# Smart Water Heaters As Energy Storage Options — Hawaii Case Study

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Many know that rooftop PV penetration in Hawaii far surpasses almost anywhere else in the world. Given the state's 100% renewables mandate by 2045, the pace to explore and quickly implement renewable energy in Hawaii has exposed many challenges and has forced them to the "bleeding edge" of the newest technologies. This forced progress now includes accelerated installation of various forms of energy storage, particularly at the grid-edge. This situation underscores the growing importance of cost-effective and scalable energy storage and its synergy to greater solar generation.

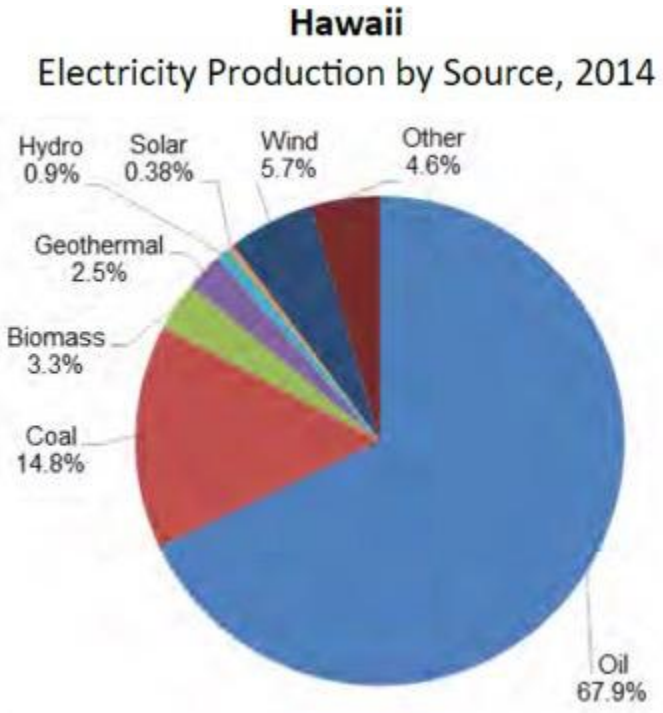
Importantly, a draft NARUC Distributive Energy Resources Compensation Manual says: "Energy storage can be used as a resource to add stability, control, and reliability to the electric grid. Historically, storage technologies have not been widely used because it has not been cost competitive with cheaper sources of power, such as fossil fuels. However, given the recent decline in cost as well as improved storage technologies, storage has become an option that is able to compete."

Our answer is focus your study on Hawaii, because of all the locations across the planet, Hawaii is transitioning faster than anywhere else from a huge and risky over dependency on imported fossil fuels, particularly for electricity generation.

That was the strategy that our company committed to (PDF) just 4 years ago, and it paid off as Hawaiian Electric began deploying our smart water heater solution about a year ago as its very first residential behind-the-meter real-time energy storage.

## Hawaii Energy Situation

For perspective, Hawaii is heavily dependent upon oil and gas for its electricity. In past years, total oil imports cost the average person in Hawaii as much as $3000/person/year, but as crude prices dropped by more than half, the money bleeding out of the islands also receded.




Hawaiian Electric's regulatory filings show that its price for low sulfur fuel oil prices dropped from $135.10/bbl in August 2014 to the current $58.44/bbl. For residential customers on Oahu, that collapse in oil prices took their $0.367/kWh electricity rate in August 2 years ago to $0.267 today. In other words, the drop in price of imported oil converted to a drop of $50/month in the monthly electricity bill for an average customer using 500 kWh/month.

Not so coincidentally, the incredible rise in oil prices that peaked in 2008, and again in August 2 years ago, spurred a torrent of legislative and regulatory activity in Hawaii. For instance, in 2007, Hawaii became the second state in the nation to set a binding cap on greenhouse gas (GHG) emissions through Act 234, a policy to reduce GHG emissions statewide to 1990 levels by the year 2020.

Hawaii's Renewable Portfolio Standard (RPS) that was established in 2001 was amended during the 2006 legislative session to require that 20% of electricity sales be produced from renewable resources by 2020. In June 2015, Governor Ige signed a bill strengthening Hawaii's commitment to clean energy by directing the state's utilities to generate 100% of their electricity sales from renewable energy resources by 2045.

As further background, the Hawaiian Islands have 6 electrical grids, and none are connected to any other island. Hawaiian Electric Company (HECO) and its subsidiaries, Maui Electric (MECO) and Hawaii Electric Light Company (HELCO), serve about 93% of the state's electric utility customers. The island of Kauai is served by Kauai Island Utility Cooperative (KIUC).

## Hawaii's transition to 100% renewables

Under Hawaii's Renewable Portfolio Standard (RPS), each electric utility company must meet the following percentages of "renewable electrical energy" sales:

- 30% of its net electricity sales by December 31, 2020
- 40% of its net electricity sales by December 31, 2030
- 70% of its net electricity sales by December 31, 2040
- 100% of its net electricity sales by December 31, 2045

The PUC stated earlier this year that RPS compliance stood at 23%. KIUC has already spent a total of $350 million to get where it is right now, and plans to get to 60% renewable energy by 2020 and 70% by 2030. Hawaiian Electric plans to get to 46% renewable energy by 2020 and 67% by 2030. It also was recently reported that it will cost $8 billion in infrastructure upgrades alone on Oahu.

As mentioned, in the spring and up until September 2014, oil was continuing to push residential electricity bills to highly unsustainable levels. Hawaiian Electric (just like most utilities) periodically updates its Integrated Resource Planning (IRP). Yet in April 28, 2014, in an unprecedented action, the Public Utility Commission (PUC) rejected HECO Companies' IRP Report and associated Action Plans and issued 4 new orders, including within Order 32052 Appendix A "Inclinations on the Future of Hawaii's Electric Utilities" which was both guidance and a roadmap to move Hawaii to a grid of the future. The PUC also set a late summer deadline for the HECO Companies to file several new and very exhaustive reports. Among those reports that HECO was required to file:

- A Power Supply Improvement Plan (PSIP) for each of the 3 separate HECO companies that addressed critical power supply resource issues including system reliability issues
- A Distributed Generation Interconnection Plan (DGIP) that addressed critical distribution system upgrade planning issues
- A Demand Response portfolio plan (IDRPP) that utilize DR in lieu of conventional generation

During the 2 years that followed, over a dozen associated PUC Dockets added thousands of pages of studies and documents to support the PUC's "Inclination" guidelines and goals, yet the key report was always the PSIP. That initial August 26, 2014 PSIP filing (at 1600 pages) was informally rejected by the Commission. Later, after a careful review, the Commission issued Order No. 33320 on November 4, 2015, where it stated that it found several shortcomings in the PSIPs that need to be addressed. The Commission ordered the Hawaiian Electric Companies to file a Revision Plan that month and ordered HECO to file updated PSIPs by April 1, 2016 — which it did.

In a June 20, 2016 submittal, HECO told the PUC that it incurred, but never sought recovery for, approximately $5 million in outside consultant costs for development of the PSIPs submitted into August 2014, and approximately $700,000 was incurred in beginning the planning and update work required in late 2015. The outside consultants began their work on the interim and updated PSIPs in late 2015. So, through May 2016, the companies incurred approximately $3,578,632 in

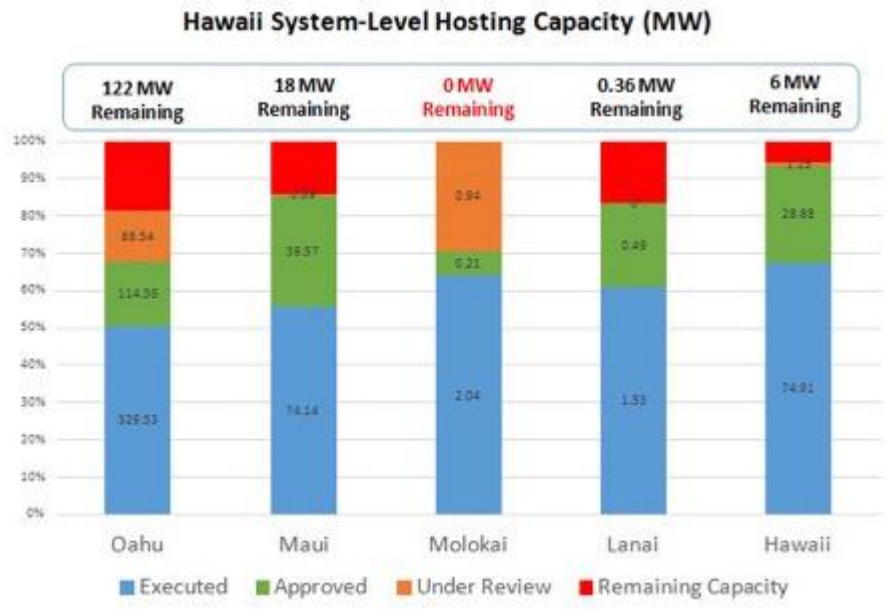
PSIP consultant outside services costs and estimated they will incur an additional $2,188,893 from June 2016 through year end.

This is a gold mine waiting to be prospected by utilities, because if HECO is correct, the research contained in the Docket has nearly $10 million in consulting evaluations and reports from companies like Energy and Environmental Economics (E3), Boston Consulting Group (BCG) and others contained within the 11,000 pages PSIP Docket alone. In addition, further critical information will be added after the 2 Technical Conferences scheduled by the PUC before the final HECO PSIP is submitted at year end.

This is the motherlode, but there are at least another dozen other supporting Dockets that contain thousands of other pages of analysis and rich veins of lessons learned. Part of the reason that those sources are so valuable is the little-known fact that Hawaii was first or among the first to investigate and institute programs, and certainly the first to face some of the expected and unexpected consequences. For instance, Feed-in-tariffs (FIT) as a renewable energy procurement mechanism were initiated in September 2009 and ended in December 2015. However, future revisions or modifications could be addressed either in Docket No. 2014-0192 (DER policies) or in Docket No. 2014-0183 (the HECO Companies' PSIPs).

Hawaiian Electric was also the first to:

- Face "feeder constraints"
    - With DOE help it collaborated with NREL and SolarCity to expand those limits
- Experience the end of net metering (October 12, 2015), which was replaced 2 new programs known as Customer Grid-Supply and Customer Self-Supply
- Experience "System Holding Capacity" limits when in July HELCO joined MECO in hitting their upside limits first mentioned by former PUC Commissioner Mike Champley in March this year



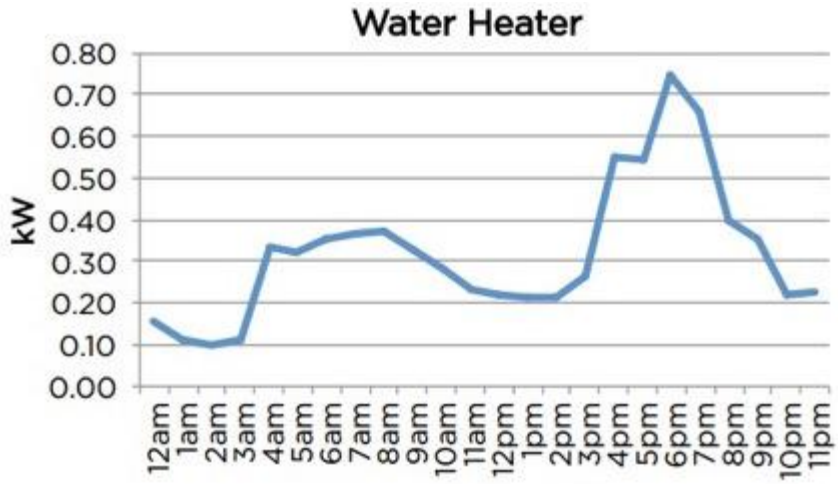
Hawaiian Electric also proposed a Time-of-Use to the PUC, and a recent working paper by University of Hawaii Economic Research Organization (UHERO) modeled it into 3 different scenarios and said:

*To maximize the success and benefits of implementing a TOU program, our study underscores two critical considerations. The first is the importance of enabling technologies providing for greater potential load shifting, both in regards to information and automation, and the second is the importance of customer participation in achieving efficiency goals in electricity generation.*

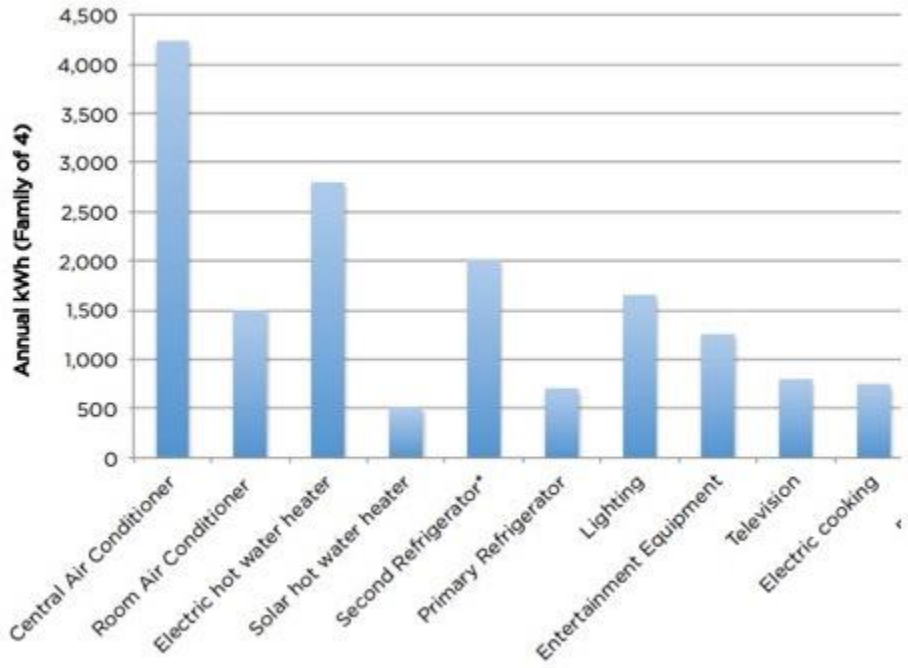
## Energy storage and smart water heaters

UHERO's model results point to the importance of appliances in a residential household's decision to shift load. The difference in percentage change during TOU periods between the Appliance and Literature Scenarios suggest that although a certain amount of appliance load is potentially switchable, residents are unlikely to switch that amount of their appliance load, especially without enabling technologies.

The UHERO paper also included some graphs which we see as pointing to the value of smart water heaters — substantial load with significant usage during the critical late afternoon ramp.




Source: UHERO, http://www.uhero.hawaii.edu/assets/TOURates_8-2.pdf




Olin Lagon, Founder and CEO of Shifted Energy, a 2014 and 2015 Energy Excelerator cohort company

This entire first ever deployment – anywhere – of Grid Integrated Water Heaters (GIWH) technology would not have happened without Olin Lagon and his company Shifted Energy. Olin is a software architect with a string of patents who has a long history of social responsibility. Born and raised in Hawaii's public housing this founder and former director of non-profit Kanu Hawaii is putting his love of technology directly to work. Olin formed Shifted Energy and joined the Energy Excelerator specifically to help leverage GIWH. He is convinced that GIWH is the single most cost-effective and scalable renewable technology that will directly benefit all stakeholders. Working directly with Hawaiian Electric, Olin and the Energy Excelerator helped fund this first deployment in western Oahu and Olin took personal responsibility ("kuleana" in Hawaii) working hands-on over the past year with plumbers and electricians during installation and start up.

In July, Olin was honored to participate in Microsoft's World Partner Conference in Toronto (if interested, see the portion in this clip from 1:20 – 1:54).

## Adding Renewables

Our final suggestions to utilities anticipating adding renewables to their power generation mix:

- Again, focus on HECO's PSIP because it states the issues, paths to solutions, and offers lessons already learned in the world's most critical hotspot for renewable integration
- Devote at least a modest budget and direct consultants to
    - Acquire the know-how to help solve looming problems by sifting through Hawaii's acquired knowledge, facts, techniques and lessons already learned
    - Examine and break information into digestible pieces
    - Compile the information into patterns of solutions
    - Expect of them a critical analysis beyond the fact finding

Mining these data results in high quality learning outcomes and solid "next steps," all stemming from the real life challenges, experiences, and solutions ongoing in Hawaii.

*About the author: Kelly Murphy, Business Development Specialist for Steffes, is responsible for the "go to market" and sales strategies for a patented and cost-effective electric energy storage system known as GETS. HECO selected the GETS System for their very 1st behind-the-meter (non-battery) residential energy storage deployment which began about a year ago. Kelly's background includes co-founding a venture capital funded energy startup company as well as being a peer reviewer for a landmark DOE study that concluded that renewable generation when combined with flexible systems is capable of supplying 80% of our total electricity energy needs in the US by 2050.*

*Learn more at http://www.steffes.com/GETS*