



# Solar Plus: A Holistic Approach to Distributed Solar PV

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## Summary

“Solar plus” is an emerging holistic approach to distributed solar photovoltaic (PV) deployment that uses energy storage and controllable devices to optimize customer economics.

## What is Solar Plus?

PV systems generate electricity only when the sun is shining—daily PV generation peaks at midday and declines as the sun sets. For residential PV customers, midday PV generation may exceed the home’s midday load, but the excess generation is unavailable for meeting late afternoon and evening loads. Some U.S. utilities have used net metering to address this temporal mismatch

between PV output and customer load profiles—crediting excess output against PV customers’ grid electricity use at or near the full retail rate. However, a trend toward lower net metering rates and other rate reforms could make standalone PV systems less economically attractive to PV customers.

Solar plus could mitigate this loss of PV value by providing a technical solution to the mismatch between PV output and customer load. With the solar plus approach, customer loads can be shifted “under” the PV output curve through electrical batteries and controllable technologies such as “smart” domestic water heaters, smart air conditioner units, and electric vehicles (Figure 1 and Figure 2).

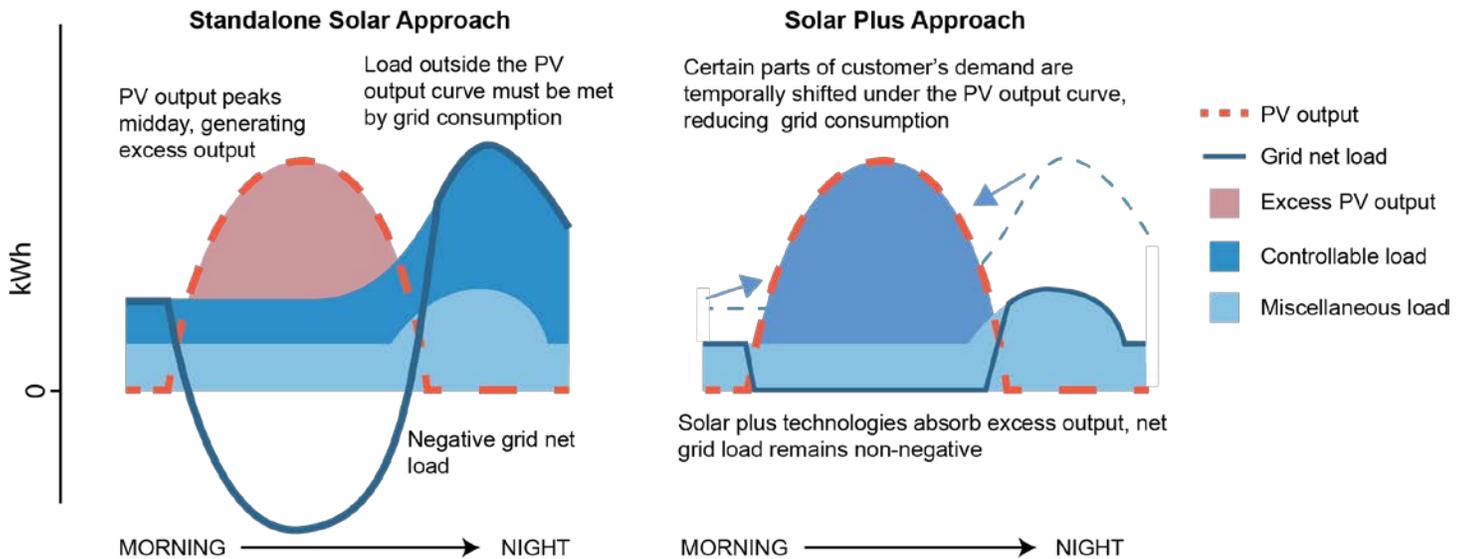


Figure 1. Customer load shifting through solar plus

Grid net load is the customer load at the meter: the net sum of customer load and PV output. Negative grid net load reflects PV exports to the grid.

## What Are the Benefits of Solar Plus?

We used the National Renewable Energy Laboratory's Renewable Energy Optimization (REopt) tool to analyze five residential PV case studies based on real rate structures.<sup>1</sup> We find that solar plus increases system value for PV customers under all rate structures. The incremental benefits of solar plus are highest for customers with low net metering rates and for those with time-of-use rates with a peak period that does not coincide with PV output.

Solar plus increases PV system value by reducing grid electricity payments in two ways. First, solar plus technologies allow customers to increase the amount of PV electricity that they consume onsite and thus reduce grid electricity consumption. Second, for customers with time-of-use rate structures, solar plus technologies shift customer loads from high-rate periods to low-rate periods. These two value streams increase PV customer savings relative to a system that has only a PV array. Solar plus may also generate additional value streams such as resiliency during grid outages and grid-level ancillary service benefits.

Our results indicate that solar plus can mitigate some of the negative impacts of lower net metering rates and other rate reforms on PV economics. The optimization of distributed PV systems with batteries and controllable technologies is an increasingly viable model in the evolving U.S. rate environment.

## More Information

For more information, download the full technical report: O'Shaughnessy, Eric, Kristen Ardani, Dylan Cutler, and Robert Margolis. 2017. *Solar Plus: A Holistic Approach to Distributed Solar PV*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-68371. <http://www.nrel.gov/docs/fy17osti/68371.pdf>

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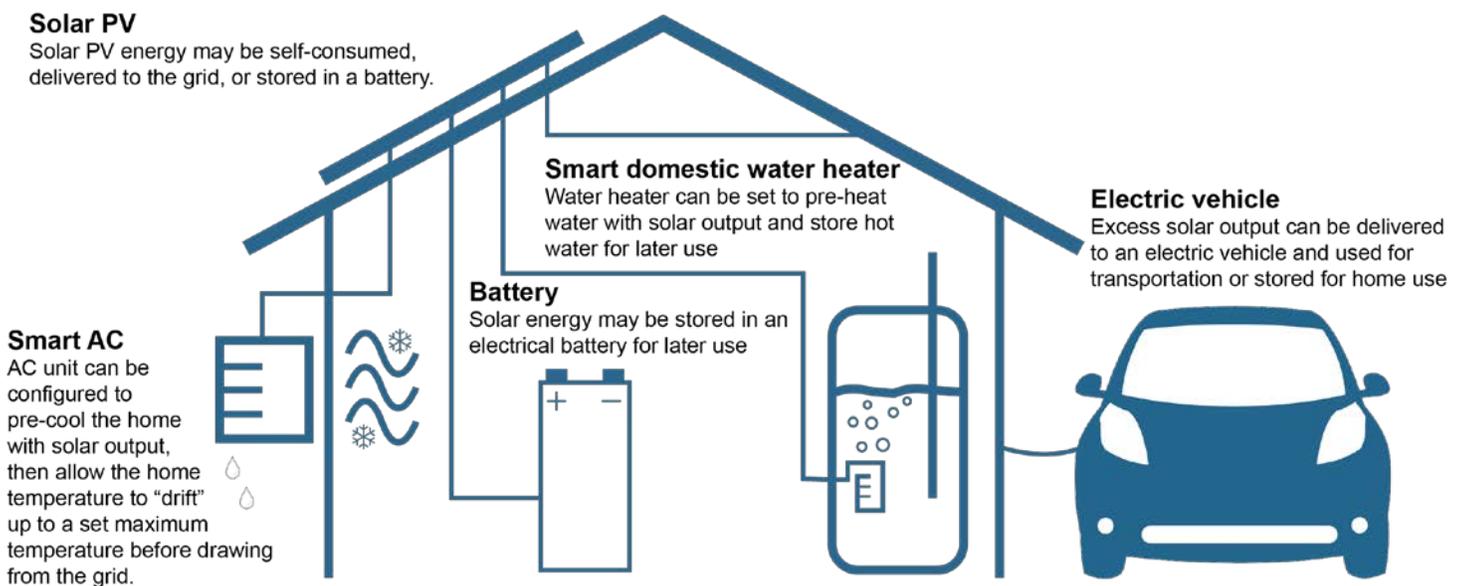


Figure 2. The solar plus approach

1. In our study, solar plus technology options included batteries, smart air conditioner units, and smart water heaters. We did not analyze electric vehicles.