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CALIFORNIA DC-COUPLED SOLAR-PLUS-STORAGE NET METERING RULING: A TECHNOLOGY AND POLICY REVIEW

Author

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Review Based on

CPUC Decision D.19-01-030
Decision Granting Petition For Modification of Decision 14-05-033 (Successror to ExistingNet Energy Mettering Tarriffs) Regarding Direct Current-Coupled Solar Plus Storage System

Decision Signed January 31, 2019

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A NEXTracker's NX Flow™ integrated solar-plus-storage system. Image: Courtesy of NEXTracker

EXECUTIVE SUMMARY

On Janaury, 31, 2019, the California Public Utility Commission (CPUC) signed decision D.19-01-030 granting a petition to modify Decision 14-05-033, which governs current Net Energy Metering (NEM) policies in California. The modification allows DC-coupled energy storage systems to adopt an inverter firmware design developed by NEXTracker, a global solar PV and storage system provider, and championed by the California Solar & Storage Association (CALSSA). This firmware modification enables solar-plus-storage projects to become eligible for NEM.

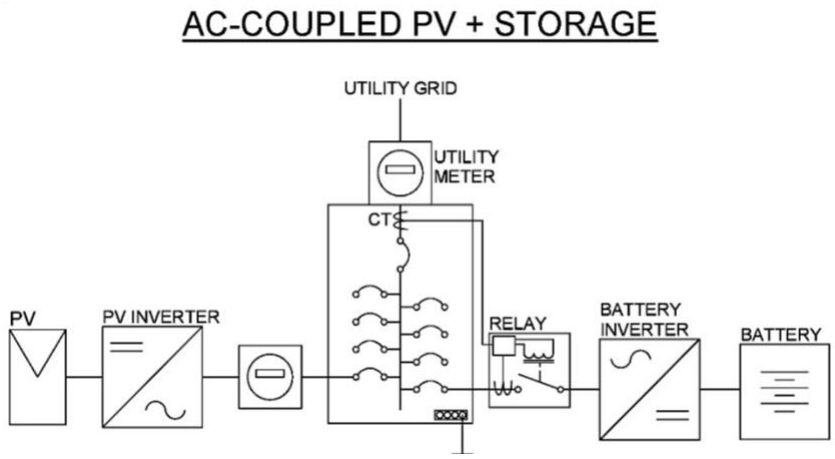
This technology and policy review by SepiSolar, an independent engineering firm, describes the history of this decision and its potential benefits to builders and owners of solar-coupled storage systems. These benefits include the following:

- For the first time in California, solar-plus-storage asset owners can export battery power onto the grid and receive NEM credits on all solar and storage exports, including those with aggregate (NEM-A) and virtual (NEM-V) tariffs.
- Developers are able to increase the size of their projects in California beyond 1 MW.
- Utility interconnection risk can be mitigated.
- Developers and tax equity investors are able to invest in solar-plus-storage projects and receive a potentially higher return on investment.
- Companies that are building solar-plus-storage projects may be able to significantly reduce interconnection and hardware costs.
- DC-coupled storage projects feature lower string inverter costs, increased system efficiency, less chance of unexpected utility infrastructure upgrades and reduced design complexity than non-DC-coupled projects.
- Engineering, procurement and construction (EPC) firms can qualify for the “Expedite Process” for utility interconnection approvals.
- Federal Investment Tax Credit (ITC) eligibility risk, a significant challenge for tax equity financiers investing in solar-plus-storage projects, may be reduced or eliminated.
- Utilities are assured that only solar-generated power is being exported to the grid for NEM credits.
- Energy storage manufacturers can now develop NEM-ready products for California as well as for other markets expected to follow California standards.

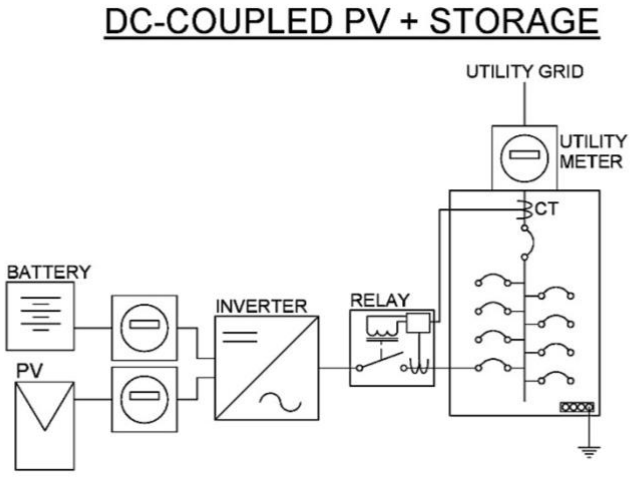
ENERGY STORAGE NET METERING IN CALIFORNIA

Before the CPUC's January 31, 2019 decision, DC-coupled solar-plus-storage projects installed behind-the-meter could not be interconnected under NEM. Utilities were concerned that solar-plus-storage owners would charge their batteries from the electric grid at an inexpensive nighttime rate and later profit by selling the stored grid power back to the utility at higher NEM daytime rates. Consequently, California utilities would allow solar-plus-storage with NEM only if it could be verified that solar-generated kilowatt-hours were being credited under NEM.

Before CPUC's NEM Storage Decision



Challenges:
1) Multiple inverters add cost
2) Multiple unnecessary AC-DC and DC-AC conversions
3) Costly metering & relay protection equipment required
4) Costly upgrades to electrical distribution equipment are common
5) PV system size constrained by utility transformers and feeders
6) Multiple tariffs required: NEM (PV) and non-export (storage)



Challenges:
1) ANSI-listed DC-rated meters not available
2) Non-export agreement required; no NEM credits
3) Costly metering & relay protection equipment required
4) Costly upgrades to electrical distribution equipment are common
5) PV system size constrained by utility transformers and feeders

Figure 1. The complexity and challenges of AC- and DC-coupled energy storage systems before the CPUC NEM storage decision

Historically, customers fulfilled this utility requirement by filing a "non-export" interconnection with an AC-coupled battery system. As a result, projects incurred costs due to having to install reverse-power (32R) protective relays, an additional utility meter to measure solar generation, switchgear and a second inverter. This AC-coupled configuration not only increased equipment and engineering costs, it also reduced system efficiency.

Not only were AC-coupled systems more expensive and more complicated to design for NEM, they could delay permission to operate (PTO) by three to six months because of requirements for additional utility inspections, testing and on-site non-export verifications. Moreover, AC-coupled systems were sized based on the sum of battery inverter and the PV CEC-AC nameplate rating, which put the developer at risk of being charged for utility upgrades when the project exceeded 1 MW.

Finally, another impediment was the potential for a burdensome verification process for tax equity investors. To accrue the entire 30% ITC for storage, the IRS requires that 100% of the energy flowing into the battery originates from a renewable source, which can be audited in order to verify compliance with ITC regulations. In AC-coupled systems, this verification is challenging because the solar system and the battery system are connected to the grid independently of one another. Even with the required extra relays and equipment installed, an audit can result in a lengthy negotiation with the IRS regarding both measurement and verification data between the two systems (solar and storage), and the timing of coincident solar generation and battery recharging events.

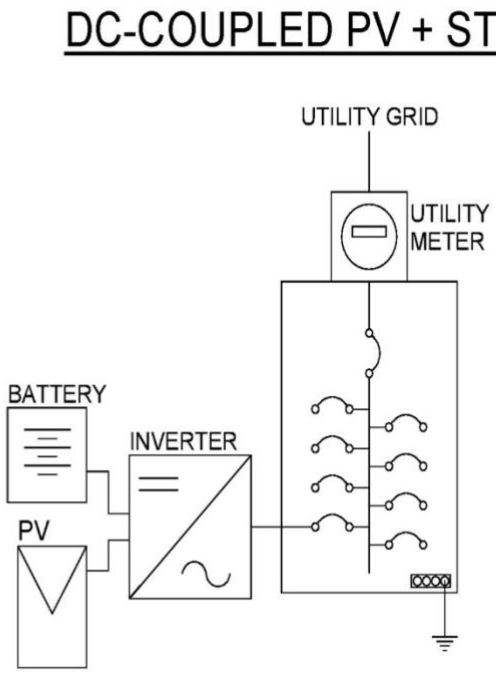
THE FIRMWARE SOLUTION AND CPUC DECISION

To reduce project development risk and increase the return on investment for DC-coupled systems, NEXTracker partnered with SepiSolar to develop a design solution that complies with prevailing utility rules and requirements, and that could also be paired with NEXTracker's NX Flow™ energy storage system. Realizing that what was needed was a firmware modification to the DC-coupled inverter and the battery product, NEXTracker and SepiSolar worked with CALSSA to petition CPUC to approve a solution for battery net metering that would satisfy utility non-import requirements.

As a result of the system-level testing completed on NX Flow that was verified by Underwriters Laboratory (UL), the firmware-based voltage control solution was shown to prevent any utility energy from being imported to the battery from the grid. While this deployment marks the first approved product, other NEM-compliant inverter and energy storage products may take advantage of using the developed firmware solution and UL testing protocol approved by the CPUC decision.

At the same time, the firmware makes it possible for solar energy to be stored and managed by energy management software, enabling the stored solar generation to be used for either self-consumption or export to the grid for the most valuable NEM credits possible.

After CPUC' NEM Storage Decision



Advantages:

1) Only 1 inverter
2) Only 1 DC-AC inversion pass
3) Full ITC compliance for entire PV+storage project
4) No complex metering of relaying projection needed
5) PV system size not constrained; overall system size determined by inverter's AC rating
6) Battery prevented from charging via grid power with inverter firmware

Figure 2: DC-coupled designs after the CPUC NEM decision. (The previous design and verification challenges of AC-coupled energy storage systems remain.)

In effect, the firmware solution allows solar-plus-storage DC-coupled systems to receive the same or even better NEM financial benefits as compared with a standard PV system—without requiring additional metering, inverters, relay hardware or delayed interconnections with the local utility company. The firmware solution facilitates enhanced NEM financial benefits compared with standard solar PV, since the solar-plus-storage firmware solution lets customers install larger systems as well as export-stored solar energy into the grid for peak NEM credits at time-of-use (TOU) rates that are more valuable to the customer.

A NEXTracker NX Flow™ integrated solar-plus-storage system. Image: Courtesy of Ideal Energy

From a technical standpoint, the firmware solution is verifiable by UL and other third parties. Utilities and regulators prefer to have a neutral, independent party review a product and verify its compliance to codes and standards, such as a firmware standard, thus making the firmware solution verifiable from both functional and regulatory compliance standpoints. UL can review and verify that the appropriate inverter firmware is in place at the time the product is certified, ensuring that regulators can confirm the firmware will function as intended without requiring further on-site verification. Unlike "software," firmware cannot be updated remotely.[1]

[1]In addition to the approved firmware decision, the CPUC may allow a software-based option, but it is contingent upon the CPUC determining that utility communication infrastructures are capable of communication with Rule 21 Phase II and Phase III communication-compliant inverters. This verification may take months or longer to verify. The CPUC also expects that UL will eventually create a new standard for the UL-verified inverter firmware solution, which will eventually replace the current testing protocol developed by NEXTracker with SepiSolar and the three major California investor-owned utilities.

WHAT THIS DECISION MEANS FOR STAKEHOLDERS

As a result of the CPUC modification, commercial customers combining storage with solar PV systems can now decide when to export either solar or battery power into the utility's grid and take advantage of NEM credits for 100% of the power exported. End-users can also leverage these benefits for NEM tariffs, including NEM-A and NEM-V. This decision should provide a major boost for agriculture and multifamily customers that frequently have aggregated (or virtual) meters.

'Super-Sized' Solar Systems

Because the DC-coupled solar-plus-storage system size is measured by the inverter's AC nameplate rating, DC solar systems can now be "super-sized" to exceed the 1 MW limit on NEM. Any excess generation over 1 MW may be stored in the DC battery, while up to 1 MW of power can be exported into the grid at favorable or optimized NEM tariffs. Thus, a 1 MW stand-alone solar system can be increased to 2.8 MW with a complementary DC-coupled 1.8 MW storage system and a 1 MW AC inverter that has the new firmware.[2]

This type of design also results in the PV system serving as a sort of baseload, since the 1 MW inverter will operate at its peak rating for a greater number of hours throughout the day than previously possible. When the solar-plus-storage system is large enough, this baseload effect can span multiple hours, even sometimes across the entire peak demand period. This helps to calculate demand charge savings without having to analyze 15-minute interval data, which can be challenging because of a random and stochastic demand profile. Furthermore, NEM-compliant battery and inverters will be able to scale with the solar system to manage clipping, while customers can financially benefit from the most valuable TOU NEM credits.

Utility Infrastructure Deferral

Another benefit to end-users and developers is that the DC-coupled solar-plus-storage firmware solution enables significant project savings from utility infrastructure deferral.

For example, a dairy farmer in Bakersfield, CA, has a 2.2 MW_{DC} system layout, but the system designer discovers that, after waiting three months in the utility's interconnection application review process, the utility substation is only rated at 750 KW_{AC}.

To keep the 2.2 MW_{DC} system, the dairy farmer would have to upgrade the substation to the appropriate rating, often at substantial cost. As a result of these extra costs, the solar system is

[2]Note that the figures quoted in this example are for illustration purposes only; real numbers will vary with storage technology, roundtrip efficiency specifications, energy storage product configuration and system architecture.

typically downsized to 750 KW_{AC} to meet the infrastructure restrictions, reducing the dairy farm's energy savings and ROI.

With the new DC-coupled firmware, a storage system can capture the excess energy that would normally be lost due to clipping on the 2.2 MW_{DC} PV system through the 750 KW_{AC} point of interconnection. The new DC-storage system configuration provides the farmer with the following benefits:

- Demand charge reduction
- TOU arbitrage
- A super-sized 2.2 MW_{DC} PV system (by keeping the AC export at or below 1 MW)
- Elimination of utility infrastructure upgrade costs

In every use case that has been reviewed so far, the amount of additional savings provided by the storage far exceeds the cost of the storage system, thereby potentially increasing project revenues, margins and internal rates of return (IRRs).

Reduced Equipment Costs

Instead of having to use expensive and time-consuming AC-coupled configurations, developers can increase ROI and payback to their customers with a DC-coupled NEM option that significantly reduces the equipment costs by tens of thousands of dollars, eliminating the need for additional meters, switchgear, relays and a second inverter.

Simplified ITC Verification for Tax Equity Investors

Additionally, inverters and storage equipment with this UL-verified feature make it more likely that the ITC benefit will be recognized for solar-plus-storage systems. By design, the firmware necessarily controls and verifies that 100% of the energy going into the battery was generated by the solar system. This avoids expensive and lengthy measurement and verification processes that are required for AC-coupled systems, mitigating tax equity risk in the project. This development also creates an opportunity for inverter and energy storage manufacturers to bring NEM-compliant products to the California DC-coupled commercial storage market.

While this testing and verification process can be convoluted, engineers are available to help OEMs upgrade existing Rule 21 inverters to quickly meet the new standards without violating any pre-existing certifications. Through this program commissioned by NEXTracker, a collaborative precedent has been set with UL on these specific verifications, enabling OEMs to gain approvals in a matter of weeks.

SUMMARY

Following CPUC's final approval for the modification of Decision 14-05-033, DC-coupled solar-plus-storage is eligible for NEM for the first time in California. The agreed-upon inverter firmware option represents a compelling opportunity for commercial solar-plus-storage stakeholders and OEMs. Developers, asset owners and end-users can benefit from NEM tariff rates, reduced installation costs and increased ROI. Tax equity investors can also be more certain their solar-plus-storage projects comply with IRS interconnection regulations for the ITC. The solution also mitigates or eliminates infrastructure upgrades for accommodating more solar on the grid. Finally, inverter and energy storage OEMs have a promising formula to modify their California storage inverter systems to meet the decision's requirements and help accelerate installations of larger solar PV systems. Utilities benefit from the decision as well, since they have assurance that solar-plus-storage owners cannot profit from charging their storage systems from the grid and selling that power back to the utility at a higher NEM rate.

A NEXTracker's NX Flow integrated solar-plus-storage system with DC-coupled NEM energy storage. Image: Courtesy of Ideal Energy

For questions or comments about the content of this white paper, please contact:
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