Decommissioning Learnings

Sharing good practice across industrial sectors 2020-2021

Cross-Industry Learning

Decommissioning is happening all around us across several different sectors.

It is important that our industries work together to share lessons learned, swap tools and techniques and build a cross-industry decommissioning supply chain and exportable UK expertise.

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Introduction

Decommissioning is happening all around us across several different sectors; in the oil & gas industry offshore platforms and pipelines are being removed, in the nuclear sector we're decommissioning the UK's earliest nuclear sites. In the defence sector there is the challenge of decommissioning nuclear-powered submarines, and older wind farms are already beginning to be decommissioned in the offshore renewables sector.

The result is that all our industries face many similar problems when it comes to the decommissioning and environmental remediation challenges. Therefore, it is important that our industries work together to share lessons learned, swap tools and techniques and build a cross-industry decommissioning supply chain and exportable UK expertise.

The Nuclear Decommissioning Authority (NDA) has a vital mission to clean up the UK's earliest nuclear sites safely, securely, and cost-effectively with care for people and the environment. Our One NDA model ensures that we are trusted to do more, both within the UK and Internationally and prepares us for the eventual incorporation of the Advanced Gas-cooled Reactors (AGRs) from EDF Energy into our estate.

The nuclear sector has historically been accused of being too inwardly focused, lacking transparency, believing itself to be unique and special.

Yet so many of our decommissioning challenges are also faced by many other industries and we have so much in common with other major infrastructure and remediation projects.

I believe that benefits will come by breaking down barriers, thinking collaboratively and building mutual respect and trust. A partnering approach is so vitally important to realise opportunities.

The challenging times we have all faced with the pandemic recently have given us a unique perspective. We should all be taking the opportunity to break out of our silos and look to each other for inspiration and experience as we all seek to build back better.

At the NDA we have been continuing to work with the Oil & Gas Authority, the Environment Agency, the National Nuclear Laboratory, Defence and Renewables to stimulate Cross-Industry Learning.

This report shares some of the key learning highlights to date and I hope it encourages and challenges you to work more collaboratively outside of your own sector.

Our sectors have far more in common than we have differences in the challenges we face.

David Peattie,
CEO, NDA

The Oil & Gas Authority's role is to work with the industry and government to ensure that the UK oil and gas sector is able to deliver energy security for the UK and at the same time play a unique and critical role in delivering the solutions that will make net zero a reality.

Our industry is in a period of transformational change. It is still feeling the impacts of the pandemic, dramatic changes in commodity prices and the growing societal pressure to avoid damaging the world's climate. These things have combined to accelerate the very real energy transition that's taking place in the North Sea. A key part of this transition is the effective decommissioning, re-use and repurposing of the vast array of infrastructure and assets spread across the UK Continental Shelf (UKCS).

In support of this work, the Oil & Gas Authority (OGA) launched a new Decommissioning Strategy this year, focusing on:

Planning for decommissioning: Driving cost efficiency through effective late-life stewardship, creating a platform for timely delivery.

Commercial transformation: Improving market efficiency, establishing a competitive and sustainable market.

Supporting energy transition from late life into decommissioning: Reducing greenhouse gas emissions from decommissioning and capitalising on opportunities to reuse or re-purpose infrastructure.

Technology, processes and guidance: The development and deployment of technology, appropriate regulatory processes and clear guidance underpin delivery of the strategy.

The scale of opportunity that these strategic pillars present can be counted in the billions of pounds, and in thousands of high-skilled jobs. To get this value for the UK and for industry we need to continue to collaborate, innovate and demonstrate delivery.

We therefore value the relationship that we maintain with the Nuclear Decommissioning Authority and in particular the Cross-Industry Learning Team, as this provides us with a vehicle that is outward facing, collegial and willing to share experiences across a range of themes of common interest.

Ultimately the objective that we share in common across decommissioning and construction-based projects is to understand what 'good' looks like whilst reducing cost and with a constant emphasis on doing it safely.

***Stuart Payne** CBE,*
Director of Supply Chain, Decommissioning and HR, Oil & Gas Authority

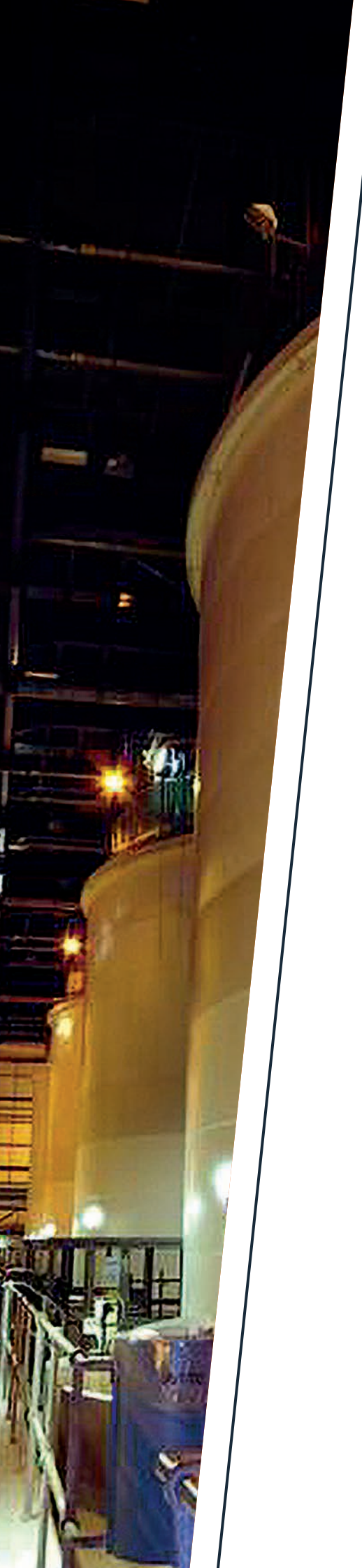
Decommissioning Costs

High decommissioning costs exist for a number of UK industries as illustrated in the by no means exhaustive table of example liabilities below. The UK has the potential to become a global leader, creating a decommissioning capability across industry sectors, and valuable exportable skills.

Industry	Cost (£ Billion)	Schedule (Years)	Major Scopes Items
UK Civil Nuclear (NDA)[1]	131 (20/21 undiscounted) 135.8 (20/21 discounted) 48 (within next 20 years)	~120 (to 2137)	17 sites, including Sellafield, Dounreay, Magnox, Capenhurst, Springfield plus construction of Geological Disposal Facility
UK Civil Nuclear (EDFE)[2]	20.5 (undiscounted to 2030)	~100	8 Nuclear Power Stations
UK Defence (Nuclear Powered Submarines)[3]	7.5 (provision)	>30	20 out-of-service + 10 in-service
UK Oil & Gas[4]	48 (P50) 61 (P90)	<50	UK Continental Shelf
UK Renewables[5]	~4–12	~50	Offshore Wind

Sources

1. NDA Annual Report & Accounts 2020/21 Nuclear Provisions
2. Nuclear Liabilities Fund Annual Report 2019
3. National Audit Office – Investigation into submarine defueling and dismantling – April 2019 – ISBN 9781 786042552
4. Oil & Gas Authority – UKCS Decommissioning Costs Estimate Report 2021
5. The Crown Estate – current versus future estimate for capacity yet to be built



Themes of Common Interest

At the NDA, we've been working with the Oil & Gas Authority, the Environment Agency, the National Nuclear Laboratory, Defence, Renewables, and other industries, to organise a series of workshops and seminars to stimulate cross-industry learning.

This collaborative working was initiated in early 2018 when the nuclear decommissioning industry recognised that it was too inwardly focused on its own mission and lacked an outward leaning posture from a learning perspective.

A number of shared themes of common interest were identified, initially between the NDA and the Oil & Gas Authority which were the topic of some early round table events and workshops. Over time, further themes of common interest were identified from a wider decommissioning industry perspective.

The organised cross-industry engagements have been designed to bring together not just different industries, but also a cross-section of organisations from within each industry. Throughout these events we have witnessed a continued drive and determination to share decommissioning lessons learned and good practice.

To date we have covered 16 unique themes and are pleased to be able to share the output of this past 12 months' collaborations in our second annual report. In addition, please do consult our online library of workshop outputs kindly hosted by TotalDecom. We invite your participation, feedback and input for future workshops and seminars as we broaden themes, introduce new topics, and include more industries.

Going forward we will continue to aid the discussion and identification of cross-industry themes of common interest, as well as encouraging collaborative projects.

We believe that different industries have much in common when it comes to decommissioning, and that we all stand to benefit from cross-industry sharing of expertise and learning.

Tangible outputs from working collaboratively across different industries are being realised but there is more benefit to be extracted. With the UK transitioning to a lower-carbon economy to meet its net zero commitment by 2050, renewable generation commitments and decommissioning cost challenges we can continue to work together to achieve in these areas. Our work aims to stimulate improved industrial productivity, re-skilling the workforce, and building on a unique stock of technology and skills that bring benefit across the economy and have significant potential in overseas markets.

A well-deserved thank you is extended to the Oil & Gas Authority, the Environment Agency, the National Nuclear Laboratory, TotalDecom, Decom North Sea, ORE Catapult and colleagues in the Nuclear Decommissioning Authority for contributing to the organisation of these engagements and this report.

Heather Barton,

Cross-Industry Learning Manager, NDA

Online Library

OCTOBER 2018

Project Management, Commercial Models, Supply Chain
Lillyhall, Sellafield

MARCH 2019

Late Life Asset Management
University of Strathclyde
Glasgow

JULY 2019

Cost & Schedule
London

MAY 2020

Skills Development
Virtual

FEBRUARY 2021

Sustainable Regional Economies
Virtual

Design for Decommissioning
Virtual

JUNE 2021

Synergies in Innovation and Technology Challenges
Virtual

Safe Decommissioning
Virtual

Commercial Models
Virtual

FEBRUARY 2019

Technical Innovation
Oil & Gas Technology Centre
Aberdeen

MAY 2019

Innovation and Regulation Roundtable
London

NOVEMBER 2019

Standards Workshop
Manchester

SEPTEMBER 2020

Net Zero
Virtual

MARCH 2021

Governance and Assurance
Virtual

www.totaldecom.com/cross-industry-collaboration/

Design for Decommissioning

From the construction of the Sellafield site in the 1940s, to the nuclear submarine build programme of the 1950s and '60s through to the development of the North Sea oil & gas of the 1970s and '80s, effort, thinking and technology investment was focused on getting the "job done", with little thought given to end of life decommissioning and waste management.

This was especially true during the design stage of assets, when the focus was on minimising early capital costs, to a lesser extent operational costs, and the abandonment expense was often ignored.

In the UK this has left an unwelcome legacy in the form of a liability of hundreds of billions of Pounds Sterling to decommission infrastructure across the oil & gas, nuclear, defence, and other sectors over the coming decades/century, with a significant element falling on the public purse.

Today, industries are now required to consider and plan for the decommissioning of new infrastructure. When looking at the cradle to grave lifecycle of a facility, it is evident that many stakeholders have a role to play in the success: engineers, designers, academics, and the public to name a few.

This cross-industry workshop promoted the inclusion of decommissioning considerations in the design phase of new-build and brownfield work, thus promoting more efficient ultimate project execution and beneficial outcomes for society, especially future generations.

Key learning highlights

Changing knowledge, understanding and hazards

Decommissioning often stretches facilities beyond their design intent and imposes new requirements on them. This is exacerbated by hazards which are unplanned for, and often insufficient space/access for new decommissioning equipment and processes. This can be aided by ensuring that a clear picture of the required end point is known. At the design stage, factoring in repurposing and/or decommissioning requirements as well as knowledge of future site dynamics can mitigate many issues.

Nuclear examples from decommissioning work at Sellafield:
(i) a common theme encountered is the lack of provision for emptying tanks/silos. This is complicated further as the facilities tend to have limited space and access, which means that retrofitting solutions is difficult.

(ii) decommissioning is preceded by extensive brownfield deployment of new infrastructure which can congest worksites.

Oil and gas regulator example:
Licensees are required to both maximise infrastructure re-use & repurposing, and minimise decommissioning costs. With wells and facilities there are many repurposing opportunities – wells and reservoirs for CO_2 reinjection and storage, platforms re-used for renewables infrastructure. This concept of a circular economy is particularly evident in the oil and gas sector.

Policy, planning, and regulation

The time and money needed to prepare for a decommissioning activity is significant, and in some circumstances greater than that of the actual decommissioning activity itself and therefore should not be underestimated. Similarly, the availability of up-to-date data and inventories is advantageous and highlights the importance of having a robust change management system. Policies and regulations change over time and can impact compliance during decommissioning, particularly around waste management and discharges.

Offshore renewables example: The learnings from decommissioning Blyth showed that plans should incorporate the following:

- Lifting points – are suitable lifting points and lifting equipment available?
- Weather – how to minimise the impact.
- What are the points of no return? For the Blyth project some of the main lifts fell into this category, and as such clear go/no-go hold points were required in the project procedures.
- Availability of key resources – are suitable vessels/equipment available and how do their plans align with yours?
- Environment considerations – need to factor in remote locations, High-Voltage electrical systems, subsea work and working heights.

Good practice in designing for decommissioning

Fostering a desire to leave a suitable legacy to drive change, and being a futurist who can identify and act upon future trends, are both desirable good practices. However, the importance of the economic case for designing for decommissioning is paramount. This factor alone can drive the inclusion of decommissioning in the design plans and impacts on all industries. There needs to be a demonstrable financial incentive for inclusion of decommissioning as an integral part of the project lifecycle.

This suggests that in some instances, economic value needs more sophisticated tools to measure the delayed impact of transferring liabilities onto future generations.

Oil and gas industry example: An economic model has been developed by the oil and gas industry that shows that in some scenarios a 35% reduction in decommissioning costs also achieves about an 8% increase in the project's Net Present Value (NPV). This model has shown that a significant way to improve NPV for a 20-year platform might be to decrease the decommissioning cost. Such financial studies that link directly with the NPV pave the way for the whole life cycle of a project to be considered.

Capturing, sharing and application of lessons learned

Successful application of lessons learned during design needs to begin with a thorough and consistent capture mechanism of the lesson during decommissioning. This then allows for subsequent sharing, both within and across industries between the decommissioning and new-build communities. Talking and listening to each other with an open mind are behaviours that should be encouraged and delivery mechanisms that are tailored to the intended audience can optimise the many benefits of sharing lessons learned.

Anthony Banford,

Chief Technologist,
National Nuclear Laboratory

Sustainable Regional Economies

Some sub-regional economies of the UK have historically become overly reliant on a primary industry for both employment and contribution to the local economy. Over reliance on a single industry in remote communities can have a stifling effect on local business diversification.

When the primary industry declines, localised systemic economic frailties are exacerbated. Lessons from the past have shown that it takes a prolonged multi-agency approach to rebuild an economy with a more sustainable outlook.

Examples from mining, specialist manufacturing, steel and shipbuilding exist where decline was not planned for and little or no investment made to help build a more resilient future economy relevant to the area. The historic effects of such decline are still seen in our highest areas of social deprivation across the UK.

This workshop was jointly hosted and facilitated by the Institute of Economic Development (IED), a professional body solely involved in working to support individuals and organisations involved in economic development.

Key insights shared:

Regeneration initiatives need to recognise a sense of place and be scaled appropriately

Successful regions are measured in terms of continued economic growth but do these always correlate to a true valuation on the health and well-being of a place? At what stage is growth in rural coastal locations considered enough? Does 'sustainable' sometimes means disinvesting after human activity has ceased, removing the human footprint of the residual community and returning the site back to nature?

There are new opportunities to be embraced, so invest to develop infrastructure where needed

Successful businesses are either close to the resource (coal and steel industries) or have easy access to markets such as with towns or cities. Investing in infrastructure can help to 'bridge the gap'.

Diversification needs to start before the twilight years of an industry

An area dependent on a limited range of sectors should be encouraged to develop innovations from existing industry and capitalise on synergies with supply chain businesses and/or customers to widen the economic base. Leaving initiatives until the twilight years may mean that the energy, confidence and scale of the workforce is in decline before the new foundations are in place.

Coastal communities are well placed to benefit from opportunities of the new 'green economy'

There are opportunities to capitalise on the possibilities of the Energy Transition, such as leveraging port development to bridge the link between offshore and onshore investments in renewable generation, hydrogen production, carbon capture and storage.

Institute of Economic Development

Inspiring people - Improving places

Economic development strategies need to have clarity and outline what is expected from each stakeholder from government down and communities up

The role of government funding and public sector agencies is to address market failure and therefore could help create the environment in which the private sector feels able and secure to invest, creating sustainable and meaningful jobs.

Government-led investment programmes sometimes don't manage to deliver to communities in most need

Measures such as commercial space, jobs created and sustained do not necessarily lead towards a happier community. To date, very little emphasis has been given towards green space, air quality, nor the effect of carbon emissions on the developments which receive grant funding.

Success measures should focus on desired outcomes not grant-funding indicators

Regeneration of an area, its economy and people is not immediate. Sustainable development is difficult in the medium term and takes vision together with a series of integrated and co-ordinated initiatives. Long-term measures may include brownfield remediation preparation and development, and training and re-skilling of the existing and future workforce aligned to the jobs appropriate to the area.

Consider the lessons learned from unintended consequences and keep in mind that societal change is about its people

Successful strategies and action plans for economic development are based on more than just the redevelopment of a brownfield site – they recognise the people within the community and work with them to bring them along the journey of opportunity diversification.

The public sector alone cannot deliver wealth creation, but can create the right environment for the business community to invest and thrive

New thinking is moving towards more formal social value contracting. Businesses can align with the contracting authority, working in partnership to enable sustainable policy outcomes.

Nigel Wilcock,

Executive Director,
Institute of Economic Development

Governance and Assurance

This workshop, held virtually over three sessions on 2, 3 and 4 March 2021, explored a number of key themes relating to the practice and value of assurance (both positive and negative) across a range of industries and stakeholders. It forms part of the ongoing commitment of the NDA to the promotion of cross-industry learning and best practice, and was organised and facilitated as a collaboration between the NDA and its assurance partner, Grant Thornton.

The four assurance-focused themes that delegates and contributors exchanged insights and perspectives on were:

- What motivates projects and programmes to withhold bad news, and how can assurance best respond?
- How assurance can address scope maturity and optimism bias.
- Maturing and evolving the traditional 'Three Lines' model to add value and insight.
- Measuring the impact and effectiveness of assurance in large and complex organisations.

Participants represented assurance best practice in organisations from the nuclear, oil & gas, renewables, and infrastructure sectors, along with representatives from professional bodies and government stakeholders.

Presentations relating to each of the four themes of the workshop were devised such that they promoted early thought as input to round-table, break-out discussions addressing each of the workshop's themes in turn. Each round-table group was asked to base its discussion around some prepared lines of enquiry or propositions relating to its chosen theme, but was free to develop them further where a broader debate added value. In addition, individuals attending had an opportunity to create new horizontal relationships across industries to stimulate ideas and collaborative working.

It was clear that the main learnings that emerged from the workshop were not industry specific, which emphasised the commonality of the challenges and approaches that different organisations and industries have in providing effective and timely assurance.

Key learnings included:

The importance of positive, receptive organisational culture and the use of common definitions and benchmarks for assurance. 'Mission focus' or 'group think' can drive behaviours and reporting, and a healthy organisation should be collectively inquisitive and receptive to innovation and constructive feedback. Organisations need to have a receptive culture, for assurance of their projects and programmes to be able to add value and provide insight.

Setting up for success – early engagement of assurance through 'opportunity framing' and the application of consistent and relevant assurance processes to entire project lifecycles. Early 'framing' of the assurance needed throughout the lifecycle will increase how robust and effective it can be.

Forward planning assurance events so they are built around the right 'products' and are occurring at a point where they can have the most impact will both mitigate risk and add value and insight.

Assurance can provide positive affirmation as well as constructive challenge. It requires appropriate credibility and expertise, and independence from the subject being assured, in order for it to identify and address optimism bias, and particularly to call out 'strategic misrepresentation' should it occur.

Effective forward planning and integration between the 'three lines' can make the process of assurance more timely and insightful. Consistently-structured and well planned assurance (such as in an Integrated Assurance & Approvals Plan) can facilitate a better understanding of emerging risks or themes that can be used to support continuous improvement at both project and enterprise levels.

The 'three lines' of assurance can add value as well as protecting it, but further evolution of the model is needed to reinforce the forward-leaning and collaborative approach. Dropping the term 'defence' from the 'three lines' (recently agreed) will make a subtle but important difference to the way assurance is perceived and engaged with.

Assurance effectiveness can be measured by its ability to identify and mitigate risk either at the organisational level or through the project lifecycle. The positive impact of assurance can be undervalued, and lead to it not being integrated early enough. Positive 'affirmative' assurance outcomes can often have less impact than negative ones – any measure of effectiveness should consider both.

Paul Innes,

Head of Major Project, Programme and Portfolio Assurance, Grant Thornton

Safe Decommissioning

Decommissioning is a significant phase in the lifecycle of every off-shore platform, turbine, and nuclear facility – and one that requires particularly careful management to maintain the hard-won high standards in health and safety that prevail in the respective industries.

In the coming years, there will be an increasing number of installations which will be taken out of production and decommissioned. Decommissioning brings specific health and safety hazards. There is an opportunity to ensure that the health and safety culture gained within the operational phases of these industries is maintained and even improved upon.

This collaborative workshop targeted the introspective nature that industries can sometimes exhibit due to a belief that their industry is special and unique. From a safety perspective, common principles exist, regardless of industry: work on complex onshore facilities such as power stations, chimneys, and grounded offshore platforms; working in high hazard facilities in congested spaces; control of contractors and leadership to name but a few.

It is recognised that ultimately, improvements in health and safety saves lives. Barriers do exist to the achievement of the aspiration of zero harm, and this workshop identified several significant ones that are common across all industries including:

- **Time and detail** – enough time is needed to understand the scope and plan a job. External factors such as scheduling, poor scoping of work and insufficient stakeholder involvement can give rise to an unintended barrier.
- **Language and communication** – including cultural expectations of stopping work and the tone and words used around the work site.
- **Insularity** – tendency to think your industry is "special". This can be compounded by the visible environments that are very different (onshore and offshore) and the different regulators that sectors have.
- **Human factors** – you cannot rely on the consistency of humans; we are affected by too much on a daily/hourly basis. Recognise that we can be the principle failure point is any plan.

These common barriers reinforce the imperative to look beyond your own boundaries and collaborate wider than your own industry.

Key learnings included:

A lesson is only learned when it is applied to deliver change, until then it is just an experience. We need to move from learning from experience to identification of lessons identified and fixed. We should not be reliant on human memory, and learnings should be consolidated into standards and ways of working. Failure of organisational memory to learn is still a recurring theme in major accidents.

Prevention Prevention Prevention. Learning comes not through injuring people, but through identifying gaps and fixing those gaps.

Humans are fallible – acceptance of this is needed so that plans can be enacted for variation in human performance. Human error has been, and will continue to be, present in events. People do not do unsafe things; they do things which turn out to be unsafe. Working conditions need to be optimised to encourage the correct behaviours. There are a number of reasons that people don't work safely with the top three identified from the group as, communication, culture and perception of risk.

There are no new accidents, rather there are old accidents repeated by new people. The human element of events needs to be included in safety investigations and risk assessments so that improvements can be made.

Engage early with regulators and have them on your team. Regulators are there to support not hinder. Regulators also have to adapt as new initiatives and ways of working are explored on decommissioning sites, and early engagement aides this. Collaborative working across regulators for offshore oil and gas decommissioning can be seen via www.decomreghub.org.uk

Lessons learned saves lives, prevents harm, and reduces risks and costs. There is a desire across all sectors to share and improve in learning. It is important to recognise what good looks like whilst appreciating that one size does not fit all. Targeting the aspiration of zero harm is present in all sectors.

DECOM North Sea

Non-compliance with the Construction Design and Management Regulations is a theme across all sectors. The main issues identified are lack of understanding of the roles within these regulations, and a general misunderstanding of required duties.

Open and active communication is vital. Two-way, proactive sharing and listening are key influences on behavioural change.

Accidents occur very easily and continual engagement with the workforce is needed to combat this. If done correctly, workforce engagement has been shown many times to be successful at driving down accidents and incidents. An “Engage-Listen-Share-Action” approach is key. Leadership plays a vital role in obtaining and maintaining a good safety culture. Visibility, availability, respect, inclusion, and collaboration are key attributes of senior leaders. This is particularly important for sites that are transitioning from an operational phase to decommissioning where there is increased conflict between priorities and cultures.

Will Rowley,
Business Advisor,
Decom North Sea

Synergies in Innovation and Technology Challenges

Scopes may be different; however, the nuclear and oil and gas industries have a lot in common when it comes to decommissioning. Technology is one such area. Both sectors need technologies that enable such things as remote access to hazardous areas, keeping people safe in challenging environments, and enabling safe and efficient completion of novel work. Technology is changing at an ever-increasing rate and working together to adapt, utilise and develop new technologies is beneficial to both industries.

Building upon our first collaborative workshop on Technology and Innovation held in 2019, the oil & gas and nuclear sectors convened again during 2021 aiming to build upon progress and establish specific cross-industry projects that could be progressed. Both engagements focused on identification of common technical areas and convened experts in technical innovation from the different sectors.

There is a strong challenge overlap between the sectors and enthusiasm to work together on specific challenges. While examining the common ground for collaboration projects, some specific ***key learning points*** were also captured.

> ***Technology advancement is a vast area – it is better to concentrate on a much smaller subset and to learn how to approach, implement and successfully deliver cross-industry challenges.***

In identifying and agreeing a subset of areas, the focus areas of the NDA, Sellafield and the oil and gas Industry were shared and compared:

NDA: The NDA has established four grand challenges for technical innovation, intended to provide an opportunity for collaboration across the NDA Estate and nuclear sector, but also with other industries with similar challenges. Technical innovation in these areas would deliver significant benefits within the NDA, across different market sectors, and also have wider societal benefit:

- Reducing our waste
- Intelligent infrastructure
- Moving humans away from harm
- Digital delivery

NDA sets out its Grand Challenges – GOV.UK (www.gov.uk/government/news/nda-sets-out-its-grand-challenges)

Sellafield: Research and development is fundamental to the delivery of Sellafield's mission of cleaning up the country's highest nuclear risks and hazards. New technologies and techniques can improve safety, security and reduce costs, timescales and environmental impact. The four streams where efforts are prioritised are:

- Retrievals
- Remediation
- Spent nuclear fuel management
- Special nuclear materials

Oil and gas: The National Decommissioning Centre (NDC) is a partnership between the University of Aberdeen and the Net Zero Technology Centre. The aim of the NDC is to undertake fundamental research and development work to assist in cost reduction and safe, environmentally responsible and sustainable decommissioning.

There are substantial synergies with the offshore wind and nuclear sectors with the opportunity to provide cross-industry benefits through joint projects with global application.

Game Changers is the UK's leading nuclear innovation programme, finding solutions and developing technologies to overcome some of the most complex challenges facing the nuclear industry. They provide a platform to connect challenge owners and solution providers and have a tried and tested innovation process that delivers results.

Challenges are open to anyone from any sector who can offer a viable solution including SMEs, universities, research organisations and large companies.

To progress the first iteration of joint challenges, a process such as the Game Changers process was identified as needing to be utilised.

Sellafield Ltd

The National Decommissioning Centre
Innovation through Partnership

The two main areas of focus from the NDC:

- Net Zero
- Digital and AI: with a particular focus on:
  - Operator Safety
  - Non-intrusive inspections
  - Data trusts
  - Digital twins

Across all of the sectors there is an ongoing theme of building wider relationships and improving the visibility of what solutions and other challenges external organisations are progressing.

Behaviourally, an openness to ideas and solutions is required. It is acknowledged that it is hard to drive innovation alone, and there is a desire to learn from others, and share with others.

The process for progressing joint technology challenges is a key enabler to successfully delivering joint challenges.

In sharing focus areas, workshop participants were able to identify over 80 possible joint challenge areas.

A grouping, prioritisation and shortlisting exercise enabled this to be reduced to 32 distinct areas that were ranked according to impact and ease of implementation.

Those in the high impact/ easy to implement area were then examined with three to be progressed based on their potential to deliver a high impact, relatively easy to achieve and had the strongest cross-industry interest:

- Characterisation of inaccessible pipes
- Secure comms in difficult environments
- Digital Twin

The people side of collaborative working must be considered alongside the technical aspect.

There is a resistance to the adoption of new technology and there is additional challenge in people gaining confidence in the ability of new technology.

Our ongoing focus is on agreeing a forward strategy for progressing the specific joint challenges identified in the 2021 workshop, and prioritising further collaboration opportunities.

Commercial Models

Sharing experience from the nuclear and offshore energy industry

The oil & gas, nuclear and offshore wind industries participated in this collaborative workshop, the objective of which was to understand the lessons of the nuclear industry: how and the why it had arrived at the current PPP collaboration model; and to consider the application and benefits to the offshore industries. Operators, supply chain contractors and regulators took part.

Decommissioning assets can be a costly economic activity as well as energy intensive, which impacts carbon intensity. All operators, regulators and industry bodies recognise that efficiencies could be gained through aggregating the scope for decommissioning across several assets in a given geographic area. There are limited examples where this has happened in the oil & gas industry.

As the oil & gas industry emerges from a challenging period, impacted by the pandemic and low oil price, the shift in focus towards emissions reduction and investment in the energy transition will lead to more opportunities for alternative commercial models. Collaboration across operators will be vital for success in this area.

Oil & Gas Authority

How should we compare our respective markets?

- **Oil and gas** – fragmented and complex shared private sector ownership with the timescales for decommissioning driven mainly by market and commercial considerations.
- **Civil nuclear** – public ownership under one Non-Departmental Public Body with timescales constrained by the ability of the public purse to finance projects whilst not compromising safety or regulatory obligations.
- **Offshore wind** – currently less fragmented but oriented more towards developing along the same lines as the oil and gas experience.

The difference between the market commercial models isn't characterised by Public versus Private; it is better defined by the fact that all decommissioning nuclear assets come under one ownership umbrella. This gives the opportunity of a unified approach to decommissioning multiple locations based on best athlete and efficiencies of scale.

Oil and gas operator knowledge of accurate decommissioning costs has a commercial advantage in merger and acquisition activity.

For example, if a company buying an asset has more knowledge on the true cost of decommissioning and it is less than what current owner expects, it could make for an attractive acquisition. This leads to operators protecting decommissioning costs and knowledge.

The sporadic nature of contract awards from multiple vendor one-off projects combined with the inevitable focus on costs, results in a diminished capacity to invest, innovate and develop.

Conclusion – are we learning?

The oil & gas sector have demonstrated their willingness to learn from other industries. The OGA decommissioning strategy continues to adapt and develop as can be seen by having embraced the opportunities of the Energy Transition. Although fragmented asset ownership and shared liabilities will continue to frustrate, the emphasis on commercial transformation and stimulating well campaigns offer the best 'bang for buck', at least in cost reduction terms in the short to medium term.

Civil nuclear decommissioning and environmental remediation could be considered as the most mature of the three markets, albeit with protracted timescales as it deals with its own legacy complexities.

Over the years it has demonstrated its ability to adapt by implementing various commercial models to balance risk, capacity and capability against the very visible backdrop and scrutiny of providing taxpayer value and social license to operate.

The PPP model is the latest iteration borne from experience drawing on lessons learnt.

Both the nuclear and offshore oil & gas industries had early drivers of necessity to exploit resources for economic benefit. Little regard was given by these industries to the inevitable requirements for decommissioning. It would seem to be a not dissimilar case for the current drive to deploy offshore wind installations. The offshore wind industry has already identified a cost gap between funds set aside for decommissioning and the eventual bill. There is also an acknowledgement that the industry is set to follow a similar trajectory to oil and gas with regards to complex asset ownership and liabilities.

It is important that we continue to collaborate across industries to capture relevant learnings and ensure common issues and errors are not repeated.

Joe Leask,

Decommissioning Manager, Oil & Gas UK

Net Zero

“That there is a climate crisis is no longer in dispute…” was the opening comment from the NDA Chair of the Environment, Safety & Security committee of the NDA Board.

All invited workshop participants and subject matter experts were in agreement, and there were some strong take-away messages, not least of which was the pace of change required, and that each individual and organisation should insist on change and feel empowered to make that change without otherwise waiting for others.

The workshop focussed on implementation of Scope 3 Greenhouse Gas emissions targets, i.e. indirect emissions, often in an organisation’s supply chain. Participants heard that Scope 3 emissions are often the largest proportion of the overall footprint. Focus on Scopes 1 & 2 alone can have a ‘balloon squeezing’ effect which merely passes on the issue to other parts of the value chain and result in rising Scope 3 emissions.

As organisations begin to address Scope 3, there will be a snowball effect on the supply chain, as they too will be required to have robust, science-based targets and reduction initiatives and will pass this on down the supply chain.

Key Take-away Messages included:

- Future procurement awards will feature scoring for evidence of carbon reduction plans using science-based targets, not just cheapest bid.
- Take every possible action to remove carbon emissions first and only then consider carbon offset/ removal schemes.
- Planting trees is good but prefer verifiable and permanent direct carbon capture and storage (without knock-on environmental consequences), as offset schemes are finite, and trees can die or burn.
- Tackle that which sustains unsustainable development – it is never just about the bottom line. The Well-being of Future Generations (Wales) Act 2015 was seen to be a good and progressive example.
- Policy makers could (should?) take precautionary approach to environment rather than economic maximization and acceleration – shift burden of proof to polluters.
- Cognitive & Structural change necessary (small but deep change), not just Behavioural (wide but shallow nudges) – people not resistant to change, but resist being changed.
- Covid-19 demonstrates that culture can change quickly.
- Don't wait for others to show leadership.
- Maximising short-term economic value is not always consistent with long-term sustainability. 'Value' is more than just money.
- A common question when it comes to investing in renewable energy is "what's the payback?". Payback in a circular economy is measurable in more than just financial terms.

Steve Hardy,

Director of Environment, NDA

Outcomes

This report demonstrates the strong and continued level support for sharing, evidenced by the ongoing programme of cross-industry engagements across 18 themes of common interest which has manifest in over 150 organisations participating in scores of workshops in recent years.

Many of these learnings will make a massive difference. Take for example the process of Opportunity Framing: a structured process for project shaping pioneered decades ago in the private sector, particularly oil & gas. Opportunity Framing is now being introduced across the UK public sector by the Infrastructure & Projects Authority (IPA), and the NDA will lead a wider and deeper implementation across its own estate. This process is expected to achieve a step-change improvement in the predictability of project outcomes, on which the NDA alone is expected to spend tens of billions of pounds over the coming years.

Take also for example the matter of cost and schedule benchmarking, another process long established in oil & gas, which is being introduced, again by the IPA, across UK government. Learnings from oil & gas have helped shape, via the global Nuclear Energy Agency, the worldwide approach of the civil nuclear decommissioning sector to new ways of removing optimism bias from cost and schedule estimates.

Initiatives such as these promise to save billions of pounds, and years of schedule from the UK government's project portfolio, and of course from the UK's nuclear decommissioning liability. All based on transferring techniques already applied within other sectors.

New processes for undertaking joint calls for academic research of use to multiple industries have recently been established.

The assets and capabilities of the UK's National Decommissioning Centre, established by oil & gas, is now to be accessed also by civil nuclear. Joint capital projects are under consideration for the building of a UK metal smelter, of use to multiple industries, and many other similar ideas are taking shape.

The benefits of learning from others, and the benefits of collaboration are undeniable, and the NDA is proud to be in a position to help facilitate ongoing cross-industry engagement.

Karl Sanderson,

Head of Cross-Industry Learning, NDA


WELLMAN
BOOTH
SAFE WORKING LOAD 4 TONNES
SAFE WORKING LOAD 2 TONNES

National Nuclear Laboratory

At the UK's National Nuclear Laboratory (NNL) we're proud to once again support the NDA to help deliver a stronger future for the nuclear sector through further cross-sector collaboration. Achieving a bright nuclear future however requires nuclear to contribute fully to the net zero decarbonisation goals set out by the UK government; and not just through baseload electricity as is often assumed.

NNL has led research over the past year on how hydrogen can enable nuclear to play a more significant role in the decarbonisation of our economy and support the delivery of the UK government's Ten Point Plan and Hydrogen Strategy. Nuclear technology is uniquely placed to deliver zero-carbon heat for efficient, advanced hydrogen production at reduced cost to the consumer (see diagram on the right).

For example, estimates by NNL indicate that just 3GW of nuclear power with today's technology generating zero carbon hydrogen could decarbonise 50% of UK shipping emissions. Equally importantly for the sector, our analysis also indicated that tens of reactors would be required to generate the quantity of hydrogen needed to drive large scale decarbonisation of heating in homes and transport applications. Nuclear has a particularly timely opportunity to support this challenge.

In May 2021, NNL brought the nuclear and hydrogen sectors together at a Roundtable to explore this vision and build on the earlier NIA Hydrogen Roadmap, which proposed a third of hydrogen production in 2050 could be derived from nuclear energy.

The Roundtable culminated in the report "Unlocking the UK's Nuclear Hydrogen Economy to Support Net Zero", set out an ambitious timeline for the rollout of hydrogen generation from nuclear.

The roundtable outlined that flexible co-generation, switching between electricity and hydrogen production could be used now and in the future to optimise capacity on a rapid basis for maximum net zero benefit. A number of actions and targets were set, including:

- By 2025, we could demonstrate nuclear heat-assisted hydrogen production, increasing efficiency of hydrogen production methods;
- By 2040, the industry could utilise planned new build of LWR, SMR and AMR with advanced hydrogen production technology to scale up production;
- By 2050 nuclear could generate a third of the UK's forecast hydrogen needs.

Delivering this vision will require true cross-sector collaboration and a recognition by energy use sectors that nuclear has a key role to play.

We've already come together to develop that vision but by working closely together now we can achieve the accelerated demonstration of the technologies required.

Nuclear sites across the UK have the skills and capability to demonstrate the key technical aspects of hydrogen generation such as nuclear heat sources and management of hazardous chemicals.

Effectively applying this unique heritage now could demonstrate the value new nuclear facilities could deliver, building the case for a long-term role for nuclear in delivering net zero.

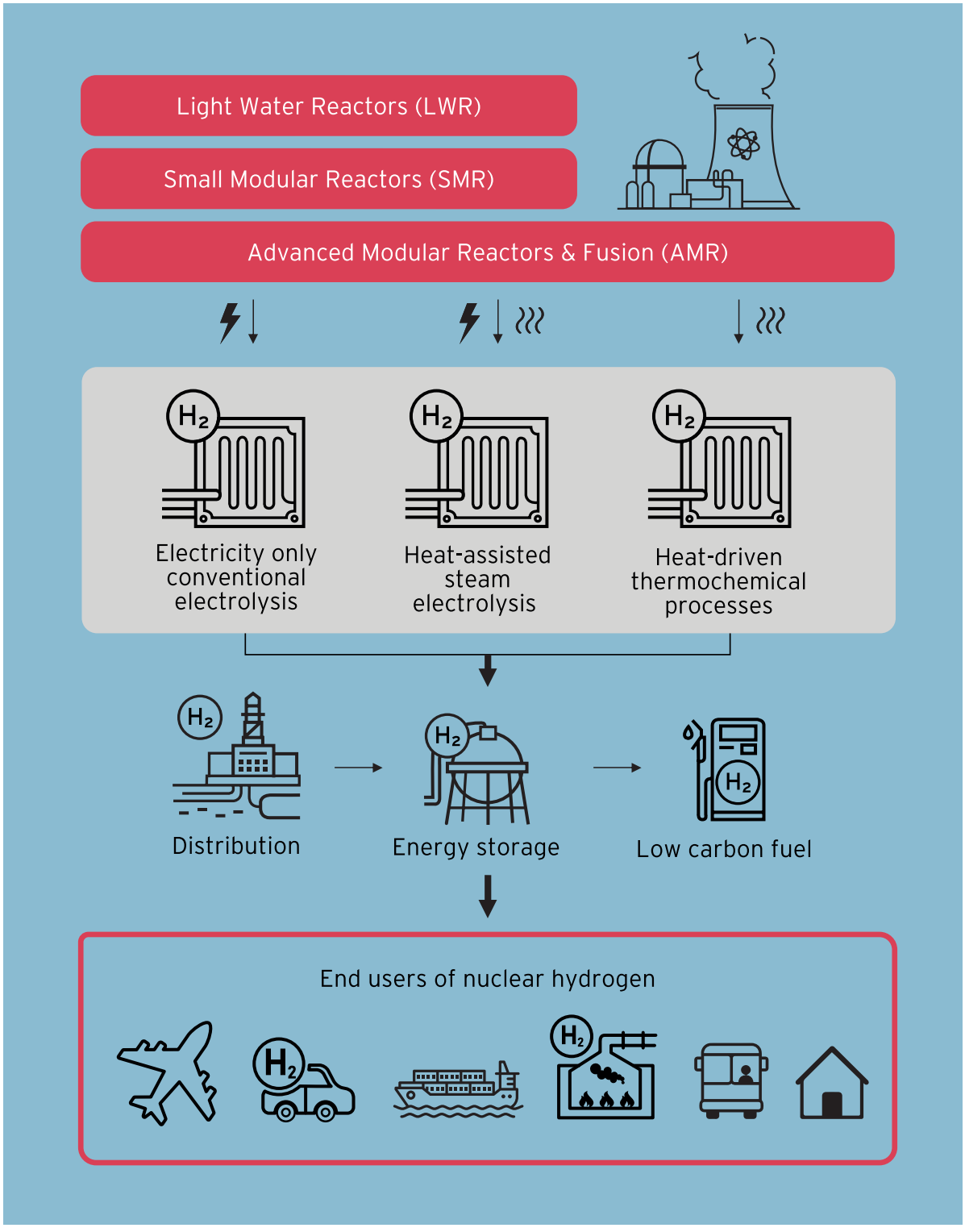
At NNL we're looking forward to bringing organisations across the sector together to achieve this, building on the achievements of the NDA to date in doing the same.

We are truly excited about the opportunity to deliver NNL's key role in achieving a vision for the sector that can create renewed prosperity across all regions of the UK, build the UK as a scientific superpower and support decarbonising some of our hardest to abate sectors.

We're excited about what the next stage of this journey holds, and we'd love to hear from you if you'd like to know more.

Allan Simpson,
Senior Research Technologist, National Nuclear Laboratory

Phil Rogers,
Technology Leader in Hydrogen, National Nuclear Laboratory


Light Water Reactors (LWR)
Small Modular Reactors (SMR)
Advanced Modular Reactors & Fusion (AMR)
H2
Electricity only conventional electrolysis
Heat-assisted steam electrolysis
Heat-driven thermochemical processes
Distribution
Energy storage
Low carbon fuel
End users of nuclear hydrogen

Game Changers success underpinned by collaboration

GAMECHANGERS
DELIVERING NUCLEAR INNOVATION

Another year along the Sellafield decommissioning road and the Game Changers innovation programme can look back on significant successes, helping develop promising solutions to challenges faced by Sellafield.

The Game Changers programme is delivered by the National Nuclear Laboratory and commercialisation specialists FIS360. It harnesses cross sector technology from a global network of expertise, gleaned through a well-defined process which identifies the most promising potential answers to Sellafield's decommissioning challenges.

Partnership and collaboration underpin the Game Changers ethos and programme partners range from individuals and SMEs to universities and national organisations. Successful applicants to challenges, selected by an expert panel, receive funding to develop prototype projects.

A prime example of the power of collaboration is found in a current Game Changers project designed to improve efficiency of soil contamination detection with the aim of ensuring the Sellafield site will be safely secured for future generations.

Part way through a 12-month development, the soil testing project is based on a collaboration between the Fraunhofer Centre for Applied Photonics (FCAP) and the University of Strathclyde's Centre for Signal and Image Processing (CeSIP). It aims to make use of spectroscopic technology to allow the detection of soil contamination with enhanced productivity and significantly reduced costs.

Challenges launched to develop potential land remediation solutions for Sellafield have produced further examples of cross-industry collaboration benefits.

Among these is a project by Createc and Hydrock which aims to address the characterisation of landfill and disposal areas using technology originally developed for landfill gas control. The project is designed to allow smaller probes to be installed in a borehole monitoring network which will measure and locate existing radiological waste present in landfill.

And an impermeable subsurface seal, designed by Resolute Energy Solutions, aims to provide a solution for leak mitigation and groundworks near sensitive structures. Again, using tried and tested technology developed originally for oil and gas applications, the project will explore the application of super absorbent, polymer materials, which it's anticipated could be used to stop and prevent leakage of radioactive materials into the ground.

Tetra Tech

We are delighted and proud to continue supporting the NDA and all our partners within the different sector representation bodies we work with. We help provide additionality to the cross-industry learning programme on behalf of the many supply chains and private sector service delivery practitioners, of common interest originally identified and subsequently added to over the last 3 years.

We are a leading provider of consulting and engineering services with 21,000 associates working across the full project life cycle worldwide. Our operations in the UK and Europe include more than 2,000 employees who are Leading with Science® to solve our clients' most complex problems. We operate across multiple sectors including property, residential, transport, defence, energy & utilities, government services and nuclear, continuing to act as a supportive bridge across these sectors and demonstrating that we understand the unique 'client culture' aspects of various sectors.

One of the key learnings that we would like to share is something that will echo with other multi-disciplinary supply chain organisations, in that to a large extent there are benefits in being sector agnostic when it comes to project delivery. A project is a project, right?

In several workshops and skills in particular, we have reflected on the fact that a speculative 85% of an engineering job for example is common across industry sectors. Another 5% is having the correct permits or security clearances (although many of these are duplicated too adding more cost into the system which the client ends up paying for). And yet another 5% of the rest is battling through the acronym challenge e.g. ALARA, HALEF, MOX & TENORM. Oil & gas colleagues may parry that with bopd, IMMH, TVDss and Well P&A (how did you do on the test?).

So when we look to attain, train and retain staff, our personal development plans are designed to give the fullest opportunity for individuals to hone their skills and experience across any sector, and where additional cultural 'SQEP' is needed, we support that aspect too.

Not only does that allow us to flex capability and capacity to take account of market opportunity peaks and troughs and passing these efficiencies on to our clients, it also has a very welcome effect of giving our personnel a better and more enriching career experience.

I mention that last point in case you would like to consider a career with Tetra Tech Ltd. Blatant – I know.

Simon Sjenitzer,

Director,
Tetra Tech

Getting Involved

Success with cross-industry collaboration relies on you! We hope that this report has encouraged and inspired you to think cross-industry during your day job.

You might be pleasantly surprised to find that your industry is not unique, that the same challenges are often faced by others, and that a colleague in another industry will often be able to add enormous value to your enterprise with a key insight, freely shared.

Similarly, the success of our cross-industry workshops to date has been thanks to the participants; arriving with an open mind and being willing to listen and share.

We have engaged with over 150 different organisations and in the workshops and roundtables to date on topics deemed as high priority for shareable experiences and expertise.

We aim to bring together not just different industries, but also a cross-section of organisations from within each industry. A typical workshop has representatives from layers of government, regulator, authority, operator, tier 1 & 2 supply chain and SMEs, academia, consultancies, trade associations and other institutions.

Workshops and seminars have comprised relatively small, hand-picked, invited-only participation, strongly facilitated and conducted under the Chatham House rule to encourage open-ness.

Shareable write-ups, post workshop webinars and other forms of dissemination have ensured the wider availability of learnings to those who could not be in the room.

Perhaps the biggest achievement of our engagements to date is that we are making cross-industry conversations part of what is now considered business-as-usual, part of the day job rather than an optional extra.

The key test of whether the learning process is working is when participants come back for more. The consensus is that the audience is indeed keen for cross-industry collaboration to continue. In addition to the sharing of learnings, there is a real appetite for tangible, cross-industry projects. We hope to report back next year with the achievements that have been realised in such joint projects.

In the meantime, if you have ideas for ways in which industries can deepen their cross-sector collaborations, please get in touch with the contacts at the end of this report and we will be pleased to help, or put you in touch with your colleagues in other industries.

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Cross-Industry Learning

In collaboration with:

Oil & Gas Authority

CATAPULT Offshore Renewable Energy

Environment Agency

NATIONAL NUCLEAR LABORATORY

we connect, we share, we learn