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## EE 492 Bi-Weekly Report 2 - sddec18-03

### Design of a More Reliable Power Grid for Puerto Rico

9/10/18 - 9/24/18

Faculty Advisor: Vikram Dalal

### Team Members

Logan Lillis - *Communications and Reports Lead*

Ricardo Rodriguez-Menas - *Webmaster and Project Plan Lead*

Heiqal Zamri - *Test Engineer Lead*

Pinjia Zhang - *Design Lead*

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### Weekly Summary

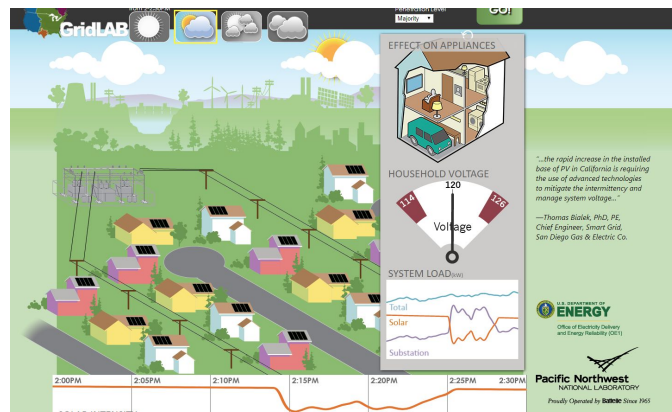
This meeting, we delved much deeper into what our goal for the semester would be. In a weekly meeting with Professor Dalal, it was decided that this semester, the bulk of our research would begin by comparing our plan to published plans. The U.S. Department of Energy released its final report titled “Energy Resilience Solutions for the Puerto Rico Power Grid” in June of 2018. The group read the document, noting pros and cons which are discussed below. From these pros and cons, the main technical areas were divided among the team as well as 6 other Puerto Rico Recovery plans to further study. With this extensive research base, our team will soon be able to write our white paper.

### Past Week Accomplishments

- ❖ Analyzed U.S. Department of Energy report
  - Strengths of the report/Ideas to continue in our design:
    - Focusing microgrids on populated areas
    - Recommending a shift to Natural Gas
    - Establishing energy-saving incentives
    - Recommending distributed generation
    - Resilient distribution infrastructure
  - Ideas to build upon/not listed in report:
    - Costs, feasibility of microgrids, technologies
    - Using baseline design certifications such as RELi
    - Reach out to PREPA for generation data
    - Economics and subsidies, other money-saving methods
    - Firmer focus on resilience and ease of replacement
    - Renewable energy

- Maintenance Plan
- ❖ Created Slides and Presentation for EE492 Presentation on 9/20
  - Logan: Problem statement, Generation, Natural Gas
  - Ricardo: Energy Storage
  - Pinjia: Renewable Energy, Microgrid Software
  - Heiqal: Microgrids, Distributed Generation
- ❖ Distributed research roles
  - Pijnia: Solar and Wind energy
  - Heiqal: Microgrids and Distributed Generation (Natural Gas Turbines)
    - Geographic locations of microgrids
    - Hospitals should have diesel generators
  - Ricardo: Energy Storage and Distributed Renewable Generation
  - Logan: Generation, existing plants, natural gas feasibility
    - Due to politics, will most likely continue imports from Trinidad and Tobago
  - All: Energy market, economic incentives
- ❖ Distributed further reading on Puerto Rico redesign proposals
  - NYPA
  - CRS
  - RMI
  - FEMA
  - PROMESA
  - PREPA
- ❖ Discussed possible software to model microgrids
  - PSS/E
    - Discouraged at EE 491 review
  - openDSS
    - ISU has licence, also open source
  - Milsoft
    - ISU has licence
  - GridLab-D
    - Open source & Cross platform
    - Reference Manual

Online([http://gridlab-d.shoutwiki.com/wiki/Documentation\\_Guide](http://gridlab-d.shoutwiki.com/wiki/Documentation_Guide))



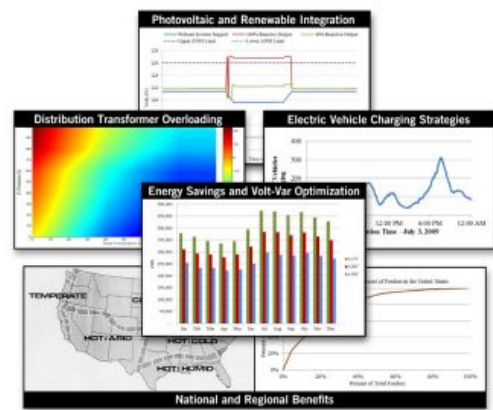
- Pinjia researched. “They had perfect simulation system online for the power design. Of course the software does not look like this, it is an open source crossing platform Linux and Windows design and analysis program. However, once we finish the design we can easy do the simulation on their web based simulation platform to have a visual feeling of overall quality of design. I think that will be very helpful later.” “The most challenging for us to design is the control part. Since power-grid is large enough for us to design the total part. We may only deep into how to control those black-box systems together to form the power grid instead of focusing every functioning part. So, the dynamic control analysis will be helpful.”
- Example of capabilities shown to right.

regional economics, and customer interactions, and how they each affect the power system. As of version 2.2, released in September 2011, GridLAB-D supports the interaction of:

- 3-phase, unbalanced (meshed or radial) power systems,
- end-use load behavior of thousands to millions of homes and appliances,
- retail level markets and transactive controls,
- distributed generation and storage,
- demand response and direct load control,
- distribution automation controls, and
- reliability.

Version 2.3, slated for release in December 2012, also will include:

- microgrid capabilities, including machine dynamics and generator controls,
- advanced control and optimization algorithms and interfaces, and
- development of combined heat and power (CHP) models, to capture the effects of waste heat and offsetting heating requirements in buildings.



Through GridLAB-D, users can predict, evaluate and extrapolate the potential of new technologies and operational strategies to save on capital expansion costs, design more effective and efficient programs and improve system reliability.

## Pending Issues

- ❖ Need to determine a software capable of modeling load flows and microgrids
  - Pinjia will work with power professors
- ❖ Need to begin writing paper/deliverables

## Individual Contributions

Team Member	Contribution	Weekly Hours	Total Hours
Logan Lillis	<ul style="list-style-type: none"> <li>● Attended group and mentor weekly meetings</li> <li>● Studied DOE Puerto Rico Proposal.               <ul style="list-style-type: none"> <li>○ Generation: NOT considering decline in population.</li> <li>○ Altering plan for natural gas/deliquification ports to include a port on the northeast edge of the island - retired naval base brownfield                   <ul style="list-style-type: none"> <li>■ This would allow for no pipeline and easy access for north of island (where main generation facilities) to natural gas</li> </ul> </li> <li>○ Microgrids: researched population centers and interconnectivity.</li> <li>○ Transmission and Distribution voltages to remain constant (230kV with 115kV supporting)</li> </ul> </li> <li>● PRIM set-up               <ul style="list-style-type: none"> <li>○ Main points: generation, natural gas, renewable energy, microgrids, distributed generation, energy storage</li> <li>○ Formatting, printed presentation</li> </ul> </li> <li>● Created Weekly Report</li> </ul>	7	9.5
Ricardo Rodriguez-Menas	<ul style="list-style-type: none"> <li>● Attended group and mentor weekly meetings</li> <li>● Meetings with professor Ian Dobson               <ul style="list-style-type: none"> <li>-Discussed about a new proposal I'm thinking to implement with respect to Micro grids inside microgrids</li> </ul> </li> <li>● Meeting with professor Ahmed Kamal.               <ul style="list-style-type: none"> <li>-Discussed partially about the same idea and how Puerto Rico can implement different alternatives of coverage and artificial storage.</li> </ul> </li> <li>● Research in EIA and other gubernamental pages about total consumption data vs reserves of Puerto Rico and how this suggest the need of implementation of storage systems.</li> </ul>	15	15.5

	<ul style="list-style-type: none"> <li>● Research about what kind of storages are use for renewable energy sources differentially from fossil fuel resources.</li> <li>● Research about alternative plans for microgrids installations and storage in the island (found NODES).</li> <li>● Research about NODES and the different of scales this alternative is used at the moment.</li> <li>● Design of a new alternative of microgrid for our proposal ( a smaller version more customer friendly)</li> </ul>		
Heiqal Zamri	<ul style="list-style-type: none"> <li>● Attended group and mentor weekly meetings</li> <li>● Researched about the new fiscal plan used for Puerto Rico</li> <li>● Researched more about the microgrids and the important aspects of it: <ul style="list-style-type: none"> <li>○ Distribution <ul style="list-style-type: none"> <li>■ Mountainous areas</li> <li>■ Suburban areas</li> <li>■ City areas</li> </ul> </li> <li>○ Cost <ul style="list-style-type: none"> <li>■ Based on the fiscal plan</li> </ul> </li> <li>○ Importance of how microgrids will not only support but also able to supply power for the island.</li> </ul> </li> </ul>	5	7
Pinjia Zhang	<ul style="list-style-type: none"> <li>● Attended group and mentor weekly meetings</li> <li>● Researched GridLab-D (see past week accomplishments for details)</li> <li>● Read through the DOE report. The types of power distribution and the disaster or community resistance may be considered when we work on project.</li> </ul>	3.25	5.25

## Plan for Upcoming Week

All:

- ❖ Continue to read and research further reading on Puerto Rico redesign proposals.
  - NYPA

- CRS
- RMI
- FEMA
- PROMESA
- PREPA

Logan:

- ❖ Continue researching generation implementation, amounts, and needs.
- ❖ Determine costs associated with transferring coal/heavy oil generation plants to dual-fueled or solely natural gas fueled plants
  - Considering plant age and efficiency, compare this cost with the cost associated with building new natural gas-fired generation facilities
- ❖ Begin looking into RELi certification, other certifications we could form our design to
- ❖ Begin looking into resilient distribution
  - Monopoles, maintenance, etc.
- ❖ Read NYPA PR Recovery Plan
- ❖ Read RMI PR Recovery Plan

Ricardo:

- ❖ Keep gathering information on Storage and different alternatives to include as storage in the new microgrid we are trying to implement.

Heiqal:

- ❖ Do more research on the designing tools of the microgrids
- ❖ Look more into the costs of each implementation based of the intended design
- ❖ Talk will Dalal on how to create these designs

Pinjia:

- ❖ Talk with Dalal about the strengths and shortcomings of each design solution as other company may implement in difference scenario. Will give the project more flexibility to adapt different cases.
- ❖ Talk with teammate about the coming presentation and finish the ppt.
- ❖ Discuss with ZhaoYu for more detail on software picking.