Value of Distributed Generation

Solar PV in Rhode Island

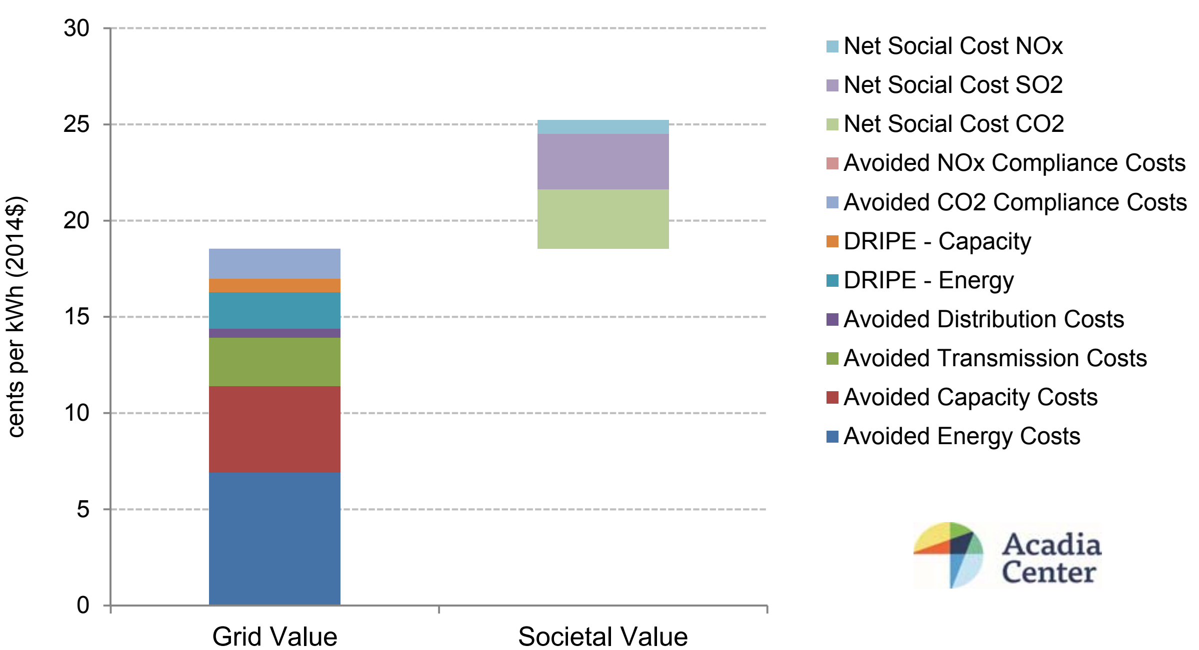
July 2015

Overview

Distributed energy resources (DERs) like solar photovoltaic (solar PV) systems provide unique value to the electric grid by reducing energy demand, providing power during peak periods, and avoiding generation and related emissions from conventional power plants. The overall value of solar is the sum total of these different benefits, which vary based on the time and location of output from solar panels.

Acadia Center assessed the grid and societal value of six marginal solar PV systems to better understand the overall value that solar PV provides to the grid. By evaluating an array of configurations, this analysis determines that the value of solar to the grid – and ratepayers connected to the grid – ranges from 19-25 cents/kWh, with additional societal values of approximately 7 cents/kWh. Figure 1 shows the grid value of a south-facing system (azimuth of 180 degrees) with a 35 degree tilt from horizontal and the corresponding, additional societal value.

Figure 1: Grid and Societal Value of Solar PV in Rhode Island – 25-year Levelized Cost (2014$)



The results of this analysis demonstrate that solar is a valuable local energy resource that provides benefits to all ratepayers and society. Deployment of clean distributed resources should be encouraged not capped. Solar PV, especially west-facing systems, can help reduce the cost of the electricity system, and while utilities should be appropriately compensated for the services they provide, DERs must also be fairly credited for the electricity and benefits they provide to the grid.

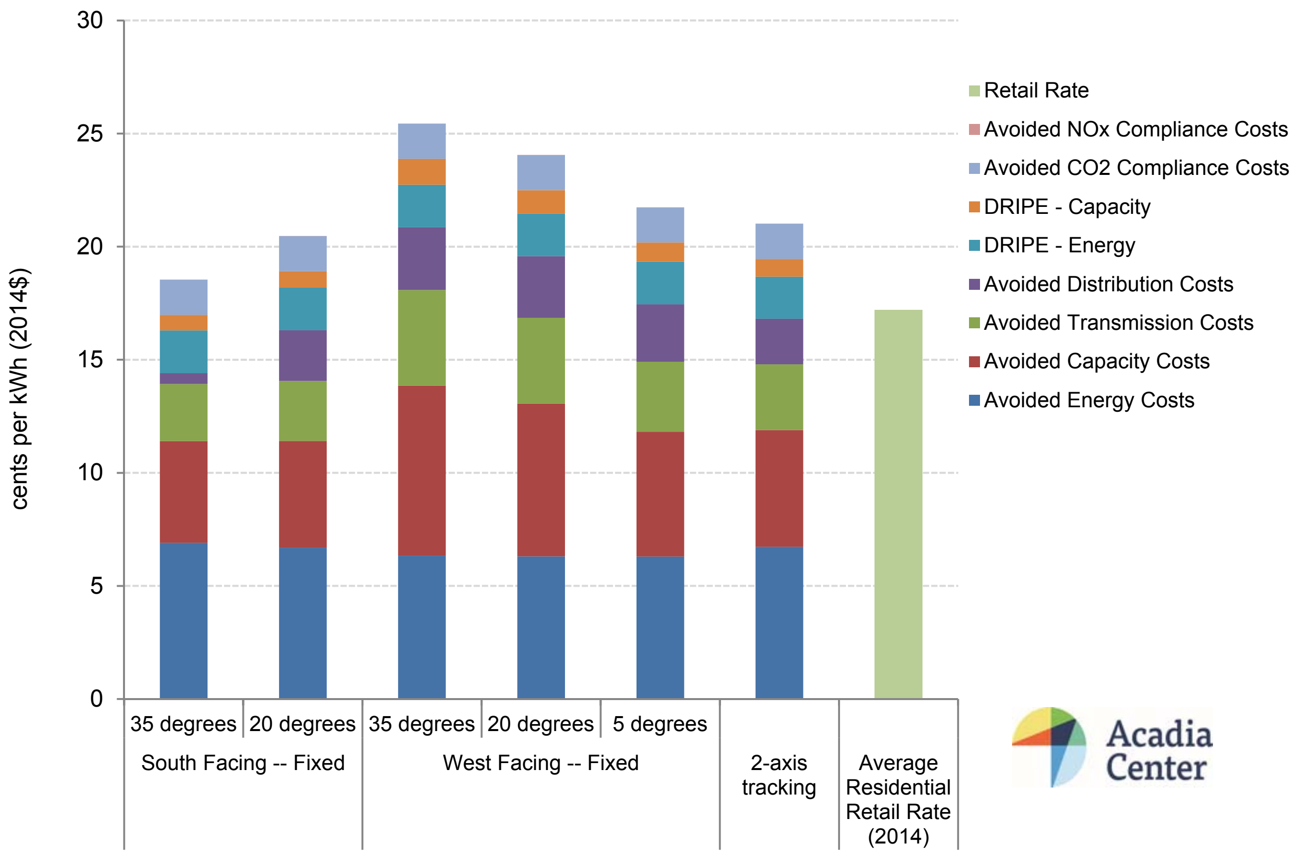
Grid Value of Solar PV

To understand how the value of solar generation is different during different times, it is worth noting that the price of electricity varies throughout the day. For example, at 6 a.m. on July 19, 2013, the average wholesale market price of electricity in Rhode Island was $49.28 per MWh; by 4 p.m. the price had jumped to $216.86 per MWh. A solar PV system feeding electricity into the grid at 4 p.m. on July 19, 2013 would have offset the need to purchase energy from another generator at the high market rate.

In addition to avoided energy costs, behind-the-meter solar PV helps offset other costs associated with the electric grid and, ultimately, all ratepayers' electricity bills. These include: avoided capacity costs; avoided transmission and distribution costs; energy and capacity market price suppression effects (also called demand reduction induced price effects or "DRIPE"); and, avoided environmental compliance costs. While not included in this phase of analysis, there is additional locational value associated with solar PV and other DERs if they are strategically located on the grid to help avoid the need for expensive infrastructure upgrades. This can increase the avoided distribution cost component and help direct more DER to be installed where it generates the most value.

Below are the results of Acadia Center's assessment of the value of an additional solar PV system installed near Cranston, RI (population-weighted center of RI). The methodology behind each component is available at: http://acadiacenter.org/?p=1764, and the precise values are provided on page 3 and in Appendix A. The average residential retail electric rate in Rhode Island is included as a point of comparison as residential rates are typically the level at which net metered customers are compensated. It would be more accurate to show the average residential retail rate in 2015, but because that data will not be available until the year has ended, 2014 rates are included here. The values for Rhode Island are slightly lower than the results from Acadia Center's Massachusetts and Connecticut value of solar studies, which is primarily due to lower DRIPE energy and capacity values, lower avoided distribution costs, and, to a lesser extent, lower avoided environmental costs.

Figure 2: Grid Value of Solar PV in Rhode Island – 25-year Levelized Cost (2014$)



Note: Where appropriate, avoided reserve capacity costs, transmission and distribution losses, and a wholesale risk premium or price hedge are included in the calculations.

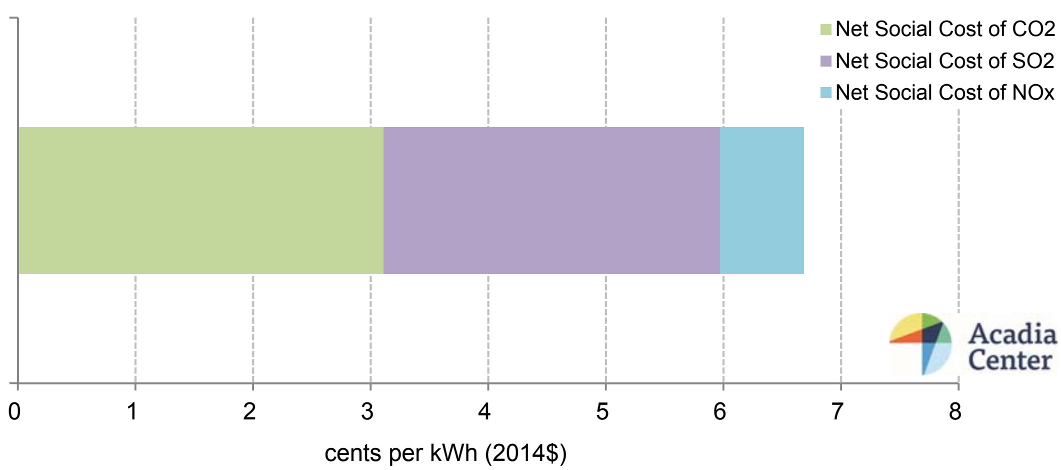
This assessment considers six different solar PV system orientations: 1) south-facing (azimuth of 180 degrees) with a 35 degree tilt from horizontal; 2) south-facing with a 20 degree tilt; 3) west-facing (azimuth of 270 degrees) with a 35 degree tilt; 4) west-facing with a 20 degree tilt; 5) west-facing with a 5 degree tilt; and, 6) a 2-axis tracking system. As shown in the figure above, the orientation of a system will deliver different values per kWh. For example, capacity-related values are larger in west-facing systems because these systems are more available during ISO reliability hours (i.e., west-facing systems that produce more energy in the afternoon). As noted below, the south and west-facing systems generate approximately the same level of absolute benefits ($) over the year; however, because these benefits are spread over fewer kilowatt-hours (due to less overall output), the result is higher per-kilowatt values for the west-facing systems, as shown in Figure 2.

Societal Value of Solar PV

Solar generates significant additional societal benefits. Economic benefits and the avoided social costs of greenhouse gas emissions and other pollutants such as sulfur dioxide enhance the value proposition of solar PV, and should be used by policymakers and other stakeholders to evaluate the net societal benefit of solar PV.

Below are the results of Acadia Center's assessment of the net social cost of carbon dioxide (CO2), sulfur dioxide (SO2), and nitrogen oxides (NOx). The societal benefits in Figure 3, below, are separate from and additional to the compliance costs for CO2 and NOx included above in Figure 2 (i.e. the values below are the social benefits only). The net environmental benefit of 6.7 cents per kWh shown in Figure 3 is the value of avoiding the average marginal kilowatt-hour of electricity. This average value can be used in the aggregate for determining the overall societal benefits.

Figure 3: Additional Societal Benefits of Solar PV in Rhode Island – 25-year Levelized Cost (2014$)



As with the components in Figure 2, the value of avoided emissions will change with increased levels of solar penetration and resulting impact on generation dispatch. Assessments that incorporate a fleet of savings may return a higher per unit value for avoided emissions if the fleet of solar pushes a more polluting generator out of the resource mix. As discussed below, it is important to get the numbers right and regularly update them to reflect changing system conditions over time.

Maximizing Benefits to the Grid

One of the key findings of this analysis is that a "flat" system of compensation – such as net metering – can distort the market for solar PV by inadequately valuing the benefits that west-facing systems provide in mitigating costs driven by afternoon peak demand. This is illustrated in the table below comparing the unit Value of Solar and Total Annual Value for each of the configurations described above, and a 2-axis tracking system which orients panels toward the sun throughout the day. Under a Value of Solar approach, the total annual value of a 5 kW south-facing system @35°

($1,300/yr) would be similar to the total value of a 5 kW west-facing system @35° ($1,397/yr), because the higher energy production benefits of the south-facing system are roughly matched by the higher peak mitigation-related benefits of the west-facing system. In contrast, under net metering the west-facing system would receive almost 20% less compensation than a south-facing system (see Table 1).

Table 1: Grid Value of Solar, Annual Output and Total Annual Value by System Type

	South-facing @ 35˚	South-facing @ 20˚	West-facing @ 35˚	West-facing @ 20˚	West-facing @ 5˚	2-axis tracking
Unit Value of Solar (cents/kWh)	18.9	20.5	25.4	24.1	21.7	21.0
Total Annual Output (kWh)	6,879	6,664	5,501	5,671	5,805	8,878
Total Annual Value ($/yr)	$1,300	$1,366	$1,397	$1,367	$1,260	$1,864
% +/- credited under net metering compared to south-facing @ 35˚	100%	- 8%	- 26%	- 22%	- 13%	- 10%

The differences in value for production from south-facing and west-facing systems also have implications for the appropriate design of policies to incent solar generation. Incentives should be designed to maximize the value that the solar PV resource provides to both system owners and all ratepayers rather than simply kWh throughput. This helps ensure that incentives are fair and optimize grid support.

Implications & Policy Recommendations

1. Solar generation is a valuable local energy resource that provides significant benefits to all ratepayers, with a per-kWh value in excess of retail rates. In the aggregate, net metering is a fair policy.
2. Once sufficiently high levels of solar PV are installed, discrepancies between the individual pieces of the value of solar and the individual pieces of retail rates should be corrected. One mechanism to do this is a "value of solar" tariff, where generation is credited at an administratively determined rate. Under this framework, individual value components can be accounted for properly. For example, only the distribution system portion of solar benefits would be paid for directly by the distribution company and the cost of the energy portion could be included in basic service rates. Such a tariff avoids any need for minimum bills or increased fixed charges, policies that reduce customers' control over their energy costs without any economic justification. See Acadia Center's UtilityVision for additional rate design recommendations and information on fixed charges.
3. Current policies may discourage the installation of west-facing systems. For customers who cannot install south-facing solar, new policies recognizing the value of west-facing solar could be beneficial for both ratepayers and society.
4. Societal benefits should be used when assessing the costs and benefits of solar PV and determining additional incentives.
5. Locational values have not been considered in this study, but are important to maximize the savings in distribution costs that solar can bring to ratepayers. Appropriate incentives can ensure that solar PV, energy efficiency, and other customer-side resources are targeted to defer or avoid the need for new infrastructure spending.

For more information:

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Appendix A

Components of the Grid Value* of Solar PV in Rhode Island – 25-year Levelized Cost (2014$)

	25 Year Levelized Value (cents/kWh) of the DG Resource in 2014$					
	South Facing -- Fixed		**West Facing -- Fixed**			**2-axis tracking**
Component	35 degrees	20 degrees	35 degrees	20 degrees	5 degrees	
Avoided Energy Costs	6.91	6.69	6.34	6.31	6.30	6.73
Avoided Capacity Costs	4.49	4.72	7.52	6.75	5.51	5.16
Avoided Transmission Costs	2.53	2.65	4.23	3.79	3.10	2.90
Avoided Distribution Costs	0.47	2.24	2.77	2.72	2.54	2.02
DRIPE - Energy	1.90	1.89	1.88	1.89	1.89	1.86
DRIPE - Capacity	0.69	0.72	1.15	1.03	0.84	0.79
Avoided CO2 Compliance Costs	1.55	1.55	1.55	1.55	1.55	1.55
Avoided NOx Compliance Costs	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006

* Value of avoiding a marginal kilowatt-hour of electricity.

Components of the Societal Value* of Solar PV in Rhode Island – 25-year Levelized Cost (2014$)

	25 Year Levelized Value (cents/kWh) in 2014$
Net Social Cost of CO2	3.11
Net Social Cost of SO_2	2.86
Net Social Cost of NOx	0.71
Total Social Value	**6.68**

* Value of avoiding the average marginal kilowatt-hour of electricity.