Executive Summary

Microgrids as a Grid Resiliency Strategy:
A Recommendation to Portland General Electric and Other Interested Parties

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Background

Portland General Electric’s service territory is not necessarily well-equipped for a catastrophic disaster, such as might be expected from a magnitude 8 or greater earthquake (expected once every 300 years in the region). Energy services will be a critical part of the emergency response in the face of such a catastrophe. The challenges of prevention and quick restoration of power might be improved by microgrid concepts and technology. The infrastructure needed to enable localized energy supply or alternative sources of power for first responders and their communities is not currently mature enough to be relied upon, particularly in the case of a major event involving days, if not weeks, of widespread outage. A resilient grid with self-sufficient community power supplies, reliable load reduction, load-shedding capability, and backup communications schemes along with a clear policy infrastructure is needed to address this gap in emergency services.

PGE has developed extensive resources that serve as a strong foundation for the development of resilience microgrids. PGE has developed a one-of-a-kind dispatchable standby generation program, with nearly 100 MW of onsite generators under utility control for peak shaving. Work done at the Salem Smart Power and its 5 MW battery has demonstrated islanding at the substation level.

While these resources serve as important components in microgrids, PGE still lacks a set of criteria for proactively identifying desirable sites for resilience microgrids. In addition, there is a need to understand the full range of projects that could be considered including possible technologies, business models, and stakeholders. In sum, there is a need for a consolidated framework for developing microgrid projects which can support grid resilience to address potential catastrophic events.

Risk Assessment

It has been known for roughly twenty five years now that Oregon is at risk for a subduction zone earthquake of potentially epic proportions. It is now understood that a magnitude 8-9 earthquake is expected in the Cascadia region (northern California to British Columbia) can be expected roughly every 300 years. The last recorded earthquake of that size was in 1700 AD. While the exact timing of such an event in the future is impossible to predict, it is estimated that an event affecting the region (originating most likely around the southern Oregon coast) has a 7-15
percent chance of occurring in the next 50 years.\textsuperscript{1} Given this risk, Oregon (and the greater Cascadia region) must prepare for the resulting devastation that would occur from such an event.

Oregon is ill-prepared for such an event and would experience much greater devastation if such an event were to occur in the region. Critical services such as water, electricity, communications, and transportation would take months to bring back online, with electricity taking anywhere from one to six months to restore, while drinking water and sewer services could take as long three years to restore in badly affected areas.\textsuperscript{2}

**Technology Analysis**

While there is still much work to be done, PGE has a wide array of technological resources at its disposal to begin to develop resilience microgrids. PGE was an early adopter of many smart grid technologies, such as advanced metering infrastructure (AMI) and distributed generation. PGE was a participant in the Northwest Smart Grid Demonstration Project, coordinated by Battelle, where PGE demonstrated the use of distributed storage and islanding capabilities at its Salem Smart Power Center.

PGE has numerous distributed energy resources already connected to its distribution system, including:

- A 5 MW, 1.25 MWh battery at the Salem Smart Power Center
- 4.8 MWac of PGE-owned solar PV
- ~91 MW of dispatchable standby generation, 28 MW of which is connected to critical facilities
- ~26 MWac of residential renewable generation
- ~24 MWac of nonresidential renewable generation
- Demonstrated distribution automation at the Gales Creek substation


\textsuperscript{2} Ibid.
Business Analysis

Microgrid projects will most likely draw on the following funding sources:

- **Utility capital**: Utility capital could be used for projects where a clear public purpose is being met. PGE would need to coordinate closely with the public utility commission to define public purpose criteria for microgrids.
- **Private/Public Sources**: Customers involved should provide funding toward project costs. This could be funded as an upfront cost, ongoing service charge, or both.
- **Renewable Development Fund (RDF)**: Where PGE develops renewable generation, the RDF should be leveraged for project funding.

Policy Analysis

There are many planned and existing policies that would interact with a microgrid strategy, including:

- **Renewable Portfolio Standards (RPS)**: Where PGE owns or procures renewable energy certificates from microgrid, they could be used for RPS compliance.
- **Clean Power Plan (CPP)**: As with the RPS, renewable generation at microgrids could be used to meet CPP goals.
• **Net Metering:** Net metering encourages adoption of distributed generation that could be leveraged in microgrids.
• **HB 2193:** Assuming that the storage bill is passed, storage investments in microgrids could be used to meet the legislated 5 MWh benchmark.

**Considerations for a Microgrid**

PGE should consider the following needs and screening criteria when exploring potential microgrid projects.

**Needs Assessment**

• **Critical Emergency Services:** There are a number of services that will be critical in response to a subduction zone event. An important consideration in emergency management is the order in which they are deployed. For instance, restoration of electric service will depend on transportation infrastructure and liquid fuel. Communications infrastructure will then depend on electric service. Ensuring that service restoration is prioritized based on the “loading order” or dependencies of services will be an important consideration in developing microgrid projects.³

• **Critical and Essential Buildings:** Emergency operations centers, police stations, fire stations, and health care facilities should be ready immediately following an event. Those in the valley, where most of PGE’s customers are located, are expected to take two to four months to recover,⁴ indicating a need for better support for these services both in terms of structural integrity and essential services.

• **Emergency Communication Nodes:** In addition to critical facilities, there will be a need for sites where populations can gather to get information on emergency operations. These sites present opportunities for PGE to provide small scale microgrid solution to support communications and other services to residential and small commercial customers while leveraging an existing municipal plan being advertised in the community.

• **T&D Strategic Asset Management:** Near term risk cost should be used as one of the criteria when assessing need for microgrid projects. PGE should look for cost-sharing and savings between asset management and microgrid projects wherever possible.

**Screening Criteria**

• **Seismic Risk:** Any potential microgrid site will need to withstand the consequences of a subduction zone event. It will therefore be important to screen out potential projects where buildings, T&D assets, and generation sources have a high probability of being damaged or destroyed. This represents a difficult balance, as the areas of greatest destruction will also be the areas of greatest need.

• **Existing Distributed Energy Resources (DERs):** Good potential projects will either have or be near (in distribution terms) to existing distributed energy resources. The manner in which these distributed resources are connected to

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³ Kent Yu, personal communication, 2015
⁴ OSSPAC, 2013.
potential sites will depend on the type and scale of the project, whether it be at the customer, feeder, or substation level.

- **Liquid Fuel Resources:** In cases where DSG is used for a microgrid, sites will need to either be capable of holding sufficient fuel stores on site or be in close proximity to fuel stores along lifelines.
- **T&D Assets:** All T&D assets should have a low risk for seismic damage or be scheduled for seismic upgrades. PGE is currently undertaking a seismic risk analysis of its T&D assets to be incorporated into its economic models.5

**Recommendations**

**Technologies**

While the specific technology mix will depend on project and locational factors, there are some high level guidelines to consider for any microgrid project designed for disaster recovery. The following technologies will be critical for microgrid development:

- **Renewable Generation:** Given the need for potentially months of power, all sites should include some renewable power. Experience from Japan showed that microgrids relying on solar continued to provide high quality power immediately following the Tohoku earthquake.6
- **Demand Response:** Load prioritization through demand response is essential for effective emergency operations.
- **Standby Generation:** Dispatchable standby generators should be included wherever possible. Liquid fuel stores should be increased at sites to a minimum of two weeks.7
- **Energy storage:** Given the intermittency of renewable resources, generation is best coupled with energy storage.
- **Distribution automation:** In the cases of multi-site projects, distribution automation will need to be enabled, either at the feeder or substation level.

**Project Types**

This report considered five project types (outlined in the table below). Each project type has its own set of advantages and disadvantages. For instance, nanogrids face few barriers to implementation, but will likely reap fewer benefits. Conversely, community microgrids are relatively difficult to implement but have the potential to realize substantial benefits.

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5 Maty Sauter, personal communication, 2015.
7 In cases of emergency facilities with no renewables, up to 3 months accordance with predicted outage times for sites in the Willamette Valley (OSSPAC, 2013).
In order to proactively identify and develop resilience microgrid projects, PGE should develop a supporting database and set of dashboards of relevant site criteria. This database would include information on:

- All current interconnects of distributed resources;
- Economic analysis of T&D asset provided by the strategic asset management group;
- Grid network model;
- Critical facilities;
- Cascadia Subduction Zone event risk factors (landslide probability, ground acceleration, soil liquefaction);
- Community emergency communications nodes;
- Critical transportation lifelines; and
- Liquid fuel stores that will be available to PGE.

Here we provide a preliminary outline of a recommended project development process. The actual process will be defined by PGE’s microgrid steering committee. Our recommended process is as follows:

- Identify potential sites
- Screen for barriers to implementation
- Prioritize remaining sites
- Gauge project interest with top sites
- For sites where interest is strong, begin project planning:
  - Identify project type and scope
  - Determine appropriate duration of service needed
  - Select appropriate technologies
  - Assess distribution asset improvements needed
  - Determine asset ownership
  - Assess funding sources and distribution of costs
Potential Projects

This section provides some initial, high-level leads for microgrid projects. These proposals are not meant to be definitive or exhaustive, but are merely presented to provide some example of what projects might look like in PGE’s service territory.\(^8\)

Substation 132

Substation 132 provides a good example of where a hybrid project might be successful. This substation has nearly 5 MWac of connected capacity, all of which is either solar or DSG. The largest capacity is at a private hospital, which has 4 MW of diesel generators already participating in the DSG program. The hospital also has 85 kWac of solar connected as well. There are two large school buildings nearby also equipped with large solar arrays. A retail outlet has a 115 kWac array as well. Figure 2 below shows a map and relevant statistics for this substation.

A complete microgrid project would require the addition of demand response technologies and protocols, distribution automation infrastructure, and extensive energy storage.

Figure 2: Substation 132 Summary

Substation 001

Substation 001 presents an opportunity for a community microgrid. The substations has a little over 2,600 kWac of connected distributed assets, the bulk of which is a 2.5 MW DSG unit housed at a wastewater treatment plant. The remaining assets consist of small scale solar installations, largely residential.

\(^8\) Throughout this section, all data has been anonymized. Assets are referred to only by code, all sites are referred to only by their use, and GIS coordinates have been altered to conceal actual location. A key to identify all data referred to in this report will be provided separately to PGE.
As with substation 132, this project would require the addition of demand response technologies and protocols, distribution automation infrastructure, and extensive energy storage.

**PV Streetlights**

Solar streetlights are a simple way to ensure that lighting service is provided following a subduction zone event. Solar streetlights consist of a pole-mounted solar cell connected to a small battery that serves the LED street light. These units can operate independently of the grid and are mounted to infrastructure that is typically already designed to withstand seismic events.

**Community Energy Kiosks**

Another possible approach to nanogrids is the concept of community energy kiosks. These would consist of a small structure mounted with a solar array and battery which would provide a range of services in the event of an emergency. The kiosk would include outlets for charging of devices, a mounted radio to provide emergency communication, and perhaps a cell tower. The kiosk would have written information available on proper emergency procedures and services available.

Community energy kiosks would be located within local communities at designated gathering locations. PGE could coordinate with local jurisdictions on the development of kiosks; with cost sharing arrangements dependent on the ownership model. Unlike with other microgrid projects, it may be desirable to slightly oversize the system, both battery and PV array, so that PGE can reap additional benefits during normal operations.
Next Steps

Given the research presented in this paper, we recommend PGE take the following steps toward a microgrid resilience strategy:

- **Consolidate disparate data** through integrated database management. System must remain flexible to changing data sources and formats while integrating into critical systems.
- **Put together internal, interdisciplinary team** including Business Continuity and Emergency Management, Innovative Technologies, Strategic Asset Management, Dispatchable Standby Generation, Key Customer Accounts, Market Managers, and Customer Insights groups.
- **Develop long-term roadmap** to be presented to public stakeholders to secure external funding or, in the case of PUC, develop framework for cost recovery.
- **Engage with identified communities** to discuss community energy projects that could be used for disaster resilience.
- **Systematically document fuel stores** for all DSG customers.
- Ensure that DSG/ADR customers develop integrated disaster management routines with their EMS’s/DA systems.
- In the near term, **identify quick wins** with nanogrid and/or single site microgrids.
- **Begin to proactively identify potential large scale microgrid sites** that achieve synergies with strategic asset management and other smart grid investments.
- **Align PGE’s microgrid strategy with its T&D investment strategy** through coordinated project planning.
- **Achieve synergies with distributed energy policy compliance.** While renewable energy and storage policies (such as net metering or the RPS) may cause unwanted complexities for PGE, they do help to create a stronger base for microgrid development. PGE should consider the benefits to grid resilience from these distributed resources when proposing future policies or rate changes.