Programme Area: Nuclear

Project: Natural Hazards Phase 3

Title: Enabling Resilient UK Energy Infrastructure: Natural Hazard Characterisation Technical Volumes and Case Studies

Abstract:

This document sets the context for the outputs of the project known as "Natural Hazards Characterisation Technical Volumes and Case Studies." It provides:

• The background context to the project and the project outputs
• Why the subject matters and action is required
• A navigation aid to the suite of documents, what they individually contain, and how they fit together
• The target audience; infrastructure owners, operators, asset managers, developers, investors, regulators and insurers
• Broader relevance and read across into transport, the built environment, and civil emergency planning and response to the impact of natural hazards
• Learning from the execution of this 5-year project relevant to investing and realising the benefits from complex, collaborative R&D
• Guidance on where to find more

Context:

The Natural Hazards Review project will develop a framework and best practice approach to characterise natural hazards and seek to improve methodologies where current approaches are inefficient. This is to improve energy system infrastructure design and the project is intended to share knowledge of natural hazards across sectors. The project will be completed in three stages. Phase one will focus on a gap analysis. Phase two will look at developing a series of improved methodologies from the gaps identified in phase one, and phase three will demonstrate how to apply these methodologies. Finally, phase 3 will develop a "how to" guide for use by project engineers.

Enabling Resilient UK Energy Infrastructure: Natural Hazard Characterisation Technical Volumes and Case Studies

Launch event

12 November 2018

Foreword

The transition to a low carbon energy future is under way, but with it comes the realisation that impacts from natural hazards are increasing in frequency and severity. Our future energy systems and infrastructure need to have resilience designed in. It is our hope that this excellent piece of work will form a legacy for the energy industry for years to come.

Jon Wills
CEO of the Energy Technologies Institute

Resilience is the capability to recover quickly from difficulties. The UK energy infrastructure, as it transitions to a low carbon, efficient and integrated system, needs to maintain this capability central to its development. These comprehensive technical volumes, produced collaboratively by a team of domain experts, provide important resources to the wider energy community; they shall help end-users to understand, characterise and mitigate the impacts of natural hazards, thus enabling resilient UK energy infrastructure.

Xavier Mamo
Director of EDF Energy R&D UK

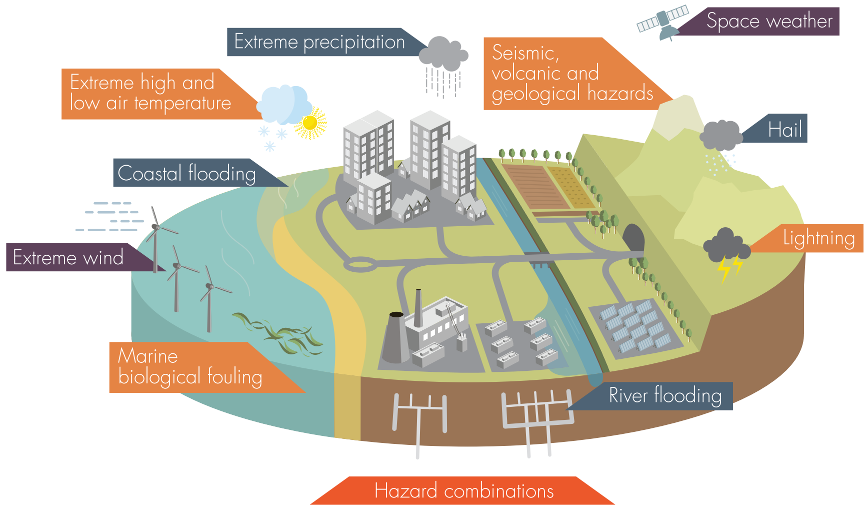
Context

Natural hazards have the potential to cause damage to various types of infrastructure across the energy system. It is vital for stakeholders within the industry to have a shared understanding of the risks and impacts of those natural hazards. This understanding enables them to adequately protect the owner's asset and the shareholders' investment and:

- ensure the health and safety of persons on site and in the local area;
- optimise the design of infrastructure to reduce the risk of expensive unscheduled engineering works;
- operate and maintain high-value infrastructure in a cost-effective manner;
- ensure resilient service to customers;
- satisfy industry-specific standards and regulation to ensure the safe operation of infrastructure.

Major shifts in the UK energy system are expected to occur in the near future, with pre-existing energy infrastructure reaching end of life, and future infrastructure design being driven by economics, innovation, and social acceptability. These changes mean that a shared understanding of the risks and impacts of natural hazards are even more important.

Many different natural hazards have the potential to impact UK infrastructure. Some — such as coastal flooding and extreme precipitation — are commonly found in the observational record and are known to have a large impact. Others — such as space weather and marine biological fouling — also pose a risk but have not been subject to as much research, and their impacts are much less well known.

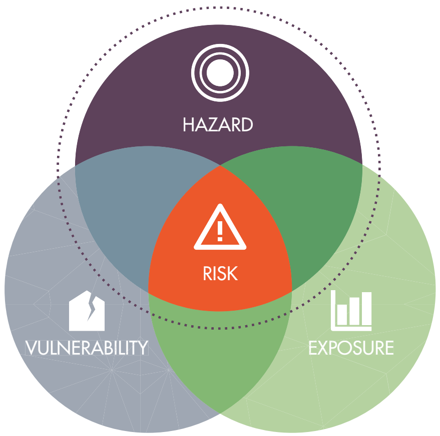


Natural hazards and the UK energy industry.

The provision for funding of research into natural hazards is often driven by past events that have affected the UK. This is understandable given the harsh and recurring damage caused by events such as the storms of 2013/14 and 2015/16. However, this approach can lead to a shortfall in other areas and drive research into silos, without a higher-level context across the range of natural hazards.

Research into the environment and natural hazards can also encapsulate a variety of approaches and techniques. Broadly, the aim of research in this area is to better understand the risks posed by natural hazards to energy infrastructure. Risk is often defined in terms of three themes:

1. Hazard – How could a natural hazard manifest, how often will this happen, and how intense will it be when it happens?
2. Vulnerability – To what degree is infrastructure likely to be damaged by a hazard if/when it occurs?
3. Exposure – What are the characteristics of the infrastructure that could be vulnerable to a hazard (e.g. value, type of building or system)?



A total estimate of risk considers the hazards, vulnerability and exposure. In this project the focus is the characterisation of the hazards.

All three of these aspects are important to give a full understanding of the risks to infrastructure and people posed by natural hazards. Vulnerability and exposure can vary across different industries and technologies, and need to be analysed on a case-by-case basis to ensure the appropriate level of protection. The natural hazard will occur at a given location irrespective of the infrastructure that is located there. Therefore it is valuable to have a better shared understanding of current good practice in characterising the range of UK natural hazards, as this can have widespread use across the whole energy industry, irrespective of the specific infrastructure. Without an appreciation of the different approaches available to characterise natural hazards and shared confidence in the application of relevant good practice, our understanding of the overall risk and confidence in its effective mitigation may be lacking.

Why is it important?

Our energy system needs to change to deliver decarbonisation and efficiency improvement. It will continue to evolve to take advantage of new technologies and innovations that could provide cleaner and greener energy solutions, and which are expected to have a greater reliance on system integration, and information and computing technology.

The impact of climate change is likely to drive alterations in the way that we live and use energy. Climate change is also expected to influence the frequency and intensity of natural hazards which could impact the production and distribution of energy. As it evolves, the UK's energy infrastructure must meet future needs and with adequate resilience to the impact of natural hazards.

Irrespective of the type of infrastructure, the potential impacts of natural hazards are becoming increasingly important – hence the need for a better understanding of hazard characterisation, regardless of the asset's vulnerability and exposure.

Whilst this project has its origins in the future needs for energy system infrastructure, the information and its applicability is relevant beyond this sector.

Past events

A set of storms struck the UK from December 2013 to March 2014 causing persistent rainfall, coastal flooding, river flooding and extreme wind.

The main impacts included flooding of the Somerset Levels and severe damage to the main railway line between Exeter and Newton Abbot at Dawlish.

The total economic damages were valued at £1.3 billion. Power, rail and road networks were impacted with up to 1 million customers affected by power outages. The direct impact to energy utilities was rated at a maximum of £1 million. This was not huge given the fact that the storms did not directly impact key power generation infrastructure. However, power outages exacerbated the impacts on residential properties (approx. £320 million cost) and businesses (approx. £270 million cost).

A similar succession of storms was also observed over the winter of 2015/16 with Storms Desmond, Eva and Frank causing widespread flooding across the UK and leading to a new UK record of 341.4 mm of rainfall within a 24-hour period at Honister Pass in Cumbria.

Sources:
Defra report - The costs and impacts of the winter 2013 to 2014 floods
https://www.metoffice.gov.uk/climate/uk/interesting/2013-decwind
https://www.metoffice.gov.uk/climate/uk/interesting/december2015

Why read this?

It is clear that natural hazards have the potential to disrupt, but how can we appropriately characterise different hazards with confidence? To do this it is necessary to understand how to use the various sources of environmental data that are now available for this purpose. This cannot be done properly without an appreciation of state-of-the-art methodologies that currently exist.

Too often, environmental risk analyses are undertaken in silos with different approaches existing for different hazards. New approaches have been developed through academic literature that currently are not necessarily well utilised in the energy industry. But it is also necessary to ensure that these academic techniques have been well validated before they are used to support the design of critical energy infrastructure.

This background of different approaches is useful for continuing science and research, but there is also a need to identify, capture and communicate current relevant good practice. Access to well-structured and clearly documented good practice can help avoid the use of outdated methods which could lead to the inaccurate specification of risk, resulting in inadequate or overly conservative infrastructure design. It is the absence of accessible and well-structured good practice that led to the Energy Technologies Institute's commissioning of its Natural Hazards Project.

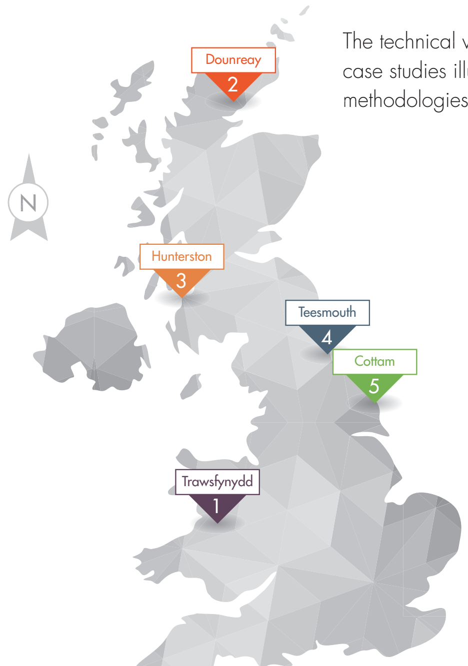
This project is the first to bring together a set of technical volumes and case studies that are directly focused on how to characterise a variety of natural hazards in a consistent way. This consistency is vital for end-users who need to consider how to protect infrastructure against a variety of hazards and combinations of hazards, not just specific hazards that have been well researched in the past.

These documents summarise the current state-of-the-art when it comes to characterising natural hazards. These hazards range from coastal flooding and extreme precipitation, with more developed characterisation approaches, to newer topics that have been researched as part of this project (hail, lightning, space weather, marine biofouling, hazard combinations).

Technical volumes have been authored for a range of natural hazards.

Volume 1 Introduction to the Technical Volumes and Case Studies	**Volume 7** Seismic, Volcanic and Geological Hazards
Volume 2 Extreme High and Low Air Temperature	**Volume 8** Hail
Volume 3 Extreme Wind	**Volume 9** Lightning
Volume 4 Extreme Precipitation	**Volume 10** Space Weather
Volume 5 River Flooding	**Volume 11** Marine Biological Fouling
Volume 6 Coastal Flooding	**Volume 12** Hazard Combinations

The technical volumes are supported by case studies illustrating the application of the methodologies at five UK sites.



How to use these documents and who should be interested

The technical volumes and case studies provided by this project have been designed to assist end-users in a multitude of contexts. In particular, they aim to:

- assist in the design of new infrastructure to ensure robustness to natural hazards now and into the future with climate change;
- ensure that current infrastructure is adequately protected against natural hazards, in particular those emerging hazards researched as part of this project (e.g. space weather, hail, lightning);
- inform investment decisions for new infrastructure projects as well as assisting with re-investment decisions to support life extension;
- improve current operational procedures across the energy industry;
- lead to better preparedness and response time during extreme events.

For the reasons outlined above, it is anticipated that infrastructure owners, operators, asset managers, developers, investors, regulators and insurers could benefit from the information contained in the technical volumes and case studies, which allows for the better characterisation of natural hazards affecting all of these end-users.

The potential benefits accrue from the application of relevant good practice by developers, asset managers and operators, and expectation of the application of good practice by investors, regulators and insurers.

Broader relevance

The technical volumes and case studies are aimed at the UK energy industry. The intended focus on the characterisation of the hazards as opposed to the vulnerability or exposure of specific assets means that these documents could be used by a wider set of end-users within different sectors, including:

- transport (air, road, rail and marine);
- the built environment including industrial and residential developments, housing and urban planning; and
- civil emergency planning and response to the impact of natural hazards.

Learning from the project

The project has led to the development of a set of technical volumes and case studies. It has been delivered within the Energy Technology Institute's £400 million programme of projects over a ten-year period, where each project has provided an opportunity for learning. For such a cross-cutting project bridging environmental research and industrial application, the following were identified as potential learning points for future cross-cutting projects:

- The benefit of having a detailed scoping study funded at the start of the project to identify what R&D might be done within the project constraints. This scoping study should be led by a diverse multi-disciplinary team with broad cross-sector experience.
- Where gaps in existing knowledge and shared understanding are identified, it is necessary to undertake expert R&D to address these knowledge gaps. This R&D work needs to be mindful of the need for transfer into practical solutions and tested through appropriate peer review to ensure rigour in research and practicality in application.
- The translation of the R&D into the final project deliverables needs to be done in a consistent way with a multi-stage review process, involving appropriate technical oversight, independent peer review, and user testing (in this instance through an external expert steering committee).
- The final outputs need to be accessible to industry, organisations and individuals at initial release and into the future. Consideration should be given to the type of host organisations with the necessary infrastructure and reach capable of making the outputs easily accessible to the intended audience.
- The learning points above demand active and expert management of intellectual property throughout such a project if the intended benefits are to be realised.

The test of the value of these technical volumes and case studies is the extent to which they are referenced and utilised by end-users. In the longer term, the ultimate test of their value in sharing a common understanding or relevant good practice is whether there is demand for future revision. Such future revision may incorporate changes arising from the industrial application of longer term research projects which change the state-of-the-art.

Where to find out more

This project has been funded by the Energy Technologies Institute (ETI). The ETI is a £400 million industry and UK government partnership in low carbon energy system planning and technology development. Its mission was to accelerate the development, demonstration and eventual commercial deployment of a focused portfolio of energy technologies, which will increase energy efficiency, reduce greenhouse gas emissions and help achieve energy and climate change goals. Since 2007, the ETI has invested in research and development activity across heat, power, transport and the infrastructure that links them — delivering innovation from strategic thinking to technology demonstration. It has created a project portfolio that has built knowledge and developed and demonstrated new technologies alongside undertaking whole energy system strategic analysis and planning.

This document has been prepared for the ETI by EDF Energy R&D UK Centre Limited, the Met Office, and Mott MacDonald Limited. The technical volumes and case studies are accessible from the websites of the Institution of Mechanical Engineers and the Institution of Chemical Engineers; this document (alongside the technical volumes and case studies) is also located on the ETI's website in the knowledge zone.

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