

Enabling resilient UK energy infrastructure: natural hazard characterisation technical volumes and case studies

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Outline

- 1 Context for the project
- 2 Project overview
- 3 Where to find out more
- 4 Summary

Context

Context

Structure of consortium

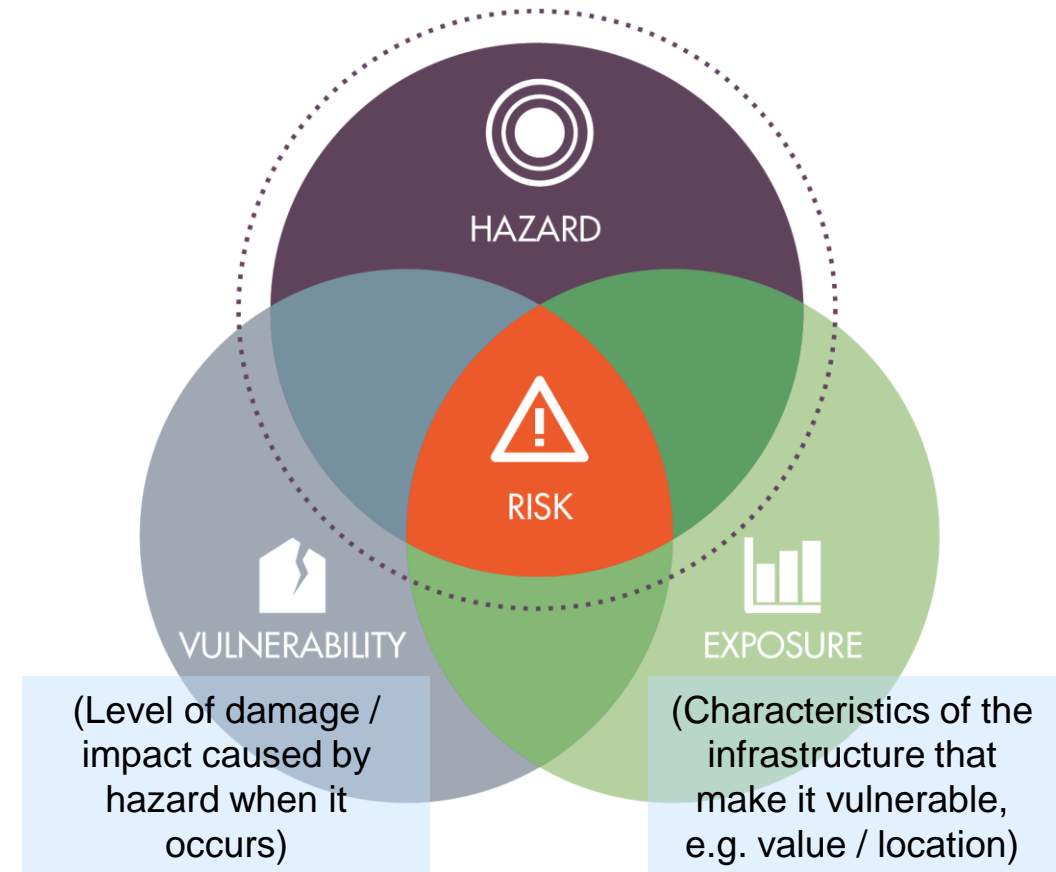
Context

- Natural hazards can be **damaging** / **dangerous** to the energy system and more widely, e.g.:
 - **North Sea flood, 1953** – 326 fatalities, start of modern coastal protection schemes in the UK
 - **European heatwave, 2003** – 40,000 heat-related fatalities around Europe; cost to farming industry €13.1bn
 - **Fukushima event, 2011** – 19,000 fatalities; 100,000 people evacuated from local area. Caused by combination of hazards



Context

- Risk associated with natural hazards =
 $f(\text{hazard, vulnerability, exposure})$
- If we do not understand any one of these elements, our understanding of the overall risk may be lacking – not good, given likely value of infrastructure!
- Resilience is required through all stages of infrastructure life cycle
- **Climate change** could affect frequency and/or magnitude of future hazards, and hence change risk level



Context

- Shared understanding of hazards and associated risks means industry stakeholders can:
 - **Protect** the infrastructure asset(s) and associated investment(s)
 - Ensure **H&S** of site personnel & local inhabitants
 - Optimise infrastructure **design**
 - **Operate** and **maintain** infrastructure cost-effectively
 - Ensure **resilience** of service to customers
 - Satisfy industry **standards / regulations**



Consortium delivering the project

Funded by Energy Technologies Institute (ETI)

Core partners:

EDF Energy (PM and CTO)

- R&D division
- Nuclear Generation
- Nuclear New Build Gen. Co.

Met Office (extreme weather R&D)

Mott MacDonald (translation to engineering practice)

Support:

Air Worldwide (insurance world view)

Verisk (space weather)

HR Wallingford (biological clogging/biofouling)



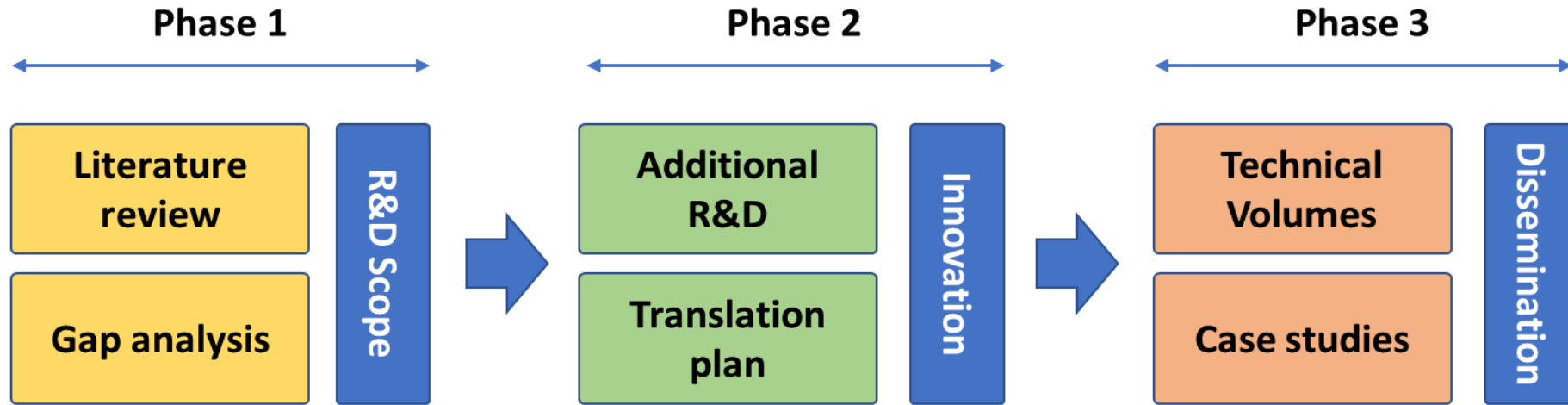
Project overview

Phase 1: Literature review & gap analysis

Phase 2: Addressing the main gaps through R&D

Phase 3: Delivery of technical volumes and case studies

The project



Scope of Phase 1

Review of the available methodologies for characterisation of natural hazards and existing gaps

Scope of Phase 2

Addressing gaps through specific R&D actions

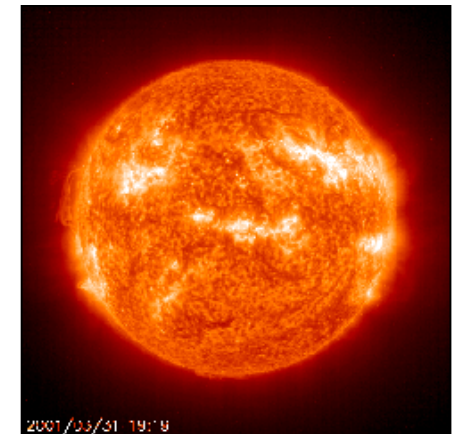
Scope of Phase 3

Deliver, illustrate and disseminate the technical volumes and case studies

Phase 1 – literature review & gap analysis

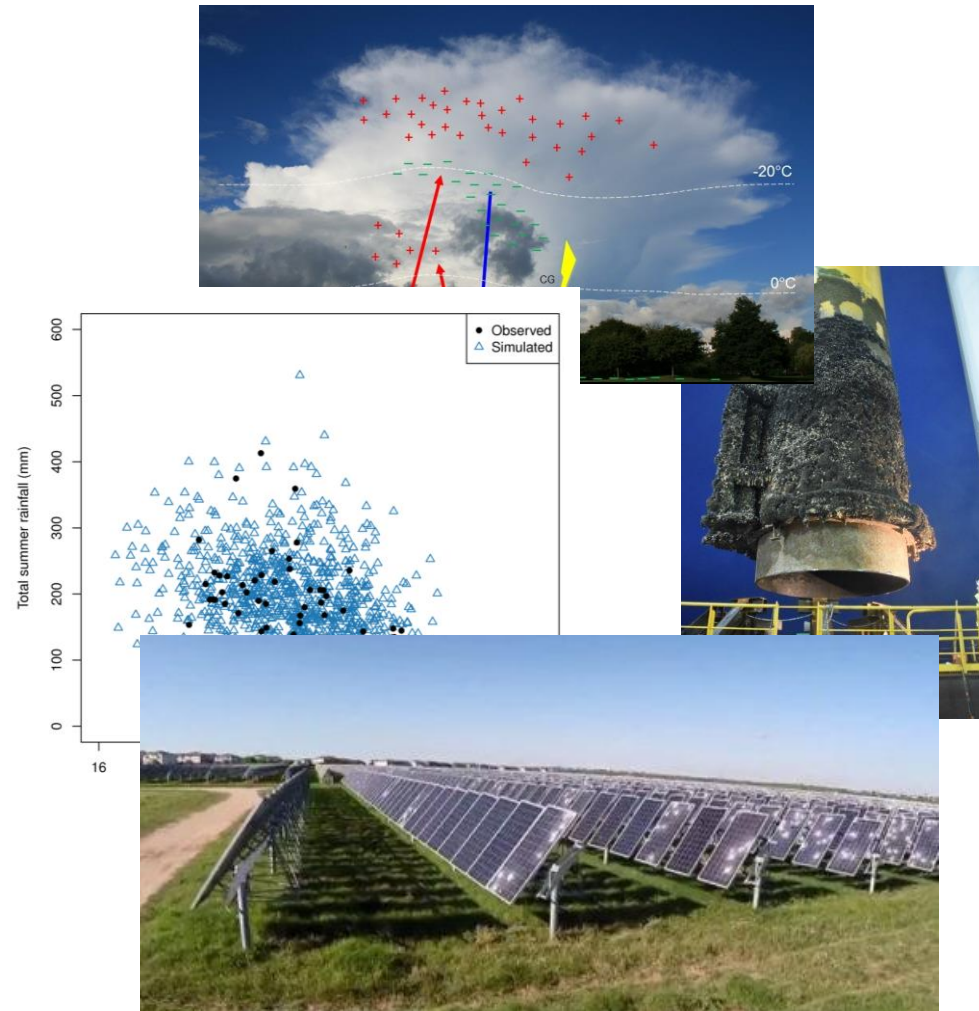
- **Scope:** available mature methodologies; sectors impacted by each natural hazard; examples of industry applications; existing guidelines / regulatory frameworks relevant for UK; trends in R&D; gaps in current literature
- Identified **five knowledge gaps:**
 - Hail
 - Lightning
 - Space weather
 - Marine biological fouling
 - Hazard combinations

⇒ Further R&D work in **Phase 2**



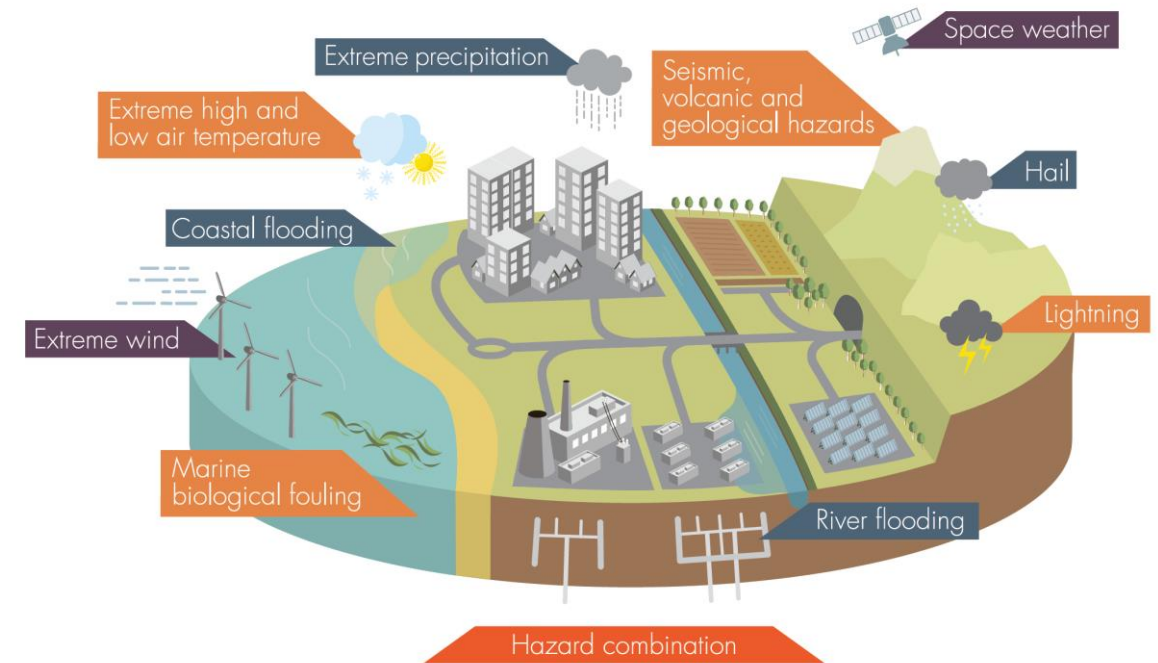
Phase 2 – addressing the main gaps through R&D

- **Additional R&D** to address gaps identified in Phase 1
- Work undertaken by **experts from project consortium organisations**
- All reports subject to rigorous **peer review** process to ensure quality of R&D output
- Phase 2 outputs to sit alongside technical volumes from more well-established hazards in Phase 3 of the project

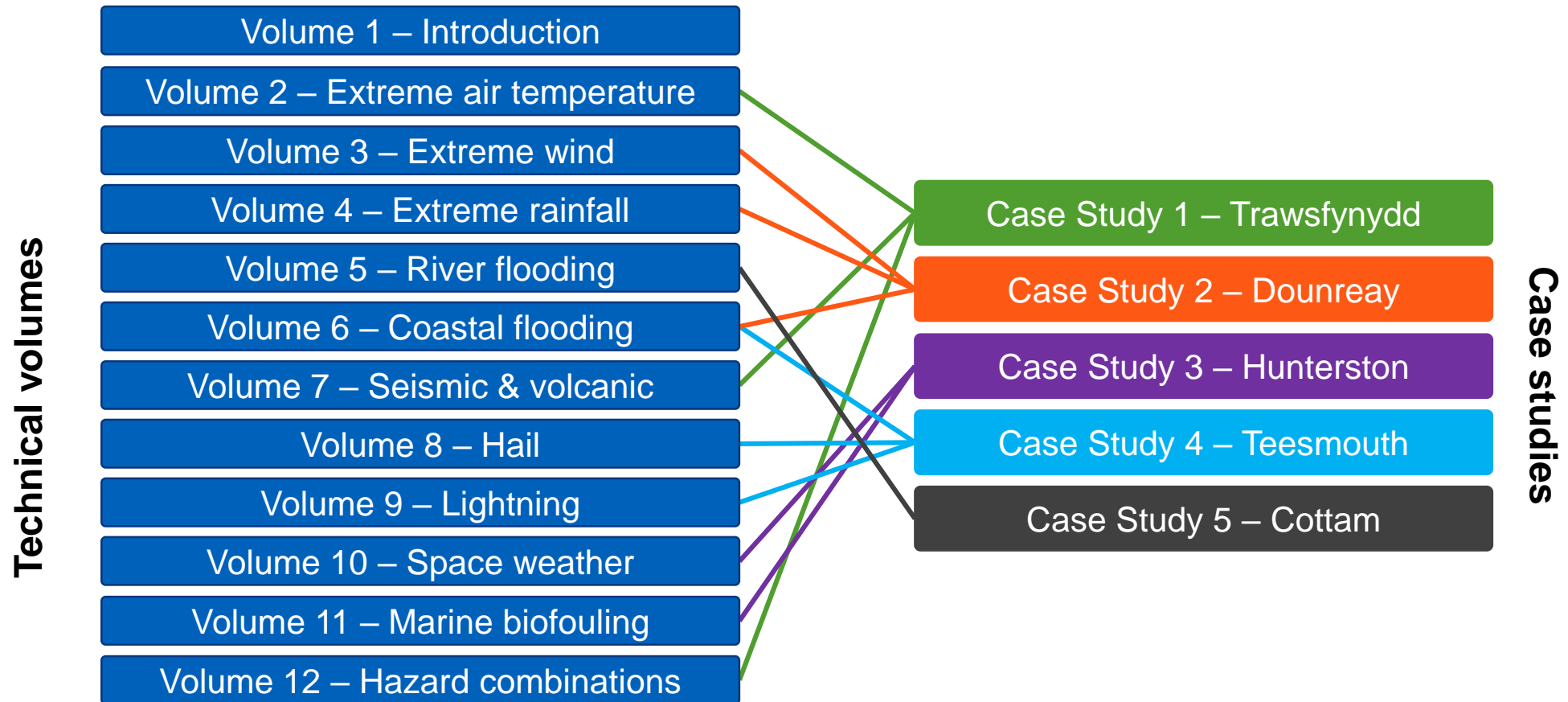


Phase 3 – delivery of technical volumes & case studies

- Prepare high-quality, peer-reviewed documents:
 - Summarising **good practice for natural hazard characterization**
 - **Consistent** across natural hazards
 - **Accessible** to end-users from a variety of **different industries**
- 12 technical volumes supported by 5 case studies:
 - **Technical volumes** summarise the science behind hazard characterisation
 - **Case studies** show how this science can be applied for a specific site



Structure of Phase 3



Why these case studies?

- **Trawsfynydd** – representative of an **inland** site
- **Dounreay** – representative of a site with **onshore** and **offshore** infrastructure
- **Hunterston** – representative of a **coastal** site
- **Teesmouth** – representative of an **estuarine** environment
- **Cottam** – representative of an inland site close to a **river**



Structure of the output documents

TECHNICAL VOLUMES

1. Introduction
2. Description of the main phenomena
3. Observations, measurement techniques, and modelling tools
4. Methodology
5. Related phenomena
6. Regulations
7. Emerging trends

CASE STUDIES

1. Introduction
2. Characterisation of the natural hazards
3. Conclusion













Peer review process

- Each document in Phase 3 has undergone an extensive **peer review** process, including:
 - **Internal** peer review – undertaken by members of the project consortium who were not involved in the writing of the original document
 - **CTO** review – the Chief Technical Officer provides a review to ensure consistency and technical quality across the documents
 - **Steering committee** review – a panel of **industry experts** from different organisations (IChemE, IMechE, ONR) read and provide comments on each document, for response by the project team



Where to find out
more

Where to find out more

 <p>Vol. 1 Introduction</p> <ul style="list-style-type: none">• Motivation behind the project and aims of the technical volumes and case studies.• Explanation of the project's documents. Primers to common technical aspects of the project.	 <p>Vol. 2 Extreme high and low air temperature</p> <ul style="list-style-type: none">• Characterising extreme high and low air temperatures.• Frazil ice formation, wildfires and enthalpy.	 <p>Vol. 3 Extreme wind</p> <ul style="list-style-type: none">• Characterising extreme wind and tornadoes.• Related phenomena include sandstorms.	 <p>Vol. 7 Seismic, volcanic and geological hazards</p> <ul style="list-style-type: none">• Characterising the risks posed by earthquakes, volcanic-ash dispersion and geological instability.• Related phenomena include tsunamis.	 <p>Vol. 8 Hail</p> <ul style="list-style-type: none">• Characterising the hail hazard.	 <p>Vol. 9 Lightning</p> <ul style="list-style-type: none">• Characterising the lightning hazard.
 <p>Vol. 4 Extreme precipitation</p> <ul style="list-style-type: none">• Characterising extreme rainfall.• Other hazards - extreme snow, ice, fog, mist and humidity.	 <p>Vol. 5 River flooding</p> <ul style="list-style-type: none">• Characterising flooding from fluvial sources.	 <p>Vol. 6 Coastal flooding</p> <ul style="list-style-type: none">• Characterising flooding from coastal sources such as high tide, extreme sea level, storm surges and wind-generated waves.	 <p>Vol. 10 Space weather</p> <ul style="list-style-type: none">• Effects of geographically induced currents.• Solar energetic particle hazard is also outlined.	 <p>Vol. 11 Marine biological fouling</p> <ul style="list-style-type: none">• Identification of and mitigation measures for marine species which grow around and clog up coastal or offshore facilities.	 <p>Vol. 12 Hazard combinations</p> <ul style="list-style-type: none">• Investigating the combined impacts of multiple hazards occurring close together in space and/or time.

- The documents have been **published online** by the IMechE and IChemE at www.imeche.org/eti
- The documents are **freely available to all**
- The IMechE and IChemE will be the “enduring homes” for the project with **potential future updates** as required with changes in the state of the art

Summary

Summary

- The project has delivered a series of high-quality outputs, directly focused on **how to characterise a variety of different natural hazards** in a consistent way, and describe **good practice in an accessible form for industry**
- The hazards considered range from those with relatively well-developed characterisation approaches, to several newer topics that have been researched as part of this project
- The documentation can **inform hazard mitigation** through original design, operational procedures, improvement projects, and emergency preparedness
- Although created for the UK energy infrastructure sector, there is **scope to use the project outputs across many other UK infrastructure sectors**, such as water and transport

Questions