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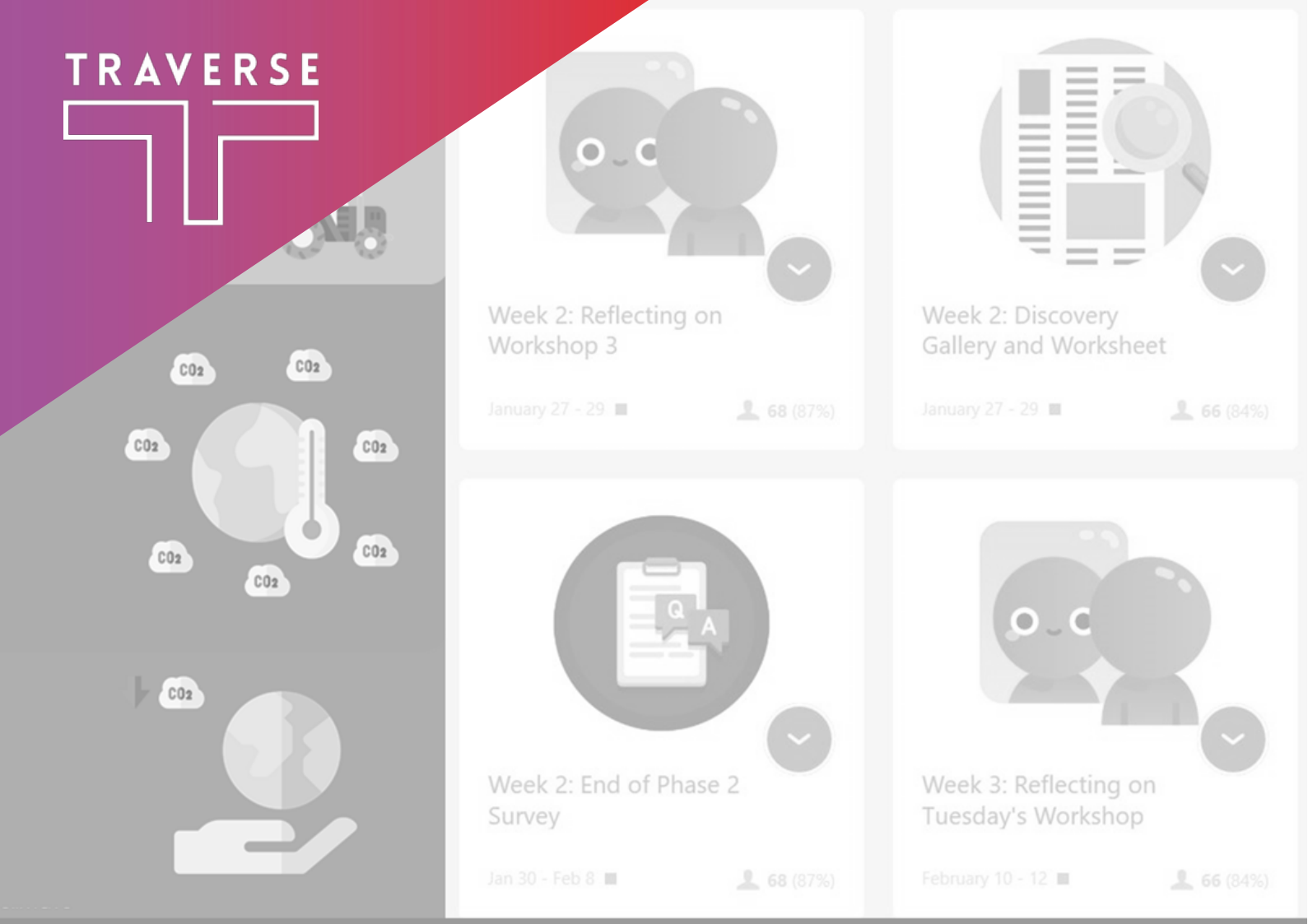

Public dialogue on advanced nuclear technologies

Engagement report – Appendices

July 2021

Department for Business, Energy & Industrial Strategy

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1. Appendix A – Method

1.1. Key dates and timeline

The contract for the public dialogue on advanced nuclear technologies was awarded in January 2020, originally for completion in October 2020. Due to Covid-19 the project was largely put on hold for approximately five months in 2020, with a resulting shift to the delivery and completion timelines.

A summary of key decisions and delivery is provided in Table 1.

Table 1: Summary of key project dates

Month	Key decision/action
January 2020	• First Project Executive meeting (Appendix D – Project Executive) • Project Board meeting (Appendix C – Project Board)
February 2020	• Project inception meeting • 3KQ appointed as independent evaluator • Oversight Group meeting (Appendix B – Oversight Group) • Project Board meeting • Topic review underway • Recruitment criteria agreed • Workshop locations agreed • Reflections on research questions and process design
March 2020	• Topic review completed • Recruitment materials underway • Materials design underway • Early piloting • Workshop dates approved • **Decisions taken in response to Covid-19:** - Cancel agreed workshop dates - Review project plan and approach in mid-April - Oversight Group and Project Board put on hold until further notice - Defer decisions for new Oversight Group member - Project Executive put on hold for several weeks - Early design to continue until May, at which point all project work would be put on hold
April 2020	• Baseline evaluation report received and reviewed • Research questions reviewed, and new research framework

	agreed. Siting and deployment were seen as the central theme across the original research questions, with the potential to influence policy. As such siting and deployment became central to the project aim and objectives. • Agreement to recruit a new Oversight Group member (ahead of their activity resuming) to improve balance. • **Decisions taken in response to Covid-19:** - Delay delivery to potentially allow for face-to-face approach in the autumn - Project Executive to take a pause, only meeting as necessary for key decisions - Materials design put on hold
May 2020	• On hold
June 2020	• Project Executive meeting to discuss a rescope, revised budget, and project plan for an online approach.
July 2020	• Project Executive meeting to agree the rescope
August 2020	• Project Executive meeting to review delivery timeline
September 2020	• New Oversight Group member confirmed and onboarded
October 2020	• Timeline agreed for dialogue to start in January 2021 • Oversight Group and Project Board meetings for updates and process design • Online process and materials design underway
November 2020	• Workshop dates agreed • Updated recruitment approach agreed • Recruitment started • Specialists list agreed and recruitment underway • Note-taking protocols agreed • Materials shared with Project Board and Oversight Group • Piloted activities and materials
December 2020	• Dialogue terminology agreed • Specialist recruitment and collaborative design • Welsh delivery approach agreed • Project Board meeting
January 2021	• Dialogue delivery • Oversight Group meeting

	• Internal interim report 1
February 2021	• Dialogue delivery • Internally Interim report 2 • Analysis and reporting started
March 2021	• Final task on the online platform (Recollective) before it closed
April 2021	• Draft report
May 2021	• Final report
June 2021	• Additional reporting outputs
July 2021	• Dissemination • Project close

1.2. Research questions

1.2.1. Objectives and research questions as per the original tender

The objectives of the project were:

1. Explore key areas of participants' interest in advanced nuclear technologies in order to help test any existing Government views and assumptions
2. Help shape Government siting policy and guidance, potentially as part of a new National Policy Statement (NPS)
3. Explore differences in participants' views between conventional nuclear and small nuclear
4. Explore participants' views of any non-electricity uses of advanced nuclear technologies
5. Determine participants' views of using Advanced Nuclear Technologies as a way of mitigating/preventing climate change
6. Explore potential differences in participants' opinions between existing nuclear communities, other industrial communities and communities without either heavy industry or nuclear.

Questions to be addressed in the dialogue included:

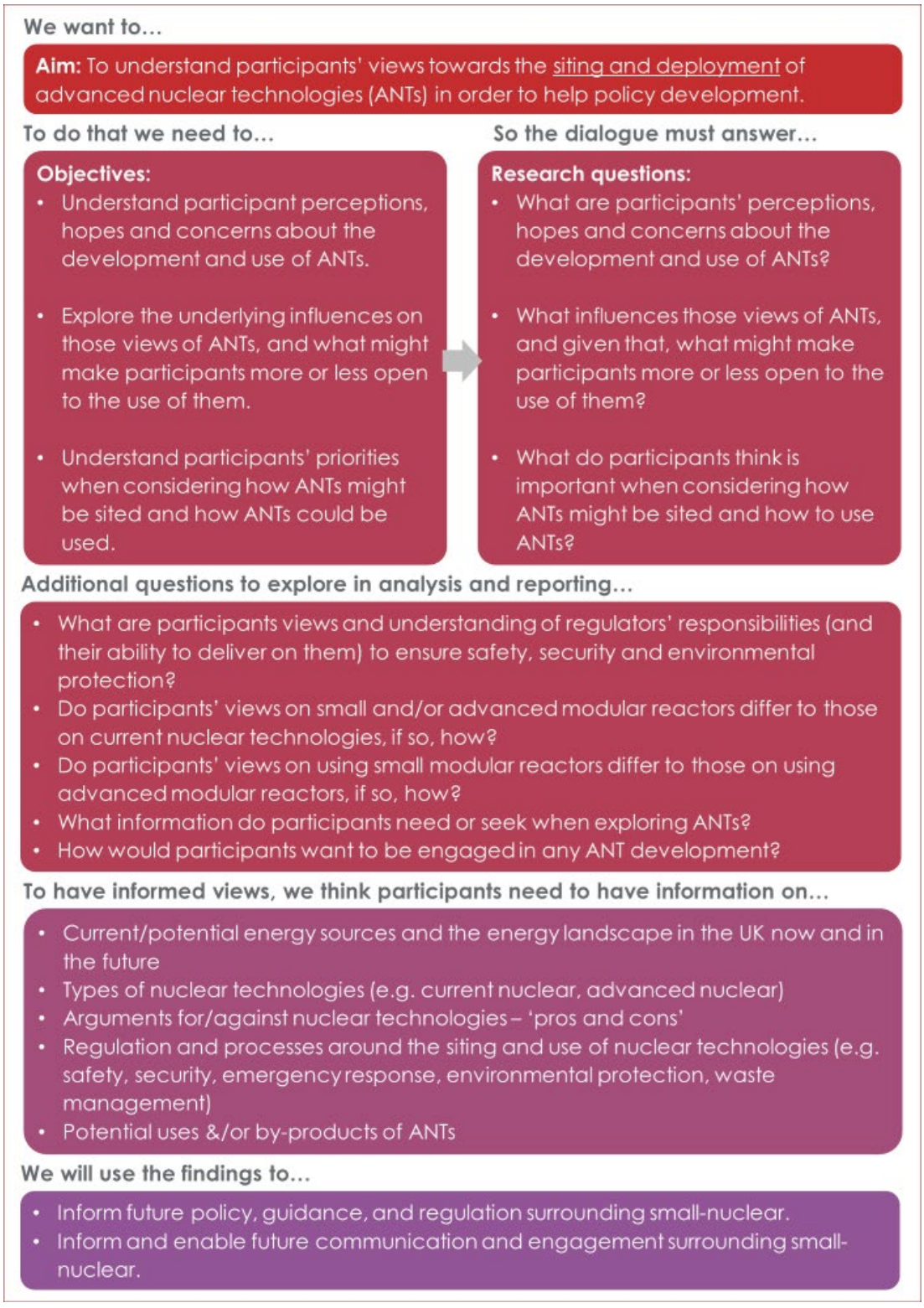
1. What are participants' views of advanced nuclear technologies?
2. What are the differences in participants' views of small vs. conventional nuclear plants?
3. What are participants' views of using conventional technologies vs. advanced nuclear technologies?

4. What are participants' views to local siting of advanced nuclear technologies?
5. What are participants views about the ability of regulations and regulators to ensure the risks posed by advanced nuclear technologies to the public or the environment are As Low As Reasonably Practicable (ALARP)?
6. What are participants' views as to non-electricity and combined heat and power uses of nuclear technologies, such as connections for heat (e.g. hot water) from nuclear reactors to warm homes?
7. Can we identify areas that participants wish to have more information on?
8. What features (safety, security etc) would a small power plant need, or what benefits could it bring (e.g.jobs, investment etc), for communities to support development?
9. How much are participants' views of advanced nuclear technologies influenced by their potential contribution to decarbonising the UK?

1.2.2. Revised objectives and research questions

Following inception meetings, the topic review, and extensive discussion among the Project Executive, as well as with the Project Board and Oversight Group, the project objectives and research questions were refined and restructured (Figure 1).

Figure 1: Agreed dialogue objectives and research questions



1.3. Topic review process

At the start of the project, February 2020, Traverse carried out a rapid topic review. The purpose of the topic review was to inform the public dialogue on advanced nuclear technologies. The review helped to establish a set of topics and perspectives to include, and hypotheses to test. It drew together the latest understanding of the issues around advanced nuclear

technologies, and the views of specialists with a range of different perspectives. This ensured that the materials and information presented to the public during the dialogue process were accurate and balanced. The process of interviewing stakeholders also allowed us to explore potential impacts of the dialogue output early, ensuring that outputs are useful and that pathways to impact are identified and factored into the policy briefings.

The public dialogue aimed to explore public perceptions of the development and use of advanced nuclear technologies. Members of the public may have different views for advanced nuclear than those they hold for current nuclear reactors and BEIS wanted to involve them at this early stage of policy development.

To support the public dialogue design process, the evidence review explored the following:

- what advanced nuclear technologies are, who is developing it, where and on what timescales;
- the policy context for developing advanced nuclear technologies and its regulation;
- the known pros and cons of developing advanced nuclear technologies;
- existing public attitudes to advanced nuclear technologies, or comparable technologies, and what influences the formation of these attitudes; and
- existing narratives around advanced nuclear technologies among the public, specialists and in the media.

The rapid topic review involved:

- **desk research**: review existing documents, including policy, academic and grey literature; and
- **stakeholder interviews**: to identify further documents for desk research and specialists for survey/workshop participants, and test understanding and the questions from the tender (Table 2).

Table 2: Topic review interviewees

Alasdair Harper	BEIS, Head of Strategy for Advanced Nuclear Technologies
Sarah Brown	Office for Nuclear Regulation, Senior Policy Adviser
Colette Grundy	Environment Agency Senior Advisor Advanced Nuclear Technologies (at time of interview) National Nuclear Laboratory, UK SMR Regulatory Engagement Lead, Safety, Security and

	Safeguards (at time of report publication)
Dr Doug Parr	Greenpeace, Chief Scientist and Policy Director
Dr Paul Dorfman	Nuclear Consulting Group (NCG) - chair
James Wiseman	NIRO/NNL
Professor Nick Pidgeon	Professor of Environmental Psychology, Director of the Understanding Risk Research Group
Colin Talbot	Co-director Cambridge Policy Labs

1.4. Recruitment

1.4.1. Sampling approach

The aim was to ensure that each of the three locations was recruited to reflect the demographics of the local area.

The three locations were identified to ensure participation from areas with local industry (Scunthorpe), without local industry (Reading), and with local nuclear sites (Porthmadog).

1.4.2. Recruitment approach

We worked with our trusted partners Plus Four to recruit participants. Plus Four work with over 700 interviewers and recruiters throughout the country through a mixture of face to face and database recruitment. This recruitment process proved challenging for a number of reasons, such as having to recruit without using face-to-face approaches (such as on-street or door-to-door recruitment) due to Covid-19.

Recruitment of participants aged 75+ was notably difficult in two of the three locations, namely Reading and Porthmadog. Covid-19 also impacted negatively on recruitment and retention of participants, according to anecdotal accounts from recruiters and communications with participants. This included illness amongst participants and their families, and additional work and caring pressures related to the pandemic.

Nevertheless, the minimum target for participants in each location was met at the beginning of the dialogue, and we achieved a balanced representation in terms of age, gender, ethnicity, social grade, and urban/rural locations and enough diversity across all groups to guarantee the quality of the dialogue.

Extending the recruitment area around Scunthorpe – the most challenging location – to include Grimsby and Hull, and including a few participants from sub-urban and rural areas in this group, which was designed to be mostly urban, facilitated the recruitment process. Additionally, as part of a less granular approach to age quotas, recruitment of participants aged 65-74, where there was no success in the 75+ range, was also permitted.

Participants were paid incentives for attending workshops and completing tasks online (Table 3).

Table 3: Incentive payment structure

Session/Activity	Incentive amount
Event 1	£25
Event 2	£25
Event 3	£25
Event 4	£25
Event 5	£25
Event 6	£50
Bonus for attending all events	£25
Bonus for completing most online tasks	£20
Prize draw (participants who completed all online tasks were entered, with one winner)	£100

1.4.3. Target vs actual quota

Following best practice, the intended sample was to over-recruit 84 people, so as to ensure that 72 participants attended (28 for 24 participants in each location), allowing for drop-outs over the course of the process. In the end, we over-recruited 108 (due to higher drop-out rate due to Covid-19) to achieve a final sample of 71 participants.

Table 4: Planned and achieved recruitment samples

Category	Quota detail	Target	Actual: start of dialogue	Actual: end of dialogue
Gender	Female	38-46	57	37
	Male	38-46	51	34
	Total	84	108	71
Age	18-19	6	7	4
	20-24	6-11	7	7
	25-29	7-10	11	10

Category	Quota detail	Target	Actual: start of dialogue	Actual: end of dialogue
Age	30-44	17-25	27	17
	45-59	16-24	26	12
	60-64	5-8	12	8
	65-74	7-11	12	9
	75+	7-11	6	4
	Total	84	108	71
Ethnic group	White British	62-68	87	56
	White Non-British	6	4	3
	Asian/Asian British	6-10	9	6
	Black/African/ Caribbean/Black British	2-4	2	2
	Mixed/Other ethnic group	2-3	6	4
	Total	84	108	71
Social grade	AB	17-21	22	18
	C1	22-26	36	27
	C2	16-20	23	13
	DE	20-24	27	13
	Total	84	108	71
Rural/ urban	Urban	56	71	46
	Rural	28	37	25
	Total	84	108	71

1.5. Delivery tools

Designing and delivering a wholly online deliberative dialogue process required the use of various digital tools. For the engagement process to be both synchronous (real time discussion) and asynchronous (can be done by individuals in their own time) we worked across multiple platforms, mainly Zoom and Recollective. This mixed approach was chosen as it supports effective involvement as participants can digest material, contribute, and

interact with each other in a range of ways.

Zoom was used to host workshops as:

- it is the platform that people are most likely to be familiar with;
- it has one of the best gallery-view settings for large groups;
- it easily enables participants to work in smaller break-out groups;
- it features helpful chat and polling functions;
- it allows the host and co-hosts to screen-share content or presentations;
- it has sufficient capacity for the audience size of the dialogue; and
- it does not limit meeting length.

Recollective was used as an online portal for tasks between sessions. The team used this to follow individual contributions – to flag if participants may have needed help or encouragement, and to understand change in views over time. Data was exported directly to our analysis tool, Magpie. Each participant created an individual account and used the platform to:

- complete online tasks in between workshops;
- complete survey questions;
- interact with each other through discussion forums; and
- review information between sessions, such as videos, transcripts of notes, questions and answers, posters, and presentation recordings.

Mural was also used in the early workshops to capture and group comments in real-time (similar to a flip chart with post-it notes), but due to participant experience and display size its use was discontinued.

1.6. Delivering in Welsh

Participants from Porthmadog were offered the choice to participate in Welsh. A detailed account of the Welsh delivery is provided below.

1.6.1. Plenary sessions

Plenary sessions included English and Welsh participants in one virtual room.

- We provided simultaneous translation from English to Welsh (provided by Cyfieithu CYMEN Translation). Participants had the choice to listen in Welsh by following a few simple steps when joining Zoom (as described in the welcome pack and the live session introduction).
- We provided a second translator for translation from Welsh to English, so that participants could ask questions or raise comments in Welsh.
- All slide packs were translated into Welsh and sent to participants before each session via email.
- Any polling done in Zoom was conducted in English, but the Welsh translation was provided in the slide packs shared with participants beforehand. The translator also simultaneously translated the questions and answer options as they were read out by the lead facilitator.

1.6.2. Break-out sessions

Participants who wanted to participate in Welsh were allocated to a Welsh speaking group, with a bilingual facilitator, using materials in Welsh.

- Facilitators were provided with a Welsh facilitator guide.
- Any specialists attending Welsh speaking discussion groups answered questions in English.
- Any questions from participants to specialists in Welsh were translated by the facilitator.

1.6.3. Note taking

Note takers for Welsh discussion groups were provided with a note taking template in Welsh, following the same structure as the facilitator guide. Following the workshop, all notes in Welsh were sent for translation back into English in order to be analysed alongside all the other data.

1.6.4. Online activities

The online platform (hosted by Recollective) and all the content posted on it were in English. However, participants were able to complete the activities, and leave comments and questions in Welsh. Traverse also shared Welsh versions of activities with participants over email as requested.

Participants were informed that communication from the Traverse project team, would be in English. If participants wanted to talk with the Traverse team in Welsh, they were asked to do so over email so that we could arrange suitable translation.

1.7. Process plans

The dialogue was structured in 3 key topics delivered over 6 weeks, through 7 live virtual workshop sessions, and ongoing asynchronous activities through an online platform.

Table 5: Overview of the full dialogue journey, including workshops and online tasks

Topic	Week	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
Onboarding	**0**	Receive resources, welcome information, and complete baseline survey						
The big picture of energy • Current/potential energy sources and the energy landscape in the UK now and in the future	**1**		**Workshop 1:** Evening plenary	Online tasks			**Workshop 2:** Morning groups	Online tasks
	2	Online tasks						
The big picture of nuclear • Regulation and processes around the siting and use of nuclear technologies • Arguments for/against nuclear technologies	**3**	Online tasks	**Workshop 3:** Evening plenary	Online tasks			**Workshop 4:** Morning groups	Online tasks
	4	Online tasks						
Nuclear technologies • Types of nuclear technologies • Arguments for/against nuclear technologies • Potential uses or by-products of MNTs	**5**	Online tasks	**Workshop 5:** Evening plenary	Online tasks			**Workshop 6:** 2 group sessions	Endline survey
	6	Endline survey continued						

1.7.1. Pre-engagement onboarding

Length	15 minutes	**Topic**	N/A
Format	Post Online platform Zoom Telephone	**Objective/s**	Equip participants to engage using the online tools Collect baseline attitudinal data
Activities	• All participants receive resource packs via the post • Provide participants their individual login details for the online platform (Recollective) • Provide 1-on-1 support as needed with accessing Recollective and familiarising with Zoom • Participants to complete a baseline survey through Recollective (hard copies for offline participants) • Photo journal / mood board • *Share 3 pictures that show what you first think or how you first feel in response to* • *'nuclear energy' or 'new technology for creating nuclear energy'* (specific term to be agreed) • Participants are expected to take photos or find images, that they will submit through Recollective (using the photo journal tool) • Offline participants will receive a large set of different printed images to choose from		
Materials	• Baseline survey • Hard copy resource packs • Selection of printed images for offline participants • Welcome email pack		

1.7.2. Workshop 1

Length	90 minutes	**Topic**	The big picture of energy
Format	Plenary	**Session objective/s**	Introduce participants to the dialogue process and topic, and the context of energy within the UK as a way in to exploring nuclear technologies.

Timing	Session	Who / roles	Materials
60 mins before	Team arrivals • Final briefings • Individual audio/video tests	Lead + Tech support	
15 mins before	Participant arrivals • Individual audio/video tests	Lead + Tech support	
15 mins	**Welcome** • Ways of working • Using Zoom • Explain the dialogue process • Participants share through the chat (name, where they are from, and something about themselves)	Lead	Slides
10 mins	**Setting the scene** • Dialogue context and topic • Objectives • How the outcomes will be used	BEIS – Lewis	Slides
20 mins	**Interactive presentation 1: Current energy landscape of the UK** (participant questions submitted over chat)	Specialist Lead chairs Q&A	Slides Prompt questions
10 mins	Break		

20 mins	**Interactive presentation 2: The future of energy in the UK** (participant questions submitted over chat)	Specialist Lead chairs Q&A	Slides Prompt questions
10 mins	**Online platform tour:** • Logging on • Finding your online tasks • Interacting with each other • Test task – how are you feeling now?	Lead	Recollective Tour script
5 mins	Close	Lead	Slides

1.7.3. Online task 1

Length	15 minutes	**Topic**	N/A
Format	Online platform	**Objective/s**	Build relationships between participants to support positive dialogue experiences

Activities	• Get to know 5 people by taking part in the discussion board that matches the animal assigned to you below.
	  o On the platform we will post 6 different discussion topics named after different animals.
	  o Participants will go into their relevant discussion group and each answer the following question. Reflecting on today's session, tell us:
	  ▪ Something you learnt
	  ▪ Something that concerns you
	  ▪ Something that you are optimistic about
	  ▪ Something you want to know more about
	  o They will then explore what the rest of their group said and comment on their responses.
	• Share your thoughts on how you would like to work together – what ground rules would you like to follow.		

Materials	• Group topics / titles		

1.7.4. Workshop 2

Length	90 minutes	**Topic**	The big picture of energy
Format	Groups	**Session objective/s**	Develop group relationships. Understand participants' early views on energy within the UK, which might surface views on different technologies and decarbonisation.

As specialists will move between groups (each group seeing 1 specialist), groups will move at their own pace, taking a self-directed break.

Timing	Session	Who / roles	Materials
60 mins before	Team arrivals • Final briefings • Individual audio/video tests	Lead + Tech support	None
15 mins before	Arrivals • Individual audio/video tests	Lead + Tech support	None
15 mins	**Welcome** • Participants will draw or give 5 words to describe themselves or something about their life; and use this as an ice-breaker in introducing themselves. • Revisit the working agreement	Group facilitator	Participant packs: paper + coloured markers Mural board
10 mins	**Perceptions** • Participants will quietly note down (on paper) the first three words or phrases that come to mind in response to "nuclear technology" • They will share their words while facilitators cluster themes in Mural	Group facilitator	Mural board Participant packs: paper / post-its + pens
40 mins	**Reflection** • Facilitators will guide them through deliberative prompt questions to reflect on the dialogue to date (first live session, online tasks, etc.)	Group facilitator	Facilitator guide Mural board

	• Facilitators will capture any questions for specialists in the Mural board, to use in the Specialist Q&A session.		
20 mins	**Specialist Q&A** • Specialist introduces themselves and their experience / field • Participants are given the opportunity to ask the specialist questions • Facilitators will have prompt questions to hand to aid discussion	Group facilitator + Specialist in energy/ climate	Mural board
5 mins	**Close** Reminder of online tasks	Group facilitator	

1.7.5. Online task 2

Length	15 minutes	**Topic**	The big picture of energy
Format	Online platform	**Objective/s**	Understand participant journey, to reflect and adapt design. Embed topic and context. Understand participants' early views on energy within the UK, which might surface views on different technologies and decarbonisation.
Activities	• Explore the Discovery Gallery (films and posters), to complete a quiz • Feedback on the engagement in the first two live sessions and online tasks • Complete a short tracking survey (builds on baseline data, repeated at the end of each of the 3 topic blocks)		
Materials	• Discovery gallery posters and film clips • Discovery gallery questions • Engagement feedback questions • Tracking survey		

1.7.6. Workshop 3

Length	90 minutes	**Topic**	The big picture of nuclear
Format	Plenary	**Session objective/s**	Introduce participants to different nuclear energy technologies, and the general regulation and processes around siting and use.

Timing	Session	Who / roles	Materials
60 mins before	Team arrivals • Final briefings • Individual audio/video tests	Lead + Tech support	None
15 mins before	Arrivals • Individual audio/video tests	Lead + Tech support	None
10 mins	**Welcome** • Recap of ways of working • Participants share how they are feeling through chat	Lead	Slides
25 mins	**Interactive presentation 1:** An introduction to nuclear energy technologies	Specialist Lead chairs Q&A	Slides
10 mins	**Break**		None
25 mins	**Interactive presentation 2:** An introduction to the regulation of nuclear energy technologies	Specialists Lead chairs Q&A	Slides
15 mins	**Plenary reflection:** Participants share reflections through chat and polling, which the lead facilitator then pulls on to wrap up the session.	Lead	
5 mins	**Close:** Reminder of online tasks	Lead	

1.7.7. Online task 3

Length	15 minutes	**Topic**	The big picture of nuclear
Format	Online platform	**Objective/s**	Reflect on information from live session 3. Exploring arguments for and against nuclear energy technologies. Self-directed exploration of nuclear energy. Understand participants' early views on what is important to consider when siting and using nuclear power stations.

Activities	• Reflecting on today's session, tell us:
	  ○ "Something I learnt"
	  ○ "Something that concerns me"
	  ○ "Something that I am optimistic about"
	  ○ "Something I want to know more about"
	• Explore the Discovery Gallery (films and posters), to complete a worksheet		

Materials	• Discovery gallery posters and film clips • Discovery gallery questions		

1.7.8. Workshop 4

Length	90 minutes	**Topic**	The big picture of nuclear
Format	Groups	**Session objective/s**	Reflect on and deliberate nuclear technologies.

Groups will move at their own pace, taking a self-directed break.

Timing	Session	Who / roles	Materials
60 mins before	Team arrivals • Final briefings • Individual audio/video tests	Lead + Tech support	None
15 mins before	Arrivals • Individual audio/video tests	Tech support	None
5 mins	**Welcome**	Group facilitator	Facilitator guide
15 mins	**Reflection:** Facilitators will guide their groups through a few prompt questions to reflect on the previous plenary session and online tasks, e.g.: • What did you hear about nuclear energy, and how did that make you feel? • What did you think about the way the public / communities are involved in the regulation process? • Which regulatory issues did you prioritise and why?	Group facilitator	Facilitator guide Online tasks data
55 mins	**Specialist Q&A** • Specialist introduces themselves and their experience / field • Participants have the opportunity to ask the specialist questions • Facilitators will have prompt questions to hand to aid discussion (some pre-prepared, others gathered from the reflection session)	Group facilitator + Specialist in nuclear energy	Facilitator guide
10 mins	**Debrief:** Groups will wrap up by reflecting on the full session	Group facilitator	Facilitator guide

5 mins	**Close:** Remind of online tasks	Group facilitator	Facilitator guide

1.7.9. Online task 4

Length	15 minutes	**Topic**	The big picture of nuclear
Format	Online platform	**Objective/s**	For participants to reflect on the dialogue to date. Understand participant journey, to reflect and adapt design.
Activities	• Participants will be given a journal activity – to use audio, video, or text, to reflect on their journey. We will provide prompts to encourage them to think about how their views on UK energy generation and nuclear energy might have developed, and what they think the pros and cons of nuclear energy technologies are. • Feedback on the engagement in live sessions 3 and 4, and online tasks 3 and 4 • Complete a short tracking survey (builds on baseline data, repeated at the end of each of the 3 topic blocks)		
Materials	• Engagement feedback questions • Tracking survey		

1.7.10. Workshop 5

Length	90 minutes	**Topic**	Nuclear technologies
Format	Plenary	**Session objective/s**	Explore modular nuclear energy technologies in greater depth.

Timing	Session	Who / roles	Materials
60 mins before	Team arrivals • Final briefings • Individual audio/video tests	Lead + Tech support	None
15 mins before	Arrivals • Individual audio/video tests	Lead + Tech support	None
10 mins	**Welcome** • Recap of ways of working • Participants share how they are feeling through chat	Lead	Slides
25 mins	**Interactive presentation 1:** Introduction to modular nuclear energy technologies	Specialist Lead chair Q&A	Slides
10 mins	**Break**		None
25 mins	**Interactive presentation 2:** The opportunities and unknowns of modular nuclear energy technologies *(i.e. arguments for / against)*	Specialist Lead chair Q&A	Slides
15 mins	**Plenary reflection:** Participants share reflections through chat and polling, which the lead facilitator then pulls on to wrap up the session.	Lead	
5 mins	**Close:** Reminder of online tasks	Group facilitator	

1.7.11. Online task 5

Length	30 minutes	**Topic**	Nuclear technologies
Format	Online platform	**Objective/s**	Reflect on information on modular nuclear technologies. Self-directed exploration of modular nuclear technologies. Understand participants' perceptions, hopes and concerns about the development and use of modular nuclear technologies.

Activities	• Reflecting on today's session:
	  ○ What is something that you **learnt**?
	  ○ What are your biggest **questions** about modular nuclear technologies?
	  ○ What **concerns** you about modular nuclear technologies?
	  ○ What are you **optimistic** about for modular nuclear technologies?
	• Rate how important you think each of the following opportunities of modular nuclear technologies is, and explain why: (this will use a scale, and the opportunities written up in previous draft materials)
	  ○ Medical use
	  ○ Hydrogen production
	  ○ Firm power with variable output
	  ○ Grid reliability
	  ○ Remote, off-grid use
	  ○ Heat generation for domestic and/or industrial use
	  ○ Energy generation for industrial use
	  ○ Nuclear waste management
	• Reflect on your journey so far, using audio, video, or text. Think back to how you felt and what you thought about the technology, compared to your feelings and thoughts now. You can share what you might have discovered through your own research (like other opportunities, uses, or disadvantages for modular nuclear technologies).		

Materials	• Flash 'cards' of each opportunity providing moderate detail to enable importance rating		

1.7.12. Workshop 6

Length	4 hour workshop with a midway hour break (10:00 – 15:00)	**Topic**	Nuclear technologies
Format	1 session in location groups 1 session in plenary + mixed groups	**Session objective/s**	Deliberate and consolidate views around the siting and deployment of modular nuclear technologies.

Groups will take self-directed break/s in each 2hr slot as needed.

Timing	Session	Who / roles	Materials
60 mins before	Team arrivals • Final briefings • Individual audio/video tests	Lead + Tech support	None
15 mins before	Arrivals • Individual audio/video tests	Tech support	None
10 mins	**Welcome** • Ways of working • The dialogue process • Participants share how they are feeling through chat	Lead facilitator	Facilitator guide
20 mins	**Reflection:** Facilitators will guide their groups through several prompt questions to reflect on the previous plenary session and online tasks, focussing particularly on the underlying motivations and rationale behind their perceptions on modular nuclear technology and the relative importance of different opportunities	Group facilitator	Facilitator guide
75 mins	**Siting activity** • Groups will look at a map of an imaginary island (on a shared screen)	Group facilitator	Facilitator guide Slide pack

	• They will be asked (in turn) where they would put a current nuclear power station, an SMR, and a next generation reactor. • Participants will note their choices on hard-copies using stickers. • Groups will discuss and deliberate their deployment approaches, exploring what they think is important to consider in the decision-making process (e.g. potential benefits and risk mitigation). • During the discussion facilitators / notetakers will note the deployment patterns, to show during discussion, making it easier to visualise areas of agreement/disagreement. **Note: The map and activity are a tool to enable deeper discussion and exploration of trade-offs, rather than a way of collecting quantitative data about where specifically participants might sight MNTs.*		Participant pack
15 mins	**Debrief:** Groups will have an opportunity to reflect on their key headlines from the different activities of the session	Group facilitator	Facilitator guide
	Close of session 1: Remind of restart time	Group facilitator	
1 hour	**Lunch break**		
10 mins	**Recap:** Headline findings from the dialogue to date	Lead facilitator	Slides
15 mins	**Mixed group welcome and introductions:** In this session participants will be working in new mixed groups, this allows a more thorough introduction and familiarisation with one another.	Group facilitator	Facilitator guide
60 mins	**Messages for policy-makers** • Groups will reflect on the headline views from presentation • Participants will work together to articulate their recommendations and expectations of modular nuclear technology regulation and siting, into a set of messages for policy-makers (for example, this might explore what issues they think should be prioritised, or mitigation measures they feel would help to deliver benefits and limit negative impacts)	Group facilitator + 3 rotating Specialists in nuclear/ energy policy	Facilitator guide

	• Specialists will rotate around groups to support them in shaping their messages, by answering questions about the policy-making context, the regulators and roles, and what may / may not be possible		
30 mins	**Plenary reflection:** Participants share reflections through chat and polling, which the lead facilitator then pulls on to wrap up the session • topics of concern or confusion • where more information is needed • areas of agreement & disagreement • **hopes** and **concerns** about development and use of MNTs One facilitator will capture content in the slides.	Lead	Slides
5 mins	**Close:** Final thank you and a reminder of last online tasks	Group facilitator	Slides

1.7.13. Post-engagement follow up

Length	15 minutes	**Topic**	N/A
Format	Online platform	**Objective/s**	For participants to reflect on the dialogue and early findings. Understand participant journey.
Activities	• Comment on a few early high-level findings (using Live session 7 headline findings slides, messages for policy-makers, and outputs of the final plenary reflection) • Feedback on the engagement in the final live sessions and online tasks, as well as the journey as a whole • Complete a short tracking survey (builds on baseline data, repeated at the end of each of the 3 topic blocks)		
Materials	• Visuals reflecting some early high-level findings • Engagement feedback questions • Tracking survey		

1.8. Analysis and reporting

1.8.1. Analysis

The team of analysts worked collaboratively throughout the process to ensure consistency and to regularly reflect on the coding framework and themes appearing from the analysis. Key findings were taken back to participants to test and refine our understanding.

Quantitative data

Survey and polling data (from online platform surveys and live polling in Zoom) were used to quantitatively analyse changes in opinions over the course of the dialogue events and to explore how these aligned with qualitative discussions. Quantitative data was analysed in Excel.

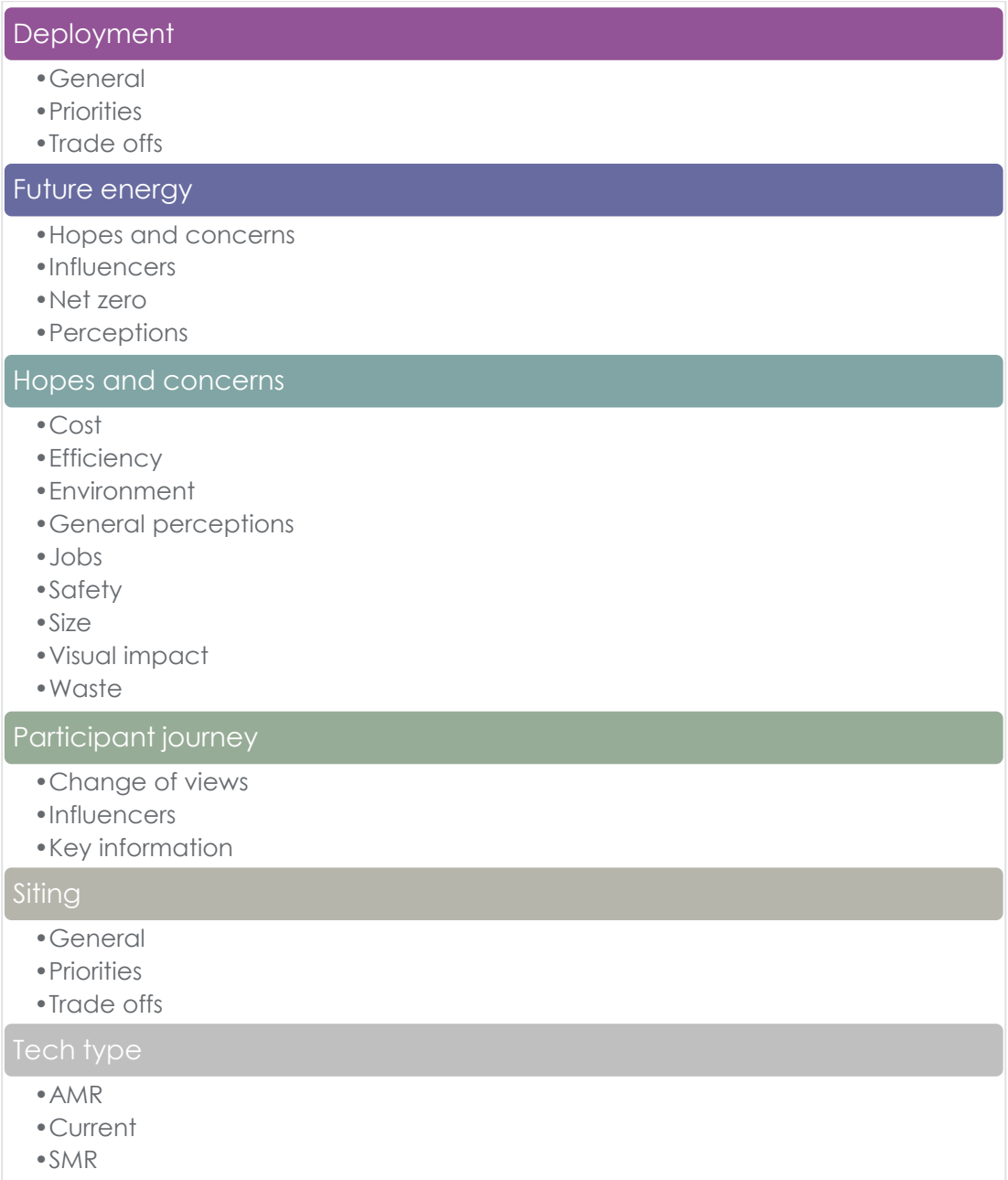
Qualitative data

We considered both stated attitudes and discourse analysis. This means that we collected data regarding the views participants expressed, but also how they expressed them.

We used a thematic coding framework to enable us to identify areas of consensus and divergence, as well as common narratives and perspectives across activities and groups. Once all the data was entered into our bespoke analysis tool, Magpie, analysts reviewed the data to pull out key themes emerging and shape an early thematic coding framework.

The emerging key themes were discussed between analysts and report writers at internal analysis and reporting meetings. The thematic coding framework was further developed in shaping a storyboard report (an outline of headings and key narratives based on the data), and through iterative review and collaborative working among analysts. The final coding framework is presented in Figure 2, where the themes broadly reflect draft chapter structure, and the codes within each reflect broad narratives from the data.

Figure 2: Thematic coding framework



Limitations

While we spoke to a large number of people, the qualitative nature of the discussions means all findings must necessarily be considered to be reflective rather than representative of the views of the population as a whole.

1.8.2. Reporting

The report structure was agreed with the Project Executive and the Oversight Group and amended after the first draft.

Sometimes public dialogue can be reported chronologically, reflecting the developing knowledge-base of participants. However, this can be uninspiring to read and instead we adopted a thematic structure for the report with commentary about how views changed included where relevant. This structure made it easier to communicate the key findings, while demonstrating the value of deliberative dialogue and how increased levels of information may affects people's views.

We also used several reporting techniques (spotlights, take-away messages and participant stories) to break up the text and highlight key findings. There were few differences between locations, and, over the course of the dialogue, participants tended to coalesce around particular views. Where differences were observed they are reported on in the various sections.

We used the data analysis to deliver five key reporting outputs:

1. **Interim report 1**: After the first week of workshops, to support workshop evaluation and refining of week 3.

2. **Interim report 2**: After the third week of workshops, to support workshop evaluation and refining of the final week.

3. **Skeleton report**: After the end of the workshop, Traverse produced a skeleton report and draft chapter with a few interim headlines.

4. **Engagement report:** This is the full report for the dialogue events, including appendices. This report leads with the qualitative analysis of the workshops and online tasks data, supported by quantitative analysis of the online survey data (including reviewing change over time).

5. **Slide deck summary:** A slide deck presenting key findings at a higher level, graphical summary for members of the public.

6. **Infographic:** A high-level, single-page visual summary of the project for members of the public.

All reporting outputs went through robust quality assurance in line with Traverse project quality assurance standards.

2. Appendix B – Oversight Group

2.1. Membership

The Department for Business, Energy and Industrial Strategy (BEIS) convened a group of stakeholders from industry, policy and academia, to provide oversight for the dialogue.

While the members of the group may be affiliated with specific organisations, they were not representing the views of those organisations.

Table 6: Oversight Group members

Name	Organisation
Andrew Walters	Committee on Radioactive Waste Management
Annabelle Lillycrop	Radioactive Waste Management
Emily Leadbetter	National Grid ESO
Marie-Laure Hicks	Royal Academy of Engineering
Phil Macdonald	Sandbag
Prof. Richard Taylor	Dalton Nuclear Institute
Steve Smith	Copeland Borough Council / New Nuclear Local Authorities Group
Steve Thomas	University of Greenwich, Emeritus Professor

2.2. Role

The role of the group was advisory – to oversee the dialogue process and materials, and to help ensure that:

- the dialogue material was comprehensive and balanced; and
- the engagement process was far reaching, accessible, and targeting all relevant audience groups where possible.

The Oversight Group provided comment on background and stimulus materials used in the dialogue, the outputs from the dialogue, and also the communications strategy for the outputs.

2.3. Oversight Group Terms of reference

Department for Business, Energy and Industrial Strategy (BEIS) public dialogue on the development and siting of small and advanced modular reactors.

2.3.1. Introduction

BEIS in collaboration with the Environment Agency, the Office for Nuclear Regulation, Welsh Government, Natural Resources Wales, the National Nuclear Laboratory, and the Nuclear Innovation and Research Office (NIRO) is conducting a public dialogue with both support and funding from Sciencewise. An Oversight Group has been established to oversee the project. The project manager is Lewis Mortimer, Project Lead, BEIS.

The project will take place between January 2020 and July 2021. Due to the Covid-19 pandemic the dialogue events will now be delivered online. Members will be asked to attend formal virtual meetings and give advice on their areas of expertise on an ad hoc basis.

The contractor that will organise, facilitate and analyse the information obtained for the public dialogue is the dialogue contractor, Traverse and the project will be independently evaluated by 3KQ.

The first Oversight Group meeting with the dialogue contractor and the evaluation contractor will be convened 13th February 2020. The last meeting will centre on a presentation of the final report by the dialogue contractor and the 3KQ's evaluation report of the dialogue process.

Every effort will be made to find dates when all Oversight Group members can dial-in to meetings. For key items of business where the group's opinion is sought then those not attending meetings will be invited to submit comments and views in advance and these will be presented to the rest of the group.

2.3.2. Project aims and objectives

To explore participant views on:

- 'small' nuclear in relation to 'big' nuclear;
- advanced nuclear technologies in relation to conventional nuclear;
- advanced nuclear in the context of mitigating climate change;
- siting and deployment of advanced nuclear;
- regulation of advanced nuclear technologies;
- potential uses of advanced nuclear (electricity generation, industrial heat, CHP etc); and
- potential features and/or benefits which would help communities support advanced nuclear development.

2.3.3. Role of the Oversight Group

It is expected that the Oversight Group will comment on the following:

- key questions to be addressed;
- background/stimulus materials (ensuring it is comprehensive, balanced and neutral and accessible to a lay audience);
- communications strategy; and
- outputs from the dialogue exercises including written reports.

In fulfilling its remit to provide independent advice, Oversight Group members will maintain an independent position on Advanced Nuclear Technologies and the UK energy mix more generally. Individual views expressed do not represent those of the whole group or of the organisations represented.

The Oversight Group will focus advice on:

Impartiality

- Ensuring that the dialogue process is balanced and perceived as such by the outside world.
- Supporting the overall process and ensuring that the right questions have been asked at the right time and that the right people are in the room.

Support for on the project process

- Helping to develop the criteria on which the success of the project is going to be judged. OG members are often members of key organisations who will use the outputs of a dialogue, so help from them on what success "looks like" is useful.
- Acting as a sounding board for potential activities or decisions about the process or content.
- Giving advice when things get challenging for the project manager – dealing with uncertainties, providing independence where needed, advice on finding and contacting the right people quickly.

Dissemination role

- Providing informed input to and feedback from the dialogue throughout the dialogue from the set-up stage through to the dissemination of findings and impact of outcomes.
- Members are key parties or stakeholders, so when it comes to dissemination of the results of a dialogue, they often own or can influence policy change in relevant institutions.
- Providing a credible independent voice for the process, if needed – quotations explaining the integrity of the process can be provided to media; in the case of controversy, media interviews could even be arranged.

The role of the Oversight Group is advisory.

2.3.4. Membership and chairing

The group will be chaired by Professor Richard Taylor.

Other members of the group include (as of 15/10/2020):

- Independent advice from Energy Sector – Emily Leadbetter, National Grid ESO
- Independent advice from Academia – Professor Richard Taylor, Dalton Nuclear Institute & Professor Stephen Thomas, Emeritus Professor of Energy Policy, University of Greenwich
- Independent advice from a Local Authority Group – Steve Smith, Copeland Borough Council & NNLAG
- Independent advice from an NGO – Phil Macdonald, Sandbag
- Independent advice on Radioactive Waste Management – Andrew Walters, CoRWM & Annabelle Lillycrop, RWM
- Independent advice on science communication – Marie-Laure Hicks, Royal Academy of Engineering

BEIS is responsible for providing the secretariat to support the Oversight Group.

2.3.5. Quorum

A minimum of 3 people are required for the meeting to be quorate.

2.3.6. Frequency of meetings

It is expected that the majority of meetings will be virtual. The Oversight Group will determine how many meetings are required but it is likely that at least one or two meetings will be required before the dialogue events which are due to be held in January/February plus at least one meeting after the draft report has been completed. The Oversight Group may review and stimulus approve materials at a meeting or by email or other communications.

Members may be expected to comment on other project papers in between meetings.

Ad-hoc meetings may be held with the agreement of the Chair as and when required. Meetings may, exceptionally, be cancelled by the Chair.

2.3.7. Transparency

Oversight Group meetings will be minuted in terms of key decisions and action points; minutes will be sent to members after each meeting. Agreed minutes may be published or made available as part of final project reporting.

3. Appendix C – Project Board

The Project Board included a range of stakeholders with a vested interest in the project and its outcomes. They supported with ensuring accuracy of materials, in some cases were called on to present specific topics in the workshops (Appendix E – Specialists), and advised on dissemination.

Table 7: Project Board members

Name	Organisation
Caroline Richards	Environment Agency
Colette Grundy	Environment Agency (at time of inception) National Nuclear Laboratory (at time of report publication)
Andrew Pynn	Environment Agency
Mike Drury	National Nuclear Laboratory
Adrian Bull	National Nuclear Laboratory
Laurence Smith	Welsh Government
Wyn Roberts	Welsh Government
Philip Rogers	Nuclear Innovation and Research Office
Jean Taylor	Office for Nuclear Regulation
Sarah Brown	Office for Nuclear Regulation
Alasdair Harper	BEIS, Civil Nuclear and Resilience
Nicholas Fidoe	BEIS, Science & Innovation for Climate and Energy
Miguel Trenkel-Lopez	BEIS, Science & Innovation for Climate and Energy
Fiona Abbott	Natural Resources Wales

4. Appendix D – Project Executive

The Project Executive was the team of individuals involved in regular communications and responsible for day-to-day project management.

This group met weekly or fortnightly (depending on the project phase) to forward-plan, reflect on recent progress, assess project risks, reflect on timelines and milestones, and make decisions.

Table 8: Project Executive members

Name	Organisation	Project Role
Amelie Trépass	Traverse	Project Director
Skye McCool	Traverse	Project Manager
Lewis Mortimer	BEIS	Project Lead
Eleanor Perkins	BEIS	Lead support
Philippa Lang	UKRI	Public Engagement Strategy and Policy
Steve Robinson	Sciencewise	Deliberative Engagement Specialist
Diane Beddoes	Sciencewise	Head of Evaluation
Laura Premack	3KQ	Evaluator
Rhuari Bennett	3KQ	Evaluator

5. Appendix E – Specialists

Sciencewise dialogues involve members of the public interacting with subject-matter specialists to learn and explore together. As such, a range of industry experts, academics, and representatives from other relevant bodies were invited to:

- participate in Q&A sessions in break-out discussions during Saturday workshops; and/or
- present at plenary information sessions, cocreating their presentations with engagement specialists at Traverse.

Specialists were selected based on their area of expertise aligning with the requirements for the dialogue sessions, as well as the approval of the project's Oversight Group.

Table 9: Specialists that participated in the dialogue

Name	Organisation	Participation
Ed Reed	Cornwall Insight	Presentation: Workshop 1
Rob Nickerson	National Grid ESO	Presentation: Workshop 1
Robert Gibson	National Grid ESO	Q&A: Workshop 2
Jeremy Gordon	Fluent in Energy	Q&A: Workshop 2 Q&A: Workshop 4
Scott Milne	Energy Systems Catapult	Q&A: Workshop 2 Q&A: Workshop 4
Greg Butler	Dalton Nuclear Institute	Presentation: Workshop 3 Q&A: Workshop 4
Juan Matthews	Dalton Nuclear Institute	Presentation: Workshop 3 Q&A: Workshop 4
Jean Taylor	Office for Nuclear Regulation	Presentation: Workshop 3
Andrew Pynn	Environment Agency	Presentation: Workshop 3 Q&A: Workshop 4
Fiona Abbott	Natural Resources Wales	Presentation: Workshop 3

Cllr David Moore	Copeland Borough Council	Presentation: Workshop 3 Q&A in Deployment Activity: Workshop 6
David Smeatham	Nuclear Innovation and Research Office	Supporting: Workshop 3 Q&A: Workshop 4
Jo deBank	Office for Nuclear Regulation	Q&A: Workshop 4
Claire Corkhill	Committee on Radioactive Waste Management	Q&A: Workshop 4
Kirsty Gogan	Energy for Humanity	Q&A: Workshop 4
Steve Thomas	University of Greenwich	Q&A: Workshop 4 Presentation co-author: Workshop 5
Phil Rogers	Nuclear Innovation and Research Office	Q&A: Workshop 4 Q&A in Deployment Activity: Workshop 6
Mike Drury	National Nuclear Laboratory	Presentation: Workshop 5
Adrian Bull	National Nuclear Laboratory	Presentation co-author: Workshop 5
Richard Taylor	Dalton Nuclear Institute	Presentation: Workshop 5
Colette Grundy	National Nuclear Laboratory	Q&A in Deployment Activity: Workshop 6
Greg Black	Environment Agency	Q&A in Deployment Activity: Workshop 6
Alasdair Harper	BEIS	Q&A in Messages Activity: Workshop 6
Lewis Mortimer	BEIS	Q&A in Messages Activity: Workshop 6
Wyn Roberts	Welsh Government	Q&A in Messages Activity: Workshop 6

5.1. Briefing note provided in addition to live briefing session

5.1.1. About the project

The Department for Business, Energy and Industrial Strategy (BEIS), working with Sciencewise, has commissioned a public dialogue project to explore public views towards the siting and deployment of advanced nuclear technologies (ANTs) in order to help policy development. In this project advanced nuclear technologies will be referred to as **modular nuclear technologies**.

In particular this project seeks to:

- understand participants' perceptions, hopes and concerns about the development and use of modular nuclear technologies;
- explore the underlying influences on those views of modular nuclear technologies, and what might make participants more or less open to the use of them; and
- understand participants' priorities when considering how modular nuclear technologies might be sited and how modular nuclear technologies could be used.

Public dialogue is a process during which members of the public interact with scientists, stakeholders (for example, research funders, businesses and pressure groups) and policy makers to deliberate on issues relevant to future policy decisions. Such dialogue is normally used to feed directly into the policy-making process; effectively as part of the evidence base alongside other types of evidence.

Crucial to this process for this project, is for the public participants to have the opportunity to interact with specialists in the field or those with lived experience of existing nuclear technologies. Moreover, we are seeking to provide a range of different perspectives on how advanced nuclear technologies could be applied in the context of the UK commitment to Net Zero by 2050. This means we are looking for a range of people to take part in the online workshops in January and February 2021.

We are inviting quite a few specialists to get involved. If you know of anybody who you think really should be involved please do get in touch with Ellie Perkins (Policy Advisor, Department for Business, Energy & Industrial Strategy.

If you are interested in attending please send your availability as soon as possible to Ellie Perkins.

We very much hope you are available to attend, and we look forward to working with you.

5.1.2. Project timetable

The project will be held online over a total of 6 weeks. It has been spread out to give participants time to get up to speed with some of the complexities around nuclear technologies without getting 'Zoom fatigue'. The research schedule is designed to take the participants on a voyage of discovery so that on the final day they are able to debate issues on siting and deployment of advanced technologies in an informed way.

We request that you log on 20-30 minutes early to each session you participate in.

The broad outline is as follows:

Week 1	Workshop 1	Tuesday 12 January 2021 6.30pm – 8.00pm
	Workshop 2	Saturday 16 January 2021 10:00am – 11.30am
Week 2	Online activities only	
Week 3	Workshop 3	Tuesday 26 January 2021 6.30pm – 8.00pm
	Workshop 4	Saturday 30 January 2021 10:00am – 11.30am
Week 4	Online activities only	
Week 5	Workshop 5	Tuesday 9 February 2021 6.30pm – 8.00pm
	Workshop 6	Saturday 13 February 2021 10.00am – 12.00pm AND 1.00pm - 3.00pm
Week 6	Closing survey	

5.1.3. Role and purpose of specialists in public dialogue

The attendance of specialists is crucial to providing citizens with access to information about advanced nuclear technologies in an accessible and engaging way, as well as exposing them to a range of perspectives on the technology.

There are different levels of involvement you might have with the project:

- Guest speaker – presenting 1 of the 6 presentations on a range of topics. We will provide high-level suggestions of key information the presentation should convey, and work with you on the materials to ensure they are accessible for participants and are consistent in style across the sessions. You would be expected to develop the content for the presentation, and consider feedback provided by the project's oversight groups. You will give the presentation in the allotted online plenary sessions. The plenary sessions will take place on a Tuesday evening.
- Group sessions – if you have been asked to take part in the group sessions you will be asked to rotate between the online break-out groups or 'rooms' and to join in the discussions where appropriate to help answer any questions participants might have or to highlight where their thinking might or might not work, for example. These sessions will take place on a Saturday. If you were available to listen in to the plenary session on the previous Tuesday to hear the presentations that they are reacting to that would be useful but not essential. We would also share the information that participants had received up to that point.
- Pre-recorded Zoom interviews with Traverse – it may be useful to use shorter snippets of information in the break-out sessions, and a pre-recorded Zoom interview can be very effective in ensuring that all participants get exactly the same information. These would be played either during live sessions or added to the online community platform (Recollective).
- Online – there will also be the opportunity to view the discussion boards and the tasks participants do on the online platform. This will also give you the opportunity to answer participants' questions online, although not necessarily in real time.

This process is invaluable for participants to ensure they have a good understanding of the topic, to correct any misunderstandings and clear up anything they are confused about.

It also can be a valuable and rewarding process for specialists. It gives you the opportunity to understand public attitudes and perceptions around advanced nuclear technologies in the moment, without needing to wait for publication of the results.

5.1.4. Guidance for specialists

Below we have also provided some general guidance for interacting with participants in the context of deliberative dialogues. We will also hold **a briefing session for you at 10-11am on Tuesday 5th January 2021,** in which we will run through the schedule and your role. This will help to ensure consistency across all contributions and to eliminate any risk of bias.

These dialogues follow the Sciencewise Guiding Principles, in that they take place between the general public, policy makers, and scientists, providing participants with information and views from a range of perspectives. Participants are not expected to become experts in the technology, but bring their own life experiences to bear on its social and ethical implications.

The Sciencewise Guiding Principles recommend that relevant stakeholders are involved at appropriate times in the oversight of the dialogue process, including the production of materials to inform the public participants. It clearly outlines that:

- the dialogue be conducted fairly with no in-built bias; non-confrontational, with no faction allowed to dominate; all participants treated respectfully; and all participants enabled to understand and question others' claims and knowledge; and
- participants are provided with information and views from a range of perspectives, and encouraged to access information from other sources, to enable participants to be adequately informed.

A specialist can explain their organisation's views on advanced nuclear technologies. However, it is important not to communicate your personal views on the issues being raised in discussions, either verbally or with facial expressions or body language.

When joining in discussions in small groups it is important:

- to be aware that the facilitator has a specific task, and a series of agreed questions that relate to the project's overall research questions;
- to cooperate with the facilitator in enabling participant deliberation – if you do wish to ask questions, please try and keep them in line with the flow of the discussion; and
- try not to get involved in a question and answer back-and-forth with participants – they should be talking to each other and exploring their own and each other's views on the facilitator's questions.

You may hear opinions that you do not agree with, please allow participants to explore their ideas and share their opinions and deliberate the issues.

- However, where these are based on misconceptions, or a clear misunderstanding of what they have been told please work with the facilitator to reiterate the facts.
- If there is a point arising which is relevant to the project and you would like to explore further again please highlight this to the facilitator (using the Zoom icons or chat function) and the facilitator will explore the issue in more detail for you if time permits.
- It is important that you do not get defensive if participants are disparaging of the technology or of your organisation's position, or feel the need to protect a concept as this may skew the deliberation.

- Similarly, you should not echo or support any views expressed by participants.

5.1.5. Confidentiality

While the project report will be published in the public domain, you are asked to not share any information about the project or your participation in it prior to that. There will be a requirement for specialists to keep discussions and outputs from the workshop, content of the workshops (both stimulus/advanced nuclear technologies experiences and participant inputs) and early iterations of project outputs (before publication) confidential. If you are approached by the media about this project, please contact BEIS before responding.

While feedback in the workshop will be captured, the full discussion will not be minuted or attributed.

6. Appendix F – Materials

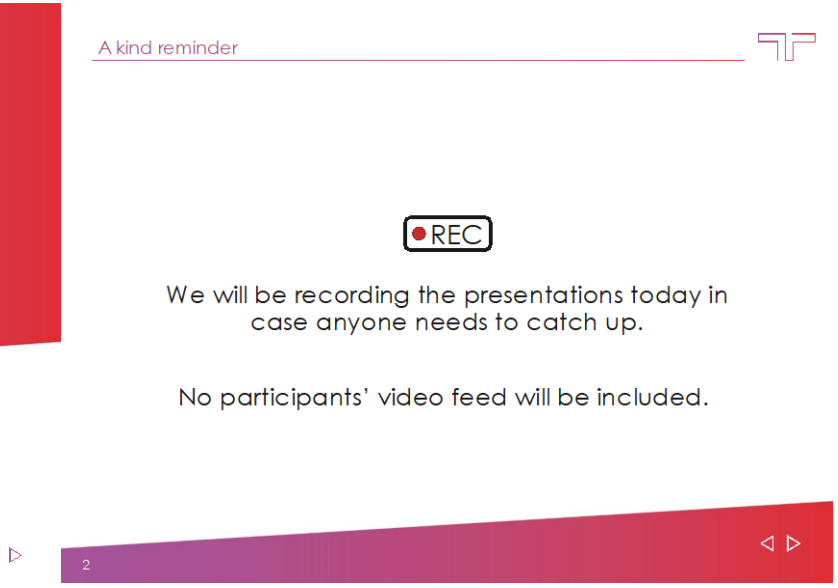
6.1. Slide packs from workshops

Participants were shown presentations at some events during the process. These were generally led by facilitators from the dialogue delivery contractor (Traverse), and sometimes included short presentations and Q&A sessions with specialists.

The slides shown at each of these sessions are below.

6.1.1. Big picture of energy – Workshop 1

At this first live session, on Tuesday 12 January 2021, participants were introduced to the dialogue process, and to the first of three key topics: the big picture of energy in the UK.



Welcome packs

Information in your welcome packs

- About the project
- Information and contacts
- Timetable
- What will be happening?
- How will it work in Welsh?
- Using Recollective
- Using Zoom
- Meet the team

3

Welcome

Who is in the room?

You A cross-section of about 80 people from Porthmadog, Reading, Scunthorpe and other areas around the Humber Estuary.

Traverse An independent research and engagement organisation. Our team tonight is
- *Amélie (Lead Facilitator)*
- *Skye (Tech Support)*

BEIS The Department for Business, Energy and Industrial Strategy. They are here to listen to your feedback and note down your questions.
- *Lewis Mortimer (Senior Policy Advisor, Advanced Nuclear Innovation)*
- *Ellie Perkins (Policy Advisor, Advanced Nuclear Innovation)*
- *Alasdair Harper (Head of Strategy, Advanced Nuclear Innovation)*

Sciencewise UK Research & Innovation's Sciencewise programme. They are here to listen to your feedback and note down your questions.
- *Steve Robinson (Dialogue and Engagement Specialist)*

Specialists
- Ed Reed, Cornwall Insight
- Rob Nickerson, National Grid Electricity System Operator

4

Welcome

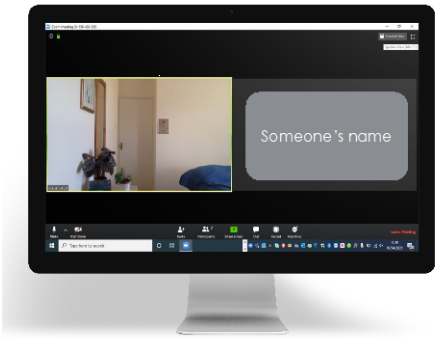
Ways of working

- Respect other people's views
- Make sure everyone has a chance to contribute
- Switch off distractions
- Have your video feed on
- Mute yourself unless talking
- Ask questions
- Pop questions into the chat window, or ask as we go

5

Welcome - Using Zoom

Zoom etiquette



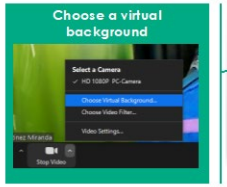
- Don't worry about children, pets, or backgrounds!
- Tell us if there's a problem
- Use the chat function for comments and questions

6

Welcome - Using Zoom

Zoom etiquette

- If you are concerned about your privacy or domestic space on camera, consider using a virtual background instead of turning your camera off.
- Choose one from the default selection, and make sure it is appropriate and does not distract other participants.



8

The dialogue process – what will happen on this project

Topic	Week	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
The big picture of energy	1	Baseline survey	**Live 1: Evening plenary**	Online tasks			Live 2: Morning groups	Online tasks
	2	Online tasks						
The big picture of nuclear	3	Online tasks	Live 3: Evening plenary	Online tasks			Live 4: Morning groups	Online tasks
	4	Online tasks						
Modular Nuclear technologies	5	Online tasks	Live 5: Evening plenary	Online tasks			Live 6: 2 group sessions	Endline survey
	6	Endline survey						

9

The dialogue process – what will happen this week?

This week

- Monday: Baseline Survey
- **Tuesday: The big picture of energy (1/2)**
- Wednesday – Friday: Online Tasks
- Saturday: The big picture of energy (2/2)
- Sunday: Online Tasks

10

Agenda for the session

Time	Activity
18:30 – 18:45	Welcome
18:45 – 18:55	Setting the scene
18:55 – 19:15	Current energy landscape of the UK
19:15 – 19:25	Break
19:25 – 19:45	The future of energy in the UK
19:45 – 19:55	Online Platform Tour
19:55 – 20:00	Close

11

TRAVERSE

Setting the scene

Setting the scene

Context and topic

- This dialogue was commissioned by the **Department for Business, Energy and Industrial Strategy (BEIS)** and **Partners**
- We want to better understand public attitudes towards **modular nuclear technologies**.
- Relevant to UK policy to tackle climate change whilst ensuring secure and affordable energy supplies.
- Modular Nuclear Technologies, sometimes called Advanced Nuclear Technologies:
  - Smaller than current reactors
  - Modular
  - 'Beyond the grid' potential
  - Some use different fuels or coolants
- Prime Minister announced £385m funding / Energy White Paper

Department for Business, Energy & Industrial Strategy
Llywodraeth Cymru Welsh Government
niro
National Nuclear Laboratory
Environment Agency
Office for Nuclear Regulation
Cyfoeth Naturiol Cymru Natural Resources Wales

13

Setting the scene

Public Dialogue

- **Public dialogue** provides in-depth insight into citizens' views, concerns and aspirations on issues relating to science and technology
- Members of the public interact with scientists, stakeholders and policy makers to think through and deliberate on issues relevant to future policy decisions.
- **Sciencewise** is a public engagement programme that helps policy makers to develop socially informed policy with an emphasis on science and technology. Sciencewise has co-funded this public dialogue.
- You can learn more about it at sciencewise.org.uk.
- **Traverse** is an independent research and engagement organisation. They are here to guide you through a learning and discussion process to explore modular nuclear technologies and what you think and feel about it.
- **Oversight** - Independent advice from representatives from academia, energy sector, local authorities, radioactive waste specialists, Non-Governmental Organisations and science communication specialists. Also have ongoing project evaluation and learning from independent engagement specialists.
- Dialogues designed to be *comprehensive*, *balanced* and *accessible*

14

Setting the scene

What are the objectives of this dialogue?

1. To understand your perceptions, hopes and concerns about the development of modular nuclear technologies, in the context of mitigating climate change.
2. To explore your views on modular nuclear technologies and understand how you feel about their different potential uses.
3. To understand your priorities when considering how modular nuclear technologies might be sited and how they could be used.

15

Setting the scene

How will we use the outcomes?

- To inform our, and our partners', policies on modular nuclear technologies. This might include:
  - our approach to siting reactors
  - where we might focus Research and Development investment
  - our policies for ongoing public dialogue and engagements in the future

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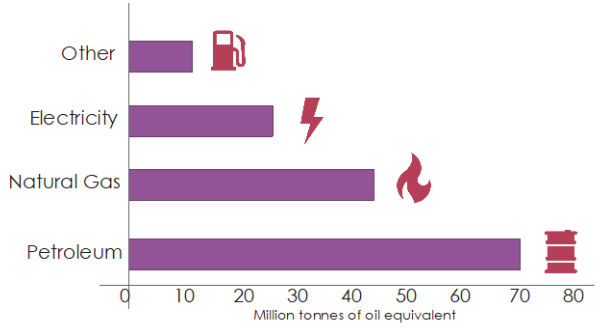
TRAVERSE

Current energy landscape of the UK

Current energy landscape of the UK

Energy Consumption by Fuel



Source: Digest of UK energy statistics 2019

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Current energy landscape of the UK

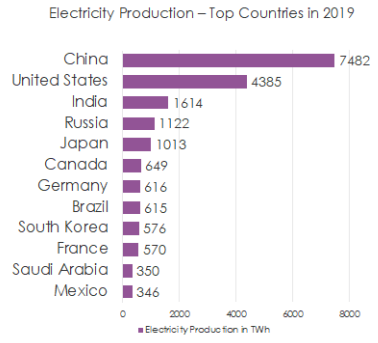
Electricity Production and Use

The UK produced around **324 TWh** of electricity in 2019

How much electricity is a **TeraWatt** hour?

1 kiloWatt -1000 Watt hour
1 megaWatt - 1,000,000 Watt hour
1 gigaWatt - 1,000,000,000 Watt hour
1 teraWatt - 1,000,000,000,000 Watt hour

A modern LED light in your house requires around 5 Watts to power it for a whole hour. So a TW is enough for 200,000,000,000 lights for 1 hour.



https://yearbook.enerdata.net/electricity/world-electricity-production-statistics.html

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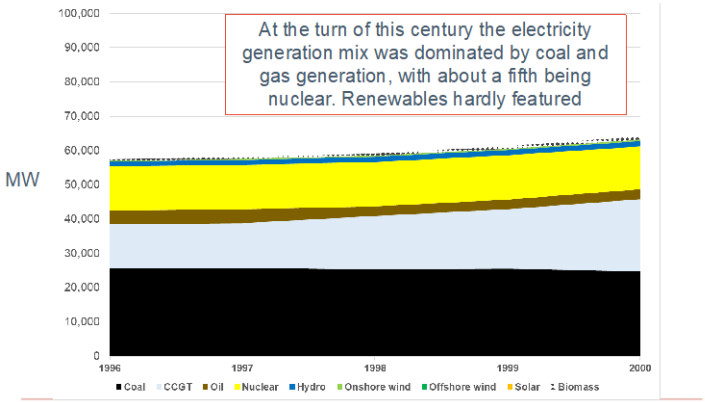
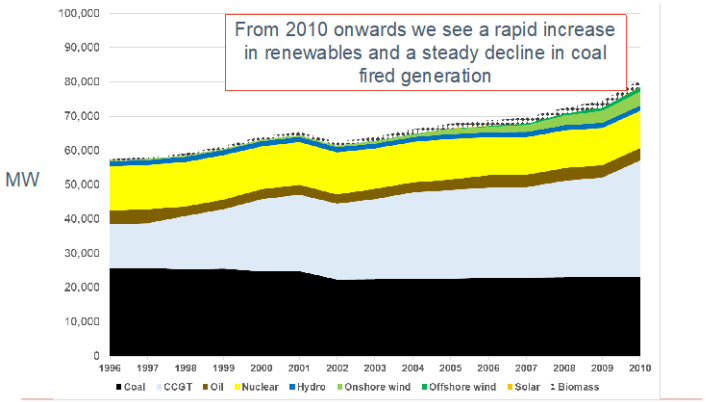
Electricity generation mix



CORNWALL INSIGHT www.cornwall-insight.com

20

Electricity generation mix



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Current energy landscape of the UK

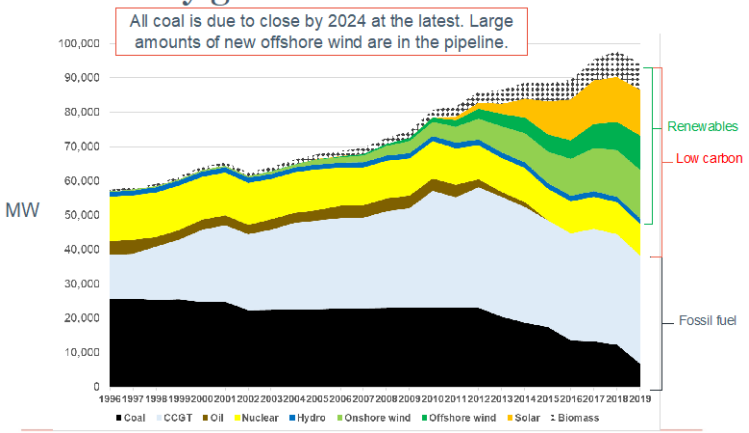
What do you think is our biggest electricity source nowadays?

- Gas
- Renewables
- Nuclear
- Coal
- Other

Data from Digest of UK Energy Statistics (DUKES)

22

Electricity generation mix



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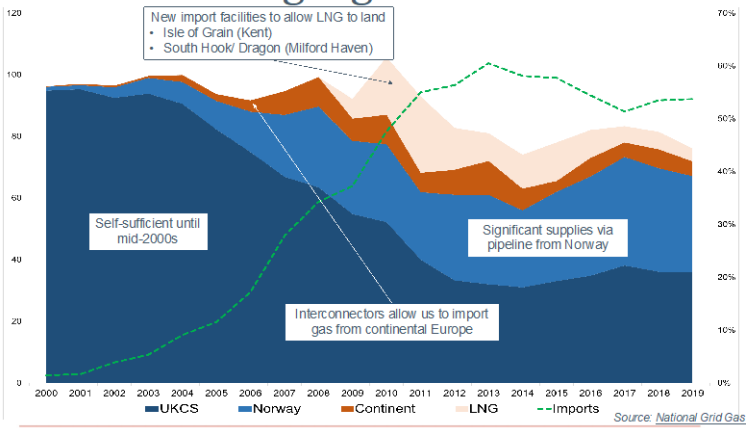
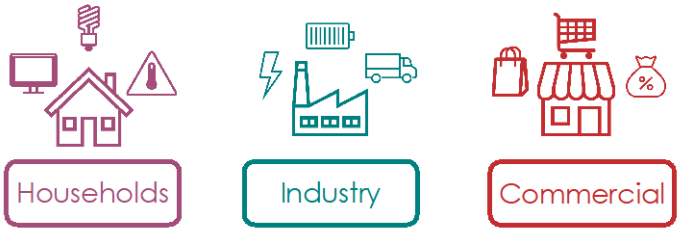
Where do we get gas from?



Source: National Grid Gas

Who do you think is the largest electricity consumer?

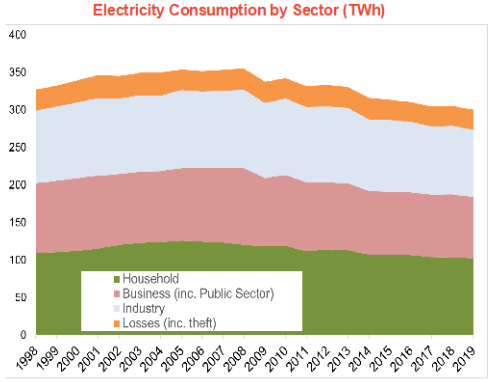
- Commercial (Businesses, Public Sector)
- Industry
- Households



Data from Digest of UK Energy Statistics (DUKES)

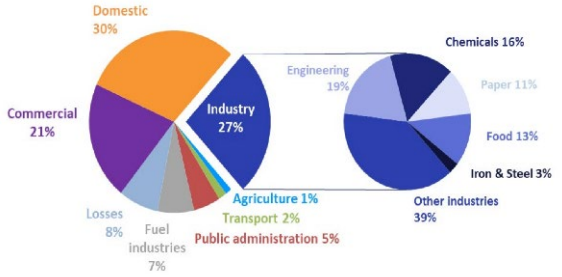
Electricity usage

- Consumption peaked in 2005
- Energy efficiency measures have helped reduce our consumption
  - Much more efficient electrical appliances
  - Industry have invested in efficient processes



Source: DUKES, 5. 2

Who uses electricity in the UK?



Total demand: 345.6 TWh
Industry demand: 91.6 TWh

Current energy landscape of the UK

Do you know how much electricity is consumed in your household in a year? Compare it with the yearly average in the UK:

- Mid terrace (2779 kWh/year)
- Flat (2829 kWh /year)
- End terrace (3442 kWh /year)
- Semi Detached (3847 kWh/year)
- Bungalow (3886 kWh /year)
- Detached House (4153 kWh/year)

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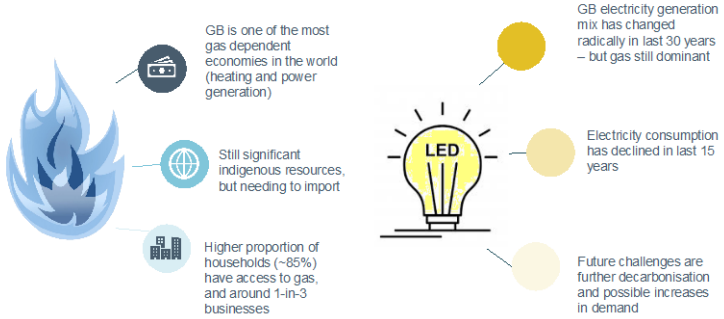
Key points



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Time for questions

TRAVERSE

The future of energy in the UK

The future of energy in the UK

What is net-zero and how to achieve it?

- The concept of net-zero refers to emissions of carbon dioxide (CO_2) into the atmosphere. CO_2 is a greenhouse gas which contributes to climate change – also referred to as global warming.
- For the UK to achieve net-zero would require us to reduce our CO_2 emissions significantly and would likely require a combination of approaches.

- Renewable Energy
- Nuclear energy
- Planting trees and restoring wetlands
- Energy efficiency and new technology
- Carbon Capture, Usage and Storage
- Behaviour change

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The future of energy in the UK

UK policy to achieve net zero

- Advancing Offshore Wind
- Driving the Growth of Low Carbon Hydrogen
- Delivering New and Advanced Nuclear Power
- Accelerating the Shift to Zero Emission Vehicles
- Green Public Transport, Cycling and Walking
- Jet Zero and Green Ships
- Greener Buildings
- Investing in Carbon Capture, Usage and Storage
- Protecting Our Natural Environment
- Green Finance and Innovation

https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945899/201216_BEIS_EWP_Command_Paper_Accessible.pdf

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The future of energy in the UK

How will the supply of electricity change?

- We will need a big increase in electricity supply. This is because we expect higher demand for electricity as we stop using fossil fuels.
- The electricity supply needs to be low carbon or negative carbon.
- As there are many ways to achieve net zero it is common to explore a range of options, often called "scenarios".

https://www.nationalgrideso.com/future-energy/future-energy-scenarios

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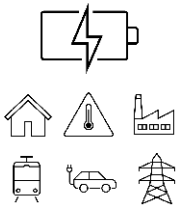
The future of energy in the UK

Can you guess some changes that we can expect in the future, that might affect our use of energy?

- Electrification of transport, such as trains and electric cars
- Electrification of heating for houses and businesses
- Increase in domestic electricity demand
- Increase in industrial and commercial electricity demand

⇩

- General increase in electricity demand



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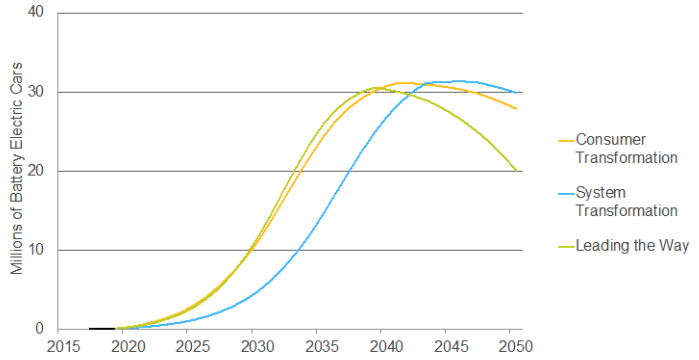
The future of energy in the UK

We expect a switch to battery electric cars



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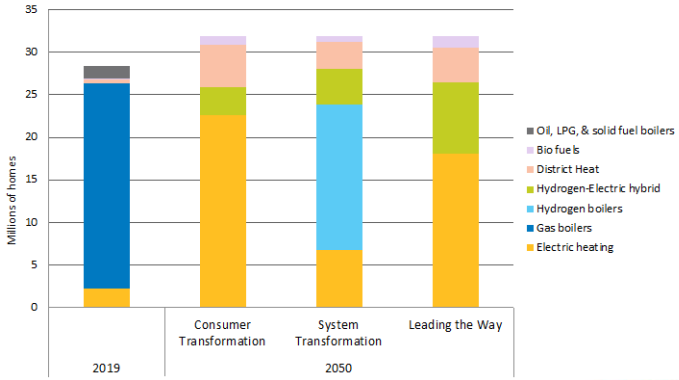
The future of energy in the UK

How we heat our homes will change



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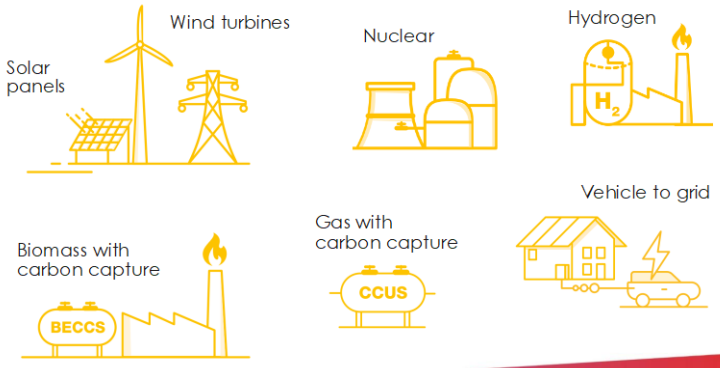
The future of energy in the UK

Low or negative carbon electricity supply



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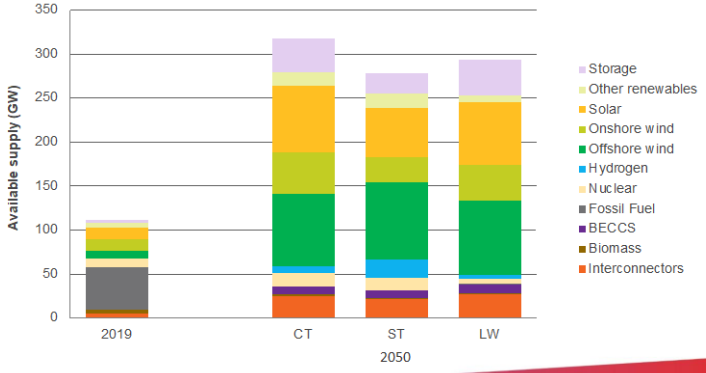
The future of energy in the UK

Growth in electricity supply



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TRAVERSE

Time for questions

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TRAVERSE *Online Platform Tour*

Thank you.

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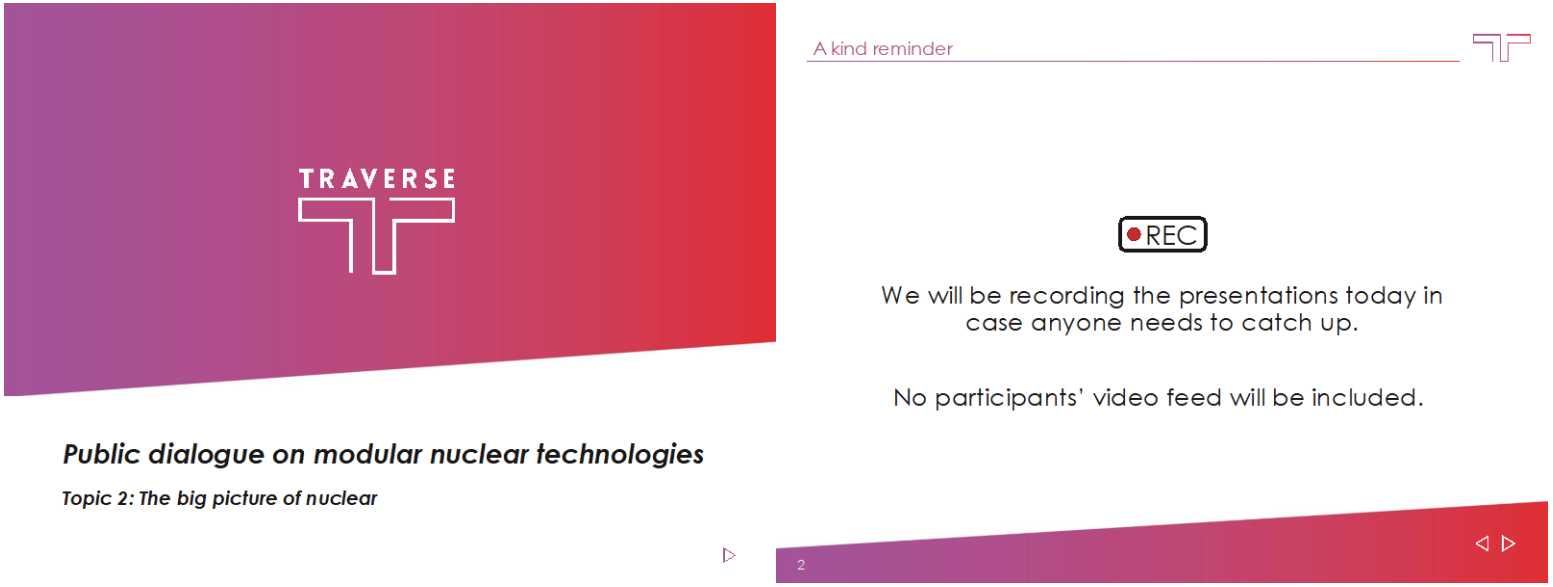
6.1.2. Big picture of nuclear – Workshop 3

At this third live event, on Tuesday 26 January 2021, participants were introduced to the second key theme: the big picture of nuclear.

Specialists from the Dalton Nuclear Institute, the Office for Nuclear Regulation, Natural Resources Wales, Copeland Borough Council, and the Nuclear Innovation and Research Office gave brief presentations and answered participant questions in a Q&A session.



Welcome

Who is in the room?

You A cross-section of around 75 people from in and around Porthmadog, Reading, Scunthorpe and the Humber Estuary

Traverse An independent research and engagement organisation. Our team tonight is *Amelie & Skye*

BEIS The Department for Business, Energy and Industrial Strategy. They are here to listen to your feedback and note down your questions. *Alasdair Harper, Lewis Mortimer, Ellie Perkins*

Sciencewise UK Research & Innovation's Sciencewise programme. They are here to listen to your feedback and note down your questions. *Steve Robinson*

3KQ They are here to provide external oversight of these dialogues and listen to your feedback. *Laura Premack*

3

Welcome

Who is in the room?

Specialists **Professors Juan Matthews and Gregg Butler**, Dalton Nuclear Institute, University of Manchester

Jean Taylor, Office for Nuclear Regulation, Communications Team
Andy Pynn, Environment Agency, Nuclear Specialist
Councillor David Moore, Copeland Local Authority

Fiona Abbott, Natural Resources Wales, Radioactivity & Industry Policy Team Leader
David Smeatham, Nuclear Innovation and Research Office (NIRO)

4

Welcome

Ways of working

- Respect other people's views
- Make sure everyone has a chance to contribute
- Switch off distractions
- Mute yourself unless talking
- Ask questions
- Pop questions into the chat window

5

Setting the scene

What are the objectives of this dialogue?

1. To understand your perceptions, hopes and concerns about the development of modular nuclear technologies, in the context of mitigating climate change.
2. To explore your views on modular nuclear technologies and understand how you feel about their different potential uses.
3. To understand your priorities when considering how modular nuclear technologies might be sited and how they could be used.

6

Welcome

Topic	Week	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
The big picture of energy	1	Baseline survey	Live 1: Evening plenary	Online tasks			Live 2: Morning groups	Online tasks
	2	Online tasks						
The big picture of nuclear	3	Online tasks	**Live 3: Evening plenary**	Online tasks			Live 4: Morning groups	Online tasks
	4	Online tasks						
Modular Nuclear technologies	5	Online tasks	Live 5: Evening plenary	Online tasks			Live 6: 2 group sessions	Endline survey
	6	Endline survey						

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Welcome

This week

- Monday: Online Tasks
- **Tuesday: The big picture of nuclear (1/2)**
- Wednesday – Friday: Online Tasks
- Saturday: The big picture of nuclear (2/2)
- Sunday: Online Tasks

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Welcome

Agenda

Time	Activity
18:30	Welcome
	An introduction to nuclear energy technologies
	Break
	An introduction to the regulation of nuclear energy technologies
20:00	Close

9

Welcome

Types and terminology

- There are different types of nuclear technology.
- Because modular nuclear technologies are still quite young, different names are used across the world.
- Some of those names can be seen as 'loaded' – they can influence how we feel.
- We are using the categories and names below.
- A list of words is on Recollective to help you do your own research.

Current nuclear technology

Modular nuclear technologies

Small modular reactors

Next generation reactors

TRAVERSE

The story of nuclear

An introduction to nuclear energy technologies

The story of nuclear

What is nuclear energy?

- The energy stored inside an atom by the forces that hold it together.
- That energy can be released by **splitting** (***fissioning***) something like uranium into two smaller parts.
  - This is the process used in all today's nuclear energy production.
- Energy can also be released by **combining** (***fusing***) light atoms.
  - This is the energy that lights the sun.
- In both cases the nuclear energy can be captured as heat and used to generate electricity, in a similar way to burning wood or fossil fuels.

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The story of nuclear

Timeline of nuclear energy

1910 | 1940 | 1950

UK

- Ernest Rutherford discovers the atomic nucleus 1910 Manchester
- **1940-42:** Work on nuclear energy starts in the UK
- **1942-45:** US and UK develop the atomic bomb
- **1946:** UK nuclear programme was started – interest in weapons and civil use

Global

- **1938:** First experimental demonstration of fission in Germany
- Recognition that fission allows the release of energy from the atomic nucleus

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The story of nuclear

Timeline of nuclear energy

1950 | 1970 | 1990 | 2010

UK

- The world's first full-scale nuclear power station, Calder Hall 1956.
- UK builds 17 power stations based on gas cooled reactors
- UK does pioneering work on nuclear technologies for next generation reactors
- Sizewell B, UK's only water-cooled reactor
- No new nuclear stations and reduction of R&D due to cheap North Sea gas and privatisation of the electricity industry

Global

- "Atoms for Peace" Conference,
- Three Mile Island accident 1978
- Chernobyl accident 1986
- Expansion of nuclear energy globally mainly based on USA water-cooled reactor technology
- Fukushima accident 2011

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The story of nuclear

Where we are today

Climate change agenda drives need to explore nuclear as part of the energy toolkit

New technologies being developed to overcome issues on expensive and complex construction and broaden the role of nuclear beyond electricity

UK Government White Paper of December 2020 signals major rise in priority for nuclear energy in the UK

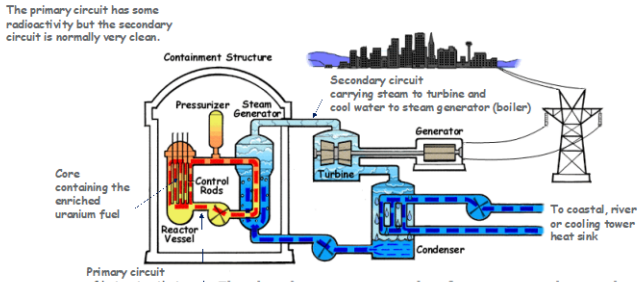
Construction of a new large nuclear power station has started at Hinkley Point C

Plans for a similar large station at Sizewell C

15

The story of nuclear

How nuclear works



The basic components of an example nuclear power plant, in this case a PWR like Sizewell B

PWR = pressurised water reactor (the water is pressurised so that it doesn't boil in the reactor)

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The story of nuclear

Technologies now and in the future

Current nuclear technology

Large scale nuclear reactors

Currently providing 18% of UK's electricity

Last power station completed 1990s

Next station approved and in construction

Modular nuclear technology

Small modular reactors (SMRs)

Next generation reactors

Under development

Future technologies being considered

The story of nuclear

Do we need nuclear energy?

- Reaching net zero targets is going to be difficult.
- All energy sources have benefits and challenges:
  - e.g., renewable energy is intermittent and nuclear power needs to be cheaper and become more flexible on meeting demand
- Generating electricity is only part of the solution –
  - energy storage both short and long term
  - ways of making artificial fuels to replace gas for heating and fuels for transport
  - to capture carbon to compensate for the gases emitted by low carbon energy sources
- Nuclear energy has the potential to support renewables to get the job done – it will be difficult to meet targets without it

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The story of nuclear

Nuclear energy: the advantages

- All forms of electricity generation release some greenhouse gases, even renewables.
  - This comes from the CO_2 produced in mining, processing and manufacturing materials.
- Nuclear power is one of the lowest emitters of CO_2 similar to that of wind power and a lot lower than solar power.
- These emissions will reduce as more of the supply chain becomes carbon emission free.
- Nuclear power operates continuously to meet demand
- Nuclear power is a concentrated energy source (1g uranium is equivalent to 25 tonnes of coal)
  - It takes up less land and the fuel supply can be stored easily.
- Uranium resources can last for another 100 years (at least) and after that newer technologies can enable "waste" uranium, used fuel and thorium to provide power for thousands of years

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The story of nuclear

Power systems: upsides and downsides

ALL low carbon energy generation methods have advantages and challenges

- Onshore wind – intermittent (only generates when the wind blows), is inexpensive but uses land and is visually intrusive
- Offshore wind – intermittent, is economic, lifetime of generators is relatively short, and area of windfarms is large
- Solar – intermittent – depends on availability of sunlight
- Nuclear – generates when required, can be flexible but high up-front capital cost means that electricity cost goes up when output goes down.
- Downsides include radioactive waste, decommissioning costs and potential impact of an accident.

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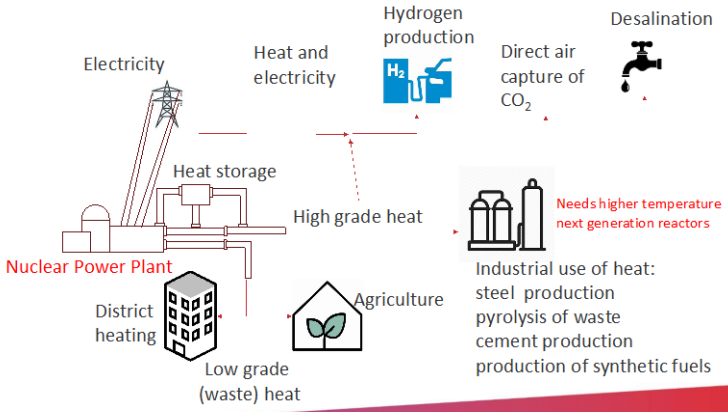
Story of nuclear

Uses of nuclear heat



The story of nuclear

Fuel cycles and waste

- Waste is one of the main drawbacks of nuclear technologies. Radioactive waste is produced, and the UK is still developing ways in which to safely dispose of it
- Most reactors use a "once-through cycle" which means the raw material goes through the reactor once and the used ('spent') fuel is waste.
  - This process results in more waste but uranium sources will last for around 100 years
- Some next generation reactors can use a "Fast reactor closed cycle", which means they can recycle and reuse much of its 'spent fuel'.
  - This results in less waste and ensures that natural resources will last for thousands of years
  - But uranium prices dictate that this route may not currently be financially viable
- With a Geological Disposal Facility (GDF), higher-activity waste would be put hundreds of metres deep underground. A GDF is internationally recognised as the safest long-term solution for this type of waste
- it is assumed a GDF will be available to receive the first waste in the 2040s, and 2070s for higher level radioactive waste

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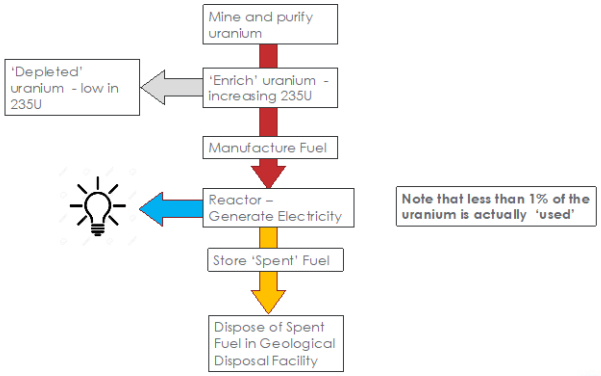
The story of nuclear

Example Fuel Cycle – once-through



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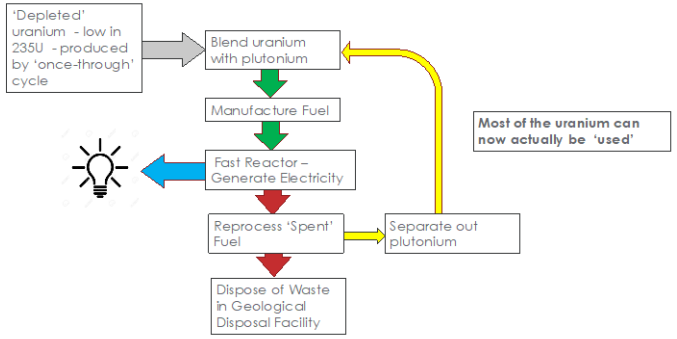
The story of nuclear

Example Fuel Cycle – Fast Reactor Recycle



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Nuclear Energy – The Conundrums

Nuclear Energy: the Conundrums

- Nuclear energy provokes strong opinions. Like/dislike of nuclear energy is mainly based on the values of the individual – these values are important.
- Access to unbiased scientific fact is essential, but how easy is it to understand?
- Nuclear energy is very low carbon, with most of all the environmental detriments coming from uranium mining.
- 'Closed' nuclear fuel cycles with fast reactors and fuel recycling can cut the amount of uranium used hugely but is not economically viable at current uranium prices.
- Uranium prices high enough to favour closed cycles are not expected for at least several decades.
- High initial capital costs, and difficulty in securing investment

TRAVERSE

Q&A Session

An introduction to nuclear energy technologies

TRAVERSE

An introduction to the regulation of nuclear energy technologies

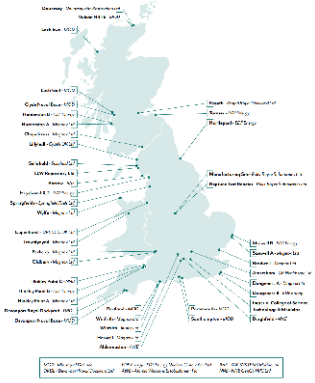
Quick poll

- *How much do you know about how nuclear power stations are regulated?*
- *To what extent do you trust or not trust the organisations responsible for nuclear regulation?*
- *And before taking part in this had you heard of ONR (Office for Nuclear Regulation)*

Office for Nuclear Regulation

ONR: What and where we regulate

Nuclear Safety
Nuclear Security
Nuclear Transport
Safeguards
Conventional Health and Safety including Fire Safety (at nuclear licensed sites)
Emergency Planning and Resilience



Enquiries: *Contact@onr.gov.uk*
Website: *www.onr.org.uk*
Twitter: *@The_ONR*

Office for Nuclear Regulation

Regulating new builds

Government Clean Growth Strategy

Small Modular Reactors
Development and implementation of a plan to engage with industry that is developing the more mature SMRs.

Next Generation Reactors
Development of a programme to grow ONR's capability and technical expertise.

Regulation of nuclear energy technology

Environment Agency

Environmental regulation at nuclear sites in the UK

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Regulation of nuclear energy technology

Environment Agency

We protect and improve the environment

Environment Agency

We create a better place for people and wildlife and support sustainable development.

We improve the quality of our water, land and air by tackling pollution.

We help people and wildlife adapt to climate change and reduce its impacts.

Natural Resources Wales

The work we do to is to make sure that the environment and natural resources of Wales are sustainably maintained, sustainably enhanced and sustainably used, now and in the future

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Regulation of nuclear energy technology

Environment Agency

Our regulators at work

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Regulation of nuclear energy technology

Environment Agency

Our regulators at work

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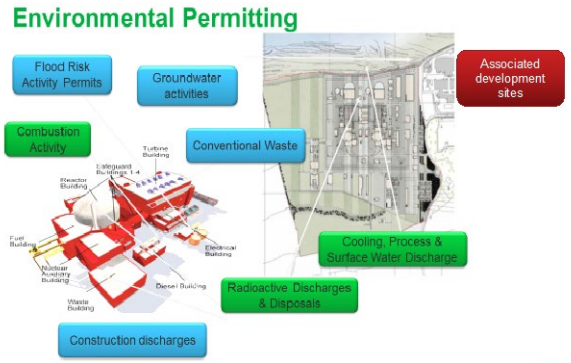
Regulation of nuclear energy technology

Environment Agency

Regulating nuclear sites



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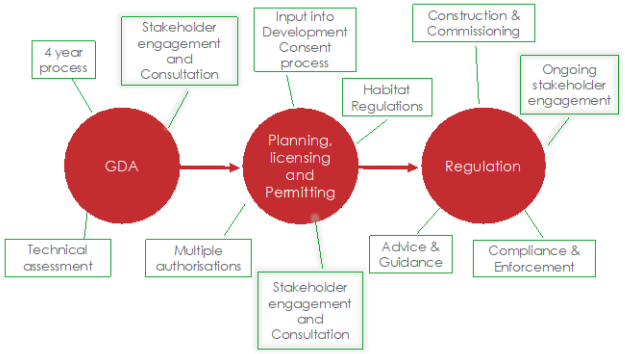
Regulation of nuclear energy technology

Environment Agency

New nuclear build regulatory process



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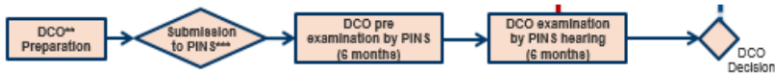
Regulation of nuclear energy technology

Environment Agency

The planning process

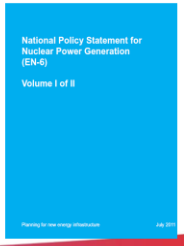


What is covered in planning

- Appropriate development
- Appropriate location
- Impact on local environment
- Socio-economic factors
- Impact from construction
- Vehicle movements
- Many others…

Who manages the process

Nuclear power stations are regarded as Nationally Significant Infrastructure and so planning matters are generally managed by the Planning Inspectorate (PINS). The decision on whether to grant a Development Consent Order (DCO) are made by the Secretary of State



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Regulation of nuclear energy technology

Environment Agency

Public and stakeholder engagement

Information

- Websites - GOV.UK / ONR / joint GDA website
- E-consultation tool (EA)
- Adverts/posters (for public consultations)
- Social media, blogs, infographics, news stories in local and trade media
- Sharing information through advocates and organisations' channels
- Publishing documents, leaflets
- E-bulletins (Joint and ONR news)

Face to face

- Conferences and workshops
- Drop-ins and stakeholder briefings
- Attending other organisations' events
- Seminars
- NGO forum
- Local meetings with groups / organisations

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Regulation of nuclear energy technology

Regulation in practice

Copeland borough council

Proud of our past. Energised for our future.

40

Regulation of nuclear energy technology

Quick poll

- *How much do you know about how nuclear power stations are regulated?*
- *To what extent do you trust or not trust the organisations responsible for nuclear regulation?*

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TRAVERSE

Q&A Session

Regulation of nuclear energy technologies

19:55 – 20:00

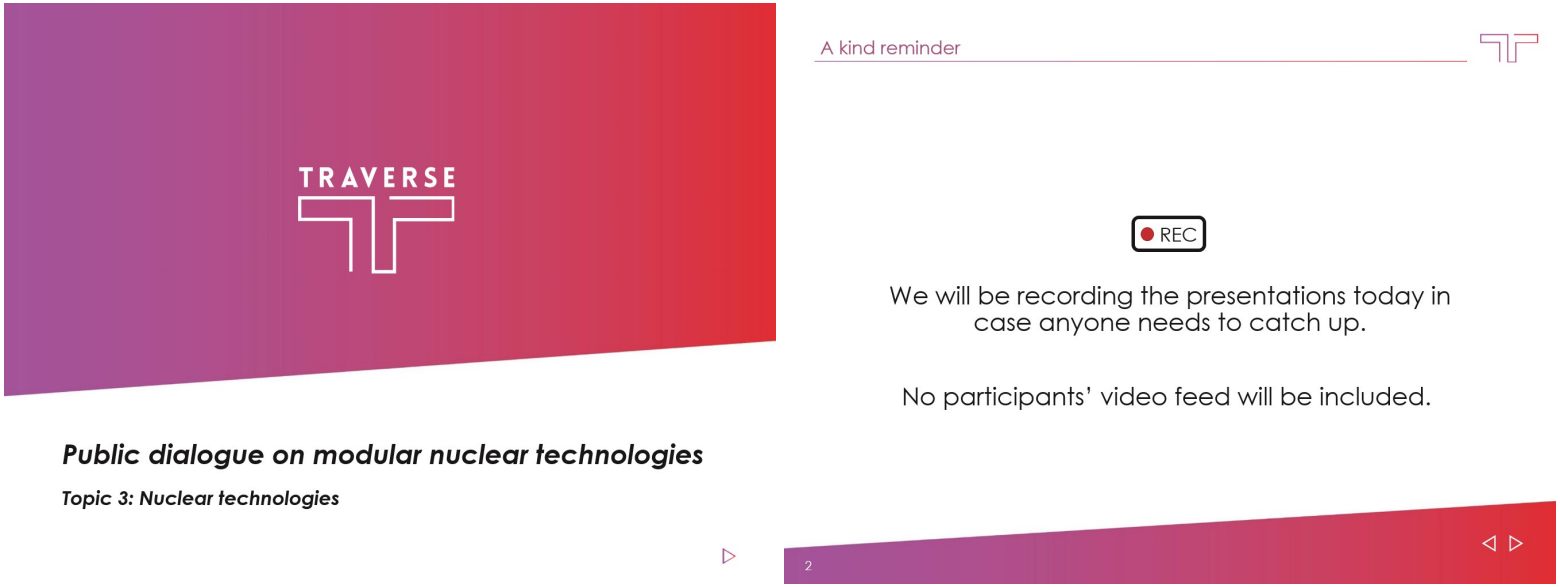
Close

- Log on to **Recollective** for your next activity
- Next workshop is **Saturday 30 January**
  - Please try log on 15 minutes early so that we can get everyone into their groups by 10:00

6.1.3. Nuclear technologies – Workshop 5

At this fifth live session, on Tuesday 9 February 2021, participants were introduced to the third key theme: advanced nuclear technologies.

Specialists from National Nuclear Laboratory, and the University of Manchester gave short presentations, and specialists from National Nuclear Laboratory and the University of Greenwich answered participant questions throughout the session.



Welcome

Who is in the room?

You — A cross-section of around 70 people from in and around Porthmadog, Reading, Scunthorpe and the Humber Estuary

Traverse — An independent research and engagement organisation. Our team tonight is **Amelie and James**

BEIS — The Department for Business, Energy and Industrial Strategy. They are here to listen to your feedback and note down your questions. **Lewis Mortimer and Ellie Perkins**

Sciencewise — UK Research & Innovation's Sciencewise programme. They are here to listen to your feedback and answer questions about the Sciencewise programme. **Diane Beddoes and Steve Robinson**

3KQ — They are here to provide external oversight of these dialogues and listen to your feedback. **Laura Premack**

3

Welcome

Who is in the room?

Specialists

Presenting — **Mike Drury**, National Nuclear Laboratory

Prof. Richard Taylor, University of Manchester

Answering questions on chat — **Adrian Bull**, National Nuclear Laboratory

Prof. Steve Thomas, University of Greenwich

4

Welcome

Ways of working

- Respect other people's views
- Make sure everyone has a chance to contribute
- Switch off distractions
- Mute yourself unless talking
- Ask questions
- Pop questions into the chat window

5

Setting the scene

6

The dialogue process – what will happen this week?

This week

- Monday: Online Tasks
- **Tuesday: Nuclear technologies (1/2)**
- Wednesday – Friday: Online Tasks
- Saturday: Nuclear technologies (2/2)
- Sunday: Endline Survey

7

Agenda for the session

Time	Activity
18:30 – 18:40	Welcome
18:40 – 19:10	Introduction to modular nuclear technologies
19:10 – 19:15	Break
19:15 – 19:45	The opportunities and unknowns of modular nuclear energy technologies
19:45 – 19:55	Reflection
19:55 – 20:00	Close

8

Welcome

Types and terminology

- There are different types of nuclear technology.
- Because modular nuclear technologies are still quite young, different names are used across the world.
- Some of those names are 'loaded' – they can influence how we feel.
- We are using the categories and names below.
- A list of words is on Recollective to help you do your own research.

Current nuclear technology

Modular nuclear technologies

Small modular reactors

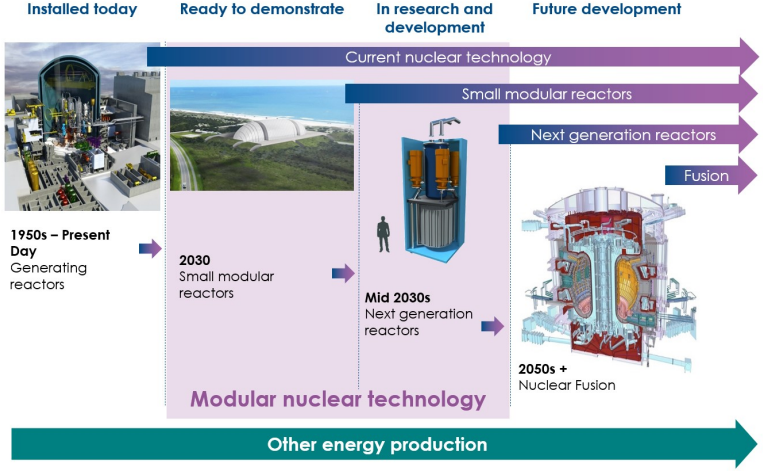
Next generation reactors

TRAVERSE

Introduction to modular nuclear technologies

Introduction to modular nuclear technologies

Evolution of Reactors



Introduction to modular nuclear technologies

Farrow Designs

Introduction to modular nuclear technologies

What are modular nuclear technologies?

Small modular reactors

- Like **current** nuclear reactors
- **Water-cooled**
- Use **existing uranium** fuel form
- Expected to be **smaller in size and output** than current reactors

Next generation reactors

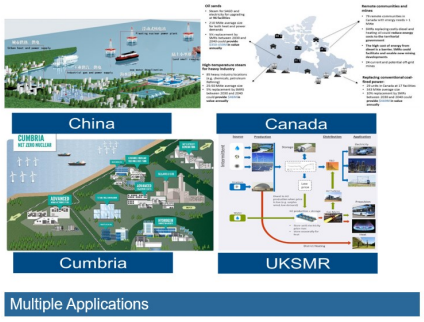
- Variety of **different cooling systems**
- May use **new uranium** fuel form
- Some produce **high level of heat**
- Expected to be **smaller in size and output** than current reactors

Both can be used for new alternative needs (electricity, balance with wind, production of hydrogen, alternative uses for industry) – ***explore more in Recollective***

Introduction to modular nuclear technologies

What need is the technology trying to address?

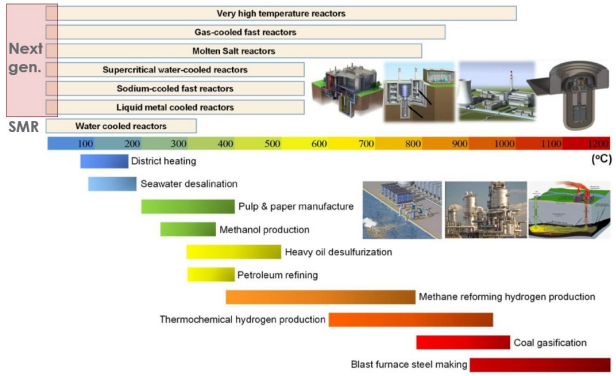
- Supply power and heat for
  - Hydrogen to power cars
  - Desalination for water
  - Provide power to remote communities
  - Industrial heat direct to manufacturing
  - Synthetic fuels for transport
  - District heating for homes
  - Medical isotopes
  - Flexible electricity to support renewable energy



Multiple Applications

Introduction to modular nuclear technologies

What need is the technology trying to address?



Source: IAEA Annex III Summary of SMR designs for Non-Electric Applications

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Introduction to modular nuclear technologies

How might they differ from current nuclear technologies?

- Physically smaller
- Modular
- Built in a factory
- Fleet approach
- New fuels & coolants
- Passive safety
- Reduced construction risk
- Reduced cost
- Use for electricity supply and heat
- Some are targeting zero waste
- Business model based on economy of multiples
- Opens up new siting options

Introduction to modular nuclear technologies

Current vs modular

	Current nuclear technologies	Modular nuclear technologies
Assembly and construction	Constructed on-site over approximately 5-10 years	Most would be manufactured off-site and assembled on-site
Nuclear waste	Fuel used once and then stored	Some could use existing waste as fuel
Output	Typically 1 station (2 reactors) will power 6 million homes	Multiple reactors for the same level of power as conventional
Output and demand	Generally consistently operate at full output; with limited scope to adjust according to demand	Greater flexibility to control output. Some can adjust power output as needed

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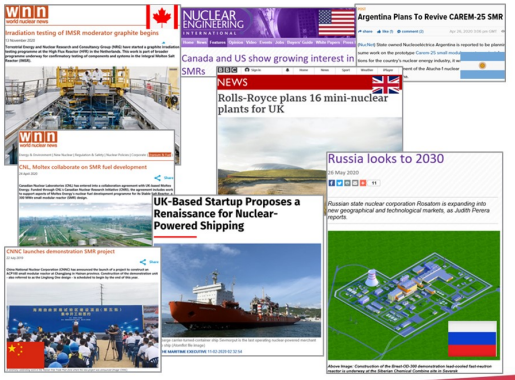
Introduction to modular nuclear technologies

What do we mean by modular and factory production?

https://www.youtube.com/watch?v=JK8KGidUnpM

Introduction to modular nuclear technologies

Modular nuclear technology is not new, and several countries are considering its implementation



TRAVERSE

Q&A Session

Introduction to modular nuclear technologies

Modular nuclear technology is not new, and several countries are considering its implementation

20

TRAVERSE ***Break***

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TRAVERSE

The opportunities and unknowns of modular nuclear energy technologies

The opportunities and unknowns of advanced nuclear energy technologies

Things to Consider

How much should you care?

- Net zero as the grand challenge of our age
- Is acceptance enough?
- Examine your motivation

- Existing sites and communities
- New sites in more urban areas
- Remote communities

Where will they go – what if it's in your backyard?

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The opportunities and unknowns of advanced nuclear energy technologies

Things to Consider

- Be reliable!
- Hydrogen
- Heat
- Medical

What else can reactors do – and does it matter?

What do we mean by next generation?

- Technical sophistication
- Maturity
- Ambition

25

The opportunities and unknowns of advanced nuclear energy technologies

Things to Consider

It's your money - do you want to spend it on this?

- Courage, commitment and resolution
- Government backing
- What could affect the cost?

- Safety and waste dividends
- Attitudes to risk
- What would give you confidence?

Safety and Waste – is the reward worth the risk and says who?

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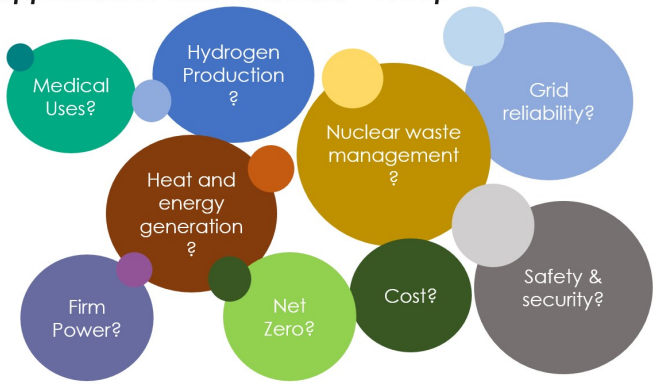
The opportunities and unknowns of modular nuclear energy technologies

Opportunities and unknowns – recap



27

TRAVERSE

Reflection

15 minutes

28

19:55 – 20:00

Close

- Log on to **Recollective** for your next activity
- Next workshop is **Saturday 13 February**
  - Log on early so that we can get everyone into their groups

Thank you.

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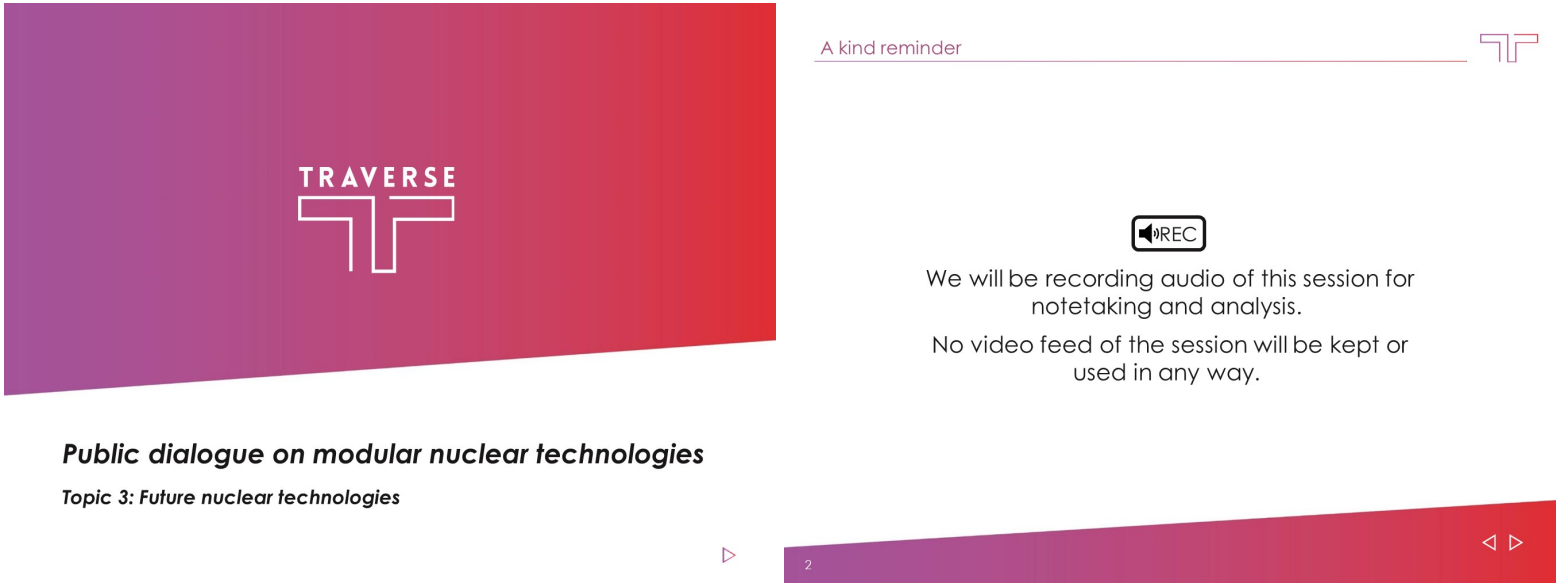
London EC1V 1NY
@traversepeople

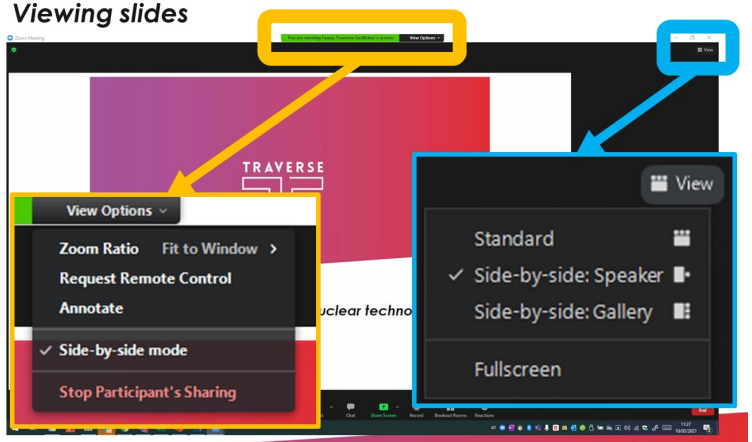
6.1.4. Nuclear technologies – Workshop 6

In the final live event of the process, slides were used to present early emerging views back to participants and guide participants through activities and discussions, including a siting activity and discussion identifying messages for policy-makers (Appendix G – Data).



Welcome

Viewing slides



3

Welcome

Who is in the room?

You A cross-section of around 75 people from in and around Porthmadog, Reading, Scunthorpe and the Humber Estuary

Traverse An independent research and engagement organisation. Today **Anna** is running the show, with **Igor** on tech support. Then the familiar faces of our group facilitators: **Clare**, **Annabelle**, **Skye**, **Louis**, **Leila**, **Maddy**, **Molly**, **Darren**, and **Steffan**. And a fleet of note-takers to capture your discussions.

BEIS The Department of Business, Energy and Industrial Strategy. They are here to listen to your feedback and note down your questions. **Alasdair Harper**, **Lewis Mortimer**, and **Ellie Perkins**

Sciencewise UK Research & Innovation's Sciencewise programme. They are here to listen to your feedback and answer questions about the Sciencewise programme. **Steve Robinson**

4

Welcome

Who is in the room?

3KQ They are here to provide external oversight of these dialogues and listen to your feedback. **Laura Premack**

Specialists (morning)
Phil Rogers, Nuclear Innovation and Research Office
Colette Grundy, National Nuclear Laboratory
Greg Black, Environment Agency

Specialists (afternoon)
Alasdair Harper, Head of Strategy: Advanced Nuclear Technologies, Dept. for Business, Energy & Industrial Strategy
Lewis Mortimer, Nuclear Directorate, Dept. for Business, Energy & Industrial Strategy
Laurence Smith, Dept. of Economy, Skills & Natural Resources, Welsh Government

5

Welcome

Ways of working

- Respect other people's views
- Make sure everyone has a chance to contribute
- Switch off distractions
- Have your video feed on
- Mute yourself unless talking
- Ask questions
- Pop questions into the chat window, or ask as we go

6

Setting the scene

What are the objectives of this dialogue?

1. To understand your perceptions, hopes and concerns about the development of modular nuclear technologies, in the context of mitigating climate change.

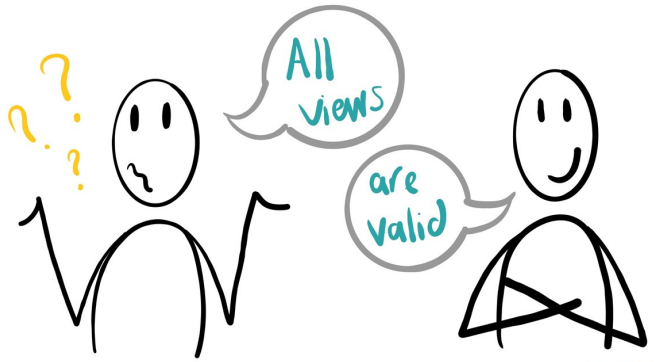
2. To explore your views on modular nuclear technologies and understand how you feel about their different potential uses.

3. To understand your priorities when considering how modular nuclear technologies might be sited and how they could be used.

7

Setting the scene

What are the objectives of this dialogue?



8

The dialogue process – what will happen on this project

Topic	Week	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
The big picture of energy	1	Baseline survey	Live 1: Evening plenary	Online tasks			Live 2: Morning groups	Online tasks
	2	Online tasks						
The big picture of nuclear	3	Online tasks	Live 3: Evening plenary	Online tasks			Live 4: Morning groups	Online tasks
	4	Online tasks						
Modular Nuclear technologies	5	Online tasks	Live 5: Evening plenary	Online tasks			**Live 6: 2 group sessions**	Endline survey
	6	Endline survey						

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Agenda for the session

Morning

Time	Activity
10 mins	Welcome
20 mins	Reflection
70 mins	Siting activity (incl. comfort break)
15 mins	Debrief
5 mins	Close of session 1
1 hour	Lunch Break

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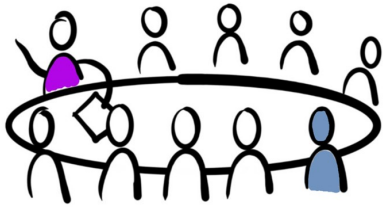
Agenda for the session

Afternoon

Time	Activity
10 mins	Recap
15 mins	Mixed group welcome
60 mins	Messages for policy-makers
30 mins	Reflection
5 mins	Close

Group session

Time to go into groups



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Reflection

Nuclear technologies

12

Reflection

Current nuclear technology

Modular nuclear technologies

Small modular reactors

Next generation reactors

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TRAVERSE

Siting game

Nuclear technologies

Siting game

Current nuclear technology

Modular nuclear technologies

Small modular reactors

Next generation reactors

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Siting game

Conventional example: Sizewell

Sizewell A (1966-2006) and B (1995-) Nuclear Power Stations (6/13 iu05) by Ted and Jen is licensed under CC BY 2.0

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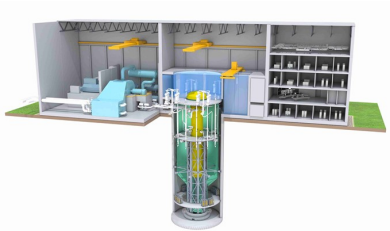
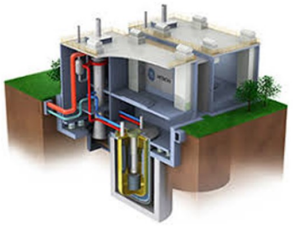
Siting game

Small modular examples





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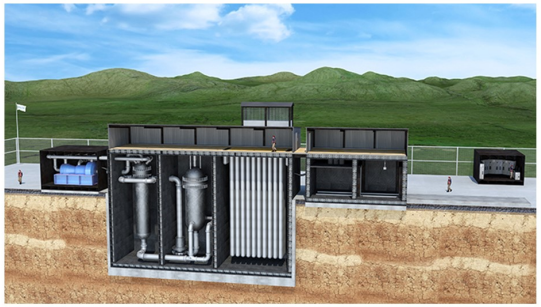
Siting game

Next generation example



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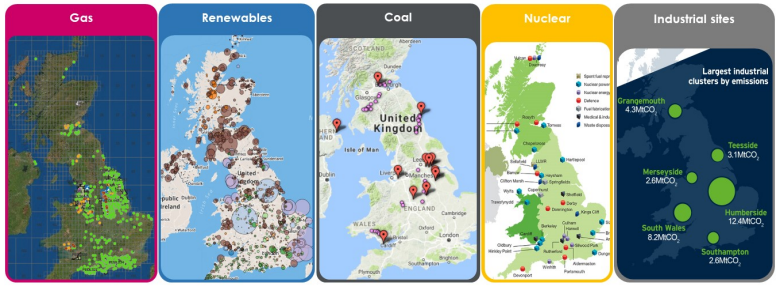
Siting game



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Lunch

1 hour

23

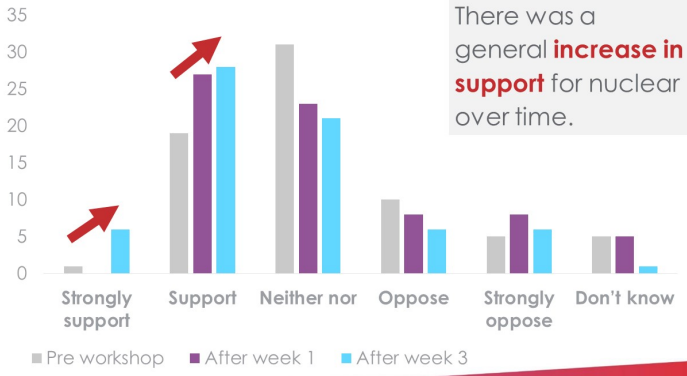
TRAVERSE

Recap

Nuclear technologies

Recap

Do you support or oppose nuclear?

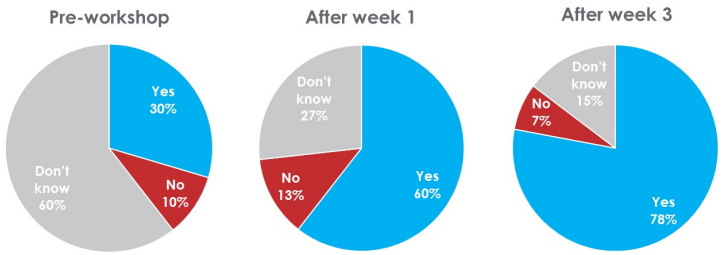


There was a general **increase in support** for nuclear over time.

25

Recap

Do you think modular nuclear technology has a role to play in the UK reaching net zero?

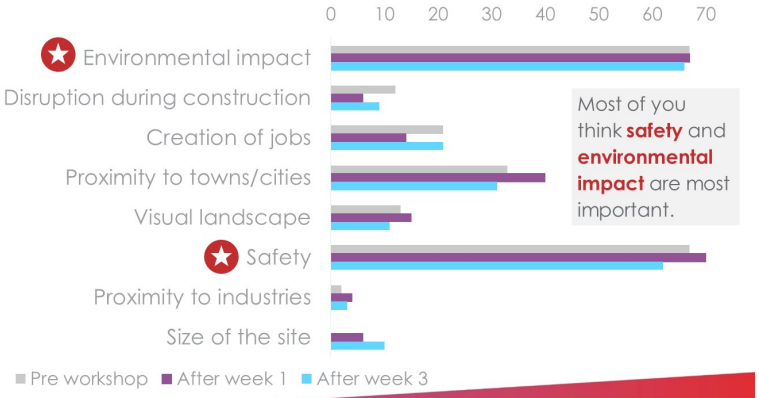


The number of who that think MNT has a role to play in reaching net zero **has increased**.

26

Recap

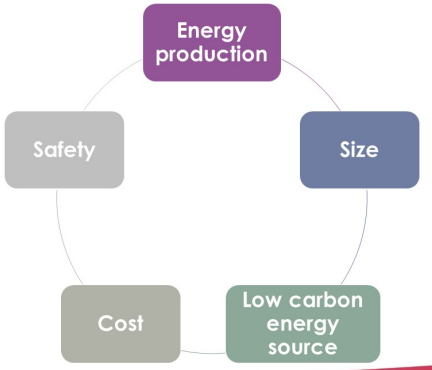
What factors do you think are the most important when considering a site for a nuclear facility?



27

Recap

What **potential benefits** of using modular nuclear technology are important or relevant to you?



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Recap

What **concerns** of using modular nuclear technology are important or relevant to you?

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Recap

Key themes and questions

- The UK's intended approach to reducing carbon emissions
- Weighing nuclear against renewables as energy sources
- Safety of nuclear
  - locally and around the world
  - historically
  - differences between current and future technologies
- Cost and affordability to end-user
- Lifespan and sustainability of nuclear technologies
- Dependencies on / use of international resources and companies
- Management and disposal of nuclear waste
- Risks of nuclear waste
- Process and independence of regulation and inspections

Recap

Emerging views

- **Expectation that future energy will be clean and green –** although there are concerns about affordability, and questions about why more isn't being done to develop renewables.
- **Divided opinions on achieving net-zero by 2050 –** some want to see more ambitious targets, while others are unsure if existing targets are achievable.
- **Concerns about the safety of nuclear power**.

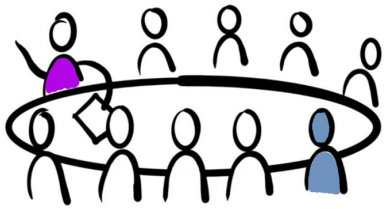
Recap

Emerging views

- **Concerns about nuclear waste –** such as the level of waste creating a problem in the future, perceived risks of storing nuclear waste, questions about regulation, and weighing the impact of nuclear waste against the benefits for net-zero.
- **Divided opinions on nuclear regulation –** some felt reassured that it can guarantee safety standards, while others still question how effective regulation can be.
- **Interest in whether modular nuclear technologies will impact the key issues around nuclear –** will it improve safety, reduce nuclear waste, and have lower impacts?

Group session

Time for NEW groups



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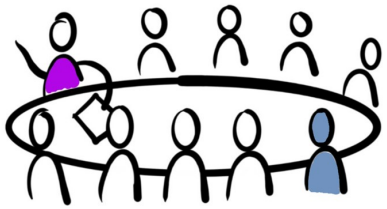
Group session

Group welcome and introductions



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Messages for policy-makers

60 minutes

Messages for policy-makers

What do you want policy-makers to think about?

Some words that might help you start your sentences

Your messages

- Think about…
- Make sure that…
- Avoid…
- Help to…
- Don't…
- Enable…
- Limit…
- Prioritise…
- Consider…

Close

5 minutes

Close

Achieving what we set out to do

We set out to:

- Understand your perceptions, hopes and concerns about the development of modular nuclear technologies.
- Explore your views on modular nuclear technologies and understand how you feel about their different potential uses.
- Understand your priorities when considering how modular nuclear technologies might be sited and how they could be used.

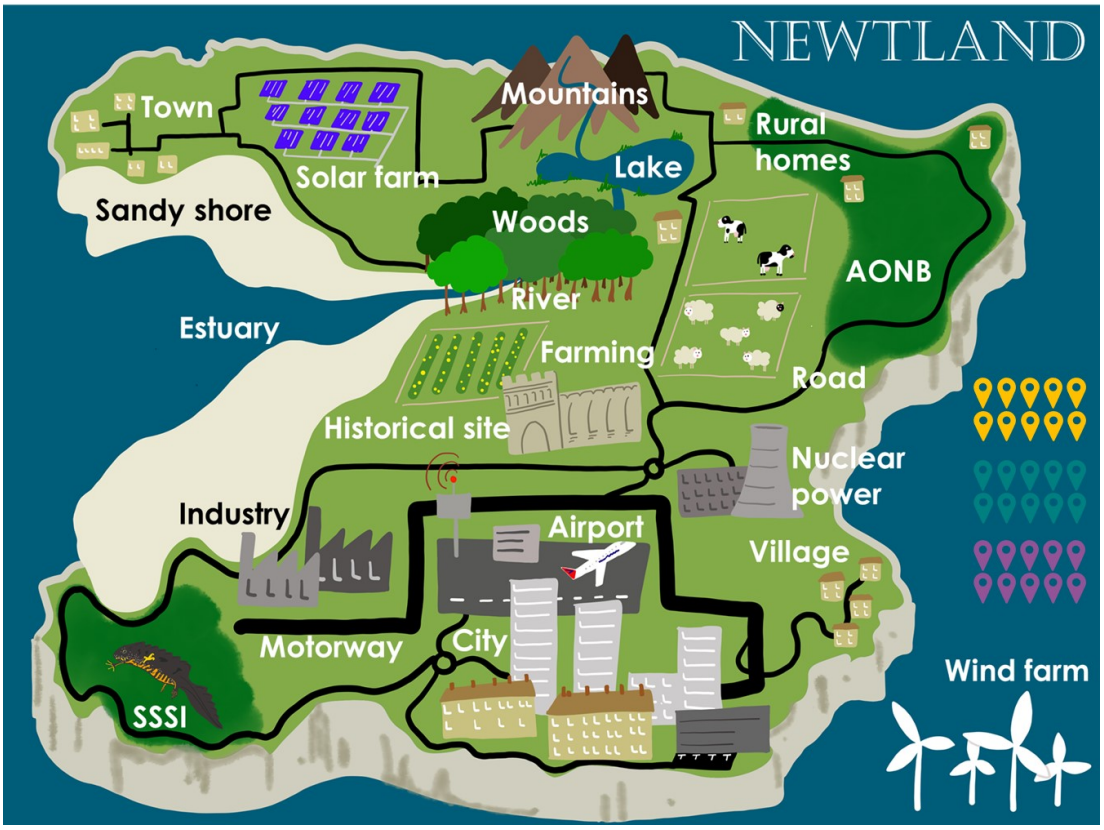
What you've shared will go on to inform policy and regulation.

Share your feedback on the dialogue, and the early findings through Recollective!

6.2. Siting activity

At the last session (Workshop 6) participants engaged in a Siting activity. The activity presented a map of an imaginary place called the Newtland and asked participants to consider where they would site conventional, small modular, and future generation reactors. Both the map and the activity were a tool to enable deeper discussion and exploration of trade-offs for siting and usage of advanced nuclear technologies, and less about collecting quantitative data about where specifically participants might site advanced nuclear technologies.

Figure 3: Map used in the siting activity in the final workshop



6.3. Online tasks

Online activities were posted on Recollective in between live sessions to gauge the level of understanding participants had of the topics that had been covered so far.

6.3.1. Pre-engagement online tasks

Photo journal / mood board

To onboard participants to the online platform and test initial perceptions, participants were initially asked to share 3 pictures that show what they first thought or how they first felt in response to 'nuclear energy'.

Participants were able to search for images on the online platform, or submit their own saved images.

6.3.2. Online task 1

Get to know 5 people by taking part in the discussion board.

To build relationships between participants to support positive dialogue experiences, participants were asked to choose from six different discussion groups posted on the platform.

Participants were asked to enter one discussion group and each answer the following question. Reflecting on the first session, tell us:

- something you learnt;
- something that concerns you;
- something that you are optimistic about; and
- something you want to know more about.

They would then explore what the rest of their group said and comment on their responses.

6.3.3. Online task 2

To understand participant journey and participants' early views on energy within the UK, which might surface views on different technologies and decarbonisation, participants were asked to explore a discovery gallery to complete a quiz.

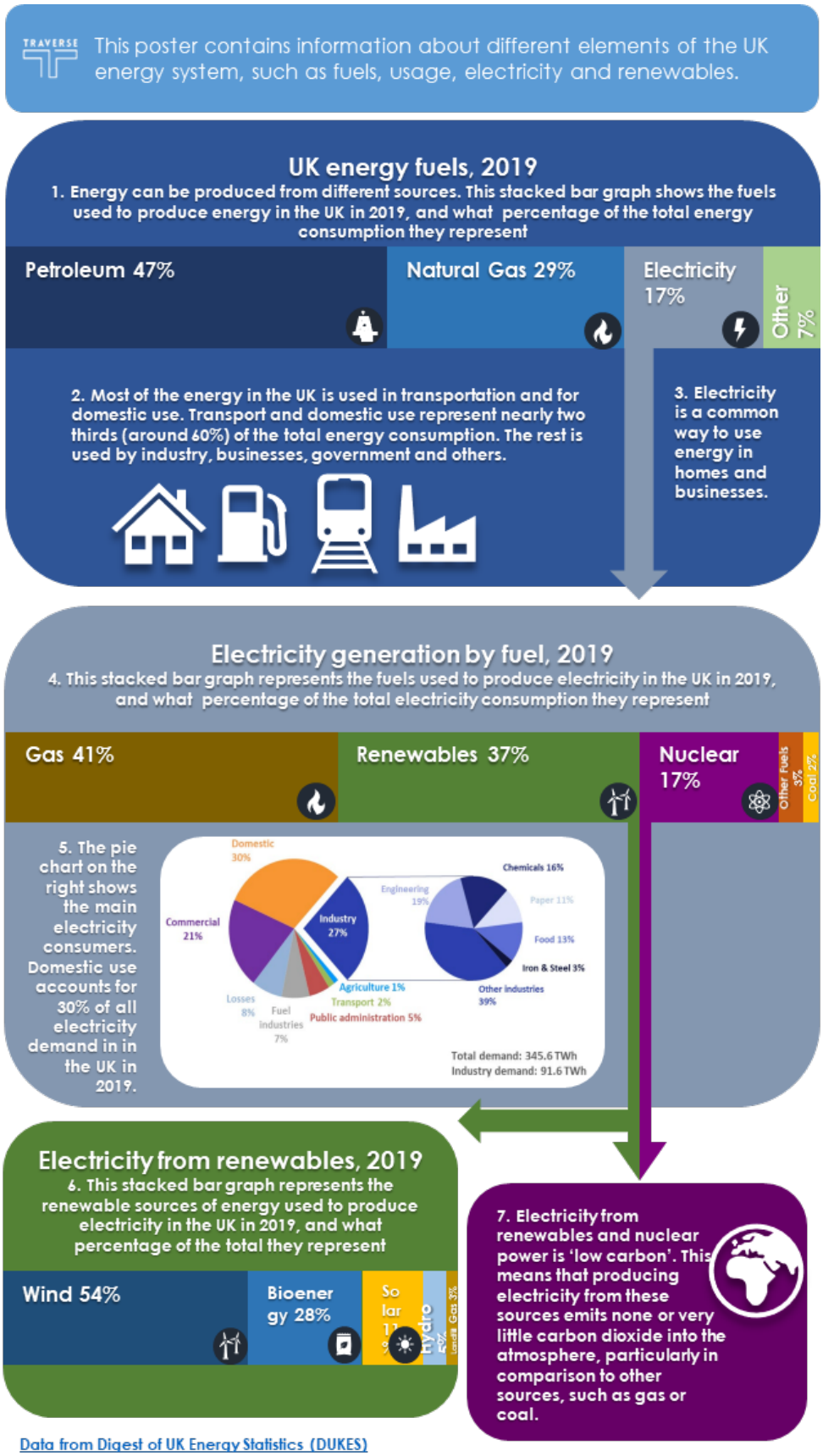
The activity text, posters, and quiz are provided below.

This task will give you an opportunity to expand and recap on some of the facts that you have heard about and discussed in the first two sessions.

The following posters contain information related to the different parts of the energy system in the UK and how they link to achieving the net zero goal.

Explore the posters to discover more about this topic. Then check what you have found out by answering a short quiz.

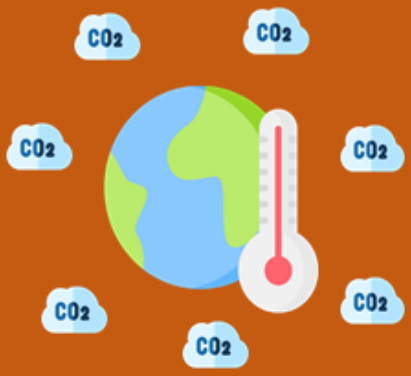
We suggest you spend 1 to 3 minutes looking at each poster, and then try answering some of the questions in the quiz. The quiz is not a test, we just want to get a sense of what participants have understood.


This poster contains information about different elements of the UK energy system, such as fuels, usage, electricity and renewables.
UK energy fuels, 2019
1. Energy can be produced from different sources. This stacked bar graph shows the fuels used to produce energy in the UK in 2019, and what percentage of the total energy consumption they represent
Petroleum 47%
Natural Gas 29%
Electricity 17%
Other 7%
2. Most of the energy in the UK is used in transportation and for domestic use. Transport and domestic use represent nearly two thirds (around 60%) of the total energy consumption. The rest is used by industry, businesses, government and others.
3. Electricity is a common way to use energy in homes and businesses.
Electricity generation by fuel, 2019
4. This stacked bar graph represents the fuels used to produce electricity in the UK in 2019, and what percentage of the total electricity consumption they represent
Gas 41%
Renewables 37%
Nuclear 17%
Other Fuels 3%
Coal 2%
5. The pie chart on the right shows the main electricity consumers. Domestic use accounts for 30% of all electricity demand in in the UK in 2019.
Domestic 30%
Commercial 21%
Industry 27%
Losses 8%
Fuel industries 7%
Agriculture 1%
Transport 2%
Public administration 5%
Engineering 19%
Chemicals 16%
Paper 11%
Food 13%
Iron & Steel 3%
Other industries 39%
Total demand: 345.6 TWh
Industry demand: 91.6 TWh
Electricity from renewables, 2019
6. This stacked bar graph represents the renewable sources of energy used to produce electricity in the UK in 2019, and what percentage of the total they represent
Wind 54%
Bioenergy 28%
Hydro 2%
Landfill Gas 3%
7. Electricity from renewables and nuclear power is 'low carbon'. This means that producing electricity from these sources emits none or very little carbon dioxide into the atmosphere, particularly in comparison to other sources, such as gas or coal.
Data from Digest of UK Energy Statistics (DUKES)

What is **net-zero** carbon emissions?

1. Modern human activity relies on **energy**. Homes, cars, businesses and industries require energy to function. The use of **fossil fuels**- such as oil and gas - to produce energy, also produces emissions of **carbon dioxide** into the atmosphere as a waste. This includes using these fuels to produce electricity.

2. **Carbon dioxide** is a greenhouse gas. This means that when it is released into the atmosphere, it contributes to the **greenhouse effect** – this is to say, it traps in the heat, creating an increase in temperature on the planet. This is often referred to as **global warming** or **climate change** and it can have negative consequences for the environment, biodiversity and human life.



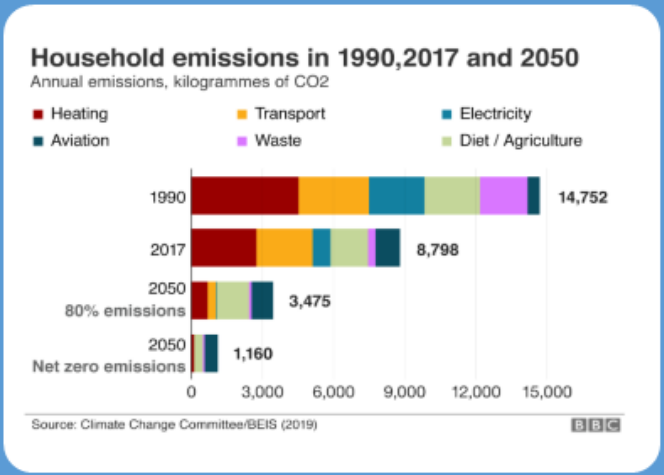
3. Achieving **net-zero**, means that the amount of carbon dioxide that reaches the atmosphere, is balanced out by the amount taken out of the atmosphere. In other words, it means that the level of carbon dioxide in the atmosphere stops increasing. Scientists consider this is a critical goal in order to tackle climate change.

4. The **UK** became the first major economy that legally committed to reach **net-zero** carbon dioxide emissions by **2050**. A move to net zero could benefit individuals, the economy, as well as the planet.

Net-zero 2050

How to achieve net-zero

1. Achieving net-zero would require changes in the way we live, the products we consume, the industries we develop and the technology we use. The graph on the right shows the carbon dioxide emitted by households in the past, against what it would need to be in 2050, to achieve net-zero.



2. There are different initiatives that can contribute to achieving net zero. Some of them focus on reducing the emissions of carbon dioxide. Other initiatives focus on reducing the carbon dioxide that is already in the atmosphere. For example:

More efficient technology that uses less energy and therefore emits less carbon dioxide.

Changes in behaviour, like eating less red meat or cycling more often.

Using renewables to produce energy and electricity since they are considered 'low-carbon'

Using nuclear technology to produce energy and electricity, since it is considered 'low-carbon'

3. It is argued that producing low-carbon energy from nuclear technologies can contribute to reducing the carbon dioxide emissions into the atmosphere. In this sense, nuclear technology could play a role in achieving the net-zero goal by 2050, as part of a mix of different initiatives.

Discovery quiz

1. Answer true or false to the following statements about energy and electricity

   - Energy and electricity are the same thing
   - Electricity is a way to use energy in households, businesses, and industry
   - Energy is a wider concept than electricity.
   - Natural gas is the most common fuel used to produce energy in the UK
   - Coal is a low-carbon fuel to produce electricity

2. Which of the following ways to produce electricity are known to cause high carbon dioxide emissions?

   - Hydro power
   - Burning coal
   - Nuclear technology
   - Burning gas
   - Wind power

3. What does the greenhouse effect cause?

   - Lower temperatures on Earth
   - Faster rotation of the Earth
   - Higher temperatures on Earth

4. What does achieving net zero mean?

   - Achieve zero degrees of average temperature on the Earth
   - Balance out carbon dioxide that goes into and out of the atmosphere
   - Extend a carbon dioxide net around the planet

5. How can nuclear technology help achieve net zero?

   - By producing low-carbon energy
   - By taking carbon from the atmosphere and storing it underground

6. Jargon buster activity:

   From the posters above and the previous session with the specialist, can you think of at least three or more terms that are not clear to you, a friend or someone in your household?

6.3.4. Online task 3

Reflection journal

To allow for reflection on information, start exploring arguments for and against nuclear energy technologies, and understand early views on siting and deployment of nuclear power stations participants were asked to fill in a reflection journal answering:

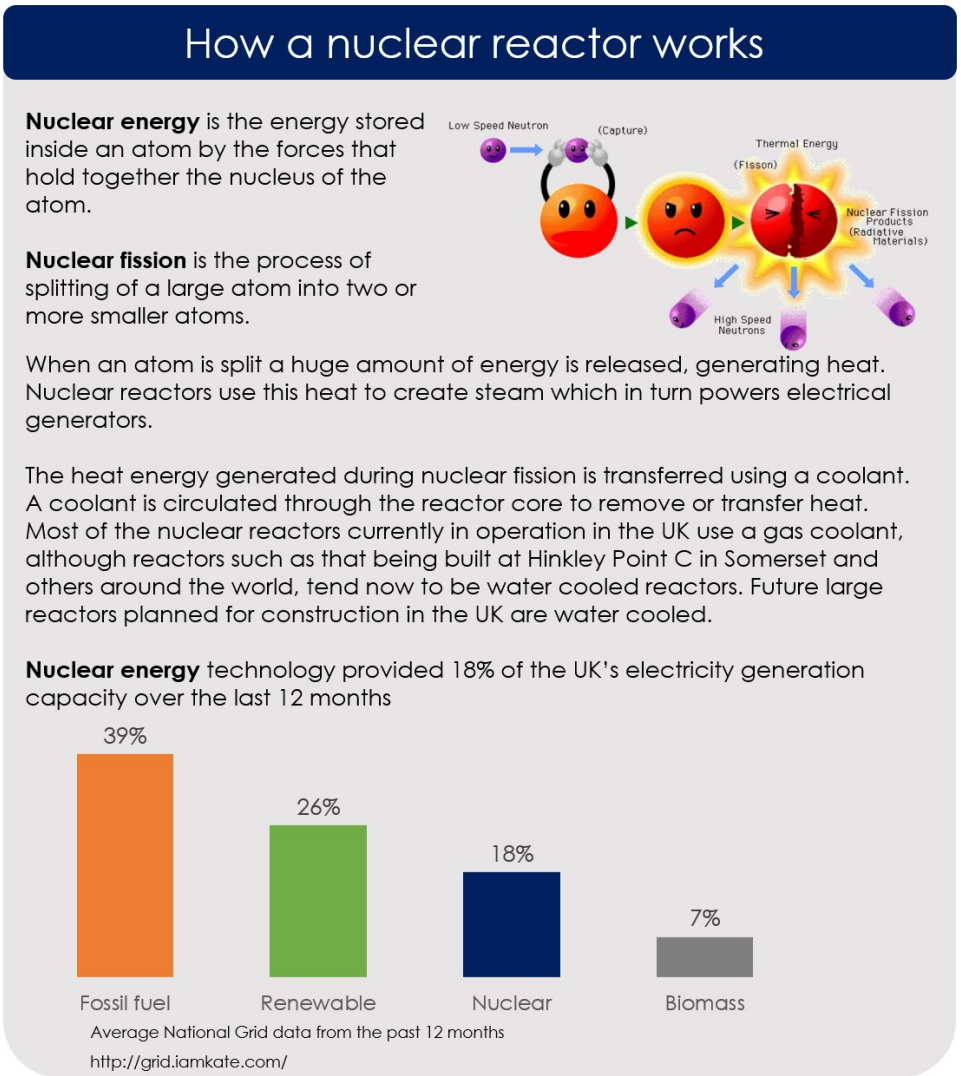
Reflecting on today's session, tell us:

- "Something I learnt"
- "Something that concerns me"
- "Something that I am optimistic about"
- "Something I want to know more about"

Participants also explored a new Discovery Gallery (posters), to complete a worksheet of questions. The posters are displayed below.

Posters

Please review the following posters.



Current nuclear reactors

Reaction type: Fission

Coolant: Most UK reactors are gas-cooled (e.g. Carbon Dioxide). Newer reactors are water-cooled

Operating temperature: Low (approx. 300°C for water cooled reactors)

Construction: On-site (8-10 years)

Status: There are 15 nuclear reactors in the UK across 7 sites.

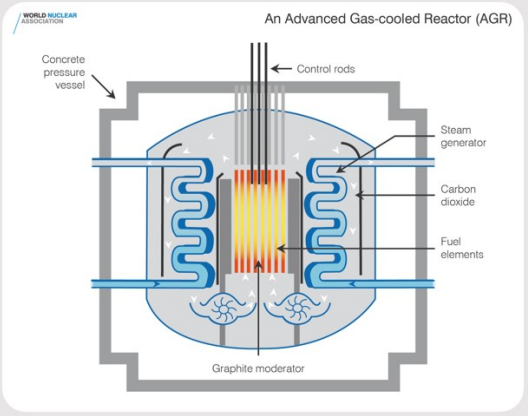
"Large" in this context refers to electrical output.

Most large reactors produce enough energy to power 900,000 to 1,200,000 homes. The largest in the UK powers around 2.2 million homes.

Lower operating temperatures mean these reactors may be less efficient than hotter reactors.

Large current nuclear reactors are designed and built according to "economies of scale" – they are built as large as possible to generate as much electricity as possible which aims to reduce the overall cost of generation.

They are designed and built bespoke - like a fitted piece of furniture - with the reactor building and turbines built and installed on site.

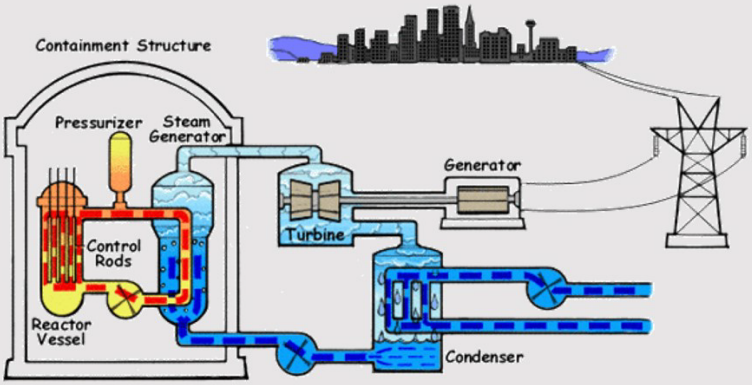


World Nuclear Association

All illustrations used are for illustration only and other designs may vary

Current nuclear reactors under construction

- The reactors currently being built or planned in the UK will be water cooled
- Control rods can be raised or lowered into the reactor core to manage the rate of nuclear reaction and the resulting heat.
- The heat from the nuclear reaction in the reactor core is transferred to separate water tank.
- This produces steam which turns turbines and generates electricity.
- The steam is cooled and condensed back into water so it can be reused and produce more steam.
- This need for large amounts of cooling water to keep the reactor core cool, is why many new plants are located in coastal areas.



Small Modular Reactors

Reaction type: Fission

Electrical output: Small/medium (could generate enough power for anything between 150,000 and 700,000 homes)

Coolant: Water

Operating temperature: Low (approx. 300◦c)

Status: Designs in development

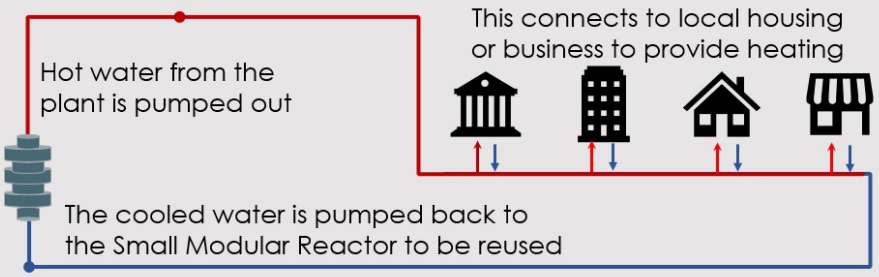
Small modular reactors are *modular* –
They would be manufactured **off-site** and assembled **on-site** with minimal construction.

Small modular reactors would be designed and built according to "economies of multiples". This means that parts could be built to standard specifications and produced in bulk. Some models have been designed for multiple reactors to be co-located at one site, sharing central facilities such as a control room.

They would be designed and built to a standard specification like a flat-pack piece of furniture that can then be assembled and placed in a variety of sites.

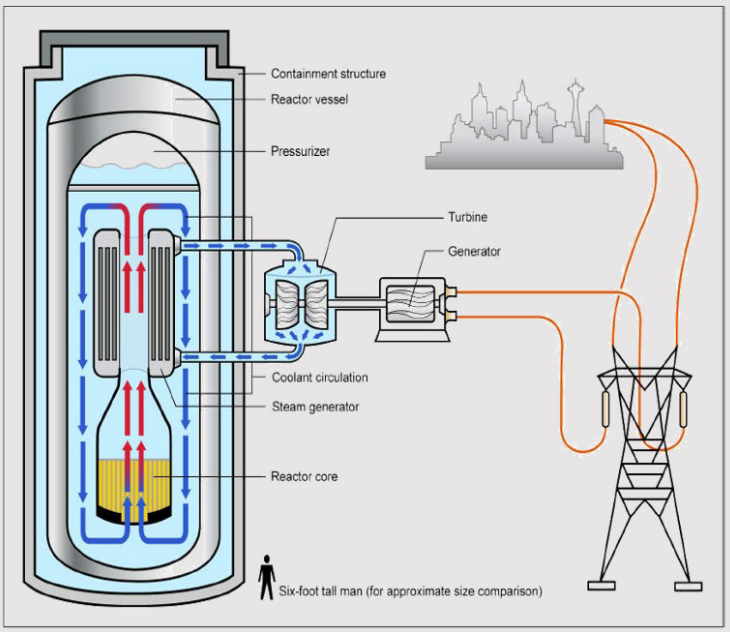
Modular designs may allow for increased efficiency which potentially require less money and take a shorter time to build. Because they can be smaller the potential impact of the reactor on the local area is reduced.

They might be able to be placed closer to population centres due to their lower power, amount of radioactive material and operational safety features. As well as electricity generation they could be used to provide industrial or district heat.



Small Modular Reactors

- These would operate in a similar manner to existing nuclear reactors, with the nuclear reaction generating heat.
- This heat would be used to produce steam which would turn the turbine to generate electricity.
- These would be smaller than existing reactors.
- Various components would be built in a factory and transported to the main site for assembly.



Source: GAO, based on Department of Energy documentation. | GAO-15-652

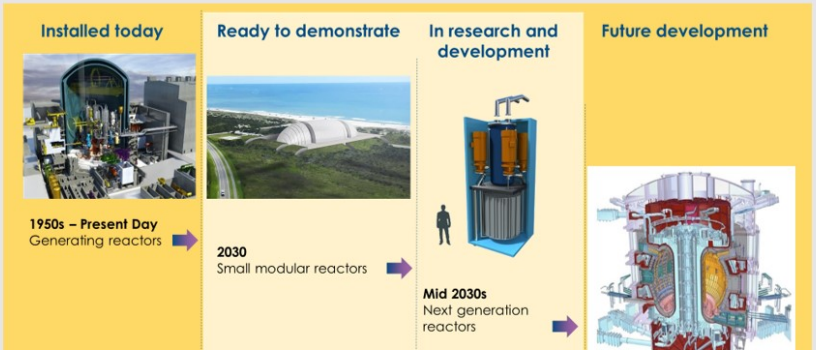
Next Generation Reactors

Reaction type: Fission

Electrical output: Small/Medium. (smallest designs could power around 15,000 homes. The largest up to 700,000 homes).

Coolant: Various
Operating temperature: High (up to 1,000◦C +)
Status: Research and development (R&D)

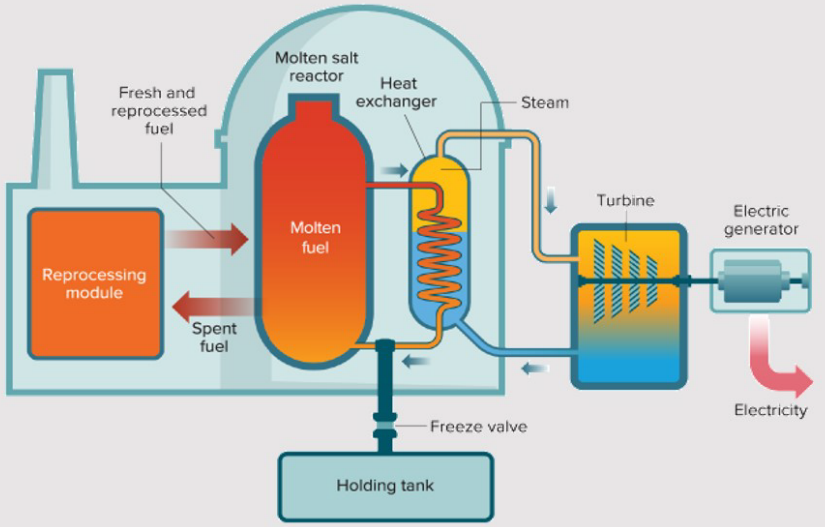
- Next generation reactors refers to a range of reactor designs under consideration for commercial use. Some of these technologies are not new and have had research and development interest in the past.
- Using different coolants, like liquid metals or helium gas, means that these reactors could operate at very high temperatures and could therefore be more efficient than water-cooled reactors. Some may also minimise the risk of coolants overheating and creating a steam/hydrogen explosion (mitigated in current designs with engineered safety systems). However, some coolants might introduce new uncertainties (waste materials, operational practices etc) which need exploring through the R&D stages.
- As some fuels for these designs are stable to very high temperatures, some reactor designers claim it will be impossible for fuel to 'melt down'.
- Many next generation reactor designs are targeting "beyond the grid" uses such as providing heat to industry or for hydrogen production.
- These designs are still at the research and development stage



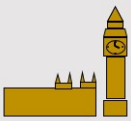
Next Generation Reactors

- The principle of using a nuclear reaction to generate heat and produce power remains the same.
- By using different fuels and coolants the next generation nuclear reactor can operate at higher temperatures.
- At present replacing spent fuel requires shutting down the reactors. Some future technologies aim to be able to add new fuel into the reactor and remove spent fuel as part of the process.
- Some designs may be able to 'breed' additional fuel or to re-use nuclear material currently destined to be disposed of. We should note that this could introduce uncertainties in other areas, such as waste materials or operational practices which would need to be explored during the research and development stages.

How a molten salt reactor works



Governance & regulation of the nuclear industry



Government
Responsible for establishing nuclear policy.

BEIS Secretary of State
Leads nuclear policy for the Government and makes final planning decisions.

Department for Business, Energy & Industrial Strategy

Department for Business Energy and Industrial Strategy (BEIS)
Government department which is responsible for ensuring the UK has a reliable, low cost and clean energy system.

Local council
A local authority provides an important local perspective during the planning consent stage and are likely to have a role in monitoring and enforcing many planning consent requirements. They may be the relevant planning authority for early site works.

Planning Inspectorate
Makes recommendations to the Secretary of State for final planning decisions.

Independent regulators

Environment Agency

ONR Office for Nuclear Regulation

Cyfoeth Naturiol Cymru Natural Resources Wales

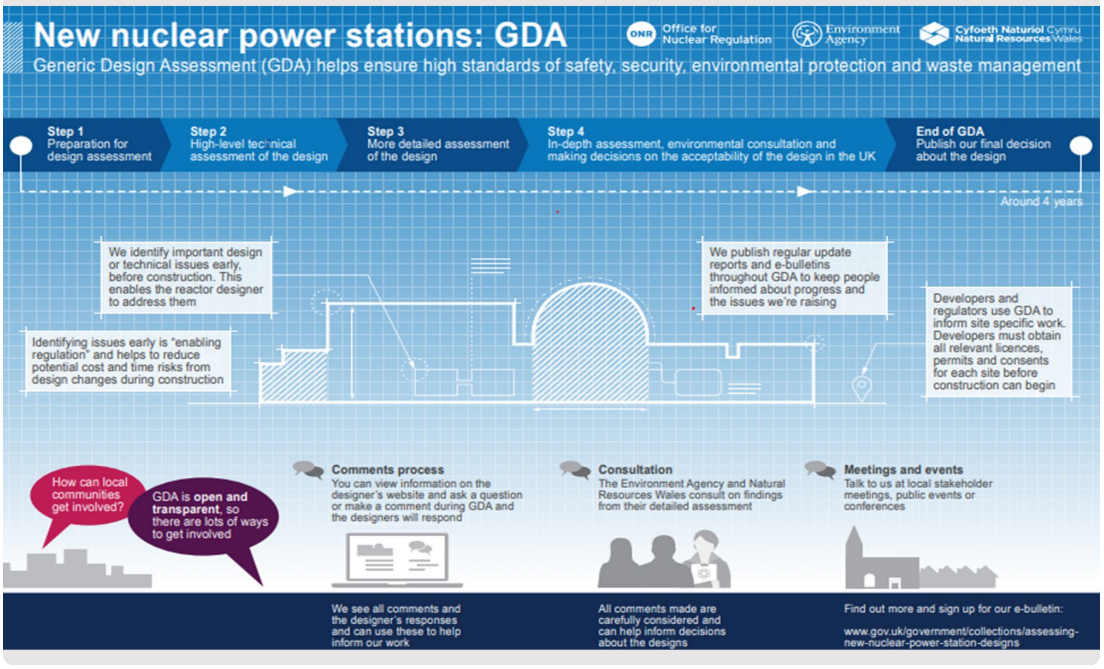
SEPA Scottish Environment Protection Agency

There are several independent regulators including the **Environment Agency**, the **Office for Nuclear Regulation, National Resources Wales**, and the **Scottish Environmental Protection Agency.**

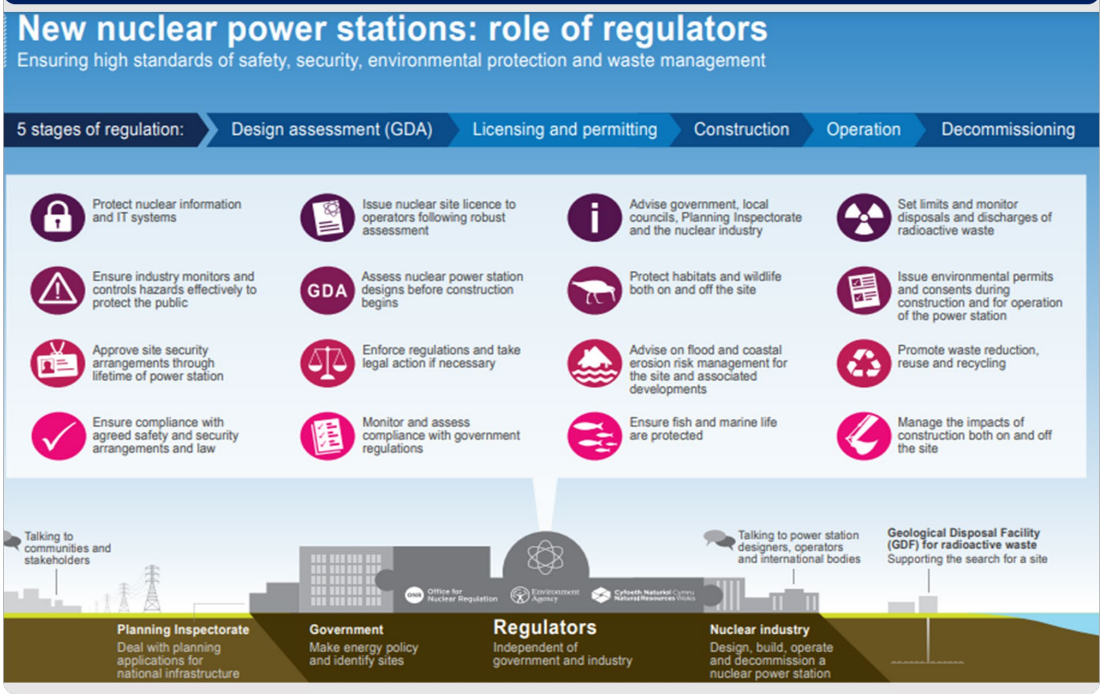
They are responsible for regulating nuclear sites and enforcing rules and provide input at the planning stages as well as monitoring sites once approval has been granted.

They regulate various aspects of nuclear plants including assessing the designs before construction, monitoring the safety of sites, security and the environmental impacts of both construction and operation.

Generic Design Assessment



The role of regulators



Activity questions

1. Have you seen or heard anything about nuclear power in the news recently? Tell us about it and how it made you feel.

2. On the image below, please add comments on what opportunities and what concerns come to mind when looking at the three main categories of nuclear energy technologies.

Key differences

Please note that this table is based on characteristics each reactor *tends to* have. There are exceptions. And of course the future designs are still being developed so there are some assumptions

	Current nuclear reactors	Small modular reactors	Next generation reactors
Size	Tend to be physically large	As the name suggests will tend to be smaller than current nuclear reactors. However, they could still be considerable in size, depending on how they are designed.	Expected to be smaller than current reactors and small modular reactors.
Output	Per reactor, can power the most homes, from 900,000 to 2 million +	Range of designs, but per reactor could power anything between 150,000 and 700,000 homes	Range of designs, but per reactor could power anything between 15,000 and 700,000 homes
Siting reactors together	Multiple reactors often sited together to operate as a single 'Nuclear Power station'.	Could operate as single units or as multiple reactors sited together to increase output.	Could operate as multiples but could also operate as individual units if targeting heat markets
Assembly and construction	Primarily constructed on-site with an aim of 5-6 years, although some have taken longer.	Manufactured off-site and assembled on-site. Aiming for 4 year construction schedule	Potentially manufactured off-site and assembled on-site will take around 4+ years
Safety	Must meet the robust safety and security requirements of the UK's independent nuclear regulator	Must meet the robust safety and security requirements of the UK's independent nuclear regulator	Must meet UK robust safety and security requirements. Some new fuels / coolants could potentially mean reactors are more "passively" safe. This means that they need fewer engineered safety systems as certain scenarios (e.g. fuel melt-down) cannot happen.
Nuclear waste	Produces radioactive wastes which the UK has years of experience managing safely and securely. Intended to be disposed in a geological disposal facility.	Produces radioactive wastes which the UK has years of experience managing safely and securely. Intended to be disposed in a geological disposal facility.	Some reactors may be able to use existing radioactive waste materials as a fuel. We should note that this could introduce uncertainties in other areas, such as waste materials or operational practices which would need to be explored during the research and development stages.

3. Imagine a small modular reactor was proposed to be built in your area. What do you think would be the main pros and cons?

4. The list below shows different aspects of nuclear energy that regulators monitor. Take a minute to read it. Select three that are most important to you, and briefly comment on the image on why you chose it.

6.3.5. Online task 4

Journal activity

The online activity shown below centred on the third topic discussed; nuclear technologies. It aimed to gauge perceptions of three different kinds of nuclear technology following more in depth information given in the previous live session. The questions participants were asked to reflect on are outlined below.

- Thinking about Tuesday's workshop where we introduced you to modular nuclear technologies, answer the following.
- What is something that you learnt?
- What are your biggest questions about modular nuclear technologies?
- What concerns you about modular nuclear technologies?
- What are you optimistic about for modular nuclear technologies?
- There are opportunities for nuclear reactors to produce more than just electricity for our national electricity system. Some of these opportunities can be achieved by most reactor designs (including current nuclear reactors), while others are only feasible when reactors are designed for that purpose. Let's have a look at some of the potential opportunities of modular nuclear technologies.

6.3.6. Online task 5

Journaling activity

Participants were asked to reflect on the latest session, answering:

- What is something that you learnt?
- What are your biggest questions about modular nuclear technologies?
- What concerns you about modular nuclear technologies?
- What are you optimistic about for modular nuclear technologies?

Think back to how you felt and what you thought about the technology, compared to your feelings and thoughts now. You can share what you might have discovered through your own research (like other opportunities, uses, or disadvantages for modular nuclear technologies).

Flash card activity

Participants were asked to review various flashcards, as displayed below.

Opportunities of modular nuclear technologies

Hydrogen production

The gas we currently use at home (for cooking and heating) and in industry is natural gas. Natural gas is mostly methane which creates carbon dioxide when it burns. **Hydrogen gas could be used as an alternative to natural gas**. This could play a key role in helping the UK achieve net-zero by 2050, by providing heat for homes and industry, or fuel for transport.

Today, most hydrogen is made by combining methane with steam. This also produces some carbon dioxide.

Hydrogen can be created in a low carbon way by splitting water molecules into the component parts – hydrogen and oxygen. This process needs heat and electricity. Most electricity generating technology could provide this, and nuclear reactors are one of the low carbon options.

New techniques are being developed to produce hydrogen, which could use heat to make the process more efficient. Some next generation reactors could be designed to produce heat for these new hydrogen production techniques.

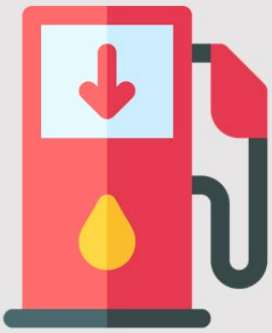
Opportunities of modular nuclear technologies

Manufacturing synthetic fuels

Transport is heavily reliant on fossil fuels, which creates a significant challenge to the UK meeting its net-zero targets by 2050.

Hydrocarbon synthetic fuels could replace fossil fuels. As a ***drop in fuel*** they could be used without changing engines or fuel infrastructure.

Hydrogen and carbon dioxide **or** nitrogen is needed to make synthetic fuels. Designers are exploring the possibility of taking low carbon, bulk hydrogen production a step further, to produce synthetic fuels for vehicles, shipping, and aviation.



Opportunities of modular nuclear technologies

Reliable power with variable output

Nuclear technology produces '**firm power**' – a supply that can be relied on 24/7, whatever the weather.

Current nuclear reactors are often designed to produce their full output all the time. Modular nuclear reactors might provide variable output. This could make it possible to decide how much electricity to make, and when (e.g. planning more at peak times and less in off-peak). However, there is debate about whether this way of managing the supply would be needed with other advances in the energy sector (like smart grids).

Firm but variable power production could complement renewable energy (which is less predictable) to help maintain a constant energy supply. This might help us meet ambitious targets to reduce carbon emissions. However, there are still challenges that would need to be addressed to use firm power in conjunction with a diverse mix of energy sources.

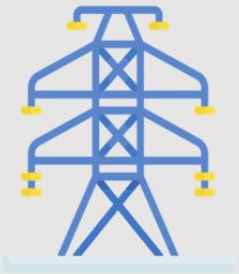
Opportunities of modular nuclear technologies

Grid reliability

Nuclear technology can provide low-carbon, reliable energy to complement the existing energy supply.

Modular nuclear reactors could be designed to operate independently of the electricity grid. This means they could help re-establish normal grid operations if there was a power cut.

Nuclear technology is considered to have a high level of reliability. This could support the use of potentially less reliable renewable energy sources, while maintaining the overall reliability of supply. This might help us meet ambitious targets to reduce carbon emissions.



Opportunities of modular nuclear technologies

Remote, off-grid use

Modular nuclear reactors may not need to be connected to the electricity grid. They could provide reliable energy for isolated communities and remote industrial sites like mines. This could reduce dependence on current off-grid power sources (like diesel generators), reducing fossil fuel use and liquid fuel transport.

While there aren't many isolated communities or remote industrial sites in the UK, countries such as Canada and the USA are looking to use nuclear technologies in this way.

A low-carbon, reliable energy supply could improve residents' health and environmental wellbeing in remote areas like these.

Opportunities of modular nuclear technologies

Heat generation

Heating homes, businesses, and industry is responsible for a third of the UK's emissions, and decarbonising heat is one of our biggest challenges to meeting Net Zero.

Nuclear energy could meet our heat demand, because reactors create heat. Heat is difficult to transport, so at the moment it is most efficient to convert the heat into electricity. But we could also directly use heat from nuclear power plants.

Some modular reactor designs could produce much higher temperatures. This might create enough heat for heating homes or industrial processes (like making paper or processing chemicals), that would normally use electricity or fuel to produce heat. If used this way, reactors would probably need to be closer (several miles) to the industries or homes being heated.

If nuclear reactors are designed to smaller and modular, it could be possible to put them in industrial areas. Having reactors alongside industry could:

- provide heat to directly power some processes (rather than using other energy to create heat),
- reduce industry use of fossil fuels (such as gas), or
- reduce industry reliance on the grid.

Opportunities of modular nuclear technologies

Nuclear waste management

Some designs could reduce the impact of nuclear waste leftover from energy generation. This could happen in different ways.

- Use existing nuclear waste as fuel (like spent fuel from conventional reactors)
- Get more energy out of the same amount of fuel
- Reduce radioactivity of spent fuel (so it takes less time to become safe)

However, these benefits have not yet been demonstrated. It could introduce new unknowns with different waste materials or processes which have not yet been proved. It would need to be explored, and some argue that the challenges could be too great to overcome.

Opportunities of modular nuclear technologies

Radioisotopes and medical uses

Radioisotopes are produced through nuclear reactions.

Radioisotopes are radioactive forms of an element – they emit radiation. Radiation is easily traceable and can cause changes in whatever it touches, making it useful in medicine, industry, and other areas.

The designs of modular nuclear reactors could be adapted to produce radioisotopes and other outputs (for example, a reactor might be capable of producing both radioisotopes and electricity).

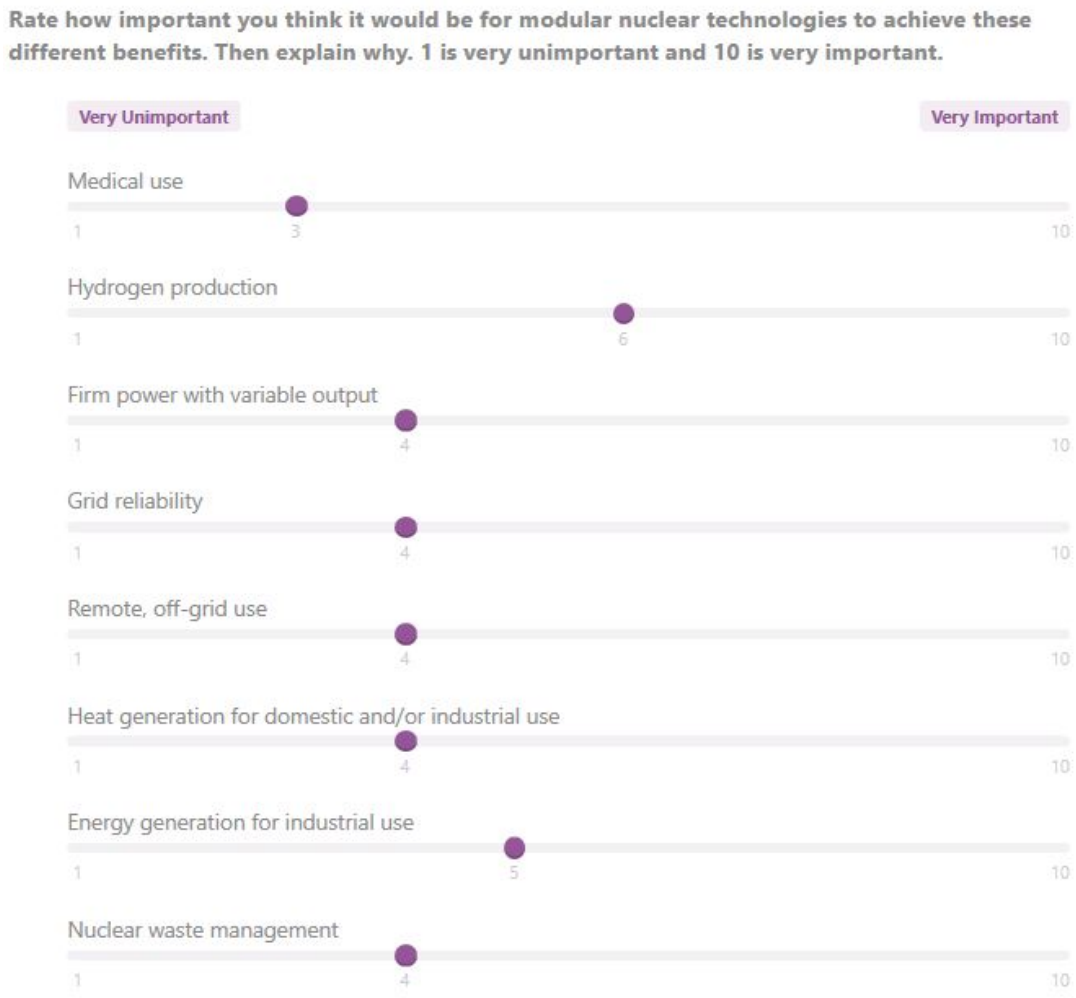
Radioisotopes are used in sterilizing things, medical imaging (like PET scans), self-powered lighting (like watch dials and emergency lighting), and cancer treatment.

Demand is expected to grow with improving medical capabilities, increasing access to equipment, and increasing cancer cases (as projected by Cancer Research UK).

Examples of radioisotopes and what they are used for

- Cobalt-60 is used in sterilising 40% of the world's single-use medical devices (like syringes, gloves, and instruments), cancer treatments, and improving safety of perishable foods (like meat, fruit, and spices).
- Technetium-99m helps to detect illnesses like cancer and heart disease through medical imaging.
- Tritium is used in medical research and self-powered lights.
- Iodine-131 is used to treat thyroid cancer.

Afterwards, they were asked to rate how important they thought it would be for modular nuclear technologies to achieve those different benefits, and explain why. A screenshot of the format of that activity is provided below.



6.3.7. Regular survey

To better understand baseline views and the participant journey, participants answered the same set of nine closed questions at four various points throughout the dialogue. The survey was posted on the online platform as part of the online task.

Nuclear energy

1. What factors do you think are most important when considering the use of nuclear power?

2. From what you know, or have heard about using nuclear energy for generating electricity in the UK, do you support or oppose its use?
    a. Strongly support
    b. Support
    c. Neither support nor oppose
    d. Oppose
    e. Strongly oppose
    f. Don't know
3. What factors do you think are the most important when considering a site for a nuclear facility? Select the 3 that you consider most important:
    a. Environmental impact
    b. Disruption during construction
    c. Creation of jobs
    d. Proximity to towns/cities
    e. Visual landscape
    f. Safety
    g. Proximity to industries
    h. Size of the site
4. Use the scales below to show how much of a role you think each solution should have in helping the UK reach net zero greenhouse gases by 2050. Net zero is when the amount of greenhouse gases we create, is the same as the amount we absorb – so there is no further increase in greenhouse gasses in the atmosphere.
    a. Renewable energy
    b. Planting trees and restoring wetlands
    c. Energy efficiency and new technology
    d. Nuclear energy
    e. Carbon capture, use and storage
    f. Behaviour change (including changes in diet and use of public and active transport)
5. Do you agree that nuclear is a low carbon source of energy?
    a. Yes
    b. No
    c. Don't know

6. To what extent do you agree or disagree with the following statements. *[setup in a grid, with options of Strongly agree//Slightly agree//Neither agree nor disagree//Slightly disagree//Strongly disagree//Don't know]*
    a. Nuclear energy will help combat climate change in the UK
    b. Nuclear energy provides a reliable source of energy in the UK
    c. Nuclear energy offers affordable energy for the UK
    d. Nuclear energy provides a safe source of energy in the UK

Modular nuclear technologies

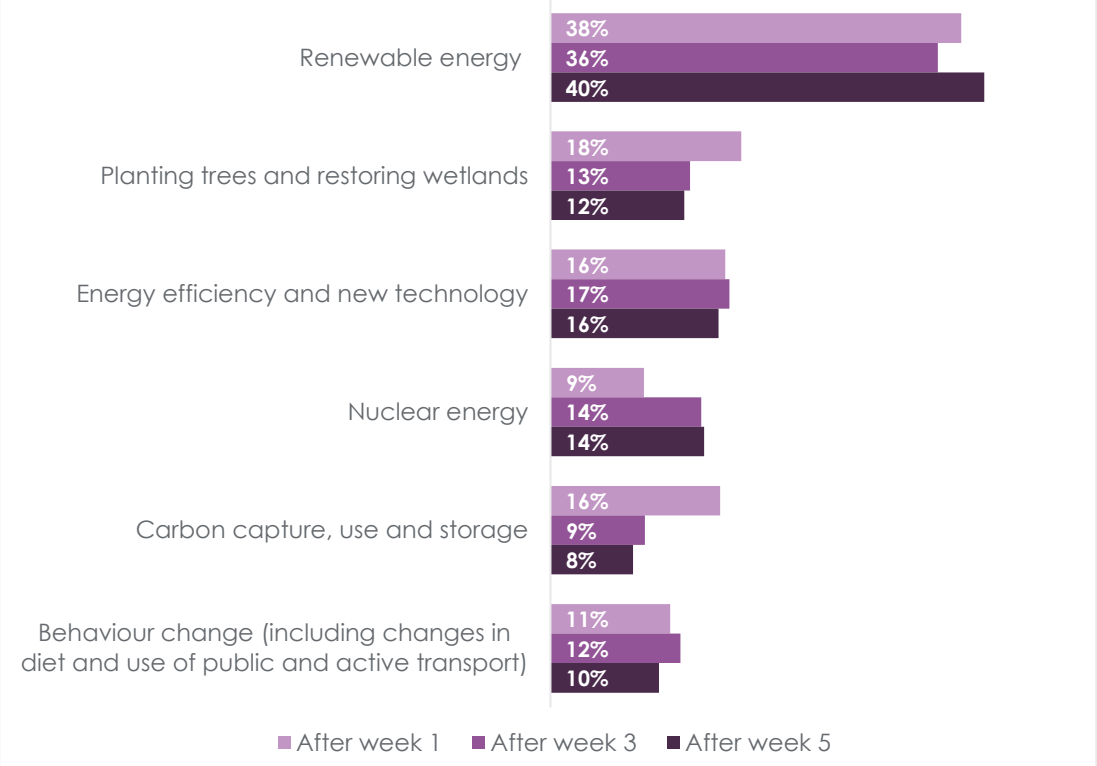
7. Before this project, how much, if anything, did you know about modular nuclear technologies?
    a. I know a great deal about modular nuclear technologies
    b. I know a fair amount about modular nuclear technologies
    c. I know just a little bit about modular nuclear technologies
    d. I have heard of this but know almost nothing about modular nuclear technologies
    e. I have never heard of modular nuclear technologies
8. To what extent do you support or oppose the potential use of modular nuclear technologies in the UK?
    a. Strongly support
    b. Support
    c. Neither support nor oppose
    d. Oppose
    e. Strongly oppose
    f. Don't know
9. We want to understand what you think about modular nuclear technology as a way to achieve net zero by 2050. Do you think that modular nuclear technology has a role to play in the UK reaching net zero?
    a. Yes
    b. No
    c. Unsure

7. Appendix G – Data

7.1. Survey results

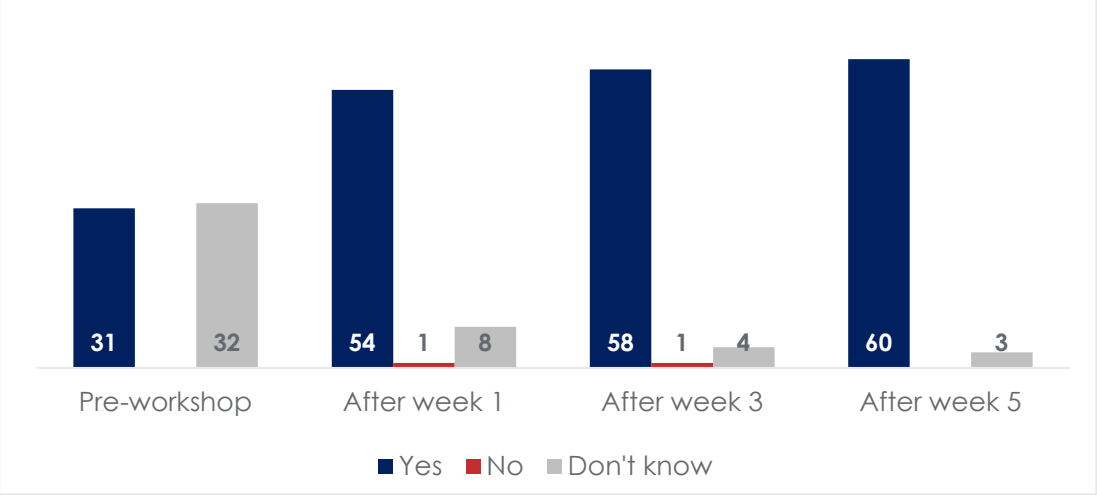
7.1.1. Perceptions about solutions to help the UK reach net zero

Figure 4: Graph of survey data from the end of each workshop week, for the question 'How much of a role you think each solution should have in helping the UK reach net zero greenhouse gases by 2050?', reflecting those participants who completed all three surveys (n=63). Participants were asked to divide 100 tokens between each of the solutions. The percentage data in the graph is an average score of 63 individual responses submitted. This graph data is potentially limited, as no other solutions apart from nuclear were discussed in depth throughout the dialogue.



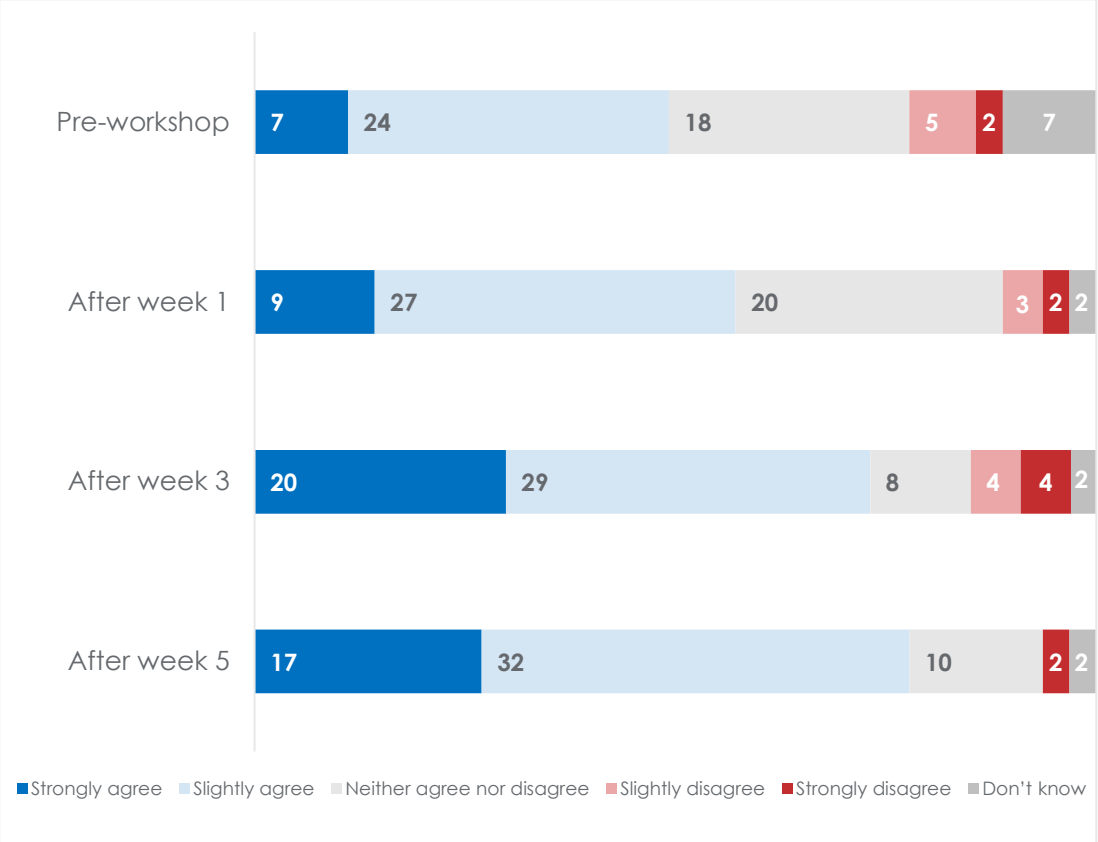
7.1.2. Perceptions of nuclear as a low carbon energy source

Figure 5: Graph of survey data from before the dialogue and the end of each theme, for the question 'Do you agree that nuclear is a low carbon source of energy?', reflecting those participants who completed all four surveys (n=63).



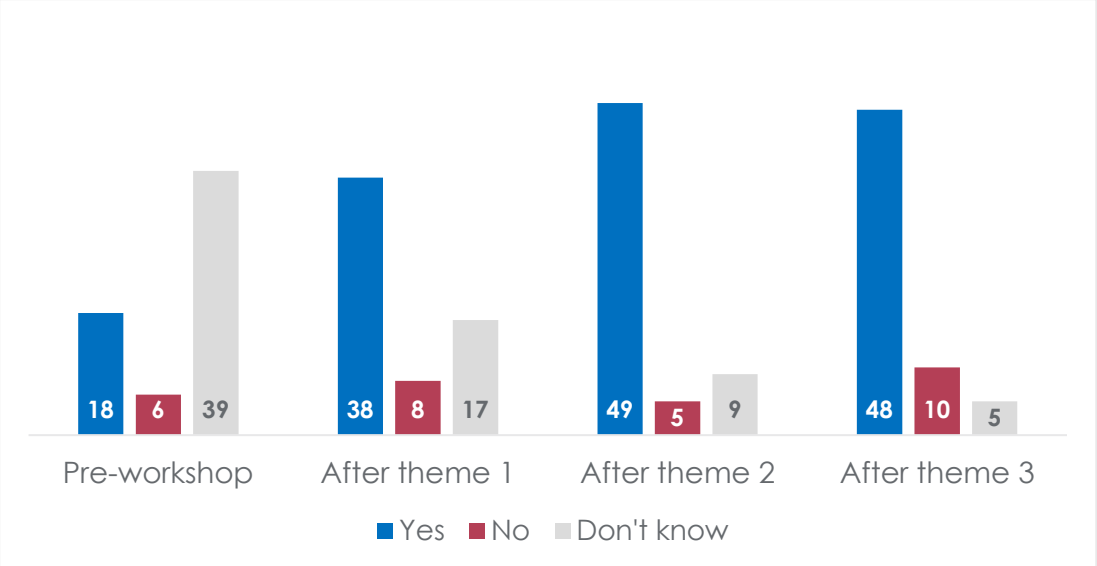
7.1.3. Perceptions of what extent nuclear energy will combat climate change in the UK

Figure 6: Graph of survey data from before the dialogue and the end of each theme, for the question 'To what extent do you agree: Nuclear energy will help combat climate change in the UK', reflecting those participants who completed all four surveys (n=63).



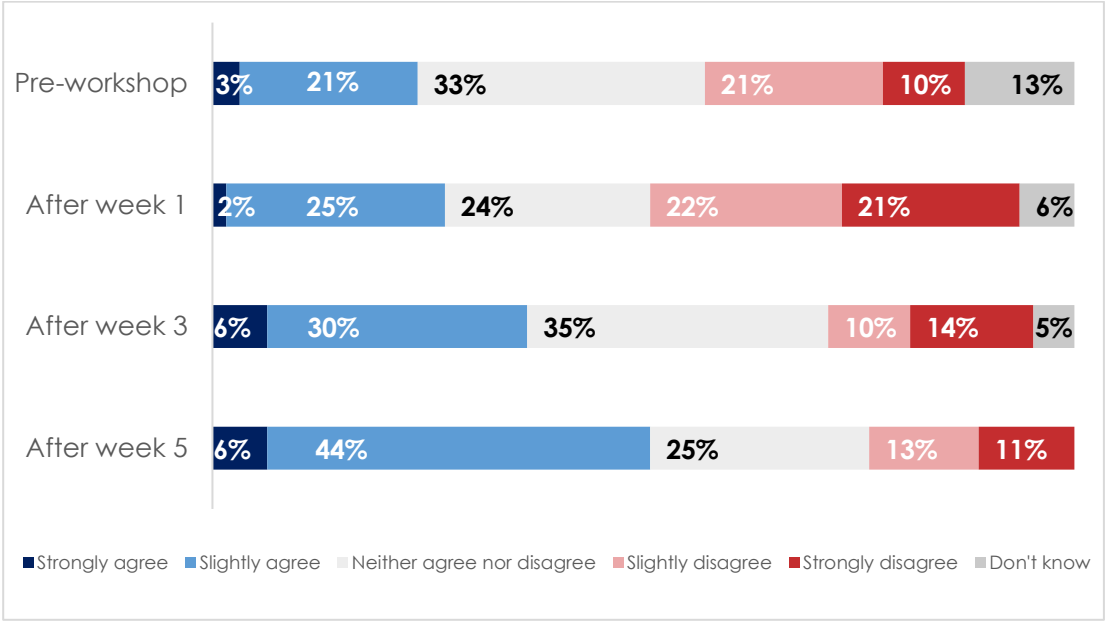
7.1.4. Perception of the role of modular nuclear technology to reach net zero

Figure 7: Graph of survey data from before the dialogue and the end of each theme, for the question 'Do you think that modular nuclear technology has a role to play in the UK reaching net zero?', reflecting those participants who completed all four surveys (n=63)



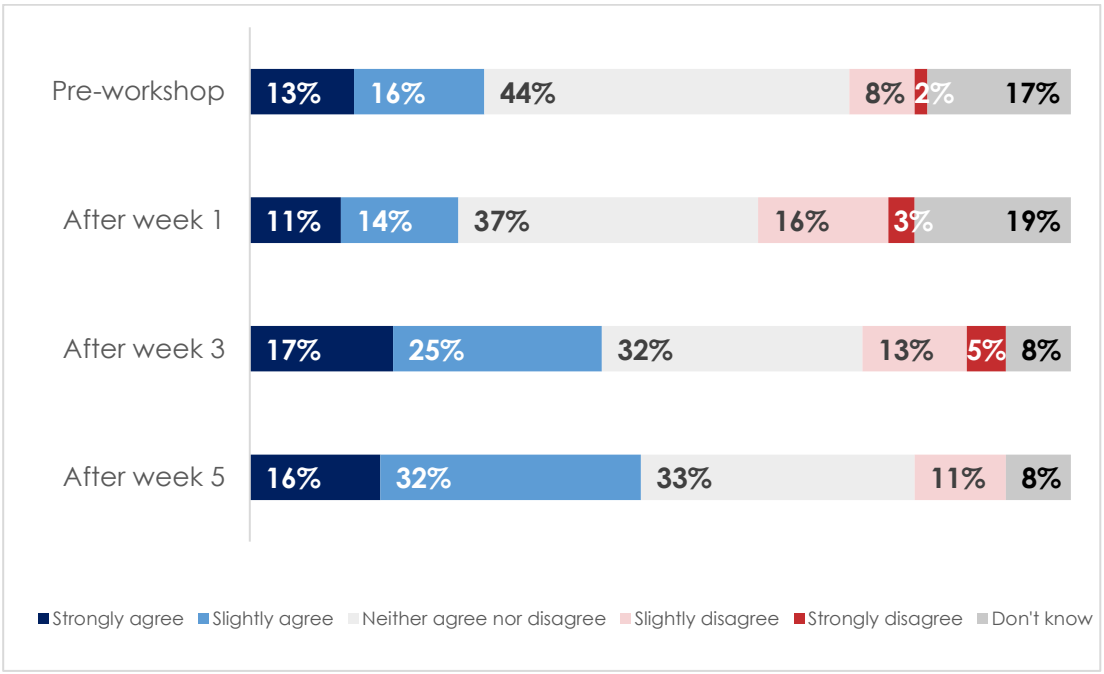
7.1.5. Perceptions about the safety of nuclear energy

Figure 8: Graph of survey data from before the dialogue and at the end of each theme, for the question: 'To what extent do you agree or disagree with the following statements: Nuclear energy provides a safe source of energy in the UK', reflecting those participants who completed all three surveys (n=63).



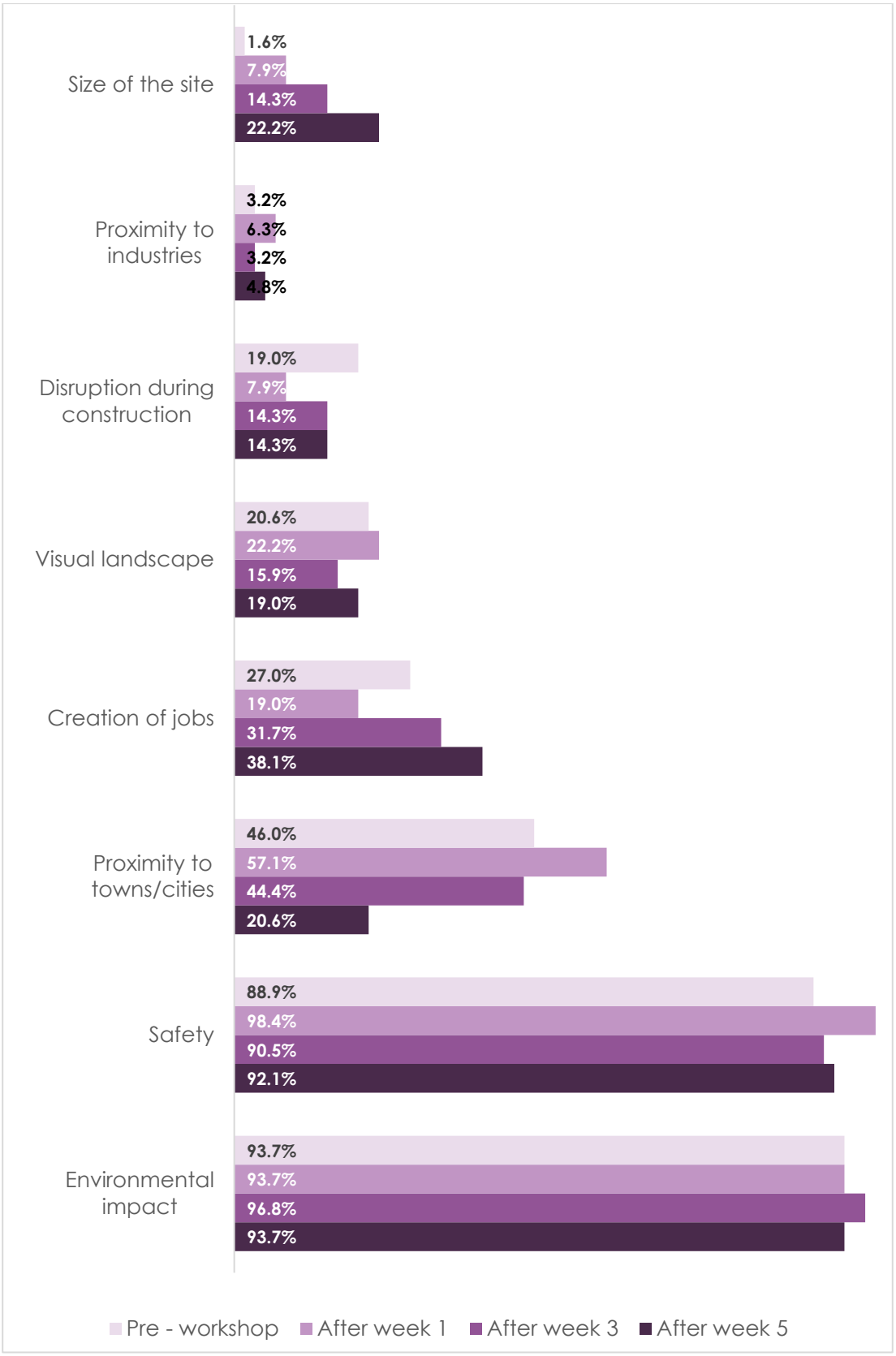
7.1.6. Perceptions about the cost of nuclear energy

Figure 9 Graph of survey data from before the dialogue and at the end of each theme, for the question: 'To what extent do you agree or disagree with the following statements: Nuclear energy offers affordable energy for the UK', reflecting those participants who completed all three surveys (n=63).



7.1.7. Factors to consider when siting a nuclear facility

Figure 10: Graph of survey data from before the dialogue and at the end of each theme, for the question: 'What factors do you think are the most important when considering a site for a nuclear facility?', reflecting the percentage of participants who selected each option (participants could select more than one option), from participants who completed all three surveys (n=63).



7.1.8. Knowledge of modular nuclear technologies

Figure 11: Graph of survey data from before the dialogue, for the question: 'Before this project, how much, if anything, did you know about modular nuclear technologies?', reflecting those participants who completed all three surveys (n=63).

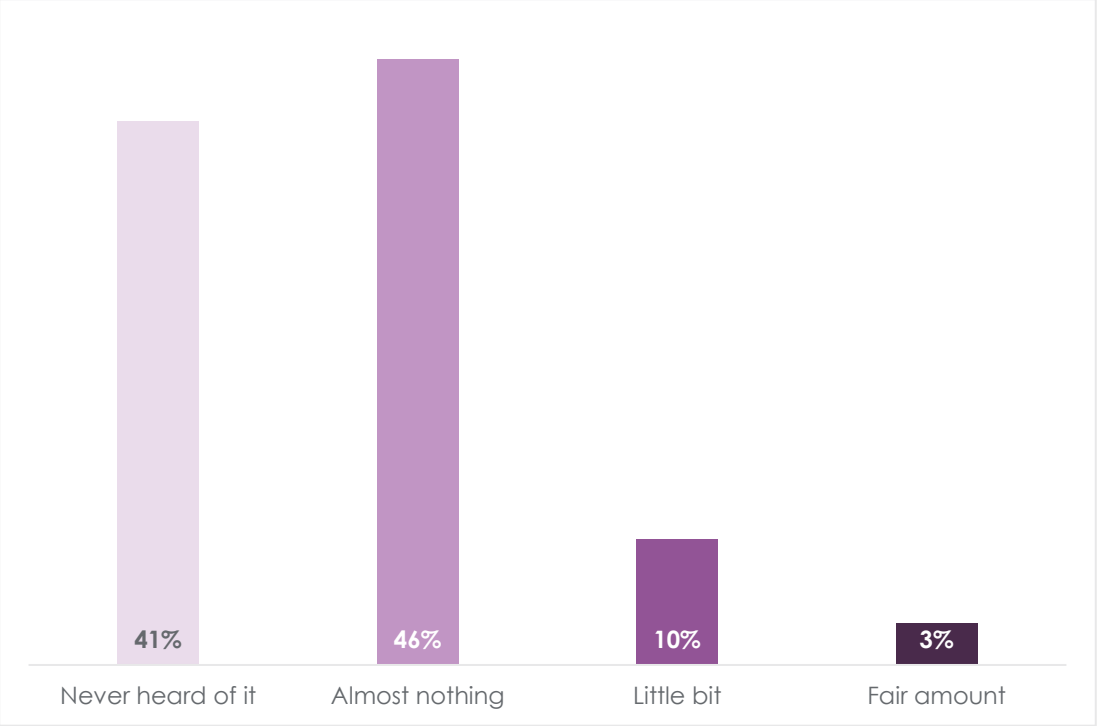
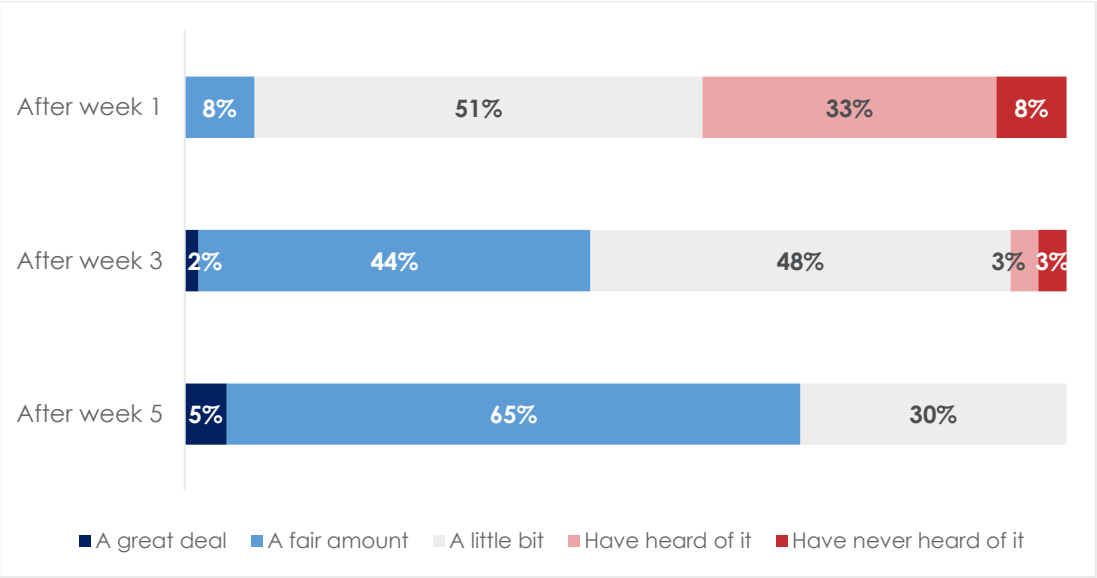
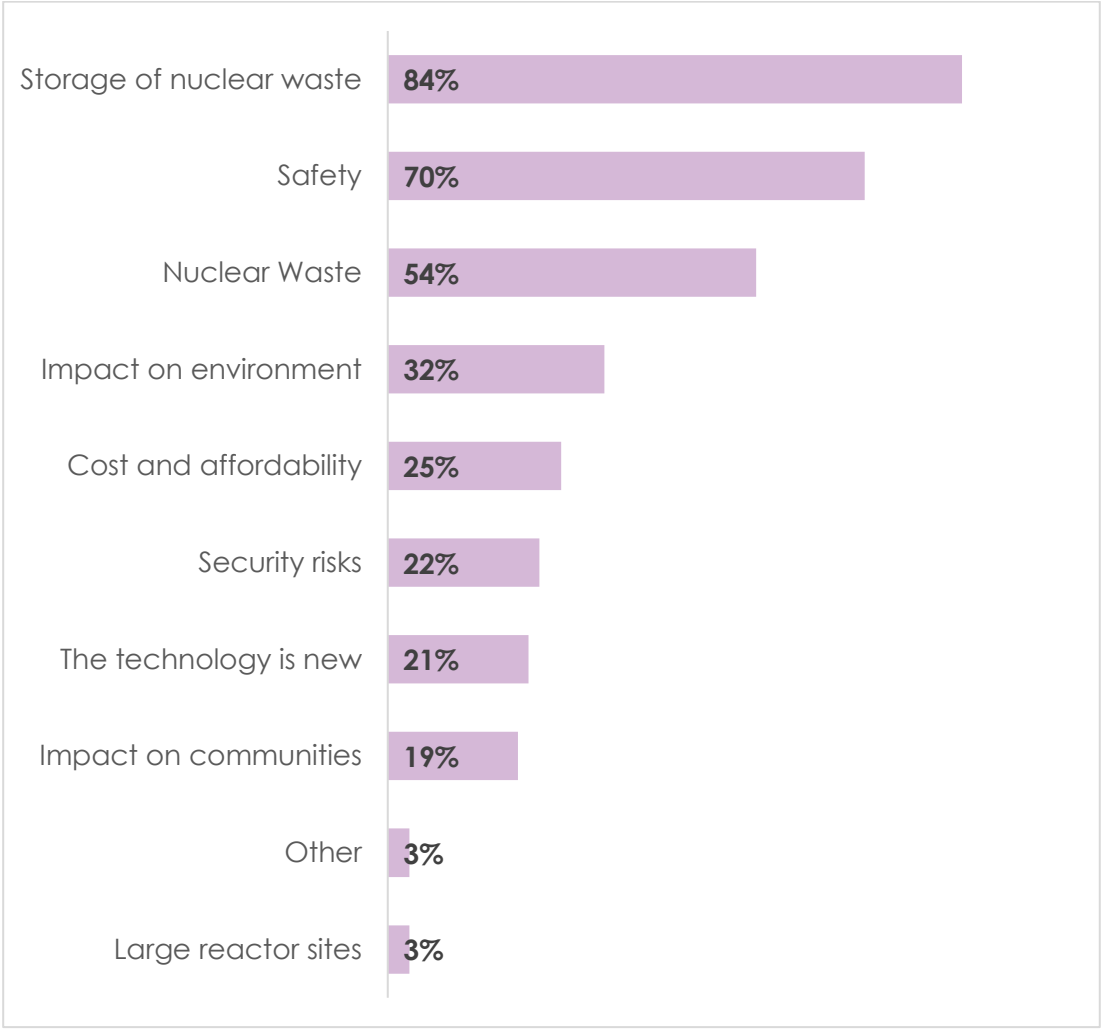


Figure 12: Graph of survey data at the end of each theme, for the question: 'How much do you feel you know about modular nuclear technologies?', reflecting those participants who completed all three surveys (n=63).



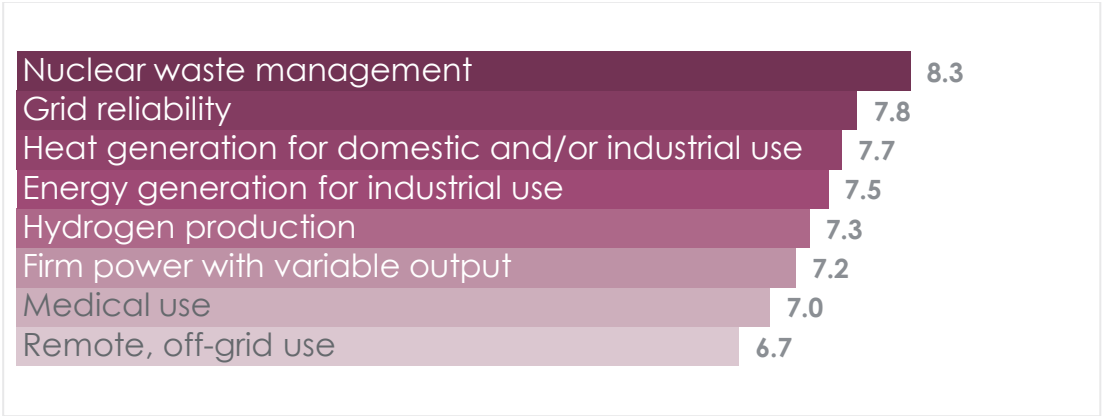
7.1.9. Biggest concerns about modular nuclear technology

Figure 13: Graph of survey data after the last theme, for the question: 'What are your biggest concerns in relation to modular nuclear technology?', reflecting the percentage of participants who selected each option (participants could select more than one option), from participants who completed all three surveys (n=63).



7.1.10. Other potential benefits/uses of modular nuclear technologies

Figure 14: Graph of survey data during the last theme of the dialogue, for the question: 'Rate how important you think it would be for modular nuclear technologies to achieve these different benefits'(on a scale from 1 - not important to 10 - very important), reflecting the average rating of each option, from participants who completed all three surveys (n=63).

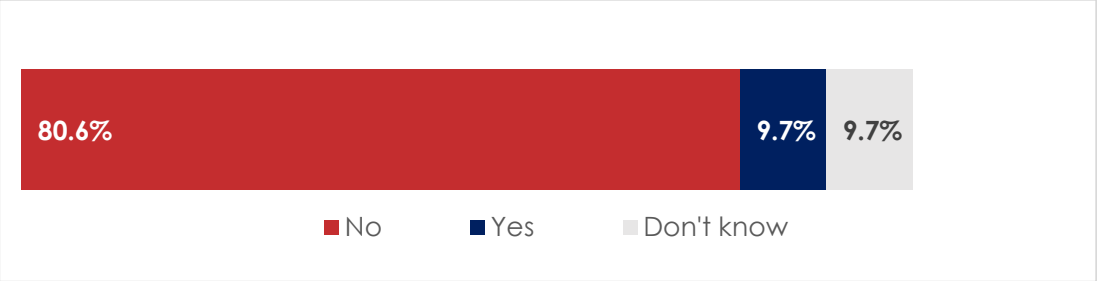


7.2. Regulator polls

During the third week of the dialogue, participants received information about regulation of the nuclear energy industry on the first session and discussed the topic in more depth with specialists on the second session. As part of the activities related to regulation, they participated in a series of two polls to understand their perception and knowledge of the regulation of nuclear energy. The data from these polls is summarised in the graphs below. It accounts for the 62 participants who completed all the polls.

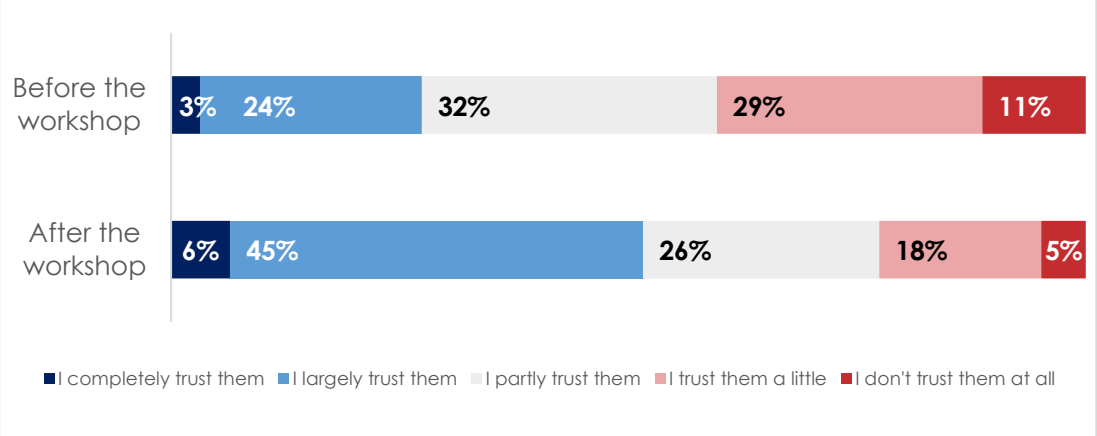
7.2.1. Awareness of the Office for Nuclear Regulation

Figure 15: Graph of first Zoom poll data during the second theme of the dialogue, for the question: 'Before taking part in this session, had you heard of ONR (Office for Nuclear Regulation)?' reflecting participants who completed both polls (n=62).



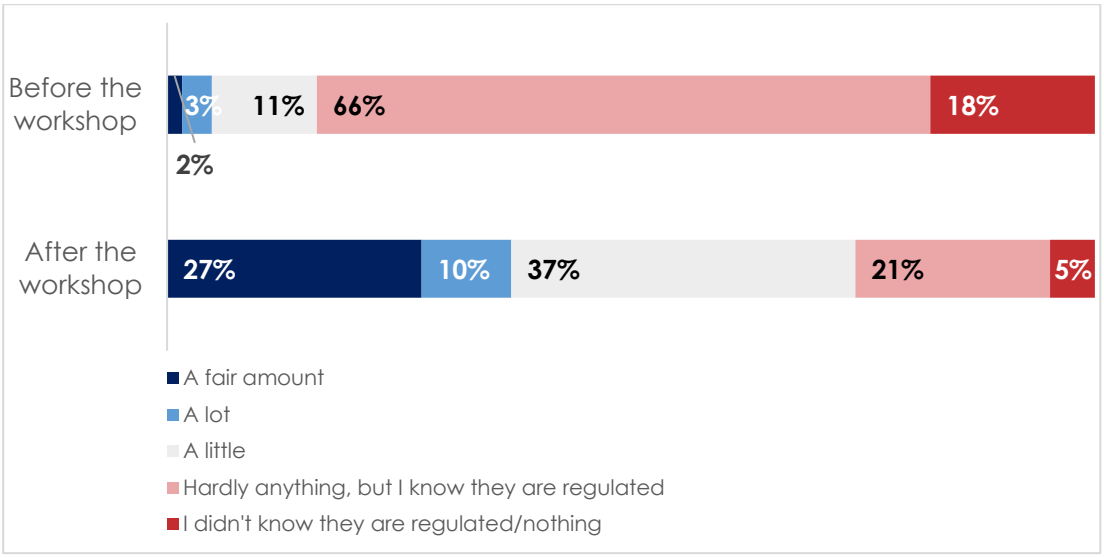
7.2.2. Trust in the organisations responsible for regulating nuclear energy

Figure 16: Graph of Zoom polls data during the second theme of the dialogue, for the question: 'To what extent do you trust or not trust the organisations responsible for nuclear regulation?' reflecting participants who completed both polls (n=62).



7.2.3. Knowledge about regulation of nuclear energy

Figure 17: Graph of Zoom polls data during the second theme of the dialogue, for the question: 'How much do you know about how nuclear power stations are regulated?', reflecting participants who completed both polls (n=62).

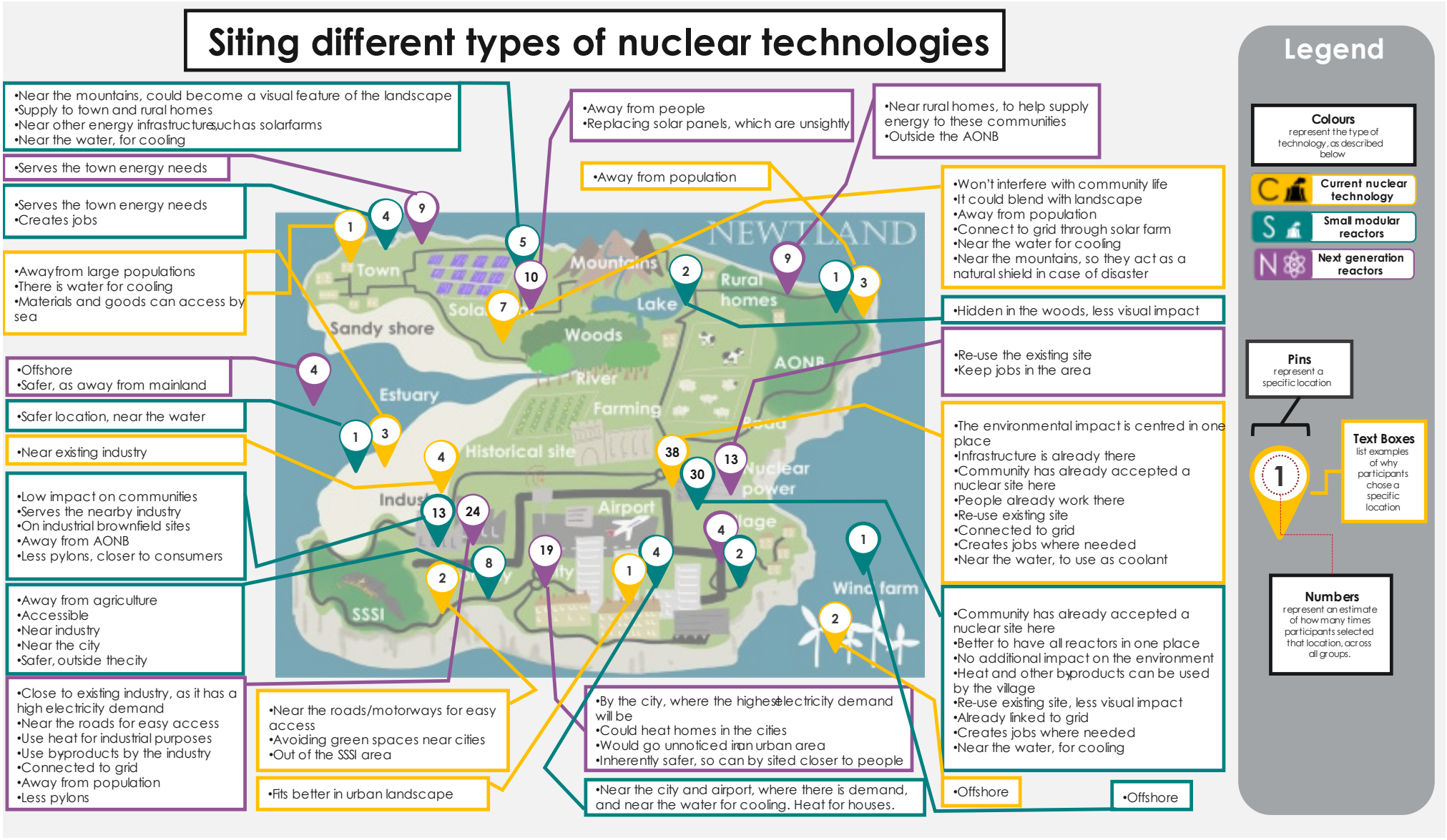


7.3. Siting activity

During the final live session, the 'Siting activity' provided a considerable set of qualitative data (see 6.2 for a description of the activity). The focus of the activity was to serve as a tool to support deeper discussion about the siting of different types of nuclear technologies, and not to collect quantitative data. However, we estimated how frequently an approximate location was selected by participants to site a specific type of technology, to better interpret the relevance of each location and the reasons why they were selected.

The image below summarises the qualitative data gathered from the 'Siting Activity' and shows the estimated number of times a location was selected by participants to site a specific type of nuclear technology, as it was recorded during the workshop discussions. This diagram was also presented to participants once the dialogue ended, to test whether this recollection of the activity felt accurate to them. Participants who interacted with this visual representation of the data commented that it was an appropriate representation of the discussion they experienced during the live session.

Figure 18: Visual representation of the data gathered during the 'Siting activity'.



7.4. Messages for policy-makers

In the final workshop, groups developed messages for policy-makers regarding nuclear technologies.

7.4.1. Group 1:

- Make sure that nuclear waste is disposed of safely
- More research into the siting of next generation reactors
- Make sure the technology is affordable
- Make sure you consider health and safety
- Make sure taxpayer gets value for money
- Think about the environment
- Make sure we take into account national security when exporting these technologies
- Think about exploring alternative technologies
- Engage with the communities
- Consider disruption to the communities
- Make sure the process is transparent
- Compensate communities

7.4.2. Group 2:

- Think about waste
- Think about safety
- Prioritise safety over cost
- Consider keeping the cost of energy low
- Limit impact on the environment
- Present more information about the benefits of nuclear energy to overcome traditional fears about it.
- Invest in research to become leaders in these technologies, particularly using hydrogen
- Consider other technologies (renewables)
- Consider any trade dependencies with other countries.
- Consult communities about the siting of stations
- Consider backup systems that need to be in place in case nuclear fails
- Jobs for the local community
- Offer compensation for the affected communities
- Consider the impact on property value on the areas chosen for siting
- Consider the visual impact of the stations, as in making them more visually pleasant
- Consider where the parts for the SMR will be produced and the potential impact this can have
- Offer training opportunities

7.4.3. Group 3:

- Empower people to decide
- Perform public consultation/engagement
- Present more information
- Educate the public, including kids in schools
- Keep energy affordable
- Think of long-term negative consequences
- Consider other technologies
- Consider how these technologies might be used in other countries
- Consider nature and the environment, wildlife
- Consider re-using the same sites
- Consider the decommissioning of SMRs
- Consider the ethical issues around mining

7.4.4. Group 4:

- Consider safety and security concerns
- Offer more information about regulation
- Make terminology more accessible
- Prioritise achieving net-zero
- Prioritise the production of hydrogen
- Consider the communities when siting
- Consider streamlining the process for geological storage facilities. Undertaking that now instead of in 70 years' time.
- Limit the impact on the environment as much as possible, using pre-existing industrial sites instead of green spaces.
- Limit the proportion of nuclear power used for power. Cap it under 20% to encourage use and development of renewables
- Consider visual impact on the countryside
- Consider the disruption to communities during construction: noise and pollution
- Consider the additional infrastructure required: roads, electric grid.
- Use brown field sites
- More engagement/discussion with the public
- Better education about nuclear
- Tackle misinformation about nuclear
- Ensure the benefits of the technology are clearly highlighted
- Prioritise renewable energy
- Keep costs low

7.4.5. Group 5:

- Think about how to fund these investments
- Think about nuclear waste
- Consider siting in locations where other energy infrastructure is going to be decommissioned, to preserve jobs.
- Take into account the visual impact of the plants
- Re-use existing sites
- Prioritise siting near communities that need jobs
- Safety
- Prioritise building on brown field sites
- Consider traffic and disruption during construction and operation
- Transparency

7.4.6. Group 6:

- Information and education are key
- More transparency
- Ensure the cost of energy remains low
- Consider radioactive waste
- Modelling of the impact
- Raise public awareness of the issues
- Bring the topics to schools
- Consider other technologies, renewables.
- Be transparent
- Consider visual impact
- Consider environmental impact
- Offer compensation to communities
- Keep the price of energy low

7.4.7. Group 7:

- Consider other technologies, such as renewables
- Consider waste
- Make more information available
- Prioritise safety
- Consider impact on the environment
- Educate and engage with the public
- Empower communities to decide how they want to be involved
- Be transparent

7.4.8. Group 8:

- More information about renewables
- Safety
- Consider decommissioning and lifetime

7.4.9. Group 9:

- Consider long term consequences of nuclear waste
- Make sure you protect the environment
- Prioritise transparency. Conflicts of interest should be declared and made public knowledge.
- Prioritise safety
- Help to improve local economies and industries
- Prioritise keeping the cost of energy affordable
- Make sure there is appropriate community engagement
- Consider scrutiny by independent parties
- Consult the community
- Consider the impact on agricultural economy
- Avoid densely populated areas.
- Avoid local historical beauty.
- Make sure that the majority of the jobs go to local people, incentives for training, apprenticeships and things like that.
- Transparency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