High-Level Design of a Distribution Microgrid

2018 SENIOR DESIGN TEAM DEC18-11

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INTENDED USE

- Assisting in the visualization of a microgrid system
- Quantifying an approximate cost of a microgrid given a user defined power demand
- Implementation in Alliant Energy's Distribution Department and their newly created Microgrid Team to better understand microgrid design

DESIGN APPROACH

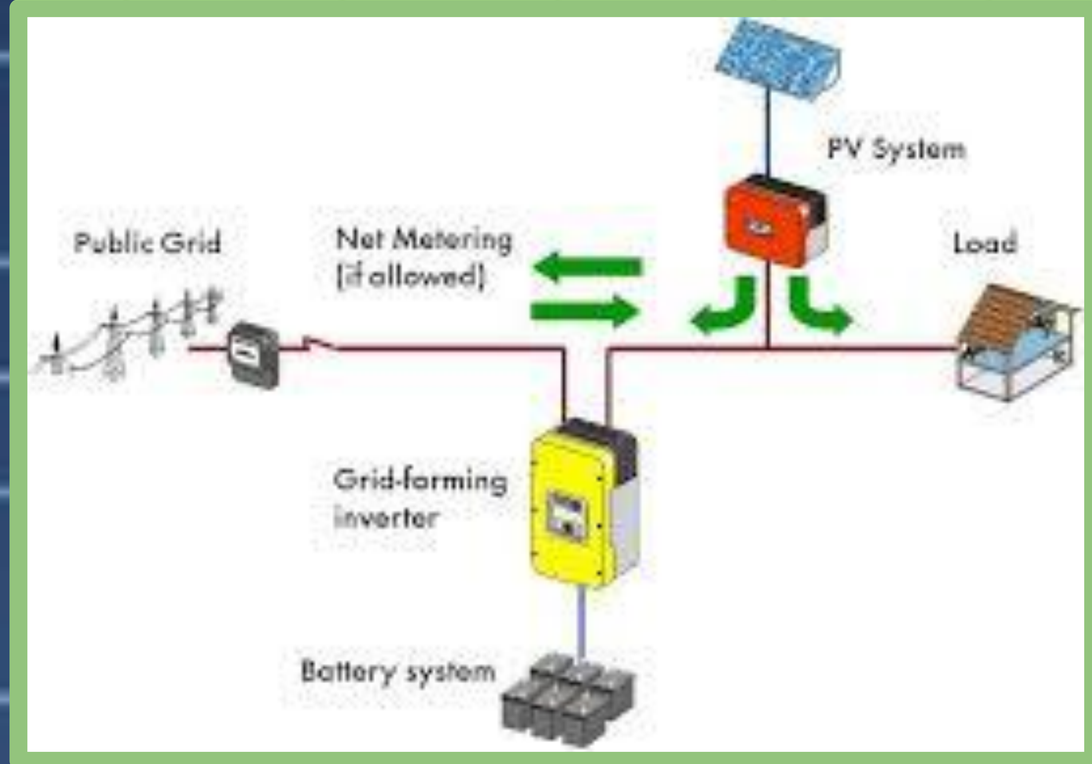
- The simulation first randomizes one year of solar and load data
- It then simulates thousands of unique combinations of solar panels and batteries
- The simulation then prints combinations with 0% excess demand (all demand met)
- Combinations with excess demand will utilize supplemental generation until user constraints are met

Real-World Constraints

- Weather is unpredictable and not easily modeled
- Failure rates of various devices

INTRODUCTION

Microgrids are the next evolution in the way people are supplied with power. For a small town in Iowa, a microgrid is being designed by a simulation tool to demonstrate the economic benefits of completely disconnecting from the traditional power grid to reduce expensive maintenance costs.



Middle Diagram: "SMA Sunbelt Energy GMBH." *Intersolar 2018*.

DESIGN REQUIREMENTS

- The simulation environment shall include solar radiation, generation, and load.
- The design will consist of solar panels, batteries, and supplemental generation from diesel fuel generators.
- The design will identify the quantity of solar panels and batteries required to meet the desired load.
- The design will quantify the relationship between Net Present Value of the system and demand met.

TECHNICAL DETAILS

- 30kW Ideal Power Grid-Tied Commercial PV String Inverters
- 360W Seraphim Solar Panel SRP-6MA
- VBA (Visual Basic Application) is integrated into an Excel macro button that runs the simulations
- The results of the simulations are printed to graphs to alalyze

TESTING

- After the simulation has finished, each combination calculates a thirty year total cost which includes base/install cost and yearly operation cost
- Thirty year total cost divided by the total amount of power generated is equal to the $/kWh
- The lower left graph plots the yearly excess demand against the cost per kilowatt to qualitatively show that as combinations of panels and batteries change, the demand met and cost change relative to a curve

RESOURCES

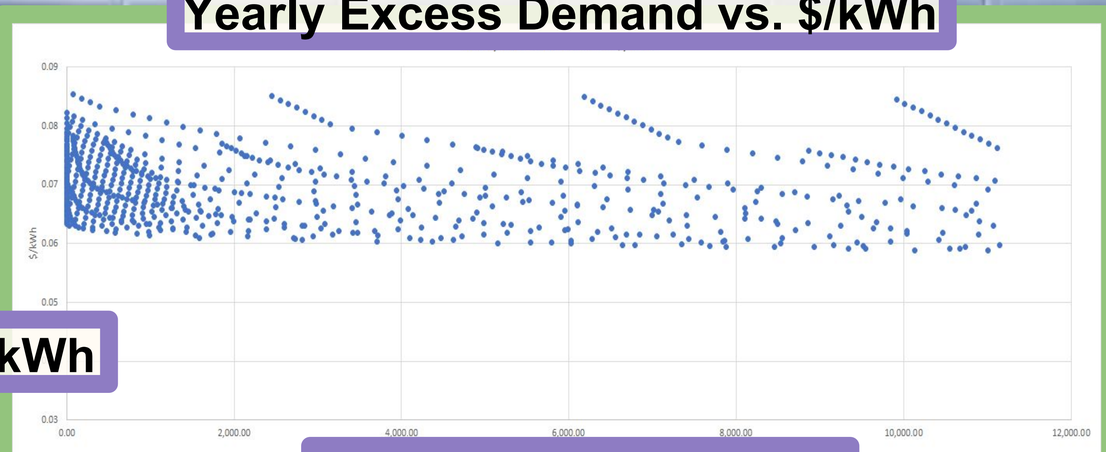
"About Microgrids". *Microgrid Institute,* 2018.
"Solar Maps | Geospatial Data Science | NREL", *Nrel.gov*, 2018.
"Solar Panels in Nichols, IA: Solar Companies, Cost, and Installation | Decision Data", *Decisiondata.org,* 2018.

STANDARDS

- IEEE 1159-2009
- IEEE 1547.4-2011
- IEEE C57.120-2017

Solar Power Generated — Excess Battery
Battery Consumed — Excess Demand

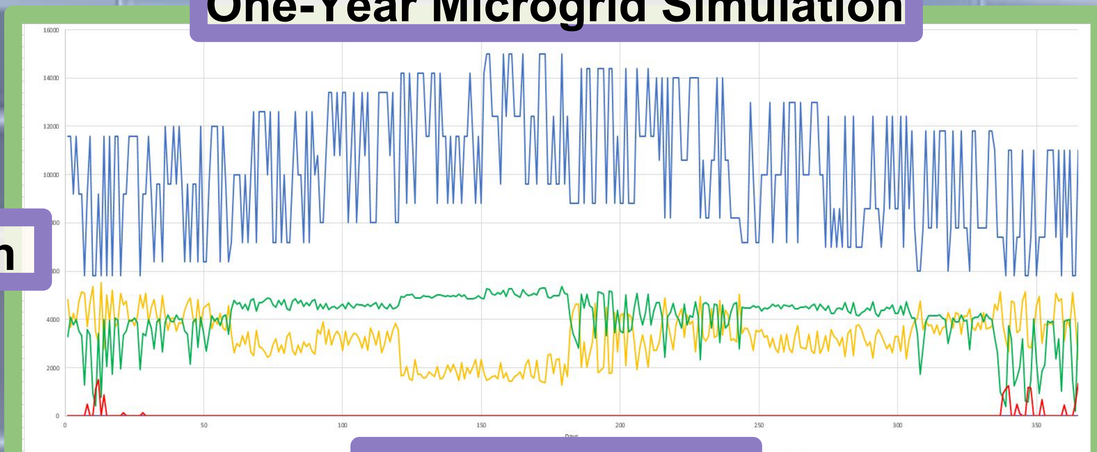
Yearly Excess Demand vs. $/kWh



$/kWh

Excess Demand (kWh)

One-Year Microgrid Simulation



kWh

Date (Jan - Dec)