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Sustainable Energy Storage Optimization using QuESt

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Personal Background

Educational

Master of Science in Mechanical Engineering
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Research Experience

- June 2019 – Present - Sandia National Laboratories
- August 2018 – Present – Energy Management Team
- June 2018 – August 2018 – Purdue University

Outline

- Introduction
- Methodology
- QuESt
- Example- Inputs
- Output
- A System more Efficient
- Result
- Next Phase
- Conclusion

Introduction

- Renewable energy is growing fast and becoming a significant source of power on the electric power system. Energy storage plays an important role in balancing out the variability of renewable energy.
- This project consists of simulating different cases to see how a PV system will perform with and without energy storage.
- QuESt is used to investigate these scenarios. QuESt is an open source program, based on Python software that works with the analysis of energy storage. The QuESt tool is an energy storage valuation and related applications.
- This work shows how can we make a PV plus energy storage system more effective and sustainable.

Methodology

The methodology of this project is as follows:

An inputs is added to the QuEst program to simulate several case, then those results are compared with an algorithm from MATLAB.

Simulate Several Cases

Simulated Results

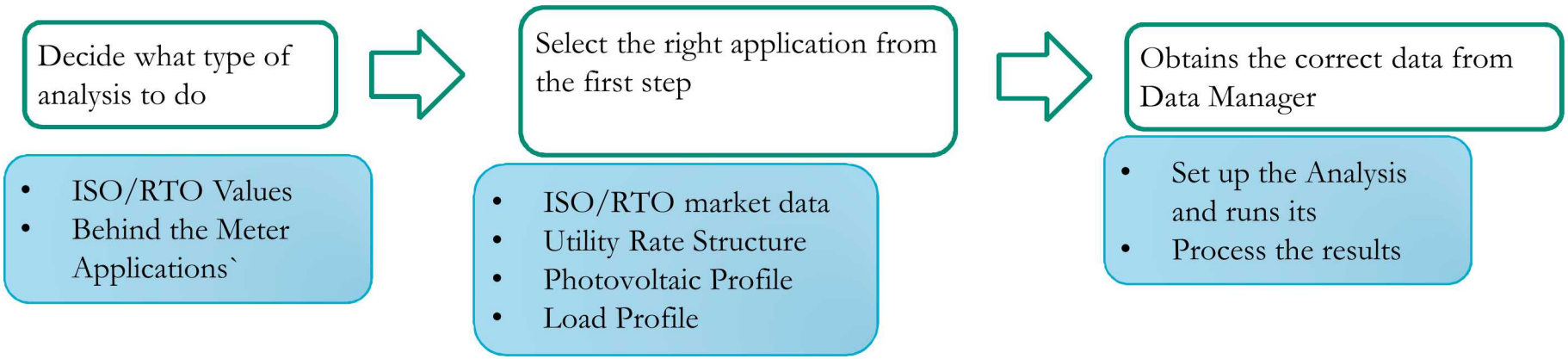
Used load ta given from QuESt and compare the results with a MATLAB algorithm

MATLAB Results

QuESt

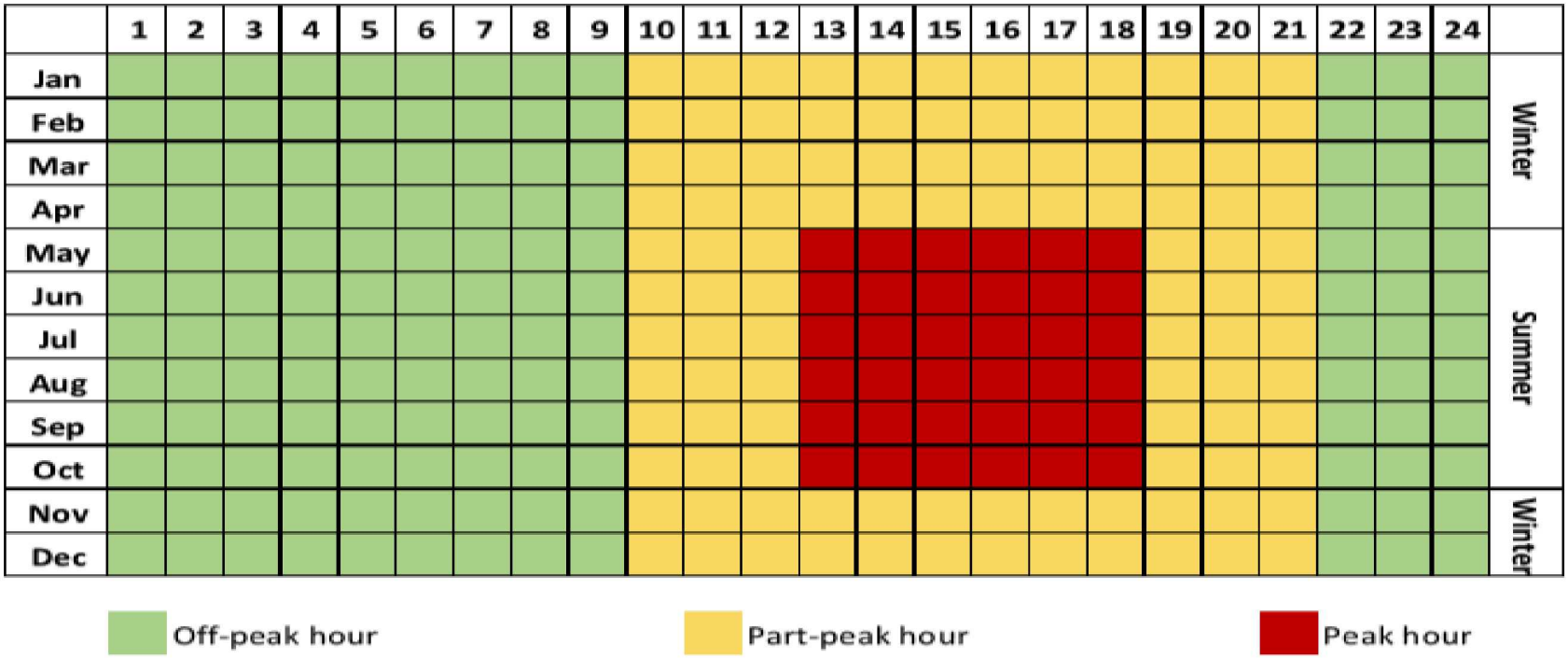
- QuESt Data Manager – Manages acquisition of ISO market data, US utility rate data, commercial and residential load profiles, etc.
- QuESt Valuation – Estimate potential revenue generated by energy storage systems providing multiple services in the electricity markets of ISOs/RTOs.
- QuESt Behind the Meter (BTM) - Estimate the cost savings for time-of-use/net energy metering customers using behind-the-meter energy storage systems.

Workflow



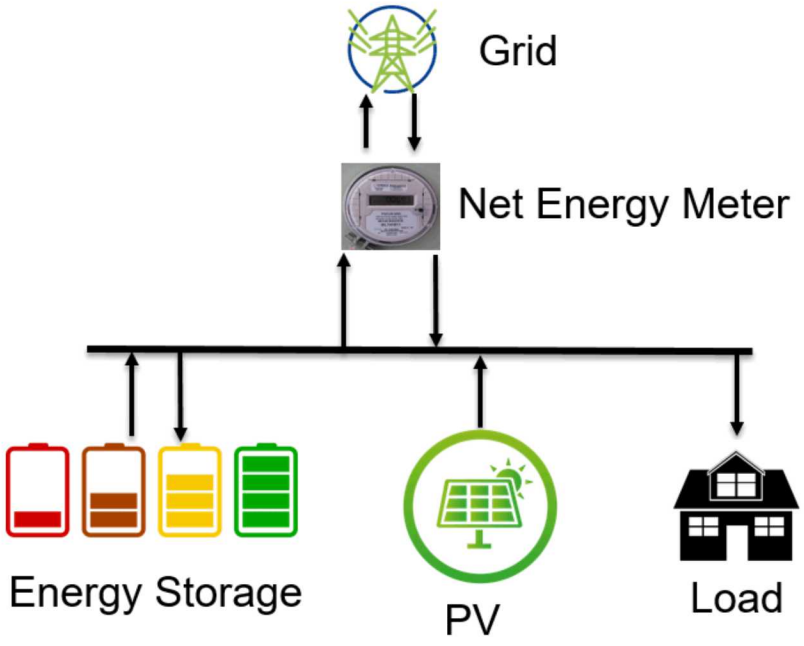
QuESt

- The batteries are programed to charge on the off-peak hours and discharge while being at the on-peak hours. The reason for this of is to avoid ~~the~~ demand charges.
- The PV will generate power mostly in the on-peak hour, therefore there will be moments where the batteries and PV will be working simultaneously.

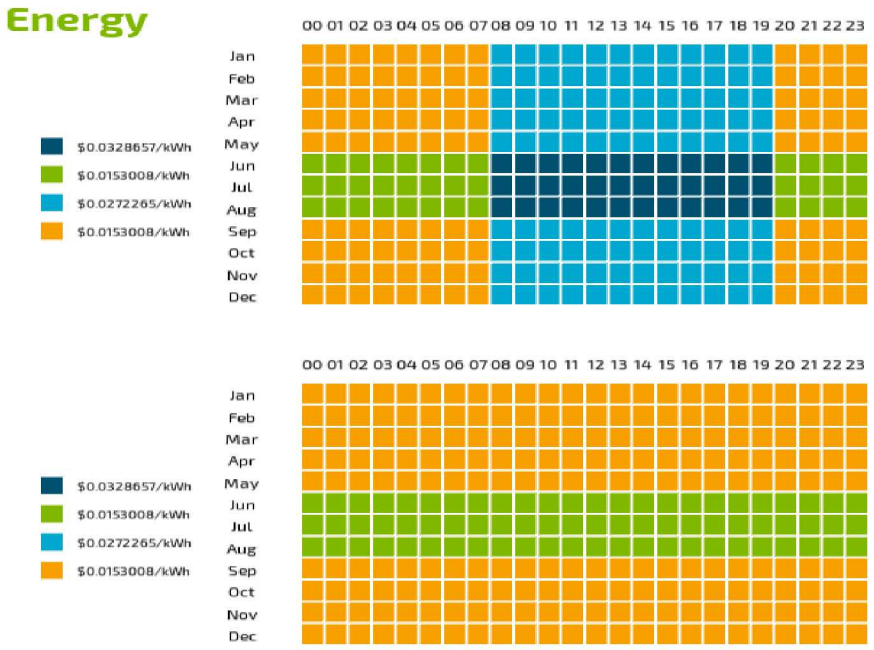


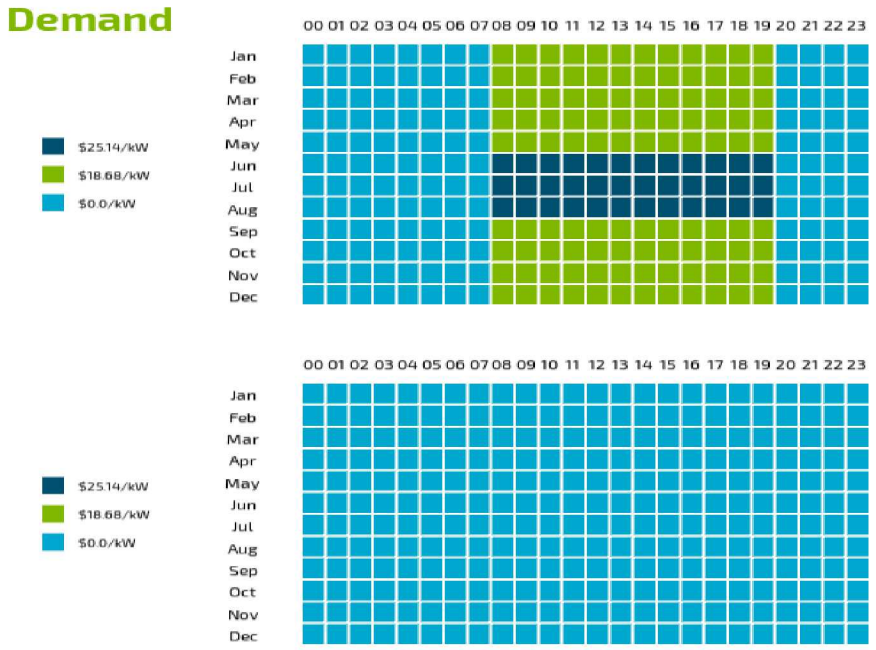
QuESt

- The PV and energy storage works together to minimize load charges.
- When the PV and batteries supplies more than is needed by the load, the excess energy is sent back to the utility through Net Energy Metering (NEM) and the customer receives a credit for each kWh.



Example – Inputs





Public Service Company of New Mexico (PNM)		
Parameter	Value	Units
PV System	50	kW
Initial State of Charge	50	%
Maximum State of Charge	100	%
Minimum State of Charge	0	%
Round Trip Efficiency	85	%
Self-discharge Efficiency	100	%/h
Transformer Rating	1000000	kW
Power Rating	100	kW
Energy Capacity	100	kWh

Outputs

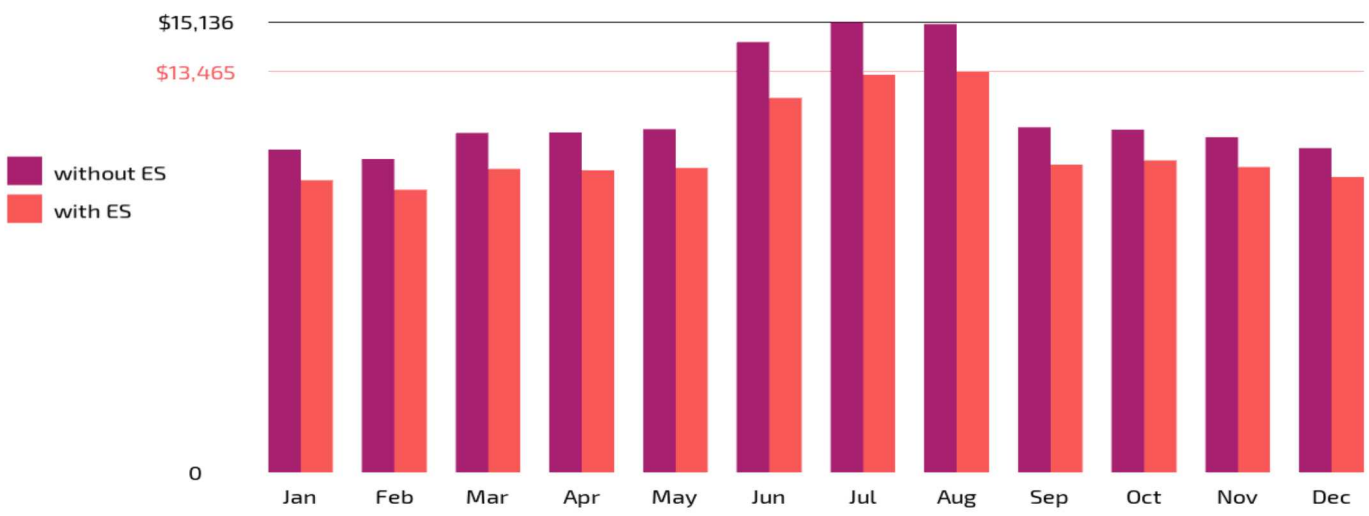
QuESt

Time-of-Use Cost Savings

home about settings

Here's the total bill with and without energy storage for each month.

The total bill is the sum of demand charges, energy charges, and net metering charges or credits. It looks like the ESS was able to **decrease** the total charges over the year by **$15,382.34**.



Reports

Total bill

Total bill comparison

Demand charge comparison

Energy charge comparison

NEM comparison

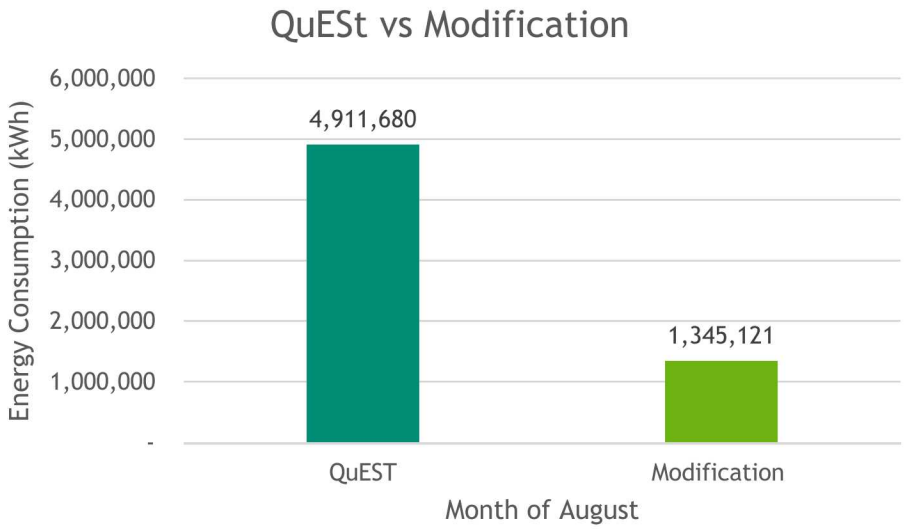
Peak demand comparison

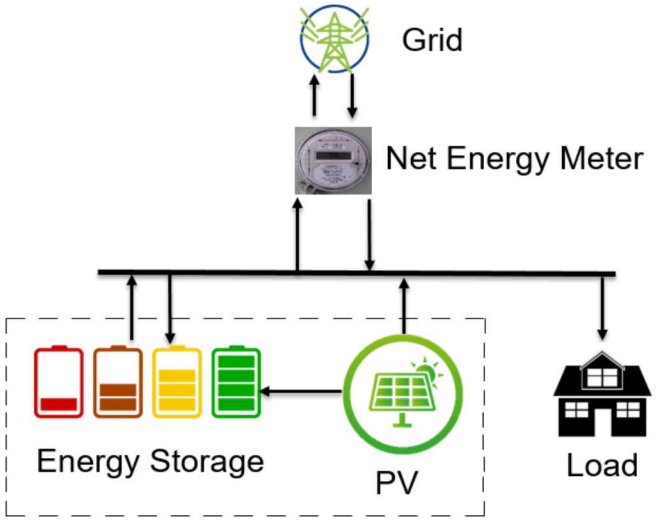
Generate report

A System more Efficient

- The energy storage is programed to discharge only in the on-peak hours, it isn't available for meeting off-peak hour demand.
- If the PV generates more than the load, then the residual energy will go directly to NEM and not to the battery.
- We manage to do an algorithm using MATLAB, that simulate the energy consumption and is program for the batteries to discharge at off-peaks and on-peaks hours, unlike the algorithm from QuESt that only discharge batteries while is on-peak hours.
- Also simulate the case where the batteries can be charged from the PV, when the PV generation is greater than the load.

Results





- This results is based on peak load of 8 MW using a revised program. Shown here is the comparison between the energy consumption between QuESt and the MATLAB. The difference was more than 3.5 million kWh-month.

Next Phase

- For the cases were the PV generate more the load charge, while the batteries are fully charge, send the residual to the NEM.
- Look at additional scenarios with the energy and demand rate compare with QuESt to see how can be more cost effective.
- Find a way to simulate situations for the use energy storage or not using energy storage when the load is low and the tariff is off-peak.

Conclusion

The Energy Storage is playing an important role in balancing out the variability of renewable energy. This is why project consisted on seeing how sustainable a PV system can be with and without energy storage. With the several scenarios that were analyzed in QuESt we found a way to make the whole system more sustainable and cost effective, by using more renewable energy and less energy consumption from the grid.

Reference

[1] Nguyen, T., and R. Byrne. "Maximizing the cost-savings for time-of-use and net-metering customers using behind-the-meter energy storage systems." Proceedings of the 2017 North American Power Symposium (NAPS). 2017.

[2] R. Concepcion, "QuESt An Energy Storage Application Suite" Sandia National Laboratory, 2019

Thank You