Energy storage shields supply chains from costly extreme weather events

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Energy storage is widely recognised as an effective measure for reducing climate-induced power outage risks and the associated supply-chain disruptions. However, it remains unclear where and how storage should be strategically deployed to maximise its effectiveness in mitigating the economy-wide losses that propagate across regions during outage events. Here, we develop a climateâ€“electricityâ€“economy nexus modelling framework to quantify the future economic consequences of weather-induced power outages across the United Kingdom and to assess the loss-mitigation potential of targeted energy-storage deployment.

The framework contains three work packages: (i) drawing on a multi-source dataset combining historical substation-level weather-induced outage records with high-resolution meteorological data, we train a machine-learning model to project future outage frequency and duration at the UK substation level. (ii)These outage shocks are then mapped into a power-extended multi-regional adaptive inputâ€“output model that captures non-linear production constraints, sectoral prioritisation under power rationing, and endogenous propagation of shortages across regions and industries. (iii) We represent energy storage as time-limited local supply that reduces effective outage hours for prioritized loads, and we rank candidate deployment locations by marginal avoided GDP losses per storage-hour under future climates.

We find that future outages intensify most strongly at substations with historically high outage frequencies. Marginal economic losses reach up to â‚¬5.5 million per outage hour, while coastal regions exhibit the highest vulnerability to cascading impacts, with average annual GDP losses exceeding 2%. Deploying one hour of storage in priority regions yields annual economic benefits of up to â‚¬47 billion, with over 80% of the gains realised in other regions via indirect cascading effects. Over a ten-year horizon, such investments achieve a nearly 30-fold return relative to deployment costs. Our findings provide important insights for developing targeted, climate-resilient storage-deployment strategies to reduce the escalating economic risks posed by weather-induced power outages.