DESIGNING AUSTIN ENERGY'S SOLAR TARIFF USING A DISTRIBUTED PV VALUE CALCULATOR

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ABSTRACT

Austin Energy plans to offer residential customers a new solar net metering tariff based on the value of solar energy generated from distributed photovoltaic (PV) systems in the grid to the utility in place of traditional net metering. Austin Energy worked with Clean Power Research (CPR) to employ the algorithms from a utility value calculator to design the solar tariff. A rebate structure was also designed in order to ensure that customers still satisfy a key economic cost-effectiveness test and address first-cost barriers facing solar customers. These two revenue types – an ongoing credit for solar production, and a one-time rebate – begin a transition toward production-based incentives for residential customers based on actual value credits for solar generation and steadily declining up-front rebates.

1. INTRODUCTION

Austin Energy's solar energy incentive programs seek value parity between distributed solar PV options and so-called "conventional generation" options. Austin Energy's approach therefore differs significantly from the traditional "grid parity" objective of equivalent levelized cost of energy between solar and the average utility cost of energy from fully commercialized conventional resources. The goal for Austin Energy is parity in value, not just cost.

Beginning with the federal Public Utility Regulatory Act passed by Congress in 1978, utilities generally paid an "avoided cost" value for customer-generated energy, typically set at the marginal price of fuel for an incremental unit of energy. Many states implemented net metering policies as an improvement over traditional marginal avoided cost approaches for valuing distributed solar generation, in order to reflect the added value of energy generated at or near the point of consumption.

While net metering represents a significant improvement in reflecting the value of distributed solar energy compared to the avoided cost approach, problems remain. First, the retail price paid by the customer and credited for solar energy under net metering (the value of "spinning the meter backwards") does not necessarily represent and likely under-represents the full value of distributed solar generation.

Second, net metering induces two unintended consequences:

1. Solar customers size their solar systems against their baseload level of energy consumption because net metering systems typically pay the old avoided cost value for excess generation. This is a practical reflection of the fact that solar capacity is fairly expensive and that excess generation rewards the customer at a very low rate. Of course, most of a solar system's excess generation is delivered to the utility at a time when the value of that energy often greatly exceeds the avoided cost rate.
2. Net metering value is coupled with consumption. That is, the value to the customer for a kWh of solar energy that offsets a unit of energy consumption is much greater that the value of excess generation, which is only credited at the avoided cost rate. Austin Energy's experience is

that many solar customers recognize and respond to this signal to use more energy, based upon some sense that their consumption is "free" when a solar system is installed.

Austin Energy designed its new "value of solar" rate to address these unintended consequences and offer an improved, decoupled net metering approach.

Austin Energy worked with CPR to develop an approach for more accurately estimating the value of energy from distributed solar systems to the utility. The value of solar approach is still an avoided cost calculation at heart, but improves on that approach and net metering by calculating a unique, annually adjusted value for distributed solar energy.

Accurately computing a value of distributed solar energy is complicated. Difficulties inherent in accurate calculation include: modeling PV generation for locations without solar ground measurements; ensuring that the modeled outputs cover specific hours in which coincident electric loads have been measured by the utility; calculating marginal line loss savings during those same hours; forecasting fuel prices; determining the effective capacity of PV by calculating hourly loss of load probabilities; and applying principles of engineering economics. These requirements have historically made solar value studies technically difficult and thus cost-prohibitive for utilities and energy agencies alike.

2. DISTRIBUTED PV VALUE CALCULATOR

To address these issues, Austin Energy utilized algorithms developed by CPR for the purpose of streamlining value studies of this type. These algorithms underpin a web-based value calculator [1] that facilitates the entry of economic and technical assumptions and quickly performs study scenarios using previously published methodologies [2]. The tool is able calculates the following value components:

- Loss savings
- Energy savings
- Generation capacity savings
- Fuel price hedge value
- T&D capacity savings
- Environmental benefits

Taken together, these savings reflect the value of distributed solar energy to the utility—a "break-even" value for a specific kind of distributed generation resource, and a value at which the utility is economically neutral to whether it supplies such a unit of energy or obtains it from the customer.

Loss savings represent the benefits that distributed resources provide by reducing system losses by producing power in the same location where it is used. Loss savings increase the value of other benefits across generation, transmission, and distribution systems, and are computed differently depending upon benefit category. However, for all categories, loss savings are calculated hourly on the margin.

Energy savings are the benefits from distributed PV generation's offset of wholesale energy purchases. Energy value equals PV output plus loss savings times marginal energy cost. Marginal energy costs are based on fuel and O&M costs of the generator most likely operating on the margin (typically, a combined cycle gas turbine).

Generation capacity savings are the benefits of added capacity provided to the generation system by distributed PV. It is calculated as the product of the cost of capacity times PV's effective load carrying capability (ELCC), taking into account loss savings.

Fuel price hedge value represents the value of the fact that distributed PV generation has no fuel price uncertainty. It is calculated by determining how much it would cost to eliminate the fuel price uncertainty associated with natural gas generation through procurement of commodity futures.

T&D capacity savings are the benefits that distributed PV generation provides by reducing peak loading on the T&D system – delaying the need for capital investments in the T&D system. It equals the expected long-term T&D system capacity upgrade cost, divided by load growth, times financial term, times a factor that represents match between PV system output (adjusted for losses) and T&D system load.

Environmental benefits recognize the fact that the environmental footprint of PV is considerably smaller than that of fossil-based generation. Environmental value equals PV output times REC price—the incremental cost of offsetting a unit of conventional generation.

Austin Energy commissioned CPR to produce a customized version of the tool to incorporate the impacts of nodal pricing in the Electric Reliability Council of Texas (ERCOT) market.

3. AUSTIN ENERGY RESIDENTIAL SOLAR TARIFF

The calculation of the value of solar at Austin Energy required a modification to the standard value tool methods in order to incorporate Austin Energy's nodal hourly prices. These represent the direct generation costs to the utility on an hourly basis, a major component of the value of solar calculation.

Fig. 1 presents the temporal relationship between nodal pricing (blue line in top part of figure) and PV output (red line in bottom part of figure) for a horizontal system on a sample day (July 30, 2011). PV generation was modeled using SolarAnywhere [3], a satellite-based data set of solar irradiance. Based on this sample day, PV output appears to correlate positively with price.

Fig. 2 presents nodal prices and PV output for seven different configurations on a transmission constrained day. The price jumps considerably on this day – peaking at about 50 times the peak price on the sample day. Consequently, this constrained day represents about 50 times the potential generation value relative to the sample day, and the PV profile match is more critical. West-facing systems are seen to be the best match with price, enabling them to capture more of this benefit by offsetting higher-priced wholesale energy.

The average nodal price fails to accurately represent solar generation value because of the relatively good correlation between price and PV output, and given that in some cases PV is available during critical peak periods. A "PV output weighted nodal price" captures the effects of price variations and choice of solar configuration.

The PV output weighted nodal price is calculated by the multiplying nodal market price by PV output factor for each hour, summing the total value for the year, then dividing by total annual PV energy production. The results are presented in Fig. 3.

The PV output weighted nodal prices range from 6.1 to 8.2¢ per kWh, compared the system average nodal price of 4.4¢ per kWh. Depending on configuration and orientation, the solar premium can nearly double the value of solar energy, relative to the average nodal price, which only reflects the average energy value for base load generation with a constant output over the year.

The PV output weighted nodal price was calculated for the near term (2 years) value of energy produced by a solar generator. For energy produced over the mid and long term—out to the 30 year expected life of the solar system—Austin Energy used CPR's value calculator methodology described above.

The combined calculation approach reflects the fact that ERCOT nodal prices only reflect energy and generation capacity value. Total benefits of distributed solar energy to Austin Energy include energy, generation capacity, fuel price hedge, T&D capacity deferrals, environment, and loss savings.

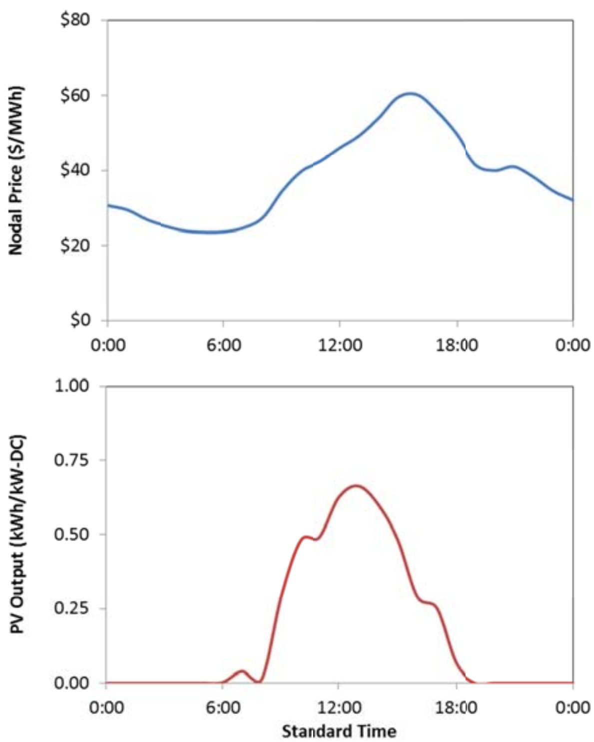

Fig. 1: Nodal price and PV output for July 30, 2011.

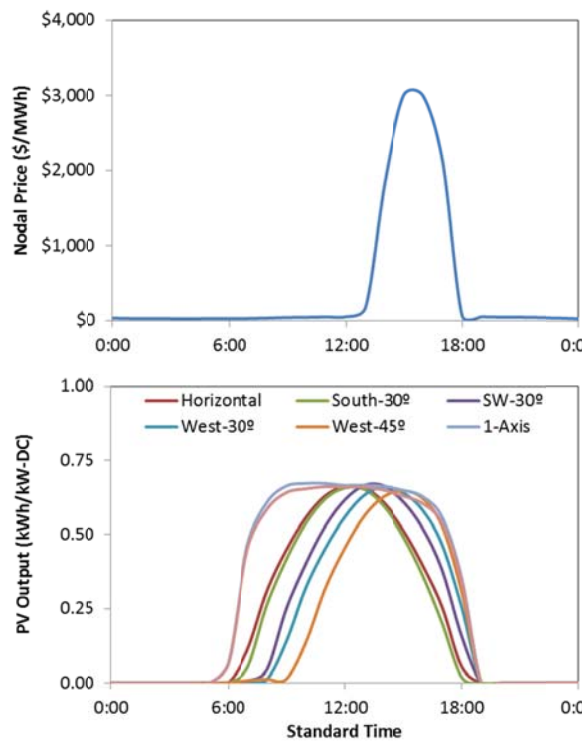

Fig.2: Nodal price and PV output for August 3, 2011.

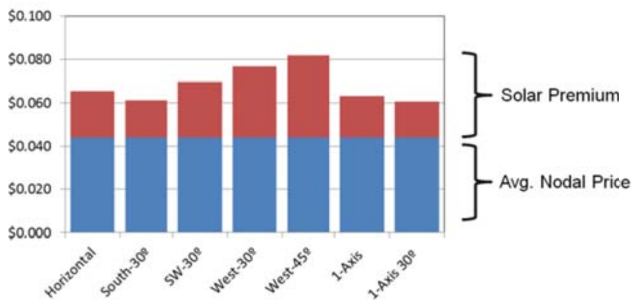

Fig. 3: Annual generation value and the solar premium.

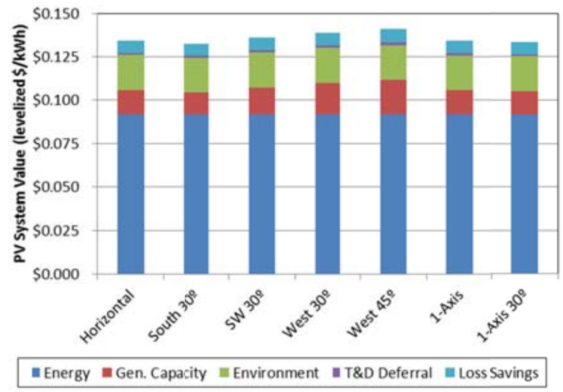

Fig. 4: PV value results by component and configuration.

The value results from the Distributed PV Value Calculator methodology are presented in Fig. 4. The fixed, south-facing PV system with a 30-degree tilt, the most common configuration and orientation in Austin Energy's service territory inventory of some 1,500 distributed solar systems, is taken as the reference system for the solar tariff. For this system, the levelized value of solar is calculated as 12.8¢ per kWh.

Austin Energy used the value of solar calculation to design a simple, improved residential solar rate. Under the new tariff, Austin Energy will calculate the residential customer's charges for electric service as if the customer had no solar PV system at their home, and then credit the customer's bill with an amount equal to the current value of solar times the total number of kWh produced by the solar system. The value of solar is recalculated each along with the utility's fuel charge, to reflect the current value of solar.

The new value of solar rate provides a more fair and accurate credit to the customer for solar generation than the traditionally calculated marginal avoided cost approach, and is more accurate than the traditional net metering approach of crediting the customer at the retail rate for solar generation offsetting consumption and a marginal avoided cost for excess generation. Furthermore, by more fairly crediting customers for installing a higher-value generation resource on the grid, the value of solar rate reduces the payback period for solar investments. And by decoupling the credit from the customer's consumption of energy, Austin Energy's proposed value of solar rate aligns the customer's incentives with a conservation ethic—each additional unit of saved energy earns the customer at least the retail rate, and if it produces a unit of excess solar generation, generates the customer a full value of solar credit.

Finally, the value of solar rate works to ensure that the utility charges for its full cost of serving the customer, even if the customer installs and operates a distributed generation system. This approach stands as a significant improvement over the approach many utilities are trying to take in setting a stand-alone distributed generation service rate aimed at recovering fixed costs associated with providing electric service and infrastructure to self-generating customers.

4. AUSTIN ENERGY REBATE

While the new solar tariff represents a more accurate and sophisticated calculation of the avoided costs to the utility, Austin Energy's rebate program is intended to provide a temporary, supplemental incentive to encourage customer investment in PV.

Since the solar tariff replaces bill savings from net metering as the primary revenue stream benefiting the customer, and generates greater value for the customer, the rebate has to be re-assessed to ensure that the amount represents an equivalent level of cost-effectiveness to the customer-investor.

The following rebate analysis is for the residential program (commercial rebates will be developed at a future date).

For program continuity, the revised rebate will continue to be calculated as it has been in the past:

$$RebateAmount\ (\$) = PVRating(kWdc - stc)\ x\ InverterEfficiency\ (\%)\ x\ RebateLevel\ (\$/kWdc)$$

The program design assumes an 8% per year drop in PV capital cost. Rebate levels reduce correspondingly at capacity-based steps until such time as the rebate is no longer necessary.

Simple payback is taken as the measure of cost-effectiveness (a different measure might be used for the commercial program), and the only other incentive available is the 30% federal tax credit, assumed to be available for all of the years of the study.

Other assumptions included in this example:

- PV capital cost is $4.25 per Wdc.
- PV capital cost reduction of 8% per year.
- Program should lead to 10 MW of new capacity by 2020.
- Rebate decreases to zero by 2020.
- Participation increases by 10% per year.
- Levelized value of solar is $0.128 per kWh.
- PV reference system is south facing, 30° tilt, located in Austin, with a 95.5% inverter efficiency.

Simply payback was calculated for a range of customers and system sizes. For example, by modeling a residential customer on an E01 rate schedule with an original annual electric bill of $1,600 per year, scaling an assumed residential load profile to correspond with this bill amount, modeling the hourly output of a 5 kWdc with the reference system location and orientation, calculating monthly retail bills and net metering carryover, the system would result in annual bill savings to the customer of $701. The reference PV system would produce a total of 6,785 kWh, so the effective economic benefit to the customer is $701 / 6,785 kWh = 10.3¢ per kWh. At this level and the current Austin Energy rebate, the bill savings of the reference PV system corresponds to a simple payback of about 9 years.

Under this structure, the 10 MW of capacity would be expected to be installed by the 2020 target date, and the total program cost may be calculated.

By holding all other values constant, Austin Energy can compare the payback period associated with a conventional net metering approach (value of solar set at residential energy rate) to that for the more comprehensively calculated value (currently $0.128/kWh).

Alternatively, the model can be used to adjust rebates to achieve a target payback period. At this time, Austin Energy is using the model to plan a multi-year rebate structure designed to accomplish a specific program capacity level—a MW goal.

A model was developed to calculate required rebates under an exponentially descending capital cost scenario and converted to capacity based steps using methods described previously [4]. The structure of the stepwise capacity-driven rebate is presented in Fig 5 (the y-axis is intentionally unspecified because the final rebate structrue is still in process).

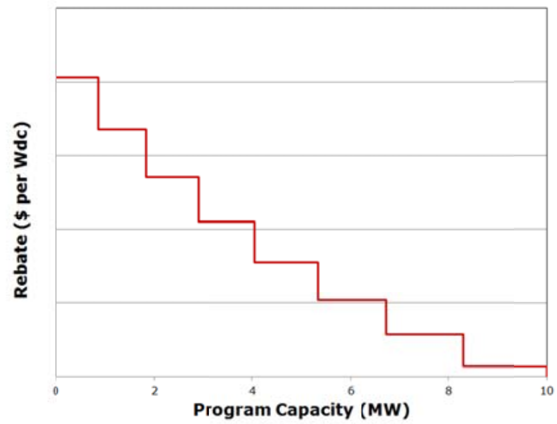

Fig. 5: Austin Energy rebate levels for residential cost-effectiveness.

6. CONCLUSIONS

Austin Energy and CPR have used a multi-factor value of the solar energy calculator to establish a new, proposed "value of solar" residential rate for retail customers. This exciting innovation in solar rate design uses a superior avoided cost calculation and simplified net metering charge and credit approach to more fairly credit customers for the value of their solar generation, align solar rates with energy conservation, and address utility distribution system costs. The more fair and accurate value of solar rate allows utilities to adjust rebates or other special incentives to focus more narrowly on correcting for first-cost and other investment hurdles faced by solar customers.

With the help of an additional cost-effectiveness model developed by CPR, Austin Energy is in the process of tuning its incentive programs to reach a specific program capacity goal while maintaining fidelity to cost-effectiveness criteria. The study demonstrated a model for structuring a stepped capacity-based rebate program. The model incorporates a declining PV price, a volumetric program goal, and a cost-effectiveness test selected as the most relevant for the customer-investor.

The value calculator methodologies were advanced under this study to provide a means for incorporating nodal pricing, specifically the prices system in place in the ERCOT system. This study illustrated the importance of calculating the generation value using properly time-synchronized solar output modeling because of the positive correlation between price and solar output. In the case of Austin Energy, this "solar premium" resulted in generation value of solar as high as twice the average annual price, depending upon configuration.

7. REFERENCES

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(3) Solar Anywhere, 2012. Web-Based Service that Provides Hourly, Satellite-Derived Solar Irradiance Data Forecasted 7 days ahead and Archival Data back to January 1, 1998. www.SolarAnywhere.com.

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