

Willingness to Pay for Microgrids to Enhance Community Resilience

ABSTRACT:

Severe weather events pose a significant risk to the operation of the electricity system. Recent weather events have exposed the vulnerability of the power system and its ability to recover from these events, while also highlighting the integral role that electricity plays in protecting the safety and well-being of society. When power outages occur, they can vary between a few minutes, a few hours, to several days or longer. Damage to the electricity system from severe weather events carry a higher impact, but a lower probability of occurring, which brings the need for resiliency to help mitigate the damages from these events. Furthermore, these types of events can hinder the ability for communities to operate critical and essential services. Given the important role that electricity plays in powering society, and the significant risk that extreme weather events pose in disrupting electricity supply, the idea of microgrids have come to the forefront to enhance electrical grid resiliency.

A microgrid is essentially a smaller scale version of the electricity grid on a localized level. The Department of Energy defines a microgrid as “a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode” (Ton & Smith, 2012, p.84). Distributed Energy Resource (DER) are resources that are located on-site or in close proximity to customers which allows them to meet some of their electricity load or in the case of energy efficiency or Demand Response (DR), it lowers demand. Some examples of DER include solar photovoltaic (PV), wind, combined heat and power (CHP), microturbines, energy storage, energy efficiency, DR, fuel cells, and electric vehicles. A microgrid can include one or more DER and they can be located at any of the entities connected to the microgrid. Microgrids can operate in two different modes – grid connected and islanded. In the grid-connected mode, the microgrid remains connected to the main utility grid whereas in the islanded mode, the microgrid separates its tie to the main grid and draws upon the generating resources within the microgrid to power entities connected to the microgrid. If there is a power failure, the microgrid will sever its tie to the main grid and enter islanded mode and provide power to those entities connected to the microgrid, and enhance the ability of the grid to come back on line following an outage, increasing resiliency.

In this paper, a Discrete Choice Experiment is used to evaluate willingness to pay (WTP) for a microgrid that would power several critical services during an extended power outage. With a sample of 939 respondents from New York State, results indicate that there is a positive willingness to pay for microgrids that would enhance the resiliency of the community during a significant power outage. Specifically, respondents were asked to value the availability of hospital services, emergency services (police, fire, EMS), access to water, emergency shelters, and four retail services (bank, grocery store, convenience store and gas station, and pharmacy). In each choice, a monthly surcharge would be added to the respondent’s monthly electricity bill.

Analysis of the choices made revealed the highest WTP was for emergency services to have normal response time while the second highest WTP was for access to potable water. We also explored the impact of age, gender, education, income, political score, energy use, backup-generator ownership, and personality scores on the WTP for the attributes. Estimation results illustrate that gender, political score, respondent's description of their overall energy use, and personality scores impacted choices in varying directions. These results provide useful information regarding the consumer benefits of microgrid development which can be balanced against the costs.