IOP Nuclear Industry Group

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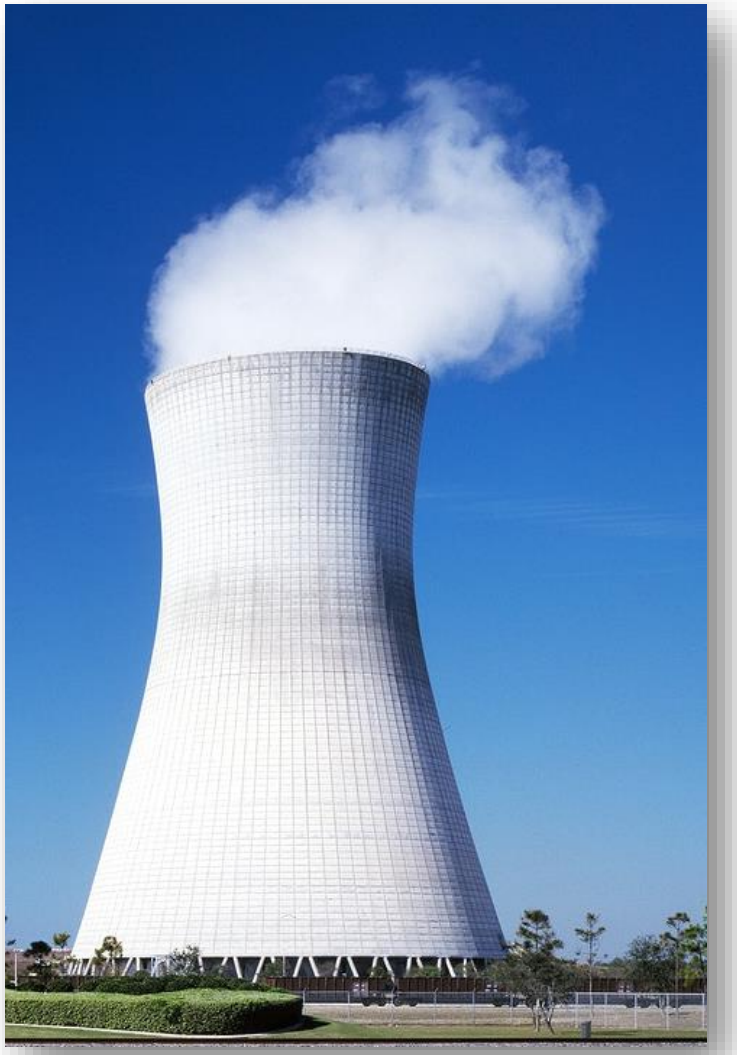

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Notes from the Chair

Welcome to the IOP Nuclear Industry Group newsletter.

As we leave Summer 2021, we find ourselves reflecting on what has been a difficult ~18 months, and hopeful that the ongoing vaccination programme will provide us with a route out of the current restrictions, and a return to more face to face engagement. I've always valued the chance to network with the broad community of the Nuclear Industry Group and am personally, very much looking forward to in-person events again.

However, the way we deliver outreach and engage with the community and the general public is changing. The webinar series that have been established over the last 18 months have been a big success. It's proven to have reached 1000's of individuals over the UK and abroad, and broken down barriers to engagement with a wide range of topics associated with physics of the nuclear industry and this should be celebrated and means that webinars will be a core focus of our event programmes going forward.

This shift to more on-line webinars is only one small change impacting our community and the nuclear sector. Society is changing and there is a real recognition of the need to de-carbonise the way we live – electricity, heat, transport, and manufacturing.

This year, the UK will host COP26, and decarbonisation will be the top of the agenda across the globe. In advance of COP26, the group is hosting an IOP-NIG webinar series to illustrate how the nuclear sector will support this agenda.

In addition, we have been working with the IOP to shape the IOP Physics in the Spotlight 2021 event to highlight the role physics can play in reaching net-zero and reaching a green economy. This is a high-profile, members led event with contributions across a number of special interest groups. Keep your eyes peeled for announcements on this post-COP26 event in the near future.

Notes from the Chair

This is certainly a fascinating time for physicists in the nuclear sector and we have an exciting pipeline of events planned; from the physics of nuclear medicine to the physics of fuel manufacturing. As always, we are keen to hear your thoughts on what topics you would like to see appearing as a future event.

And as the world around us keeps on changing, it is important that we make sure that the IOP nuclear industry group is serving it's purpose as a special interest group for the IOP. The committee have spent some time over the last few months considering how we will contribute to the IOP's latest strategy, and have set ourselves four objectives:

1. Increase the number of people engaged
2. Be a proactive contributor to public engagement
3. Leverage our networks and partnerships to contribute towards reducing the skills gap in the nuclear sector
4. Improve awareness of secondary-school aged children of the diverse array of career opportunities across the nuclear sector

The IOP have launched a number of pertinent initiatives that we will look to contribute towards and make sure the nuclear sector is aware of:

- Challenge Fund
- Limit less

If you have any proposals, or feel that your organisations might want to table a proposal, please do feel free to get in touch with the committee.

I also wanted to take the opportunity to say thank you to a few individuals. Firstly, to our outgoing Chair, Heather Beaumont. Heather's contribution to the Nuclear Industry Group and the broader IOP cannot be understated – from supporting public consultations through to arranging an international Tropical Research Meeting in collaboration with the IAEA. Many thanks for all your efforts Heather.

Secondly, I'd like to pass on my thanks to our outgoing committee members Zahid Riaz (secretary) and Andy Hicks (treasurer). Both have supported the committee over a number of years and supported a number of different events – thanks to you both.

Finally, I'd like to say 'welcome' to our newest committee member, Eve Moss, who has taken up the role of secretary from Zahid.

Committee Updates

Welcome to our new group secretary - Eve Moss

This year Eve joined our committee as our new group secretary and is already helping the group run efficiently. I'm sure you'll all join us in welcoming Eve and thanking her for her contribution.

Voting Underway in committee elections

Following recent voting for several new committee members, we're imminently going to be announcing the results of the group elections, so keep an eye out for this soon. Thanks to everyone who's nominated, we've got some really great candidates to choose from.

Group Prizes

Career Contribution Prize:

The 2021 IOP Nuclear Industry Group Career Contribution prize was won by Dr. Robert Mills from The UK's National Nuclear Laboratory (NNL). Robert is a nationally and internationally recognised expert in the field of Nuclear Data. Operation of the nuclear fuel cycle is dependent on the ability to accurately predict and track materials under irradiation. Nuclear data is critical to this ability, providing the baseline empirical data that enables reactor neutronics calculations, criticality safety assessments, fuel cycle development, waste management and much more. Robert has made an active and sustained contribution to global nuclear data libraries for over 30 years, contributing to the OECD-NEA facilitated Joint Evaluated Fission and Fusion (JEFF) nuclear data library since 1988 where his evaluations of fission product yields are incorporated in the international standard nuclear data files JEF-2.2, JEFF-3.1, JEFF-3.1.1 and JEFF-3.3. He was a founding member of the UK Nuclear Science Forum which he now chairs. He has worked closely with the IAEA's nuclear data section on supplying nuclear data for safeguards applications, and he is currently the chairman of an IAEA Coordinated Research Product on Updating Fission Yield Data for Applications. Robert has also demonstrated outstanding commitment to the promotion of the nuclear industry throughout his illustrious career from presenting at international conferences to the recruitment and mentoring of graduates to the nuclear industry.

On receipt of this prize Robert said: *"I would like to thank the committee for awarding me the Institute of Physics Nuclear Industry Group Career Contribution Prize and my colleagues for nominating me. This award has prompted me to recall my career and the many people I have the pleasure to meet and work with so far. Unfortunately, no deep insights were revealed by this introspection that I can share in a few lines but it was interesting."*

The Nuclear Industry Group committee feel Robert is a more than worthy winner of this prize, as I'm sure you will agree, congratulations Robert.

Early Career Prize:

The 2021 IOP Nuclear Industry Group Early Career Prize is this year awarded to Prof. Shutaro Takeda, co-founder of Kyoto Fusioneering Ltd. and Associate Professor at Kyoto University. Since completing a Bachelor of Engineering at Kyoto University in 2014, Shutaro has added a Master's degree and PhD, co-authored a book on the commercialisation of fusion published by the IOP, and designed an innovative breeding blanket concept which could significantly scale down magnetic confinement fusion reactors. After raising £1M in funding for this concept he launched the first nuclear fusion start-up company in Japan which has since grown significantly and has several international clients. In 2020 Shutaro joined the International Atomic Energy Agency (IAEA) as an Associate Project Officer and lead a new private-public partnership initiative in fusion energy. Colleagues praised his innovative thinking and enthusiasm, and noted he is always ready to help and praised his professionalism.

On receipt of this prize Shutaro said: *"I am extraordinarily humbled and elated to be named for the distinguished Early Career Prize. This recognition means a great deal not just to me but also to the fusion community. I've strived for the commercialisation of the energy throughout my early career, as an IAEA officer, and as a co-founder of the first fusion start-up in Japan, Kyoto Fusioneering. And today, I felt the tide turning. This recognition renewed my belief that fusion is no longer a* confusion *nor* illusion *-- but it is an actual future energy option for humanity! Thank you all from the bottom of my heart."*

The Nuclear Industry Group committee were extremely impressed at how much Shutaro has achieved already in his career to date, and are pleased to award this prize, congratulations!

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Licencing a New Nuclear Power Plant- Sizewell C so far…

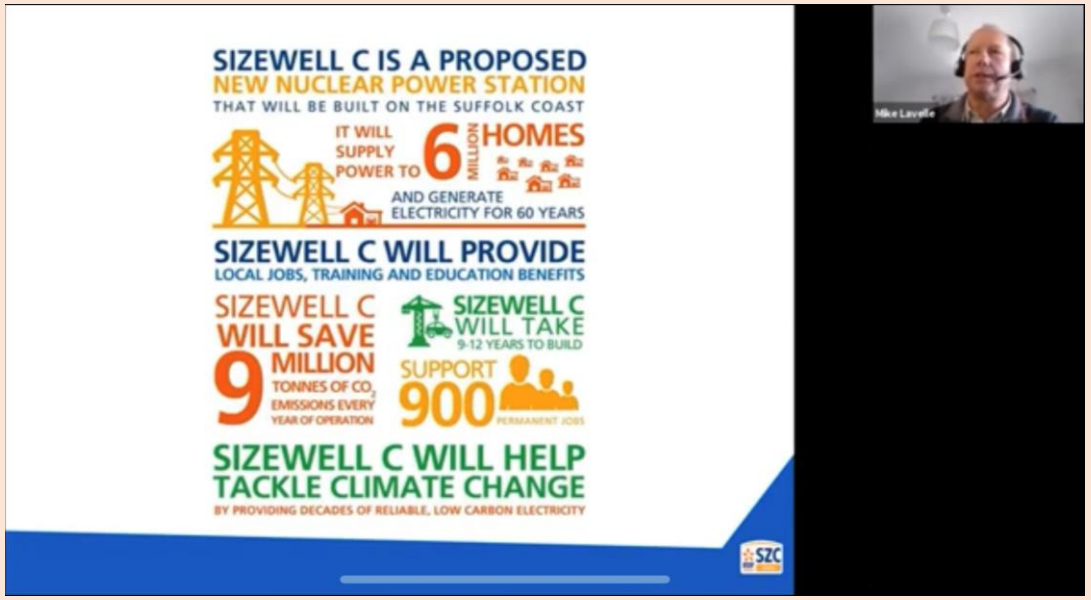
A presentation by Mike Lavelle (EDF), 11/02/2021

Sizewell C is a proposed new nuclear power station which will look to supply power to 6 million homes, saving 9 million tonnes of CO2 emissions for every year of operation. It is a twin EPR.

The ONR and expectation on licence holders was discussed, alongside proportionality. Some licence conditions may not apply at certain stages – but there still needs to be a demonstration that the right processes will be in place.

A question was asked about waste generation and disposal– Mike noted that the design of the reactor is more efficient at burning fuel due to a heavy reflector. Design of plant has also been conscious of minimising waste build up.

A question was asked about the difficulties faced. Mike discussed Licence Condition 17 – Management and Arrangements. Demonstrating competence to the ONR and EA when there is only a fraction of the workforce in place, and ensuring right behaviours and skills are adopted is difficult. Have to demonstrate competence up front to the regulators.



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SizewellC EDF CGN

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Digital Innovation in Nuclear (1)

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IOP-NIG organised a series of three complementary webinars, in April and May 2021, that explored novel projects in the developing field of 'Digital Innovation in Nuclear'. All three talks were well attended, with people connecting from around the world, reflecting the growing interest in this new area. Taken together, the webinars outlined how innovative digital technologies have the potential to provide transformative solutions in what is traditionally seen as a risk-averse industry. The challenges to achieving this via a wide range of innovative solutions were discussed, together with lessons learnt from prototype implementation and the route to successfully deliver a digital project at a live nuclear facility that adds value at pace.

Chris O'Leary, 30 June 2021.

A Digital Future for Nuclear? by Dr Mark Bankhead of NNL; 30 April 2021

YouTube link

Mark opened by discussing the importance of harnessing innovative nuclear power technology to meet the UK government's commitment to net zero carbon emissions by 2050. He noted the aspiration for efficiency saving goals of 30% on new build and safety case production, and 20% on decommissioning; plus the need for a more competitive supply chain and £2bn domestic and international contract wins by 2030. He went on to discuss the challenges of siloed working, loss of fidelity during information handover and the need to promote collaborative working; these being areas in which digital could play a part, connecting the acquisition of raw data to the knowledge/decision making process.

Mark went on to define what is meant by 'digital', covering industry buzzwords such as 'Big Data' and 'Quantum Computing'; then set himself the challenge of answering the question of whether digital is the route to meet those government goals. This included his interpretation of where current digital themes sit on the Gartner Hype Cycle. He also clarified that 'Digital Transformation' means "*doing things differently*" rather than simply enhancing current practice.

The remainder of the talk focussed on Project FAITH; a partnership between multiple organisations with three key workstreams: offsite modular manufacture of a thermal hydraulic test rig; the thermal hydraulics science behind the rig; and the development of a digital twin across the lifecycle of the asset. The development of a Common Modelling Environment (CME) was described as "*a place where everyone goes to interact with everyone else*", and the benefits of using virtual reality to understand the FAITH rig laboratory layout during COVID lockdown were provided.

The development of a proof-of-concept digital twin of the rig was presented; a simple Simulink model of the system, with a dashboard GUI, that is coupled to Ansys Fluent. The model also made use of NVEC core components (a topic discussed in more detail in the second webinar).

Mark closed by discussing the lessons learnt during the FAITH project; these included the need to introduce innovation more quickly within R&D projects; quantification of loss of fidelity during handover; and the gains realised through efficient collaboration.

Digital Innovation in Nuclear (2)

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The Nuclear Virtual Engineering Capability (NVEC) by Dr Albrecht Kyrieleis of Jacobs; 6 May 2021

YouTube link

Albrecht discussed the four-year long NVEC project; a collaboration between NNL, Jacobs, Rolls-Royce, EDF Energy, the Nuclear AMRC and the Virtual Engineering Centre; covering context, case studies and future developments. The project is part of the BEIS 'Nuclear Innovation Programme' under the 'Reactor Design' theme, with a goal of delivering significant efficiency savings across the nuclear life cycle. The NVEC approach is to develop a common data and modelling environment that can overcome siloed working and improve information handover, while promoting a digitally-enabled culture that breaks-down barriers to collaboration and exploits technological innovations such as 'Digital Twins'. A detailed explanation of Digital Environment architecture was provided, together with four specific case studies:

- AGR graphite analysis for EDF: use of NVEC to improve collaborative working.
- System level modelling: complex system modelling of a molten salt AMR.
- Decommissioning: combining data from a Remotely Operated Vehicle (ROV), incorporating point-cloud imagery from a 3D stereo camera with gamma-ray data from a Compton camera, and SixthSense, to survey a cell with unknown contents and areas the ROV cannot reach.
- Industrial Internet of Things (IIoT) at N-AMRC: importing real plant/asset sensor data, pre-processing, validation and storage to reduce the burden of ad-hoc analysis.

Adoption of Digital Twin Technologies at a Nuclear site by Mr Chris Sheryn and Dr Ashwin Rao of PA Consulting; 14 May 2021

YouTube

The talk opened with an explanation of 'Digital Twins', defined as "*virtual models of a physical system and its parts, that support better decision making*", and why they are seen as one of the next big steps in Industry 4.0. It was noted that the label was something of a catch-all term, and that there are four different categories (in increasing development complexity): '*Existence Twin*', '*Performance Twin*', '*Predictive Twin*' and '*Cognitive Twin*'; with a need to match this complexity to business need. Chris stressed the need to avoid a '*Stranded Asset*', i.e. building a digital twin for a problem that has not yet been identified – this can lower an organisation's confidence in the ability of the technology to deliver value.

The rest of the webinar focussed on the real-world problem of controlling cost at a UK nuclear site for infrastructure where steam is used in several safety critical processes. A structured approach to defining the anticipated value for adopting a digital twin was outlined; demonstrating how value can be realised at pace, piloting the solution and then embedding the value at scale. Ashwin discussed the build of a representative (physical) laboratory model, designed to address the question "*what is the minimum amount of information required to take a higher quality decision?*"; this allowed rapid engagement with operators and other stakeholders, and was seen as being crucial to the success of the project. He went on to discuss how the digital twin was initially constructed using CFD, but then used an equation-based model that employed machine learning for real-time prognosis; and how this model was subsequently validated against the real system. The ability of this digital twin to model, then display via dashboards, the impact of various degraded plant conditions, from a financial and time perspective was demonstrated. The talk closed with the message that "*Adoption, not implementation, is the key to accelerate the usage of digital across nuclear*".

Physics of Decommissioning & Waste Management

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IOP-NIG organised a three-part webinar series, with guest speakers from EDF, Magnox and RWM, exploring the Physics of Decommissioning and Waste Management. The speakers took the audience on the journey from preparing to characterise and process the waste, through to decommissioning and finally disposing of the waste, discussing the science, and touching on potential career paths through these final stages of a reactors life. More than 100 people joined for each webinar, and judging by the excellent and diverse questions raised, the audience we're clearly engaged with the topic. A special thanks to our speakers Claire, Gwen and Meyrem.

Jeni Liley

Nuclear Decommissioning in EDF by Claire Wallace of EDF; 29 June 2021

YouTube

EDF have eight nuclear power stations in the UK. The seven Advanced Gas-cooled Reactors will transition to the defueling and decommissioning phase of their lifecycle in the next decade. Preparation work to support defueling and decommissioning is already well underway. Claire's presentation provided an overview of the decommissioning strategy, the work scope required to be performed during the first phase of decommissioning, and took a look at the activities already underway across the defueling and decommissioning programme.

Magnox Decommissioning Journey by Gwen Parry-Jones of Magnox; 6 July 2021

YouTube

The mission of Magnox is to safely and securely deliver all of its sites to closure, but each of the 12 Magnox sites brings its own risks and challenges. In her presentation, Gwen Parry-Jones, the CEO of Magnox, explored the complex process of managing the decommissioning strategy on a national scale, highlighting the contributing factors and unique challenges, as well as the progress made so far and the most notable successes delivered by Magnox workforce to date. Gwen also took a brief look at the exciting future of the company and the opportunities it will bring.

A Permanent Solution for Higher Activity Radioactive Waste by Meyrem Sari of RWM; 13 July 2021

YouTube

This presentation provided a high-level overview of the role of Radioactive Waste Management (RWM) in the nuclear industry. RWM plays a key role in delivering a long-term solution for managing the UK's higher activity radioactive wastes. One part of their mission is to deliver a geological disposal facility (GDF). RWM have launched a siting process to find a willing community and suitable geology to host a GDF., working alongside communities to achieve this. The other part of the RWM mission is to provide waste management solutions. The waste ultimately designated to a GDF needs to be in a suitable form and RWM work with waste producers to ensure that processing and packaging of wastes is done accordingly with long-term safety and geological disposal concepts in mind.

Ongoing Events

COP26 – Nuclear's Role in the Green Economy

In the run up to the Committee of Parties (COP26) United Nations Climate Change Conference (COP26) in Glasgow, the Nuclear industry Group are hosting a series of webinars examining nuclear's place in a net zero future.

- 29th September 2021, 12:00 - Sustainability in action at Hinkley Point C by Lauren Brown (EDF)
- 6th October 2021, 12:00 - Life Cycle Assessments by Andrea Paullio (University College London)
- 13th October 2021, 12:00 - The role of large, small and advanced nuclear in a full energy system model by Paul Nevitt (NNL)
- 20th October 2021, 12:00 - The Opportunity for Zero Carbon Hydrogen from Nuclear by Phil Rogers (NIRO)

Full details can be found on the IOP Events page: https://events.iop.org/

EDF

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Upcoming Events

Physics in the Spotlight

How can physics and physicists help create a thriving low-carbon, environmentally friendly and socially inclusive economy?

Attend the IOP Physics and the Green Economy Summit, a hybrid event, 22 – 26 Nov 2021, to discuss scientific and technological advances in energy generation and decarbonisation, and the practical challenges that need to be overcome.

This summit follows COP 26, the United Nations conference on the environment, taking place in Glasgow earlier in November, and the UK Government's recently published 'Ten Point Plan for a Green Industrial Revolution' that sets out the actions required for our economy to transition to net zero. Physics is fundamental to the technologies that will be required to implement this transition.

http://spotlight2021.iopconfs.org/Home

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Nuclear Institute – Net Zero Needs Nuclear

This year's United Nations Climate Change Conference (COP26) in Glasgow represents a critical opportunity for our nations to come together and take action, collectively changing the way we think about climate change and setting us on the path towards achieving Net Zero.

The Nuclear Institute YGN are a group of young, international volunteers made up of engineers, scientists and communicators, who are passionate about saving our planet. We have a vision of a clean, sustainable and abundant low-carbon future for all and our mission is to accelerate the ability of the world to achieve Net Zero by 2050, by driving collaboration between nuclear and renewable technology.

Net Zero Needs Nuclear, so the Nuclear Institute have launched a coordinated campaign of activities and communications in the build up to, and at COP26.

Details of their mission, work, and how you can support and get involved can be found online: https://www.netzeroneedsnuclear.com/