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Quantifying changes in climate resilience of our electricity networks

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Abstract: For energy networks to play their part in helping society achieve net-zero requires 3 things: (1) significant shifts of previously non-electric energy demand onto the electricity network to take advantage of low carbon energy technologies, (2) decarbonising of energy generation via greater penetration of renewables and (3) enabling greater investments in future networks by reducing the uncertainty around how a future climate may affect electricity infrastructure. Wilkinson et al. (2022) developed an early warning system for electricity distribution networks (EDNs) which they demonstrated made good predictions of fault numbers. This work has adapted that framework by replacing weather forecasts with the latest round of climate models (UKCP18). The model works by first using reanalysis data to establish relationships between climate intensity and the likelihood that these intensities would cause faults on UK EDNs. These relationships were used in this study together with UKCP18 local (2.2km) projections (Kendon et al. 2019) which were overlain GIS asset databases to produce projections of how faults may increase or decrease in the future. In our analysis we have used the RCP8.5 scenario which is a worst-case scenario in which we assume global greenhouse gas emissions continue to increase towards the end of the 21st century and no mitigation measures are used to reduce them. The UKCP18 projections represent the most up-to-date, UK climate relevant, projections and so this work can be considered to have used the latest climate science to establish a better understanding of how changes to our climate may affect EDN assets in the future. In this work we have considered what the likely changes are to be in windstorms and hot weather events, in four regions in the UK. These have been calculated for different return periods (up to a 1 in 50 year event) and for two different climate horizons (we also present the current climate for comparison). The three time horizons are : present climate (TS1: 1981-2000) and two future simulations (TS2: 2021-2040 and TS3: 2061-2080). Our key findings are as follows:

1. We have high confidence that extreme windstorms are more likely to occur over the UK in the future. In our study, the biggest increase we could expect to see a 1 in 50 year return period windstorm causing 30% more faults on the network and a 1 in 50 year event occurring on average approximately every 20 years in the 2061-2080 scenario.
2. For hot weather, the maximum temperatures are set to increase, with a 1 in 50 year event occurring every 5 to 10 years on average for TS2 (2020-2040) and on average every 1 to 2 years for the TS3 (2061-2080). We can also expect the number of heat related faults to more than double in this scenario.

Our results show that significant investments are required to ensure our EDNs maintain resilience in a future climate. We argue that the methodology we have adopted to measure this future resilience deficit is rationale and applicable to any climate hazard or critical infrastructure network as long as the three datasets mentioned above are available. Finally, we have not considered how EDNs may change as we transition to a net-zero economy; however, our modelling framework can incorporate this by the modifying the asset database.

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