The Untapped Value of Backup Generation

While new guidelines and regulations such as IEEE (Institute of Electrical and Electronics Engineers) 1547 have come a long way in addressing interconnection standards for distributed generation, utilities have largely overlooked the untapped potential of these resources. Under certain conditions, these units (primarily backup generators) represent a significant source of power that can deliver utility services at lower costs than traditional centralized solutions. These backup generators exist today in large numbers and provide utilities with another option to reduce peak load, relieve transmission congestion, and improve power reliability.

Backup generation is widely deployed across the United States. Carnegie Mellon's Electricity Industry Center reports that there are about 12 million backup generators in the United States with over 200 GW of generating capacity (growing at ~5 GW per year)[1]. Today, Smart Grid technology can integrate these resources into the grid in an intelligent way, allowing utilities to effectively deploy them in a fully coordinated manner. For example, Portland General Electric (PGE) has engaged more than 40 MW of standby generation at customer sites to address peak load.[2] Using these resources could reduce required installed capacity and would increase the operating reserve margins for the network, resulting in lower electricity prices.

An Electric Power Research Institute (EPRI) study estimates that by 2010, 25% of new electric power generation will be in the form of distributed generation.[3] This reflects a growing need for reliable power as the cost of outages increases. Some of these generators are large, industrial three-phase generators, however, an increasing number of smaller, grid-connected generators are entering the market. These generators are in many cases single-phase units of less than 100 kW, primarily meant as backup power for specific loads, and are generally underutilized. This unused capacity represents a potential goldmine of resources for utilities that does not require extra transmission, generation, or extensive permitting; nor does it suffer the same losses as centralized solutions.

As backup generation continues to expand, opportunities will come not just in connecting these resources to the grid, but also from better load integration. A recent study by Lawrence Berkeley National Laboratory shows that much of the expected growth in distributed generation will likely come from industrial customers, especially in sectors like the health care industry where high quality, reliable power is important and floor space is limited.[4] Plus, the latest Energy Information Administration (EIA) load growth research shows the greatest projected increases are in the commercial sector. With ~ 75% of commercial businesses purchasing backup generators (18 kW average size), this represents a perfectly distributed, ready-to-use resource for peak shaving.[5] Building codes for certain kinds of industrial, commercial, and large residential buildings require the use of backup generators in order to operate elevators, fire systems, and critical services during emergencies. However, these backup generators are usually made to operate independently of the building's main electrical equipment, and must be separately activated in an emergency.[6] The technology exists today to tie these same systems into the main electrical system of the building, allowing them to serve the building loads during prolonged emergencies and during peak load hours. This not only helps to ease peak load, but also allows the building operator to recoup some of the cost of the backup generator by reducing power purchased at high rates and by potentially reducing peak power charges.

Utilities must be aware, however, of the limitations of their distribution systems in accommodating these generators. If utilities are to go beyond just turning on backup generators to take load off the system and actually use their excess generating margin to feed power onto the grid, then more precautions must be taken to ensure the safety of the system:

- Adequate voltage regulation must be maintained through the use of voltage regulators. Voltage support must be sufficient to maintain adequate voltage with distributed generation disconnected. A recent IEEE paper estimates that adding a fast responding voltage regulator to a feeder can increase the acceptable backup generator contribution from 5% to 10% of feeder capacity.[3]
- Installing appropriately rated fuses and reclosers to detect faults will prevent unnecessary fuse burn outs. Fuses and reclosers must be rated correctly and coordinated in order to resolve issues that could arise from the addition of distributed generation units.
- Limiting and filtering harmonics introduced by backup generation units is important for maintaining power quality. Grid-connected DG units introduce harmonics into the system, potentially increasing harmonic distortion above acceptable levels. As more backup generation is connected using power electronics, this problem will continue to affect power quality to loads on the line. Efforts must be taken by utilities and/or customers to ensure that these harmonics do not exceed acceptable levels.[3]
- Avoiding unexpected islanding is an important safety factor. Maintaining fuses and installing important safety equipment protects both utility work crews and the public from danger.
- Appropriate visualization and decision support must be provided both to the utility and to customers. As more backup generation is incorporated into the grid, effective dispatch and management will become more commonplace. Due to its inherent complexity, modern (21st century) visualization and decision support software will be required to increase transparency and improve coordination throughout the grid.

Backup generators are important resources that have not been used to their full potential. Utilities that manage these resources effectively can trim their costs and create a more robust power generation portfolio that is finely tuned to their customers' needs. By setting appropriate incentives, standards, and by developing and deploying Smart Grid technologies, these untapped resources will benefit utilities and customers alike.

This article was written by Alex Zheng with input from Bruce Renz, Steven Bossart, Joe Miller, and Steve Pullins.

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2. Dispatchable Standby Generation
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3. Interconnecting Single-Phase Backup Generation to the Utility Distribution System
   R. Dugan et al. Oak Ridge National Laboratory. IEEE Transmission and Distribution Conference and Exposition. 2001.

4. A Model of US Commercial Distributed Generation Adoption
   K.H. LaCommare et al. Ernest Orlando Lawrence Berkeley National Laboratory. January 2006.

5. Energy Information Administration. Electricity, US Data.

6. Distributed Generation: Standby Generation and Cogeneration
Ozz Energy Solutions, Inc. February 28th, 2005.

For more information about distributed generation resources, please see the following sources:

7. Utility-Connected Distributed Generation: Lessons from the Federal Sector
Federal Energy management Program. Energy Efficiency and Renewable Energy. Department of Energy November 2006.

8. Overview of Distributed Generation Interconnection Issues
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9. Detroit Edison Distributed Resources Utility Applications & Case Studies
H. Asgeirsson. DTE Energy. Presentation to IEEE Power Engineering Society General Meeting. June 9th, 2004.

10. 1547 - IEEE Standard for Interconnecting Distributed Resources with Electric power Systems
IEEE, July 2003.