Comparing the Costs of Utility-Scale and Residential-Scale PV

Electricity generated from solar photovoltaic (PV) panels has become a rapidly-growing source of carbon-free power in the United States over the last decade. Compared to other solar-electric technologies, solar PV systems are unique. Highly scalable, they can be deployed in configurations from as small as a few kilowatts (kW) for distributed, residential rooftop to hundreds of megawatts (MW) in utility-scale power plant applications.

According to the Solar Energy Industries Association (SEIA), there are over 20 GW of installed solar facilities in the U.S. Utility-scale accounts for around 60% of that, residential installations account for around 20%, and the remaining goes to commercial and industrial. All sectors are growing rapidly and are expected to continue to do so in the future.

Due to its popularity and visibility, residential-scale PV is often the main solar application considered in policy and regulatory circles when discussing solar options. Utility-scale solar is often overlooked. A new study by economists at The Brattle Group, "Comparative Costs of Utility-Scale and Residential-Scale PV in Xcel Energy Colorado's Service Area," sponsored by First Solar with support from the Edison Electric Institute (EEI), explores the benefits of utility- vs. residential-scale solar by assessing the difference in cost to consumers of equal amounts of both types of installations in a representative utility setting. Specifically, the study finds that customer generation costs per unit of electricity produced (MWh) are approximately twice as high for residential-scale systems as for the equivalent amount of utility-scale PV systems.

The cost advantage of utility-scale PV generation is unlikely to be reversed by differences in transmission, distribution, or ancillary services costs. The emissions and other environmental reductions of utility-scale PV are also anticipated to be roughly 1.5 times as large as for residential-scale PV. As a result, the overall benefits of utility-scale solar are likely to be substantially larger than the benefits of rooftop solar per dollar spent on solar PV capacity.

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> Large-scale solar power plants are usually going to be substantially less expensive per kWh generated than rooftop PV, and they allow everyone access to solar power. From the standpoint of cost, equity, and environmental benefits, large-scale solar is a crucial resource.
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> **Dr. Peter Fox-Penner**
> **Principal, The Brattle Group**

STUDY SCOPE

Compares the per-megawatt hour (MWh) generation costs of adding 300 MW_{DC} of PV panels either in the form of: (1) 60,000 distributed 5-kilowatt (kWh) residential-scale (rooftop) systems owned or leased by retail customers OR (2) 300 MW of utility-scale solar power plants that sell their entire output to Xcel Energy Colorado under long-term power purchase agreements (PPAs). This amount of solar power is at the same level that Xcel Energy Colorado expects to achieve over the next few years.

The study includes a reference case and five scenarios with varying investment tax credit (ITC), PV cost, inflation, and financing parameters.

KEY STUDY FINDINGS

• For the Reference Case, generation costs per solar MWh are found to be approximately twice as high for residential-scale systems (16.7¢/kWh) than for the equivalent amount of utility-scale PV systems (8.3¢/kWh). To put this in perspective, national average all-in retail residential electric rates in 2014 were 12.5¢/kWh.*

• The large gap in per-MWh costs between utility- and residential-scale systems results principally from: (a) lower total plant costs per installed kilowatt for larger facilities; (b) greater solar electric output from the same PV capacity due to optimized panel orientation and tracking; and (c) other economies of scale and efficiencies associated with utility-scale installations.

• Based on a literature review, avoided transmission and distribution costs by residential-scale systems (if any, which may depend on where and how densely they are located) are not large enough to significantly impact this gap in generation costs.

The generation cost difference between the utility and residential-scale systems owned by customers ranges from 6.7¢/kWh to 9.2¢/kWh solar across the scenarios.

OTHER IMPORTANT FACTORS AND IMPLICATIONS

• While the results of this study solely apply to the Xcel Energy Colorado system and should not be transferred to other regions without proper calibrations, the general relationship between costs is likely to hold true for most U.S. utilities with significant solar potential.

• While this report only quantifies the customer paid generation costs of utility- and residential-scale PV systems, it qualitatively discusses differences in monetized non-generation costs and benefits and non-monetized benefits (externalities). The researchers believe that inclusion of these costs and benefits are not likely to change the conclusion of this study as: (i) a review of literature suggests that total cost of PV power within a fully optimized power system will be less expensive for equal amounts of utility-scale compared to residential-scale; (ii) the majority of non-monetized benefits are positively correlated with MWh output; therefore, one would expect greater value to be ascribed to utility-scale systems because of the significantly higher relative output of those systems.

• It is certainly possible that in some locations, residential-scale PV will have cost and system advantages over utility-scale solar. We have looked only at likely costs, not the extremes of possible costs for either approach. Both are going to be helpful and necessary in order to decarbonize our power system. But the important implication of this study is that at present, utility-scale solar may often offer power and environmental benefits more cheaply and equitably than distributed, residential PV.

CONCLUSIONS

Overall, the findings in this report demonstrate that utility-scale PV systems have inherent cost and performance advantages that will often make them significantly more cost-effective than residential-scale PV systems for achieving the economic and policy benefits commonly associated with PV solar. This is a significant consideration for utilities and their regulators assuming that they are looking to maximize the benefits of procuring solar capacity at the lowest overall system costs. With the likely onset of new greenhouse gas savings targets from pending Environmental Protection Agency (EPA) rules, the options for reducing carbon emissions and the costs of achieving them will take on even greater importance. Simply stated, most of the environmental and social benefits provided by PV systems can be achieved at a much lower total cost at utility-scale than at residential-scale.

*Prices noted are based on historic data and not necessarily reflective of current pricing.