

## Adaptation and Resilience of the UK Energy System to Climate Change

### Key messages from research

In 2012, the Engineering and Physical Sciences Research Council<sup>1</sup> invested over £3m in research<sup>1</sup> to better understand the implications of climate change, including severe weather events, on the UK energy generation and transmission systems, and to consider potential adaptation strategies. Knowledge and evidence now emerging from this research aims to inform the development of national and regional policies seeking to ensure that resilient systems are in place to meet future energy needs.

#### Adaptation and Resilience in Energy Systems (ARIES)

Professor Gareth Harrison, [Gareth.Harrison@ed.ac.uk](mailto:Gareth.Harrison@ed.ac.uk)

*Assessing future changes in energy demand and their effect on energy provision in a future climate. Investigating the impact of climate change on large-scale renewable energy generation.*

- Changing climate will affect renewable energy through changes in resource and operational performance but changes are modest and tend to reinforce existing seasonal and regional variations. Some resources such as solar and hydropower are likely to increase slightly, while wind and wave show limited changes. In most cases the need for adaptation is low but there appears to be evidence for positive adaptation measures for hydropower.
- Systematic bottom-up modelling of energy demand can be used as part of an appraisal of impacts of climate change on electricity generation and demand.
- The characteristics of energy demand exhibited by individual buildings can be effectively aggregated through the use of upscaling algorithms integrated with existing software used by industry. This enables energy demand projections to be based on detailed energy performance modelling of multiple buildings at high temporal resolutions. This form of data is of greater value to those concerned with the generation and distribution/transmission of energy.
- The probabilistic nature of future climate projections can allow a climate-based risk analysis to be carried out on the likelihood of defined thresholds being exceeded. This can aid the design of resilience into energy networks that are serving that demand.
- Whilst there are clearly climate impacts on both supply and demand, the expected changes appear to be less significant than the changes that will be brought about through technological and behavioural change arising from efforts to decarbonise.

#### Resilient Electricity Networks (RESNET)

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*Providing a comprehensive approach to analysing climate-related changes in the reliability of the UK's electricity system, and tools for quantifying the value of adaptations to enhance resilience to climate and socio-technological changes.*

- The physical infrastructure of the national grid is likely to remain resilient to direct climate change impacts over the coming twenty years, assuming that electricity demand does not significantly increase. Whilst higher

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temperatures will impact transmission capacity, there are a range of measures that can easily mitigate this in the short term.

- The grid will need very substantial upgrading if the UK is to make the changes necessary to deliver on its 2°C commitments, driven by both rapid increases in electricity demand and the addition of new generating plants. Increasing levels of intermittent supply will have repercussions for grid operation, but the electrification of heating as well as road transport will place substantial new loads on the grid, with associated implications for societal resilience to interruptions in the electricity supply.
- The increased electrification of household energy services such as heating if not coupled with significant efficiency savings could lead to an additional demand of approx. 46TWh per annum (based on 45% of households installing heat pumps).
- In the event of widespread adoption of air conditioning within the commercial and domestic sector, there will be a significant increase in summer electricity demand, potentially shifting peak annual demand from winter to summer before 2030.
- The impact of the future wind climate on electricity networks is still uncertain. The latest round of climate projections are still dominated by uncertainty, as the projected changes are relatively small compared to the range of results from different models. This is particularly true for wind extremes, where the problem is compounded by the limited ability of the models to reproduce wind extremes in the current climate and the coarse spatial resolution of climate models relative to topographic variability.
- In the absence of significant global emission reductions, as climate impacts begin to increase the grid will increasingly require significant investment if it is to deliver 'acceptable' levels of performance. What is considered 'acceptable' needs to be made explicit as the modelling suggests that even very high levels of investment in reinforcing the transmission grid will likely be insufficient to guarantee resilience if increases in extreme weather events are realized through climate change.

### **Adaptation and Resilience of Coastal Energy Supply (ARCoES)**

Professor Andy Plater, [gg07@liverpool.ac.uk](mailto:gg07@liverpool.ac.uk)

*Providing guidance on the risks that might face coastal energy deployment in the future. Specifically, the risks that might be experienced by power stations, substations and the distribution grid and including evidence to inform adaptation decisions to reduce the risk of failure in a future climate.*

- Nuclear power stations are located on shorelines that are resilient to storm surges.
- Flooding due to storm surges, wave overtopping of sea defences and high river flows may combine to produce greater areas and depths of flooding. This risk is likely to increase with sea-level rise
- Flood events with the same probability may result from different combinations of wave height and extreme water level, causing different flood extents and depths.
- Incremental projections of future sea-level rise identify 'tipping points' at which the extent of flooding increases greatly, requiring a step change in management strategy and resourcing. These thresholds may be explored using an open-source decision-support tool.
- The Real Options methodology provides a probabilistic assessment of the optimal time for investment in energy distribution assets to build resilience to future sea-level rise.
- Projections of future flooding identify coastal locations that are less suited for the next generation of energy infrastructure.
- Implementation of tidal barrages as a means for combining energy generation with enhanced sea defence capability has the potential to both decrease and increase future flooding in adjacent areas.
- Innovative sea defence by 'landscaping' works with natural processes to reduce coastal erosion and simultaneously create habitats and environments.