Hawaiian Sunblock

Solar Facing Unexpected Barriers Despite Low Cost

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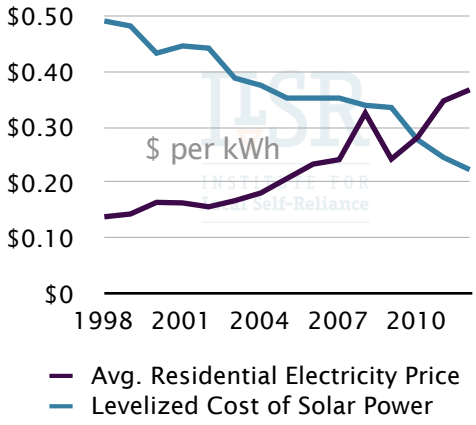
INSTITUTE FOR
Local Self-Reliance

Executive Summary

An island state reliant on imported oil for 83% of its electricity generation, Hawaii has become the pioneer for solar grid parity in the United States. It had an early commitment to solar power in the name of energy independence and state energy mandates and incentives encouraged the development of more solar power.

A rapid rise in the price oil and a rapid decline in the cost of solar have suddenly removed the economic barrier to solar, but like a receding tide, it has also uncovered unexpected and previously hidden barriers.

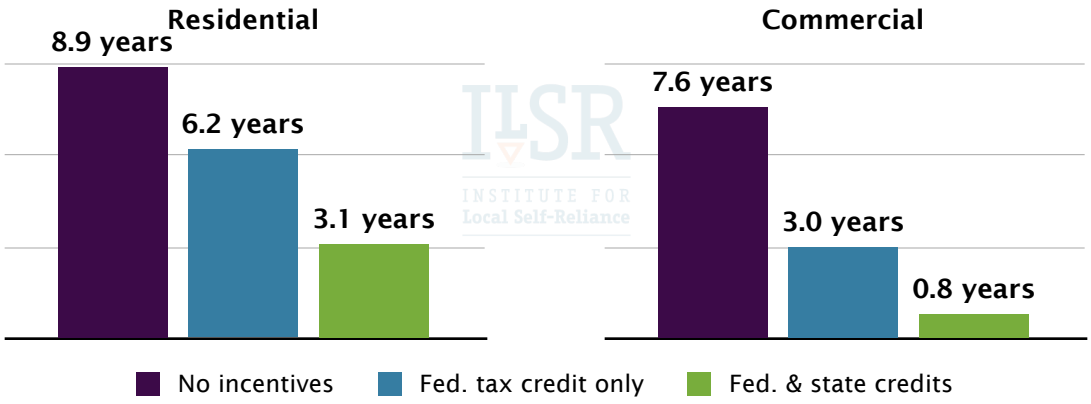
Hawaii Residential Solar Crossover in 2010



Solar is Profitable

With abundant sunshine and falling solar costs, solar power in Hawaii can pay back in a remarkably short time. Since 2010, electricity from solar has cost less than electricity from the utility, with the gap steadily growing. Without any incentives, an investment in a residential solar project pays back in just 10 years while adding significant value to the property. Adding in federal and state tax credits reduces that payback period to 5 years. Payback periods for commercial solar are even better, thanks in part to federal accelerated depreciation.

Simple Payback from Solar Power in Hawaii

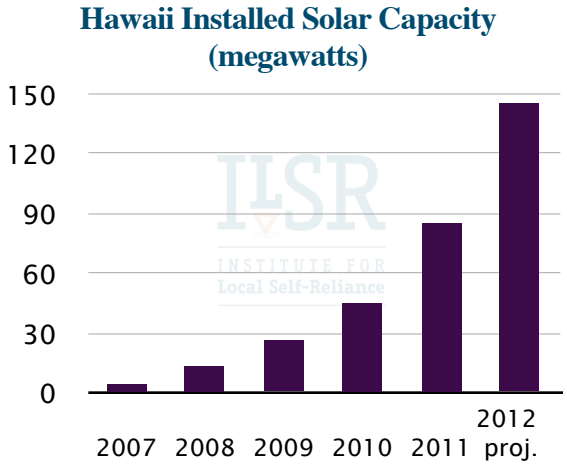


Solar is Growing Rapidly

A combination of economics and policy has led to a surge in solar installations. Installed capacity in Hawaii rose from 25 megawatts (MW) in 2009 to over 85 MW in 2011, and forecast to reach nearly 150 MW by the end of 2012.[12]

Limits to Solar Growth

Although the economics of solar suggest no end to its potential, there are a number of logistical and technical limitations that have become a concern:



- **Wiring and interconnection** costs have meant unexpected costs for one-quarter of homeowners, for electrical upgrades, and nearly 90% of commercial solar projects, for interconnection studies.
- **Local government** lacks the capacity to efficiently process a surge in permit applications to install solar.
- **Utilities** have introduced two stumbling blocks for solar:
  - **The "15% rule"** limits distributed solar from providing more than 15% of electricity on local electric power lines based on somewhat arbitrary safety margins, requiring many potential producers to face the specter of a time-consuming and expensive interconnection study, and
  - "**Curtailment**," a situation where the utility will turn off a solar array in the name of grid stability and refuse to pay for electricity generated.
- **State incentives** have to adjust to the rapidly changing prices for solar and grid electricity to avoid being unnecessarily generous to solar power producers.

NON-COST BARRIERS

"It's not like the gates of heaven open up when solar becomes cheaper"

Isaac Moriwake, Earthjustice

Hawaii Blazes the Trail

Hawaii may be first, but in the next decade 100 million Americans will live in metropolitan areas reaching solar grid parity. The lessons from Hawaii will provide useful context for policy makers from San Diego to New York City to Phoenix. Will cheap solar open the floodgates or will poor policies and reluctant utilities hold it back? The Aloha State may provide the answers.

Acknowledgments

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Since 1974, the Institute for Local Self-Reliance (ILSR) has worked with citizen groups, governments and private businesses to extract the maximum value from local resources.

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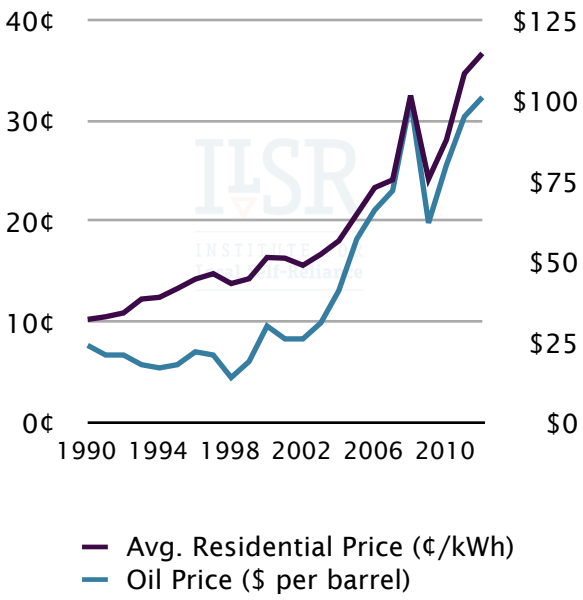
Introduction

The cost of solar power has fallen dramatically in recent years, and by the end of the decade many Americans could get cheaper electricity from their rooftop than from their utility.[3]

Hawaii residents have already crossed that threshold. An island state with long and expensive supply lines for fossil fuels, it relies heavily on imported oil for electricity generation. In 2009, 83% of Hawaii's electricity was generated from fuel oil.[4] With oil prices increasing significantly in recent years, residential customers pay 37 cents per kilowatt-hour (kWh) of electricity, two-and-a-half times more than typical customers in the continental U.S.[5]

Hawaii's Electricity Price & Oil Prices

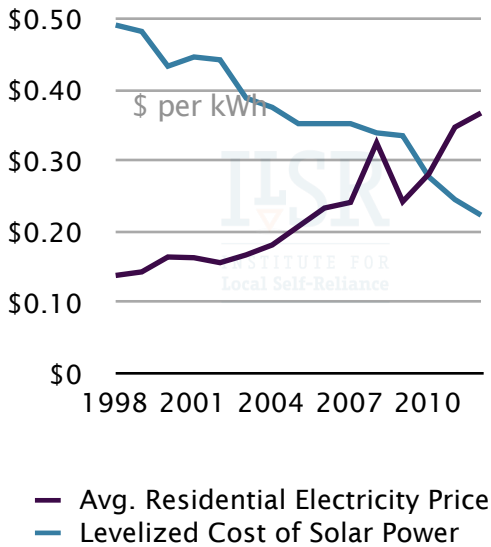


The 2008 spike in oil prices brought renewed focus to the island state's interest in energy independence and led to several policy initiatives to encourage domestic renewable energy production. Most prominently, the state increased its renewable energy standard from 20% by 2020 to 40% by 2030[6] and enacted a CLEAN Contract (a.k.a. feed-in tariff) program.[7] In 2008, the state also signed a non-binding memorandum of understanding with the U.S. Department of Energy to try to transition to a 70% clean energy economy by 2030.[8]

These policies added to an already strong commitment by the islanders to increase the portion of their electricity coming from renewable sources. A 35% state tax credit for solar hot water and solar PV (capped at $5,000) was enacted in 1976.[9] The legislature had passed a law preventing homeowner associations from restricting the placement of solar PV systems.

These policies spurred the creation of Hawaii's solar industry as the price of electricity and solar power converged more rapidly after 2002. By 2010, the surging price of oil caused electricity prices to converge with the falling cost of solar power. That year, the cost of unsubsidized solar fell below the cost of residential electricity for the first time, with the relative value of solar only improving since then.

Residential Solar Crossover in 2010



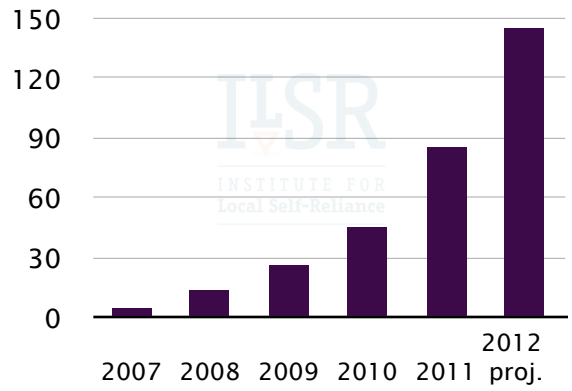
Today, as oil prices return to their historic trend line, solar electricity in Hawaii can be competitive without incentives.

In the words of Hawaii's former Energy Administrator, Ted Peck, "the state has 'created a new sector,' [and] 'renewable energy will be a driver of Hawaii's economy at least for the next decade.'"[10]

It's a bold statement, but the potential is there. Today solar power generates just over 1% of the island state's annual electricity.

That could change significantly. Installed solar capacity doubled each year between 2007 and 2011. Hawaii's approximately 85 MW at the end of 2011 was enough to rank 2nd in the U.S. in per capita solar installations.[11] [12] The pace of installations continued rapidly in early 2012, up 45% from the first quarter of 2011.[13] A recent study found that Hawaii could meet 49% of its electricity needs with rooftop solar alone.[14] The economics of solar are also likely to remain favorable.

Hawaii Installed Solar Capacity (megawatts)



But there are barriers that may prevent the fullest deployment of solar energy.

For example, the cooperative utility on the island of Kauai recently closed its net metering program, citing full capacity (15% of its system peak demand). Local governments are swamped by solar permit applications. The Hawaiian Electric Company, serving the state's largest and most populous island, has an extensive database of residential neighborhoods where solar (de facto) cannot be installed because of the utility's 15% limitation.

Solar economics in Hawaii are terrific. But without solving the technical and logistical challenges of integration, even cheap solar may remain on the margins of Hawaii's electricity system.

NON-COST BARRIERS

"It's not like the gates of heaven open up when solar becomes cheaper"

Isaac Moriwake, Earthjustice

NET METERING

Net metering is a common policy supporting on-site renewable energy generation. It allows a residential or commercial customer to spin their meter backwards as they generate electricity from a rooftop solar array. The customer then pays the "net" electric bill: consumption minus their on-site generation.

Typically, generation in excess of consumption is not compensated at the full retail price of electricity. In Hawaii, excess generation can be carried forward for up to 1 year before it is forfeit to the utility.

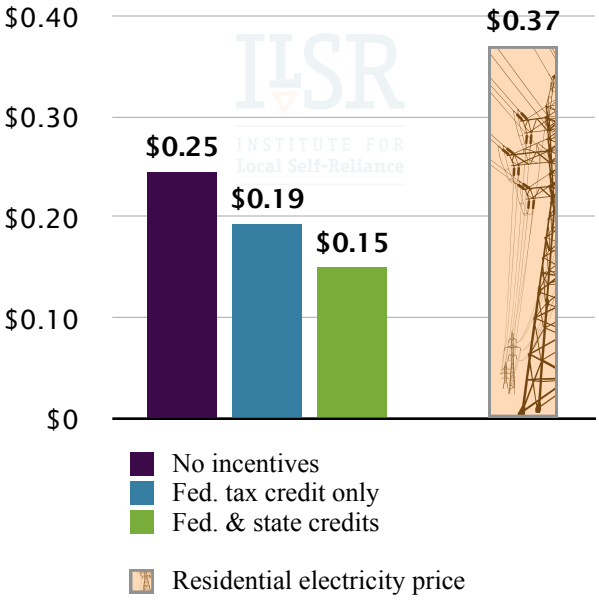
Solar Grid Parity

As the cost of solar power has fallen, Hawaii residents have become the first Americans who can get electricity from their own rooftop for less than from their utility.

Residential Solar

In 2012, a residential rooftop solar array could be purchased and installed for around $5.50 per Watt of capacity.[15] At that price, the cost of solar electricity (without incentives) divided over 25 years of production (the "levelized cost"[16]) is 24.5 cents per kilowatt-hour (kWh). With the federal tax credit, this falls to 19.3 cents, and the addition of the state tax credit drops the cost to 15 cents. (For detailed assumptions, see the Appendix).

Cost of Rooftop Solar in Hawaii



With the average cost of residential electricity at 37 cents, rooftop solar is an enormous cost saver for the typical Hawaii ratepayer.

Even without incentives, the typical customer would save $79 per month (after making payments for the solar array) using net metering. With the federal and state incentives, the savings would be $139 per month. In other words, a solar array is a very attractive financial investment for Hawaii consumers.

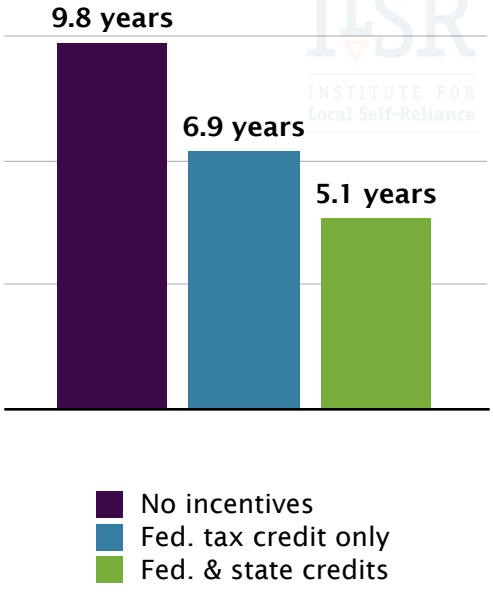
Average Monthly Net Savings from Solar

Basis	Solar Cost
No incentives	$79
+Federal 30% tax credit	$112
+State 35% tax credit	$139

While levelized cost is a figure commonly used by electricity regulators and utilities, it's not a common calculation for a household or business.

The following chart illustrates the savings from the perspective of simple payback on a 5 kW solar array. See the Appendix for more details on the calculations.

Simple Payback from Residential Solar



Solar on a rooftop also increases a home's value. In a study in early 2011, the home value appreciation was $5.50 per installed Watt.[17] In this example, a 5 kW system would increase the home value by $27,500

– equal to the cost of the system! This estimate may be high, as the cost of solar has fallen significantly since the study was published.

For some residents, this valuable solar array would increase property taxes by $76 to $153 per year (5-9% of the annual savings from going solar).[18] But for the 75% of Hawaii's population that lives in the city or county of Honolulu, their solar PV system is exempt from property taxes for 25 years.[19]

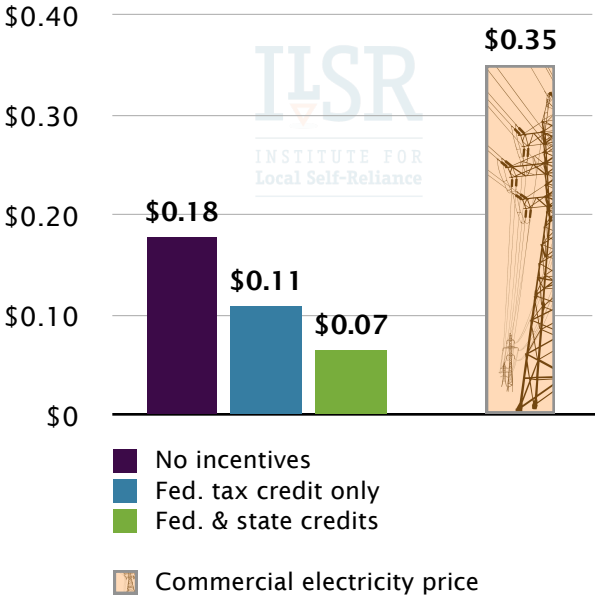
With incentives, solar is a very lucrative investment and even without incentives it can provide a reasonable return for Hawaii residents.

Commercial Solar

If solar seems a great deal for residential projects, then the 1-year payback for commercial scale solar is downright amazing.

Installed costs for these larger projects are lower than for residential solar, in the ballpark of $4.00 per Watt.

Cost of Commercial Solar in Hawaii

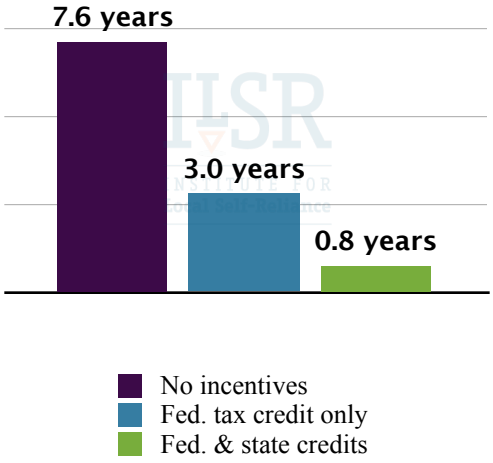


At this price, the cost of solar electricity (without incentives) divided over 25 years of production (the "levelized cost") is 17.8 cents per kilowatt-hour (kWh) for commercial scale solar. With the federal tax incentives (the 30% tax credit and depreciation), this falls to 10.9 cents, and the addition of the state tax credit drops the cost to 6.5 cents.

Against the average commercial electricity rate of 35 cents per kWh, solar electricity measures up very well.[20]

The following chart illustrates the savings from the perspective of simple payback with net metering, a more intuitive calculation, for a 50 kW commercial solar array. In the case of commercial solar, the multiple incentives and high electricity price mean a payback period of just one year. (For a more detail on these calculations, see the Appendix).

Simple Payback from Commercial Solar



Not all businesses could take full advantage. Net metering is limited to systems of 100 kW or smaller (50 kW on the island of Kauai) and the larger size of commercial solar arrays means they are now often subject to more detailed (and expensive) interconnection studies.

CLEAN Program (Feed-in Tariff)

Hawaii's alternative to net metering is a CLEAN contract (or feed-in tariff) program, launched in November 2010. The program provides 20-year contracts for the purchase of solar electricity based on the project size. Projects smaller than 20 kW receive 21.8 cents per kWh, while projects up to 500 kW can get 18.9 cents. Tier 1 and Tier 2 projects that accept a reduced state tax credit can receive a higher payment, 27.4 and 23.8 cents, respectively.

The state's CLEAN/FIT program is capped at 80 MW overall, divided between Oahu (60 MW), the Big Island, Maui, Lanai, and Molokai. The following table illustrates the size categories and rates for Oahu (the other islands have smaller project size caps).

Hawaii Solar CLEAN/FIT Program (Oahu)

System size or location	Contract price (per kWh)
< 20 kW (Tier 1)	$0.218
20 to 500 kW (Tier 2)	$0.189
500 kW to 5 MW (Tier 3)	$0.197

These rates compare to $0.37 per kWh for residential net metering and $0.35 for commercial net metered projects.

So far, only 11 MW of the program's 60 MW capacity has been built (although 95% of the capacity has been reserved).[21] The reasons for this are discussed further in the Limitations section, but for residential sized project the simple answer is that the CLEAN program pays less than net metering.

The CLEAN program offers two distinct benefits for commercial scale solar projects. It pays for all electricity production at the contract rate, allowing participants to produce more than on-site consumption.[22] It also provides a simple process for interconnecting and financing projects larger than the 100 kW net metering limitation.

The CLEAN program's contract rates are also of interest to Hawaii utilities, since they are currently far lower than the retail cost of electricity. For identical 50 kW solar projects, for example, a utility will credit a business $26,000 per year with net metering but only pay $14,000 per year with a CLEAN contract. With federal and state incentives, the difference to the project owner is a payback period of 1.5 years with the CLEAN contract versus less than a year under net metering.

This may be why, when their net metering program was fully subscribed, the Kauai island cooperative utility offered a 2 megawatt "net metering pilot" that pays 20 cents per kWh on 20-year contracts for projects 100 kW and smaller.

The price differential between CLEAN and net metering may narrow over time. In Germany, for example, an abundance of solar power reduced wholesale electricity prices during afternoon peak demand periods. This could mean that as solar grows in Hawaii, retail electricity prices begin to fall.

Ultimately, Hawaii's CLEAN program is another successful tool for expanding distributed solar power.

Limitations

Although Hawaii's abundant sunshine, low solar costs, and generous incentives make solar very lucrative, there are a number of obstacles to the growth of the state's solar market.

Wiring & Interconnection

Old electrical service on many single-wall construction homes in Hawaii means an electrical upgrade (e.g. from 100 to 200 amps) is required to install solar in as many as one-quarter of residential projects. The upgrade costs $3,000 to $4,000 and the expense cannot be offset by federal or state incentives.[23]

A $3,500 electrical upgrade adds another 1.2 years to the typical payback period of 5.1 years for solar with incentives.

Commercial projects face a similar barrier. In 2012, as many as 90% of proposed commercial solar projects face an interconnection study that will add 6 months and $30,000 to $50,000 to the cost of the solar array.[24] A $40,000 interconnection study would add 1.5 years to the typical payback period of just under a year.

INTERCONNECTION PROBLEM

"The most common response to running into the specter of triggering a ... study is for the customer to give up on their ambitions for renewable energy."[25]

Local Government

The surge of interest in solar has led to significant project delays as local government tries to keep pace with demand. On the island of Oahu, for example, 70% of building permits are for solar PV systems, but there are no more city inspectors now than there were four years ago.[26]

Furthermore, the enormous market has led to the launch of many fly-by-night solar installers with limited experience. Their inexperience can require multiple on-site inspections by city staff, adding delays to all solar projects.

A MASS MOVEMENT

"We are having a mass movement of people trying to get out from under the utility thumb, overwhelming the government's ability to process applications."

Mark Duda, President of the Hawaii Solar Energy Association

Curtailment

One reason for the relatively slow development of solar under the state's CLEAN program is resistance from Hawaii's near-monopoly utility. The investor-owned Hawaiian Electric Company (serving all populated islands except Kauai) claims it can curtail – or refuse to purchase power – from any solar project in the program, at their discretion.[27] With incentives based on output, this may make attracting investors difficult, even with fairly lucrative prices.

The "15% Rule"

Another barrier is the "15% rule," a very conservative safety margin for local grid operations adopted by most U.S. utilities, including those in Hawaii. The rule limits solar PV to 15% or less of annual maximum use – "peak demand" – on distribution circuits (the power lines in alleys and neighborhoods bringing electricity to homes and businesses).

The rationale for the rule is that, in the event of a power outage, utilities don't want a local line unexpectedly powered by local solar.[28] For this to happen, there must never be more electricity generated by local solar than there is local demand.

This means that the amount of solar on the grid should never exceed the minimum demand of a power line in a given year. Analysis suggests that the annual minimum demand is close to 30% of annual peak demand, and utilities created a safety margin by dividing it in 2. Hence, 15%.

Until recently, Hawaii utilities have adhered to the 15% of peak "rule." The Kauai utility suspended their net metering program, having reached the 15% threshold. Prospective solar producers on Oahu face an expensive and time-consuming interconnection study if there is no local capacity left under the 15% cap.[29]

There are several ways to improve upon the 15% rule.

One problem with the traditional rule is that the minimum demand on a power line generally occurs in the early hours of the morning (e.g. 4 AM), but a solar PV array doesn't reach its maximum rated output until noon. Hawaii solar advocates successfully negotiated a change to the 15% rule in 2011, and now the annual minimum demand is calculated using demand on Sundays at noon, rather than weekends in the early morning.

In California, the process has proceeded somewhat further, with utilities not only having to focus on minimum demand during hours that solar PV is producing power (coincident demand) but also abandoning the arbitrary "division by 2" metric.[30]

Finally, the issue also has a technical solution: utility equipment that accepts two-way power flows.

Evolution of the 15% Rule

Original

Measure	Threshold
Annual peak demand	100%
Annual min. demand	30%
Screening limit /2	**15%**

Hawaii (2011)

Measure	Threshold
Annual peak demand	100%
Annual min. demand *(noon Sundays)*	**50%**
Screening limit /2	**25%**

California (2012)

Measure	Threshold
Annual peak demand	100%
Coincidental min. demand	**50%**
Screening limit	**50%**

(For more on this issue, read the Technical Barriers section of our Rooftop Revolution report).[31]

Hawaii is also on the front lines for testing the limits of distributed solar generation. The cooperative utility on the island of Kauai is testing a 1.2 MW solar array that supplies 100% of a distribution feeder during the daytime hours.[32]

Although the 15% rule restrains solar development in Hawaii, there are indications that it may continue to loosen.

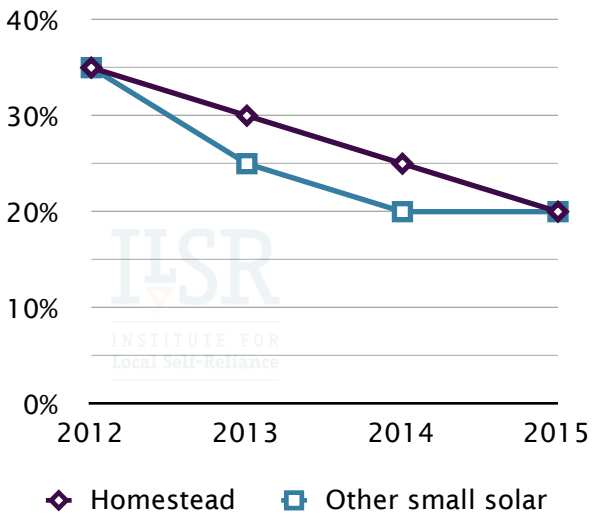
Balancing Incentives

A final limitation to Hawaii's solar policy is an incentive imbalance. The 35% state tax credit is simply too inflexible for a market whose prices change rapidly.

This analysis shows that, with current prices and incentives, solar could pays back in 5 years for residential customers and 1 year for commercial customers (barring wiring upgrades or interconnection studies). Even without the state tax credit, the payback period is 7 years and 3 years, respectively, for residential and commercial solar power.

Solar advocates have already worked to change the state's incentive to accommodate recent economic changes, and a compromise bill (HB 2417) nearly passed the state legislature in 2012. The bill would have reduced the tax credit for solar on a primary residence from 35% in 2012 to 20% by 2015. Other small-scale solar would be reduced from 25% in 2013 to 20% in 2014 and thereafter.

Proposed Change to State Solar Tax Credit



For utility-scale solar (connecting to the sub-transmission or transmission system), the bill would have changed the tax credit into a production payment of 8¢ per kWh for the first 10 years of operation.

These changes are a good response to criticism that the tax credit is unnecessarily generous. Other options could include indexing the tax credit to various market measures such as the installed cost of solar and the retail price of electricity. The tax credit could also be used as a backstop to the federal tax incentive, should Congress fail to extend or prematurely terminate the 30% federal credit before it expires in 2016.

Conclusion

Hawaii is a solar grid parity pilot for the rest of the United States.

Its uniquely high electricity prices and abundant sunshine have made solar a cheaper electricity source than retail electricity from the utility. Its generous incentives have made investment in residential or commercial solar extremely lucrative.

But the Aloha State is also a warning that the "gates of heaven don't open just because solar is cheap."

Residential and commercial customers have encountered unexpected costs for electric upgrades or interconnection. Utilities have been quick to apply limits on solar development based on the "15% rule." Local governments have struggled to keep pace with demand for permits.

The rapid changes in the economics of solar and electricity have also upset the delicate balance between taxpayers and solar investors.

The fact is that solar grid parity is the first of many barriers that must be overcome. As solar has become competitive, just as a receding tide reveals a new landscape it has exposed many other technical and logistical challenges to maximizing local solar development.

Hawaii is already a solar leader and has the technical potential to supply nearly 50% of its electricity from rooftop solar alone. But the success of its solar market will depend on its ability to move beyond grid parity and to address the newly revealed challenges to a cost-effective local solar future.

MOTIVATION

"The state wants to do larger scale renewable energy projects and run cables between islands to balance the load.

Citizens are only assuaged by by their opportunity to zero out their bill...they are focused on wiping out load. Some want more solar, and are even buying an electric vehicle to pump up their load."

Mark Duda, President of the Hawaii Solar Energy Association

Appendix

Residential Solar Costs in Hawaii

The following table illustrates the assumptions for a financial analysis of a typical 5 kilowatt (kW) rooftop solar array. The expected annual output is based on solar insolation data from Honolulu and may not reflect the wide variation in the solar resource in the islands' many micro climates.

Residential Solar Grid Parity Calculation

Installed cost @ $5.50/W	$27,500
System output (annual)	7,583 kWh AC 0.5% annual degradation
Incentives	
Federal tax credit (30%)	$8,250
State tax credit (35%, capped at $5,000)[4]	$5,000
Project Finances	
Debt portion	80%
Debt term	10 years
Interest rate	5%
Discount rate (5%) less inflation (3%)	2%
Project life	25 years

Simple Payback from Residential Solar

Installed cost @ $5.50/W	$27,500
Incentives	
Federal tax credit (30%)	$8,250
State tax credit (35%, capped at $5,000)	$5,000
TOTAL COST	$14,250
System output (annual)	7,583 kWh AC 0.5% annual degradation
Electricity cost	$0.37 per kWh
Annual savings	$2,806
Simple payback	
No incentives	9.8 years
Fed. tax credit only	6.9 years
Fed. & state tax credits	5.1 years

Commercial Solar Costs in Hawaii

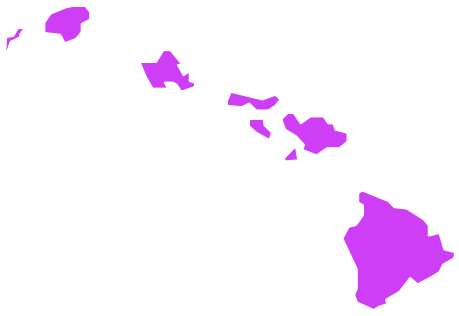
The expected annual output is based on solar insolation data from Honolulu and may not reflect the wide variation in the solar resource in the islands' many micro climates.

Commercial Solar Grid Parity Calculation

Installed cost @ $4.00/W	$200,000
System output (annual)	75,829 kWh AC 0.5% annual degradation
Incentives	
Federal tax credit (30%)	$60,000
Federal depreciation	~$48,000
State tax credit (35%, capped at $500,000)	$70,000
Project Finances	
Debt portion	80%
Debt term	10 years
Interest rate	5%
Discount rate (5%) less inflation (3%)	2%
Project life	25 years

Simple Payback from Commercial Solar

Installed cost @ $4.00/W	$200,000
Incentives	
Federal tax credit (30%)	$60,000
Federal depreciation	$48,000
State tax credit (35%, capped at $500,000)	$70,000
TOTAL COST	$22,000
System output (annual)	75,289 kWh AC 0.5% annual degradation
Electricity cost	$0.35 per kWh
Annual savings	$26,351
Simple payback	
No incentives	7.6 years
Fed. incentives only	3 years
Fed. & state incentives	0.8 years



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