



Hutson, C., Martin, P., Payne, L., Oughton, N., Wyness, K. E., Smith, D., Warren, A. D., Rennie, S. L., Jones, C. P., Banos, A. K., Payton, O. D., Sutcliffe, J. E., Paraskevoulakos, C., Liu, C., Darnbrough, J., Springell, R. S., Hallam, K. R., Stevens, O. A. C., Logan, M., ... Scott, T. (2017). The Importance and Impact of Public Engagement for the Nuclear Industry. In *Waste Management Symposia 2017: Proceedings of a meeting held 5-9 March 2017, Phoenix, Arizona, USA* Article 17602 (WMS Journal; Vol. 2, No. 3). Waste Management Symposia, Inc..

<http://www.wmsjournal.org/index.cfm?Publication=Volume2,%20Issue3>

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WM2017 Conference, March 5 – 9, 2017, Phoenix, Arizona, USA

The Importance and Impact of Public Engagement for the Nuclear Industry – 17602

Chris Hutson *, Peter Martin *, Liam Payne *, Natasha Oughton *,
Kate Wyness *, Dave Smith *, Xander Warren *, Sophie Rennie *,
Christopher Jones *, Antonios Banos *, Oliver Payton *, Joseph Sutcliffe *,
Haris Paraskevoulakos *, Chong Liu *, James Darnbrough *, Ross Springell *,
Keith Hallam *, Oliver Stevens *, Mary Logan *, Jamie Townes *, Lewis Roberts
*, Richard Pancost *, David Marshall *, Hayley Shaw *, Amanda Gray *, Dong
Liu **, Kathryn Hutson ***, Oscar Yapp ***, Stephen Huntley ***, Anna
Adamska ****, Rebecca Smale *****, Thomas Scott *

* University of Bristol, ** University of Oxford, *** Magnox Ltd, **** Sellafeld
Ltd, ***** Horizon Nuclear Power Ltd

ABSTRACT

The South West Nuclear Hub has joined with its industrial partners to engage with the public about the pros and cons of nuclear power, and open a balanced and evidence-based dialogue around common areas of concern, such as nuclear safety and nuclear waste. This programme of industrial engagement must continue into the future if we are to understand and effectively address those concerns, and make the UK's nuclear renaissance work for all.

INTRODUCTION

The UK's Nuclear Industry Association asserts that 65,791 people work in the civil nuclear sector, an increase of 2,000 jobs over the last year [1]. Many of these jobs are highly skilled and well-paid, providing economic stimuli to areas across the whole country. At a time when the UK economy is struggling due to investment fears over Brexit and closure of manufacturing industry, the nuclear industry has the potential to literally help power the economy in terms of both electricity and productivity.

One of the most pressing issues in the nuclear industry is the challenge it faces in addressing public concerns, around both safety and waste. Ultimately, the decision to expand the UK's strong history in nuclear power or to halt investment lies with the Government, and its electorate.

In October 2016 the UK Government signed a contract with EDF Energy to authorise the building of a new nuclear power station at Hinkley Point C which, when operational, will provide 7% of the UK's electricity supply. There are plans for several other nuclear plants to be built in the coming years, and the UK could well be on the brink of a nuclear renaissance.

EDF Energy, Horizon Nuclear Power and NuGen are all planning new nuclear reactors in the UK; their projects are at different stages. Each project relies on the public acceptance of nuclear energy, and so public engagement is seen as a priority.

What is clear, though, is that public acceptance will not be achieved by attempts to 'educate' the public. Of course, misinformation and myth must be addressed through outreach programmes that make evidence and fact available. However, we must also recognise that many who oppose the industry do so from a highly educated position. As such, genuine engagement is critical in ensuring we fully understand and can completely address the concerns of citizens, either through new research, new solutions or simply via a more open and engaged dialogue that builds trust in the sector.

The University of Bristol's South West Nuclear Hub was established to provide a link between the Higher Education, Nuclear Industry and Government sectors. The main aims and objectives of the Hub are to: create a single door for the nuclear industry to access and form partnerships in academic research and teaching in the region; shape the direction of regional and national nuclear energy related research and teaching to ensure it best meets industry needs; deliver highly skilled people ready for employment in the nuclear energy industry through tailored training programmes such as the MSc courses; and provide public benefit by supporting the safety and cost-effectiveness of nuclear energy operation, construction and legacy clean-up.

This paper is a timely overview of the public engagement activities of the Hub with its industrial partners, which have been initiated to improve public awareness about the nuclear industry, engaging with the population about issues concerning the public and industry.

BACKGROUND

Through negative media coverage, public confidence in the safety of nuclear power has suffered worldwide from the accident at Fukushima. Therefore, the University of Bristol's South West Nuclear Hub and its industrial partners have taken a proactive step to engage with the UK public and inform the debate surrounding energy policy.

In March 2011, the Great East Japan earthquake struck 72 km offshore from Tohoku, Japan, 24 km below the surface and measuring 9.0 on the Richter Scale. Together with the ensuing tsunami, 15,894 deaths were caused by this natural event, despite Japan's early warning system.

At Sōma, Fukushima, a wave measuring 7.3 m inundated the coastal area. Though the earthquake detection systems at all nuclear reactors on this coastline operated correctly to initiate shutdown, power to the Fukushima Daiichi Nuclear Power Plant for residual heat removal was lost, which eventually led to the hydrogen explosions and release of fission products over the Fukushima prefecture.

To date, nobody has died from radiation exposure or radiation-induced cancers. UNSCAR, IAEA and other independent expert bodies have conducted extensive research to conclude that ongoing nobody is likely to. Over 1000 deaths have been attributed to the relocation of ~156,000 people, with most of these being elderly

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and infirm people. Figure 1 shows images taken from within the exclusion zone.



Figure 1. Clockwise from top left: Kawamata Junior High School with topsoil removed from its playing field; Collapsed house damaged by the earthquake; Deserted cattle farm with topsoil collected into sacks; Paddy fields with topsoil removed. All locations are within the evacuation area and so are uninhabited.

The Japanese Government has committed significant financial aid to the affected area, with the most visible steps being in terms of relocation compensation and land remediation. Figure 2 shows an example of the many bale storage sites in the Fukushima Prefecture, in which potentially contaminated topsoil has been collected into plastic sacks, thus allowing the return of agricultural productivity. Bale sites will allow the safe storage of contaminated soil until the hazard decays to background radiation levels.



Figure 2. A bale storage site mid-construction, aiming to concentrate contamination.

THE RESPONSIBILITY OF NUCLEAR EXPERTS

The University of Bristol's South West Nuclear Hub carries out a wide spectrum of research. Some of this research is aimed at furthering the current understanding of nuclear material properties to ensure safe, long-term storage of nuclear waste. Our focus on innovation and applied research has meant that our collaborations with Magnox, EDF and Sellafield have lasted many years. Having worked on behalf of the nuclear industry for many years, we are eager to drive outreach and engagement activities and encourage debate and discussion on the topic of nuclear energy and its role in the energy mix. As environmentalists, our team's motivation for applied research is always to make the world a better and safer place.

There is a tendency for some press outlets to be more interested in reporting negative stories around nuclear power. Generally these are poorly-researched and misinformed articles, but unfortunately can attract the most attention. Therefore, members of the nuclear research and industrial community must offer accurate factual information to the media to allow the public to come to an informed opinion themselves.

We aim to increase public acceptance of nuclear by accepting that there are waste management issues, actively addressing those concerns through new research and technology, but also increasing the awareness of the work of the many talented scientists and engineers who are actively seeking solutions to those issues. In conjunction with industrial partners, we have been able to offer facts to the public debate, and this growing voice is starting to ensure that we redress the balance in evidence considered by the public and decision-makers.

THE SOUTH WEST NUCLEAR HUB'S PUBLIC ENGAGEMENT PROGRAMME

The public engagement programme aims to address three key nuclear topics: energy; waste disposal; and health effects. These topics were selected following

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evidence from previous public dialogues showing these were the areas of primary concern to the public. Together with our industrial partners, who have recognised the need for evidence and dialogue, we have started to dispel some nuclear myths, to explore the science behind nuclear reactors and to demonstrate the principles of radioactive waste disposal. As an ongoing commitment, this programme will continue into the future.

Joint academic and industrial perspectives

A significant contribution has been made by the nuclear industry, in terms of funding as well as staff on a voluntary basis. In particular, the staff willing to engage with the public in this programme significantly enhance the public experience. They provide the public with an insider's perspective on the operation of plant, which is unusual in an educational context. Their detailed plant knowledge has proven invaluable in educating the public about how nuclear systems operate.

Industrial team members consist of graduates and experienced engineers, with expertise ranging from health physics, safety case, fuel transport, operations and materials science. The emphasis for these experts was on engagement and discussion rather than simply official communications.

The South West Nuclear Hub's relationship with industry has developed during this project thanks to their contribution of staff and equipment. EDF has indicated a willingness to support future events.

A targeted approach to public engagement

A previous study [2] has identified stakeholder groups as being either passive, supportive or obstructive. However, with an emphasis on engagement it has been more appropriate to take a different approach targeted at the following key groups:

1. ***Children and young teenagers.*** This is a key demographic because of the industry's skills shortage, which is becoming worse as many of our experts reach retirement age. It is important for young people to be inspired to take on the challenges presented by nuclear energy, particularly the management of nuclear waste and decommissioning. Generally, they also have fewer preconceived ideas, meaning they come from an unbiased position; this is extremely helpful in enabling them to understand the facts.
2. ***General public not engaged in energy policy.*** Raising the awareness of the issues with all sources of energy, from renewables to coal-fired stations through to nuclear waste, is important in educating the population about the choices made on their behalf, for which they will pay both financially and environmentally. This group also constitute most of the electorate, so are very important in terms of political acceptance for future decision-making.
3. ***Adults interested in energy policy, including those both for and against the nuclear industry.*** Many have the strongest preconceived notions of nuclear science, and so are often unable to accept alternative perspectives.

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For each of these demographics, a different approach to engagement must be taken, which must be appropriate to the audience.

We use a combination of talks, interactive displays and activities, making public engagement suitable for - and tailored to - children of all ages, as well as adults. Adults interested in debating nuclear power have been presented with facts whilst children are encouraged to learn about science and engineering of power generation and the use of robotics to handle dangerous substances. We have found that visitors to our exhibition stand have found the experience both educational and enjoyable.

Our understanding of the public perception of nuclear power has led to the conclusion that waste management is the most important issue for the industry to address. The authors have found that careful communication with explanations of the scientific principles involved in the safety of nuclear plants and health physics at the appropriate level is sufficient to convince many people of the benefits of nuclear power. Occasionally, this has meant going into detail about the process for building a safety case, periodic safety reviews and the role of the nuclear regulator. On many occasions, a detailed understanding of the events leading up to, and reasons for, each of the major nuclear accidents is required.

A MULTI-FACETED PROGRAMME

Several approaches have been taken to extend the impact of the public engagement programme; these are here described in turn.

School visits

Young people need to be inspired to study science and engineering, so that the nuclear industry continues to have a supply of talented and committed individuals to continue safe operation of plant and disposal of waste. Therefore, it is fitting that a nuclear engagement programme should start in local schools, showing off exciting innovative technologies such as drones used for radiation mapping, pipe crawlers and robots. Members of the team make regular visits to schools to inspire the next generation.

In October 2016, the winner of the Nuclear Institute's Young Generation Network Speaking Competition described the need to inspire young people with a talk entitled 'How do you teach nuclear fission to ten year olds?' Though complex, it was proven that this is indeed possible and that the impact of doing so would be far-reaching for years to come. By trialling the teaching methods with a group of Girl Guides she was able to show how it is possible to inspire girls as well as boys with innovation in nuclear science and technology. She was able to show how the teaching methods for nuclear fission could easily be adapted for different age groups and different complex scientific theories.

An interesting concept which the speaker touched on was: teach the children; teach the parents. She explained how enthusing children about a complex scientific

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concept and inspiring them to take an interest in that subject could easily lead to them discussing the topic at home over the dinner table. This is another way of indirectly reaching the wider public.

Industry visits to schools can be rewarding for both the children and the professional. For the children it is a break from the norm, usually involving an interactive activity or presentation from an industry expert. The experts tend to have a real enthusiasm for their subject which can really inspire the children. For the professional it is rewarding to impart their knowledge to the younger generation and see how the children enjoy the departure from their usual classes. Though it is difficult to gauge immediately how a visit from an industry professional will inspire or change the children's opinions of a subject, it is often clear to see how they have enjoyed the workshop and a quick show of hands or pop quiz at the end of the session gives an indication of what was learnt and how much fun was had.

Horizon Nuclear Power has developed excellent relationships with local schools both in the Gloucestershire area and Anglesey, close to where its proposed nuclear power station sites will be located. These strong relationships involve school visits from professionals and support at science workshops in the schools. Horizon Nuclear Power is a supporter of engagement with schools to inspire and enthuse local children at all ages, from primary and secondary schools through to apprentices.

Large festival exhibitions

Large festival exhibitions have been used in successive years in Bristol to interact with the public, discussing the role of nuclear power in the UK energy sector. The centrepiece of this effort was our Bristol Harbour Festival exhibition, centred around the question 'Is Nuclear Green?' and designed to initiate debate while providing factual information.

University of Bristol research students and staff contributed to the preparation and staffing of the exhibition, and were joined by staff from industrial partners. The exhibition was designed to be engaging to all visitors, and members of public were able to have their questions answered by enthusiastic experts. It enabled a debate which is nationally significant to be brought directly to the general public, with input from academics and industry.

This weekend-long exhibition was run in two successive years during a larger city-wide festival, and each year an estimated 2,000 people visited the exhibition. In addition, Twitter analytics show that 4,000 people engaged with the Twitter feed, with impact continuing after the event through discussions and blog comments [3].

The exhibition related to three key areas of nuclear: i) power generation; ii) health and radiation; and iii) waste disposal, and included:

1. A robotic arm to demonstrate the use of master-slave manipulators used inside active cells.

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2. Foot pedal generator connected to a racing car track, demonstrating power generation.
3. A comments board allowing the public to share their own opinion on the question 'Is Nuclear Green?' (Figure 3).
4. A dry ice 'cloud chamber', to visualise radioactive particles.
5. Nine informative roller banner posters containing information about nuclear power generation, disposal routes for waste, the nature of radioactivity and details on the realities of the energy mix. An example is shown in Figure 3.
6. An operational steam engine, to demonstrate power generation through a steam turbine.
7. A card game comparing radiation doses produced by everyday activities with doses produced by the nuclear industry, showing that background radiation is present naturally all around us in the environment.
8. An interactive screen showing the different types of radiation by means of a 'Radioactive Orchestra'.



Figure 3. (left) Example of display posters using the current energy mix to make the case for nuclear power; (right) Opinions board allowing the public to express their views.

The exhibition also enabled the authors to receive feedback from the population of Bristol and surrounding areas to our 'Is Nuclear Green?' question. The authors discovered that approximately two-thirds of votes answered 'Yes', with many stating that nuclear is our best hope until an alternative is found, such as fusion or better storage of renewable electricity. Using polling by YouGov, similar feedback was obtained by the Nuclear Industry Association [4].

It was also learned from discussions and from the opinions board that many of the 'No' votes were concerned about waste disposal, often commenting that burial left the problem to future generations. In addition, there were environmental concerns, and fears about safety, citing historic events such as Fukushima and Chernobyl. However, after discussion with the staff, many agreed that safety issues were not as serious as they originally thought, once the serious attitude to safety taken by the industry was understood.

The most effective approach to educate and engage members of the public visiting the exhibition was to approach guests as they arrived, providing a guided tour around the sections of the exhibits. This allowed an informal debate, and the opportunity for a more personal interaction, as well as encouraging questions and concerns to be raised. This resulted in people often leaving with a better opinion of nuclear power, since it allowed their worries to be addressed directly and misconceptions to be challenged.

All age groups were considered when planning the exhibition. We were able to tailor the experience depending on age group, making sure we had a range of interesting

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information for adults and engaging games for children. Children could demonstrate the principle of electricity generation using a pedal generator to light a bulb or a racing car track. Also popular was a challenge to use a robotic arm to pick up a small token and deposit it in a pot.

The need for new electricity generation capacity in the UK was explained to members of the public, and the different sources (coal/gas/wind/solar) discussed. Comparisons of the relative benefits of each energy source were presented, in terms of reliability, deaths per terawatt-hour produced and lifetime CO₂ emissions. This stimulated many debates about the relative harm done to the environment and society by the use of each electricity production method.



Figure 4. Young children enjoying putting on overalls as if to protect themselves from contamination and holding a 'dummy' Magnox nuclear fuel element (without uranium inside!).

With a Magnox fuel element (Figure 4) and a working model of a steam turbine, we explained how electricity is generated in a nuclear power station. Operational safety concerns were addressed, as were myths surrounding radioactivity. Radiation is all

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around us as a natural phenomenon, not limited to being a product of nuclear power (Figure 5). Finally, waste disposal strategies were presented and discussed.

The Twitter feed gained increasing popularity during the event, and in fact continues to make 'impressions'. Between our weekend event in July 2015 and mid-August 2015 the twitter feed achieved 10,000 views, showing that the online engagement was also successful. The 2016 event also made use of Twitter to enhance overall engagement.



Figure 5. Dose rate flashcards explaining that radiation is a natural phenomenon.

Another highlight for visitors was the chance to debate one-on-one with nuclear researchers, who listened carefully and respectfully to other points of view, answering questions and replying to challenges. To gather opinions on the green credentials of nuclear power a voting system was used, so that visitors could drop green or red coins into 'Yes' or 'No' tubes corresponding to their views. The voting system and a debate with an anti-nuclear campaigner are shown in Figure 6. A comments board collected further thoughts, with 'Yes' voters citing environmental reasons, and concluding that nuclear is 'the best option for now', whilst 'No' voters expressed concerns about waste disposal and risk. The final tally showed that well over half of voters voted 'Yes'. Perhaps, as one green voter wrote, 'more education leads to less negativity' – this was exactly the desired impact.



Figure 6. (background) The coin-drop voting system measuring impact; (foreground) Discussion with an anti-nuclear campaigner.

Media engagement

This is important because media coverage is known to influence public attitudes. An analysis of the German media coverage [5] before and after March 2011 concluded that "attitude changes are a result of ubiquitous and consistent changes in media coverage on nuclear power".

Media training has been arranged specifically to allow the team to engage well with the media about their own research projects and the nuclear industry more generally.

The team has been fortunate to have been invited for several media appearances, with members appearing on BBC News bulletins to explain the role of the South West Nuclear Hub after its opening, including different aspects of nuclear research undertaken at Bristol University. The team has also been given air time by the BBC to reassure the public about safety, in answer to the UK Government's decision to allow new nuclear build in the local area.

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Animations and press releases [6] have been used to make nuclear research more accessible to the public, and over time these positive stories should improve public acceptance. As an example, the University of Bristol's research into the diamond battery concept, in which carbon-14 from nuclear waste streams may be made into a long term energy source has proven to be popular news item in the press: according to the University Press Office the estimated overall reach of this campaign was 11,814,091 individuals.

Talks to interested groups

Local science groups, in particular the local branch of the British Science Association, invited the team to speak about the advantages and disadvantages of nuclear. The British Science Association event was an interactive discussion where we presented how nuclear reactors operate, what makes them safe, what waste is produced and what the strategy is for that waste, before opening out to audience Q&A. The team received a good deal of challenge from the audience, which may in part have been promoted by the presence of two anti-nuclear campaigners handing out flyers.

When discussing technical issues, the team found it to be exceptionally difficult for people with an established position to change their view in light of new evidence. In particular, those who associated nuclear waste with nuclear weapons were unable to accept that any amount of redundancy, diversity or segregation in nuclear systems could be sufficient.

At the end of the session, the team received several very kind compliments from audience members who had initially been against nuclear but, having understood the need for compromise in their fervour for renewables, had been convinced by the science and factual information provided to them.

CONCLUSIONS

Together with its industrial partners, the South West Nuclear Hub has developed its programme of educational outreach and public engagement to increase the public's level of understanding, trust and acceptance of civil nuclear power. The principle outcome of this programme has been that those scientists and engineers in favour of a nuclear renaissance have been given the opportunity to present the facts through multiple channels.

The impact of this and other engagement programmes will be difficult to measure over a short-term basis, but long-term it should be possible to demonstrate an improvement in public perception of the industry.

The public acceptance of the nuclear industry will be crucial to the success of the nuclear renaissance in the UK and around the world, and this will be achieved by multiple forms of public engagement from different sources.

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ACKNOWLEDGEMENTS

The authors would like to acknowledge support, both financial and in-kind, from our industrial partners: EDF Energy; Sellafield; Magnox; and Horizon Nuclear Power. This project was enabled by funding from the Engineering and Physical Sciences Research Council's Impact Acceleration Account (grant number EP/K503824/1) and from the University of Bristol's Widening Participation Fund.

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Figure 7. Team photograph at one of the public engagement events.