Understanding the Response to Disruptions in the Electricity System

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I. OVERVIEW

Extreme disruptions to the electricity system, such as Superstorm Sandy and Hurricane Matthew highlight the need to understand the effect of these events on energy infrastructure, the resilience in the energy systems, and the interactions between the electricity system and the social behavior of people affected by the disruption, including potential displacement. This paper studies the economic restoration of the electricity system after a disruption event, considering the priorities set by planners and policy makers in the system.

II. METHODS

In terms of obtaining empirical data to evaluate the validity of our proposed solutions, we offer two approaches: surveys and statistical estimation.

For the surveys, we use expert elicitation, collecting information from local governments, utilities and emergency responders regarding their past experience, and their actions and chain-of-command based on past disruption events. We also use a survey of households to capture their perception and internalization after their last experienced events. Our electrical restoration model maximizes the criticality-weighted load, subject to the constraints obtained from the expert's survey, resource constraints and the physical characteristics of the system, as well as contractual characteristics such as demand response agreements.

III. RESULTS

Our results are presented as a consecutive sequence of models, including the use of distributed generation, mobile resources and demand response availability, calibrated using the surveys. We measure the social welfare obtained in this transient restoration stage, as the sum of the demand restored considering its importance (e.g., critical loads such as hospitals and emergency management centers have a higher priority than warehouse restoration). Each successive model adding a single feature at a time achieves a increase in social welfare as expected, but some spatial tradeoffs are revealed that require in some instance the use of policy rules.

IV. CONCLUSIONS

This proposal uses the information from surveys to better understand the management of the restoration process after an exogenous disruption. We use economic measures to model how decision makers implement the restoration process of the electricity system, and suggest a model for the optimal management of this process, informed by the surveys collected. The application of this work include its use for a wide array of disruptions, particularly in developing countries where disturbances are more common, and provides a baseline for future models of other energy systems, e.g., the gas network.

NOTES

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