Hawai'i at the Energy Crossroads

Under the specter of a mainland utility takeover, islanders must choose between a legacy of large centralized power or a burgeoning network of distributed energy

Matt Grimley and John Farrell
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ILSR's DEMOCRATIC ENERGY INITIATIVE

Executive Summary

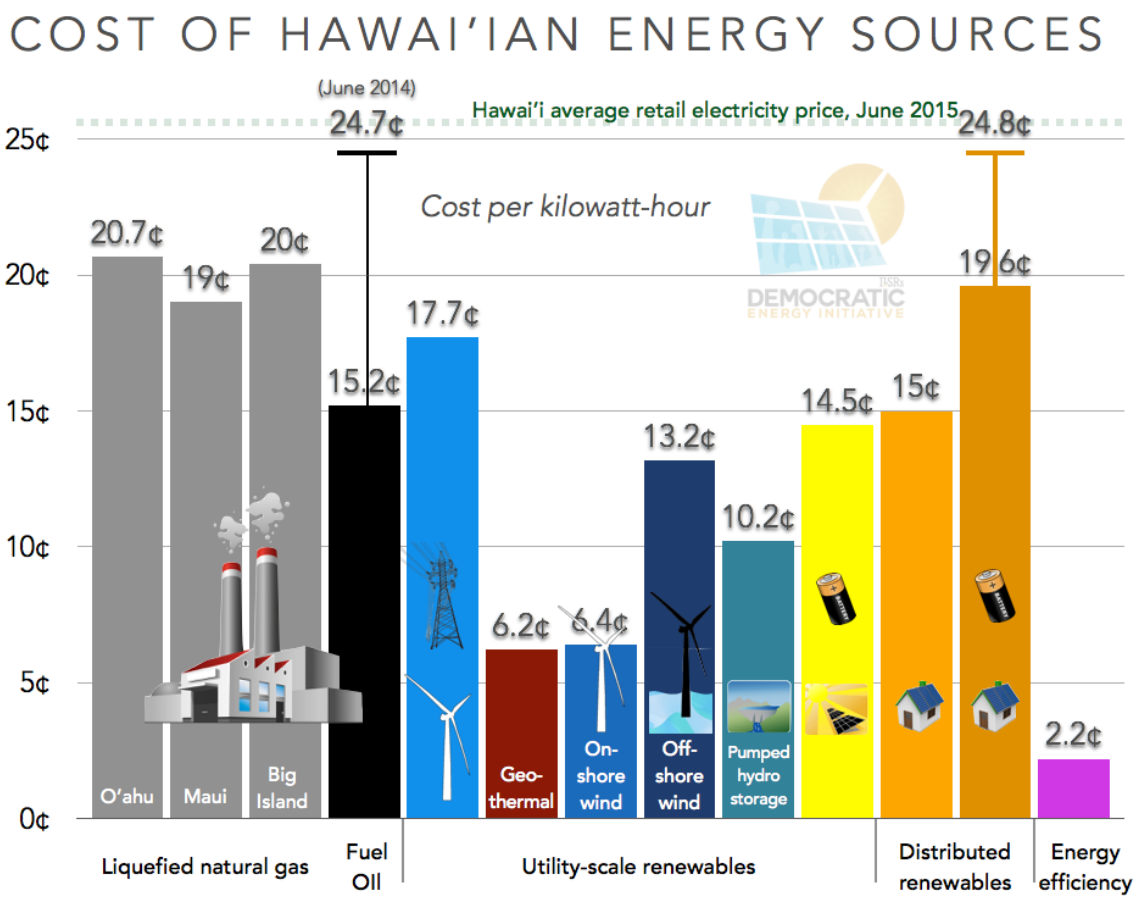
On the one hand: Sky-high electricity prices. A 20th century electricity system burning fuel oil and controlled by large monopoly electric utilities. A proposed utility takeover.

On the other hand: A new 100% renewable energy standard. Rooftop solar on one of ten homes, saving each customer hundreds of dollars per year. Cost-effective energy storage. A rising interest in locally controlled utilities.

Welcome to Hawai'i at the Energy Crossroads.

In the next year, Hawai'i faces decisions that will determine how and if it can meet its 100% goal. Immediately, it includes how to value rooftop solar production and whether to approve a takeover of the Hawaiian Electric (HECO) Companies by NextEra Energy, a multi-billion dollar, Florida-based energy company. But beneath the surface, there is a fundamental question of whether power should be generated from the top-down or the bottom-up.

Hawai'i can achieve 100% renewable energy by focusing on decentralized renewable power. And it can do it for cheaper, with more broadly distributed economic benefits, than its electric utilities are proposing. The following chart illustrates the opportunity for cost-effective distributed electricity.



In contrast, the HECO Companies and NextEra are planning a costly, large-scale approach. They want to import liquefied natural gas to supplant fuel oil, slowing the transition to renewable energy and likely costing customers more. They have plans for an inter-island transmission cable to support large-scale renewable energy projects that have, historically, failed to prove cost-effective, and that aren't likely to be economically or environmentally attractive to their customers.

This crossroads is unique to Hawaii in 2015, but the questions it poses are a "postcard from the future" that will confront all electric utilities and their customers across the United States in the next decade. Will electric customers be able to seize the opportunity of distributed power generation? Or will utility companies maintain their monopoly over the power and economic rewards of the electricity system?

Acknowledgements

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Matt and John (email: jfarrell@ilsr.org)

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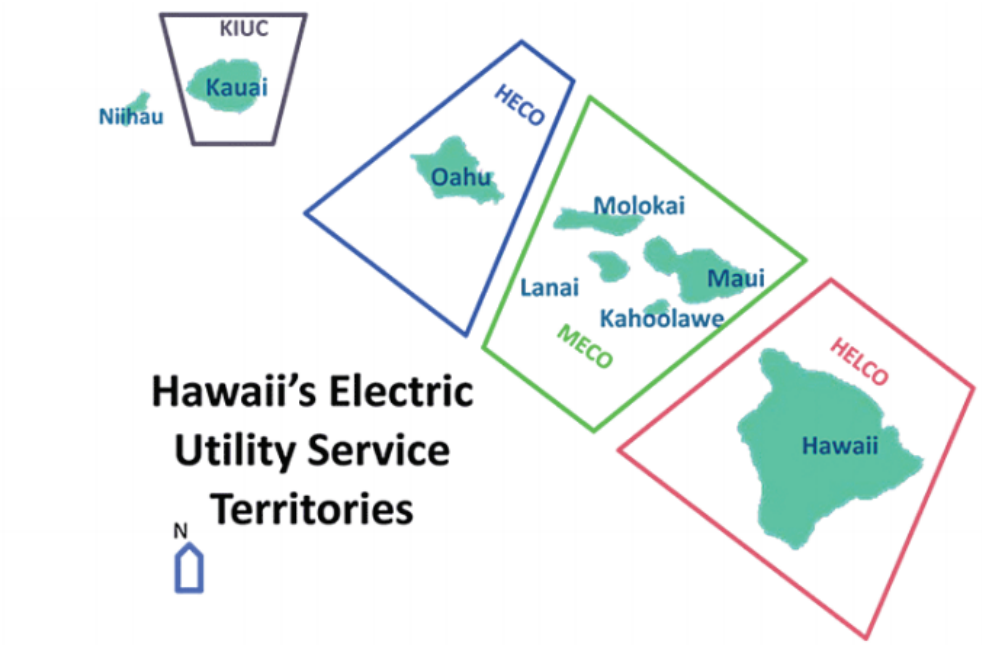
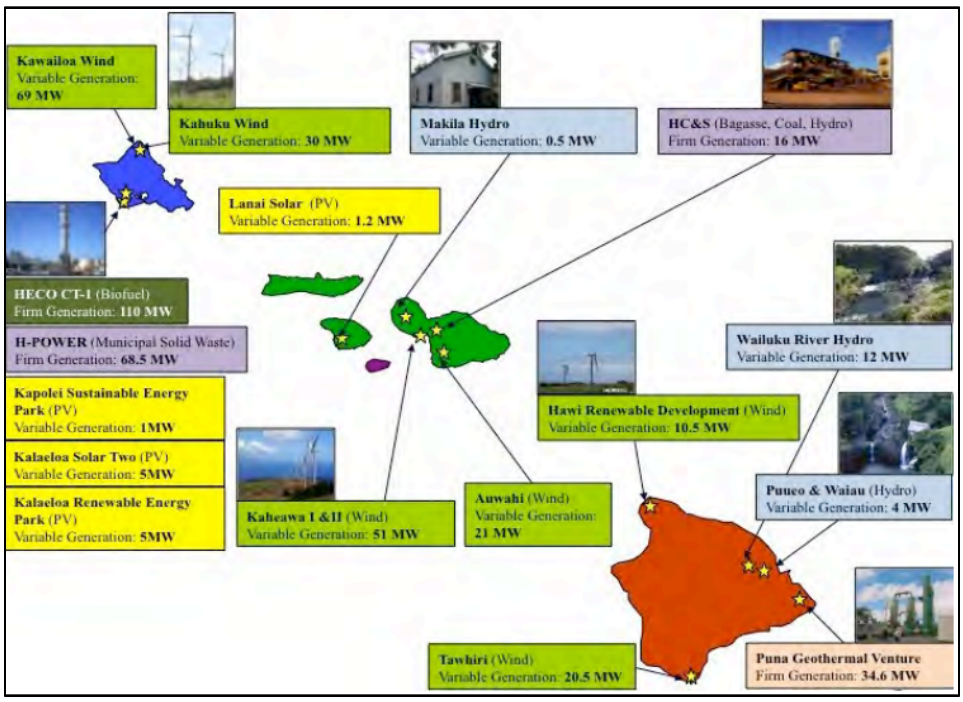
Decision Point

In Hawai`i, as in the rest of the United States, the electricity system has largely remained in the hands of regulated monopoly utility companies – in this case, the Hawaiian Electric (HECO) Companies, which include the Maui Electric Company (MECO) and the Hawaiian Electric Light Company (HELCO). One island, Kauai, is served by an electric cooperative, the Kauai Island Utility Cooperative (KIUC), where customers also own their electric utility. These Hawaiian utilities are wholly responsible for everything from the large, centralized power plants to the transmission and distribution power lines to the meters on homes and businesses. For years, that system made sense, when the only economical way to generate electricity or manage the electric grid was through large-scale fossil-fueled power plants.



Map credit: "Hawai'i Energy Facts and Figures: May 2015," Hawai'i State Energy Office

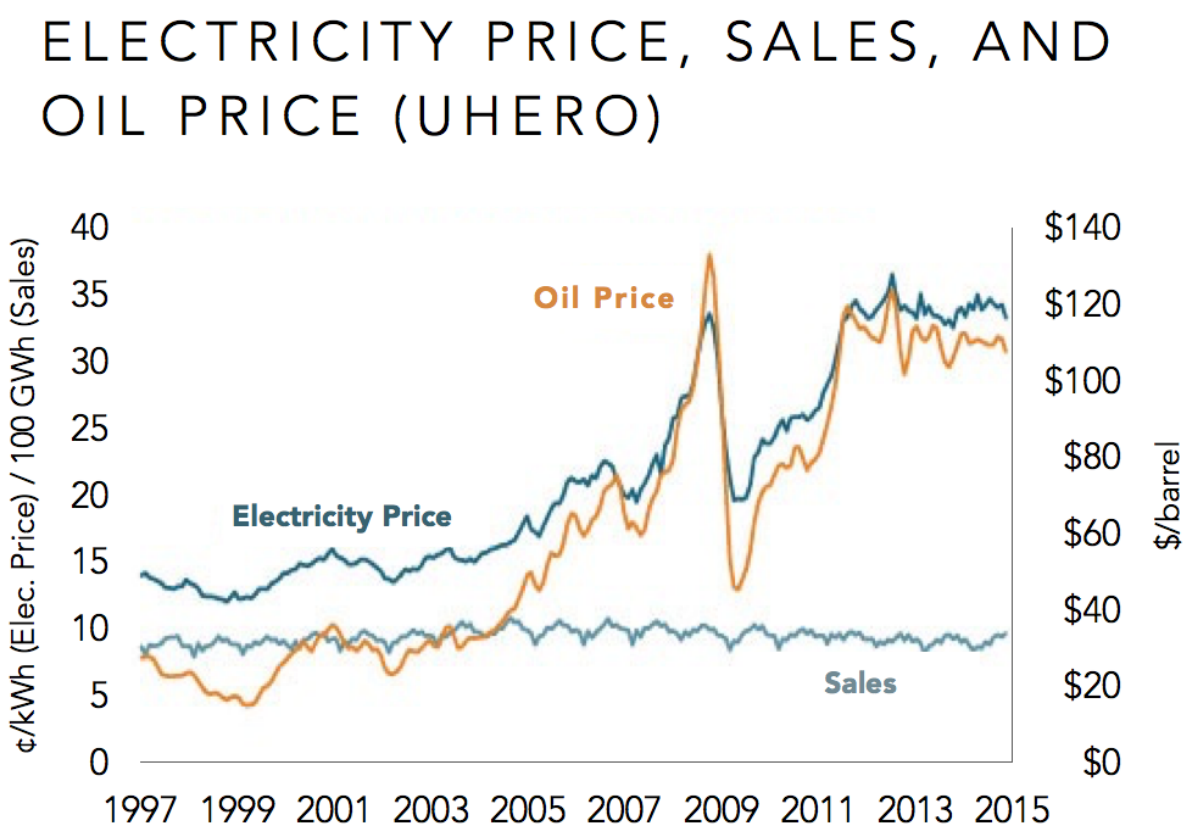


Renewable energy projects, as of 2014, across Hawai'i. Picture does not include more than 300 MW of rooftop solar across state. Source: HECO PSIP

But the rise of rooftop solar, batteries, and distributed computing like smartphones has fundamentally changed the technological and economic paradigm. Many state regulators, from Maine and Minnesota to New York and California, are already exploring how the decentralizing energy technology of the 21st century suggests decentralizing control of the electricity system.

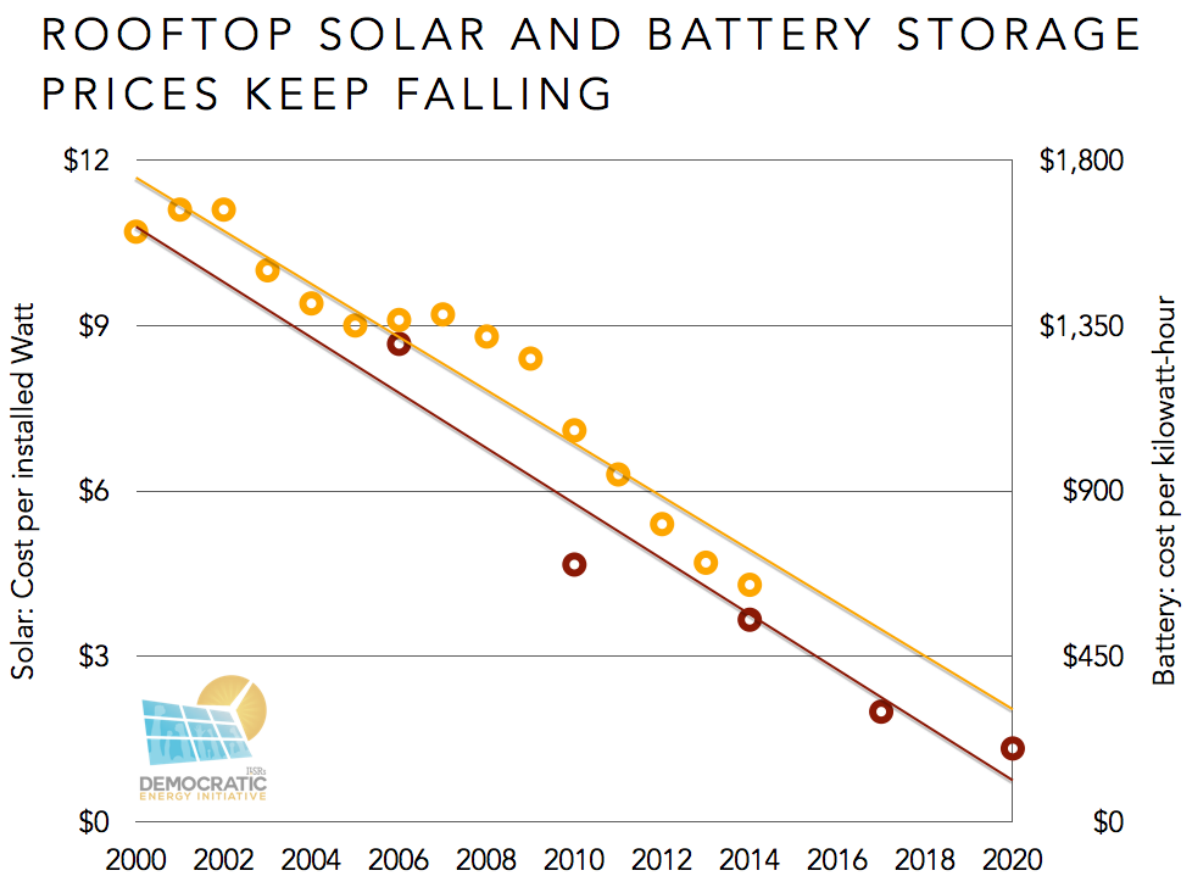
For Hawaiians, there is an added twist.

Unlike almost anywhere else in the country, the state depends entirely on imported fuel oil for its electricity. As recently as 2003, more than 90 percent of the islands' electricity came from fuel oil.[1] When crude oil prices rise, electricity rates follow. Until the past few months, electricity on the islands cost more than 30 cents per kilowatt-hour, double or more than mainland prices, mirroring the per-barrel prices of crude oil.[2]



Meanwhile, electricity sales have been flat since 1997 even while Hawai'i's gross domestic product doubled.[3]

To combat high and volatile electricity rates, Hawaiians installed rooftop solar on their homes. Already, one-in-three single-family homes have rooftop solar, contributing to more than 70,000 systems around the state, one of the highest penetrations of rooftop solar in the world. Costs for rooftop solar continue to decline more than 10 percent per year. Costs for energy storage that can hold and shift excess solar energy production are declining just as fast.[4]



Amid the surge in rooftop solar, Hawaiian electric utilities have built more renewable power plants to meet state mandates, including wind power and geothermal. Today, more than 20 percent of the electricity sold on the islands is from renewable resources, including more than half the energy on Hawai'i Island and more than one-third on Kauai.

It's only the start. A new state law compels electric utilities to power 100 percent of their net electricity sales with renewable energy by 2045, up from 40 percent by 2030.[5]

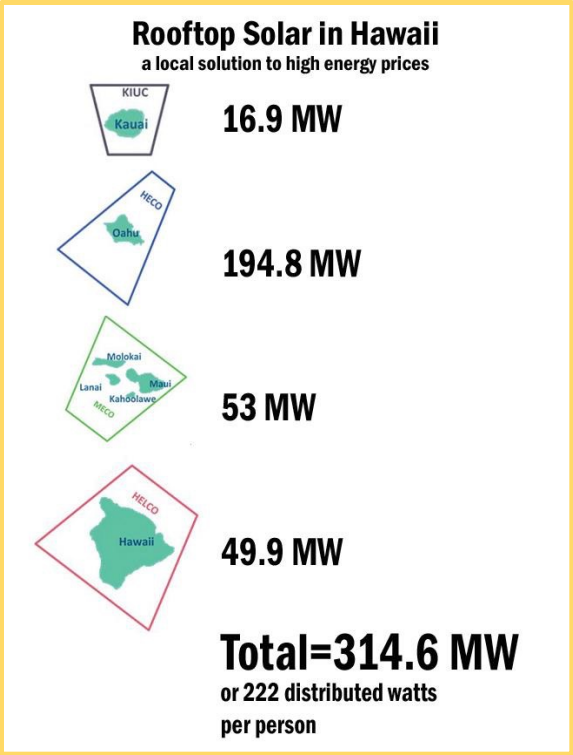
Thus far, utilities and their customers have been able to advance renewable energy along the two parallel paths of centralized and decentralized power. But to reach 100% renewable energy, it may be too costly to support both a 20th century centralized and 21st century decentralized strategy. A power plant or power line built today will still be operating in 2045, creating what is known as "path dependency," making it harder to invest in decentralized alternatives in the future. The competition between these visions will reverberate, materially and socioeconomically, for years.

Hawai'i's power is shifting, literally, from the utilities to their customers. Yet the 20th century vision for Hawai'i – as advanced by the utilities – includes arbitrary limits on distributed generation such as rooftop solar. It includes importing liquefied natural gas (LNG), and making

massive investments for relatively small savings when equally large investments are needed in renewable energy, storage, and a redesigned grid.

Last century's vision includes an additional factor: a takeover of the HECO Companies by NextEra Energy, a $17-billion company from the mainland that employs nearly 14,000 people in 27 states.[6] Last year, NextEra offered $4.3 billion to take over the HECO Companies, which serve 95% of Hawai`i's population. Only the Kauai Island Utility Cooperative is not included in the NextEra deal.

NextEra is comprised of more than 900 subsidiaries, and is best known for NextEra Energy Resources and Florida Power & Light.[7] The former is the largest unregulated generator of wind and solar power in the nation; the latter is one of the largest regulated monopoly utilities in the U.S.



The merger is controversial, not just for the change in ownership and control of the island state's largest utility, but because it also reinforces the centralized approach to clean energy. NextEra's unregulated subsidiaries build utility-scale renewable projects, but have no experience in managing rooftop solar or soliciting bids from third-party developers. Likewise, subsidiary Florida Power & Light (FPL) has a history of actively opposing renewable energy, especially rooftop solar, and is highly reliant on centralized power generation from nuclear fuel and natural gas.[8] Several signs point to the new merged entity becoming another Florida Power & Light: NextEra has expressed interest in replacing imported oil with imported liquefied natural gas to fuel Hawai`i's power plants, along with constructing an inter-island undersea transmission line to serve O'ahu's energy needs from large renewable energy projects sited on less populated islands.

In contrast, at least one study suggests that each island is capable of meeting its own electric needs with on-island renewable resources.[9]

Most public officials in Hawai'i strongly support locally generated renewable energy. Hawai`i's Governor David Ige has said he opposes both the NextEra takeover and plans to import natural gas.[10] Maui County's Mayor Alan Arakawa has publicly stated a need for the County to achieve 100% renewable energy, even ordering his staff to study whether a municipal or cooperative utility can help the County achieve this goal more quickly than the incumbent MECO:[11]

> *"...we could produce 100 percent of all of the energy we need locally,"* Arakawa said

> in an interview with the Honolulu Star Advertiser. "*Why are we working in a direction to substitute purchasing something outside of the state [fuel oil] and just changing the form [liquefied natural gas] to make the electric companies, their stockholders wealthy while the taxpayers and users here are paying roughly three times more than the rest of the United States?"*

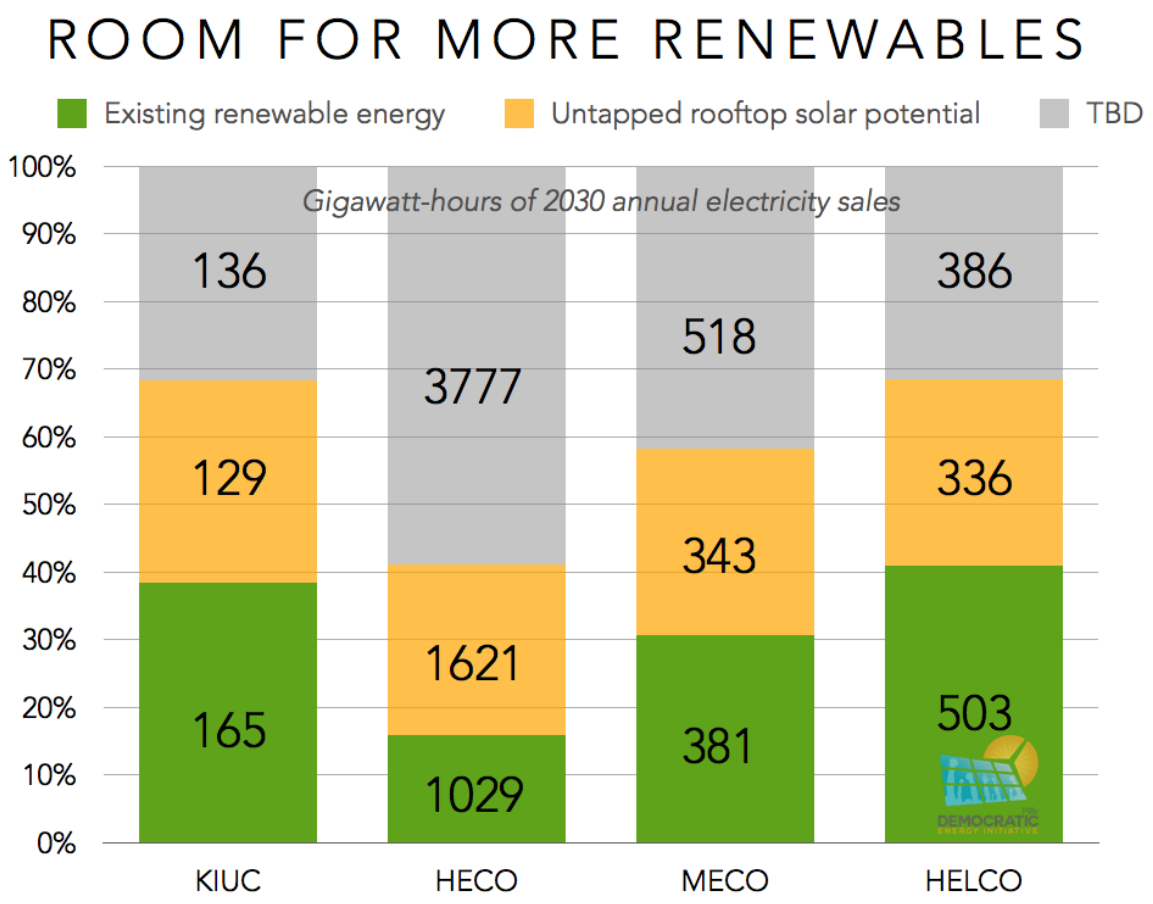
Hawai'i is at an Energy Crossroads. Along one path lie large-scale development, an expensive inter-island undersea transmission cable, and massive investment and continued dependency on imported fossil fuels for at least the next two decades. Alternatively, a surge of local power generation could transform Hawai`i's electricity system into a decentralized network of energy producers and consumers.

The state can now enable or undermine its 100% renewable energy goals, and protect or transform the 20th century mode of centralized production, control, and ownership.

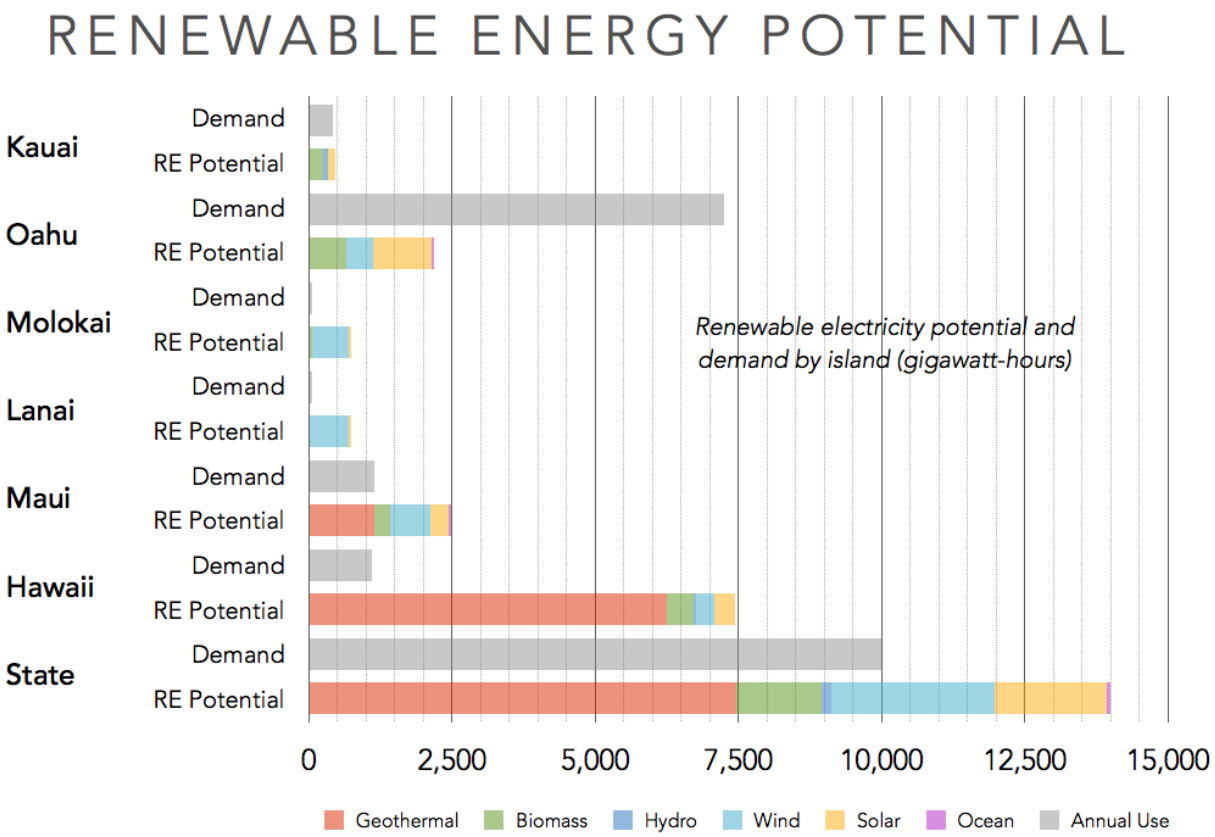
This report is an attempt to illuminate Hawai'i's potential and obstacles on its path to 100% renewable energy.

How Much Renewable Energy?

There is much at stake for Hawai'i, including enormous rooftop solar potential that could push each island much closer 100% renewable electricity (below).[12] Most islands could get 20-30 percent more of their electricity from rooftop solar alone.



According to the state, each island also has renewable energy options beyond rooftop solar (below).



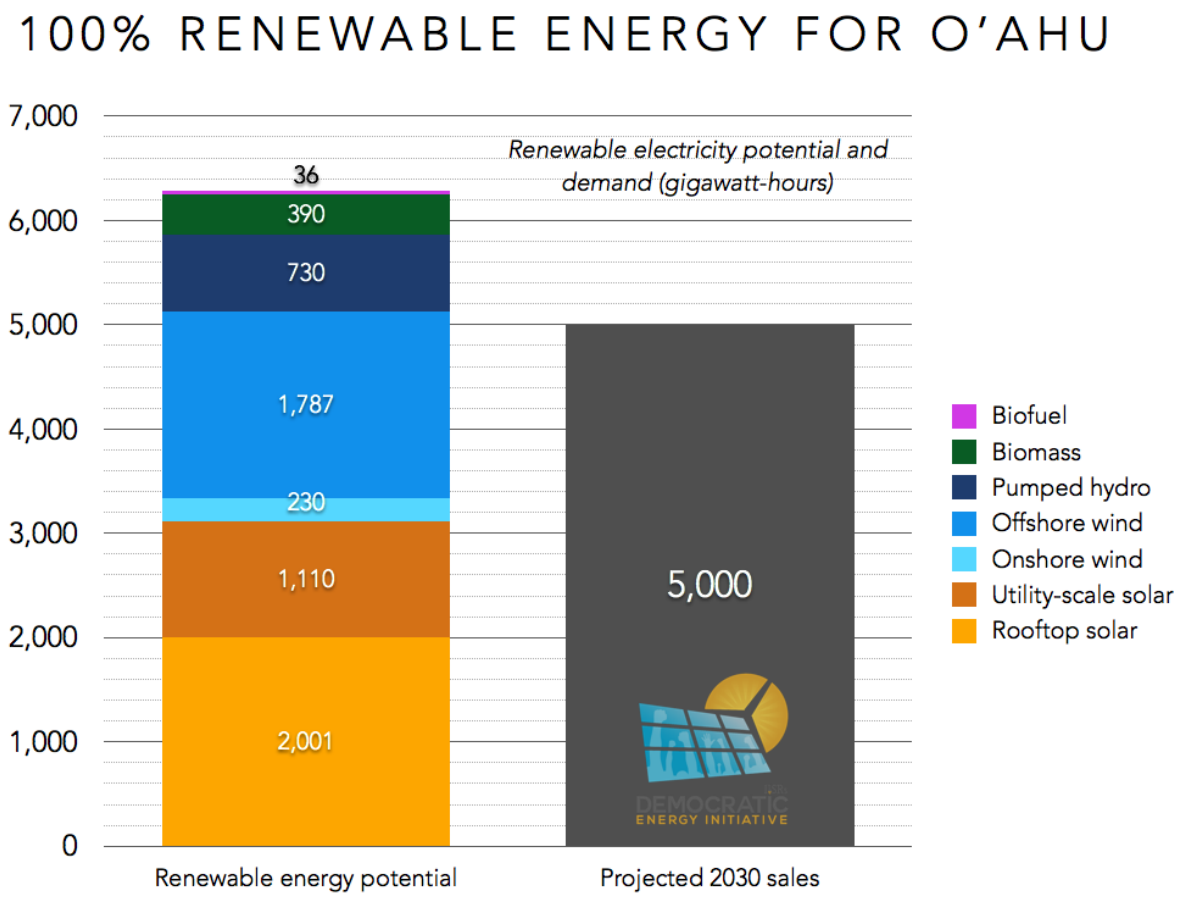
Source: Hawaii State Energy Office

It appears that each island has the renewable energy to meet its annual electricity needs and then some – except O'ahu, that is. But the chart above, drawn from numbers in an NREL report, overlooks a number of opportunities the island could tap.

According to utility documents, HECO's yearly demand is likely to drop more than 1,000 gigawatt-hours by 2030, largely through energy efficiency.[13] Based on findings from the Hawai'i Public Utilities Commission,[14] O'ahu's demand could drop further – to 5,000 GWh per year by 2030 – if deeper yet economically viable efficiency standards are implemented.[15] (Similar additional savings could be realized on other islands.)

Reduced demand on O'ahu can be met by several overlooked resources not included in the above chart. ILSR has adjusted the island's rooftop solar potential to 1,262 MW based on average installed system size.[16] An additional 700 MW of utility-scale solar and 75 MW of onshore wind potential are added, based on HECO's most recent resource plan. Other sources estimate hundreds of megawatts in potential for offshore wind and pumped hydro storage on the island.[17] Biomass and biofuels, though predicted to have much more potential, were assumed to continue at their 2014 levels of production.[18] Even thousands of megawatts in ocean thermal energy conversion and wave energy, not included here, could push O'ahu well

past its supposed local renewable energy limits.

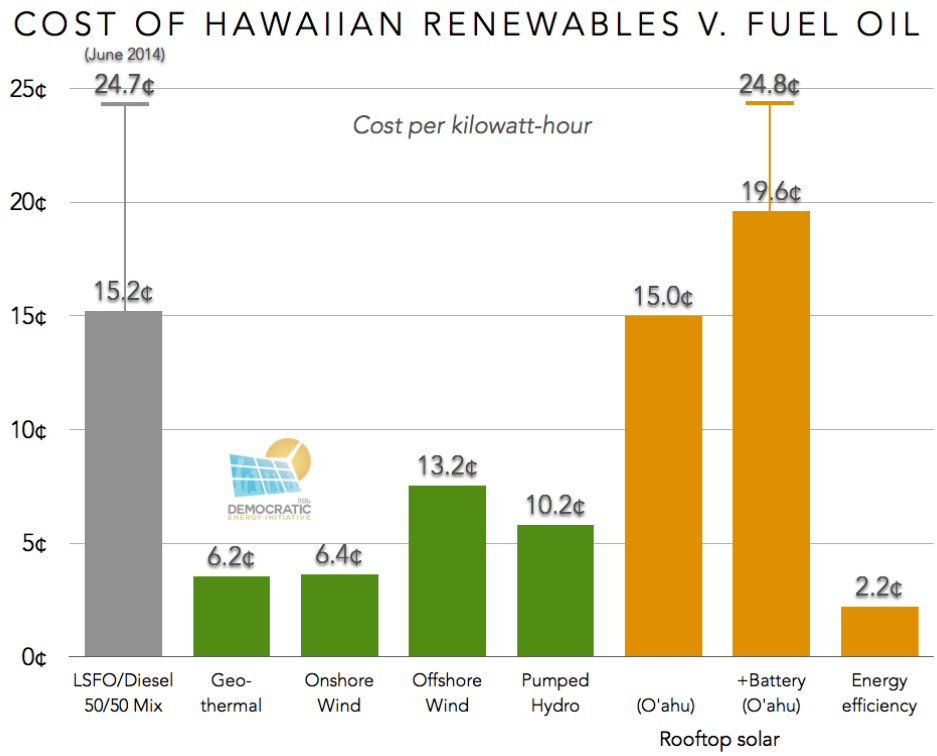


Reaching the 100% renewable energy future on every island isn't without controversy. Although much of the potential can be met with on-site solar, O'ahu in particular will have to tap resources such as wind that raise questions about cost, cultural and environmental impacts, and variability. For example, bird migration patterns that have prohibited development of utility-scale wind on Kauai may also impact the potential to develop large-scale wind on O'ahu and other islands. Geothermal energy has also generated local opposition on the Big Island.[19]

The Power of Rooftop Solar

Fortunately, the potential for on-site renewable energy (with minimal environmental impact) is enormous. Fully developed, rooftop solar would supply one-third of O'ahu's electricity, and still more when deeper energy efficiency is taken on.[20]

Even without subsidies, rooftop solar is also inexpensive. Shown with other renewable energy sources and energy efficiency below, it is economically competitive with electricity generated by burning fuel oil.[21]



While other renewable energy technologies will tend to be developed by third parties, reaching full rooftop solar potential will require resolution of a major conflict between the HECO Companies and their customers over compensation. Compensation varies across the islands by more than a factor of two, but largely tracks the price of oil, either through the retail electricity price or another proxy such as "avoided cost." HECO recently proposed more than halving the compensation rate for its solar-producing customers.[22]

Current Compensation Rates for Customer-Sited Rooftop Solar

	KIUC	HECO	MECO	HELCO
Favored rate	Schedule Q	Net metering	Net metering	Net metering
Reimbursement type	Avoided cost	Retail	Retail	Retail
Value ($/kWh, June 2015)	.152	.295	.351	.359

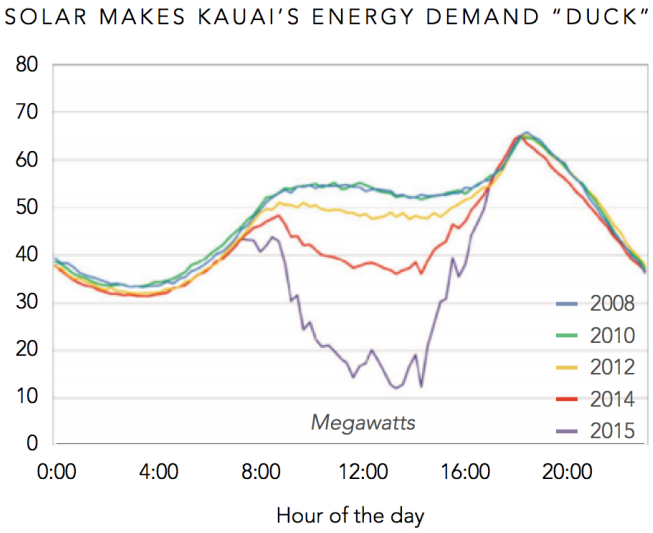
The issue is whether solar energy produced by rooftop solar arrays provides as much as value to the grid as it earns for its customers. This issue is not specific to Hawai`i. Environment America recently summarized the debate by illustrating that, in most mainland states, the value of solar energy exceeds the compensation solar producers receive by offsetting their energy's use to the utility. However, as former Austin Energy executive Karl Rábago says, "utilities simply do not think things they do not own or control can be resources."[23]

Like many mainland utilities, the HECO Companies claim non-solar customers subsidize those who use solar to the tune of $53 million a year.[24] However, the utility hasn't conducted a study on the costs and benefits of solar energy, nor has it addressed the issue in its two most recent rate cases.[25] In other words, net metering may not be the most accurate valuation for solar, but neither the utility nor the Public Utilities Commission has provided a more accurate alternative to date.

Beyond the battle over compensation, there are also *potential* technical limitations. Several years ago, the HECO Companies temporarily restricted solar by a "15% rule," claiming that no more than 15% of the grid's peak energy could come from rooftop solar. The rule was only loosely based on data, and subsequent investigation has suggested that solar could provide nearly twice that much power to the grid without significant hardware upgrades.[26]

In recent months, the U.S. National Renewable Energy Laboratory and others determined that Hawai`i's power lines could technically handle twice the amount of distributed energy previously advised by the utility, from 120% of the daytime minimum load to 250%.[27] The leap was made by updating a firmware setting on Enphase smart inverters – which HECO estimated to be on 90% of all residential PV installations[28] – on new and existing solar installations.[29]

Although many perceived technical limitations to local solar, like the 15% rule, have been surpassed, utilities are nonetheless contending that the grid also faces global limits, as illustrated by the so-called "duck curve" (right, so called for its similarity to the waterfowl's side profile). As more solar has been installed on Kauai island, it substantially reduces daytime demand for electricity (shown by the purple curve). The other Hawaiian islands face similar situations now or in the near future, where utilities assert "either generation assets will have to be curtailed [solar being the likely candidate since its low capacity factor is causing the situation], electrical demand will have to increase, or significant storage assets will be required to store excess generation and provide confidence that conventional units can be de-committed."[30]



All else being equal, massive growth in rooftop solar creates one certain financial problem: little remaining daytime demand for other power plants, such as the utility's existing oil-fired (or proposed natural gas-fired) units. But the utilities may be exaggerating the technical challenge of quickly ramping up production their power plants. There are several solutions to the problem

– from efficiency, to turning solar panels westward, to time-of-use pricing – that have yet to be deployed at any measurable scale in Hawai'i.[31]

While the amount of customer-sited power generation is unprecedented, the technical limitations thus far have been relatively trivial to overcome. Given its minimal environmental harm and localization of economic benefits, distributed generation also has advantages for customers over larger scale power plants.

Despite these advantages, rooftop solar will not be enough to power most islands. But there are some promising opportunities for storing the sun and other sources of renewable electricity generation.

Energy Storage

Inexpensive energy storage is seen as a panacea for powering a grid when the wind's not blowing and the sun's not shining. One form that has been widely adopted where possible, pumped hydro facilities, uses electricity in periods of low demand to pump water uphill into a reservoir, releasing it through generating turbines downhill when demand rises. Other forms of energy storage such as chemical batteries are becoming rapidly more economical, with some estimates that storage prices will drop by 60% over the next five years.[32]

For Hawai'i, with its high electricity prices, the future is now for storage. Several Hawaiian companies already have plans to offer electric customers battery storage with a solar PV system. At least two, SolarCity and Blue Planet Energy, are offering to take customers off the grid entirely. Hawaiian utilities that have experimented with storage adjacent to wind and solar power plants to handle variability, are now starting to tackle storage as a means to deal with peak demand, following the lead from California utilities.[33]

In the short term, energy storage such as batteries may help most with "fast-ramping" events, periods where electricity demand or supply moves rapidly up or down. With wind or solar power, this happens when the wind abruptly dies or the sun is obscured completely and briefly by passing clouds.

KIUC's fuel oil- and diesel-fired power plants have traditionally filled the fast-ramping gaps. But a new battery on KIUC's Anahola solar array, entering service in summer 2015, allows the utility to avoid using these dirty peaking power plants. The battery can store 4.62 megawatt-hours of electricity, while dispersing up to 12 megawatts instantaneously, for a total upfront cost of $7 million dollars. (In comparison, a 4.6 megawatt solar array would likely cost around $8 million.)[34] This semi-trailer-sized storage enables the utility to smooth the supply of solar energy through any passing clouds.

While batteries typically supply or absorb power for short durations, time can be provided for other, slower-responding forms of storage (like pumped hydro) or conventional power generation to fill the larger gaps in electricity supply. But in the long run, battery storage may help variable wind and solar power mimic traditional power plants.

One recent example is the Kauai cooperative's agreement with SolarCity to purchase energy from the nation's first "dispatchable" utility-scale solar array, called such because the addition of a large battery allows it to deliver power on-demand.[35] The 52 megawatt-hour battery and 13 megawatt solar array will be able to store noon-time solar power for over 2,000 homes for four evening hours.[36] Including the 30% federal tax credit and $350,000 in state tax refunds, the dispatchable solar will cost 14.5 cents per kilowatt-hour, slightly higher than KIUC's other utility-scale solar, but cheaper than existing fuel oil generation.[37]

The cooperative is also considering pumped hydro storage, particularly a $65 million dollar, 25 MW project forecast for construction in 2019.[38] It could provide up to 250,000 kilowatt-hours of energy per day, operating at a price comparable to oil, and falling to pennies per kilowatt-hour once the project is paid off.[39] If approved, it could even supersede the cooperative's consideration of LNG as a fuel for its power plants.

Although there are hundreds of megawatts of potential on every island in Hawai`i, HECO does not consider pumped storage in its plans because it's "highly dependent on site availability, may face substantial permitting and public acceptance challenges, have high capital costs and require long lead times (more than seven years) to develop." [40] Yet siting a bulk shipping terminal for LNG has many of the same challenges, higher costs, and half the usable lifespan.[41] Additionally, pumped storage hydro enjoys more community support than use of liquefied natural gas.

Pumped hydro has huge potential to aid Hawai`i's 100% renewable energy standard by combining with locally-sourced energy. Using HECO's own numbers (at the high end of the range), pumped hydro has a levelized cost hovering near 10 cents per kilowatt-hour. With nothing but rooftop solar energy fueling it, pumped hydro storage provides electricity at a levelized cost near 25 cents per kilowatt-hour, though KIUC's reported lower capital costs and falling solar costs suggest an even lower levelized cost in the near future for all island utilities.[42]

The seemingly high cost may be well worth it. In a recent filing, the California Energy Storage Alliance suggests that the grid value of solar plus storage is identical to the 25 cents per kilowatt-hour cost (to Californian utilities).[43] El Hierro, an island in the Canary Islands with about half the electricity demand of Kauai, is now nearing 100% renewable energy through an installed pumped hydro system.[44]

While the utilities debate the merits of storage technologies versus natural gas, distributed storage is not-so-quietly growing, allowing a home or business owner to shift energy use, or even to get off the grid entirely. Hawai'i utilities are uniquely vulnerable to customers using distributed storage to "defect" from the grid because their power costs are so high.

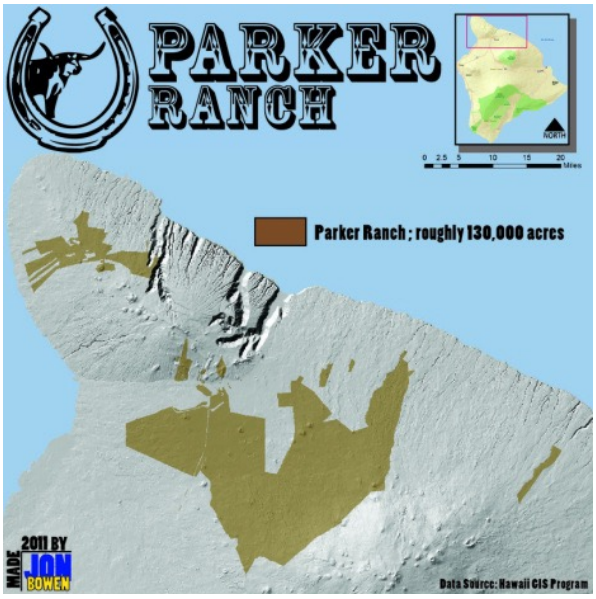
Earlier this year, Tesla Motors Inc. announced the release of its Powerwall battery,[45] one of the first commercially viable residential storage technologies.[46] A single 7 kilowatt-hour Powerwall battery can be installed for $500 per kilowatt-hour now, estimated to drop to $300 or below in a decade. ILSR estimates the unsubsidized cost of energy from a residential solar array paired with a Powerwall is between 19 and 30 cents per kilowatt-hour, often less than buying electricity from the incumbent utility.[47] Employing a group of batteries on the distribution network, such

as the 1 MW battery at the Maui Smart Grid Project,[48] may have similar or greater economies-of-scale.

Smart Grids

The economics of storage and distributed power in Hawai`i are remarkable, and combining them with new, distributed smart grid technology is already allowing a rancher on the Big Island to plot a way to reach 100% renewable energy many years ahead of the new state law.

In 2014, when HELCO projected its rates to rise close to $1 per kilowatt-hour over the next few decades, Parker Ranch President and CEO Neil "Dutch" Kuyper thought he could do better. So he did what many utilities would do – he hired consultants to create a microgrid plan for his ranch and the surrounding community.



Currently run as a charitable trust, the ranch is spread over 130,000 acres on the northwest tip of Hawai`i Island. 26,000 cattle graze there on prime pasture, a land that also has rich renewable energy potential, including wind, geothermal, and pumped hydro storage.[49] The 200 megawatts of available pumped hydro storage is more than enough for the entire island's demand. Ultimately, the consultants suggested that Parker Ranch could be run more economically as a cleaner, smarter grid than by remaining a HELCO customer.

This kind of "smart" grid stands in contrast to the 20th century "dumb" grid, the latter characterized by one-way power flows from utility to customer, minimal automation, and minimal real-time operation data for anyone but grid operators. A smart grid has advanced meters, electronic monitoring, and widely distributed large and small energy resources. It can coordinate distributed energy sources such as household batteries and solar with large-scale ones, can automatically avoid or reduce outages, and can provide real-time data and pricing. A microgrid, such as that proposed at Parker Ranch, is a localized smart grid that can operate on its own, separate from the larger grid.

For "Paniolo Power," Parker Ranch's nascent utility, creating a microgrid means reconstructing the transmission and distribution grid, down to the customers' meters. Financed over 30 years, the microgrid supplied by renewable energy was found to cost less than buying power from the incumbent utility.

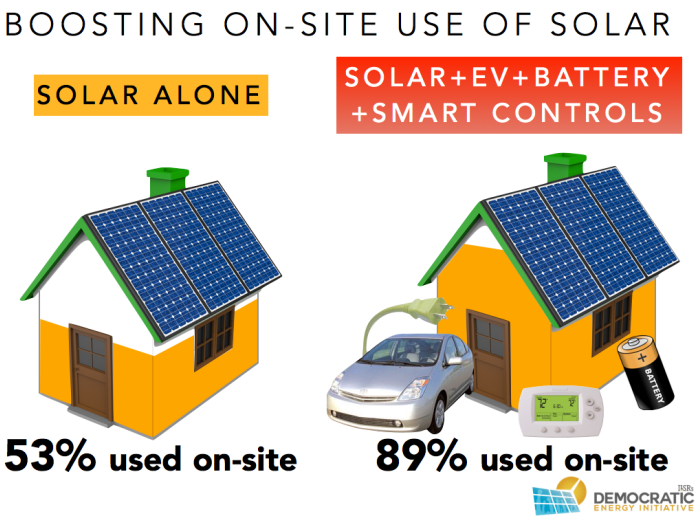
Thus far, the HECO Companies have confined their smart grid endeavors to a few government-supported microgrids and the deployment of smart meters, with a much smaller impact. HECO

has smart meters on 5,200 houses within six clustered neighborhoods on O`ahu, a small fraction of its total customer base.

Meanwhile Kauai island cooperative installed smart meters on the majority of Kauai homes in 2013, more than 30,000 in total.[50] The shift has helped the cooperative to more accurately forecast and manage energy demand and to redesign electricity rates, including a time-of-use pilot program for its member-owners.

NextEra has pledged to accelerate the installations of smart meters in HECO territory, but all utilities could do more. To fully expand rooftop solar in the state, batteries and demand-shifting appliances will be needed to make full use of power in-house when the sun is shining, and manage the flow of energy to distribution circuits during the daytime. Under smart management, rooftop solar penetration need not surpass technical limits on distribution networks. And excess daytime energy can then be shifted toward evening needs.

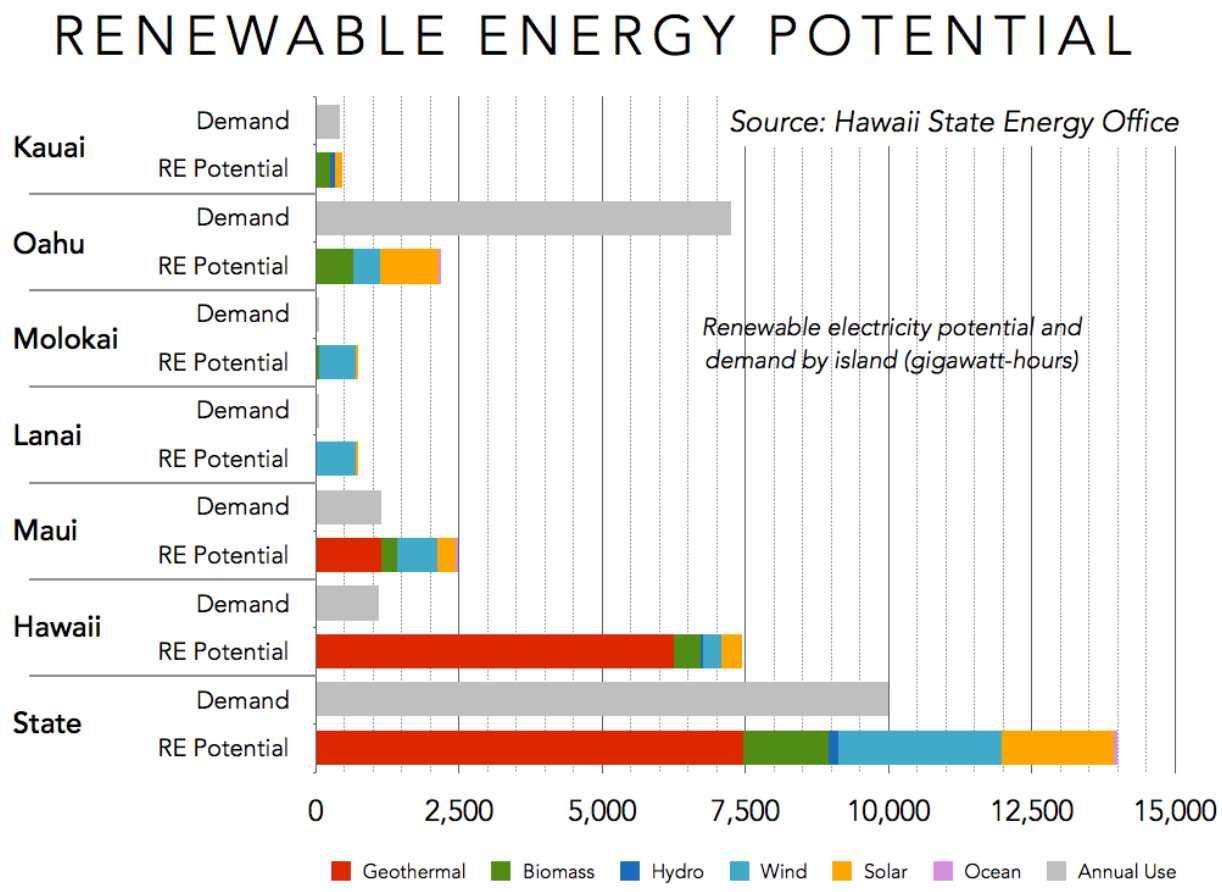
The Rocky Mountain Institute has explored what using a smart grid for flexible load management (as Kauai is testing) can do for utilities.[51] They found, for HECO in particular, that electric vehicle charging coupled with controls on dryers, air conditioners, water heaters, and battery storage, can increase on-site usage of rooftop solar from 53% to 89%. For an investment of about $1,000 per home, customers would decrease bills by 33% while opening up a whole new market of non-exporting rooftop solar. With more customers using their own solar power, it would reduce demand on the distribution grid as well as the need for more distributed or centralized backup power or storage.



A distributed path for power is open for Hawai'i. But that's not necessarily the future, according to HECO, NextEra, or even the Kauai cooperative.

Business as Usual

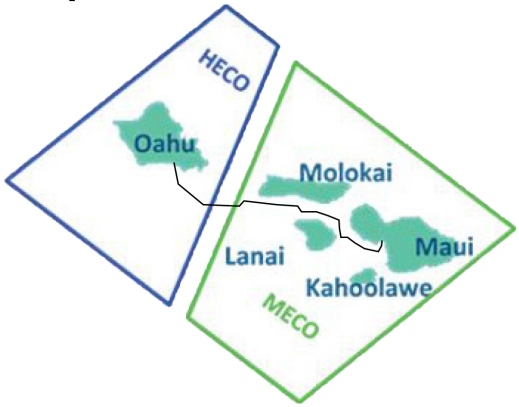
No matter the path chosen, Hawai'i's electricity will become more renewable over time, but the method makes a difference. One stark difference is where and how each island sources its renewable power.



Large-Scale Projects

A popular utility interpretation of the above chart is that the less-populated islands should export excess energy to O'ahu. With its focus on large utility-scale renewable energy, NextEra has been investigating a high-voltage undersea transmission line to bring power from Maui to O`ahu.

Proposed interisland cable route



The proposed transmission cable project (in a variety of permutations) has always had its champions, going back to the 1800s. NextEra is the latest player, touting the cable's viability despite high costs and a

path that cuts through or under the National Marine Humpback Whale Sanctuary. It was NextEra Energy Hawaii's initial work on the cable – including purchasing four acres of potential project land on O`ahu – that first piqued the company's interest in buying the HECO Companies.[52]

Though contradicted by HECO's own studies, NextEra Energy Hawaii said in 2014 that the $600 to $800 million cable is economical and in the public interest.[53] A PUC docket (2013-0169) remains open on the matter,[54] but one University of Hawai'i publication (and ILSR's analysis) suggests that falling prices for storage and solar could make an inter-island cable obsolete.[55]

In addition to questionable economics, investments in an inter-island cable would divert funds from supporting the continued growth of local solar power, such as reinforcing the distribution grid and adding distributed energy storage. And there is no guarantee that power sent on the cable to O'ahu won't be oil- or natural gas-fired.

An inter-island transmission cable would almost certainly serve HECO or NextEra's continuing interest in large-scale renewable energy projects, projects that have often failed to be cost-effective. HECO has attributed higher costs to importing hardware and securing the rights for land, but the state's Consumer Advocate says that its office and the Public Utilities Commission can't get a clear picture of the actual costs and profit margins for HECO's proposed projects.[56] In fact, only two of HECO's renewable energy projects have been successfully competitively bid with information open to the state – the others have secured waivers or been grandfathered into older bidding rules.[57]

For example, the HECO Companies have paid upward of 14 cents per kilowatt-hour for wind, sometimes even more than 20 cents per kilowatt-hour, usually with an exemption from the competitive bidding process granted by the PUC.[58] This compares to 3 cents per kilowatt-hour on the best Midwestern wind farms. Even allowing for unique land and hardware costs, it's a 466% price premium! Prices for utility-scale solar are similarly disproportionate, but in comparison to small rooftop solar, recently bid utility-scale solar projects on O'ahu (e.g. 14.5 cents per kilowatt-hour for the Waianae solar project) are nearly the same price as unsubsidized rooftop solar (15 cents per kilowatt-hour, by ILSR's estimate).[59]

These utility-scale projects have other prices that need to be carefully considered. Currently, an unregulated NextEra subsidiary, NextEra Energy Hawaii, plans to build a 60 MW wind farm on Maui's southern hillsides.[60] But here, as with many other lands across the state, there are loud concerns from locals over environmental damages and impact on tourism.[61] A recent study from the U.S. Department of Energy backs these voices: researchers found utility-scale energy projects, including wind and an inter-island cable, to have the most negative impacts on the environment, as compared to rooftop solar and energy efficiency.[62]

Additionally, the wind project on Maui might not even be used for the island. It would push wind to near half of Maui's yearly demand, with some residents saying that the project will be used with an inter-island transmission cable, despite reassurances from state government officials and NextEra to the contrary.

There is also a conflict of interest for the new Maui wind project. If the takeover is approved, the wind developers will negotiate with their parent company, NextEra. Scott Hempling, a professor and attorney testifying on behalf of Hawai`i`s State Office of Planning in the takeover proceeding, says NextEra's subsidiaries are pursuing several other energy projects in Hawai`i.[63]

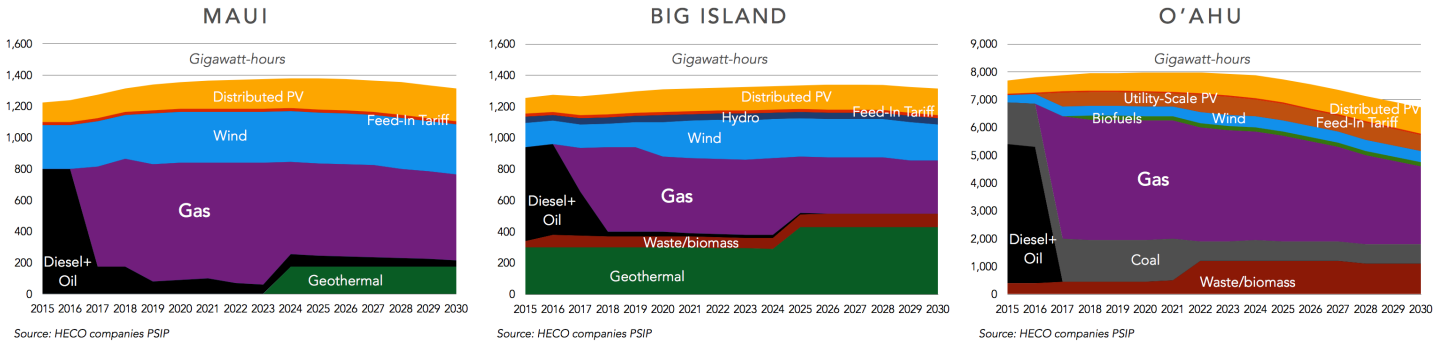
While community ownership could help promote the acceptance and local benefits of wind projects across Hawai'i,[64] community-scale investments in the state are limited to a now-delayed community solar program from HECO.[65]

A Big Gas

The starkest contrast between a distributed and centralized energy future for Hawai'i is the interest of HECO Companies and KIUC in swapping oil dependency for natural gas. Many mainland utilities have transitioned their coal-burning power plants to natural gas, but Hawai`i`s utilities face a major logistical hurdle in replacing fuel oil: gas would have to be shipped to the islands in a super-cooled, liquid state and held in super-insulated containers and tankers until re-gasified at newly constructed ports.[66]

The following charts illustrate the HECO utilities' proposal for using LNG to replace fuel oil. Over the next two decades, millions of cubic feet of natural gas will be imported to retire use of fuel oil. While building billions of dollars of new infrastructure, commissioning new natural gas-fired plants, and converting and retiring old fuel oil plants, the HECO Companies will simultaneously begin swapping out natural gas for renewable energy on each island due to the pending switch to 100% renewable energy.

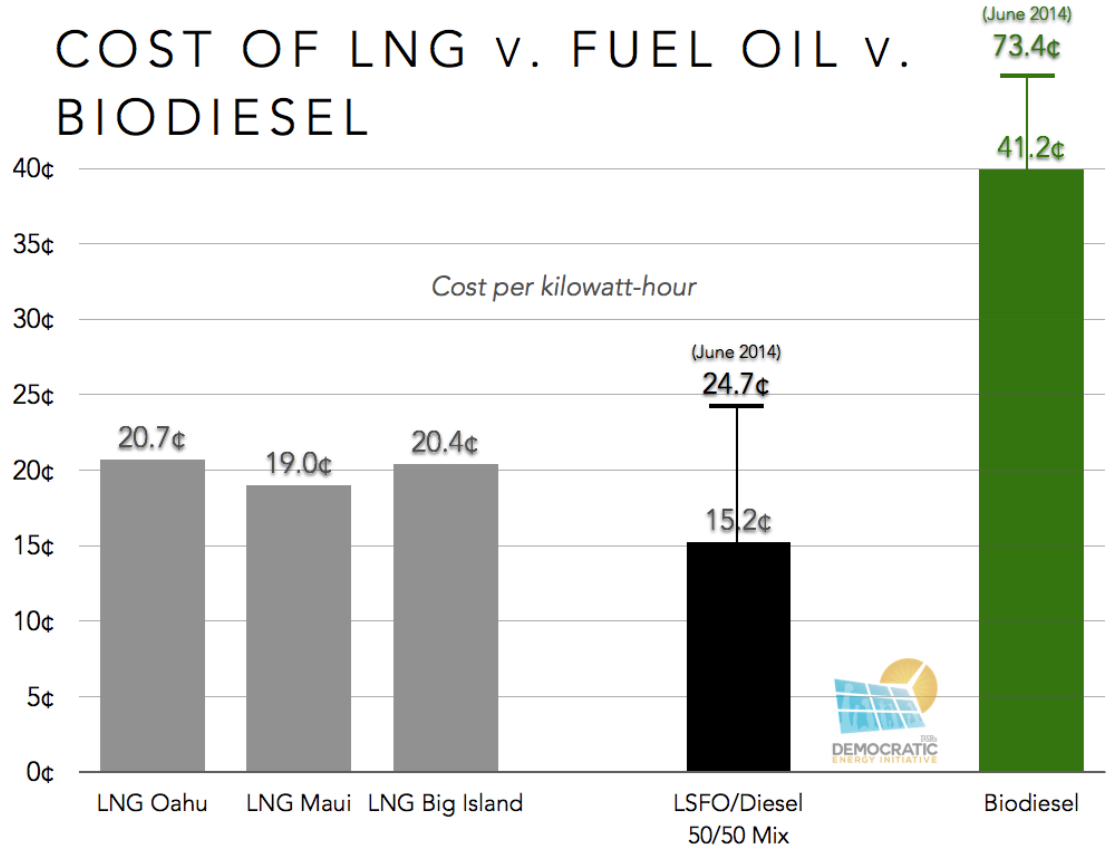
Proposed Energy Mix for 2015-2030



The proposed conversion to LNG has major drawbacks. Firstly, it's unlikely to result in any significant reduction in greenhouse gas emissions. While cleaner at the smokestack, natural gas is a far more potent greenhouse gas than carbon dioxide. A 2014 Cornell University analysis found that unless expensive infrastructure upgrades are made and upstream emissions are well-regulated and enforced, natural gas-fired electricity generation produces more lifecycle greenhouse gas emissions than coal.[67] At best for LNG in O'Hawai'i, according to the University of Hawai'i, there may be modest greenhouse gas reductions. [68]

Additionally, the purported cost savings of LNG – 6 to 25 percent according to the University of Hawaii study cited previously – rely heavily on the cost of oil and a faulty presumption that renewable energy (including energy storage) will continue to cost more. If oil prices remain low, electricity from LNG will actually cost more than fuel oil.

The following chart shows projected costs for power from natural gas supplied power plants, as estimated by ILSR. At roughly 20 cents per kilowatt-hour, electricity from these power plants will cost 18 to 50 percent more than electricity from a clean air regulation-compliant 50/50 mix of low-sulfur fuel oil and diesel at current prices.[69]



These LNG estimates do not include the potential for infrastructure cost overruns, future transport cost increases, or the likely smaller-than-proposed shipments given the state's mandate for a 100% shift to renewable energy (even though that same mandate has a loophole that could guarantee fossil fuel production past 2045).[70] The price also excludes the cost of environmental damage near gas pipelines and wells sited in mainland communities that bear the extraction costs.

LNG has a number of prominent opponents. Both the Governor and Maui County's Mayor are concerned that conversion to LNG simply swaps one fossil fuel dependency for another without substantial economic or environmental benefit. Even KIUC, while studying the issue, is aware of substantial disagreement on the issue on Kauai.[71]

State legislators also clearly feel swapping one fossil fuel for another is bad policy. They passed a law to minimize the use of LNG for anything other than a "cost-effective transitional, limited-term replacement of petroleum for electricity generation" that would not "impede the development and use of other cost-effective renewable energy sources." [72] An enormous investment in LNG, no matter how it's done, would likely do just that.

Large-scale development without competitive bids, an expensive inter-island undersea transmission cable proposal, and massive investment in continued dependency on imported fossil fuels for at least the next two decades: this is the proposed path from the HECO Companies and NextEra, in stark contrast to the localized alternatives.

Choosing the Future Now

Thirty years may seem like a long time, but the decisions made in Hawai`i in 2015 and 2016 will determine if the utilities can meet the 100% by 2045 renewable energy standard, and whether it will be done using a 20th century paradigm of centralization or seize the 21st century's opportunity to decentralize.

Both centralized and decentralized paths require new, potentially expensive investments, especially as they modernize a complex electric grid. But poor choices now can make the ultimate end significantly more expensive.

The most immediate choice is whether to allow the NextEra takeover. Many have pointed out NextEra's questionable pedigree. Its Florida subsidiary has little renewable energy capacity and a strong record of using its economic monopoly to control the state's political discussion to deny competition and customer choices for cleaner energy. NextEra's plans for Hawai`i – at least those that they've released publicly – include a worrying interest in large transmission and LNG infrastructure, along with thousands of dollars donated to top state officials in Hawai`i.[73] Allowing the takeover of the HECO Companies could delay or derail progress toward 100% renewable energy and reducing dependency on imported fossil fuel.

State and local governments in Hawai`i are wary of NextEra's effect on the islands' communities and local economies. None of the intervenors in the takeover docket support the deal as it currently exists. Hawai`i's Governor Ige has indicated his opposition to the takeover and plans to import natural gas.[74] Maui County is considering condemnation of MECO's assets to create its own municipal utility.[75] Community and business leaders on Hawai'i formed the Hawaii Island Utility Cooperative, with support from the national electric cooperative association, to buy HELCO if the opportunity presents itself.[76] Honolulu's city council, representing the entire island of O'ahu, will soon vote on whether to authorize a study on its own electrical cooperative.[77] Most recently, 40 Hawaiian lawmakers called for a study of public utilities as an alternative to the NextEra takeover.[78]

Others worry about history repeating itself. In testifying to the PUC on the proposed takeover, Leo Asuncion, Director of the State Office of Planning, spoke of the dangers of another out-of-state company coming into the islands:

> *"Hawai'i is isolated from the rest of the United States, so job loss in Hawai'i is a major issue. Unlike states on the U.S. mainland, those employed here in Hawai'i, and specifically those who have worked for a company in Hawai'i for a long period of time and have established roots in our local communities, cannot simply pack-up and head with their family to the next state to find job opportunities or to start a new job. Job loss in Hawai'i reverberates for many years, in terms of impacts not only to the local workforce, but also to areas of State concern such as income tax revenues and unemployment levels."*[79]

Others worry that this is part of a disturbing national trend.

Scott Hempling, in his testimony to the Public Utilities Commission in the NextEra merger docket, says electric utilities used to be guided by the Public Utility Holding Company Act of 1935.[80] This law required that electric and gas utilities "stick to their knitting"; to devote their management attention and financial resources to providing essential utility service, locally. This law prevented acquisitions for the sake of acquisitions (i.e. for profit's sake).

Then in 1980, mergers started to occur between electric utilities. These were mostly bound to utilities in the same geography, but the Energy Policy Act of 1992 mostly gutted that requirement. Then the Energy Policy Act of 2005 repealed the Public Utility Holding Company Act altogether.

Now, "there is no federal limit on holding company arrangements involving geographically dispersed utilities, mixtures of utility and non-utility businesses, debt leveraging or complex corporate family structures," says Hempling. This NextEra takeover attempt – and the current rash of other takeover attempts in states from Maryland to Wisconsin [81] – would not be possible but for that repeal.

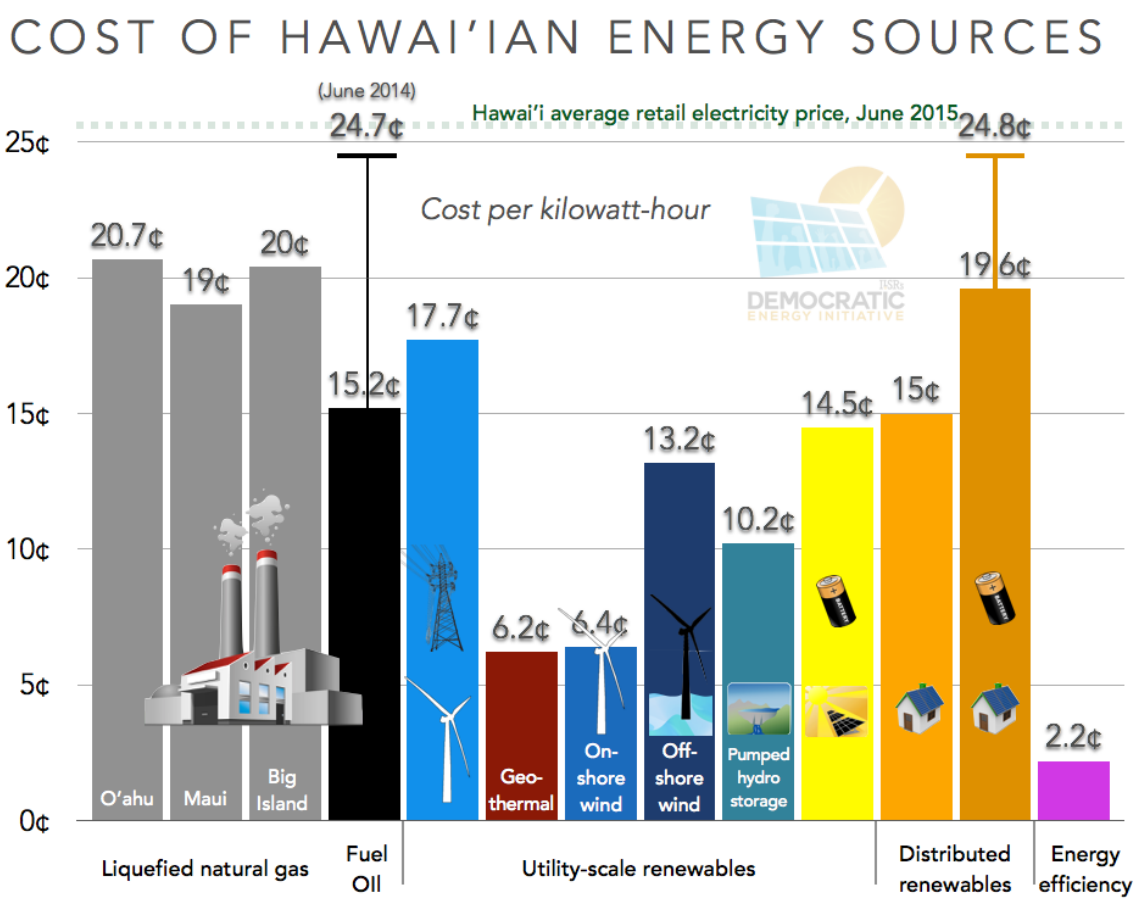
HECO and NextEra are following a familiar game plan of electric utilities. The only way they see to avoid flat earnings with stagnant power sales is to build and own assets. It doesn't matter what they are: a huge wind farm, an inter-island transmission cable, a liquefied natural gas import terminal. Under current rules in Hawaii and most states, the utility will earn a nearly guaranteed 10 percent return on investment based on those assets. If NextEra didn't expect this return, then why offer a 26 percent ($568 million) premium over HECO's worth.

Even HECO knows there's another path. According to its own data, the cost of continuing business-as-usual for electricity ranges from $212 to 227 per megawatt-hour for the year 2030.[82] Its 100% renewable energy scenario in 2030 is well within reach (see chart below).

Utility Cost of Energy Forecast

HECO			MECO			HELCO		
Today	Planned	100%	Today	Planned	100%	Today	Planned	100%
$264	$220	$282	$248	$212	$252	$210	$227	$255

And yet, ILSR's analysis using HECO's numbers suggests that renewable energy may be the cheapest course, cheaper even than HECO's business as usual projection. Using the utility's cost estimates for LNG, and locally relevant renewable energy prices, the following chart shows that **nearly every Hawaiian renewable energy resource costs less than its fossil fuel competitors**, and that even massively distributed (unsubsidized) solar and storage is competitive with imported fossil fuel.[83]



There are several conclusions from these numbers:

1. Energy efficiency is the cheapest of all supply options.
2. Renewable resources such as onshore wind and geothermal are by far the cheapest new electricity supply options. Even rooftop solar is competitive with existing fossil fuel generators.
3. Based on current prices, the proposed substitution of liquefied natural gas for fuel oil will mean higher electricity prices. Both cost more than renewable alternatives, even with today's storage costs.

It's worth nothing that decentralized power generation like rooftop solar has a unique value not captured in the above chart: local economic benefits. A locally owned one-megawatt solar array can return over $5 million in local benefits compared to a comparable utility-owned solar array.[84]

Conclusion

There are two paths for Hawai'i: a legacy of large centralized power plants or a network of distributed energy generators; a system that rewards that largest companies or a system that benefits the community and environment; a struggle with the utility to 100% renewable energy or island-by-island energy systems that widely disperse the economic rewards of generating energy.

Even if they must be addressed here first, the tensions felt in Hawai'i are not unique. Across the country, people are battling electric utilities that are trying to reduce compensation for solar ownership and fight renewable energy. In every state in the next decade, falling costs of distributed renewable energy and energy storage will threaten the incumbent utility's business model.

Hawai'i's choices now have enormous implications for the states that follow. Some have called its crossroads a "postcard from the future." We hope the message of distributed power is delivered.

HECO Companies, NextEra Takeover Timeline

Remaining Public Hearing Dates and Locations

KAUAI
Wednesday, October 21, 2015, 6:00 p.m.
King Kaumualii Elementary School Cafeteria
4380 Hanamaulu Road
Lihue, Hawai'i

O'AHU
Tuesday, October 27, 2015, 6:00 p.m.
McKinley High School Cafeteria (location tentative)
1039 South King Street
Honolulu, Hawai'i

Formal Evidentiary Hearings

9:30 a.m. – 5 p.m. Located at Neil S. Blaisdell Center, O'ahu.

November 30 - December 3
December 7 - 11
December 14 - 16

Expected Merger Decision

Summer 2016

Appendix: Levelized Cost of Energy Assumptions

For each levelized cost of energy calculation, barring home-owned options, the following was assumed (below). Worksheets for each calculation can be downloaded on ILSR's website.

- 70% debt at 12% cost
- 30% equity at 8% cost
- 5 year, 100% depleting MACRS
- LCOE taken at 15 years, at 8% discount rate
- All future capital costs taken as upfront costs
- Assumed generation and debt for 30 years
- Upfront and ongoing costs organized using Cost of Generation calculator available from the California Energy Commission
- Except where noted, costs were estimated from the U.S. National Renewable Energy Laboratory's Annual Technology Baseline and Standard Scenarios

Resource	Capital costs	Variable O&M ($/MWh)	Fixed O&M ($/kw)	Fuel Costs ($/MMBTU)	Capacity factor	LCOE ($/MWh)	Sources
LNG O'ahu	$1.8 billion	PSIP data, including PPA costs; otherwise estimated at $20, increasing 2%/year	---	PSIP data; otherwise estimated at $12, increasing by 2%/year from 2019	---	$207	PSIP
LNG Maui	$250 million	PSIP data, including PPA costs; otherwise estimated at $20, increasing 2%/year	---	PSIP data; otherwise estimated at $13, increasing by 2%/year from 2019	---	$190	PSIP
LNG Hawai`i Island	$76 million	PSIP data, including PPA costs; otherwise estimated at $20, increasing 2%/year	---	PSIP data; otherwise estimated at $13.4, increasing by 2%/year from 2019	---	$204	PSIP

Blended low sulfur fuel oil and diesel (50/50 mix)	---	---	---	---	---	$132 + $20 = $152 for O&M; $227 + $20 = $247 in June 2014	DBEDT
Biodiesel	---	---	---	---	---	$392 + $20 = $412 for O&M; $714 + $20 = $734 in June 2014	DBEDT
O'ahu-Maui cable + 200 MW onshore wind	Estimated $600 million for cable (NextEra) and O'ahu infrastructure upgrades (NREL); $400 million for onshore wind	$13.5 for cable	$51 for onshore wind	---	35%; also assumes 5% line losses	$177	NREL
KIUC Solar-plus-storage PPA	----	---	---	---	---	$145	Source
Geothermal	$6000/kw	---	$115	---	---	$62	NREL
Onshore Wind	$2000/kw	---	$51	---	35%	$64	NREL
Offshore Wind	$6000/kw; $243/kw for offshore grid connect	---	$132	---	50%	$132	NREL

Pumped hydro storage	$4500/kw	---	$31	---	41%	$102	PSIP for capital costs, though KIUC and El Hierro costs suggest much lower costs are attainable
Energy efficiency	---	---	---	---	---	$22	HI PUC

For rooftop solar scenarios, NREL's System Advisor Model was used with location-specific inputs. LCOE was taken after 30 years. One hundred-percent debt for ten years at 5% interest was assumed. No tax incentives were taken. Solar and storage option was calculated assuming a single 7 kWh Powerwall, $500/kWh starting out, $300/kWh replacement after 15 years. 4 kWh nightly discharge, and 365 kWh of yearly storage losses. Complete SAM calculations are available for download on ILSR's website.

Resource	Capital costs	Variable O&M ($/MWh)	Fixed O&M ($/kw)	Capacity factor	LCOE ($/MWh)	Sources
Rooftop solar	~$4000/kw	---	$20	15% to 18%	Kauai: $162 O`ahu: $150 Maui: $148 Hawai'i: $178	PV Watts
Rooftop solar and storage	Solar: ~ $4000/kw 7 kWh Powerwall: $800/kWh; as blended costs with new battery after 15 yrs.	---	$20	15% to 18%	Note: Costs varied depending on location and solar array size (3 to 7 kW). Kauai: $213-$270 O`ahu: $196-$248 Maui: $193-$244 Hawai'i: $233 - $297	PV Watts and IREC

All numbers presented here are meant as hypotheses and warrant further examination with more detailed datasets.

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These estimates may not account for electricity use of a new rail system: http://www.ansaldohonolulurail.com/

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Note: this premium may vary if the utility in question is member- or municipally-owned.