RESET: A Tool to Evaluate Renewable Energy Storage Options

Rebecca Hausheer, Kurt Heinze, Sheena Katai, Karly Kaufman, Jefferson Litten & Gomati Madaiah

Bren School of Environmental Science & Management, University of California, Santa Barbara

INTRODUCTION

In the last few decades, the drawbacks of fossil fuel dependency—including global climate change, energy security, and price volatility—have become increasingly prominent. One way to reduce fossil fuel dependency is to harness the earth's renewable energy resources, such as solar and wind power, and turn them into usable electricity. However, widespread adoption of renewable energy solutions has been limited by intermittency and variability of solar and wind resources—electrical generation can only occur when the wind blows or the sun shines. Energy storage addresses this limitation by allowing electricity to be stored for use later when generation is unavailable—a process called load shifting.

ABOUT ENERGY STORAGE

Energy storage involves the conversion of electrical energy into another form such as chemical, kinetic or potential energy. The energy can then be stored and then converted back to electrical energy when the electricity is needed. Leading energy storage technologies include batteries, fly-wheels, compressed air storage and pumped hydro.

PROBLEM

The decision to invest in an energy storage system is complex (see Figure 1). Energy storage can offer economic benefits from applications such as peak shaving or load shifting. However, these benefits must be compared against the significant costs of energy storage systems including up-front capital expenditure, operations and maintenance, replacement, and insurance. Prior to this project, no comprehensive tool existed for electricity customers to evaluate energy storage options.

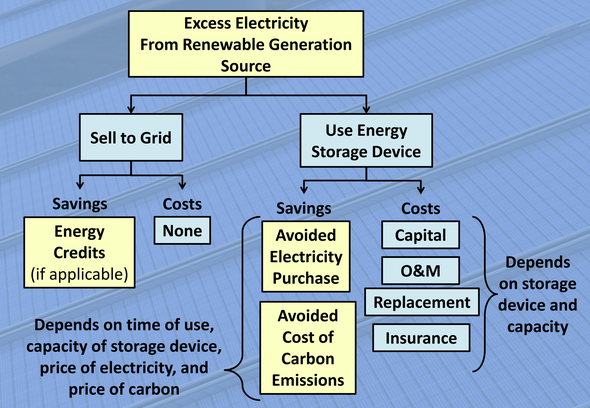


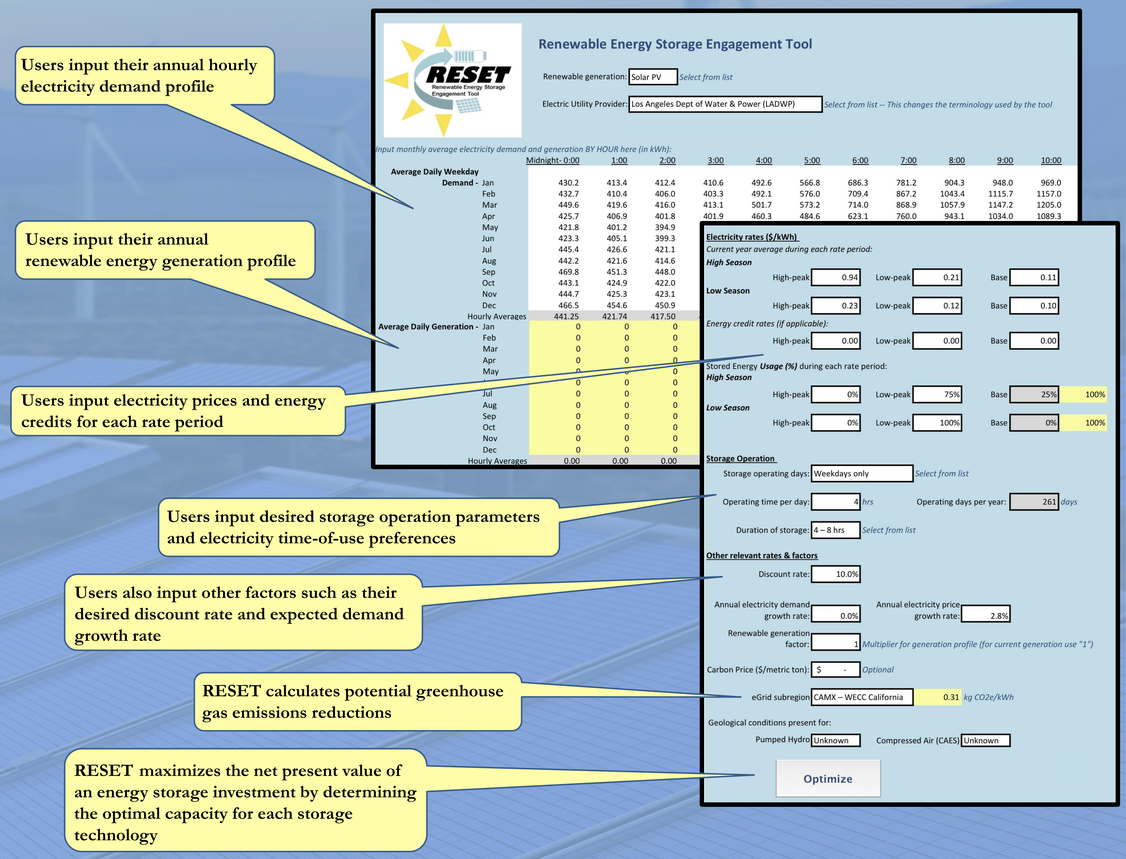
Figure 1: Storage Decision Conceptual Model. If an electricity customer generates excess electricity, the customer may either sell that excess back to the utility (if eligible) or opt to store it.

OBJECTIVE

The objective of this project was to develop a tool that calculates the lifetime costs and benefits of an energy storage system for electricity customers who possess on-site renewable generation. This tool was designed to first calculate the users excess generation and then optimally size an energy storage system to maximize the value that excess energy.

THE *RESET* METHODOLOGY

To address our objective, our team created the Renewable Energy Storage Engagement Tool (RESET). RESET calculates the maximum economic value of excess renewable generation by optimally sizing energy storage systems. RESET allows any electricity customer to compare and evaluate the economic profitability of multiple energy storage technologies at their site.



Fourteen energy storage technologies are analyzed within the RESET framework. The costs and operational characteristics of the included energy storage technologies—both of which change according to the size of the required system—are used to determine the optimal size of the energy storage system required to meet the client's needs. First, RESET calculates the excess electrical generation that would be available for energy storage. Next, RESET maximizes the net present value of each energy storage technology, determining the optimally sized system for storing the available excess. The results are displayed graphically and in tabular form—allowing the user to compare the optimal capacity and net present value for all fourteen technologies.

Acknowledgements: Professor Sangwon Suh, AECOM, Los Angeles Harbor College, Yardi Systems Group

CASE STUDY

RESET was used to evaluate energy storage options for Los Angeles Harbor College, a 10,000-student community college with a 2.1 megawatt (MW) solar photovoltaic generation system. Harbor College presented to our group two main problems:

1. Harbor College lacks the metering equipment to measure any excess electricity generation that may exist from their solar array
2. Because Harbor College's solar generation capacity exceeds a threshold set by their utility, Harbor College is not eligible to receive compensation for excess electricity sent back to the grid.

Given these problems, we used RESET to first calculate Harbor College's excess generation and then evaluate the optimal storage technology and capacity for the campus.

RECOMMENDATIONS

Based on Harbor College's existing generation and demand profiles, RESET calculated that sized storage capacity was 0 kilowatt-hours for all technologies (see Figure 2). In other words, the potential savings in avoided future energy bills do not exceed the costs any energy storage system. However, by increasing solar generation capacity or reducing demand through efficiency, energy storage may become a more cost-effective option at Harbor College.

Technology	Optimal Capacity	Optimal NPV	NPV, 500kWh
Flooded Cell Lead-Acid Batteries	0	$0	-$213,749
Valve Regulated Lead-Acid Batteries	0	$0	-$272,411
Nickel Cadmium Batteries	0	$0	-$900,965
Zinc Bromine Flow Batteries	0	$0	-$380,285
Sodium Sulfur Batteries	0	$0	-$896,305
Lithium-Ion Batteries	0	$0	-$1,163,320
Vanadium Redox Flow Batteries	0	$0	-$700,730

Figure 2: RESET Results for Harbor College. The optimal storage and net present value for all technologies were zero. Assuming a moderate size energy storage system of 500 kWh, net present values were all negative.

CONCLUSIONS

Though in this case study, storage was not profitable—our analysis demonstrates how energy storage can make emission-free, renewable generation available during all hours of the day. With further innovation and economies of scale, the costs of energy storage technologies will eventually fall, making energy storage coupled with renewable generation a more feasible option for electricity customers across the nation. Renewable generation and energy storage in tandem can help replace fossil-fuel based electrical generation. It is our hope that RESET will allow all users to better understand the benefits of energy storage and aid in the path towards a clean energy future.