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Electricity supply interruptions:

Sectoral interdependencies and the cost of energy not served for Scottish Economy

Executive Summary

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Modern economies are crucially and increasingly dependent on the services of a reliable power sector. This dependence, to a large extent, stems from the reliance of other critical infrastructure (CI) sectors such as natural gas, water supplies, petroleum, telecommunications, and transportation, on power supplies. Meanwhile, critical infrastructures are also interdependent and interact with each other in numerous and sometimes complex ways. The interdependencies among CIs are the main factor behind the unforeseen chains of events, or the 'cascade effect', in the event that at least one CI fails. This is particularly important in the case of failure in the power supply system, as this tends to propagate the ripple rapidly to other infrastructure sectors. Furthermore, the ripples of electricity supply shocks often reach beyond their first-order effects. Previous experience from exceptional events in the power sector has raised concern about the economic consequences of such failures. An important part of these costs is due to the indirect and induced effects resulting from interdependency and the spilling over of power failures to other infrastructures.

An optimal response to these events entails having information about their (economic) impact at sector and economy level. Such information would help to protect the critical infrastructures better in the event of major service disruptions and to minimize the consequences of cascading effects resulting from power failure. Additionally, a related query from a policy perspective is the level of investment required to prevent major incidences in the power sector. The estimated societal cost of major service interruptions can be a useful figure when calculating the amount that a society might be

This study analysed the interdependency effects and economic impact of electricity supply disruption using a Dynamic Inoperability Input-Output (DIIM) model. We applied the model to a case study of 101 sectors of the Scottish economy in 2009. Our analysis demonstrated that inoperability can be different from economic loss and that highly inoperable industries in the short run (after shock) are not necessarily the same as those most affected economically. This is because the sensitivity of revenue and operational status to a particular input (for example, power) might vary for a given sector and across different sectors. The results also indicated that ranking of the affected sectors in terms of inoperability and economic loss metrics are robust with respect to extent and duration of interruptions. This ex ante analysis helps decision makers to prioritize vulnerable sectors for resource allocation and resiliency enhancement against major power outage incidences. It also helps to manage forced outages in an economically informed way by avoiding random outages.

We also estimated societal cost of energy not supplied (SCENS) taking interdependencies among sectors of the economy into consideration. The results show that SCENS ranges from about £4300/MWh for 1 minute of interruption to a maximum figure of around £8100/MWh for an outage of three hours and more. Additionally, SCENS increases very marginally with the extent of power blackout.

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