Review of Standby and Ancillary Services in the Context of Behind-the-Meter Photovoltaics

Pieter Gagnon and Alison Holm

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Solar Technical Assistance Team (STAT) Network

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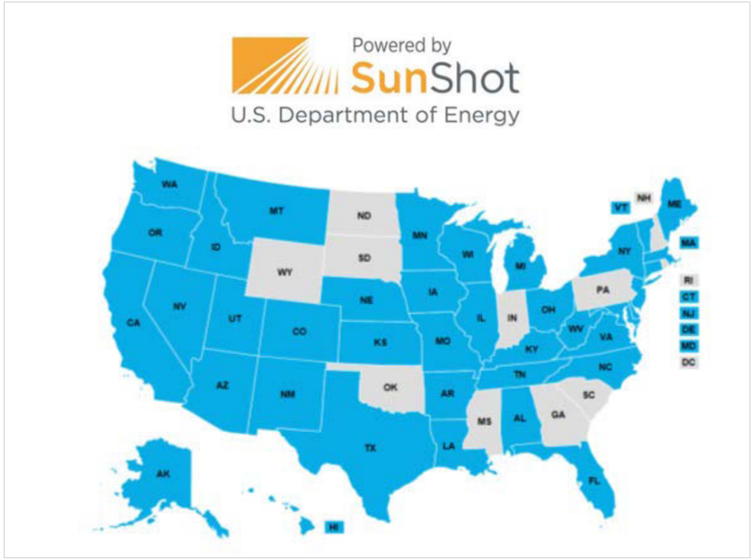

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This presentation was developed to meet an immediate need and was based on the best information the analysts had available within timing constraints.

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NMPRC Request

The New Mexico Public Regulatory Commission (NMPRC) requested information on the following topics:

- Overview of ancillary and standby services
- Examples of how ancillary and standby services are defined, used, and analyzed in other jurisdictions
- Considerations regarding how ancillary and standby services may be economically valued
- Background information on how ancillary and standby services differ from fixed costs to serve owners of behind-the-meter solar photovoltaic (BTM PV) systems.

The assistance was requested within the context of NMPRC's implementation of NM Stat § 62-13-13.2. The scope of technical assistance *does not* include specific legal or advisory support on the statute itself, but instead aims to provide NMPRC with a common set of definitions and summary information on how similar issues are approached in other states.

- Ancillary and Standby Service Definitions
- Interaction of Ancillary Services and Behind-the-Meter PV
- Standby Rate Design
- Rates for Residential Behind-the-Meter PV Customers

Ancillary and Standby Service Definitions

Definitions

- **Ancillary services:** A broad array of services that help system operators maintain a reliable grid with sufficient power quality.
- **Standby services:** Services provided by a utility to one of their customers with on-site generation, where the utility agrees to provide power in instances where the customer's generation is unable to completely supply their electricity demand.

'Ancillary' and 'standby' services are not mutually exclusive. Standby service rates can include components to collect revenue to cover ancillary services.

Ancillary Services

Ancillary services are categorized differently across the various balancing authorities in the US. Below are listed some common broad categories of service:

- Operating reserves: Generators or loads that are capable of adjusting their electrical consumption or generation to respond to supply/demand imbalances over a range of timeframes:
  - Regulation reserves: Reserves held to respond to supply/demand imbalances over relatively short timeframes (i.e., several seconds)
  - Flexibility reserves: Reserves held to respond to supply/demand imbalances on timescales greater than regulation reserves, and to address imbalances from forecast error.
  - Contingency reserves: Reserves held to meet unplanned generation or transmission outage.
- Frequency control/regulation: Actions to ensure that the grid frequency stays within a nominal range.
- Voltage control: Actions to ensure that voltage levels on distribution networks stay within a nominal range. Often includes the provision of reactive power.
- Black-start capability: Actions to restart the electric grid after a complete loss of power.

Ancillary services are procured regardless of the existence of distributed generation (DG), although DG can influence the cost of having a particular service fulfilled. We discuss the impact of behind-the-meter (BTM) PV on reserves and voltage control on the following slides. Other services, like black-start regulation, may not be meaningfully affected by DG, depending on interconnection guidelines.

Standby Services

Standby rates can include different types of services that a utility is agreeing to provide to the customer. *Standby rates for customer-cited resources* (EPA, 2009) defines the four most common as:

- *Supplemental power*: Additional electricity for customers whose onsite generation does not cover all their needs. In many cases this is the otherwise applicable full requirements rate.
- *Backup power*: Supports load that would otherwise be served by DG during unscheduled outages of onsite generation.
- *Scheduled maintenance power*: Provision of service when DG is scheduled to be out. Since this is typically during off-peak hours, this often does not include capacity charges.
- *Economic replacement power*: Electricity offered by the utility, when it can be sold at lower prices then the cost of on-site generation.

The majority of residential behind-the-meter PV adopters in the U.S. purchase supplemental power from their utility under the otherwise applicable full requirements rate.

Ancillary Services: Revenue Collection and Interaction with Behind-the-Meter PV

BTM PV Impacts on Reserves

Operating reserves are traditionally required at the transmission level and typically provided by centralized conventional generators, although centralized renewable generators and distributed generators are increasingly providing them as well. The table below summarizes a literature review of how various reserve types may be impacted by behind-the-meter PV.

Operating reserve type	Description	Impact of Behind-the-meter PV
Contingency reserves	Reserves held to meet unplanned generation or transmission outage	**Typically none** if reserves are based on single-largest contingency. If based on load, BTM PV could reduce reserve requirements
Regulation reserves	Reserves held to respond to small fluctuations in load	BTM PV typically increases short-term variation in net load, and thus tends to **increase this reserve requirement**
Flexibility reserves	Reserves held to respond to variations in net load on timescales greater than met by regulation, as well as variations from forecast error	BTM PV typically increases long-term variation in net load and uncertainty in net load over various timescales, and thus tends to **increase reserve requirements**

The content on this slide was adapted from *Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generators to the U.S. Electric Utility System*, Denholm et. al, 2014.

Impact of BTM PV on Voltage Control and Reactive Power Provision

Reactive Power: At the transmission level, reactive power is used to serve loads that need it, ensure stability, and maintain system voltage. Most transmission-scale reactive power is provided by traditional generators. BTM PV with advanced inverters is technically capable of providing reactive power, and thus reducing the quantity of power required from traditional generators.

Voltage Control: Power injections from BTM PV can cause local voltage problems, thus BTM PV can raise the cost of voltage control. The threshold at which PV would have the potential to violate voltage limits varies between feeders and where the PV is located. Advanced inverters can mitigate this problem, although there are currently no incentives to encourage PV owners to provide this service.

The content on this slide was adapted from *Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generators to the U.S. Electric Utility System*, Denholm et. al, 2014.

Estimating BTM PV Impact on Ancillary Services

Approaches for estimating the impact that BTM PV has on ancillary services can be broadly grouped into three categories:

- Assume no impact:
  - Assumes PV penetration is too small to have a quantifiable impact.
- Simple cost-based methods:
  - Make a simple estimate of the impact of BTM PV on the quantity of a service required, and then multiply that by a historical or estimated cost of providing that service. For example, assume that PV reduces net load, therefore reducing spinning reserve requirements. Multiply by the historic cost of spinning reserves in CAISO to obtain an estimate of the benefit.
  - This method is inherently limited, since most ancillary services do not have simple relationships with the quantity of BTM PV in a region, and many services do not have markets to observe prices.
- Detailed cost-benefit analysis:
  - Detailed analysis of BTM PV's impact on ancillary services generally requires state-of-the-art approaches and tools. A discussion of these tools and approaches is given in Denholm et. al 2014.

The content on this slide was adapted from *Methods for Analyzing the Benefits and Costs of Distributed Photovoltaic Generators to the U.S. Electric Utility System*, Denholm et. al, 2014.

Ancillary Service Revenue

The costs of procuring ancillary services are typically bundled into rates. Some rates list their constituent components, which can provide insight into the relative contribution of particular ancillary services. For example, below is a subset of the unbundled components from Tuscan Electric Power's (TEP) Residential Basic Service and Large General Service rates (TEP 2017A, TEP 2017B).

	Residential Basic Service	Large General Service
System control and dispatch	0.012 ¢/kWh	$0.05/kW
Reactive Supply and Voltage Control	0.045 ¢/kWh	$0.18/kW
Regulation and Frequency Response	0.044 ¢/kWh	$0.18/kW
Spinning Reserve Service	0.119 ¢/kWh	$0.48/kW
Supplemental Reserve Service	0.019 ¢/kWh	$0.08/kW
Total	0.239 ¢/kWh	$0.97/kW

The average cost of electricity for the residential sector in TEP is approximately 11 ¢/kWh (EIA 2017), so the services listed here make up approximately 2% of the total cost of electricity. Note that all of the revenue for ancillary services that support electricity to the residential basic service customers are collected through energy (¢/kWh charges), whereas all revenue for the large general service customers is collected through demand ($/kW) charges. This is not ubiquitous, but is also not uncommon.

Standby Rate Design

Standby Rate Design

Historically, standby rates have primarily been applied to customers with large on-site generation, typically megawatt-scale co-generation or fossil fuel generators. Standby rates specifically designed for behind-the-meter PV are relatively new and less widespread. Rates and charges specific to residential BTM PV customers will be discussed in following slides.

Standby rates for customer-sited resources (EPA 2009) reviews existing standby rates. They posit that well-designed standby rates will "…give customers a strong incentive to use electric service most efficiently, to minimize the costs they impose on the system, and to avoid charges when service is not taken." They suggest that the following best practices:

- Contract demand or reservation charges are small in relation to the variable charges for peak demand and energy
- Peak demand charges are not ratcheted
- Revenue to cover capacity costs are recovered either through energy charges or daily as-used demand charges
- The rate structure yields a high value of retail rate savings per kWh produced on-site instead of purchased from the grid

Standby rates for Combined Heat and Power Systems (RAP 2014) also discusses best practices in standby rate design, and presents five case studies of existing standby rates in the U.S. A subset of their recommended best practices are paraphrased here:

- Unbundled, for transparency
- Supplemental power should be based on the otherwise applicable full requirements rate
- There should not be an assumption that all forced outages of on-site generators occur simultaneously, or during system peak, unless there is statistical evidence of either one
- Pro-rated, daily, as-used demand charges for backup power should be used to provide an incentive for generator reliability

The criteria outlined above are illustrative examples, and not meant to be an endorsement. There is reasonable disagreement in the literature about what constitutes a well-designed standby rate. There is no objectively correct answer, because – as with all rate design – there are tradeoffs between different objectives (e.g., economic efficiency, equity in contribution towards fixed charges covering historical investments, rate complexity, metering technology requirements, etc.)

Overview of Charges and Rates for Residential Behind-the-Meter PV Customers

Rates and Charges Specific to Residential BTM PV Customers

- The following slides highlight examples of charges or rates specifically applied to residential customers with BTM PV systems. The rates and charges take different forms, such as:
  - An additional monthly charge based on the capacity of the installed PV system.
  - A reduction of the per-kWh charges and the introduction of a demand charge component, relative to the standard rate for customers without PV.
  - An additional per-kWh charge based on the metered production of the PV system.
  - The creation of a separate rate class for residential PV customers.
  - Higher fixed charges for PV customers, relative to non-PV customers.

- The stated motivations for introducing or increasing residential BTM PV customers varies between utilities, but typically include a concern that customers on primarily volumetric rates are avoiding revenue collection that is nominally intended to cover payments for historical capacity investments by the utility, and therefore shifting those costs to utility shareholders and other non-adopting ratepayers.

- We only discuss a sample of rates or charges specifically applied to residential BTM PV customers. Other actions potentially motivated by similar concerns, such as increasing fixed charges for all customers or a transition to time-of-use rates, are not discussed here. For a more exhaustive aggregation of rate proposals that potentially influence BTM PV, see the quarterly 50 States of Solar reports put out by the North Carolina Clean Energy Technology Center.

Residential BTM PV specific charges and rates that were proposed but ultimately not implemented

Georgia Power: In 2013, GP proposed a monthly fee based on the installed capacity of the PV system – $5.56/kW-installed per month. This proposal was withdrawn as part of a settlement agreement. Ultimately, rates that compensate distributed solar at an avoided cost rate were implemented.

Public Service Company of New Mexico: In 2014 PNM proposed an "interconnection fee" of $6/kW-installed per month. This was rejected by the PRC in 2015, citing application incompleteness.

Southern California Edison: In 2015 SCE proposed a monthly $3/kW-installed "grid access charge" as a successor for net energy metering (NEM). This was not implemented, and ultimately full-retail NEM was replaced with "NEM 2.0" that has non-bypassable charges for solar customers, but no standby-style component.

Residential BTM PV specific charges and rates that were proposed but ultimately not implemented

El Paso Electric: In 2015 EPE proposed a "Partial Requirements" rate class for residential customers with DG. Ultimately a settlement was reached that does not include demand charges, and instead has a $30 minimum bill for new DG solar customers.

Oklahoma Gas and Electric: In 2015, OK G&E proposed adding a demand charge to and increasing the fixed charge of its residential time-of-use (TOU) tariff, which is mandatory for all new DG customers. In 2017 the Oklahoma Corporation Commission rejected the increased fixed charges and mandatory demand charges.

Rocky Mountain Power: In 2016, RMP proposed a successor NEM rate that had a higher fixed charge, as well as a rate with a demand charge. Both proposals were suspended to allow discussion among stakeholders. A three-year transition program is currently underway that has a slightly reduced export rate for solar, as the PSC studies the value of exported solar.

Oncor: In 2017, Oncor proposed adding a demand charge for residential DG, that would only be applied if the customer's monthly bill would otherwise fall below the demand charge level. In this manner, it acted as a minimum bill, where the lower limit of each customer's bill would be set by their monthly billing demand. This proposal was dropped in a settlement.

Residential BTM PV specific charges or rates that are pending

Tucson Electric Power: In 2015, TEP proposed new rates for “partial requirements customers,” including new solar adopters. There are two proposed rates. Both have TOU energy charges, but one includes a $2.50/kW-installed grid access fee, and the other includes a demand charge. TEP’s proposal is still pending.

Unisource Energy Services: In 2015, UES proposed new rates for “partial requirements customers,” including new solar adopters. There are two proposed rates. Both have TOU energy charges, but one includes a $1.00/kW-installed grid access fee, and the other includes a demand charge. UES’s proposal is still pending.

Residential BTM PV specific charges or rates that have been implemented

Arizona Public Service (APS):

- APS has implemented three revenue-related mechanisms motivated in part by distributed PV adoption. Only one of the DG-specific rates has a traditional standby component – the other details are given for context.
- **Rates for DG customers:**
  - In 2017, a settlement was reached where residential DG customers have a choice between four rates. Three of the rates have demand charges, and one has TOU energy charges and a per-kW-installed standby charge (A “Grid Access Charge” of $0.93/kW-dc-installed).
- **Compensation for exported solar electricity:**
  - Solar export rates (which are reevaluated annually) are determined either by a “Resource Comparison Proxy” or based off of an avoided cost estimation that includes a 5-year forecast. The methodology was developed as part of a value-of-solar proceeding.
- **Lost Fixed Cost Recovery (LFCR) adjustment charge:**
  - The Arizona Corporation Commission has approved APS collecting revenue from the general population, to cover a portion of the revenue that nominally would have contributed towards fixed costs, but was not collected due to energy efficiency or distributed generation.
    - “The LFCR mechanism permits APS to recover on an after-the-fact basis a portion of its fixed costs that would otherwise have been collected by APS in the kWh sales lost due to APS energy efficiency programs and to distributed generation such as rooftop solar arrays. The fixed costs recoverable by the LFCF mechanism were established in the 2012 Settlement Agreement and amount to approximately 3.1 cents per residential kWh lost and 2.3 cents per non-residential kWh lost. The LFCR adjustment has a year-over-year cap of 1% of retail revenues. … Distributed generation sales losses are determined from the metered output from the distributed generation units” (APS Rate Application e-01345A-16-0036, part 1 of 3)
  - For example, on January 15th, 2016, APS filed its annual LFCR adjustment, requesting an adjustment of $46.4 million to be effective for the first billing cycle of March 2016. This revenue is collected from both adopters and non-adopters of BTM PV.

Residential BTM PV specific charges or rates that have been implemented

Eversource: In 2018, Eversource won approval from the Massachusetts Department of Public Utilities to implement a Monthly Minimum Reliability Contribution. This will be implemented as a mandatory demand charge rate for residential customers with solar.

Santee Cooper: In 2015, SC implemented a monthly $4.40/kW-installed standby charge for distributed solar customers. In 2017, SC proposed increasing this charge, but the SC board of directors later suspended the proposed rate increase after the construction of the V.C. Summer Nuclear plant was halted.

Salt River Project: In 2015, SRP implemented a mandatory rate for residential PV customers. Compared to their residential time-of-use plan for non-solar customers, the solar rate has reduced energy charges, the addition of a demand charge, and higher fixed charges.

Southwestern Public Service Company: In 2015, SPS proposed increasing their already-existing standby charge for residential DG customers from $0.031/kWh to $0.041/kWh. The charge is based off of DG production, regardless of whether it is consumed onsite or exported. A 2016 stipulation agreement kept the charge at the $0.031/kWh level. Since the agreement there have been other efforts by SPS to increase the standby charge, including an effort ongoing at the time of this document’s publication.

Alabama Power: AP has a monthly $5/kW-installed charge for residential solar customers.

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