SAND2020-9613C

Energy Storage Benefits to San Carlos Apache Tribe

Rodrigo D. Trevizan, Tu Nguyen and Stan Atcitty

Abstract: San Carlos Apache Tribe (SCAT) is currently served by an unreliable power grid. Generation and transmission assets are limited and power is costly. When storms are expected to occur in the region, the regional hospital is disconnected from the grid to avoid damage to sensitive medical equipment. In this situation, power is provided by diesel backup generators during business hours. Construction of a 2 MW solar photovoltaic array co-located with the hospital is planned. In this study, we have analyzed the benefits behind-the-meter Battery Energy Storage Systems (BESS) can provide to decrease fuel and electricity costs. Results show that energy storage has the potential to reduce fuel costs and reduce curtailment of solar generation.

San Carlos Apache Tribe Facts

- Located in Southeast of Arizona
- Population: 10,000 people
- Area: 2,900 sq. miles (2x Rhode Island)
- Limited electric power resources
  - Community solar photovoltaic (PV)
  - Planned 2 MW PV array co-located with hospital inside of reservation
  - Only 1 69kV transmission line in San Carlos Irrigation Project (SCIP) area
- Average 100 outages per year
  - Could affect 4,000 to 6,000 people

Project Goal:

- Provide technical assistance to the Tribe to enable informed decision making with respect to future planning of Renewable Energy Portfolio, including potential benefits of ESSs

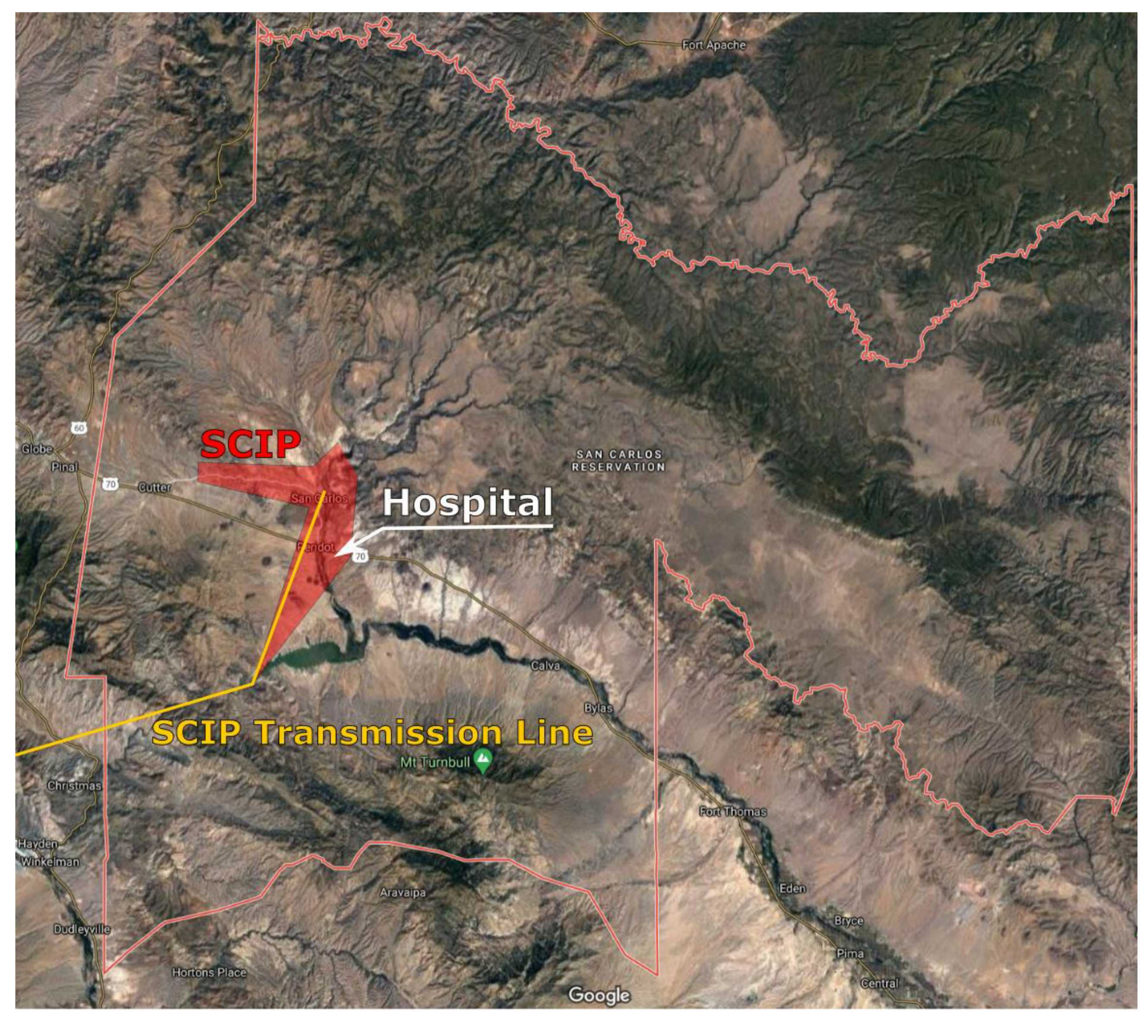


Fig. 1. Hospital and San Carlos Reservation. Source: Google Maps.

Benefits of Energy Storage

- BESS can be deployed virtually anywhere
- Behind-the-meter (BTM) cost savings with BESS:
  - Reduce demand charges
  - Reduce PV curtailment
  - Reduce fuel consumption of diesel generators

Assumptions

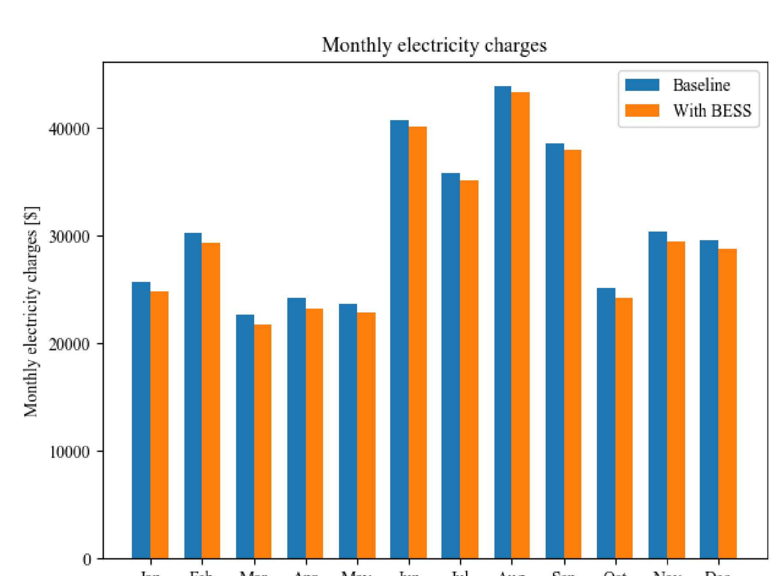
- Backup generators, PV array and BESS are BTM
- BESS round trip efficiency: 86%[1]
- BESS throughput is under equivalent of 3,500 cycles at 80% depth of discharge over its life (10 years)[1]
- Load does not increase in the period
- BESS and PV are ac connected
- BESS costs $388.00/kW and $372.00/kWh[1]
- Hospital's electric system is isolated from grid during business hours during monsoon season
- Historical monthly energy (kWh) for 2 years is known and assumed constant over 10 years
- Load profile is similar to nearby hospitals found in OpenData[2] and is adjusted by monthly mean
- Average efficiency of generators is 27% (10.24 kWh/gal)
- Solar profile of PV array obtained with PVWatts[3]
- Price of diesel: $3.171/gallon (constant over period)
- Interest rate of 3% per year
- SCIP does not have net metering policy
  - Energy injected in SCIP's grid will not yield any benefit to the hospital
- SCIP's Industrial Rate Schedule
  - Demand: $7/kW
  - Energy: $0.0718/kWh
  - Monthly service charges: $250.00

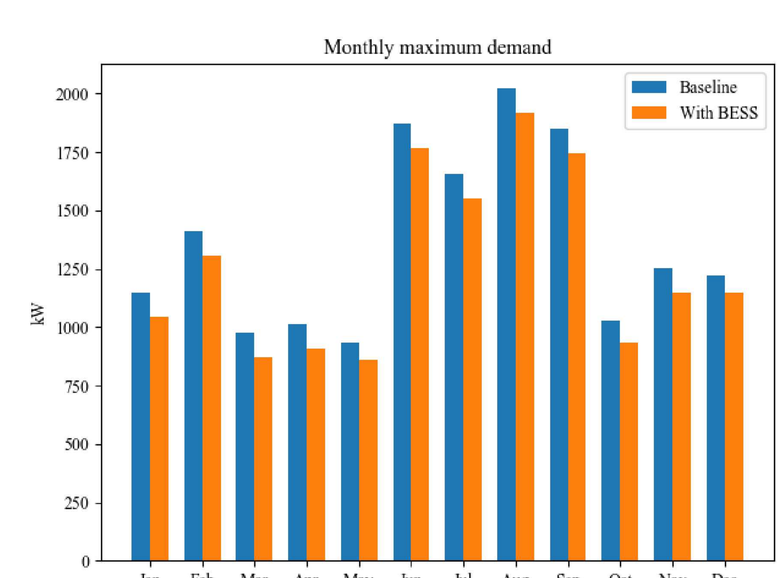
Case Study

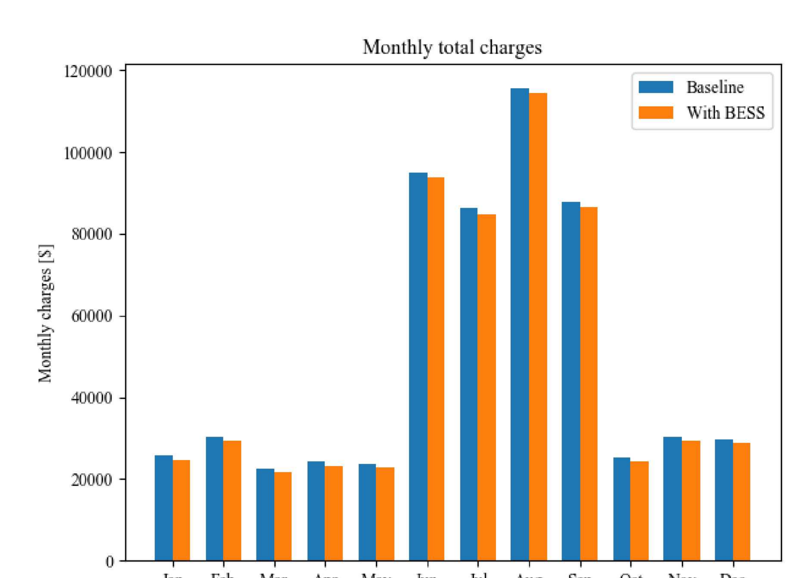
- San Carlos Apache Healthcare
- Power outages are very common during monsoon season (June through September)
- To avoid damage to sensitive medical equipment, hospital is islanded from distribution grid when storms are expected to hit the region
- Backup diesel generators power the hospital during business hours
- To provide redundancy, generators operate at low load levels and should be capable of providing power in case one of them goes offline
- Cost savings are estimating the reduction in fuel and electricity costs when BESS is deployed with PV and diesel generators
- **Technical objective: find optimum size and scheduling of Lithium-Ion BESS that maximizes net present value (NPV) of investment over 10 years.**

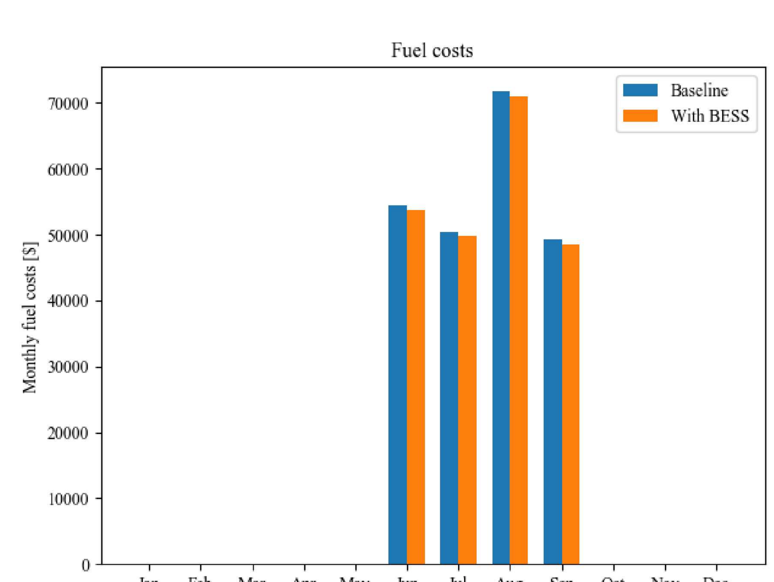
Results

- Solution to problem of optimal scheduling of BESS, PV and diesel generators and optimal sizing of BESS to maximize NPV of cost savings obtained by a script written using Pyomo









$$NPV = \sum_{y=1}^{10} \frac{S_y}{(1+i)^y} - I$$

$$I = p_{kW} B_{kW} + p_{kWh} B_{kWh}$$

- S_y: estimated cost savings in fuel and electricity charges due to use of BESS (per year)
- i: interest rate (per year)
- I: cost of capital investment
- y: year
- p_{kW}: price of BESS per kW
- B_{kW}: power capacity of BESS
- p_{kWh}: price of BESS per kWh
- B_{kWh}: energy capacity of BESS

Table. 1. Results of optimization: optimal BESS sizes, investment, cost savings per year and objective function (NPV).

BESS power (B_{kW})	BESS energy (B_{kWh})	NPV	Investment (I)	Cost savings (S_y)
104.47 kW	**151.85 kWh**	$12,297.98	$ 97,023.60	$ 12,442.55/year

Table. 2. Comparison between costs of operation (fuel and electricity), PV curtailment and peak demand of system with and without BESS.

Case	PV curtailment	Fuel cost	Electricity cost	Total cost	Peak demand
Diesel gen. + PV	631,256.43 kWh/year	$ 225,869.30/year	$ 370,524.92/year	$ 596,394.23/year	2,077.99 kW
Diesel gen. + PV + BESS	596,541.86 kWh/year	$ 223,054.18/year	$ 360,897.49/year	$ 583,951.68/year	1,920.45 kW

Conclusions

- BESS can reduce fuel costs and electricity charges for the hospital of up to **$ 12,442.55 per year**
- Cost savings are due mainly to reduction in demand charges, reduction in PV curtailment and fuel cost savings
- Net present value of profit is $12,297.98
- With perfect load foresight, cost savings over 10 years can pay for BESS investment of $97,023.60 with a small profit
- Without perfect foresight of load, performance of controllers deployed in the field is expected to be sub-optimal, therefore cost-savings should be reduced

References

1. Mongird, K., V. Viswanathan, P. J. Balducci, M.J.E.Alam, V. Fotedar, V. S. Koritarov, and B. Hadjerioua. Energy storage technology and cost characterization report. No. PNNL-28866. Pacific Northwest National Lab.(PNNL), Richland, WA (United States), 2019.
2. Open Data, Energy Information Administration. [Online] https://www.eia.gov/opendata/
3. Dobos, A. P. *PVWatts version 5 manual.* No. NREL/TP-6A20-62641. National Renewable Energy Lab.(NREL), Golden, CO (United States), 2014.

Acknowledgement: Funding was provided by the US DOE Energy Storage Program managed by **Dr. Imre Gyuk** of the DOE Office of Electricity Delivery and Energy Reliability Special thanks to Nathan Nash, Cedar Polk, Waylon Dude, Kyia Jackson, Kevin Cassadore (San Carlos Apache Tribe), Heather Zunino, Scott Fillerup, Arlin Billy (Indian Health Services - Phoenix, AZ), Brandon Slim, and Kevin Rogers (San Carlos Apache Healthcare) for information and clarifications regarding load data.