12-fold reduction in waste, both safely and efficiently, will significantly reduce the lifetime waste management costs to Sellafield Ltd and the UK tax-payer. This saving is conservatively estimated at ~£890 million. The canister technology developed by GeoRoc Limited also has numerous potential applications.

What are the next steps towards commercialisation?

GeoRoc Limited are continuing to increase the technological maturity of HIP technology. This includes engineering and operating an integrated pilot plant, proving the process flexibility and producing radioactive samples. GeoRoc Limited is communicating the benefits of this technology widely to waste holders and regulatory bodies around the world.

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Heat Trace Limited

Feasibility study into novel new materials for heat tracing applications inside nuclear containment

The objective of this project was to develop a self-regulating (SR) trace heating cable, suitable for use in the nuclear industry. SR heaters have the potential to offer significant energy savings compared to existing technology.

What was the business need that motivated the project?

SR type heaters are commonly employed in the oil and gas sectors for the purposes of freeze protection and the maintenance of process temperatures. SR technology offers a number of advantages over constant wattage heaters, namely mineral insulated (MI) types, which appear to be the technology of choice for nuclear trace heating solutions. Traditional MI cables do not offer the flexibility associated with their cheaper SR counterparts and must be designed specifically for a given circuit length, cable terminations prepared off site prior to installation.

What innovative approach did you take to address the challenge?

Historically, silicone rubber (SiR) has been used in jacket materials for energy distribution cables. SiR is not commonly used for SR heaters and a prototype was manufactured using a SiR formulation. Radiation exposure testing in progress at AMEC Foster Wheeler, Harwell to benchmark prototype performance against existing cables.

What are the expected benefits to industry?

SR heater performance is temperature dependent, heater power output decreases as the temperature of its surroundings increases. SR heaters offer significant energy savings compared to constant wattage types. In addition, they can be cut to length and on site modifications such as re-routing of cables can easily be accommodated.

What are the next steps towards commercialisation?

We are currently awaiting the completion of a radiation exposure study at AMEC which is due to finish August 2016. Cables have been subjected to dose rates in accordance with international standards and those typical of operating conditions experienced in a nuclear power plant. Results to date are extremely encouraging.

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Hybrid Instruments Limited

Tribeca

Partner organisation
Lancaster University

The main objective of the project is to develop a prototype solid scintillator-based radiation detection instrument for fast, accurate and precise detection and measurement of waterborne tritium.

What was the business need that motivated the project?

Tritium handling for decommissioning of legacy reactors has been identified as a global economic growth opportunity in the government's Nuclear Energy R&D Roadmap. Contract analysts have reported a fourfold upswing in requirements for tritium analysis over the last ten years. One site alone advises that their expenditure on such measurements is almost £500,000 per annum. An area of urgent need is on sites of nuclear accidents, notably Fukushima Daiachi. Low concentrations are notoriously difficult to measure.

What innovative approach did you take to address the challenge?

Our approach is to exploit a new electrochemical process for the selective pre-concentration of tritium from dilute solutions of tritiated water into palladium metal. This process is subject of a patent application. The palladium is incorporated into a solid scintillator for detection by photo-multiplier.

What are the expected benefits to industry?

Industry will benefit from the replacement of expensive, time consuming post-sampling analysis using laboratory based liquid scintilllator systems with a much cheaper in-situ measurement of tritium concentration with greater sensitivity.

What are the next steps towards commercialisation?

This feasibility project has brought the technology to technology readiness level 5 (TRL5). Advance to commercialisation will require further funding and will be with industrial and site operators as partners. Discussions are taking place with several potential partners which has revealed some parallel opportunities for the technology.

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Ionix Advanced Technologies Limited

Stability of piezoelectric materials for nuclear applications

Partner organisation
National Nuclear Laboratory

The project objective was to determine the resilience of a new piezoelectric material to nuclear operating conditions. This enables physical measurement devices for use in extreme environments, such as crack monitoring. We successfully demonstrated the robustness of the materials to nuclear flux.

What was the business need that motivated the project?

The industry need to "take measurement to the extreme" which was a key driver. Being able to perform extreme environment crack and corrosion monitoring will enhance productivity due to reduced downtime, reduce maintenance and operating cost, and enhance safety.

What are the expected benefits to industry?

The devices developed will enable continuous extreme environment crack and corrosion monitoring. This will enhance productivity due to reduced downtime, reduce maintenance and operating costs, enhance safety, with benefits in the order of £millons.

What innovative approach did you take to address the challenge?

We proved the ability of Ionix materials to withstand high gamma radiation at high temperature, for short periods. This was using a new set-up we designed for use at the Dalton Cumbria facility to demonstrate Ionix materials working successfully under the required operating conditions. This provides the base from which we can develop and test measurement devices.

What are the next steps towards commercialisation?

The next step will be to look at how Ionix measurement devices perform physical measurements, stand up to these environments, with the added complexity of packaging and electrical interconnects. We are exploring funding avenues and industry interest for the next steps.

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Kromek Group plc

High dynamic range spectroscopic radiation detectors

Aim was to establish the feasibility of novel high resolution spectroscopic radiation detectors with a larger dynamic range than currently available devices, thereby covering a dose range typically encountered in nuclear power generation scenarios.

What was the business need that motivated the project?

Within the civil nuclear power supply chain there is a need for high dose rate radiation spectrometers which cannot be satisfied with existing equipment. Locations within nuclear power station environments have radiation levels which can vary by many orders of magnitude. These may be encountered at any stage from initial commissioning and operation to end of life decommissioning. Such radiation measurements must be taken as part of safe working practices and routine monitoring. The new instruments will remove the need for multiple detectors to be carried for different environments; speed up measurements and decisions; improve safety and reduce cost.

What innovative approach did you take to address the challenge?

An innovative pixel design was investigated; For IPR reasons this cannot be expanded upon at this time.

What are the expected benefits to industry?

This novel detector will reduce the number of detectors that must be installed, or that a worker has to carry. It will also allow quick adaptation to changing environments, improving worker safety, data accuracy and minimizing time while reducing operational and maintenance costs.

What are the next steps towards commercialisation?

As the project moves from prototype to product customer feedback will be essential. We expect real world constraints on size, weight, power and environmental capability to be important and seek partners to provide input here. Conversion to final product will require additional financial support.

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LabLogic Systems Limited

Novel system for localised, real-time radiometric measurements of ground water at civil nuclear sites

Design, development and testing of a novel on-line ground water monitoring system with the capability of extracting and characterising samples on a periodic basis via remote operation.

What was the business need that motivated the project?

The periodic monitoring of ground water samples in and around civil nuclear sites is of key importance, both in terms of ensuring that any possible contamination resulting from leaks or spills is detected in a timely fashion and to satisfy the regulatory demands of the Office for Nuclear Regulation and the Environment Agency. The current well monitoring process is resource heavy in terms of both the cost and time required to obtain, analyse and collate the data arising from measurements of ground water samples. The system developed here aims to automate much of this process in order to increase the throughput of ground water sampling to provide full non-radio- and radio-metric characterisation.

What innovative approach did you take to address the challenge?

This project has been innovative in applying existing measurement principles employed in drug development. The challenge was met through the application of a combination of hardware and software elements to provide a cost-effective, reliable and long-term measurement solution. A quicker sample analysis time results and also provides capability for remote campaign measurements.

What are the expected benefits to industry?

The system presents an economical solution to obtain and present accurate and continuous data that is more cost-effective than the processes employed at present. The low running costs and high reliability also contribute to the economic operation. Small sample volumes present a reduction in waste production that is also of benefit and a field-based remote solution reduces the environmental impact.

What are the next steps towards commercialisation?

A site trial is due to take place with a nominated borehole at Sellafield during Spring 2016. Following the results of the trial, it is envisaged that a further 6-9 months of R&D effort to refine the design and operation will enable the complete system to be available to the market by the end of Q1 2017. Other applications within the civil nuclear sector are also being investigated.

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Metamet Consultants Limited

A condition-based structural integrity and remaining life model for austenitic stainless steels

Partner organisation
John Brear - Plant Integrity Ltd

Three stainless steels were subjected to extended laboratory heat treatments. A model was developed to correlate the life-limiting degradation of creep, tensile and impact properties with the precipitation of deleterious precipitation particles.

What was the business need that motivated the project?

There are structural integrity issues arising from the continued life extension of the AGR fleet- in particular with the austenitic stainless steels used in the heat exchangers for tubing and supports. These materials, operating in the creep regime, are subject to potentially life-limiting degradation of mechanical properties, as a result of the precipitation of various particle species within the material over time. There is a need to assess the remaining life of plant from the examination of the metallurgical condition of the materials.

What innovative approach did you take to address the challenge?

New methods were developed for classifying and quantifying precipitation species after extended heat treatments. An innovative preliminary model was developed which correlates the quantitative assessment of the precipitation species with the measured degradation in mechanical properties (creep, tensile and impact).

What are the expected benefits to industry?

When fully developed the model will be an important tool in assessing the structural condition and remaining life of high temperature plant. The benefits will accrue from potential life extension of plant beyond the initial design and in the potential avoidance of service-limiting failures.

What are the next steps towards commercialisation?

A subsequent project is being developed extending the data to realistic times and temperatures for the AGR fleet. This will produce a prototype model for commercial exploitation, either directly or by licensing. The techniques developed are currently being exploited in plant life assessment in the petrochemical industry.

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Metrix NDT Limited

Metrology using Optical and X-ray Inspection - MOXI

This project evaluated the feasibility of an improved Non Destructive Testing (NDT) instrument that simultaneously produces and combines high resolution optical measurements of the surface and detailed internal X-ray computerised tomography (CT) model of a test sample.

What was the business need that motivated the project?

NDT techniques remain at the core of the manufacturing quality assurance, however, current x-ray CT systems are prohibitively expensive for the average SME. MOXI provides a concept that enables SMEs to acquire x-ray NDT equipment at a cost around 5 to 10 times lower than the current top end systems.

What innovative approach did you take to address the challenge?

This project combined the data obtained simultaneously from two separate inspection modalities (x-ray and optical scanning) to provide the inspector with a high resolution optical surface map wrapped around a slightly lower resolution CT model.

What are the expected benefits to industry?

The eventual outcome of this project will be a more cost effective solution for in-house NDT and enable a wider range of SMEs, to enter the supply chain to high integrity industries such as nuclear, oil and gas, aerospace and automotive, all of which demand a high degree product quality assurance.

What are the next steps towards commercialisation?

The feasibility study highlighted the opportunity to produce a range of x-ray cameras – MetCAM. The most basic of these, an in-line, line scan camera has already generated orders for the company. However, there is still substantial work required to develop the full MOXI concept before any product could be launched.

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Metrosol Limited

Development of a driftless thermometer to improve safety and efficiency in the nuclear power industry

Partner organisation
National Physical Laboratory (NPL)

The design, building and testing of a proof of principle prototype, drift-free, Johnson Noise Thermometer (JNT) that can operate in the harsh environment found within a nuclear power station.

What was the business need that motivated the project?

The provision of an accurate and driftless thermometer will improve safety and efficiency within the civil nuclear power industry. The lack of drift means that operators can continue to run the power plant at higher temperatures whilst maintaining safety through the whole life of the plant. Even a small increase in the operating temperature with its associated efficiency increase will have a significant increase in total energy output and therefore revenues over the long plant life. It will also reduce carbon emissions from the electricity industry by displacing base load generating capacity from fossil fuels.

What innovative approach did you take to address the challenge?

A new JNT (patented) was developed that removes commutation (switching amplifier inputs to provide a reference) and allows the generation of much higher Johnson Noise signals. We also developed effective electromagnetic interference (EMI) shielding, a simultaneous calibration current system and advanced digital signal processing using Fast Fourier Transforms (FFT).

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What are the expected benefits to industry?

We have developed a driftless, fundamental temperature measuring technique that allows true thermodynamic temperature measurements directly from a purely electrical measurement with no calibration requirement. Our system operates over a wide temperature range and does not require periodic calibration or changing of the sensor to maintain accuracy.

What are the next steps towards commercialisation?

Having developed a proof of principle prototype, the next stage is to develop a fully engineered, pre-production prototype. We are already in contact with companies involved in tier 1 supply to the nuclear industry in the temperature measurement field. We also have offers to test our system in “real world” harsh environments including the core of experimental nuclear reactors.

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MicroLab Devices Limited

Modular radiochem sample analysis for integrated fast and cost efficient workflow

Partner organisation
National Nuclear Laboratory

Automation and Optimization of the radiochemical separation workflow. This project analysed and developed solutions to the key areas from sample preparation, separation techniques and finally automated analysis.

What was the business need that motivated the project?

Radiochemical sample analysis is still a very manual and labour intensive process. This project followed on from a previous project which automated separation using microfluidic technology. Here this project looked at the front and back-end procedures to provide a fully automated solution. The business need is that automation provides increased efficiency, through-put, safety and repeatability.

What innovative approach did you take to address the challenge?

We have investigated and developed technology ranging from microfluidics, through to microwave digestion and ICP-MS. It is not about using the latest technology but using the best and optimum technology to address workflow goals. Using a combination of existing and new technology complimented by automation was the approach taken.

What are the expected benefits to industry?

Improved sample processing - faster, more efficient, less waste and cost. Reduced operator dose and sample/result consistency along with a compact foot print meaning less expensive lab space.

What are the next steps towards commercialisation?

We are working with a number of labs and end users to hone this technology to improve their workflows.

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Nuclear AMRC

Enhanced learning through the use of virtual, augmented reality and simulation

Partner organisation
EDF Energy, GSE Systems

The feasibility of large volume 3D scanning used in combination with virtual reality (VR) to contribute to enhanced employee learning, power plant operational efficiencies and improvements in maintenance activities in a nuclear power station environment was investigated.

What was the business need that motivated the project?

Planning for activities during outage periods is difficult due to the scale of the environments involved and the limited periodic access available. It was thought that large volume 3D scanning used in combination with virtual reality could contribute to enhanced employee learning, power plant operational efficiencies and improvements in maintenance activities in a nuclear power station environment.

What innovative approach did you take to address the challenge?

Laser scanning is a recognised technology for data capture in architecture. To investigate the feasibility of 3D scanning as a suitable data capture method in the nuclear environment, a set of trials were conducted at EDF Hinkley Point B power station. By visualising the data in VR, greater levels of understanding were achieved.

What are the expected benefits to industry?

The ability to capture and visualise accurate as-built representations of facilities which only have periodic access allows the use of these models for enhanced communication and outage planning. This means that there are huge potential savings in term of planning time, transfer of best practice and stakeholder engagement.

What are the next steps towards commercialisation?

The technique has been proven and demonstrated to EDF's UK outage managers community. Further alignment with EDF group practise is planned. Adoption as a verified technique will allow the further development of hardware and software integration.

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O C Robotics

LaserPipe - Remote in-bore laser welding of nuclear pipelines

Partner organisation
TWI Ltd

LaserPipe is an Innovate UK funded R&D project looking into the feasibility of in-bore pipe welding using industrial high-powered lasers, coupled with snake arm robotics for hazardous or confined space deployment.

What was the business need that motivated the project?

Regular plant maintenance of nuclear facilities is required to replace deteriorated, often corroded, pipes. Nuclear plant is a challenging environment, and often with limited external access to the pipes. External orbital cutting and welding processes are not viable. LaserPipe investigated the feasibility of combining two innovative technologies: snake-arm robots and fibre lasers, to advance and demonstrate reliable remote welding from inside of pipework, where external access is limited.

What innovative approach did you take to address the challenge?

The combination of snake-arm robotics for confined/hazardous space operations and industrial laser welding is a totally radical approach to a serious challenge. LaserPipe has proven the concept is sound through extremely encouraging results.

What are the expected benefits to industry?

For nuclear maintenance and decommissioning the ability to deliver high powered lasers through existing pipework to otherwise inaccessible locations has a number of benefits; welding new section of pipework but also cutting sections using the same/similar technology.

What are the next steps towards commercialisation?

OC Robotics are already in discussion with number of stakeholders interested in the further development of LaserPipe. The next stage is to identify key use-cases which will shape the form, fit and function of LaserPipe as it matures towards commercialisation. Key technical enhancements will be the miniaturisation of the tool and dispensing with the outer shielding collar.

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Somers Forge

TransForge - Production of forged dissimilar metal transitions for improved reliability in new nuclear power plant

Partner companies
TWI

Trying to improve the reliability of transitions in nuclear power plants

What was the business need that motivated the project?

High failure rates at weld joints between carbon steel and austenitic alloys in nuclear pressure vessels and the associated difficulty of inspecting joints inside the reactor calls for a new approach to connections. These failures result in significant additional costs due to ongoing inspection and repair work.

What innovative approach did you take to address the challenge?

Removal of the need for an in-situ dissimilar weld by production of welding and re-forging dissimilar metals to make a fully consolidated composite forging. This unique component can be welded on site through traditional welding methods.

What are the expected benefits to industry?

Reduction in failure rates, and an increase in available plant hours due to reduction in downtime. Improvement in safety standards through standardisation of a novel transition piece which could reduce the risk to plant manufactures through elimination of in-situ welding of dissimilar metals.

What are the next steps towards commercialisation?

Further testing is required to prove the longevity of the product in a corrosive and radioactive environment. This would include research into the relevant accreditation requirements and market requirements. Research will also be conducted to diversify the technology, allowing further applications in markets such as forge tooling.

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Sound Mathematics Limited

Composite model-based signal and image processing algorithms for semi-automated crack characterisation

Under this project a code has been produced, utilising freely available image processing algorithms, grouping the images, assessing the probability of the results. It is applicable to characterising planar cracks. in walls of nuclear reactors.

What was the business need that motivated the project?

This project aims at automating aspects of inspection of components of nuclear power plant using ultrasonic Non-Destructive Evaluation, significantly speeding up and improving quality, accuracy and reliability of ultrasonic inspection and therefore operation of both new and existing plant. The cost-effective safe inspection solution focuses on the development of fast algorithms for crack characterisation, with a view of bringing the company's crack characterisation software to market, developing a steady source of revenue.

What innovative approach did you take to address the challenge?

We are developing a novel combination of signal processing algorithms, known image processing algorithms and elements of artificial intelligence. We are doing this to generate one or more inspection reports, which offer human inspectors a choice of possible conclusions with regard to presence, size, orientation and position of large cracks.

What are the expected benefits to industry?

There is a commitment globally to building new nuclear power stations and extending the life of existing ones and a shift towards fast automated data collection during their inspection. However, data interpretation is still done by human inspectors and a severe shortage of suitably qualified personnel is anticipated.

What are the next steps towards commercialisation?

A collaboration with leading vendors of ultrasonic equipment, end-users and insurers.

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STS Defence Limited

Project CLAIMS (Coolant Leak Artifically Intelligent Monitoring System)

Project CLAIMS (Coolant Leak Artificially Intelligent Monitoring System) will provide a technology demonstrator, of an advanced automated condition monitoring system for detection and classification of leaks from the primary circuits of light water reactors.

What was the business need that motivated the project?

The business motivation was to develop the underpinning technology for an eventual solution to reduce the costs associated with unplanned downtime due to small leaks in pressurised water reactors e.g. Oconee-1 plant 18 day shut-down in 2013, which, based upon accepted values of levelised electricity cost, can be calculated as a loss of sales to the operator, Duke Energy, of the order ~$32 million.

What innovative approach did you take to address the challenge?

The Innovation approach is to use relatively low-cost sensors in the lagging around reactor pipework, coupled with fault detection algorithms, based upon prior background IP relating to detecting primary circuit leaks in naval PWRs, to detect very small leaks.

What are the expected benefits to industry?

The expected benefit is the eventual development of an advanced, and completely retro-fitable, system in the Surveillance, Diagnostics and Prognostic area as defined by the IAEA, capable of detecting and classifying small leaks.

What are the next steps towards commercialisation?

The next steps would be to scale up to produce an early prototype based upon a section of the lagging used on reactor pipes, and use in-situ. This would be required to collect additional 'healthy' data over and above the leak data trialled already and demonstrate in a representative environment.

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Symetrica Security Limited

New Techniques for the rapid characterisation of low-level waste and surface contamination

Partner companies
Cavendish Nuclear

The project aim is to validate a new technique to quantify the amount of each gamma-ray emitting radioactive element that is present in an inspected area using a hand portable gamma-ray spectrometer.

What was the business need that motivated the project?

This new technology could lead to a very substantial reduction in the time taken to make certain routine observations in the area of land-remediation studies and the clearance of bagged-waste materials for safe disposal. The application of this technology could displace the need to use cooled germanium spectrometers, except for a very limited number of applications, making it a cheaper and easier to use solution.

What innovative approach did you take to address the challenge?

We use a novel technique by which accurate isotope-identification and quantification data can be derived using a new version of the proprietary techniques that Symetrica have developed in the Homeland Security field.

What are the expected benefits to industry?

Significant financial advantages can be achieved in nuclear waste management, site restoration and decommissioning through the ability to make use of less expensive instruments and, in some cases, achieving a dramatic reduction in the time needed to make an observation.

What are the next steps towards commercialisation?

Results from this study feed into Innovate UK funded project Smartscan, where we will develop, commission and test a gamma and a neutron assay system. Smartscan will provide peer-reviewed capability in realistic measurement challenges with key customers with insight into operational costs and efficiency of new assay tools.

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Tacit Connexions Limited

Improving the decommissioning process with intelligent semantic building histories

Our Smart Wiki software was configured to provide a collaborative system that is secure, employs intelligence and Q&A Wizards, and reasons about users' intentions to automatically assemble contextual information, data and 'know-how'.

What was the business need that motivated the project?

Sellafield Limited identified a key area for improvement where innovation in capturing, managing and disseminating the knowledge and expertise of their staff could be applied more efficiently and effectively to Post Operation Clean-Out (POCO) and Decommissioning of buildings where facilities had been in operation and where incidents may have occurred. A key need was to improve the speed, quality and completeness of information gathered about the operational history of the particular building or facility to aid its characterisation (radiological, chemical, structural, etc.), prior to POCO and decommissioning.

What innovative approach did you take to address the challenge?

No other real-time reasoning system is used in the nuclear sector to: improve information and data use; allow best practice to be shared across the community; offer continuous improvement capabilities; take inputs from many different sources; combine technologies of Smart Wikis, knowledge-based (AI) systems, ontologies, cyber security and data integration.

What are the expected benefits to industry?

Significant reductions in the time needed for retrieval of all contextual information and data, for completeness of search, for quality of results, and for minimal rework all result in shorter user cycle times and cost savings. Other applications of Smart Wiki technology show audited cost savings in excess of 20%.

What are the next steps towards commercialisation?

Since project completion in August 2015, Smart Wiki solutions have been configured for clients in non-nuclear supply chain sectors including hi-tech manufacturing, aerospace, legal, utility, and defence. Preliminary discussions with one of the nuclear SLCs are on-going. Demonstration of the Smart Wiki software as configured for Sellafield is available on request.

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XCAM Limited

In-situ monitoring of Tritium and Carbon 14 in groundwater

Partner organisation
Sellafiald Ltd

The project explored the feasibility of developing a novel instrument to sample water in-situ, in boreholes, for water borne Tritium, providing continuous monitoring, alarms and reducing worker radiation exposure.

What was the business need that motivated the project?

Tritium in groundwater is a major contaminant and pre-cursor to other contaminants occurring in groundwater discharge plumes. Current monitoring for Tritium is through manual collection of samples from boreholes which are sent to a lab for processing. The manual collection process can expose workers to radiation. Results take 4-6 weeks providing only a small snapshot of levels and preventing tracking of trends and early alert of a leak. Sellafield Ltd had identified that an in-situ tritium monitoring solution would deliver benefits through provision of alerts and continuous measurement.

What innovative approach did you take to address the challenge?

The prototype utilises a novel silicon sensor based solution to directly sample the water under test. The unit is waterproof, compact and has the potential to be size reduced to allow it to be left in the borehole for continuous sampling with external communications for reporting.

What are the expected benefits to industry?

The development has the potential to deliver a solution which provides continuous sampling, tracking of tritium level trends and alarm in the case of a leak rather than waiting a number of weeks or months as current procedures. In high radiation areas it will allow measurement while reducing personnel exposure to radiation.

What are the next steps towards commercialisation?

The project has delivered a prototype, demonstrating detection to c.1500bq/l making it suitable for monitoring boreholes with higher contamination levels. A development project will be required to deliver a production unit in either a well-head or down-borehole form factor incorporating external communications and data logging.

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2012 Collaborative R&D projects

Beran Instruments

Intelligent condition monitoring for civil nuclear structures

Partner organisation
EDF Energy, University of Bristol

Building on the potential 25% time-saving for machine fault diagnosis demonstrated in an earlier Innovate UK funded feasibility study, the project's goal was to further the integration of Intelligent Condition Monitoring in the Nuclear Power Industry, facilitating the expansion of condition monitoring to balance-of-plant.

What was the business need that motivated the project?

Increasing the coverage of condition monitoring in the Nuclear Industry is currently constrained by the labour-intensive manual processes required to configure and screen plant for exceptions. This results in the sub-optimal monitoring of balance-of-plant, leading to costly preventative or corrective maintenance strategies, and increasing the risk of unplanned outages. We identified the need to develop automated data processing technologies that identify key features and trends in measured data, facilitating the expansion of condition monitoring to balance-of-plant, and enabling the industry to improve system-wide asset availability and cost-savings.

What innovative approach did you take to address the challenge?

Working collaboratively with EDF Energy and the University of Bristol, we built on the outcomes of the feasibility project. Exploiting the last ten years of EDF Energy historic fleet data, we incrementally developed innovative technologies that individually held potential for exploitation and, when coupled as a system, provided an advanced data screening engine.

What are the expected benefits to industry?

The initial feasibility study identified potential 25% saving in time taken to perform routine condition monitoring. The outcomes from the Product Demonstrator are expected to sustain this enhanced performance, improving the nuclear industry's condition monitoring coverage to wider assets, thus enabling development of optimised maintenance strategies and increasing through-life cost savings.

What are the next steps towards commercialisation?

We intend to modularise and re-profile the technology into production quality code supporting sustainability and exploitation. A pre-production prototype will be developed that will enable additional trials by our customer base, enabling refinement, ready for deployment into products targeted at nuclear, conventional and renewable power industries and diversification into aerospace markets.

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C-Tech Innovation Limited

ELectrochemical ENhancement of Nuclear DEcontamination Solutions 2 (ELENDES)

Partner organisation
National Nuclear Laboratory

The ELENDES projects scaled up and nuclearised a patented electrochemical process for removing chloride and organics (i.e ETDA, formic acid) from spent decontamination solutions generate during nuclear decommissioning operations.

What was the business need that motivated the project?

Large amounts of infrastructure from the civil nuclear programmes are to be decommissioned over the next 50+ years. During the decommissioning process it is often desirable to remove surface contamination in order to reduce hazard to workers and simplify further processing operations (e.g. providing man access for cutting and size reduction operations). Wet decontamination procedures are commonly employed for this purpose, which generate large volumes of liquid effluent. Management and disposal of effluent is a limiting factor in deployment of wet decontamination processes.

What innovative approach did you take to address the challenge?

The combination of the development of customised aggressive decontamination agents, which without ELENDES could not be disposed of, with a specially designed radiation resistant electrochemical cell, which removes the halides and organics thereby allowing downstream effluent treatment, offers a true step change in decontamination technology.

What are the expected benefits to industry?

Benefit is derived by decoupling decommissioning from central treatment facilities, hence accelerating decommissioning activities and reducing lifetime costs and reduction in waste volumes. Contaminated pipework can be reclassified as lower level waste, or in some instances unclassified and recycled and consequently the amount of waste entering repositories will be minimised.

What are the next steps towards commercialisation?

The technology has been proven on 1L batches of active solution and 10L batches of inactive simulant solutions. The next stage is to prove the 10L pilot rig in active trails before deployment of the technology at Site License Companies undertaking post operative cleanup operations and decommissioning of steel plant.

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Costain

Plasma vitrification of intermediate level waste

Partner organisation
Tetronics International

We have developed and proven a plasma vitrification furnace for the treatment of a wide variety of Intermediate Level Wastes and demonstrated significant volume reduction can be achieved.

What was the business need that motivated the project?

The estimated inventory of Intermediate Level Waste generated by the UK's existing and legacy sources is 290,000 cubic metres. Over 90% of this waste plus any future waste from new sources is yet to be processed, packaged and stored. Conventional nuclear waste treatment processes based on cementation usually result in a significant increase in waste volume. Plasma vitrification can result in a significant volume reduction whilst at the same time enhancing the waste stability to allow safe, long term storage.

What innovative approach did you take to address the challenge?

There is extensive experience of using vitrification to process hazardous wastes but it has not been used in the UK nuclear industry. The main challenge was to demonstrate that the approach could be adapted to meet the challenges of the nuclear sector. This required innovations to ensure that all the challenges of remote handling, off-gas treatment and the nuclear safety case were addressed.

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What are the expected benefits to industry?

The process can handle a high throughput and is flexible to a wide variety of solid and liquid waste types. Using plasma heating, a ten-fold volume reduction can be achieved by converting the waste to a stable glassy form. This creates the opportunity for significant cost savings which are critical to the implementation of a safe and affordable long term storage solution for the UK's radioactive inventory.

What are the next steps towards commercialisation?

We have already built a test facility and demonstrated the technology on simulated waste with positive results. The next step is to prove the technology by treating active waste. We are currently seeking opportunities which will enable us to do this.

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Cybula

Monitoring Complex Assets using Patterns in Signal data (MCAPS)

Partner organisations
EDF energy nuclear generation and EDF SA

The project aimed to demonstrate the value of archived performance data from a large fleet of rotating machinery operated by EDF NG using Cybula's pattern matching tools could be used to detect and diagnose anomalies across a fleet of assets.

What was the business need that motivated the project?

EDF NG have deployed a vibration monitoring system on critical rotating machinery which along with other performance data is monitored in 'real time' to provide alarms and alerts. The data is archived as many thousands of files and so is not readily accessible. Cybula wanted to show how improved monitoring of these assets could be achieved using pattern matching algorithms which could detect and diagnose performance anomalies by using the fleet-wide historical data. In addition, both EDF NG and EDF SA had specific analytical tools that they wanted incorporating into the software platform.

What innovative approach did you take to address the challenge?

Developed software that cleans, processes and consolidates proprietary data leading to the construction of a data library for a fleet of assets which can be accessed by Cybula's pattern matching tools including AURAalert to detect anomalous performance, Pattern Search to diagnose an event and Cluster, a tool to analyse transients.

What are the expected benefits to industry?

There is hidden value in the large volumes of time-series data collected and stored as a result of monitoring assets. Across many diverse applications, Cybula's software analytics can be used to detect fault conditions earlier, diagnose those faults and predict future outcomes.

What are the next steps towards commercialisation?

EDF NG have awarded Cybula a contract to deploy the software system on a trial basis with a limited range of assets during 2016. Cybula is at late-stage development of its' Event Visualisation Platform which will monitor multiple assets using the analytics developed in this project.

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EDF

Fracture of graphite fuel bricks

Partner organisations
EDF Energy Generation, EDF R&D France, University of Manchester

This project supports the Plant Life Extension programme of Advanced Gas-cooled Reactors (AGRs) nuclear plants by understanding crack initiation and propagation mechanisms in irradiated and oxidised graphite and analysing the statistical behaviour of the core containing cracks.

What was the business need that motivated the project?

AGR cores are composed of thousands of graphite bricks. After years of service, the heterogeneous irradiation and temperature gradually modify the microstructure and internal stresses of the bricks. This modification may lead to crack initiation and propagation in those graphite bricks, which cannot be replaced. The Plant Life Extension programme, developed by EDF Energy, aims at understanding this phenomenon for the coming years with in-core inspections, experiments and mechanical models. The work performed during the project is part of this programme.

What innovative approach did you take to address the challenge?

The intercalation of bromine is a very innovative technique that enabled us to generate cracks on internally stressed specimens for the first time. Additionally the models developed rely on very advanced tools (mesh adaptation and crack propagation) and very large models that are pushing the current limits of software capabilities.

What are the expected benefits to industry?

The work performed will be integrated in the safety case procedure, reducing uncertainties, helping the justification of the increase of tolerability of the graphite core. The exploitation time of the nuclear plant will therefore be safely increased. The benefits are expected to be of several thousands of millions of pounds.

What are the next steps towards commercialisation?

Given the promising results obtained, some additional experiments will be conducted on new brick-like geometries of interest for the company. While the validation of the models is still ongoing, they are being transferred to end users (Amec Foster Wheeler and Atkins) and are being integrated in the safety cases procedures.

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EDF Energy

Environmental impact on the structural integrity of nuclear components

Partner organisations
Bristol University, Imperial College, University of Manchester

Carburisation of stainless steels is a newly identified degradation mechanism within Advanced Gas-Cooled Reactor (AGR) components which could challenge the plant lifetime. This project aimed to understand the impact of carburisation and develop an adequate structural integrity.

What was the business need that motivated the project?

Nuclear safety is the overriding priority for EDF Energy. Ensuring that degradation mechanisms within nuclear plant are fully understood and safely accounted for is therefore essential in underpinning the safe lifetime extension of the current AGR fleet of 14 reactors. Carburisation was an emergent risk to the lifetime extension of these reactors. At the onset of the project it was unclear what the risk was to the lifetime of the AGRs. The project need was to rapidly clarify the risk through the development of a lifetime assessment methodology.

What innovative approach did you take to address the challenge?

The technical challenge of quantifying a mechanism that takes years to occur in just 300µm of material was a challenge for a 3 year project. As a result novel preconditioning methods and novel mechanical testing approaches have been developed to acquire the data required to inform the assessment methodology.

What are the expected benefits to industry?

The project has led to a rapid understanding of the carburisation mechanism which has had a positive impact on nuclear safety and clarified the risks to AGR lifetimes. This has provided EDF Energy with an opportunity to account for and mitigate these risks.

What are the next steps towards commercialisation?

Due to the importance of the findings of this project, the outcomes have been rapidly internalised within EDF Energy. This has allowed EDF Energy to develop mitigations to the risks which include extending the scope of reactor inspections, re-assessments of plant components, development of safety cases and further R&D to reduce conservatisms in lifetime assessments.

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EDF Energy Nuclear Generation

The influence of graphite irradiation creep on plant life optimisation

Partner organisations
University of Manchester, University of Surrey

To improve the understanding of irradiation-induced creep in graphite and hence increase confidence in Advanced Gas-cooled Reactors (AGR) lifetime estimates, in turn securing the stability of the nuclear supply chain.

What was the business need that motivated the project?

Prior to commencement of the project, there was significant uncertainty in the ageing behaviour of the graphite moderator within the AGR cores. At the same time, EDF Energy was aiming to extend the lifetimes of its 14 AGRs by an average of 9 years per reactor – thus bridging the gap until new nuclear build comes online. The uncertainty in behaviour exposed the company long-term strategy to risk in respect of early plant closure, with knock-on consequences for the wider the UK supply chain, affecting all parties' security and investment strategies.

What innovative approach did you take to address the challenge?

We approached the problem from a number of directions: first-principles modelling, microstructural examination (including first-of-kind experiments at the UK's DIAMOND Light Source) and technically challenging irradiation experiments in a specifically designed facility, leading to updated engineering assessment models.

What are the expected benefits to industry?

The project has already made a significant contribution to its goal of securing AGR lifetime and it is expected that these benefits will be substantiated over the next 1 to 2 years. A spin-off commercial collaboration is being established between the University of Manchester and Deben UK Ltd.

What are the next steps towards commercialisation?

Completion and analysis of the world-leading experiments; validation of the modelling against plant observations; dissemination of output and publicising the capabilities developed during the project.

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Enabling Process Technology Limited

REsidual Stress and structural Integrity Studies using Thermography (RESIST)

Partner organisations
University of Southampton, TWI, NPL, AMEC Foster Wheeler

To develop a physical understanding of, and a theoretical framework for, residual stress (RS) evaluation by thermoelastic stress analysis, material models for calibration of data and system models for the determination of RS; and Demonstrators for RS evaluation.

What was the business need that motivated the project?

To create a robust non contact, non destructive and portable system for residual stress assessment. The proposal is to develop a system that can load in situ sufficiently to obtain the thermoelastic response from around weldments and hence ascertain rapidly the extent of the region containing residual stress and then evaluate the residual stress using advanced modelling procedures based on the experimental data. Weld residual stresses have the capacity to strongly influence structural integrity of nuclear power plant components, the examples of so called reheat cracking in heavy section austenitic steel welds in AGR boilers.

What innovative approach did you take to address the challenge?

The major technological challenge will be bringing together the experimental data with material or system models in a way that is computationally efficient and straightforward to apply and meet industrial needs, providing a unique and world leading approach.

What are the expected benefits to industry?

There is no single approach that can provide a portable, full-field, non-destructive, non-contact RS analysis; this proposal provides an opportunity to develop such a technique, so a successful outcome will represent a radical change to the current state of the art.

What are the next steps towards commercialisation?

To take the current portable RSA demonstrator and combine this with component models to give an RS assessment. The objective is to allow the user to compare the onsite measurement with a simulated result to show if there is an area of concern.

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Laing O'Rourke

Optimisation of large concrete Design for Manufacture and Assembly (DfMA) structures for the Nuclear Industry

Partner organisations
ARUP, BRE, Imperial College

The aim of the project is to optimise the design for manufacture and assembly (DfMA) of large preassembled components for reinforced concrete construction in nuclear and heavy civils projects.

What was the business need that motivated the project?

Laing O'Rourke is the current nuclear new build constructor and is motivated in providing quality off site construction technology across its projects. DfMA already brings benefits to safety, quality, efficiency, programme and reliability across other Laing O'Rourke projects. Hinkley Point C, the United Kingdom's new nuclear power station, has vast amounts of complex reinforced concrete with a high requirement for quality and reliability. This project therefore aims to optimise DfMA technology for nuclear projects and unlock the huge potential of DfMA deployment.

What innovative approach did you take to address the challenge?

Six workpackages (substructure, superstructure, joints, reliability, optimised manufacture and optimised assembly) all developed new technology through innovation. Specific innovation examples are: new robotic construction techniques, new structural joint designs based on headed bars, wireless sensor monitoring, advanced hybrid and solid precast construction techniques.

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What are the expected benefits to industry?

The main advantage of DfMA is bringing assurance to safety, quality and reliability. Performance benefits include programme savings (particularly on-site) and bringing efficiency to both on and off-site operations. On a project of the scale of a nuclear new build, the potential benefits are vast.

What are the next steps towards commercialisation?

Firstly, we must identify suitable projects in the heavy civil sector, and then deploy the technology to verify that high standards of quality and reliability can be achieved in practice. The next step will be deploying to nuclear sites and a specific target is the Small Modular Reactor (SMR)

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Micron Semiconductor Limited

High temperature radiation hard detectors (HTRaD)

Partner organisations
Schlumberger, Wolson Centre for Materials Processing at Brunel University

The objective is the development of a Chemical Vapour Deposition (CVD) diamond radiation-hard sensor for neutron and gamma detection with long term reliability and suitable for use in high temperature settings such as nuclear power generation plant.

What was the business need that motivated the project?

Helium 3, used for neutron detection and absorption, is scarce and costly to manufacture, and the other current technologies are either cumbersome, expensive or low-resolution. Laboratory-grown, high-purity diamonds have the potential to become cost-efficient neutron sensors with spatial, time and energy resolution, thus removing the need for helium 3. High-energy physics, oil-well logging, nuclear physics and nuclear monitoring are the main fields of activities that will benefit from this technological breakthrough.

What innovative approach did you take to address the challenge?

Laboratory-grown diamond processing can now produce single crystal diamonds with little contamination, that can be used as large band gap semiconductor detectors. The further processing steps are identical (in principle) to standard semiconductor manufacturing. Diamond material can withstand high temperature and radiation levels and allow for more extreme applications.

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What are the expected benefits to industry?

A cost-effective and compact neutron sensor for use in harsh environments will become available to the nuclear industry (nuclear power plant monitoring and development, defence and the oil-well industries as well as the high energy and nuclear physics communities).

What are the next steps towards commercialisation?

A single-window neutron detector with a conversion layer will be the first product to reach the market. The next steps consist in adapting the design of the detector to increase the neutron detection efficiency, and in increasing the temperature rating, currently at 125° C.

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OC Robotics

LaserSnake2

Partner organisations

TWI, National Nuclear Laboratory, ULO Optics Ltd, Laser Optical Engineering Ltd

LaserSnake2 combines flexible snake-arm robots with high-powered laser cutting tools to selectively dismantle structures within complex and cluttered nuclear environments. Additionally industrial robots have been used to develop a dedicated size reduction facility using laser cutting.

What was the business need that motivated the project?

LaserSnake2 follows the initial LaserSnake feasibility study performed by OC Robotics and TWI. Both projects are focused on developing a confined and hazardous space cutting tool required for nuclear decommissioning. The success of the feasibility study (combining off-the-shelf laser cutting tools and snake-arm robots), together with feedback from the nuclear industry indicated there was a significant industrial appetite for the system to be developed further - resulting in LaserSnake2. The technology developed by LaserSnake2 also has a huge potential in other industries with hazardous maintenance and inspection activities.

What innovative approach did you take to address the challenge?

LaserSnake2 combines innovative snake-arm robots, with significant laser optic development delivering a system capable of conducting decommissioning activities in remote nuclear environments. The project engages closely with Sellafield, understanding the processes and regulations surrounding nuclear decommissioning, and ensuring the developed technology meets the needs of the complex environment.

What are the expected benefits to industry?

With the flexible snake-arm robots integrated with the powerful laser cutting head, significant time and financial savings can be made by utilising the technology to reduce operator exposure and reach previously inaccessible areas.

What are the next steps towards commercialisation?

Identifying and conducting further active deployments of the system to build industry confidence - historically challenging with new innovations. End users to actively find current or near future decommissioning applications where LaserSnake can be used to both prove the technology is capable and show real benefits (financial and health and safety).

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Plant Integrity Limited

On line and global structural health monitoring of high temperature steam lines

Partner organisation
Brunel University

UltraSteamLine (USL) project aims to develop an on-line permanently installed structural health monitoring system for early detection of defects in super heated pipes in nuclear power plants and prevent safety critical pipe failures.

What was the business need that motivated the project?

The world stock of nuclear plants is ageing, with many units already over 40 years old and this figure will increase as more utilities seek to extend the life of ageing plants. The risk of large defects being present due to corrosion and other effects rises with the age of nuclear plant. Current pipeline inspection methods are time consuming and can only be used at ambient temperatures during plant outages. USL will enable in-service inspection hence significantly reduce energy unavailability and plant operation and maintenance costs.

What innovative approach did you take to address the challenge?

USL is a novel technology that extends the temperature capabilities of the state-of-the-art long range ultrasonic guided wave inspection by redesigning the existing system for high temperature application and utilising ultrasonic temperature compensation and statistically based acceptance criteria for detecting pipe defects.

What are the expected benefits to industry?

Apart from economic benefit to power plant operators (PPOs) by reducing energy unavailability caused by plant outages, the system will also help PPOs meet stricter regulations imposed throughout the EU. It will meet operational and occupational health and safety requirements by preventing pipe failures and human intervention in extreme operating environments.

What are the next steps towards commercialisation?

To conduct pilot studies in service environments in power plant for validation of the defect detection and monitoring performance of USL system in comparison with currently available commercial systems. To produce final specification and industrial designs to ramp-up production. To prepare dissemination, sales and marketing plan.

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Sellafield Limited

Measurement and modelling of sludge transport and separation processes

Partner organisations
University of Leeds, MMI Engineering Ltd

Development of an instrument for in-situ sludge bed concentration measurement utilising acoustic backscatter, coupled with a predictive modelling technique incorporating flocculation and agglomeration into the OpenFoam computational fluid dynamics modelling platform.

What was the business need that motivated the project?

In many nuclear waste processing operations, there are significant challenges involved with the transfer, collection and disposal of multiphase sludge and slurry wastes. The UK's largest problem is the Sellafield legacy pond wastes, that contain diverse sludge wastes which are known to be made up of mixtures of mineral, metal and organic particulates.
The wide range of properties and length scales found in these materials makes it difficult to characterize the sludge wastes. Additionally, sludge properties may change considerably during initial pumping transfer from the ponds to secondary separation units.

What innovative approach did you take to address the challenge?

The use of Acoustic Backscatter techniques to monitor the changing concentration profile of sludges in-situ, alongside predictive modelling incorporating flocculation and break up, has been developed from conception. The Acoustic backscatter technique provides a continuous profile through a bed of settling sediment which can be used to infer concentration.

What are the expected benefits to industry?

Use of the integrated technologies will provide a decreased reliance on sampling for material sentencing; better understanding of sludge settling for informed operating decisions regarding potential unit operations, faster more optimal sentencing; programme acceleration potential and ultimately hazard reduction acceleration.

What are the next steps towards commercialisation?

We will conduct a trial of the technology on a radioactive plant to demonstrate the performance in this environment, confirm measurements against a baseline sampling campaign, and validate modelling against plant performance. During the latter phase of this work, potential commercialised production routes for the unit will be investigated.

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Sheffield Forgemasters RD26 Limited

Advancement of castings in the nuclear supply chain

Partner organisations
TWI, University of Sheffield

Sheffield Forgemasters International Ltd wants to enter a new market for civil nuclear power station components by offering a cast solution for a reactor coolant pump that is currently produced as a forging. The impact of entering this new market would be increased sales and job creation.

What was the business need that motivated the project?

Sheffield Forgemasters International Ltd is a World leader in the production of cast reactor coolant pump casings for nuclear power stations. SFIL wanted to enter the Eastern European market for civil nuclear power station components by offering a cast solution that replaces the current forged design. Successful qualification of a cast design could result in significant orders and would establish a presence in the Eastern European supply chain.

What innovative approach did you take to address the challenge?

There were questions concerning the castability of the steel grade, the optimum methods for casting and heat treatment, mechanical properties that could be achieved, dimensional control, welding procedures and ultrasonic inspection. A collaborative R&D project with TWI Ltd and The University of Sheffield was proposed to address all these issues.

What are the expected benefits to industry?

The project has driven innovation, leading to the implementation and use of new manufacturing techniques and quality control methods. Benefits include:- (i) Increased sophistication of computer simulated casting. (ii) 3D laser metrology to aid dimensional inspection and machining of large castings. (iii) Automated strip cladding of large castings. (iv) Phased array ultrasonic inspection.

What are the next steps towards commercialisation?

The technical outcomes of the project have given Sheffield Forgemasters the level of assurance needed to pursue a future production effort. Sheffield Forgemasters hopes to exploit the outcome of the project by winning orders in the targeted market.

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Sheffield Forgemasters RD26 Limited

The development of novel manufacturing techniques for nuclear applications

Partner organisations
Mermec UK, Rolls Royce, University of Sheffield

The project involved production of the largest ever, civil-nuclear disc forging manufactured in the UK. Production was enhanced through development of finite element models, 3D laser metrology and mechanical property prediction using controlled heat treatment.

What was the business need that motivated the project?

Production of large, civil nuclear forgings is a challenging task and whilst capability lies within the UK (plant and past experience), the UK does not currently supply into this market. Various barriers exist, including geopolitical influences and thus to gain a market share, the UK must differentiate itself from international competitors. This project has allowed for differentiation through implementation of state-of-the-art technology. Such technology aims to provide OEMs with demonstrable process control and experimentation that is not available anywhere else in the world.

What innovative approach did you take to address the challenge?

Innovations include: (i) implementation of in-situ metrology, resulting in energy/re-work savings, (ii) ability to simulate microstructure developed at any location and test/predict mechanical properties, (iii) production of a fully tested and inspected civil nuclear forging and (iv) production of fully validated computer simulations of the manufacturing process.

What are the expected benefits to industry?

As a result of the project, the consortium is able to demonstrate the UK capability in the large forging sector, to industry. The state-of-the-art technology developed, alongside demonstrable experience, provides industry with UK manufacturing and research options and should encourage confidence in the UK supply chain.

What are the next steps towards commercialisation?

The project has spawned further research activities, aiming to improve upon modelling/ predictive capabilities and metrology. Next steps towards commercialisation involve on-going dissemination of capability to OEMs, in the hope of winning orders for large forgings.

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Innovate UK is the UK's innovation agency. Innovate UK works with people, companies and partner organisations to find and drive the science and technology innovations that will grow the UK economy - delivering productivity, new jobs and exports. Our aim at Innovate UK is to keep the UK globally competitive in the race for future prosperity.

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