

# Clear as Mud.... The Radiation Protection Challenges of New Nuclear Build

**Professor Pete Bryant**

**Head of Environment, Decommissioning & Radiation Safety**

# What is Sizewell C?



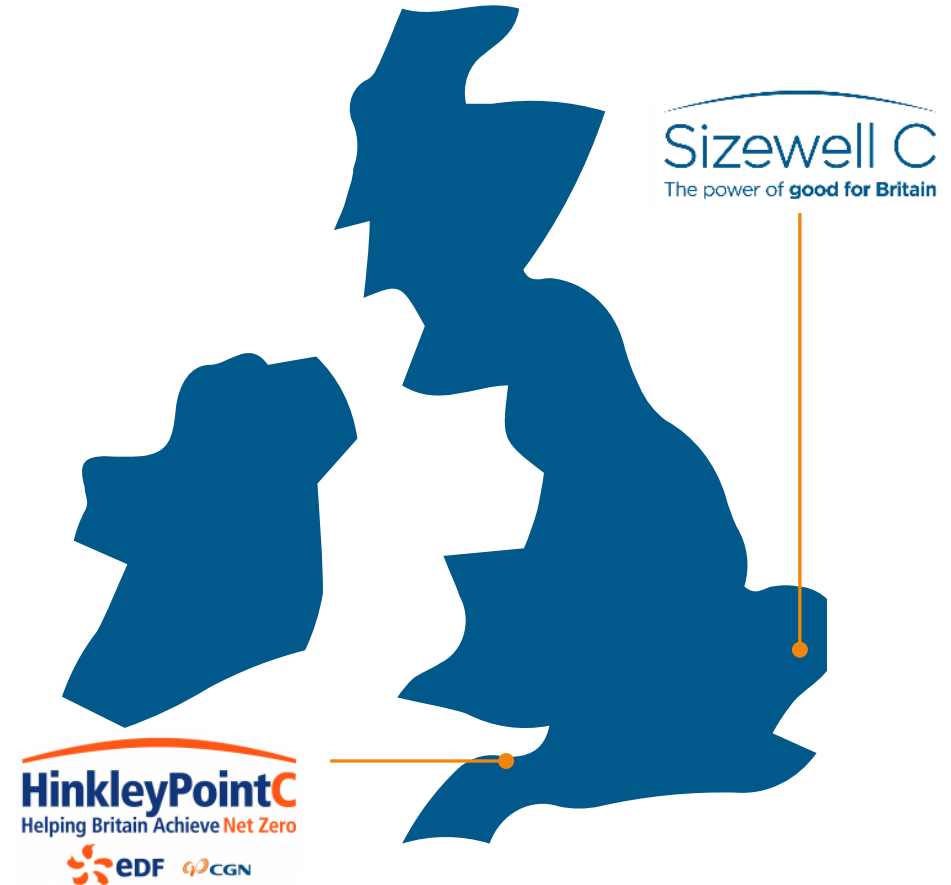
# Overview of Civil New Nuclear Build in the UK

## ■ Hinkley Point C

- Located in the South West of England
- 2 x EPR Units (1,650 MWe per Unit)
- Includes Spent Fuel and Intermediate Level Waste Storage Facilities.
- Construction commenced in March 2017, First Unit Operation ~2027

## ■ Sizewell C

- Located in South East of England
- 90% Replica of Hinkley Point C – Main differences are associated with Cooling Water Infrastructure.
- Advanced Works ongoing with Main Construction scheduled to start in 2024.

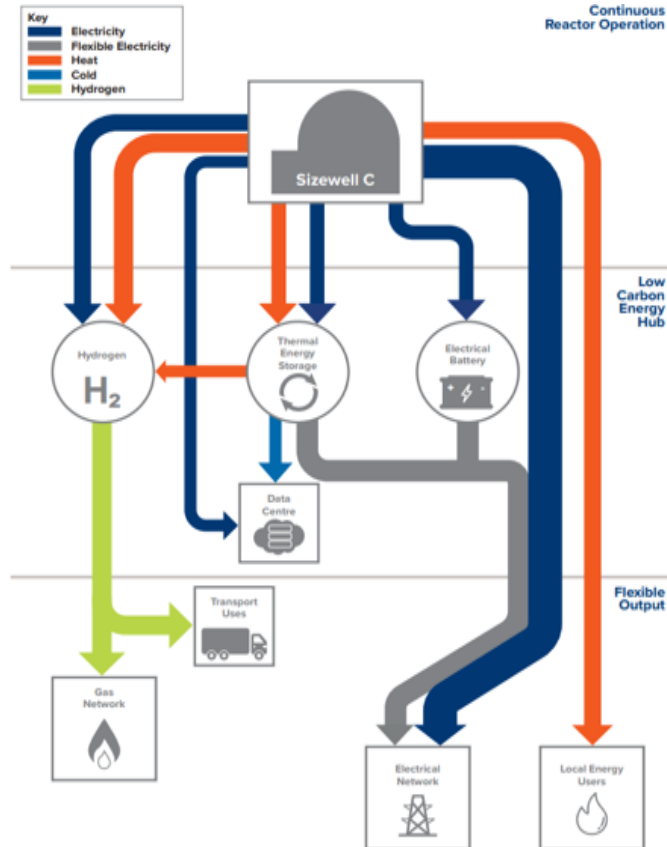


# Driving Net Zero Innovation

SZC can be a genuine 'servant of the system', driving the energy transition across sectors and the UK.

## Sizewell C Energy Hub

As part of an Energy Hub, SZC could make an even greater contribution to the UK's net zero ambitions, helping to decarbonise industry, transport and heating.



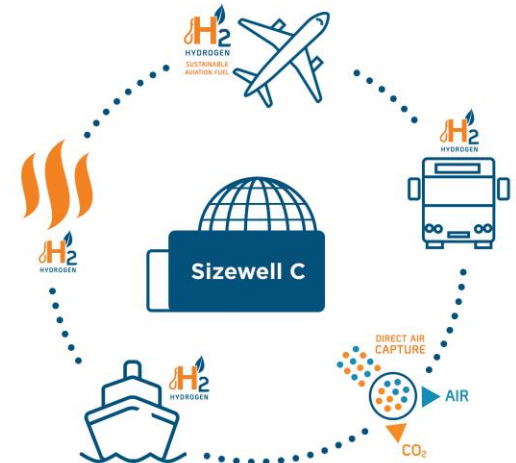
## Direct Air Capture

- A consortium led by SZC awarded £3,000,000 by Government to develop a **DAC prototype**.
- **Small demonstrator-scale plant**: could capture 100 tonnes of CO<sub>2</sub> per year.
- **Scaled-up integration with SZC**: could capture 1.5m tonnes of CO<sub>2</sub> a year – nearly enough to offset the annual emissions of the UK's rail network.



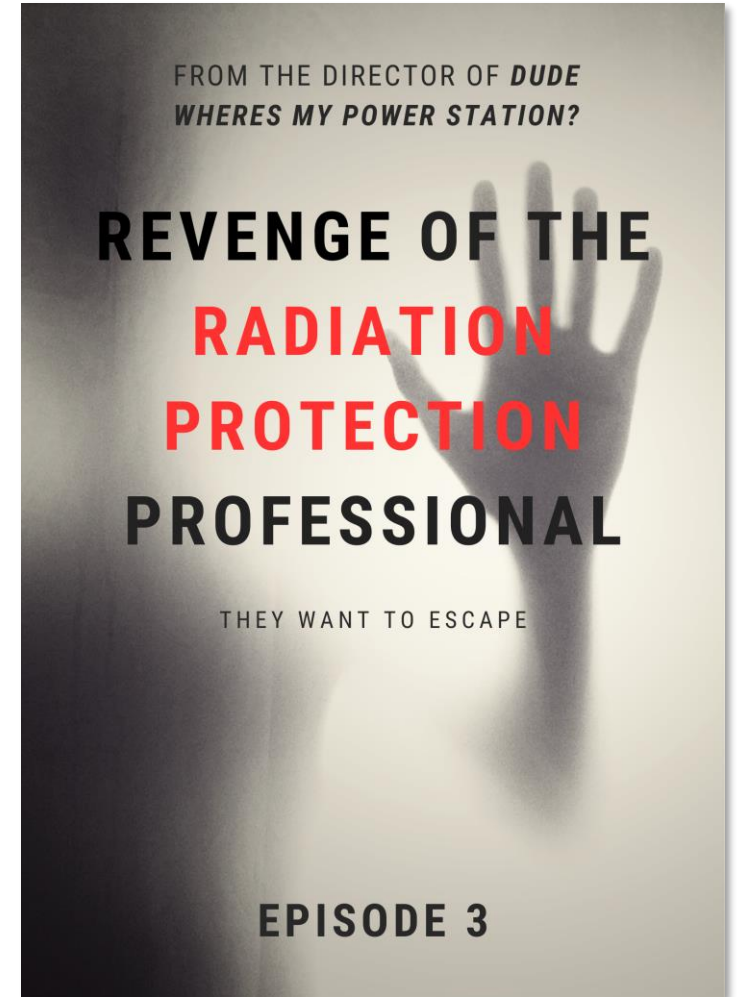
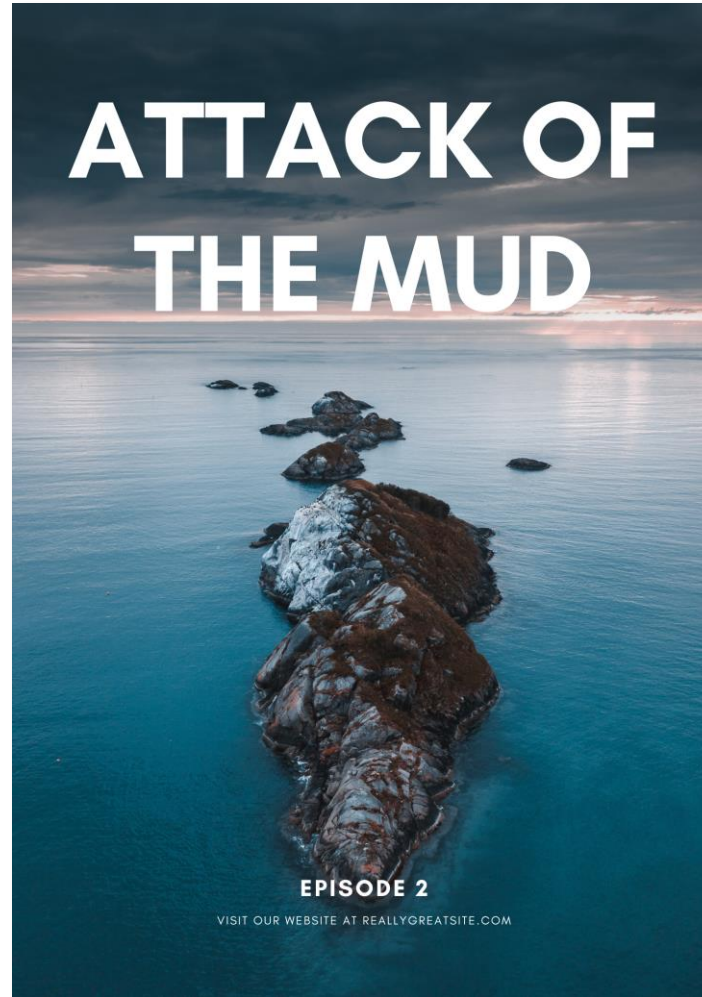
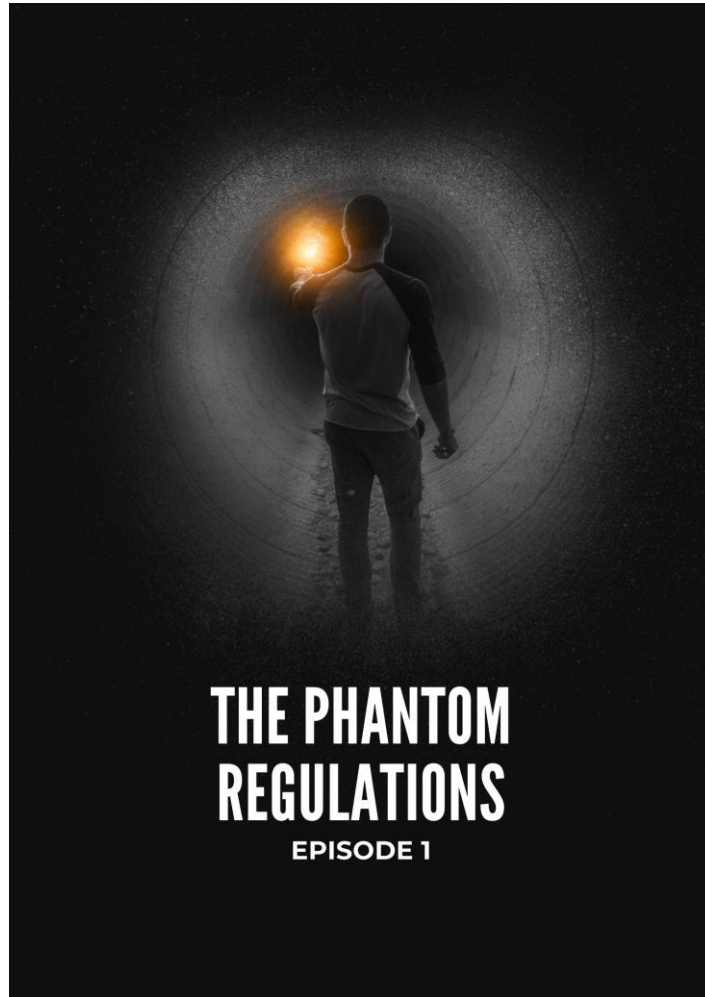
## Hydrogen in Construction & Operation

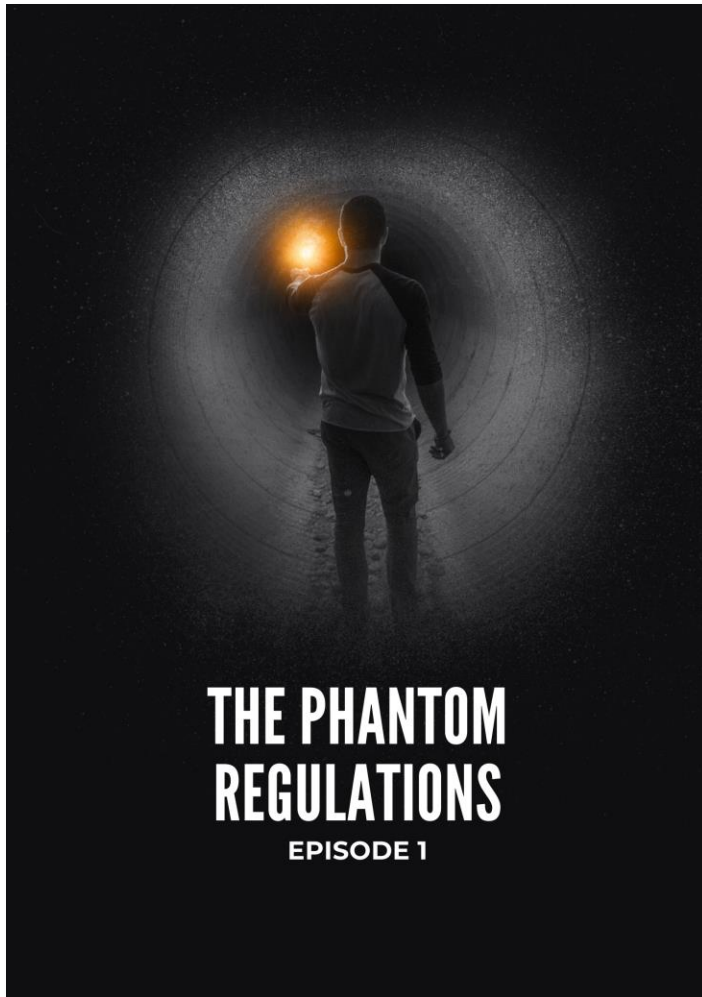
- **Construction**: SZC is exploring the use of hydrogen buses and construction equipment during its construction (186 buses needed).
- **Operation**: Hydrogen produced by nuclear can fuel road, shipping and aviation.



# So, what are the Radiation Protection Challenges?

# What are the RP Challenges?





# phantom

*noun*

- an apparition or specter.
- an appearance or illusion without material substance, as a dream image, mirage, or optical illusion.

# Example - Dewatering Hinkley Point C

**Hinkley Point B**  
“Advanced Gas  
Reactor”  
Recently Stopped  
Operation.

**Hinkley Point A**  
“Magnox Reactor”  
Undergoing Decommissioning

**Hinkley Point C**  
“Twin EPR (Pressurised Water  
Reactor)”  
Under Construction



# Example - Dewatering Hinkley Point C



# Example - Dewatering Hinkley Point C



# Defining the Sludge



## Radioactive Material / Waste

- Some radioactive substances are **Out of Scope** of the legislation (Environmental Permitting Regulations 2016) and so are not legally classed as radioactive material or radioactive waste.
- Governed by whether the concentration of radionuclides is above specified levels.
- Sludge even at worst concentration would **NOT** be considered “Radioactive Waste”



## Nuclear Matter

- “Nuclear Matter” definition, is broader than the definition of “radioactive material”
- Includes any fissile material and any radioactive material produced in or made radioactive by the process of producing or utilising any fissile material as.

## Licence Condition 5: Consignment of nuclear matter

- 1) The licensee shall not consign nuclear matter (**other than excepted matter and radioactive waste**) to any place in the United Kingdom other than a relevant site except with the consent of ONR.
- 2) The licensee shall keep a record of all nuclear matter (including excepted matter and radioactive waste) consigned from the site and such record shall contain particulars of the amount, type and form of such nuclear matter, the manner in which it was packed, the name and address of the person to whom it was consigned and the date when it left the site.
- 3) ...

**But...the sludge is not “Radioactive Waste” as its activity is too low...?**

# Converged Solution?

- Boreholes at the Boundary between the Hinkley Point C and A Site are sampled monthly and monitored for Tritium.
- Should Tritium be detected then the Consignments of Sludge and also the samples sent offsite for analysis are (retrospectively) recorded as Nuclear Matter.

...

Sounds sensible?

...

- But due to the number of samples being taken the offsite lab could not manage the throughput of samples so had to outsource to a second lab...

# I have a sample with 3 Bq/L of Tritium...



## Lab 1

- Limit of Detection of ~5 Bq/L
- Sample is **NOT** treated as Nuclear Matter...

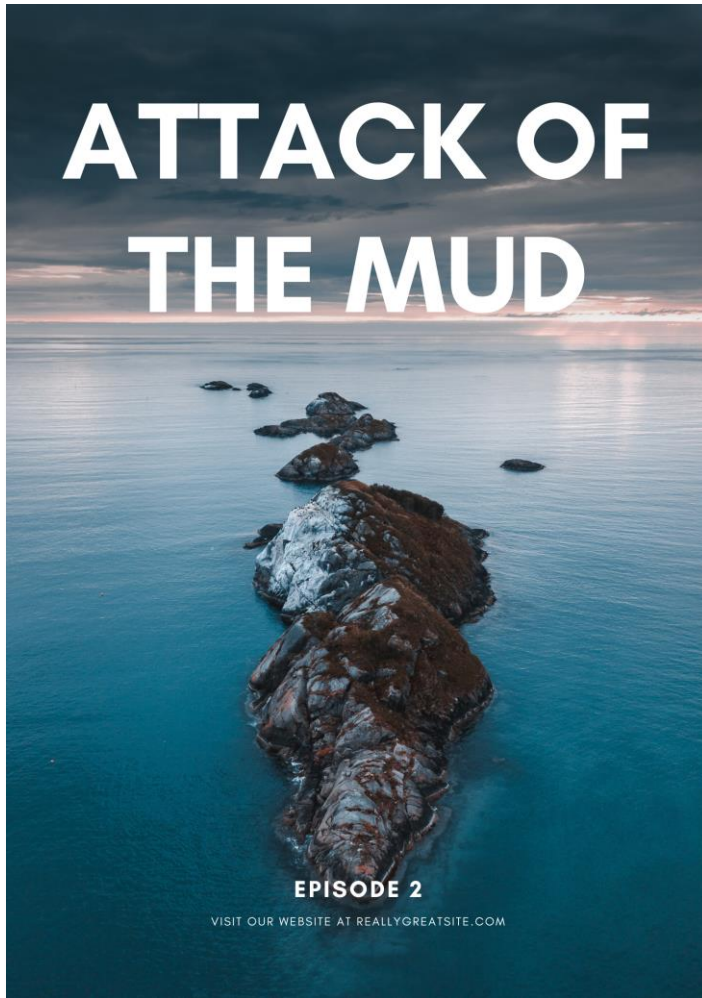


## Lab 2

- Limit of Detection of ~1.5 Bq/L
- Sample is treated as Nuclear Matter...

**Solution...Introduce an Analytical Threshold, above which the material is deemed Nuclear Matter?  
(Agreed on 5 Bq/L)**

- Is the outcome proportionate to the risk of the hazard? Noting the Drinking Water Standard for Tritium is 100 Bq/L? 4 x the Maximum Level of Tritium on site...
- What about the costs of the monitoring? Could this money not have been better spent on improving safety or environmental performance elsewhere?
- Was the outcome sustainable? Noting that as the groundwater was defined as Nuclear Matter it prohibited us using it for other applications such as Dust Suppression (and resulted in us bringing potable water on site).
- Is the Regulatory Framework Fit for Purpose?



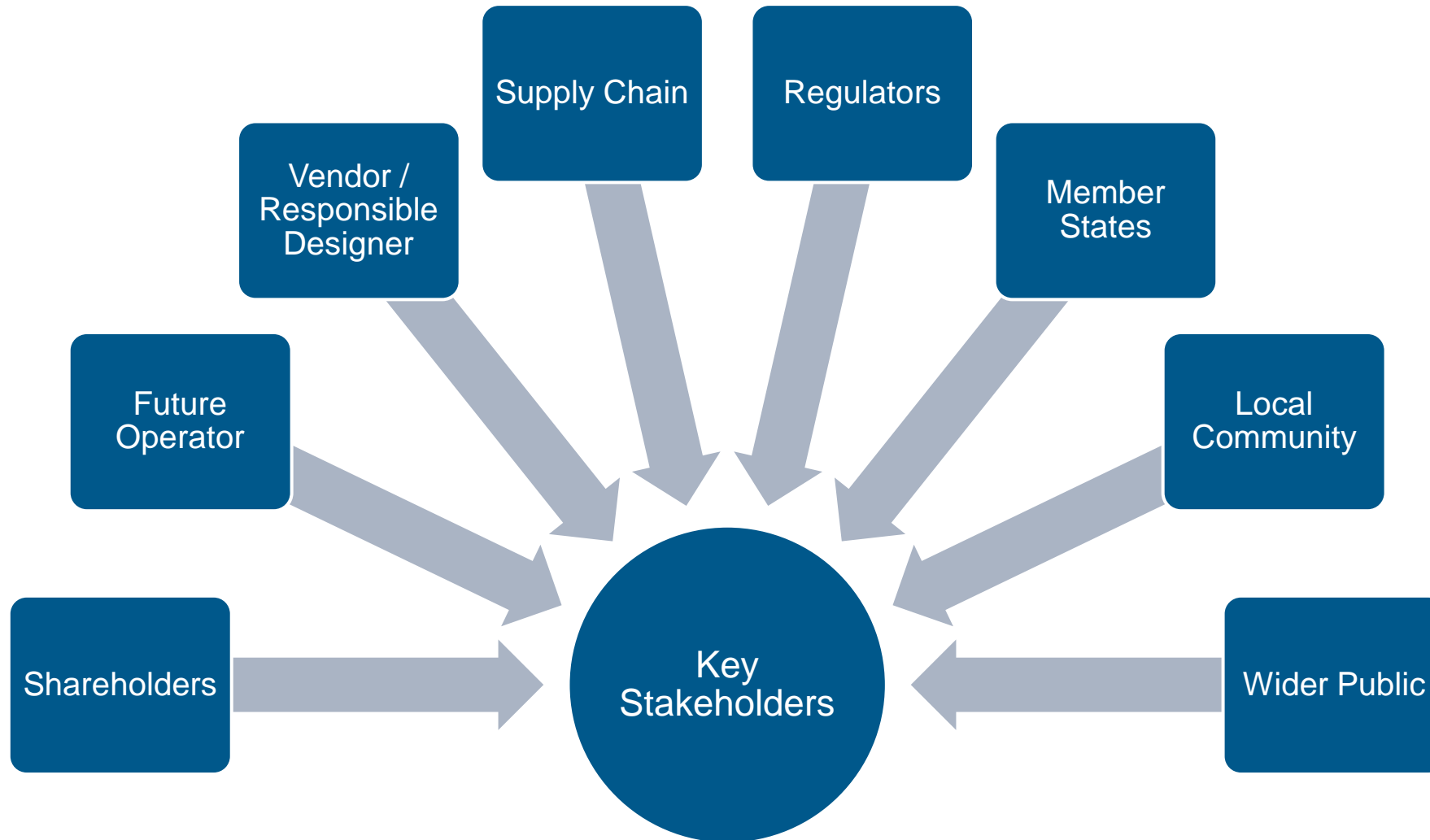
# mud

*noun*

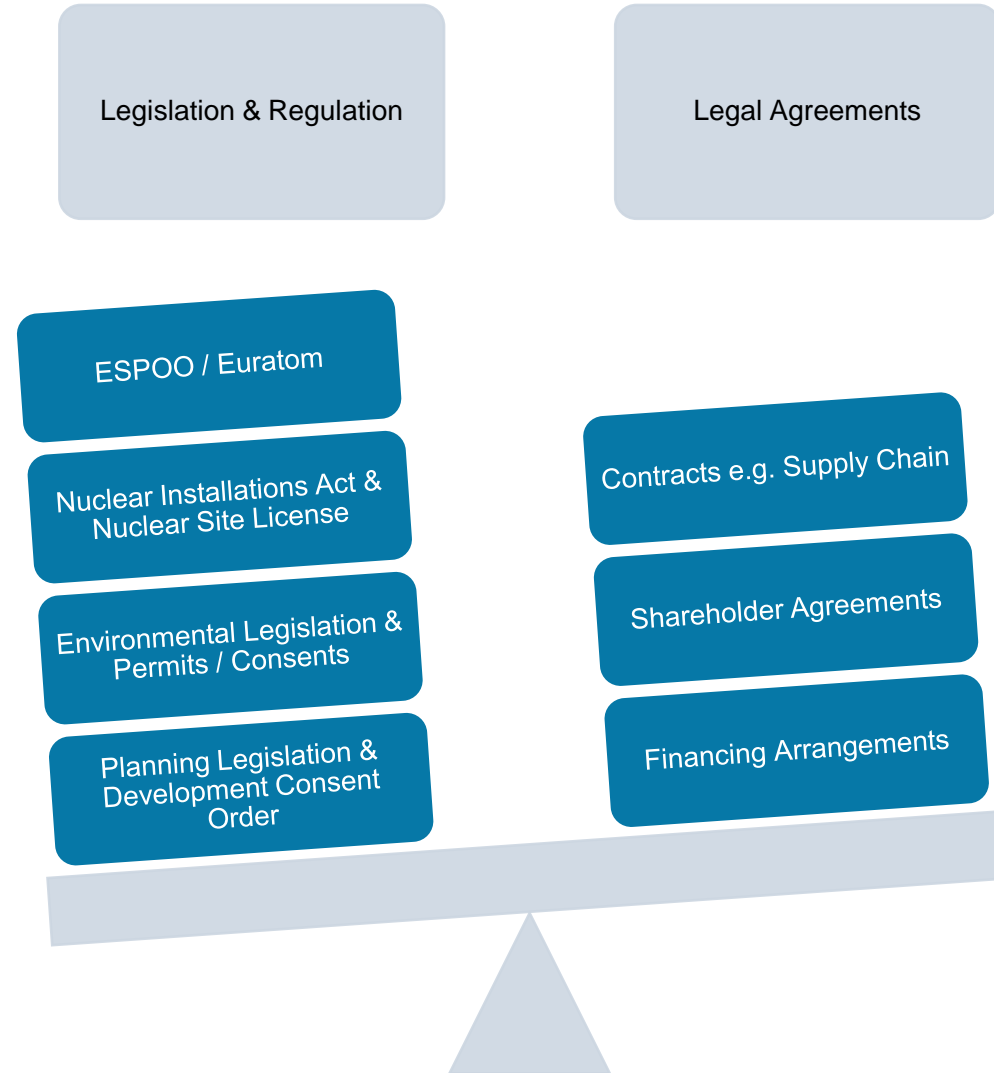
- soft, sticky matter resulting from the mixing of earth and water.
- information or allegations regarded as damaging or scandalous.



# Key Stakeholders



# Legal Framework Encouraging Stakeholder Engagement



# Group Exercise

Think about the following activities:

- Skydiving
- Going on a Night Out Dancing in City such as Sydney
- Commuting to Work in City such as Sydney via Bike

Which carries the greatest risk of serious injury?

# Sources of Radiation Concern

BBC

Sign in

News

Sport

Weather

iPlayer

Sounds

More

Search

NEWS

Home

UK

World

Business

Politics

Tech

Science

Health

Family & Education

Entertainment & Arts

Stories

More

Science & Environment

Chernobyl zone shows decline in biodiversity

By Victoria Gill  
Science reporter, BBC News

30 July 2010

f

Share

The largest wildlife census of its kind conducted in Chernobyl has revealed that mammals are declining in the exclusion zone surrounding the nuclear power plant.

The study aimed to establish the most reliable way to measure the impact on wildlife of contamination in the zone.

It was based on almost four years of counting and studying animals there.

Scientists say contamination in the Chernobyl exclusion zone has affected biodiversity

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A source indicates the cabinet is "more positive" about the chance of a third vote on the PM's deal

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30 years after Chernobyl disaster, wildlife is flourishing in radioactive wasteland

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1

Gove's treachery helped create this nightmare. Making him PM is the worst way to solve it

2

Soldier charged after 'going rogue' during computer game on virtual battlefield

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# Case Study - Hinkley Point C





# Case Study - Hinkley Point C

e-Petition: Suspend Marine Licence 12/45/ML to dump radioactive marine sediments from the Hinkley Point nuclear site into Wales coastal waters off Cardiff

“ We call on the National Assembly for Wales to urge the Welsh Government to direct Natural Resources Wales to suspend the licence it has granted to NNB Genco, which permits up to 300,000 tonnes of radioactively contaminated material, dredged from the seabed at the Hinkley Point Nuclear power station site, to be dumped into Welsh inshore waters.

We further request that the suspension of the licence is used to ensure that a full Environmental Impact Assessment, complete radiological analysis and core sampling are carried out under the auspices of Natural Resources Wales, and that a Public Inquiry, a full hearing of independent evidence and a Public Consultation take place before any dump of the Hinkley sediments is permitted.

Marine Licence 12/45/ML, granted by the Welsh Government, permits the disposal of up to 300,000 tonnes of radioactively contaminated marine sediment, dredged from the seabed at the Hinkley Point nuclear site, into the Cardiff Grounds marine dump site close to the South Wales coast. This will allow work to begin on the 2 new Hinkley C nuclear reactor pipelines.

The sediments to be dredged are adjacent to the waste pipes used for the discharges from Hinkley’s 4 existing reactors. Analysis, commissioned by UK Government agencies, shows that the sediment is contaminated by radioactive waste discharged to sea over 50+ years of operations at the Hinkley site. Calculations derived from the official data indicate that the proposed dredge sediments may hold at least 7 billion Bq of aggregated radioactivity, yet reports state that doses to humans would be very low.

Hinkley’s radioactive discharges to sea contain over 50 radio-nuclides, but the analysis has only investigated 3 of them. Thus, the actual aggregated radioactivity content of the sediments will be much higher than indicated by the available analysis. The available evidence also implies that only surface samples (0 to 5cms deep) of the sediment have been analysed, despite the fact that core sample research from elsewhere in the Irish Sea demonstrates that, at depths below 5cms, radioactivity concentrations may be up to 5 times higher.

While sedimentary radioactive material is initially likely to disperse, studies prove that it later re-concentrates in coastal and estuarine mudflats and saltmarshes, and is also available for sea-to-land transfer during onshore winds and coastal flooding. We note the absence of research on the fate of such radioactivity in South Wales inshore waters. In this context we are concerned that the environmental and human health (dose) risks from the proposed disposal have not been adequately researched and that any conclusions based on the current incomplete data, are unreliable.

”

← Tweet



Dylan Eryl Morgan  
@DylanEryl

No dumping of radioactive mud from Hinkley near Cardiff Bay! Sign the Assembly e-petition now.



2:31 pm · 17 Oct 17

18 Retweets 12 Likes



Ruth Muirhead #NHSLove · 18 Oct 17

Tweet your reply

OVER  
100,000  
SIGNATURES



Guardian news  
@guardiannews

Hinkley nuclear site radioactive mud to be dumped near Cardiff



Hinkley nuclear site radioactive mud to be dumped near Cardiff  
theguardian.com

NEWS

Super Furry Animals And 300,000 Tonnes Of Mud: Why The Hinkley Point C Power Station Is The Subject Of A Court Battle

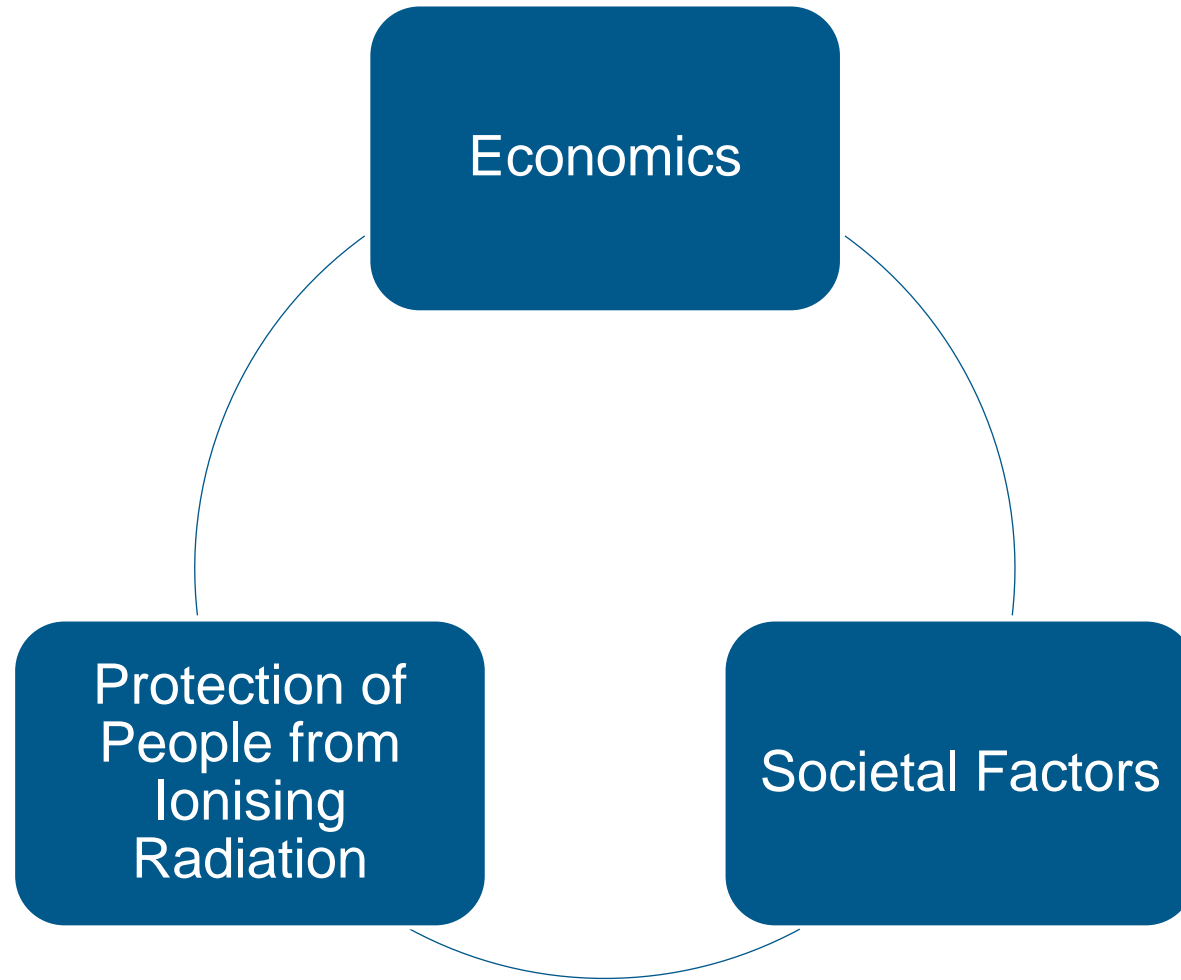
“They try to convince us that the mud is safe and there’s nothing to worry about but I can’t take the nuclear industry’s word for it”

01/10/2018 16:49 BST | Updated 02/10/2018 09:47 BST

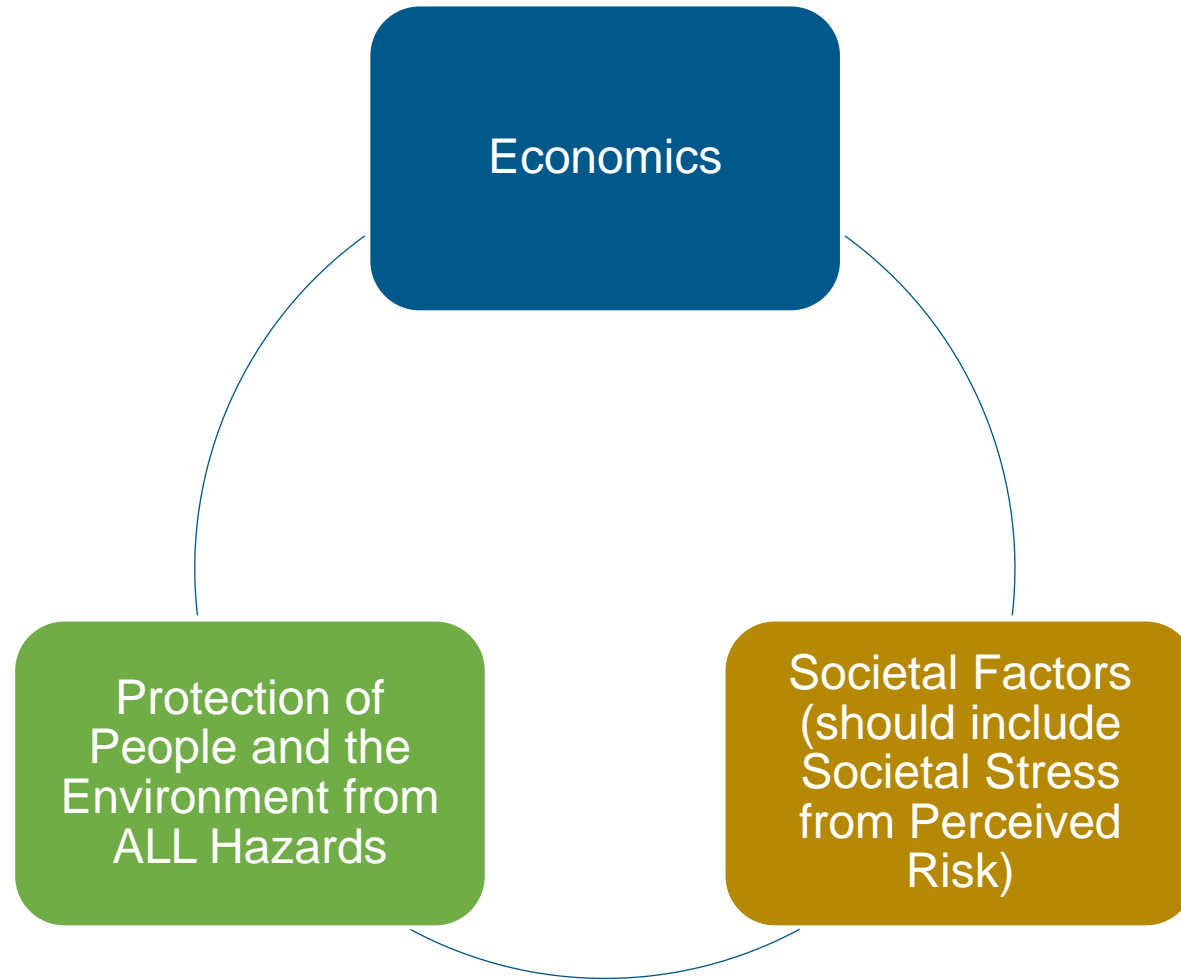


By Rachel McGrath

# What did we learn?



# What did we learn?





# How do we communicate?

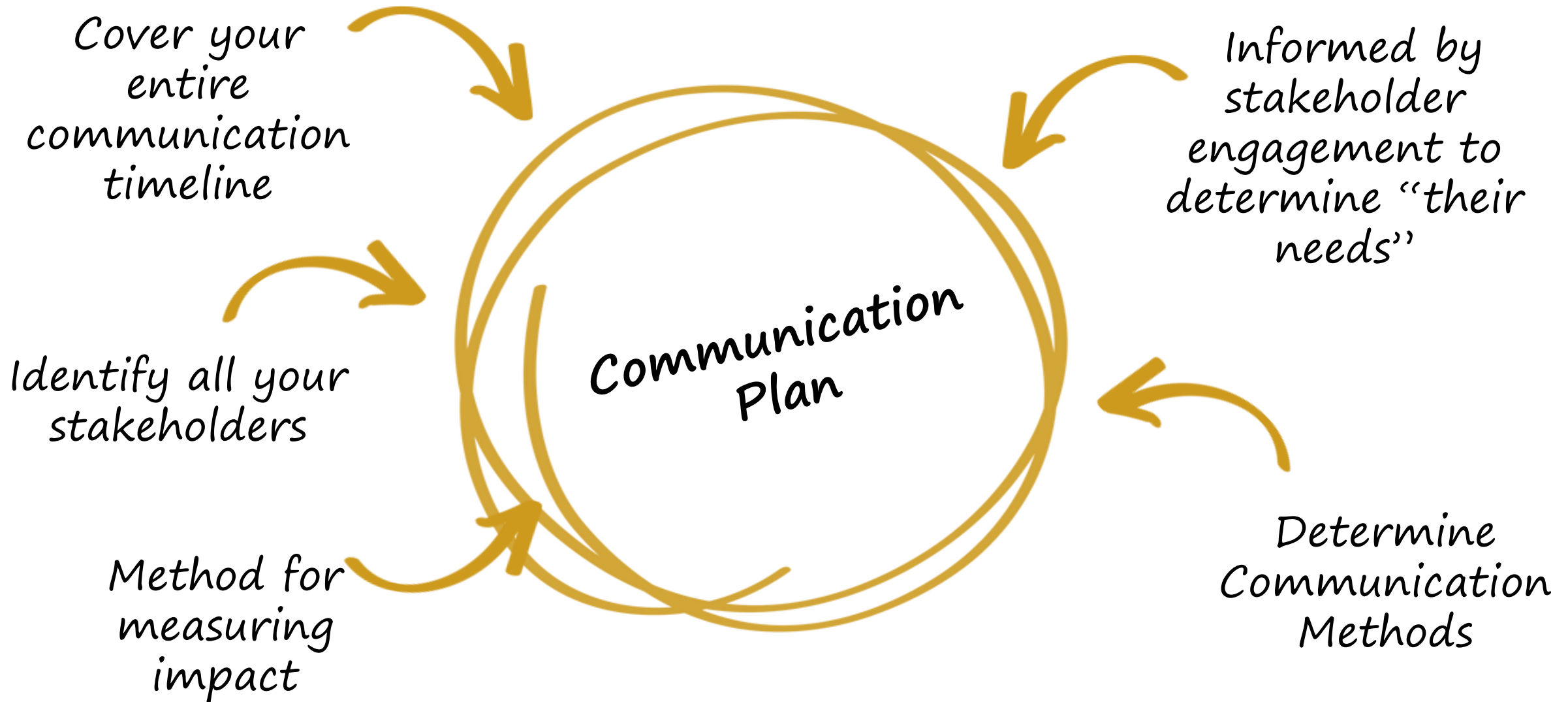
## Why are we communicating?

To enable people to make their own informed decisions. *“People will decide if it is safe themselves”*

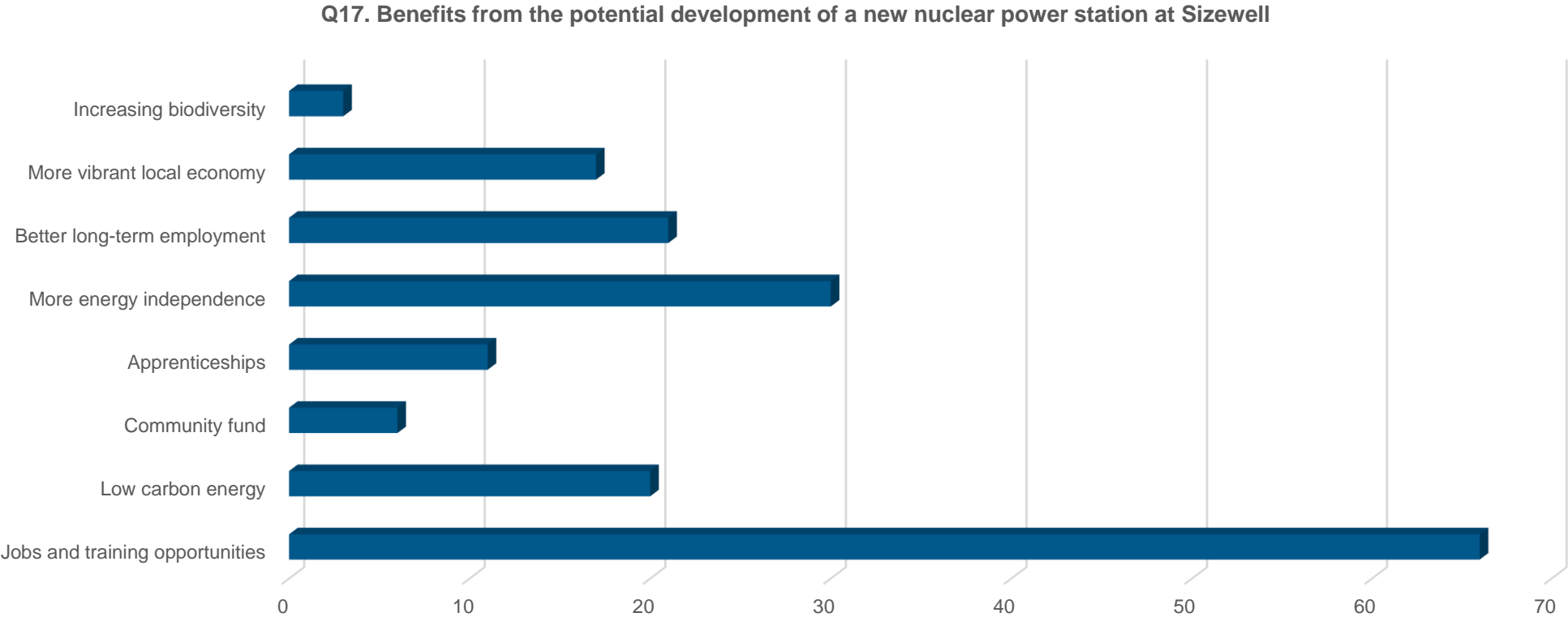
## How do we do it?

- Build Trust with Stakeholders
- Develop Tools for Communicating
- Ensure a consistent approach by working together

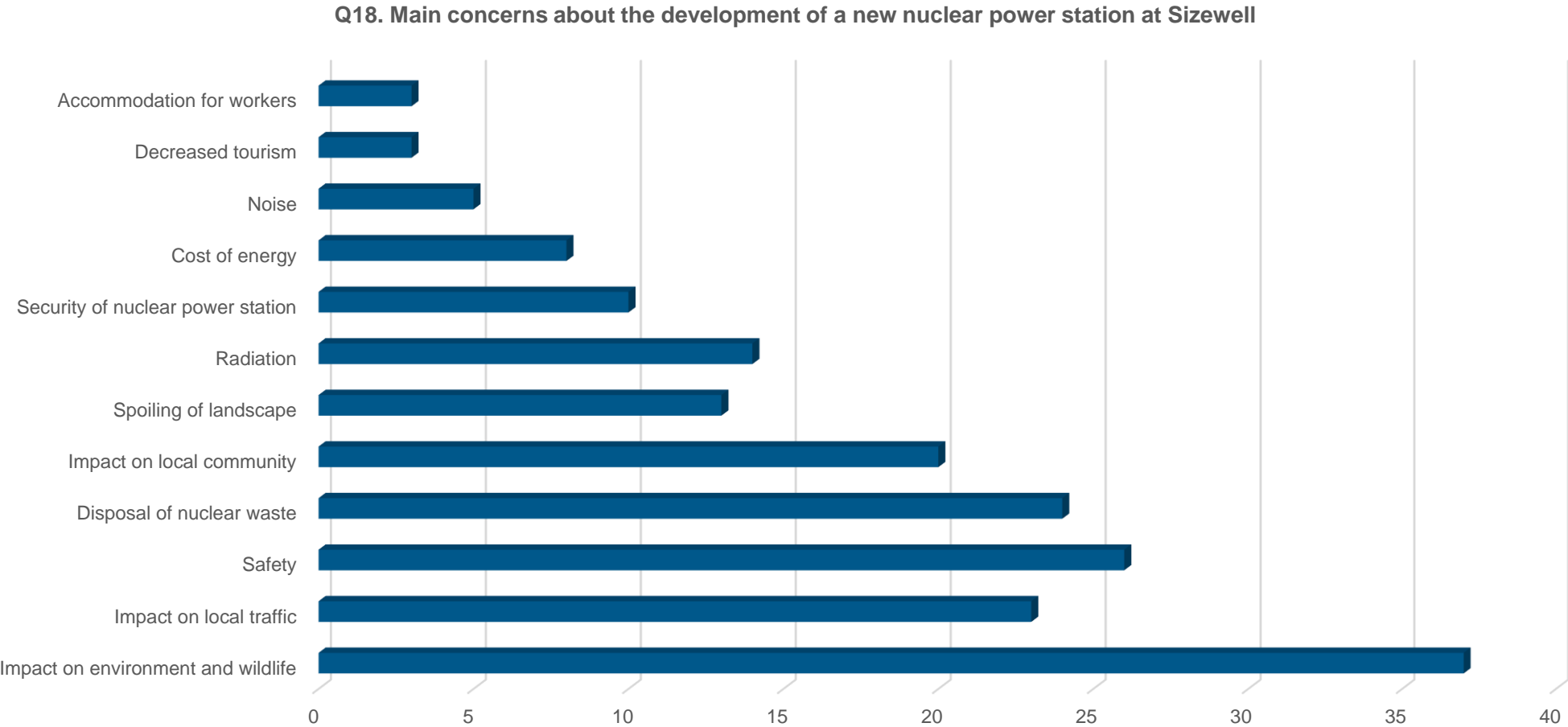
# How do we communicate?



# Areas of Local Community Interest at Sizewell C



# Areas of Local Community Interest at Sizewell C



# Example - Radioactive Waste



# Example - Radioactive Waste

## Letters

We are currently only able to accept letters by email.  
Write to us at: [edlletters@east.co.uk](mailto:edlletters@east.co.uk) but please include your postal address

### The need for local policing

Sir, - Sheema Rawlings, a local Conservative councillor, laments the recent increase in anti-social behaviour in Woodbridge (EADT letters, May 4). If she had read my comments criticising the increase in the police precept in the years since Tim Passmore became the PCC (EADT letters, March 24) she would have seen that many residents have been concerned for some time that the dearth of local preventative policing in Woodbridge could be a contributory factor to this problem. I am delighted that Mr Passmore has now been to see the problem for himself. The cynic in me finds just a hint of a link to his quest for re-election. In her letter to the EADT, councillor Rawlings also gives a blatant plug for Robin Sanders in his quest to become a county councillor for the town but sadly she fails to mention the great work done over many years in the service of youth by Caroline Page the sitting councillor. Hopefully, whoever becomes the PCC, it will lead to a reassessment of the needs of local policing which might not be as glamorous but is just as important as the fight against organised crime brought to our TV screens in Fast Justice, the documentary featuring the Suffolk Constabulary.

JOHN SANKEY,  
Woodbridge.

### Arrogant and inaccurate

Sir, - I have always considered the EADT to give a balanced account of events, present and historic, so it was a shock to read (EADT, May 1) columnist Michael Cole's arrogant and inaccurate article on Ireland. The most savage war on the island of Ireland was led by Oliver Cromwell in 1649. The Drogheda massacre was of such violence, even by 17th century standards, that it is classed as a war crime. He banned Catholicism and also killed any Catholic priests he captured. The Irish were thrown off their lands and they were given to Protestants. By the 18th century the Irish were reduced to subsistence farming and during the Great Potato Famine they were left to starve. A million people died and a million more emigrated. In spite of English persecution,

### Will Sizewell C will be obsolete before completion?



A computer-generated image showing how the new twin reactor Sizewell C would look if it is built.

Sir, - EDF continue their campaign of advertisements and letters in support of building two more nuclear fission reactors and a storage dump for uranium isotopes and radioactive waste on Sizewell beach. The accidental meltdowns and disasters at Chernobyl, Three Mile Island and Fukushima happened because these fission reactors could not be managed safely nor easily be turned off. The Chernobyl reactor is still burning a hole in the earth's crust! Fission reactors and their uranium isotope waste have cost hundreds, possibly

thousands of lives. People exposed through Chernobyl are still dying. Watch the documentary "Chernobyl" for a clear picture of the possibilities of fission reactors and the radioactive waste they produce. We should not build any new fission reactors in our country. The world will be generating electricity from small, safe and manageable nuclear fusion reactors within ten years (long before the Sizewell C fission reactor could be built). The Chinese, the USA, the French and many other nations are closing fission reactors and turning their attention to

nuclear fusion. Prototypes will soon be up and running. These fusion reactors will be small, flexible, easily managed and can be turned on and off. They will produce infinitely less waste than the fission reactors. They will be safe and can be placed closer to centres of need. They will be ideal supplements to solar and wind generation. The world is at last recognising the possible dangers of the nuclear fission reactors that we are planning to build at Sizewell. The world is also now alerted to the impossible task of

effectively dealing with waste uranium isotopes that remain hazardous to all forms of life for over one 1,000 years. EDF are planning to store this hazardous waste on Sizewell beach and I believe that waste and the reactor could eventually go into the sea. In my view, the building of these fission reactors on the Sizewell beach is the wrong technology in the wrong place and it is a hazardous legacy that we are handing to our children's children. It must be stopped.

MARTIN DEIGHTON,  
Woodbridge.

the Irish continued to struggle for independence and now the Republic of Ireland is a modern country, with three political parties sharing government at this present time. A country of writers, poets, singers and musicians, their influence has spread to many countries around the world.

ANNE LONSDALE,  
Aldersburgh.

### Wrong candidate?

Sir, - George McKissock, who clearly has not accepted the democratic decision of the EU referendum, made the comment

that there are not many letters from Brexiters published in these columns nowadays (EADT letters, May 8). So, is he implying that he wishes to poke the bear and wake the sleeping giant? I agree with him that things are not currently ideal at this early stage of independence from the EU, especially for our fishing industry. It would be interesting to also get his point of view on the Hartlepool by-election win for the Tories. Was that also "stupid and rash" of Labour to put up a 'Remain' candidate in a strongly 'Leave' area, I wonder?

IAN SMITH,  
Bury St Edmunds.

### Memories of home

Sir, - I am Suffolk and bred some 88 years ago and severely miss East Anglian news since moving to France 16 years ago. Today however I have in some small way caught up with the news. My son when posting a gift wrapped it in local newspapers! Wonderful! I have spent all day just reading and catching up and yearning for the 'old days'. It has been good to see places like Sudbury, Lavenham, Bury St Edmunds doing so well. I have been trying to remember the name of a large store in Sudbury that sold glass, China, clothes, shoes, etc. They gave excellent service,

was it Glasswells? Here in this part of France they do not seem to cater for taste and good service. Long live the newspaper.

MURIEL ROSE WEBBER  
(CALVESBERT),  
France.

### Don't judge Sir Keir yet

Sir, - Following the bad results for Labour in some areas, Sir Keir Starmer, has started on a process to try and get voters back, following on from the news that Angela Rayner would be removed and offered a new post. This has caused outrage.

nuclear fusion. Prototypes will soon be up and running. These fusion reactors will be small, flexible, easily managed and can be turned on and off. They will produce infinitely less waste than the fission reactors. They will be safe and can be placed closer to centres of need. They will be ideal supplements to solar and wind generation. The world is at last recognising the possible dangers of the nuclear fission reactors that we are planning to build at Sizewell.

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MARTIN DEIGHTON,  
Woodbridge.



# Example - Radioactive Waste

Sizewell C will generate 40 times less waste



The dry fuel store at Sizewell B  
Picture: EDF ENERGY / TONY PICK

Sir, - I would like to provide a response and reassurance regarding the safe management and disposal of radioactive waste and spent fuel at Sizewell C following the letter from Martin Deighton (EADT, May 13) and the comments made by William Kendall (EADT, May 12).

All sources of energy generation produce some form of by-product or waste, whether it is carbon dioxide from fossil fuels, chemical wastes from photovoltaics (solar panels), and in the case of nuclear power, radioactive waste and spent fuel. The fact most rocks we find in the earth's crust have a natural level of radioactivity means that in addition to nuclear power there are a fair few industrial processes that generate radioactive waste. This is primarily from the

processing of natural materials and mining including the refining of materials used by sources of renewable energy. As part of the environmental consents needed prior to construction, Sizewell C must demonstrate to the environmental regulator that the radioactivity and volume of radioactive wastes to be generated and disposed of have been minimised in line with principle of Best Available Techniques and the Waste Hierarchy.

The EPR reactor planned to be built at Sizewell C has been designed from the outset with waste minimisation in mind. As a result of these improvements Sizewell C will generate 40 times less radioactive waste per unit of electricity than the older existing plants. Any radioactive waste or spent

fuel that will be generated is captured within Sizewell C's integrated waste strategy, ensuring that all wastes streams throughout the life cycle of Sizewell C are appropriately managed and have an assigned and agreed disposal route.

Waste with low levels of radioactivity will be promptly disposed of at the UK's Low Level Waste Repository, whereas the more radioactive wastes and Spent Fuel will be packaged into passively safe packages and placed into interim storage on the Sizewell C site. This is prior to disposal at the UK's Deep Geological Repository in line with UK Government Policy.

The robust shielding built into the Spent Fuel Packaging and interim stores will reduce any radiation from the waste and spent fuel to a level which

poses no risk to the workforce, public or the environment. The additional radiation exposure to a member of the public living near the Sizewell C interim stores when full will be 1,000 times less than what we get from natural background radioactivity, and less than that from drinking a cup of coffee a day. Further information on radioactive waste management in the UK can be found in the expert review conducted by Arup and a number of internationally recognised academics ([www.arup.com/projects/eu-sustainable-finance-taxonomy](http://www.arup.com/projects/eu-sustainable-finance-taxonomy))

**PETER BRYANT,**  
Sizewell C Head of Environment, Decommissioning and Radiation Safety.

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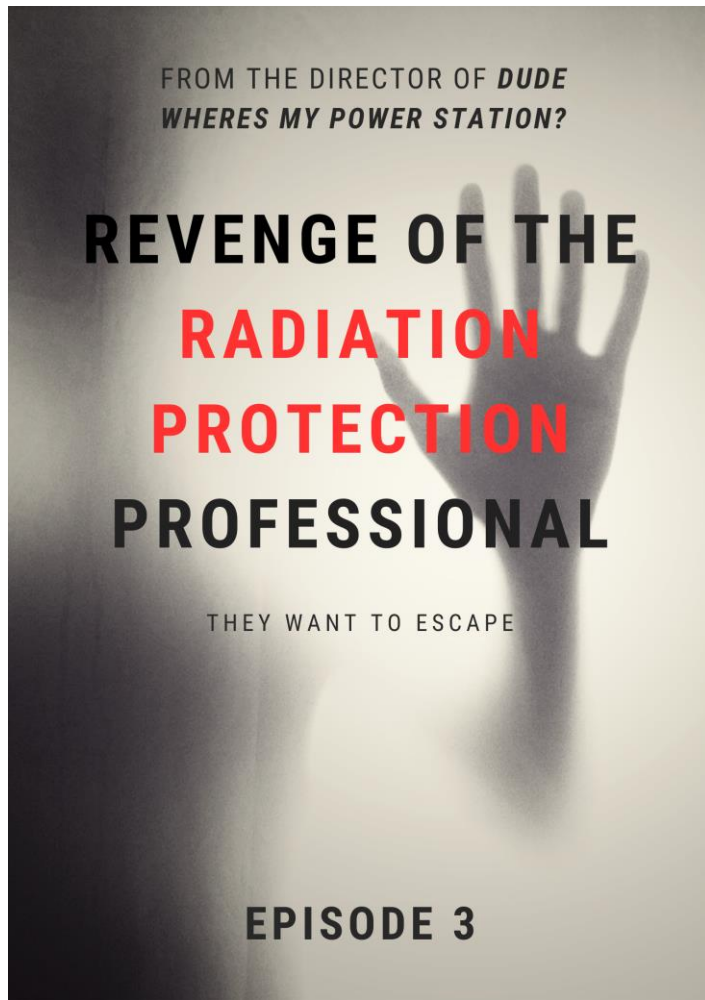
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**PETER BRYANT,**  
Sizewell C Head of Environment, Decommissioning and Radiation Safety.



# professional

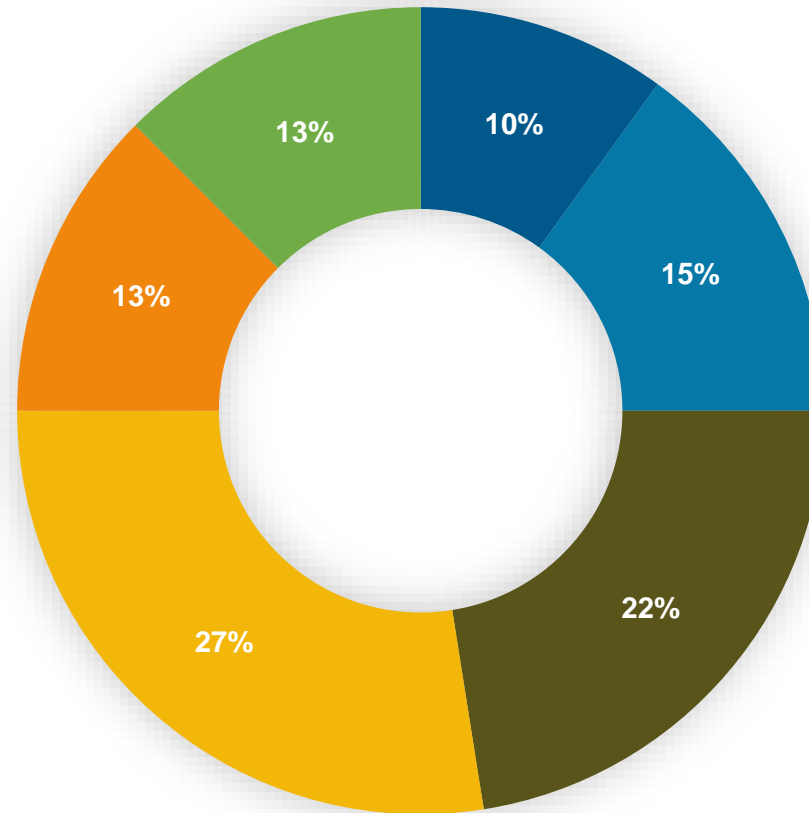
*noun*

- someone who is paid to participate in a sport or activity
- someone who has a lot of experience or skill in a particular job or activity.

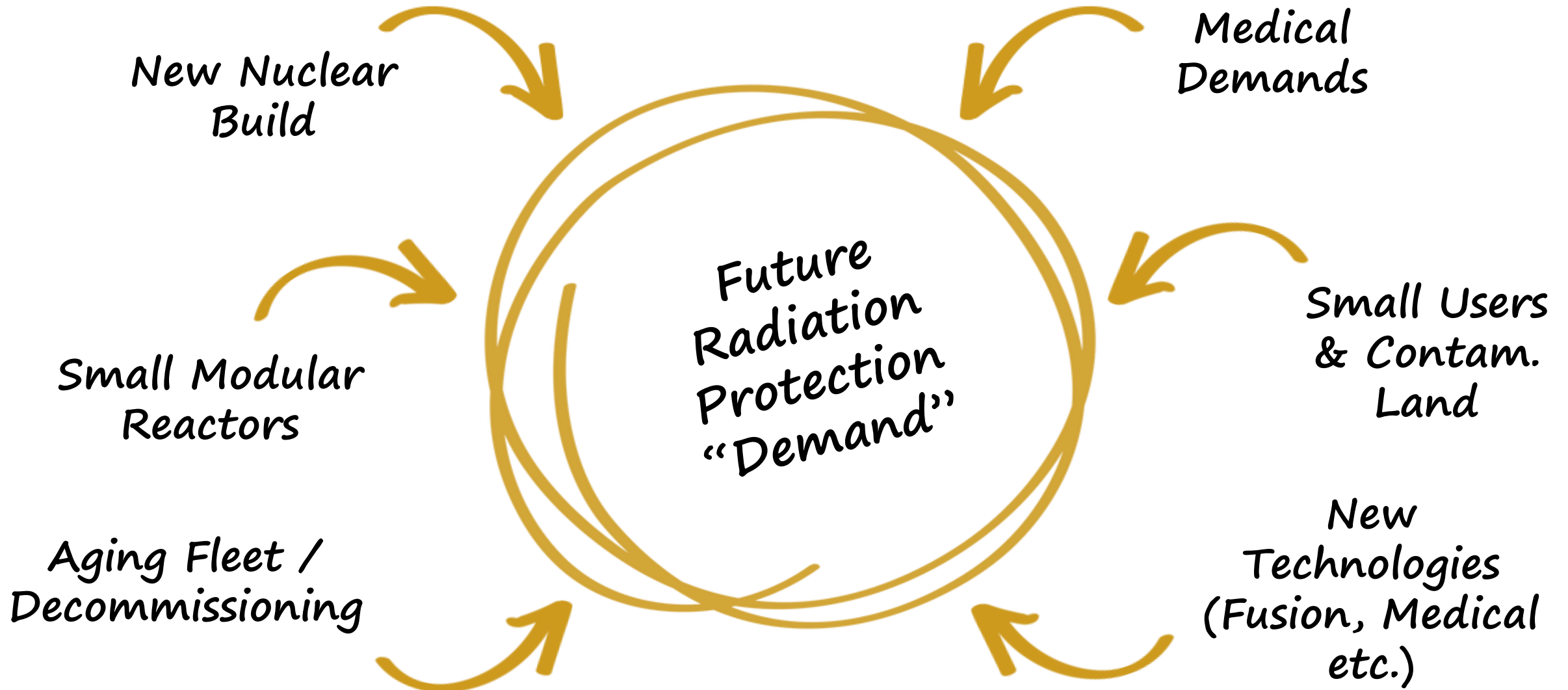


# Age Demographic of RP Workforce

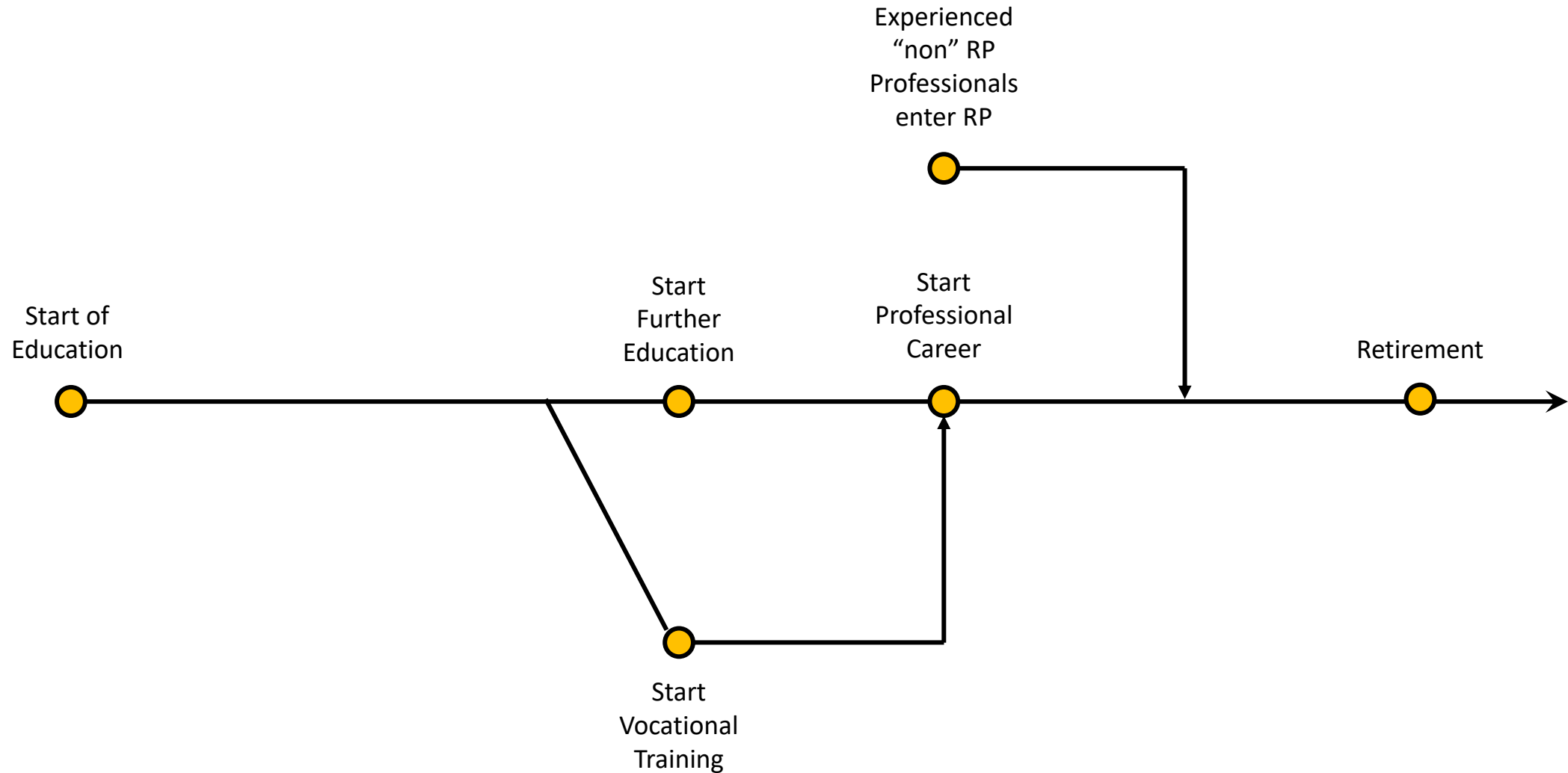
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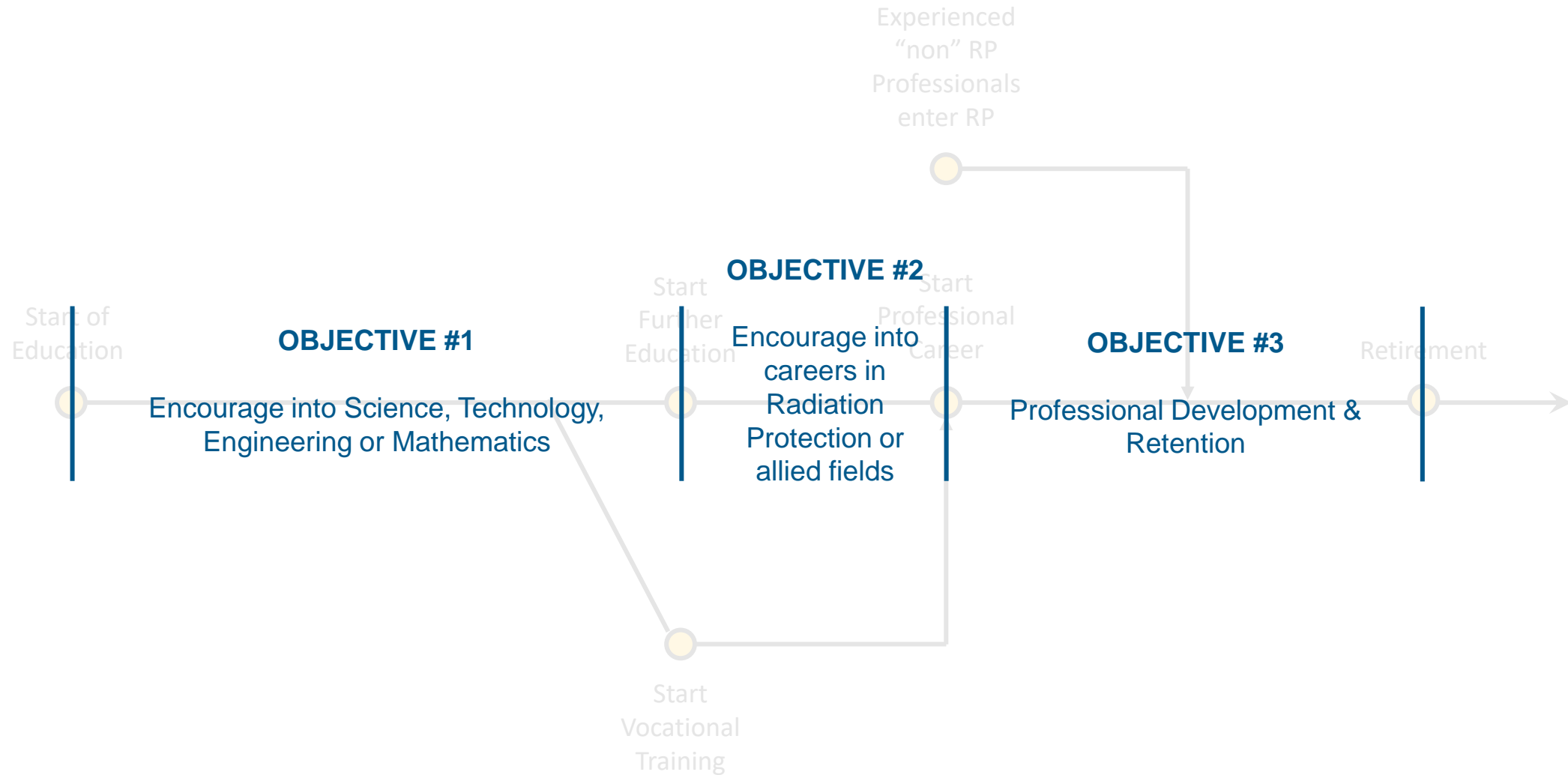
# RP Workforce Demand



# Typical Career Path of RP Professional



# Typical Career Path of RP Professional



# Objective 1 - Encourage into STEM



# Objective 2 - Encourage into RP Careers

YOUNG SZC

Key Roles

Training Providers

Construction

Operational

YOUNG SZC

Key Roles

Training Providers

Operational 2

Construction 1


Construction 2

Operational 1

Operational 2

YOUNG SZC

Environment Lead



Meet Clare Proctor

ENVIRONMENT LEAD

"Some of the best times I've had at work is as part of a team working towards the same thing so I'm looking forward to the start of construction at Sizewell C. It also helps that its 20 minutes up the road!"

I started my career on Sizewell A power station when it was in operation and then as it went into decommissioning. I moved to work for EDF on Hinkley Point C and am now the Site Environment Lead for Sizewell C.

My current responsibilities include conducting site visits to ensure our contractors are complying with regulations, identifying environmental requirements which must be understood and adhered to by our workers and ensuring we have the right permits required to carry out our work on site.

I have found, over the last 10 years, that I have continuously learned and developed and most importantly am rarely bored! Having come from a nuclear background, I now have experience of planning during the development stages of the projects and construction from working on HPC during the earthworks phase. I've also had the opportunity to become a mental health first aider for Sizewell C having seen the benefits at Hinkley Point C.

edf

Habitat creation scheme at Sizewell C hosts local students

Watch later

Share



# Objective 3 - Professional Development and Retention



Attendees and facilitators at the course pilot this week. Far left is SZC's Pete Bryant.

## Addressing skills gaps in the nuclear industry

Over the last few years SZC has been working with the **University of Liverpool** to develop a practical training course on '**Radiation Detection, Measurement and Environmental Sampling**'. The course aims to build the skills needed to support construction and operation of future stations and address skills gaps within SZC, HPC and Nuclear Generation. The first pilot ran this week with attendees from SZC, HPC, **Environment Agency** and the **Office for Nuclear Regulation**. The course was delivered by **University of Liverpool professors** and SZC's **Dr Pete Bryant**.



# RISING GENERATIONS GROUP

- Pull the resources of Operators, Professional Bodies, Regulators, Universities etc.
  - Stop all going to the same events.
  - Remember why we are doing Outreach! - Unbranded Outreach.
  - Build Co-ordinated Training Programmes and University Courses.
- Innovative ways of communicating. Why are we not using Social Media more?
  - Increase target audience. Could we use YouTube? Or Other Social Media Platforms (e.g. TikTok)?
  - What about Main-Stream Media?
- Need Employer “Buy In” to support development (Professional and Career) and retention of staff.
  - Training Programs
  - Career Progression
  - Support attending external training and events
  - Develop mechanisms to support those non-RP Professionals that want to convert into a career in RP
- Diversity in RP careers - mobility between employers / countries.



New Nuclear Presents an exciting opportunity for our Profession. But with that comes its challenges, of which they are often not technical.

- **The Phantom Regulations** - The design of the Regulatory and Legal System can result in conflicts or areas where they do not align. It is important to remain outcome focused and look at how it can be applied more flexibly and proportionately.
- **Attack of the Mud** - Where the public are involved in a radiological exposure, no matter how low the risk, consideration should be given to the potential need for engagement as a mechanism to mitigate any societal stress. Remember *...ultimately the PUBLIC will decide if the radiation is safe....but help them base that decision on “real” risk, not “perceived”*.
- **Revenge of the Radiation Protection Professional** - By working together this brings the unique opportunity of pulling our efforts and resources to a common goal, allowing us to share good practice, whilst reducing the strain and burden on any one organisation and offering the opportunity to maximising our impact in tackling the skills gap.

# Further information on Case Studies

OPEN ACCESS  
IOP Publishing | Society for Radiological Protection  
J. Radiol. Prot. 41 (2021) S1–S8 (8pp)  
<https://doi.org/10.1088/1361-6498/abd348>

## Communicating radiation risk: the role of public engagement in reaching ALARA

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Received 22 October 2020; revised 30 November 2020  
Accepted for publication 14 December 2020  
Published 1 June 2021



**Abstract**  
The ALARA (an acronym for ‘as low as reasonably achievable’) principle, keeping the likelihood of incurring exposure, the number of people exposed and the magnitude of their individual doses ‘as low as reasonably achievable, taking into account economic and societal factors’, is at the core of radiation protection. For many decades the principle has been an area of continuous development, with recent work highlighting the importance of engaging not only with the decision-makers in the ALARA process but all stakeholders who may incur an exposure. This paper considers a particular case study in which the dredging of non-hazardous sediment in the United Kingdom near a now decommissioned nuclear power station raised substantial public concern about radiological exposure. This turned what was a straightforward construction activity into a complex public engagement and reassurance task, at a significant cost disproportionate to the level of radiological risk. This paper highlights the key lessons learnt from the case study, including not only the importance of engaging the public as part of the ALARA process but also of considering the societal impact arising from stress and concerns if misinformation is allowed to promulgate. A discussion is included on the need to underpin any engagement with a clear plan, including pre-engagement, implementation and reinforcement of messages. In addition, the role of the radiation protection professional

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1361-6498/21/1-0533.00 Printed in the UK

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Citation P A Bryant 2021 *J. Radiol. Prot.* **41** S1  
DOI 10.1088/1361-6498/abd348



OPEN ACCESS  
IOP Publishing | Society for Radiological Protection  
J. Radiol. Prot. 41 (2021) S79–S88 (10pp)  
<https://doi.org/10.1088/1361-6498/abf815>

## The role of radiation protection societies in tackling the skills shortage and development of young professionals and researchers

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Received 29 March 2021; revised 1 April 2021  
Accepted for publication 14 April 2021  
Published 18 August 2021



**Abstract**  
Over the last 10 years there have been increasing concerns raised about a potential skills gap in the field of radiation protection (RP). Noting these concerns in 2019, the Society for Radiological Protection, the UK’s Chartered Professional Body, launched a study to determine the RP demand in the UK going forward along with the capacity of the profession. The initial results show that over 50% of the SRP membership retires in the next 10–15 years, coupled with an increase in RP demand across the nuclear fuel cycle, medical sector and advancement of new technologies or applications requiring RP advice. This provides strong evidence supporting the concerns of a future skills gap. This paper presents a framework highlighting three core objectives that need to be met to resolve the skills gap. A review of the existing initiatives being undertaken by the Society of Radiological Protection to meet these objectives is included, identifying both areas of good practice and areas for further work and development. A key theme in tackling this challenge has been identified as the need to foster greater collaboration between RP professionals, and organizations both within the UK and abroad, such as IRPA, national societies, employers, academia and industry. This brings a unique opportunity to direct

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1361-6498/21/1-0533.00 Printed in the UK

S79

Citation Peter A Bryant 2021 *J. Radiol. Prot.* **41** S79  
DOI 10.1088/1361-6498/abf815



Any

# Questions?