stem

Designing California Solar + Storage Projects for Maximum ROI Under NEM 3.0

Leveraging AI-driven modeling and battery storage to capture solar value

September 2023

Introduction

Net energy metering (NEM) has catalyzed tremendous growth in California's customer-sited renewables, especially solar. A feature of the state's electricity landscape since the mid-1990s, NEM is how customers get compensated for the renewable energy they export to the grid.

To incentivize solar adoption, California initially credited NEM customers at the full retail electricity rate; in effect, a customer's monthly utility bill simply reflected the net energy they consumed from the grid. With attractive payback periods and intuitive bill credits, NEM proved very successful in driving rooftop solar and building a thriving industry.

While NEM 3.0 complicates solar development, new modeling tools and battery storage solutions offer outsized rewards

Now, California faces a new challenge: a shortage of clean energy when it's needed most – typically in the late afternoons and early evenings when solar generation dies down. The state also has a relative oversupply of clean electricity during the day. Its proposed solution, in theory, is simple: pay more for clean energy when it's more valuable and less when it's less valuable.

NEM 3.0 is part of California's effort to compensate distributed renewables in line with their dynamic value to the power system, as that value is understood by the California Public Utilities Commission (CPUC). It is a fundamental departure and overall drastic reduction from solar compensation under earlier NEM iterations. And while it undoubtedly complicates new distributed solar projects, it offers outsized rewards to developers who leverage the tools and solutions needed in a NEM 3.0 world.

This Stem whitepaper provides an in-depth look at how NEM 3.0 changes the landscape for new solar + storage projects in California – and how **battery storage and AI-driven modeling are key to maximizing solar ROI going forward.**

The Challenge of NEM 3.0

Net energy metering has helped to make California's solar market the largest in the United States. At first quarter-end 2023, the state had more than 13 gigawatts (GW) of net-metered solar deployed across nearly 1.2 million customer sites.[1] The vast majority of these projects were built in the last decade.

While this growth is encouraging, California still needs much more solar. According to California state agencies, a total of 12.5 GW of distributed solar and nearly 17 GW of utility-scale projects must be deployed between 2021 and 2030 for the state to be on track to achieve its clean electricity goals.[2]

Given this challenge, many found the CPUC's decision to cut solar export compensation under NEM 3.0 perplexing. While businesses are less exposed to this change than homes, who typically send more solar to the grid, understanding how California values solar – and how it has elevated battery storage – is essential for maximizing ROI from commercial and industrial (C&I) projects.

How NEM changed

Under NEM 3.0, solar export compensation is completely unrelated to a customer's electricity rate. Instead, solar will be compensated at the hourly value it offers the grid as determined by the CPUC. During midday hours, this value is often close to zero (and can be literally zero). But for a few hours per year, particularly in late summer evenings, it climbs up to nearly $3 per kilowatt-hour (kWh). Figure 1 shows illustrative values for weekday solar export compensation in PG&E territory for 2023.

NEM 3.0 is a fundamental departure and overall drastic reduction from solar compensation under earlier iterations

[1] California Distributed Generation Statistics, "Statistics and Charts," accessed June 15, 2023, https://www.californiadgstats.ca.gov/charts/.
[2] California Energy Commission, "2021 SB 100 Joint Agency Report, Achieving 100 Percent Clean Electricity in California: An Initial Assessment," published March 15, 2021, updated September 3, 2021, accessed June 15, 2023, https://www.energy.ca.gov/publications/2021/2021-sb-100-joint-agency-report-achieving-100-percent-clean-electricity.

2023 Weekday Base Export Compensation

Hour of Day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	0.053	0.056	0.051	0.052	0.056	0.054	0.054	0.061	0.062	0.057	0.054	0.051
2	0.053	0.056	0.048	0.047	0.050	0.049	0.051	0.054	0.053	0.050	0.057	0.050
3	0.051	0.056	0.050	0.048	0.052	0.050	0.052	0.053	0.052	0.051	0.054	0.049
4	0.051	0.055	0.050	0.047	0.051	0.051	0.050	0.053	0.051	0.050	0.053	0.049
5	0.051	0.056	0.050	0.048	0.051	0.052	0.050	0.052	0.051	0.050	0.054	0.048
6	0.053	0.057	0.052	0.049	0.055	0.050	0.051	0.053	0.051	0.050	0.056	0.051
7	0.056	0.058	0.052	0.050	0.053	0.052	0.053	0.053	0.053	0.051	0.058	0.056
8	0.057	0.060	0.053	0.040	0.036	0.052	0.054	0.055	0.053	0.052	0.061	0.061
9	0.055	0.048	0.047	0.014	0.018	0.045	0.050	0.056	0.049	0.051	0.048	0.055
10	0.048	0.031	0.028	0.009	0.007	0.038	0.050	0.055	0.040	0.043	0.046	0.048
11	0.046	0.026	0.017	0.011	0.011	0.037	0.050	0.055	0.040	0.043	0.041	0.045
12	0.046	0.028	0.019	0.008	0.012	0.039	0.050	0.055	0.041	0.043	0.037	0.042
13	0.045	0.027	0.018	0.004	0.009	0.039	0.050	0.055	0.041	0.043	0.038	0.042
14	0.044	0.028	0.018	0.002	0.008	0.041	0.049	0.056	0.042	0.044	0.039	0.043
15	0.046	0.029	0.017	0.001	0.008	0.088	0.051	0.060	0.046	0.047	0.042	0.046
16	0.052	0.041	0.022	0.001	0.009	0.143	0.060	0.117	0.058	0.099	0.069	0.059
17	0.061	0.062	0.034	0.006	0.019	0.207	0.075	0.133	0.119	0.120	0.067	0.063
18	0.063	0.062	0.056	0.024	0.038	0.225	0.213	0.315	0.139	0.167	0.070	0.067
19	0.066	0.064	0.065	0.064	0.068	0.285	0.227	0.499	2.654	0.126	0.071	0.069
20	0.065	0.064	0.075	0.072	0.074	0.251	0.226	0.727	2.996	0.126	0.068	0.069
21	0.062	0.063	0.075	0.090	0.088	0.195	0.134	0.340	0.215	0.072	0.065	0.067
22	0.059	0.061	0.065	0.068	0.076	0.088	0.092	0.281	0.090	0.066	0.062	0.065
23	0.056	0.059	0.057	0.060	0.062	0.074	0.083	0.192	0.082	0.059	0.060	0.057
24	0.055	0.058	0.051	0.056	0.057	0.058	0.055	0.061	0.062	0.054	0.057	0.055

Figure 1. Illustrative base solar compensation in PG&E territory for weekdays in 2023 (Source: CALSSA)

The tool that determines export value is the Avoided Cost Calculator (ACC), which is updated annually and modified significantly every two years.[3] The ACC averages hourly values across days in a month and differentiates between weekdays and weekends, so that a given hour (e.g., 4-5pm) has the same value for all weekdays in a given month.[4]

Overall, NEM 3.0 – or the Net Billing Tariff, as it is known – is expected to reduce solar customers' compensation for providing electricity to the grid by about 75%. Most of the time, solar export values will be below (and sometimes well below) customers' retail electricity rates.

Implications of NEM 3.0

Sharply reducing export values during peak solar production creates a strong signal to pair solar with storage

For new California distributed solar projects, the more plentiful solar generation is relative to site load, the less these projects stand to earn. This turns traditional project economics on its head. Here are three key takeaways for new C&I solar projects under NEM 3.0:

- **Impacts will vary.** Stem's modeling finds differential impacts for new C&I projects under NEM 3.0, depending on system size and load profile. Some that would see a large reduction in IRR from previous NEM versions will be able to make up for lost export revenues with battery storage. Others will simply see lower returns, with projects having higher export percentages obviously being more exposed to value loss.
- **Batteries are key.** Sharply reducing export values during peak solar production creates a strong price signal to pair solar with storage. Batteries enable customers to store and consume the solar they generate ("solar self-consumption") and cash in on opportunities to supply the grid during high-priced hours. Correspondingly, storage attachment rates with new solar projects are expected to climb.
- **Modeling is essential.** As we discuss throughout, California's Net Billing Tariff is highly complex, with export rates that vary widely across hours, days, and years. To be profitable, new projects must effectively co-optimize onsite solar consumption alongside exports during peak hours. Accurately modeling solar + storage systems and the context in which they will operate is a key step in mitigating project risk and maximizing ROI.

The remainder of this whitepaper drills down on each of those findings to provide more granular insights about designing successful solar + storage projects for California C&I customers under NEM 3.0.

[3] The ACC is meant to reflect utilities' marginal costs of serving customers; any resource (e.g., distributed solar) below this cost by definition benefits the grid. For more, see: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/demand-side-management/acc-models-latest-version/2022-acc-documentation-v1a.pdf.

[4] For C&I customers, ACC values will be locked in for five years and float annually thereafter. Customers can also opt out of the lock-in period.

Designing Projects for Maximum ROI

To assess the impact of NEM 3.0 on end-users, we looked at the impacts of the NEM 3.0 tariff in SCE across 4 load profiles: Industrial, Large Warehouse, Big Box, and School. Using Stem's proprietary simulation application, Athena Analyzer, we also drilled down to see the impact that storage has on overall system savings as shown in Table 1.

Table 1: Impact of storage on overall system savings

Sites Assessed

Load Type	Site Peak Demand kW	Annual Energy Use kWh	PV Size kW_{DC}	Annual PV Export (kWh) before storage	ESS Size kW / kWh
Industrial	2501	15,154,688	3200	360,805	1205 / 2409
Large Warehouse	2931	17,588,967	8590	6,189,735	2890 / 5781
Big Box	700	12,874,616	723	105,017	642 / 1285
School	355	2,167,870	332	315,971	500 / 1019

Savings Results

Load Type	Solar Savings NEM 2 → NEM 3	Percent Change	Storage Savings NEM 2 → NEM 3	Percent Change
Industrial	-$34,893.67	-3.87%	$83,200.28	26.79%
Large Warehouse	-$719,103.11	-30.05%	$268,424.19	74.26%
Big Box	-$9,473.56	-4.42%	$27,383.63	31.77%
School	-$26,509.23	-28.46%	$60,431.32	150.50%

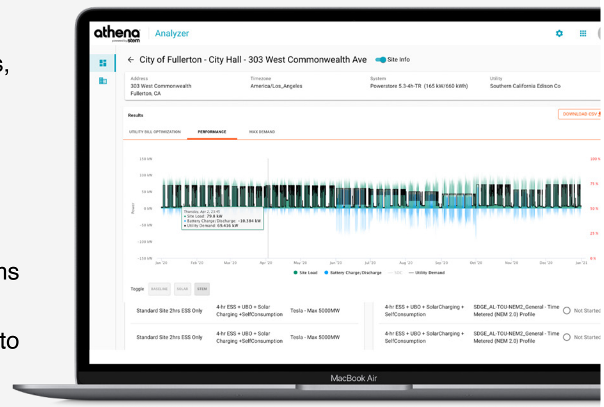
The impact on solar savings from NEM 3.0 compared to NEM 2.0 is negative across all load types. The worst impacts occur for the Warehouse and School load profiles, which see a >25% decrease in solar savings. Warehouse and School have the most amount of PV export prior to adding storage, so it makes sense that NEM 3.0 has the most detrimental impact to these load profiles. Conversely, Industrial and Big Box loads are large enough relative to solar generation that solar export is limited to begin with. The impact of the reduced value of solar export is small, at less than 5% decrease in savings.

Although School projects have the biggest decrease in solar savings under NEM 3.0, they have the most to gain by adding storage. Storage savings increase by over 150% for these load profiles! Energy storage helps to avoid the negative impacts from the transition to NEM 3.0 by reducing export from solar when it's less valuable and instead charging the system to reduce demand and energy charges later in the evening when energy and demand charges are highest. These savings are compounded when the storage system is able to export during the most valuable time periods under NEM 3.0, summer evenings, which also coincide with the lowest energy usage time periods for schools.

For an example of the incremental value of storage under NEM 3.0, we look at the school system performance over the course of a September day in Athena Analyzer as shown in Figure 2; Figure 3 shows tariff rates for a summer weekday school load profile under the SCE TOU-GS-3-E tariff for NEM 3.0. We can see that the facility load peaks around noon. The ESS starts charging around 6am and continues charging at varying levels to soak up the extra PV that no longer receives favorable export rates under NEM 2.0. In addition to minimizing export, the energy storage system (ESS) maintains a facility demand setpoint of around 25 kW throughout the day. Afterwards, the battery discharges in the evenings when solar production wanes and the grid peak rises, between 4-9pm. This maximizes energy arbitrage savings by mitigating the effects of higher energy rates during this time period and maintaining peak demand savings with a 0 kW setpoint. These examples are pulled from the performance of the system during the week in September, when the export rates under NEM 3.0 are highest. When the battery is able to export alongside the solar, the savings in September increase exponentially because the battery can prioritize charging for those key moments when rates reach almost $3 / kwh as shown in Figure 4.

Athena® Analyzer™ is Stem's proprietary project valuation tool. With artificial intelligence (AI) driving best-in-class revenue modeling simulations, Analyzer provides a realistic window into how solar + storage and standalone storage systems will perform financially over time.

Analyzer is part of Athena, Stem's trusted enterprise platform that unlocks flexibility across the clean energy value chain. Analyzer's simulations take into account system operational requirements and all possible value streams – including utility bill optimization, incentives, demand response, wholesale market revenues, system performance optimization, and energy savings – to help you design projects for maximum ROI.



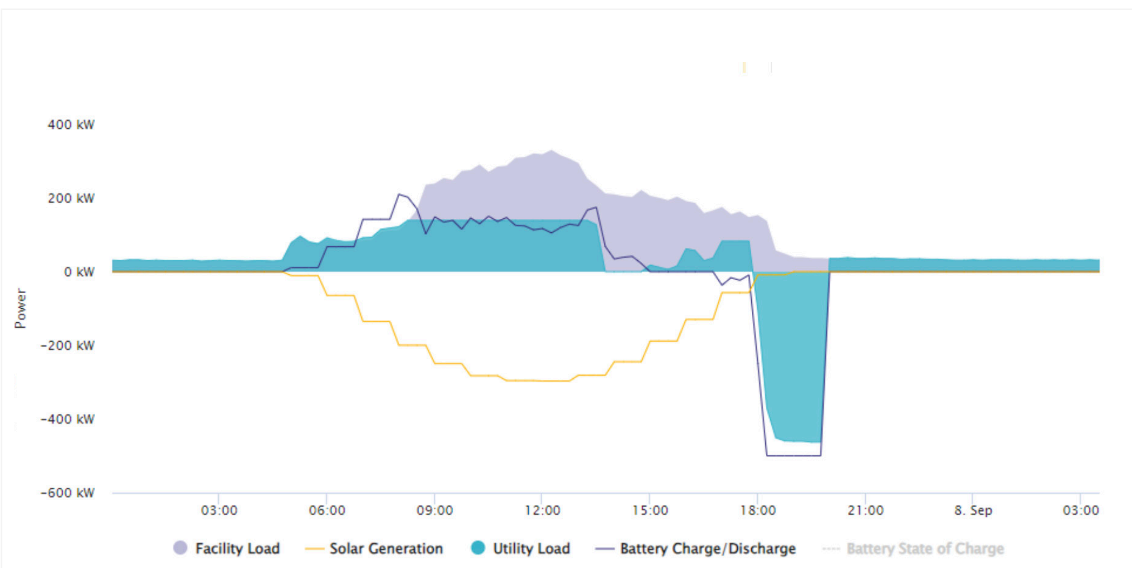


Figure 2. Depiction of a summer weekday performance cycle for a school load profile under NEM 3.0 as displayed in Athena Analyzer

Facility Load = Utility Load - battery - solar
Solar Generation = Conversion of energy from sunlight into electricity
Utility Load = Point of interconnection meter reading, no calculation here just a direct reading of the meter
Battery Charge/Discharge = The process of a battery increasing or losing voltage, or energy
Battery State of Charge = The amount of available energy in a battery at a given time relative to its capacity

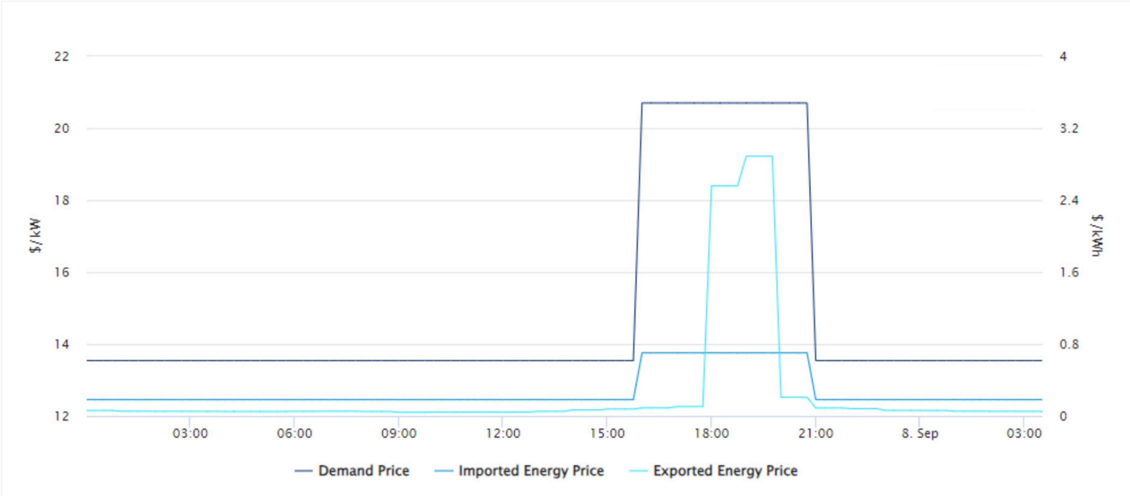


Figure 3. Tariff rates for a summer weekday school load profile under the SCE TOU-GS-3-E (B 2kV) tariff for NEM 3.0 as displayed in Athena Analyzer

Demand Price = The maximum power demand is multiplied by the demand charge rate of the prevailing utility rate
Imported Energy Price = The active energy (in terms of kwh) imported from the grid by a solar power plant
Exported Energy Price = The proportion of the renewable energy that is exported from on-site renewable generation to the energy grid

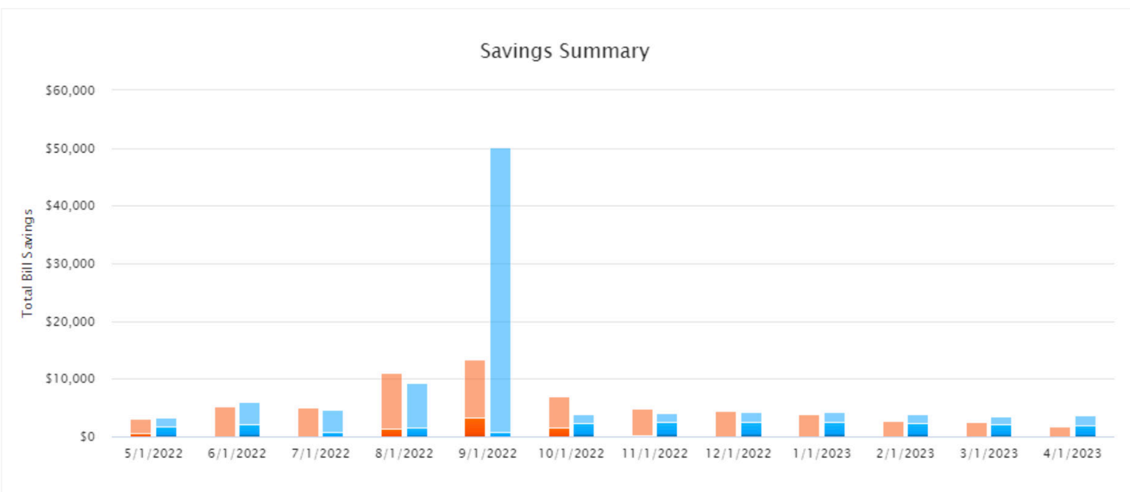


Figure 4. Annual solar and storage savings for a school load profile under the SCE TOU-GS-3-E (B 2kV) tariff for NEM 3.0 as displayed in Athena Analyzer.

Conclusion

Three critical insights emerge in the context of NEM 3.0's impact on new commercial and industrial (C&I) solar projects in California. Firstly, Stem's analysis underscores the diverse implications of NEM 3.0 for such projects, contingent upon factors like system size and load profile. This means that while some sites might experience significant reductions in returns, others could offset the loss of export revenue by incorporating battery storage, a vital strategy for sustaining value.

Secondly, the significance of battery integration becomes evident under NEM 3.0. As the tariff drives down export values during peak solar production, the importance of battery storage intensifies. Batteries facilitate the consumption of self-generated solar energy and supply excess power to the grid during periods of peak demand, ultimately contributing to the projected rise in storage attachment rates for new solar undertakings, particularly when enabled for export.

Lastly, the importance of accurate modeling comes to the forefront. Navigating the intricacies of California's Net Billing Tariff demands precise modeling to optimize both onsite solar consumption and export activities during peak hours. This strategic approach mitigates project risks and amplifies ROI by ensuring the seamless operation of solar + storage systems.

For an in-depth assessment of the effects of NEM 3.0 on your solar + storage projects, contact your Stem representative and explore the capabilities of Athena Analyzer for thorough project evaluation.

Your California Solar + Storage Project

NEM 3.0 is only the latest chapter in California's ongoing trend toward reducing compensation for distributed solar. For years, battery storage has been key to future-proofing solar against such changes. Under NEM 3.0, storage has become even more important in California, as have the modeling tools that help maximize ROI.

Stem pioneered energy storage in California more than a decade ago, and was the first to serve C&I customers in California and many other markets. Through our Stem Partner Program, we help hundreds of channel partners realize a broad range of successful solar + storage and standalone storage projects. Our expert teams and capabilities support partners from the earliest project discussions through development, commissioning, and operation.

With 30+ million run-time hours across more than a decade of experience, Athena is Stem's trusted enterprise platform that unlocks flexibility across the clean energy value chain. Our Athena Analyzer application offers best-in-class site simulation and revenue modeling capabilities so projects can maximize ROI in California and all energy storage markets.

To learn more about how Stem can help you realize successful clean energy projects in California and elsewhere, contact your Stem representative or visit us at www.stem.com today.

About Stem, Inc.

Stem (NYSE: STEM) is a global leader in AI-driven clean energy solutions and services.

Stem (NYSE: STEM) provides clean energy solutions and services that maximize the economic, environmental, and resiliency value of energy assets and portfolios. Stem's leading AI-driven enterprise software platform, Athena® enables organizations to deploy and unlock value from clean energy assets at scale. Powerful applications, including AlsoEnergy's PowerTrack, simplify and optimize asset management and connect an ecosystem of owners, developers, assets, and markets. Stem also offers integrated partner solutions that improve returns across energy projects, including storage, solar, and EV fleet charging.

For more information, visit www.stem.com.

101323