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Resilient Power Solutions for End of Line Communities

By

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Education in Electrical Engineering:
B.S.E.E. (Magna Cum Laude), Univ. of Puerto Rico, Mayaguez (Power)
M.S.E.E., Michigan State University, East Lansing, MI (Robotics & Control)
Ph.D., Michigan State University, East Lansing, MI (Power Electronics)
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Areas of interest: Photovoltaic Systems, Mathematical Modeling of Renewable Energies, Optimization, Power Electronics, Resonators, Nonlinear Control, Electric Drives, Unmanned Vehicle Applications, Power Markets, Cyber-security, Robotics, Engineering Education.

Courses: INEL 6085, 6001, 6000, 5505, 4998, 4995, 4505, 4102, 4076, ICOM 5995, INME 4998

Summary Professional Experience (Currently, ECE faculty member at UPR-Mayaguez):
-Argonne National Laboratory, DuPage County, Illinois, USA
-Fermi National Accelerator Laboratory, Batavia , Illinois, USA
-Lord Electric Company, Transmission Lines Division, San Juan, PR
-University of Southern California. Los Angeles, CA
-Chinese Academy of Science, Institute of Automation, Beijing, China
-Volgograd State Technical University, Volgograd, Russia

Publications (More than 80 IEEE peer-review publications, and 50 of them with undegraduates as coauthors):
-Transactions and Publications in the IEEE Power Electronics Society, IEEE Education Society, American Institute of Aerospace and Aeronautics, IEEE Power Society and IEEE Control Society

Outline

- Why Energy Storage for Resilient Power Solutions?
- Evaluation Criteria for Location Selection of Energy Storage Systems
- Resilient Power Solutions Sub-Tasks:
    - Study on the use of recently closed public schools in PR
    - Study on the use of abandoned lands for portable storage
    - Study on the use of industry park with closed facilities
    - Study on the use of closed commerce building
    - Study on the use of energy storage for communications
- Questions?

Why Energy Storage for Resilient Power Solutions?

- After Hurricane Maria, Puerto Rico has been experiencing the massive effects of an unreliable electric system.
- Puerto Rico should consider energy storage as a potential area of investment given the availability of diverse energy sources (e.g. solar).
- Microgrids with energy storage capabilities will enhance the reliability and resiliency of the current PR's electric system.
- Independent energy storage systems could be used as energy buses to mitigate or compensate fluctuations in the electric grid.
- Energy storage systems can be selected based on the amount of critical loads, typical duration of power outages, impact to loads, etc.

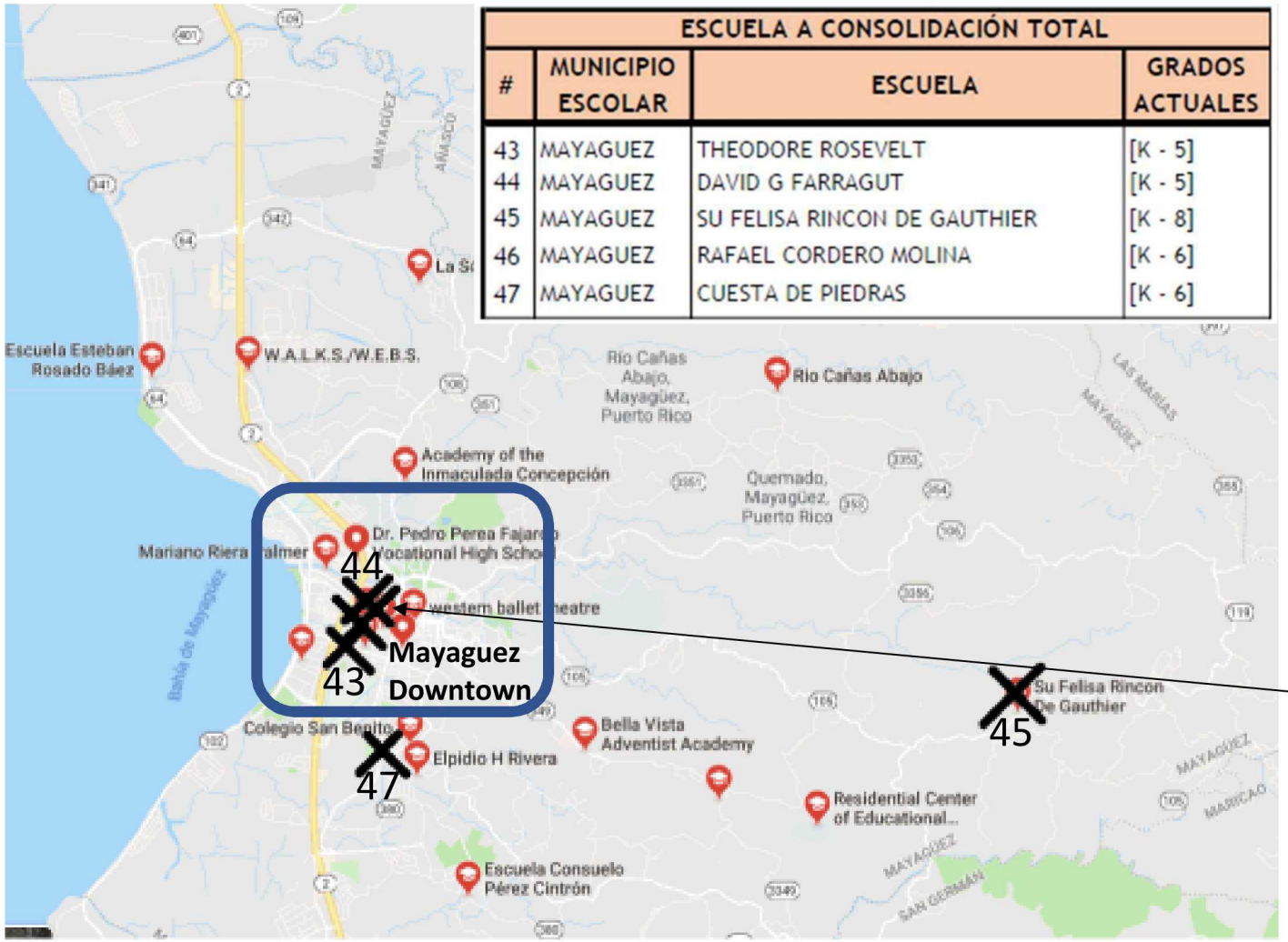
Evaluation Criteria for Location Selection of Energy Storage Systems

- Social Impact/Service
- Economic Impact
- Impact to the General Population
- Population in Risk (Age, Income)
- Use of Resources (Water, Electricity)
- Impact to Other Infrastructures
- Risks vs Benefits
- Practical Decision Making

- Costs to Keep the Infrastructure Non-Functional versus Functional:
  - Operation
  - Production
  - Maintenance
- Limit for Investment
  - Population
  - Costs of Investment versus Revenue
  - Recovery

1. Energy storage recommendation: Study on the use of recently closed public schools in PR

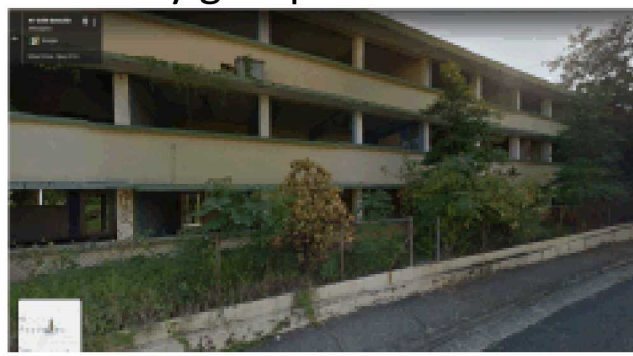
ESCUELA A CONSOLIDACIÓN TOTAL			
#	MUNICIPIO ESCOLAR	ESCUELA	GRADOS ACTUALES
43	MAYAGUEZ	THEODORE ROSEVELT	[K - 5]
44	MAYAGUEZ	DAVID G FARRAGUT	[K - 5]
45	MAYAGUEZ	SU FELISA RINCON DE GAUTHIER	[K - 8]
46	MAYAGUEZ	RAFAEL CORDERO MOLINA	[K - 6]
47	MAYAGUEZ	CUESTA DE PIEDRAS	[K - 6]



Motive:
On April 2018, the PR's Department of Education announced the consolidation and closing of nearly 300 public schools in Puerto Rico*.

Advantages:
- Local Public Lands Owned by the Government.
- Location: In many cases, the closed schools are in privileged geographical locations
- In some cases, the state gave the public schools to private institutions, or community groups
- Many of those former public have limited use ~~use or no current use~~.

For example, the former Hostos school could be used as an strategic energy storage site in Mayaguez.



*https://media.noticel.com/o2com-noti-media-us-east-1/document_dev/2018/04/05/Mayaguez_1522964924437_10944294_ver1.0.pdf

2. Energy storage recommendation: Study on the use of abandoned lands for portable storage

*https://www.sandia.gov/ess-ssl/

Motive:

For several decades there have been emigration of Puerto Ricans to the mainland. As a result, several public housing and private lands have been abandoned.

Advantage:

- Abandoned public lands and public housing could be considered as distributed energy storage facilities.
- Location: In many cases, some of the abandoned structures are close to main avenues and highways.
- For example, in the area of Mayaguez several public housing have been closed given the deteriorated structure and facilities. In some cases some of the buildings have been removed but the land is still useful for potential energy project for the benefit of the remained local population.
- As an additional advantage the use of novel energy storage facilities as battery containers could provided as parking lot facilities for those moving energy containers for emergency fast response.

3. Energy storage recommendation: Study on the use of industry park with closed facilities

Motive:

After 2006 and the end of IRS Section 936, PR has suffered an economic recession with main effects in the industrial sector*.

Advantage:

- Local Public Lands and Industry parks owned by the Government.
- Location: In many cases, the closed industries are in privileged geographical locations with massive population density. In some cases, the closed factories are completely abandoned.
- For example in the area of Mayaguez several industries related to tuna fish packaging and clothing manufacturing have been closed about 20 years but structures are still intact and useful for energy storage applications. Right now some of those industries have been given to academic and religious institutions .

*https://enciclopediapr.org/en/encyclopedia/section-936-of-the-internal-revenue-code/

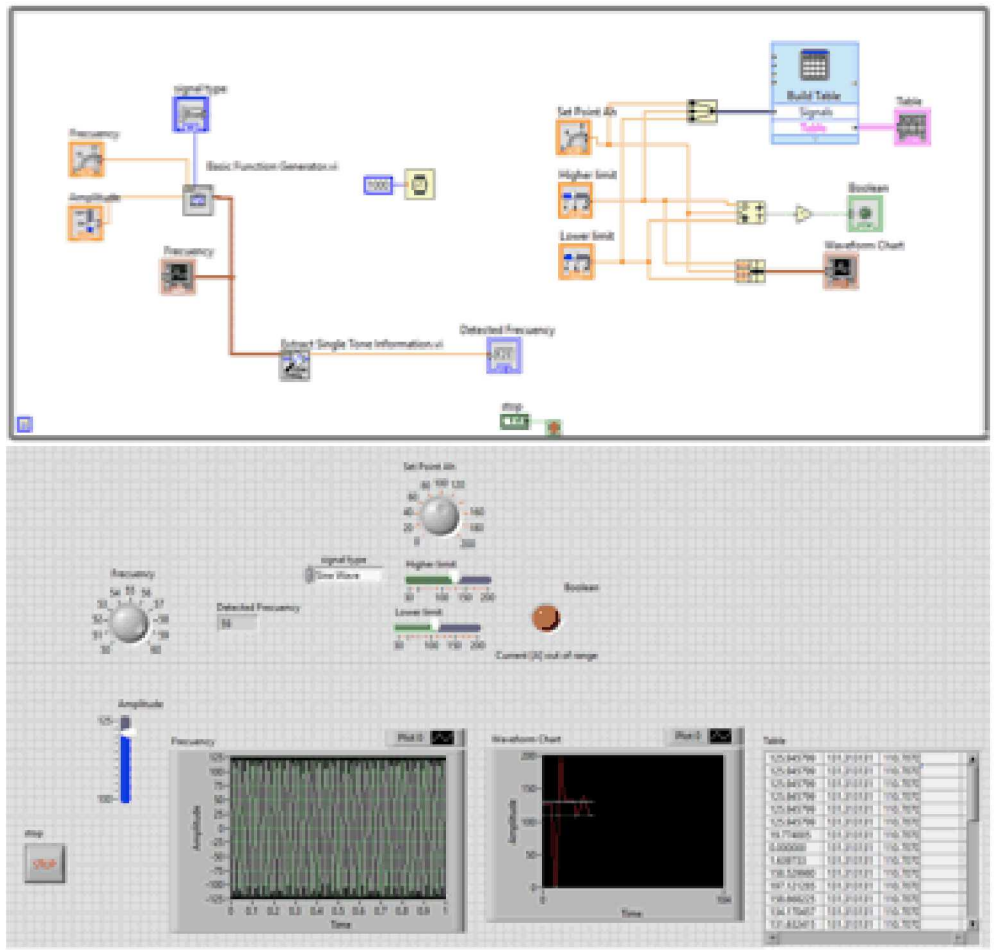
4. Energy storage recommendation: Study on the use of closed commerce building

Motive:
Puerto Rico recession, emigration and growth rates during this two decades have caused main effects in the commercial sector*.
Advantage:

- Location: In many cases, the closed commercial structures are in privileged geographical locations with massive population density. In some cases, commerce like these are completely abandoned. They are near principal avenues and highways.
- For example in the area of Barceloneta closed locations are recently constructed meaning they are in excellent conditions.
- Another feature the location close to (approx. no more than 3 miles) pharmaceutical industries such as Abbvie, Abbot, Meriel, Avara and Pfizer.

*https://www.newyorkfed.org/medialibrary/media/research/current_issues/ci20-4.pdf

5. Energy storage recommendation: Study on the use of energy storage for communications



LabView (LV) Simulations for AC Source of Telecommunication Systems

Motive:

For any local economy to be successful in this current economy, the use of telecommunications plays a vital role.

Advantage:

- Location: During the current pandemic catastrophe, companies like AT&T, Claro, T-Mobile, Sprint have been playing a vital role not only keeping a virtual economy alive but also creating a new way to keep our current life in topics related to online-education, virtual jobs, entertainment, no-contact food delivery.
- It is important to develop a resilient communication system and energy storage could provide an opportunity to improve telecommunications specifically in Central Office (CO), Cell Towers (CT), Video Ready Access Device (VRAD), etc.
- Specifically energy storage should be selected based on the reliability of the different Power Sources (PS), Load Power Consumption (LPC), and LV-Simulations.

Questions?

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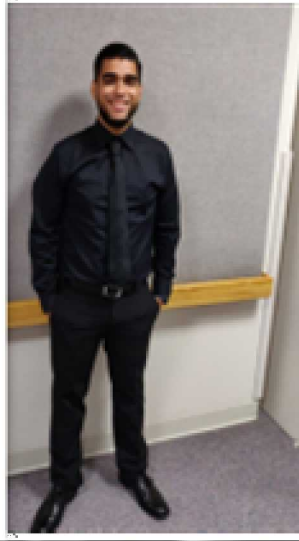

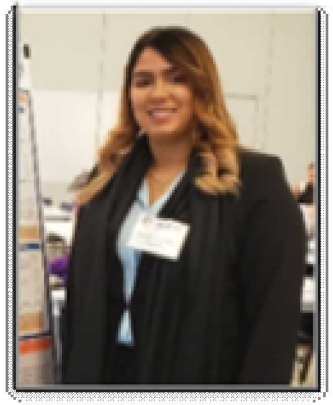

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