# Applicant Information

**Project Sponsor:** Andy Eiden, Manny Obi

**Sponsoring Departments:** Distributed Resource Planning, Grid Edge Solutions

# Project Information

**Name of Project:** Modeling Grid-Enabled Residential Loads in Distribution Systems

**Project Description:**

Portland State University (PSU) and PGE propose to develop a distribution system simulation environment capable of modeling end-user loads and the impacts these loads may have on distribution assets. Our specific interests are grid-enabled residential loads. These loads may act autonomously to regulate customer energy consumption. Or, they may be aggregated by a utility or third party, then harnessed to act in concert to provide grid services. The proposed simulation environment would allow distribution planners to consider the impacts grid-enabled loads could have on a distribution system. Specifically, we intend to model the NeoCharge, which enables autonomous load sharing, and Eaton EMCBs, which are remotely-controllable circuit breakers. However, the environment could be expanded in future to consider grid-enabled water heaters, EVSE, BIS, etc.

We will develop the simulation environment within GridLab-D (GL-D). GL-D is a distribution modeling application developed by the Pacific Northwest National Laboratories. It is well-suited for modeling end-user loads. GL-D has been used by others to model distributed energy resources, conduct rate structure analysis, analyze peak load management, and simulate distribution automation systems. For more detail, see the addendum. PGE internal project team members will supervise PSU students in determining which features of GL-D are of most interest to the company, and therefore should be included in the course of study. For example, PGE will provide scenarios of interest to integrate effects of different rate structures to analyze impact on DER behavior, and subsequent distribution system impacts, within the simulation environment.

This project will be coupled with a senior capstone project, for which senior ECE students will build test beds for the NeoCharge and EMCB devices.

**Are you requesting funds for multiple years?** ☐ Yes ⌧ No

# Project Benefits

**Alignment with corporate imperatives.** Please identify which corporate strategy this project aligns with:

⌧ Reduce greenhouse gas emissions by more than 80% by 2050

⌧ Increase electricity to 50% of total energy use by 2050

⌧ Deliver operational excellence and competitive financial returns

Current PGE practice is to model loads as static peak loads within CYME depending on the customer requests for capacity additions, etc. Distribution planners do not typically consider changes to end-use consumer loads, especially in residential developments, unless there are PQ implications of specific devices with known effects. Therefore, a distribution modeling tool capable of considering grid-enabled loads will help PGE understand how such loads can be used to achieve operational objectives, such as peak demand mitigation, ancillary service provision (e.g., volt-var optimization, frequency response), and renewables integration. All of these factors will help reduce greenhouse gas emissions and promote adoption of electrical appliances (such as heat pumps, resistance water heaters, electric dryers, EVSE) among customers. A model that considers the impacts at the distribution level will help PGE deliver operational excellence by giving distribution planners, the DRP team, and DR program managers a granular perspective of the characteristics and capabilities of grid-enabled loads that is important to develop a holistic understanding of the value of such resources.

**Benefits:** Please explain how this project will benefit PGE and create or have the potential to create a benefit for PGE’s customers (e.g. improved reliability, operational efficiency, save energy, reduce peak demand, enhance customer service, improve safety, resiliency, support renewables integration, etc.).

This project will benefit PGE by providing tools for planners and engineers that will lead to a better understanding of the potential value of grid-enabled residential loads. Such loads may be used in grid services programs to provide peak demand mitigation, ramp rate control, and economic arbitrage. In turn, these services will improve reliability and operational efficiency while supporting renewables integration. The project will benefit the company’s residential customers by encouraging adoption of grid-enabled appliances, which will allow customers to participate in grid service programs, save energy, lower their utility bills, and help support renewables integration.

PSU has developed capabilities using GL-D for power systems research, and is currently working on a DOE-sponsored project in collaboration with both PNNL and PGE. PGE and PNNL are collaborating on a GL-D-related project that would complement this proposal. These related projects point towards potential for developing additional collaborations between PGE, PNNL and PSU in future.

**Learning Objectives:** Please identify PGE’s top 3 learning objectives associated with this project:

1. Demonstrate the value of modeling grid-enabled residential loads.
2. Understand how grid-enabled loads may be controlled to impact system reliability.
3. Understand how user behavior and market incentives can affect availability of grid-enabled residential loads

**Deliverables:**

The PSU team will develop the following products:

* Capstone report
* End-of-project report (MS Thesis)
* GridLab-D model files
* Data files (.csv, .xls, etc)
* Code (Python) for all functions developed for this work

# Project Details

**Project Team (internal)**

* Andy Eiden, Manny Obi: project direction, project supervision

**Project Team (external)**

* Robert Bass (Portland State University): project design, oversight, publication
* PSU Graduate Student: project execution
* PSU Undergraduate capstone team: project execution

**Evaluation Plan:**

The PGE project partners will periodically review the work conducted by the PSU team. The PGE partners will advise the PSU capstone team in coordination with the team’s faculty sponsor during the Winter and Spring terms.

**Identify project timeline and key milestones:**

|  |  |
| --- | --- |
| **Date** | **Milestone Description** |
| 11/30/20 | Capstone group assigned, meets with PGE partners |
| 01/04/21 | Capstone group begins work |
| 6/15/21 | Capstone report |
| 12/15/21 | PSU MS Thesis published |

**Dependencies:**

Does the project require support from other departments to ensure completion?

⌧ No

Does the project require capital to be completed?

⌧ No

# Addendum - Notes on GridLab-D

Distributed energy resources: The advent of new distributed energy resource (DER) technologies, such as on-site distributed generation and grid-enabled appliances controls creates a number of technology opportunities and challenges. GridLAB-D will permit utility managers to better evaluate the cost/benefit trade-off between infrastructure expansion investments and distributed resources investments by including the other economic benefits of DER (e.g., increase wholesale purchasing elasticity, improved reliability metrics, ancillary services products to sell in wholesale markets).

Rate structure analysis: GridLAB-D provides the ability to model consumer choice behavior in response to multiple rate offerings (including fixed rates, demand rates, time-of-day rates, and real-time rates) to determine whether a suite of rate offerings is likely to succeed.

Peak load management: Many peak-shaving programs and emergency curtailment programs have failed to deliver the expected benefits. GridLAB-D can be calibrated to observe consumer behavior to understand its interaction with various peak shaving strategies. The impact of consumer satisfaction on the available of peak-shaving resources can be evaluated and a more accurate forecast of the true available resources can be determined. GridLAB-D will even be able to evaluate the consumer rebound effect following one or more curtailment or load-shed events in a single day.

Distribution automation design: GridLAB-D will offer capabilities that support the design and analysis of distribution automation technology, to allow utilities to offer heterogeneous reliability within the same system but managing power closer to the point of use.

[1] GL-D Market User Guide. <http://gridlab-d.shoutwiki.com/wiki/Market_User_Guide>

[2] Aggregate Demand Response model. <http://gridlab-d.shoutwiki.com/wiki/Aggregate_demand_response_model>