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Optimizing Storage and Renewable Energy Systems with REopt

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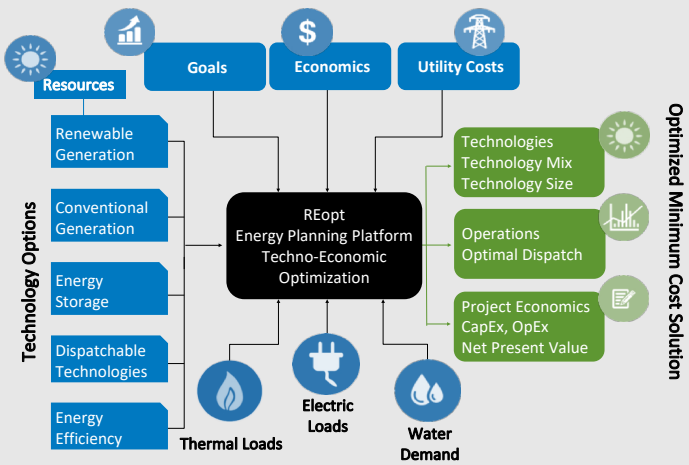
Background

Under the right conditions, behind the meter (BTM) storage combined with renewable energy (RE) technologies can provide both cost savings and resiliency. Storage economics depend not only on technology costs and avoided utility rates, but also on how the technology is operated. REopt™, a model developed at NREL, can be used to determine the optimal size and dispatch strategy for BTM or off-grid applications.



REopt is an energy planning platform that helps clients meet cost saving, resiliency, and energy performance goals. Formulated as a mixed-integer linear program, it is used for techno-economic analysis of renewable and conventional generation, energy storage, dispatchable technologies, and energy efficiency.

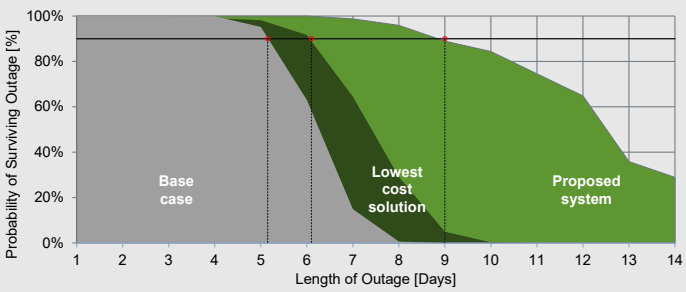
Optimizing BTM Storage and RE to Extend Probability of Surviving an Outage

NREL evaluated thousands of random grid outages and durations throughout the year and compared the number of hours the site could survive with diesel generators and fixed fuel supply vs. generators augmented with PV and battery systems.

The system configuration with the lowest life cycle cost of energy when grid-connected results in $0.5 million of life cycle savings and extends the 90% probability of surviving an outage to 6 days.

A system configuration proposed by the site was evaluated using the same methodology. While it results in life cycle costs $0.1 million higher than the base case, it extends the 90% probability of surviving an outage to 9 days.

	Generator	Solar PV	Storage	Life Cycle Cost	Outage
Base case	2.5 MW	-	-	$20 million	5 days
Lowest cost solution	2.5 MW	625 kW	175 kWh	$19.5 million	6 days
Proposed system	2.5 MW	2 MW	500 kWh	$20.1 million	9 days



Storage and PV extend probability of surviving outage at little to no added cost

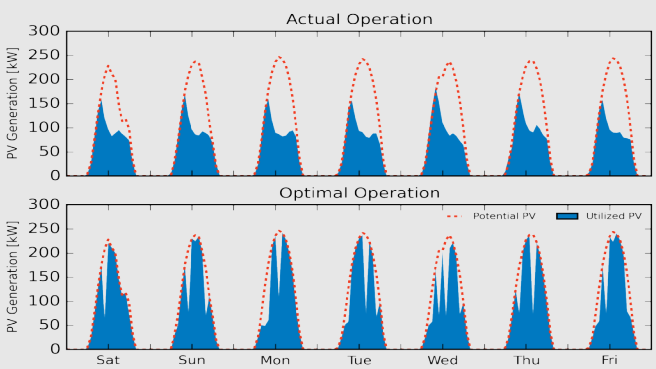
Optimizing Off-Grid Energy System Operation

Alcatraz Island implemented a PV-diesel-battery off-grid system in 2012 to reduce fuel use; however, the system did not save as much fuel as expected.

Generators were charging the battery too often, limiting the storage capacity of excess PV. REopt was used to refine the dispatch strategy of the existing systems. The optimized operating strategy would increase use of the existing PV system

	Actual Operation	Optimal Dispatch
Fuel used (gal/year)	30,908	15,001
Fuel cost ($/year)	$108,178	$52,504
PV curtailed (%/year)	30%	4%
Battery use (kWh/year)	249,224	166,051

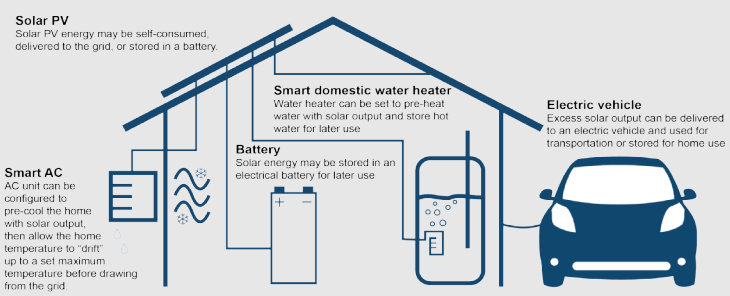
(reducing curtailment from 30% to 4%), reduce annual fuel consumption and cost by about 50%, and limit battery wear and tear.



Optimal operations are able to utilize more of the potential PV generation

Optimizing Residential BTM Solar "Plus"

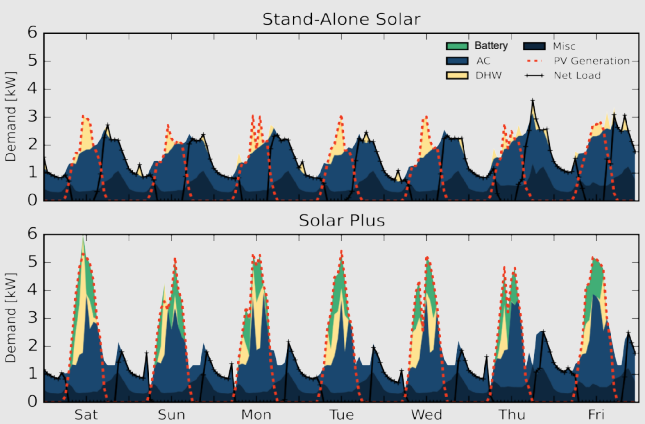
Solar "plus" uses energy storage and controllable devices to optimize customer economics, especially in a post-net metering environment. PV along with electric batteries, smart domestic water heaters, smart AC units, and electric vehicles can enable customers to increase solar self-consumption and realize value from a larger share of their system's output.



REopt was used to determine the optimal mix and size of solar and solar "plus" to lower the life cycle cost of energy for a number of post-net metering residential utility tariffs (including time-of-use and demand tariffs).

For the Hawaii time-of-use residential tariff—where no energy export is allowed—the solar "plus" approach increases net present value by a factor of three relative to the stand-alone solar approach. Increased system value stems from the ability of the customer to use solar "plus" technologies to realize value from excess solar PV output; increasing cost-optimal system size and reducing system curtailment.

Customer load profiles, grid net load, and solar PV output



The smart AC unit and smart domestic water heater are dispatched each day to pre-cool the home and pre-heat water with solar PV output. Any excess output remaining after pre-cooling and water heating is delivered to a battery, which is dispatched to further reduce TOU rates.

	PV system size (kW)	Battery size (kWh/kW)	Smart water heater & AC	PV generation (kWh/yr)	Electricity savings ($/yr)	NPV
Solar	4.6	-	-	6,247	$957	$5,684
Solar Plus	8	7.8/1.3	Deployed	11,663	$2,690	$16,851

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