Eleven Reasons Why Behind-the-Meter Distributed PV Lowers Electricity, Health, and Climate Costs for Everyone

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Utility Versus Distributed PV

Utility PV is large-scale ground- or water-mounted PV connected to the grid. Distributed PV is small-scale PV on buildings (roofs, walls, windows, carports), parking lots, parking structures, hillsides, yards, and vacant lots that service buildings directly.

There are two main types of distributed-PV systems: behind-the-meter (BTM) and in-front-of-the-meter (FOM) systems. FOM systems are part of the main transmission and distribution system, just like utility PV systems are. However, FOM systems are smaller than 20 megawatts nameplate capacity, whereas utility PV systems are larger than that. Second, FOM systems connect to distribution lines, whereas utility PV systems connect to transmission lines. Because FOM systems are connected to distribution lines, they serve buildings directly, minimizing the need for additional transmission lines. However, distribution lines are connected to transmission lines, so FOM PV can also feed its electricity to the transmission system. They are, therefore, subject to the same market and grid connection rules as are utility PV systems.

BTM systems are also smaller than 20 megawatts, but usually a few to tens of kilowatts in size. They serve buildings directly, but if the BTM system is connected to the grid, any excess electricity produced from the system may be sent back to the grid. If not enough BTM PV electricity is available to serve a building, the grid can then supply electricity to the building. Because the meter that determines electricity use for a building only reports the incoming electricity from the grid and the outgoing electricity back to the grid but not the electricity consumed by the building from the BTM system, such a system is referred to as a behind-the-meter system. If a BTM system is not connected to the grid, the system is run in isolation as a microgrid.

If BTM distributed PV (hereafter BTM PV) is co-located with battery storage, the system first provides electricity to a building it services. Any excess electricity is then stored in the batteries. Remaining electricity is sent to the grid if the system is grid-connected; otherwise, it is lost through curtailment. Thus, if all else is the same, BTM PV reduces immediate grid electricity demand by supplying electricity directly to buildings, avoiding the need for grid electricity to those buildings.

Grid operators generally oppose BTM distributed PV because its first impact is to reduces demand for grid electricity. Utilities claim that the remaining customers must pay a higher cost for the remaining demand, mostly because the fixed cost of the transmission and distribution system is now spread over fewer customers. They further argue that only wealthy people can afford BTM PV, so the higher cost of grid electricity disproportionately affects low-income grid customers. Utilities have used this argument to stymie the expansion of BTM PV in many states (e.g., California, Hawai'i, Nevada, Arizona, Utah, and Florida), and countries.

Why BTM PV Helps Everyone

However, the opposite is true. BTM PV lowers electricity, health and climate costs for everyone for at least 11 reasons.

1) First, the claim that BTM PV reduces grid electricity demand and, therefore, increases costs to grid customers by spreading the fixed cost of transmission and distribution over fewer customers ignores the realities of the current energy transition, where transportation, buildings, and industry are being electrified and the electricity is increasingly being provided by WWS. In the limit, this results in an overall reduction in energy demand worldwide of about 54.4 percent. However, all remaining energy will be electricity, so electricity needs will almost double (Jacobson et al., 2024). With a doubling of electricity demand, even if 25 percent of the total electricity demand is met with BTM PV, overall grid electricity needs will still increase by 50 percent compared with today. Thus, the assumption by utilities that a large growth in BTM PV reduces demand holds true only for low levels of electrification, not for large-scale electrification, which is needed to address climate, pollution, and energy security problems.

2) Second, BTM rooftop PV electricity requires no new land, whereas utility PV needs new land. Thus, most BTM PV reduces land requirements and habitat damage compared with utility PV, benefiting both BTM and grid customers.

3) Third, BTM PV reduces the need for transmission and distribution lines. BTM PV users connected to the grid still need transmission and distribution lines when their PV and co-located battery system do not produce sufficient electricity or when their PV system produces excess electricity, which is fed to the grid through the lines. In contrast, grid customers need transmission and distribution lines for 100 percent of their electricity consumption, and utility PV requires transmission and distribution lines for 100 percent of its generation.

4) Fourth, when a BTM-PV and co-located battery system produces more electricity than the building it serves consumes, excess electricity is sent back to the grid. This helps grid customers avoid blackouts during hot summer days in particular.

5) Fifth, transmission line sparks have led to devastating wildfires, such as in California and Hawai'i. The cost of such fires and undergrounding transmission lines due to the fires have been passed down to customers in California, for example (Bittle, 2024; Associated Press, 2023). BTM PV reduces fire occurrence and these costs.

6) Sixth, the addition of BTM PV reduces the mining, processing, and burning of polluting fuels (fossil fuels and bioenergy) for electricity generation on the grid. Reducing polluting fuels reduces exposure of the general population to gases and particles that cause morbidity, mortality, and health costs. Thus, BTM PV directly reduces health costs for both distributed-PV and utility-PV customers. Since many electricity-generating power plants are located near low-income communities, the health-cost benefits of BTM PV accrue more to low-income residents than to high-income residents.

7) Seventh, by reducing greenhouse-gas emissions from polluting fuels, BTM PV reduces climate damage to both distributed-PV and grid customers.

8) Eighth, by reducing the use of fossil fuels, BTM PV reduces energy insecurity problems associated with fossil fuels, and this benefit accrues to both BTM PV and grid customers.

9) Ninth, installing BTM PV creates more jobs than installing and running utility PV and other grid-scale electricity generation, and this benefits a state or country as a whole.

10) Tenth, because rooftop PV absorbs 20 to 26 percent of the sunlight that hits it, then converts the light to electricity, less light is absorbed by the building, cooling the building during the day, reducing daytime electricity demand for air conditioning (Dominguez et al., 2011). Such cooling is greatest during summer and during the day, when electricity prices are highest. By reducing demand in this way during peak times of day, BTM PV reduces strain on the grid and the risk of blackout to grid customers. At night, solar PV panels act as insulators, keeping buildings slightly warmer than they otherwise would be (Dominguez et al., 2011), potentially reducing the demand for heating at night.

11) Eleventh, BTM PV facilitates the transition of a building to all-electric, thereby reducing occupant costs in the short run and long run. Normally, two forms of energy, such as fossil gas and electricity, are used in buildings. However, there is nothing that fossil gas can do that electricity cannot do less expensively and cleaner. An issue arises because, the more appliances in a building switched from gas to electric, the greater the electricity demand in the building. Utilities often charge a higher rate for electricity use beyond a threshold. This disincentivizes customers from electrifying more appliances. On the other hand, BTM PV provides the additional electricity at a lower cost than does grid electricity in most places, so electrifying a building that has BTM PV reduces overall electricity cost compared with electrifying and using only the grid for the electricity. Moreover, electrifying reduces outdoor and indoor air pollution from fossil gas use in buildings and mining the gas, benefiting both BTM PV customers and grid customers.

Additional Benefits of BTM PV

BTM PV results in at least three additional benefits for PV owner and building occupants but not necessarily users of grid electricity:

1) First, BTM PV allows building occupants to keep their electricity on during a grid blackout. With one or two batteries co-located with the PV, the building can even continue to function using stored solar electricity at night. During a blackout, utility customers receive no electricity at all.

2) Second, although the wholesale price per unit electricity of utility PV is less than the cost per unit electricity of BTM PV, utility customers do not pay the wholesale price of utility PV. Instead, they pay the retail price plus the price of transmission and distribution, which sums to about four times the cost of BTM PV in, for example, California. As such, a utility-PV customer who adds and uses BTM PV can reduce their daytime cost of electricity by up to a factor of four.

3) Third, builders of new homes with only BTM PV and no fossil gas eliminate the costs of installing fossil gas pipes and digging ditches for them ($3,000 to $20,000) and of a fossil gas hookup fee charged by the utility ($3,000 to $15,000).

Summary

In sum, BTM PV should be installed as much as possible worldwide. It not only helps to eliminate pollution emissions from current electricity generation, but it also reduces the need for land and for transmission and distribution lines, thereby reducing the cost associated with both plus wildfire risk. Due to the scale of the WWS transition needed worldwide, both distributed (BTM and FOM) and utility PV will be needed in large quantities (Jacobson et al., 2022; 2024). As such, policies should encourage both and hinder neither.

References

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