# Net Metering, Distributed Energy Storage and the Decarbonized Future

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## Introduction

### *Purpose*

When creating policy, policy makers ought to think about the future when weighing the costs and benefits of their decisions. This paper explores how current policy makers may be ignoring the long-term effects of their decisions with respect to net metering, energy storage, and deep decarbonization.

The purpose of this paper is to explore the implications of the continued use of net metering on energy storage through the lens of achieving the goal of deep decarbonization, and to then create a recommendation on policy pathways that would best achieve this goal of deep decarbonization going forward. This analysis is separated into two parts; first, it must be established that net metering in its current form if continued without reform will lead to significant harm to the field of energy storage. Secondly, different options will be explored and recommended.

### *Policy Recommendation*

After analysis of different states and policies, it is clear that net metering in its most basic form of kilowatt hours generated minus kilowatt hours used being converted into credits is not sustainable in the long term. Through the lens of deep decarbonization, we can see that there are major conflicts of interests between net metering and consumers investing in distributed storage such as solar batteries.

This paper examines two different scenarios/alternatives that would make sense in a post net metering world. The first is a simple absence of net metering and replacement of it with other incentives to install distributed solar that do not discourage the installation of storage. The other option is a policy that Hawaii has implemented called Smart Export. It combines net metering with baked in incentives and mandates to install battery power.

## Background & Justification

### *Deep decarbonization*

Deep decarbonization is a term that refers to the process of radically reshaping society, especially sectors like energy and transportation, into one that does not emit significant additional carbon emissions. This deep decarbonization pathways project, or DDPP for short, roughly outlines this process with three pillars[1]:

1. Energy Efficiency and conservation
2. Decarbonizing electricity and fuels
3. Switching end uses to low-carbon supplies.

Essentially, to get rid of carbon emissions in society, we must eliminate or reduce the use of energy where energy does not need to be used, eliminate the creation of carbon emissions in the processes of creating energy and electricity, and make any remaining processes that emit carbon to switch to the now carbon-neutral electricity.

Although all three pillars are vital to the long-term goal, the pillar that is most in scope for this class and the one that this paper will mostly deal with is the second one, the elimination of carbon from electricity and fuels. More specifically, this paper will deal the policies that will alleviate some of the side effects of the elimination of carbon from our electricity, namely load balancing in a grid with a high percentage of intermittent renewables. Arguably, this is the most difficult to achieve and most important pillar. Without it, the last pillar of electrifying things such as cars would be useless- electric cars would simply shift emissions from the engine to the power plant.

Although it is a lofty goal, as all efforts to reshape society are, deep decarbonization is vital to the health and survival of humans and animals throughout the world. Currently, careless volumes of greenhouse gas emissions have rapidly destabilized our planet’s climate, causing real and

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[1] http://deepdecarbonization.org/wp-content/uploads/2015/06/DDPP_EXESUM.pdf

measurable harm to quality of life.[2] Deep decarbonization directly seeks to address this.

There are a few important aspects of this goal that are especially noteworthy. First of all, it is a long-term goal, meaning if policy makers are to pursue deep decarbonization, they must make policy that will contribute to this goal or sub goals that will meaningfully contribute to the end goal. There are cases where it is possible to lower emissions in the short run, but create policies, incentives, or institutions that in the long run make it much harder to actually achieve the goal of deep decarbonization. One such example is the conversion of coal plants to natural gas; the creation of more fossil fuels in our mix that will last for decades will only make it harder to reach our goals in the future.

## *Energy Storage*

Energy storage is easily one of the most important cogs in the machine that is a decarbonized society. Although energy storage has not taken off like solar has, through the lens of deep decarbonization, storage is just as important. In a system where there is a high level of intermittent renewables, energy storage is one of the most important tools for keeping load and supply approximately equal in a cost-effective way.

In a deep decarbonization scenario, what is currently known as the duck curve will dramatically worsen. Although solar is typically load

[2] https://climate.nasa.gov/effects/

following, it is not able to consistently produce energy. Instead, its production tapers down as the sun sets. All of a sudden, households with rooftop solar that used to appear to the utility/grid as nonexistent in terms of load come online, giving the appearance of a huge increase in load following the sunset and before people start going to sleep.

As an example of what a future with a high number of intermittent renewables may look like, look to Hawaii. The Duck Curve there is often referred to as a "Nessie" curve because the steep increase in demand at sun down resembles the neck of the Loch Ness monster.

This scenario would be fixed by the proliferation of energy storage. Instead of limiting the amount of intermittent renewable energy because of load balance concerns, society could produce as much intermittent renewable energy as needed and save any excess over current load for later.[3]

Recently, energy storage has become a hot topic, especially batteries. With new technology lowering the cost of batteries, storage has creeped toward the realm of viability in cost effective load management. However, currently, there are a large number of factors that contribute to disincentivizing this important new technology, with one of the most impactful ones being net metering.

Although there are many forms of storage, this paper will mostly focus on distributed storage in the form of solar batteries in the residential context.

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[3] https://www.energy.gov/eere/articles/confronting-duck-curve-how-address-over-generation-solar-energy

## *Net metering*

Net metering is one of the most important policies in the renewable energy regulation realm. At its most basic level, it is the policy that permits what are conventionally consumers to sell their electricity back to the grid/utility. Typically, what this looks like on a residential level is households with rooftop solar generating energy beyond the load of the household and selling any excess energy back into the local grid, typically for money or some sort of credit.[4]

Originally implemented to incentivize the installation of once expensive distributed solar energy such as rooftop solar, net metering has arguably been pretty successful in its goal; in certain markets, rooftop solar has incredibly high rates of penetration. For example, zip codes in cities such as San Diego and Davis have seen over a quarter of its thousands of households install solar. One zip code in Bakersfield has seen a third of its 6800 households install rooftop solar.[5]

However, this deceptively simple policy has far reaching implications for the renewable energy realm, especially when it comes to energy storage and deep decarbonization. Recently, net metering has become quite controversial, and many states have voted to roll it back for various reasons. States such as Indiana cite the supposed cost of solar being pushed onto consumers who do not own rooftop solar.[6]

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[4] https://www.seia.org/initiatives/net-metering

[5] https://www.ohmhomenow.com/2016-solar-penetration-state/zip-code-solar-penetration-2/

[6] https://www.utilitydive.com/news/indiana-will-phase-out-retail-rate-net-metering/441932/

*Status of Net Metering in Different States*

- California

California currently has two different ongoing programs for conventional net metering. The original net metering policy, NEM, has reached its cap, so any new solar customers will be enrolled into NEM 2.0 until 2019.[7] NEM only deals with solar energy, and does not allow battery storage energy to be sold back to the grid.

The original net metering has a fairly conventional structure-customers with solar panels generating excess energy can sell it back into the grid for a per kWh credit.

NEM 2.0 is mostly the same, with three key changes. First is the introduction of time-of-use rates. All customers enrolling in the new version of net metering will have to choose time-of-use rates. What this means is that credits will not be worth less relatively than before, as prices for electricity are generally highest outside of the window in which solar will generate excess.

Second is an interconnection fee. This means that customers enrolling in the new NEM will have to pay a fee to the utility- around $140 depending on the utility- to sign off on its installation. Lastly, the new NEM introduces Non-bypassable charges. These are per kilowatt hour charges that must be paid when buying electricity

[7] https://news.energysage.com/net-metering-2-0-in-california-everything-you-need-to-know/

from the grid.[8] Currently, California does not allow electricity that has been routed through batteries to qualify for net metering.

- *Hawaii*

Hawaii is one of the few states to have rolled back net metering, albeit after a decade of incredibly quick growth in distributed solar installation- by net metering's end, around 20% of all households had installed solar.

In October 2015, a Hawaii Public Utilities Commission ruling officially ended net metering.[9] However, it is unique in that it is one of the most liberal states in the entire country. Unlike some states that have rolled back net metering based on mostly more conventionally conservative reasoning such as Indiana, Hawaii has really reached a limit where the rate of penetration of distributed solar generation has made operating the grid difficult.

Solar Energy Industries Association reportedly was cautious in critiquing the order to end net metering, Sean Gallagher, SEIA VP of State of Affairs says:

> "While it may be appropriate to make certain rate changes in Hawaii now, other states are a long way from reaching that point."[10]

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[8] http://www.cpuc.ca.gov/General.aspx?id=3800

[9] https://www.hawaiianelectric.com/products-and-services/customer-renewable-programs/net-energy-metering

[10] https://www.pv-magazine.com/2015/10/14/hawaii-shuts-down-net-metering-to-new-customers_100021550/

Marco Mangelsdorf, president and founder of Hawaii PV Coalition also offers the following explanation:

> "There are no villains in this drama. Hawaii has an unprecedented amount of DG PV feeding into our isolated island grids. There are limits to what today's grids can accommodate"[11]

After the end of net metering in Hawaii, there were two alternatives that were put in place. One would be a battery/storage option and the other a new net metering lite policy. Immediately after the end of net metering, these options were respectively Customer Self Supply and Customer Grid Supply. These were replaced in 2018 by yet another two programs, Smart Export and Controllable Customer Grid Supply.

The Customer Self Supply or CSS program would mandate that customers would have to buy or lease their own battery. The solar panels would then not be allowed to export any energy onto the grid.[12] However, there were issues with this program; permits for batteries were slow to come. In May of 2017, 420 residential rooftop solar systems attached to batteries were waiting for permits, but the Honolulu Department of Planning and Permitting had only given out 33.[13]

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[11] https://www.greentechmedia.com/articles/read/rooftop-solar-in-hawaii-crashes-with-loss-of-net-metering-lack-self-supply

[12] https://www.hawaiianelectric.com/products-and-services/customer-renewable-programs/customer-self-supply

[13] https://pv-magazine-usa.com/2017/05/29/hawaii-strains-to-permit-batteries-as-self-supply-permits-grow/

This CSS option was succeeded by Smart Export in 2018, giving more options for exporting to those who owned batteries. Now, solar owners would use their solar power and charge their batteries with any excess. At night, Smart Export users would be able to sell back any power that they had stored in their batteries back into the grid. However, between the hours of 9am to 4pm, no export credits would be allowed to be generated. [14]

The Customer Grid Supply program was essentially the same as the old net metering except the utility would buy the energy instead of receiving net kilowatt hour credits. Under the old system, a customer's bill would be kilowatt hours used minus kilowatt hours generated.[15] Under the Customer Grid Supply program, the utility would instead take your energy and buy it at a fixed rate, which was lower than the retail rate. This new program had a fixed cap of enrollment that was reached in November 2017.

To replace CGS, Hawaii implemented Controllable Customer Grid Supply. New systems under this program would have advanced inverters that would allow the utility to shut off exporting panels if there was a capacity issue. Utilities would take the exported energy when needed and would shut off excess solar generation if not.[16]

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[14] https://www.hawaiianelectric.com/products-and-services/customer-renewable-programs/smart-export

[15] https://www.hawaiianelectric.com/documents/products_and_services/customer_renewable_programs/nem/guide_to_nem.pdf

[16] https://www.hawaiianelectric.com/hawaiian-electric-companies-open-up-capacity-for-grid-supply-solar-program

Hawaii promised to only shut off excess solar generation after shutting down its own plants first. Customers would have the most possible number of credits before the utility would step in and control the output.

## Net Metering and its Effect on Storage

There are a variety of ways that continuing net metering the way that it is in states such as California for too long would be harmful. With a deep decarbonization goal in mind, continuing net metering may end up creating a lot of issues that will be more difficult to solve than simply ending net metering. Most importantly, distributed storage would not be developed further. However, other concerns such as grid stability and cost equity are important factors as well.

### *Effect on Storage*

The most important aspect of net metering is its ability to allow consumers to treat the grid like a battery. This means that consumers will not have an incentive to use their batteries.

As previously mentioned in the background, batteries are incredibly important in order to achieve a state of deep decarbonization in a cost-effective manner. A 2016 study by Mileva et. al. modeled power system balancing for deep decarbonization of the electricity sector and concluded that storage would be important to keep the lights on. It wrote that:

> "Consistently low wind output in the summer can put high stress on the grid… Storage with a large energy subcomponent would be required to address these energy shortages."[17]

As it stands, most of the cheaper and cost-effective renewable sources of energy are intermittent and unpredictable. In the foreseeable future, the most cost-effective way of introducing renewables into the energy portfolio will be technologies such as solar and wind. Time and time again, we see that most solar experts recommend that consumers avoid buying any storage if they live in a state with any sort of net metering policy.[18] NREL found that:

> "When NEM is available, the grid serves the same purpose as a battery. When net-metering is not available, storage projects are found to be economical in more cases."[19]

The current California NEM 2.0 attempts to address this through forcing its new customers to enroll into TOU- time of use rates. However, this will not change the issues with batteries for two reasons. First of all, the time of use rates are not drastic enough to warrant investment into batteries. Jim Lazar, Regulatory Assistance Project senior advisor puts it this way, saying:

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[17] https://www.sciencedirect.com/science/article/pii/S0306261915014300#!

[18] https://www.solarpowerrocks.com/affordable-solar/get-home-solar-battery-2018/

[19] https://www.nrel.gov/docs/fy18osti/70813.pdf

> "Moving to default TOU in California may not be that big a change because most customers have a pretty normal distribution of usage and won't see a big difference in their bills if they do not respond"[20]

Secondly, there is the issue that even if the difference between lower rates and higher rates in the TOU scheme is high enough, Californians will not be able to sell their energy back to the grid if it has touched the battery. Currently, Californians are only allowed to directly sell solar back to the grid. The moment it touches a battery, California declares it to be ineligible for its net metering scheme.[21] This will still heavily disincentivize consumers to get batteries, since the benefit of selling energy back to the grid at higher TOU rates is now impossible.

When looking through the lens of deep decarbonization, net metering becomes a harmful policy left untouched. In the long term, it is difficult to fulfill that second pillar of decarbonizing electricity and fuels. While it is true that the duck curve is often overstated as a problem with regards to safety and reliability, without storage, any load balancing that would occur in a high intermittent renewables scenario would be very expensive.

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[20] https://www.utilitydive.com/news/as-california-leads-way-with-tou-rates-some-call-for-simpler-solutions/532436/

[21] https://www.google.com/search?q=battery+net+metering&oq=battery+net+metering&aqs=chrome.0.0j69i60l2j0.6719j1j7&sourceid=chrome&ie=UTF-8

# Exploring the Alternatives

## *A Null Hypothesis of Sorts- Simply Ending Net Metering*

The simplest method to stop net metering from disincentivizing the development of storage is to simply end net metering. Obviously, net metering was created to serve some sort of purpose; the question is whether that purpose has been fulfilled and whether getting rid of it would be a wise idea.

As it turns out Net Metering, originally created to incentivize consumers to install solar has been incredibly successful in fulfilling its purpose. In fact, as we saw in Hawaii and some parts of California, it was too successful. Hawaii had reached levels of distributed solar popularity where certain congested circuits were getting dangerously close to becoming unreliable and unstable.

Although within the realm of States, Hawaii is unique in that it does not have the possibility of exports/imports as it is an island state. However, this sort of lack of import/exports of energy is actually a good simulation of a deep decarbonization scenario where there will be little to no natural gas or coal to import. The Scientific American puts it this way:

> The state [Hawaii] is electrically isolated from the mainland. With no power lines linking Hawaii's small grid with the rest of the United States, the utility has nowhere to dump extra solar power and no access to backup electricity generation from outside the state.[22]

[22] https://blogs.scientificamerican.com/plugged-in/3-reasons-hawaii-put-the-brakes-on-solar-and-why-the-same-won-t-happen-in-your-state/

Although the scientific American argues that this is not the case in other US states, it is likely that a deep decarbonization scenario would demand that these conditions arise.

In the absence of net metering, other incentives or mandates ought to be put in place in order to speed up the adoption of renewables and distributed storage. There are a countless number of ways to implement this and it is not possible to cover every combination and analyze optimal combinations in depth in this paper. However, here are some of examples of possible alternatives to net metering that promote solar and batteries:

- Mandates/Obligations

  Mandates are one way to create adoption of renewables and battery technology, specifically Renewable Portfolio Standards and similar structures. Renewable portfolio standards, or RPS for short, are mandates or regulations that create an obligation for utility companies to have a certain amount of renewable energy in their energy portfolio.

  These standards have been around for a while now, first implemented by Iowa in 1983. [23] They have a variety of pros and cons to RPS. They are meant to be a more hands-off approach to achieving higher levels of renewable adoption; by definition, utilities get to decide how they would like to achieve the proportion/proportion/number of renewables set by the state. However, there are issues with the proving additionality when utilities can buy certificates, or RECS, from renewable energy

[23] https://emp.lbl.gov/sites/all/files/lbnl-62569.pdf

producers to make sources like coal or gas into “renewable” in the eyes of the renewable portfolio standard.

While renewable standards for energy portfolios are an old idea, standards for battery storage are a more novel idea. California is the only state to have implemented one. In 2010, Assembly Bill 2514 had the CPUP set a target of 1.3 gigawatts of storage from Transmission, Distribution, or Customer sources.[24]

- Tax Credits

One simple method to incentivize batteries and renewables is to use tax credits. In fact, on the federal level, tax credits are already in place. The Solar Investment Tax Credit, or ITC for short, is a federal 30% tax credit for residential properties. It boasts a 1600% annual solar installation growth since 2006 when it was implemented. Essentially, what it does is for each dollar spent on installing solar, 30% of that is given as a credit that can go towards paying personal income taxes.

This tax credit is set to step down to 26% by 2020, 22% by 2021, and is gone by 2022.[25] However, if the need to incentivize solar more arises, these tax credits are one way to incentivize solar in a big way.

For energy storage, tax credits are in a similar position; already existent on a federal level and has potential to be expanded. Currently, the rates for the energy storage ITC is 30% until 2019,

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[24] https://www.energy.ca.gov/renewables/tracking_progress/documents/energy_storage.pdf

[25] https://www.seia.org/initiatives/solar-investment-tax-credit-itc

and ramps down at a similar rate as the tax credit for rooftop solar.[26]

## *Another Choice- Hawaiian Style Smart Export*

One alternative to traditional net metering bakes incentives to introduce more distributed storage into the mix is Smart Export, briefly explained in the background section. There are a variety of benefits as well as pitfalls to such a program.

One big pitfall to such a program is the difficulty in implementation. The earlier implementation of Smart Export, Customer Self Supply, ran into issues with permits. However, there are two rebuttals to this pitfall.

I. First of all, arguably, permitting pitfalls are not unique to any policy. Regardless of whatever policy-oriented incentive structure, there will be issues getting permitting streamlined. In fact, any policy that promotes storage is more incentive in research and work being done on battery safety and better permitting practices.
II. Secondly, any policy that promotes storage is more incentive in research and work being done on battery safety and better permitting practices.

There is also the issue of implementation with respect to introducing the option of sales back into the grid at night. Is it even worth going

[26] https://www.seia.org/sites/default/files/2018-05/SEIA-Energy-Storage-ITC-Factsheet-May2018.pdf

through the hassle to try and allow this over CSS, the first iteration of Hawaiian policy without exporting? This is a question that California currently faces.[27] In October 2017, the CPUC responded to PG&E, SDG&E, and Edison trying to

> "Seek clarity on how DC1-coupled photovoltaic (PV) plus storage systems can qualify for the net energy metering (NEM) tariff"

However, recently Hawaii has found that technology has since caught up to the levels necessary to make sure exports are not mismanaged.

> "The commission does not find that an additional smart production meter is necessary for the interim Smart Export program at this time, given the program's export structure."[28]

Allowing exports back into the grid would be helpful in managing the neck of Nessie's Curve. Although typical solar batteries only last for a few hours given a typical household's load, the batteries are able to discharge throughout the peak demand and supply the grid with cheaper solar energy from batteries rather than more expensive ways to manage load currently employed like gas "peaker" plants.

In the long run, Smart Export seems to have an advantage over its sister policy, Controllable Customer Grid Supply, since it has a distributed storage policy baked in. As a result of Smart Export, Hawaii expects that around 3500-4000 households will enroll and bring a battery online along

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[27] http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M197/K530/197530360.PDF

[28] https://dms.puc.hawaii.gov/dms/DocumentViewer?pid=A1001001A17J23B15234B02181

with it.[29] For reference, Energy Sage reports that the typical solar battery has a capacity of around 10 kilowatt hours[30], which multiplied by the 4000 households comes up to a total capacity of up to 40 megawatts! For reference, PG&E, which serves around 16 million people[31], has procured around 46 megawatts of storage under its RPS like program, last updated August 2018.[32] Hawaii's population is only 1.4 million.

In short, CGS does not present any incentive to create any storage; however, the controllable aspect is potentially a valuable aspect that could hypothetically be required with a Smart Export like policy in the future if need be.

## Conclusion

In conclusion, it is clear that there are a lot of reasons why net metering cannot continue as it does in its most basic form. Looking from a deep decarbonization perspective, there is an issue of making later progress harder than it should be. With net metering, distributed storage adoption is not financially viable, and there is no incentive to develop it.

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[29] https://puc.hawaii.gov/wp-content/uploads/2017/10/Hawaii_PUC_Smart-Export_CGS_Fact_Sheets_FINAL.pdf

[30] https://www.energysage.com/solar/solar-energy-storage/what-are-the-best-batteries-for-solar-panels/

[31] http://www.pgecorp.com/corp_responsibility/reports/2015/bu01_pge_overview.jsp

[32] https://www.energy.ca.gov/renewables/tracking_progress/documents/energy_storage.pdf

Therefore, it will not be adopted at a rate fast enough to be in accordance with a deep decarbonization vision.

Two post net metering suggestions are explored. First is simply ending net metering and replacing it with other schemes such as tax credits. The second is to model a policy after Hawaii's Smart Export policy, which bakes incentives for storage into a net metering-esque policy.

Note that this paper does not make exact calculations as to when net metering ceases to be viable and crosses the line into doing more harm than good. Instead, it simple concludes that, at some point, net metering must end in order to give way to a deeply decarbonized future.

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[1] https://blogs.scientificamerican.com/plugged-in/3-reasons-hawaii-put-the-brakes-on-solar-and-why-the-same-won-t-happen-in-your-state/

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Export_CGS_Fact_Sheets_FINAL.pdf

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[1] https://www.energy.ca.gov/renewables/tracking_progress/documents/energy_storage.pdf