ENPHASE

Comprehensive solution maximizes customer ROI under net billing tariff (NEM 3.0)

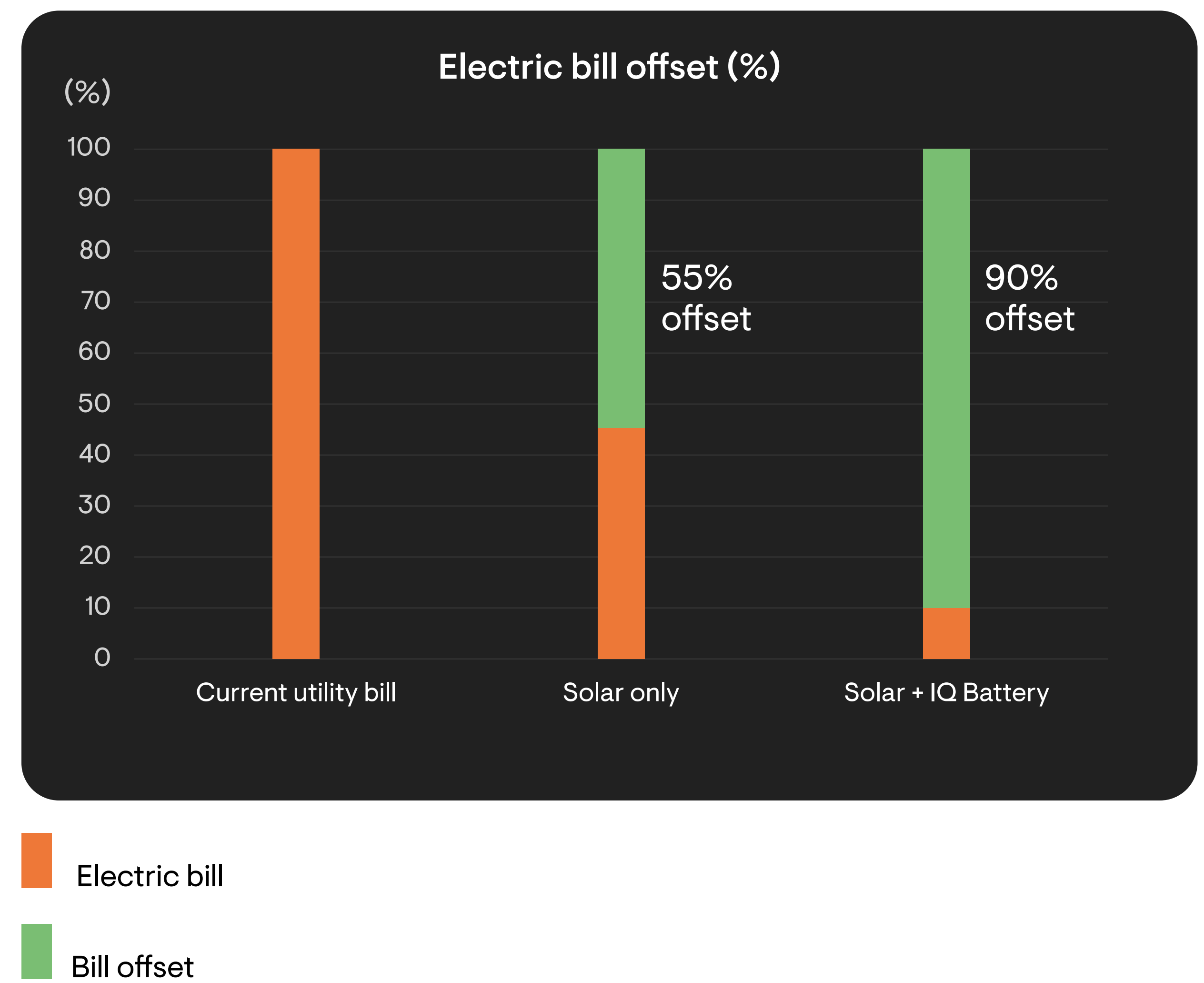
Contents

1. Introduction

California's new Net Billing Tariff (NBT), or NEM 3.0, is the successor tariff to NEM 2.0. NEM3.0 incentivizes customers to move from the installation of solar-only systems to solar + battery systems. This evolution of residential solar systems from NEM 2.0 to NEM 3.0 was motivated by the need to match energy supply and demand in the grid through the creation of a market-driven tariff structure.

Enphase has developed a comprehensive solution that can improve homeowner ROI under the NEM 3.0 tariff mechanism. In Section 3, we will show that adding a small grid-tied battery to a solar system can significantly improve the homeowner's electric bill offset from 55% for solar only systems to 70%–90%, while delivering a payback period of about 5 to 7 years. We will also show that this solution is very easy to design, install and commission.

Homeowners will still have a choice to opt for a larger solar and battery system that improves payback under NEM 3.0 as well as provide backup power when the grid fails.



Refer to Section 3 for more details.

1.1 Background

Under NEM 2.0, solar systems that sell excess energy during the day are compensated at near retail rates. On the other hand, buying energy from the grid is governed by Time-of-Use (ToU) rates.

Under NEM 3.0, solar systems that sell excess energy to the grid, in the middle of the day, are poorly compensated, at near wholesale rates. However, selling energy during certain periods of the year, when demand on the grid is high, the compensation is also very high. Similar to NEM 2.0, buying energy from the grid continues to be governed by ToU rates. It is expected that over time, the spread between Peak and Off-Peak rates will continue to widen.

The result of the time varying value of buying and selling energy from the grid economically incentivizes homeowners to store the excess solar they generate in the middle part of the day and consume it during late afternoon or early evening peak demand periods. In addition, the rate incentivizes homeowners to export energy during high compensation periods. The table below shows the rates at which you buy energy from the grid. As you can see, buying energy from the grid during summer peak periods is very expensive and hence should be avoided. For example, in PG&E territory, the summer peak rate is $0.546/KWh and SDG&E territory, the summer on-peak rate is $0.816/KWh.

PG&E E-ELEC		
Summer	Peak	0.546/KWh
	Part-Peak	0.385/KWh
	Off-Peak	0.328/KWh
Winter	Peak	0.315/KWh
	Part-Peak	0.293/KWh
	Off-Peak	0.279/KWh
Monthly Fixed Charges		$15.00

SCE TOU-D-PRIME		
Summer	On-peak	0.622/KWh
	Mid-Peak	0.364/KWh
	Off-Peak	0.242/KWh
Winter	On-peak	0.565/KWh
	Mid-Peak	0.222/KWh
	Off-Peak	0.222/KWh
Monthly Fixed Charges		$14.00

SDG&E EV-TOU-5		
Summer	On-peak	0.816/KWh
	Off-Peak	0.481/KWh
	Super-Off-Peak	0.154/KWh
Winter	On-peak	0.511/KWh
	Off-Peak	0.448/KWh
	Super-Off-Peak	0.145/KWh
Monthly Fixed Charges		$16.00

The sample table below shows PG&E's rate at which energy can be sold back to the grid under NEM 3.0. This is an average of all hours in the month. The export rate for every hour for the entire year has been prescribed. There is a total of 8,760 hours (24 hrs x 365 days) available. Selling energy to the grid in the middle of the day when the grid has sufficient energy supply will result in significantly lower compensation. In addition, under NEM 3.0, if a homeowner sells energy at certain times of the day, during certain months of the year when the demand on the grid is significantly higher, the homeowner can be very well-compensated. For example, the compensation for selling energy to the grid during certain times can be as high as $2.996/KWh. Homeowners should export as much as possible during these high-rate periods. The rate structure for selling energy to the grid has been published by the California Public Utilities Commission (CPUC) for the entire year, on an hourly basis.

To promote a smooth transition from NEM 2.0 to NEM 3.0, the CPUC adopted fixed "adders" to the hourly export rates during the first five years of the NEM 3.0 tariff. Customers lock in the value of the adder, which steps down by 20% per year, for the entire nine-year term of their NEM 3.0 agreement. The CPUC adopted enhanced adders for low-to-moderate income (LMI) customers compared to non-LMI customers.

The combination of avoiding purchasing energy during peak times and selling energy during certain other peak times can result in a healthy financial return on investment (ROI) for California homeowners. In other words, a home that can self-consume most of the year and intelligently sell energy during certain months of the year can improve the ROI for the homeowner.

2023 Weekday base export compensation (no adders)

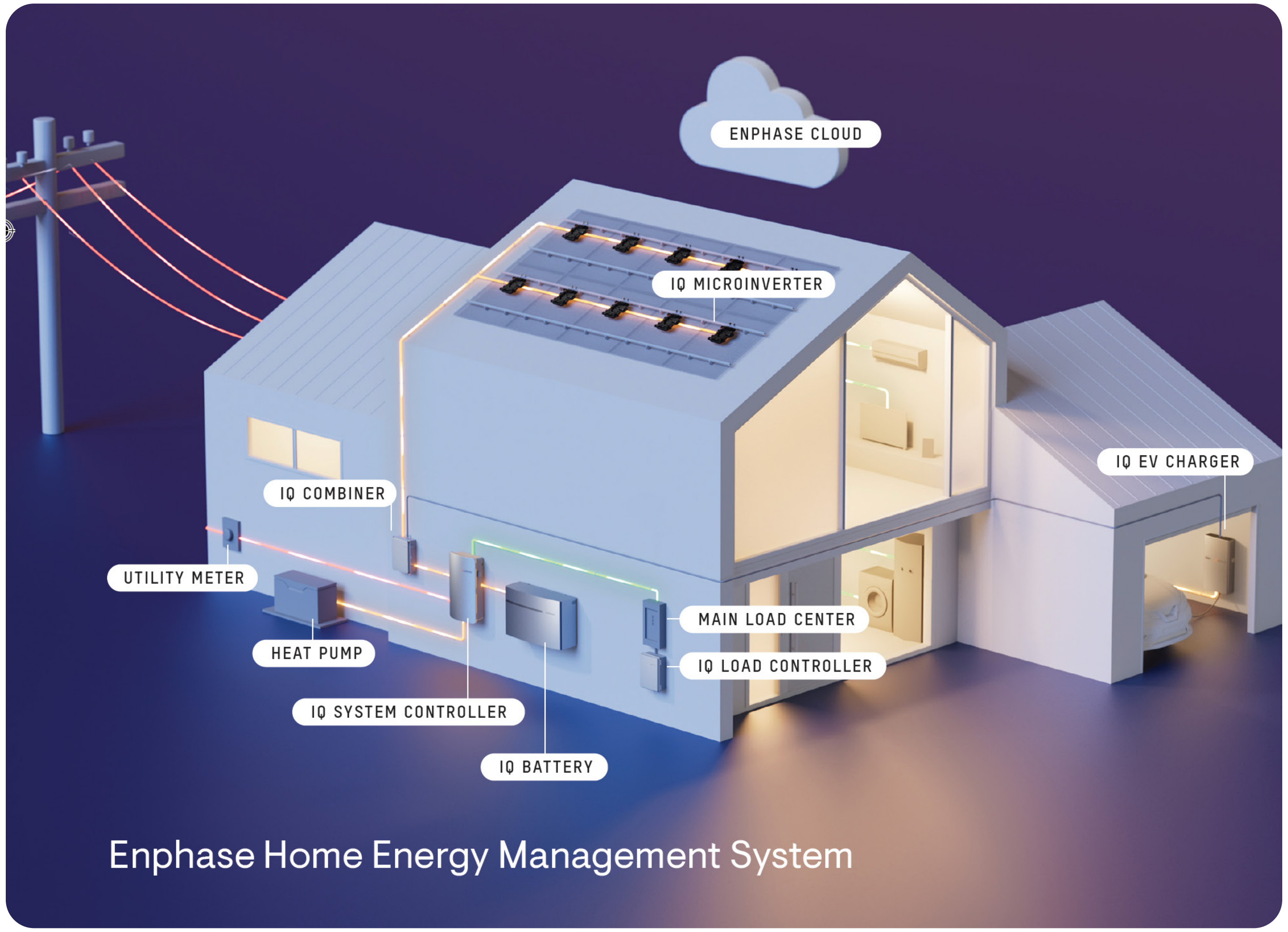
Hour of day	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	0.053	0.056	0.051	0.052	0.056	0.054	0.054	0.061	0.062	0.057	0.054	0.051
2	0.053	0.056	0.048	0.047	0.050	0.049	0.051	0.054	0.053	0.050	0.057	0.050
3	0.051	0.056	0.050	0.048	0.052	0.050	0.052	0.053	0.052	0.051	0.054	0.049
4	0.051	0.055	0.050	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

Source: CPUC and CALSSA

1.2 The Enphase Energy System

There is a strong push towards whole home electrification. This includes adding heat pumps, electric water heaters and most important of all, EVs. This move towards whole home electrification has a significant impact on energy demand. A home that adds 2 EVs and a one heat pump will likely more than double its average daily electric consumption. If the homeowner does not have solar and batteries, then this demand must be met by the grid. Meeting such high demand is going to be extremely challenging for the grid infrastructure to support. For example, the distribution infrastructure may have to be upgraded to support this major increase in both power and energy.

In an environment where the buy rates are variable, such as with ToU, the economic impact on electrification for homeowners can be large. The perfect solution for many homeowners is to add solar and batteries to their homes. This way they can generate their own energy, store, and use it to meet whatever objective they may have – self consumption or electric bill optimization. Such a home will require a very sophisticated energy system with hardware and energy management software. The Enphase Energy System which includes microinverters, batteries and EV chargers, federates the power flow between solar, batteries, appliances, EVs and the utility grid to help maximize ROI for homeowners.



1.3 Comparing ROI under NEM 2.0 and NEM 3.0 for solar-only systems

Under NEM 2.0, there was no compelling reason to add a battery to a solar system other than to provide backup. This meant that the battery was a drag on the ROI for homeowners. If a homeowner installed a solar-only system that was designed to offset by 100% the yearly energy consumption, it would result in an electric bill offset of over 90% and a payback period of about 4 to 5 years, depending on the utility.

Under NEM 3.0, designing a solar-only system with a 100% yearly energy consumption offset will result in an electric bill offset of only about 55% and a payback period of about 6 to 8 years. This is because in a solar-only system, homeowners have no control on when they can use their solar energy. The solar-only system will offset homeowner consumption when there is sufficient solar irradiance, and any shortfall or excess is accounted for by either buying energy from the grid or selling energy to the grid. The problem as stated before is that under NEM 3.0, homeowners are poorly compensated (less than wholesale rates) for selling energy into the grid in the middle of the day when their solar system is producing excess energy.

2. The comprehensive solution for NEM 3.0

Enphase has developed a comprehensive solution to solving the NEM 3.0 problem and restoring homeowner ROI. The comprehensive solution includes:

- Solargraf design and proposal tool that allows installers to model complex interactions between solar, batteries, consumption, and tariff and provide a simple proposal
- Microinverter based solar system
- Grid-tied or grid-agnostic battery with smart charging and discharging
- Power control system to help avoid main-panel upgrade
- Energy management system with forecasting and optimization

The addition of a smart IQ EV Charger which can be intelligently controlled to avoid charging during peak ToU rates can further improve the ROI for the homeowner. This comprehensive Enphase solution is all managed and controlled by an energy management system and can be viewed by the homeowner on their Enphase App.

2.1 The evolving role of the battery

Historically, batteries have primarily been used to provide backup power to the home during a grid failure. Under NEM 3.0, the role of the battery has expanded to provide a buffer to manage solar's intermittency and the varying buying and selling rates of energy to deliver better economics for homeowners. This means that the configuration of the battery, balance-of-system requirements, and cost of installation all change depending on the use case.

For backup, batteries must be capable of starting heavy loads such as air conditioners, electric water heaters, etc. during off-grid operation. Typically, backup systems have larger batteries to support the longer duration of outages. They are also configured to hold a reserve capacity of 20% to 30%. The balance-of-system requires safety devices such as a System Controller/MID and installation requires a significant amount of work in the main panel. The additional components and labor needed to install these systems make them expensive.

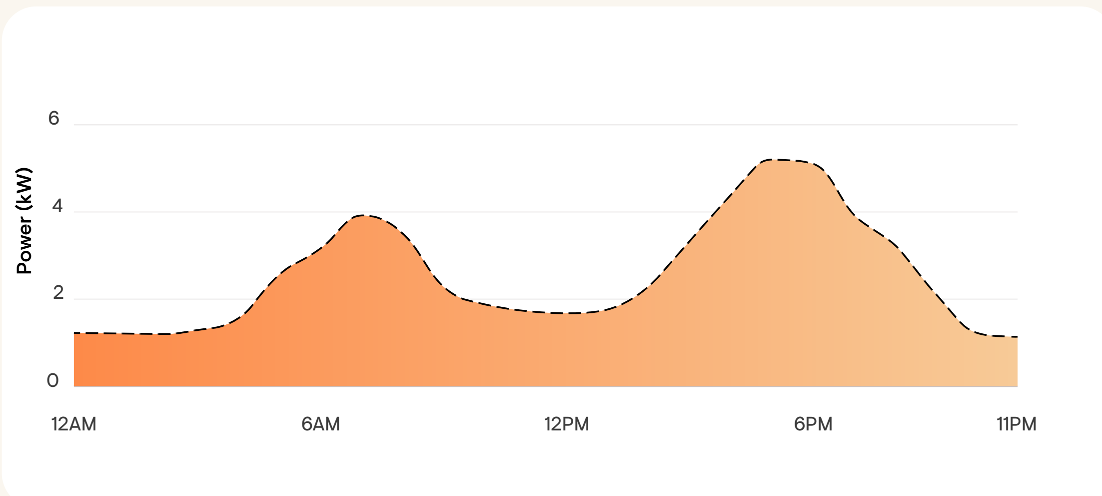
On the other hand, if the battery is only used to provide a buffer to manage solar's intermittency and the varying buying and selling rates of energy from the grid, the battery configuration, balance-of-system, and installation can be much simpler. The battery can be a grid-tied battery, like solar. Furthermore, the battery can be set at almost 0% reserve capacity, allowing more of the battery to be used for storing excess solar since the battery does not have to provide any backup. However, this also means that when the grid fails, both solar and the battery will stop operating.

As shown in section 3, adding a small battery to a solar system can significantly improve the economics for homeowners. As a point of comparison, under NEM 2.0, a solar-only system will yield a 90%+ electric bill offset for a 100% kWh offset. Under NEM 3.0, the same system will likely yield only a 55% electric bill offset. The addition of a battery, the size depends on the homeowner's consumption profile, but is generally much smaller than a battery used for backup, can improve the electric bill offset by as much as 70% to 90%. This is a very good ROI for the homeowner.

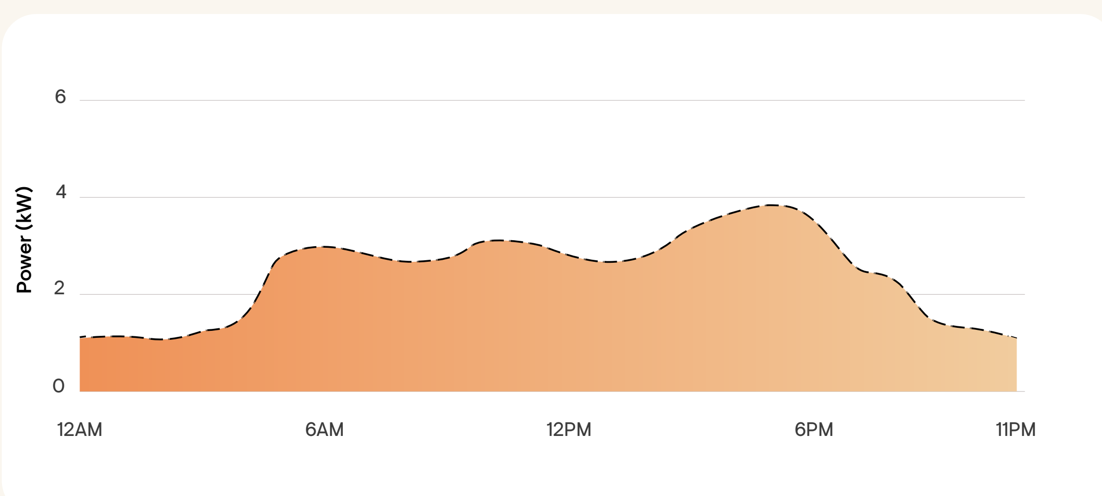
2.2 Consumption profile impacts payback

The consumption profile of homeowners has a big impact on their payback. Homeowners that consume most of their energy later in the day, particularly during peak demand periods, will require a larger battery, and thereby a larger investment, to avoid buying energy from the utility during that time. On the other hand, homeowners that consume most of their energy during the day will require a much smaller battery. These homeowners have two advantages: they consume the energy in the middle of the day when solar is also producing at its highest capacity; thereby they won't need to store much of their solar production or consume much energy during peak demand, which means they do not need large batteries. If homeowners can change their consumption behavior, they can materially impact the payback.

Peaky late evening consumer



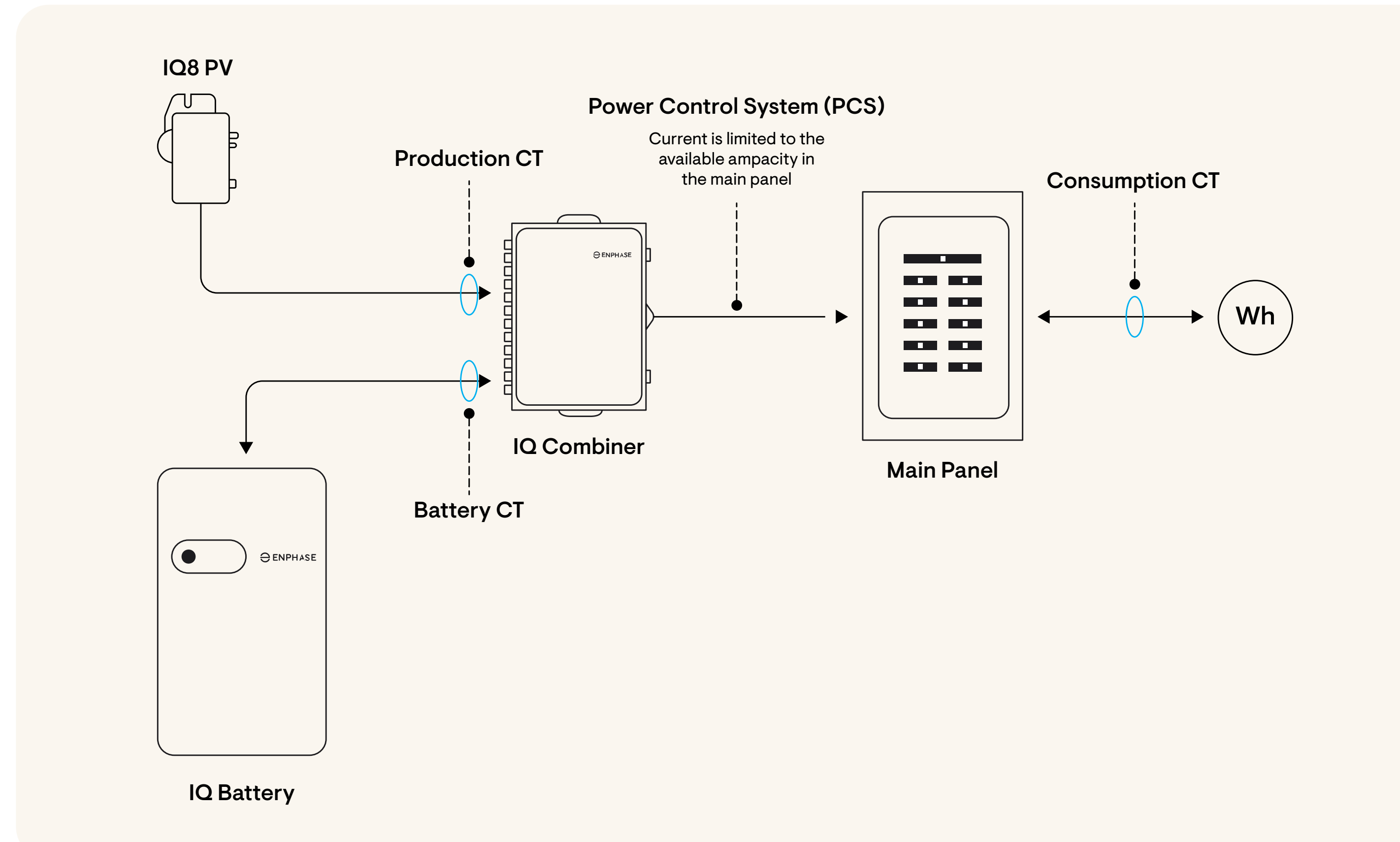
Mid-day consumer



2.3 Grid-tied and grid-agnostic energy system

Under NEM 3.0, battery attach rates will increase significantly. There will be two groups of customers—one that uses batteries to provide backup and the other that uses batteries to improve the economics of solar.

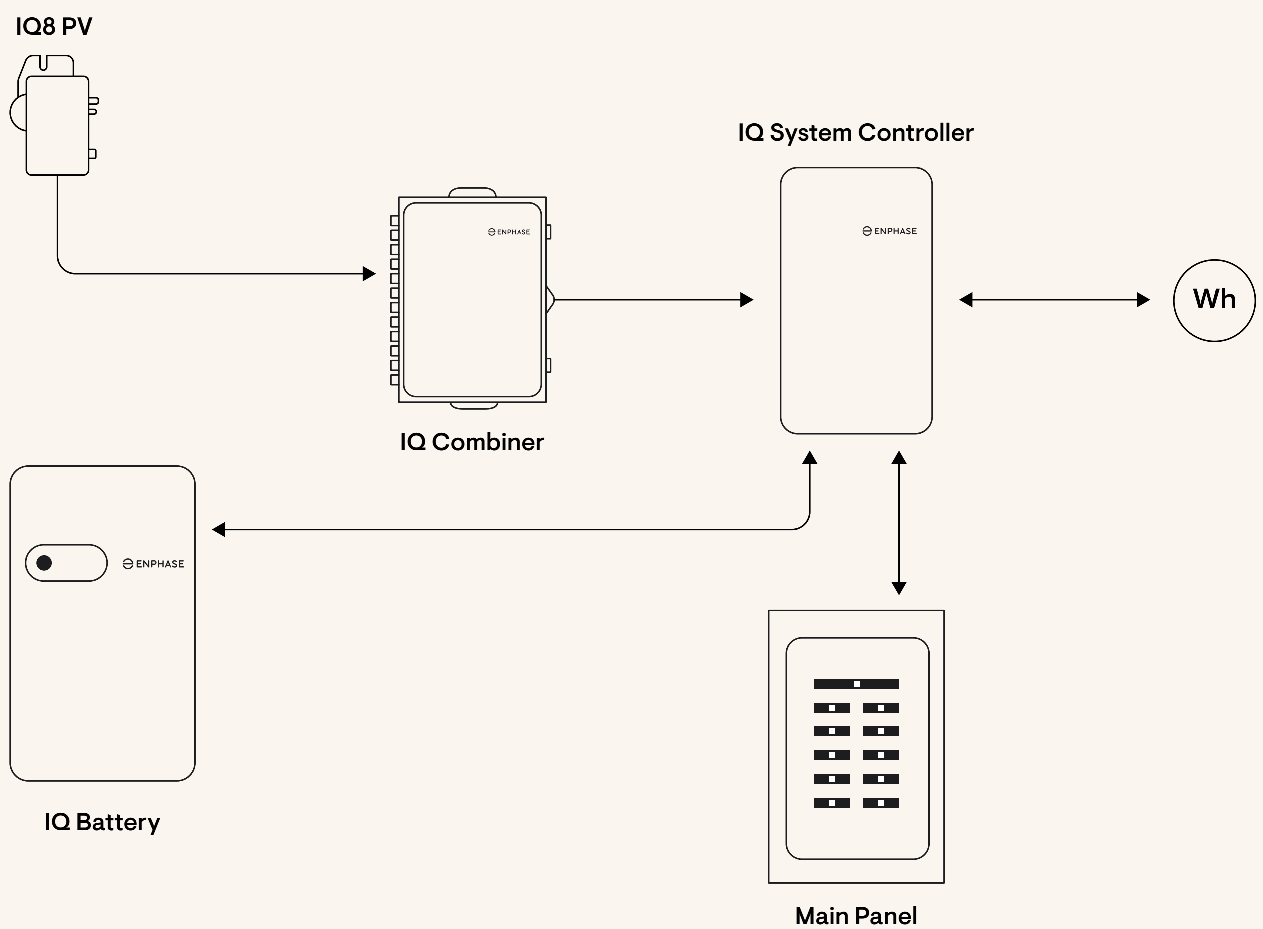
The group of customers that use a battery for improving the economics are expected to have smaller systems that are grid-tied. A typical system could be about 7.68 kW of solar and 10 kWh of battery. Installing these systems is very easy and fast; there is no System Controller/MID or load control to install. There is no need for building a backup panel and moving circuits in the main panel. It is expected that installation and commissioning of an Enphase grid tied battery system will take about one hour. It is important to recognize that this battery system will not provide backup, which means that when the grid fails, the battery will also shut down, along with solar, and that is the tradeoff.



Adding a battery can sometimes trigger a main panel upgrade. With Enphase this can be avoided through a software algorithm called Power Control System (PCS). PCS closely monitors the output from the Combiner Box to ensure that the current is limited to a preset value as determined by the amount of available ampacity in the main panel. This allows for an oversizing of both the solar and battery under the assumption that neither the solar nor the battery will be simultaneously exporting at full rated power. Avoiding a main panel upgrade can save thousands of dollars and further improves the payback.

The second group of customers that have used a battery for backup under NEM 2.0 tend to typically have larger solar and battery systems. Typical systems are closer to 10 kW of solar and almost 20 kWh of batteries. The reason for these larger batteries is because in backup mode, the system must be capable of starting heavy loads such as air conditioners. The design of the system is to optimize the capability to start all loads that are backed up. The good news is that these customers will also benefit under the new NEM 3.0 tariff. The battery will play a dual role – providing better economics as well as backup. These systems will also be more expensive to install since you will need to install a System Controller/MID and load control, build a new backup panel, and in general, move circuits around in the main panel.

Both these customer types can be supported by Enphase with the same battery except for changes in the balance-of-system.



Similar Power Control System features are available in this configuration as well.

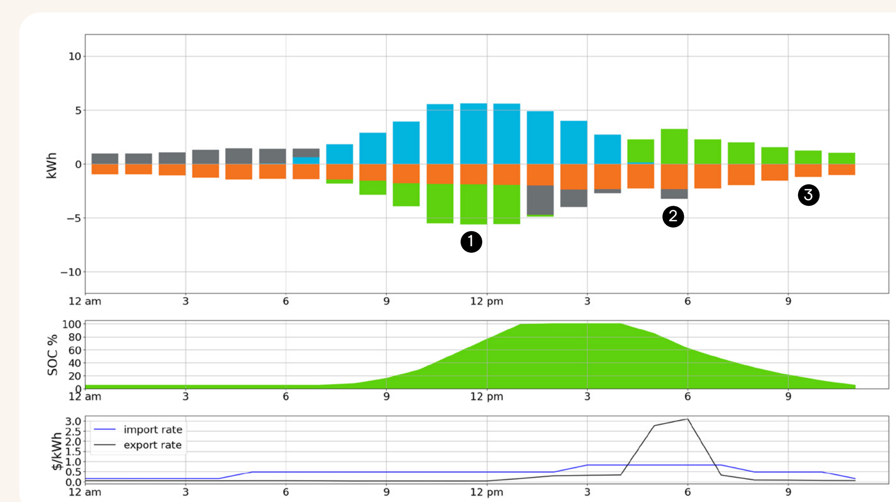
2.4 Self-consumption and savings mode

In both grid-tied and grid agnostic battery configurations, the energy system can operate in two different modes: self-consumption and savings mode. In both these modes, smart export is enabled. Of course, backup is only possible in grid agnostic configuration.

In self-consumption mode, the energy management system will minimize buying energy from the grid in order to maximize carbon offset. This means that when production from solar is not sufficient to meet the home's consumption, the battery will discharge to supplement solar production thereby optimizing for maximum carbon offset. If solar is not available and the batteries are fully discharged, then the system will buy energy from the grid as a last resort.

In the case of savings mode, the energy management system will optimize buying energy from the grid in order to maximize electric bill offset. This means that when production from solar is not sufficient to meet the homes consumption, the system will buy from the grid, such as during off-peak and super off-peak times, before discharging the battery to supplement solar production. In other words, the system will preserve the charge in the battery to use during peak rates thereby optimizing for maximum electric bill offset. Under no circumstance will the battery be charged from the grid to maintain NEM integrity. Self-consumption and savings mode operations are shown in the graphs below. In both modes, smart export is enabled. The behaviors between the two are distinctly different.

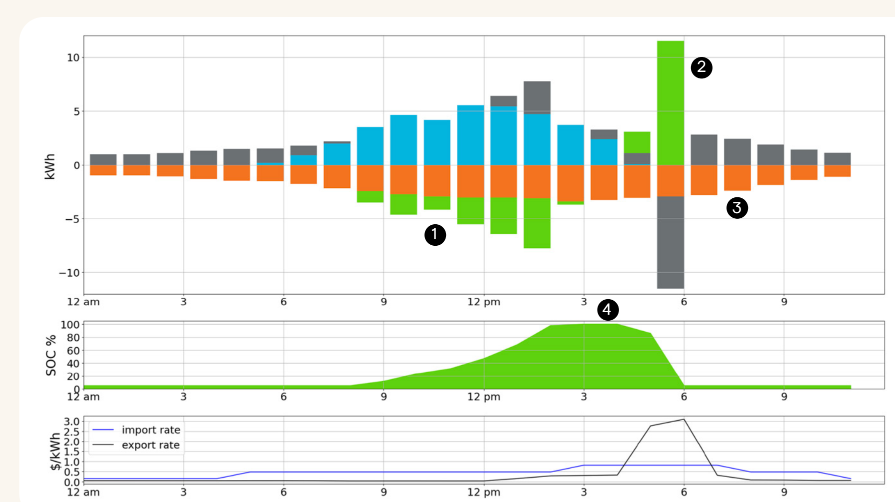
Self-consumption mode with smart export



1. Battery is charged from solar to avoid buying energy from the grid
2. Battery holds sufficient charge to not buy energy from the grid at night; excess energy is sold to the grid to generate revenue
3. Battery is discharged to service the load and avoid buying energy from the grid

- Solar Production
- Home Consumption
- Battery Charge/Discharge
- Grid Import/Export

Savings mode with smart export



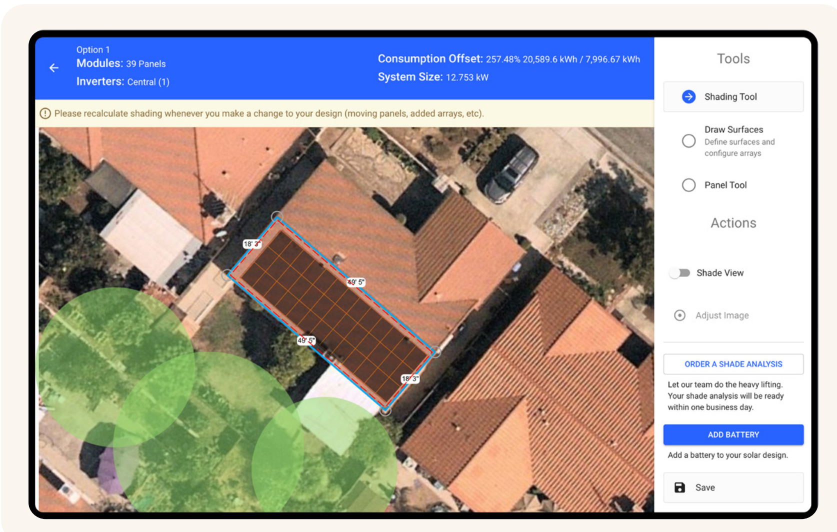
1. Battery is charged from solar to avoid buying energy from the grid during peak time and for selling to the grid later in the day
2. Battery discharges to service the load and sells energy to the grid to generate revenue for the homeowner
3. Homeowner buys energy from the grid
4. Battery holds charge for use later in the day

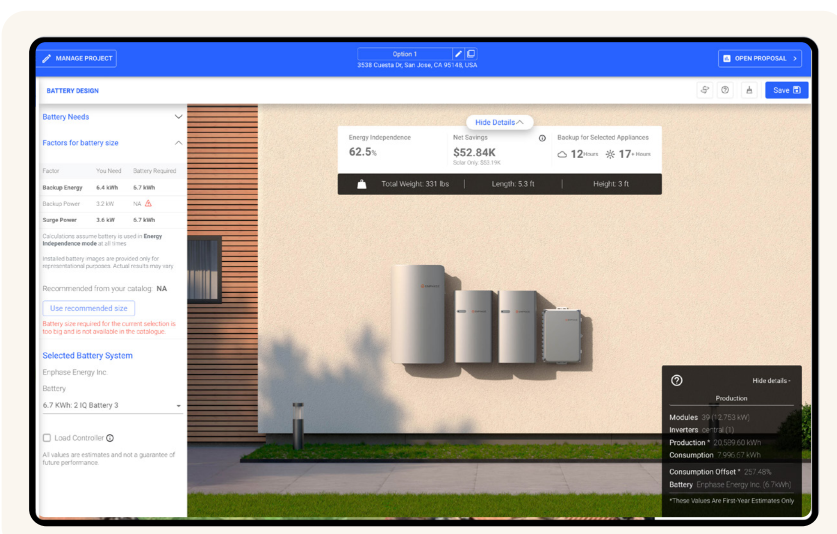
- Solar Production
- Home Consumption
- Battery Charge/Discharge
- Grid Import/Export

2.5 Solargraf design tool

The Solargraf design tool from Enphase helps our installers to quickly and easily design solar and battery systems to operate under NEM 3.0 tariffs. The key to this tool is the software simulation and optimization engine—the same software engine that is part of the Enphase Energy System. This ensures that the proposal generated for the homeowner, and its financial analysis, matches the system's actual operation. This is possible because the hardware and software are all built by Enphase and there is an intimate knowledge about the operation of the hardware and software system.

As an example, the software optimization engine has shown that under NEM 3.0, the installer now has more flexibility in choice of roof surface. Solar panels can be placed south or west facing, or both.

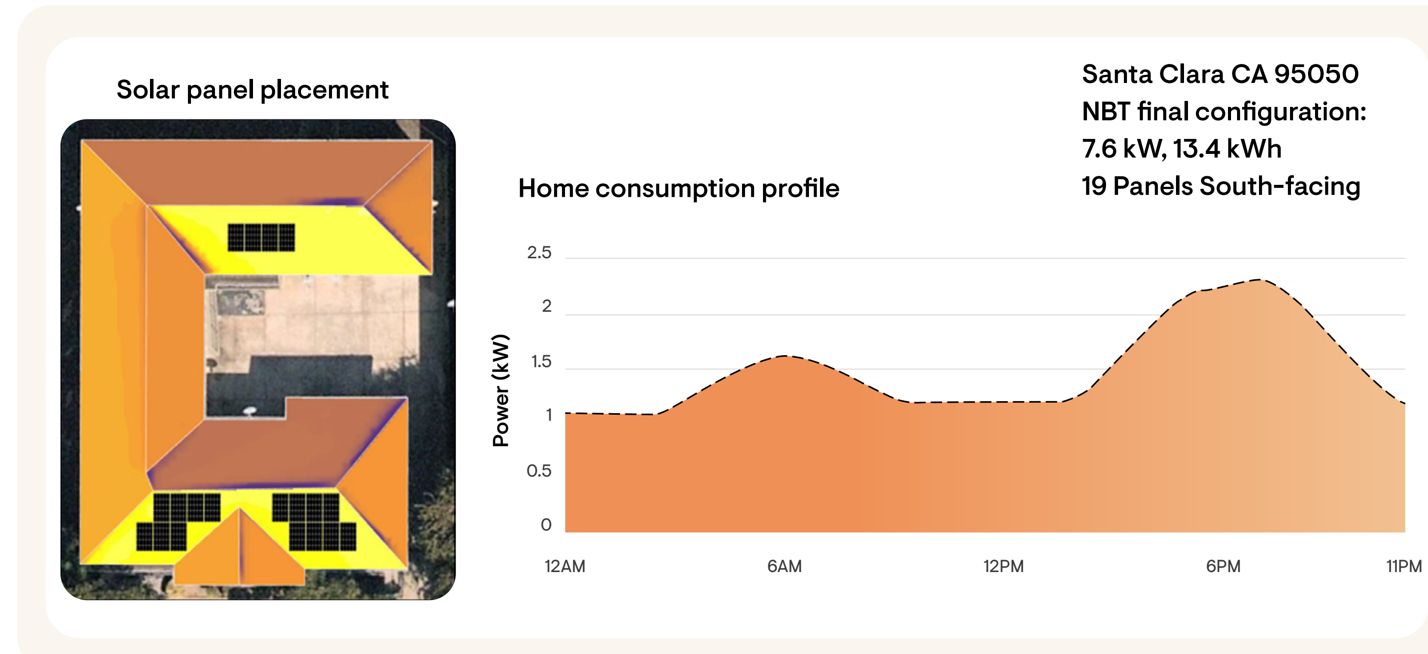




3. Financial analysis

Under NEM 2.0, designing a solar system to match 100% consumption offset would be sufficient to achieve an electric bill offset of more than 90%. This drops to about 55% under NEM 3.0 for all the reasons previously discussed. Our data indicates that a solar system with the right size battery can improve the electric bill offset as much as 70% to 90%.

We used Solargraf to model different homes in California. The metrics that we tracked were solar system size and orientation, electric bill offset, net system cost, net savings, and payback period. As can be seen in the table below, for a given consumption profile, a south facing solar system achieves an electric bill offset of 58.22% when there is no battery attached. Attaching a battery of 6.7 kWh to 13.4 kWh improves the electric bill offset to 72.54% to 89.44%. This means that if homeowners invested less than $7,000 dollars in a 6.7 kWh battery, they would realize a benefit of about $19,000. In all the different scenarios, the payback period stays constant to about 6 years.



Tariff	Orientation	Solar kW	Battery kWh	Cons. Offset %	Bill Offset %	Sys cost $	Net Sys cost $	Net savings $	Self-cons %	Payback Yrs
NEM 2.0	West	7.6	0	92%	90.52%	$25,080	$17,556	$165,788	38%	3.6
NEM 2.0	South	7.6	0	100%	92.72%	$25,080	$17,556	$177,672	38%	3.5
NEM 2.0	South	7.6	13.4	100%	92.72%	$43,840	$30,688	$155,167	64%	5.8
NEM 3.0	West	7.6	0	92%	58.69%	$25,080	$17,556	$105,336	38%	5.3
NEM 3.0	West	7.6	13.4	92%	88.50%	$43,840	$30,688	$134,814	61%	6.1
NEM 3.0	South	7.6	0	100%	58.22%	$25,080	$17,556	$103,208	38%	5.3
NEM 3.0	South	7.6	3.4	100%	65.26%	$29,840	$20,888	$113,249	45%	5.6
NEM 3.0	South	7.6	6.7	100%	72.54%	$34,460	$24,122	$122,549	52%	5.8
NEM 3.0	South	7.6	10.1	100%	81.22%	$39,220	$27,454	$131,135	60%	5.9
NEM 3.0	South	7.6	13.4	100%	89.44%	$43,840	$30,688	$137,750	64%	6.0
NEM 3.0	South	7.6	16.8	100%	91.31%	$48,600	$34,020	$142,148	69%	6.2

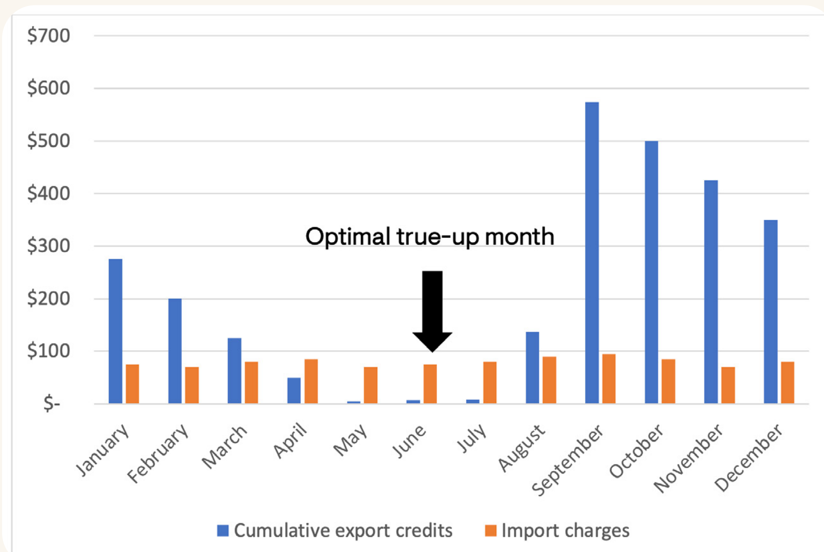
Modelling Assumptions: *Module wattage: 400 W, Inverter wattage: 295 W (IQ8+), Utility: PG&E, Solar cost: $3.3/W, Storage cost: $1400/kWh, Utility escalation: 4%, Net savings reduced by 50% in 15th year of initial storage cost for replacement, External shading: none*

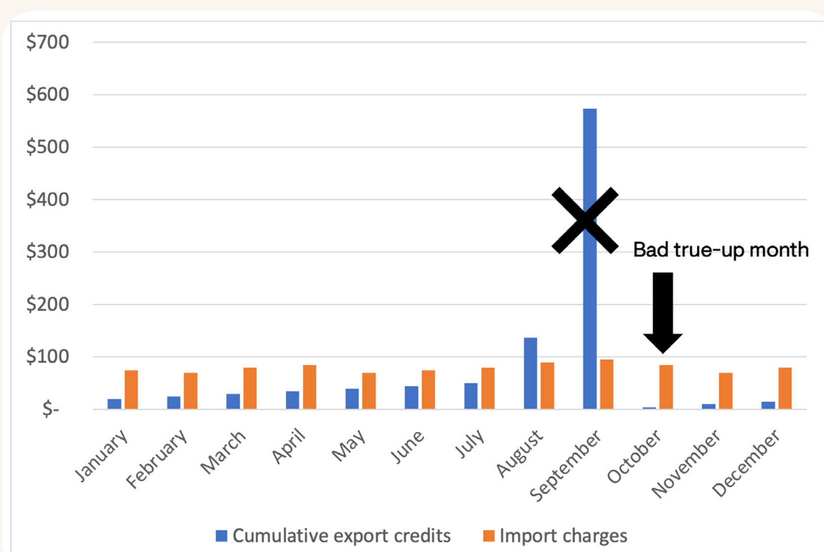
All the modeling assumed that a homeowner paid cash for their system. Financial metrics such Net savings and Payback period were calculated over 25 years. If the system were to be financed, either via loan or PPA, the payback period will change. Solargraf can model different types of financing and generate a proposal.

4. Yearly true-up

Unlike NEM 2.0, under NEM 3.0, homeowners will have a KWH true-up at the end of year. In addition, they will have to pay their bills monthly. In the case where the system generates credits from export compensation in months like August and September, these credits will be used in the following months until they run out. It is important to have sufficient runway in order to allow for the credits to be fully used. If the true-up occurs immediately following the generation of the credits, there is no guarantee that the utility will roll over the credits into the next year.. A conservative approach to solving this problem is to opt for a change in true-up date to June. This will ensure that those credits generated in August and September have sufficient time to be fully used.

Below is an illustration of a good and bad true-up month.





5. Conclusion

The future of California's solar industry is bright. As more consumers move towards whole home electrification, the need for solar, batteries, and EV chargers will continue to increase along with market-based utility pricing. This means that systems that manage the energy within the home will have to evolve to become more sophisticated. The key is to ensure that the sophistication does not increase the complexity of design, installation, and operation.

Under NEM 3.0, adding a small battery to a solar system can significantly improve the homeowner's electric bill offset from around 55% for solar-only systems to as much as 70% to 90%, while delivering a payback period of about 5 to 7 years. These are very compelling economics for the homeowner, and we believe our installer partners can be successful under NEM 3.0.

Enphase provides a comprehensive solution for NEM 3.0. The solution includes a battery which can be configured for gridagnostic or grid-tied operation, power control system to avoid main panel upgrade, Solargraf design tool, and finally an energy management system to operate the Enphase energy system either in self-consumption or savings mode.

Compared to some of the other solutions in the market, Enphase is more efficient since there is no single point of power conversion failure. It is easier to design, install and maintain since there is no string-sizing or high voltage DC switchgear needed and is plug and play. It is also safer since there is no high-voltage DC in the system. This is the power of a semiconductor and software-based distributed architecture. Enphase is a one-stop-shop for hardware software, warranty, training, and customer service.

Revision history

REVISION	DATE	DESCRIPTION
DSH-00105-2.0	October 2023	Updated chart on page 5 and minor text updates
DSH-00105-1.0	June 2023	Initial release

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