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Net Metering: In Brief

November 14, 2019

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SUMMARY

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Net metering is a policy that allows electricity customers with their own generation capacity to be financially compensated for the energy they produce. Net metering is widely regarded as having an important role in deployment of distributed generation (DG), especially solar energy. State and local governments have authority to establish net metering policies, and some have done so for many years. Congress took action to encourage net metering in the Energy Policy Act of 2005 (EPACT05), and the policy now exists, in some form, in 45 states. Recent state net metering policy modifications, and potential effects on solar energy deployment, may be relevant to congressional discussions regarding the role of renewable energy sources in the nation's electricity system.

Solar photovoltaic panels (e.g., rooftop solar) accounted for 97% of the generation capacity participating in net metering programs in 2018. Net metering participation roughly quadrupled from 2013 to 2018, according to data from the U.S. Energy Information Administration. Hawaii has the highest participation rate of any state, with 15% of electricity customers participating in net metering in 2018. In a majority of states, however, net metering customers account for less than 1% of total electricity customers.

States differ in the way net metering customers are compensated. A common method is the retail rate, under which energy from net metering capacity offsets energy consumed from the grid in a one-to-one fashion. This method is often described as the "meter running backward." Retail rate compensation was initially adopted, in large part, for its administrative simplicity. Some stakeholders continue to prefer it for the relatively high payments it gives to net metering customers. Other stakeholders criticize retail rate compensation as overcompensating net metering customers for the electricity they produce. Part of this criticism comes from the fact that electricity retail rates reflect not just costs associated with generating electricity, but also costs associated with building, maintaining, and operating the transmission and distribution systems ("the grid"). Electricity rates are typically designed so that utilities can recover their total costs associated with providing electricity. If a sufficiently large number of customers participate in net metering, costs might increase for non-net metering customers in order to pay for the grid benefits. This possibility is known as a cross-subsidy, or sometimes a cost shift. In addition to these concerns about fairness, some critics of retail rate compensation raise concerns about equity, because historically most net metering customers have had above-average incomes. Empirical evidence of the cost increases for non-net metering customers is mixed, partly because studies make different assumptions about costs and benefits associated with DG. Some projections in different states have quantified a potential cross-subsidy, but projections in other states have concluded that the value of cross-subsidies are approximately zero.

States have considered, and in some cases adopted, alternative compensation approaches to address concerns over cross-subsidies. One type of approach adds a fixed charge to net metering customers' bills to reflect the costs of maintaining the grid. Another type of approach provides an alternative compensation rate (i.e., not the retail rate) that net metering customers receive for the energy they deliver to the grid. Options for alternative compensation rates are avoided cost rates, which reflect primarily the utility's cost of producing electricity, and value of solar (VOS) rates, which additionally consider societal benefits such as reduced air emissions. Generally, rates that consider more benefits (and avoided costs) associated with DG have a higher monetary value and might promote greater levels of DG penetration. States have included different costs and benefits in analyses conducted to estimate alternative compensation rates, resulting in different monetary values for alternative rates. Even if states opted to include the same types of costs and benefits, they might derive different values for rates, since the relative costs and benefits of DG can vary based on local circumstances. Relevant local circumstances include overall penetration of DG, average and marginal electricity costs, congestion in transmission and distribution systems, and potentially other factors.

Other state net metering policy provisions can affect deployment of DG. They relate to whether to adopt program caps, thereby limiting the number of participants; which technology type and what size generator are eligible; how long customers can "carry over" credits associated with surplus electricity generation; and what types of system ownership arrangements may participate in net metering. A related consideration is whether third parties, such as solar leasing firms, may develop DG in the state.

Some Members of Congress have expressed interest in various aspects of net metering policy since passage of EPACT05. Legislation has sought to limit revisions that states can make to net metering policies; expand access to net metering for different types of electricity generation; and estimate costs and benefits associated with net metering, among other topics.

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Introduction

For roughly the first 100 years of the electric power industry, electricity generation occurred mostly in large, centralized power plants. Partly in response to the energy crisis of the 1970s, Congress established policies to promote, among other things, alternatives to centralized power plants, including generation capacity located on customer property.[1] Customer-sited generation is a type of distributed generation (DG) and can be located on commercial, industrial, or residential properties.[2]

One policy intended to promote DG is net metering. In the Energy Policy Act of 2005 (EPACT05; P.L. 109-58) Congress encouraged states to adopt net metering, defined in the law as

> service to an electric consumer under which electric energy generated by that electric consumer from an eligible on-site generating facility and delivered to the local distribution facilities may be used to offset electric energy provided by the electric utility to the electric consumer during the applicable billing period.[3]

State net metering policies may be relevant to congressional discussions about the role of renewable energy sources, like solar, in the nation's electricity system. Solar photovoltaic (PV) is the most commonly deployed energy type participating in net metering, comprising 97% of net metering capacity in 2018.[4] Other federal and state policies (e.g., tax incentives, renewable portfolio standards, carbon pricing) may interact with net metering policies to determine the deployment pace of distributed solar energy sources and other types of DG.

Also, some Members of Congress may be interested in how some states have modified their net metering policies in recent years, including the effect of those modifications on stakeholders. Some recent state policy changes are expected to expand solar energy development, while others are expected to slow it. Among other options, Congress could choose to restrict, encourage, or require certain kinds of state policy modifications, or take no action on state net metering policies, depending on congressional priorities. This report provides background information and discusses current issues related to net metering policy.

What Is Net Metering?

Net metering policies determine how electricity customers with distributed generation are compensated for electricity they deliver to the grid.

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[1] For instance, some policies were included in the Public Utility Regulatory Policies Act of 1978 (PURPA; P.L. 95-617).

[2] Distributed generation (DG) is one type of distributed energy resource (DER), the other types being energy efficiency and demand response. This report only discusses DG. Other types of DER do not participate in net metering programs because they do not generate electricity. In cases where energy storage, such as a battery, is co-located with DG behind a single meter, the combined system typically participates in net metering as a single unit of generation capacity.

[3] 16 U.S.C. §2621(d). Net metering, like other retail electricity transactions, is regulated at the state or local level. EPACT05 added net metering to the list of "states-must-consider" standards in PURPA. Federal law does not require states to adopt these standards, but it does require states to consider adopting these standards. For a discussion of the "states-must-consider" standards see Department of Energy (DOE), *Public Utility Regulatory Policies Act of 1978 (PURPA)*, accessed August 30, 2019, https://www.energy.gov/oe/services/electricity-policy-coordination-and-implementation/other-regulatory-efforts/public.

[4] CRS analysis of data from U.S. Energy Information Administration (EIA), *Form EIA-861M (formerly EIA-826) Detailed Data*, updated June 27, 2019, https://www.eia.gov/electricity/data/eia861m/. This statistic includes virtual net metering capacity (i.e., community solar) which is not necessarily located on customer property.

Net metering is frequently used to mean a policy of *net energy metering* (NEM), which specifies that electricity delivered to the grid from a net metering customer is compensated on a one-to-one basis for electricity purchased from the grid. Every unit of electricity generated by the customer (typically expressed in kilowatt-hours, kWh) is subtracted from the amount of electricity they consume, for billing purposes. This is frequently described as "the meter running backward."[5]

Other analyses and discussions sometimes distinguish different policy options, including:

- *buy-all, sell-all*, under which a utility buys all electricity generated by the net metering customer at one (usually, lower) rate and sells all the electricity consumed by the customer at a different rate (usually the same retail rate charged to any other customer); and
- *net billing*, under which electricity delivered to the grid is compensated at a pre-determined value, which might be measured as a rate or a fixed amount.[6]

This report will generally use the term *net metering* to refer to any of these policies since they are closely related to each other, in that they provide financial support for DG.

How Common Is Net Metering?

As of April 2019, 45 states had net metering policies in place that require utilities to offer net metering to customers. Some of these policies include alternatives to net energy metering. Further, some of these policies predate EPACT05.[7] In the states that do not require utilities to offer net metering, some utilities voluntarily offer net metering service to customers.

According to the U.S. Energy Information Administration (EIA), almost 2 million customers participated in net metering programs in the United States in 2018, compared to over 153 million electricity customers overall.[8] In other words, about 1% of U.S. electricity customers in 2018 participated in net metering. The number of net metering customers increased from 2013 to 2018 as shown in **Figure 1**. Data before 2013 also show growth in net metering participation, but EIA changed the way it reported net metering data beginning in 2013, so these data are not shown below, in the interest of consistency.[9]

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[5] The concept of an electricity meter comes from the behavior of older, mechanical electricity meters. In these meters, a dial can spin forward or backward depending on whether electricity is flowing to or from the customer. Most electricity meters installed today use digital technology and do not literally run backward when surplus generation is delivered to the grid.

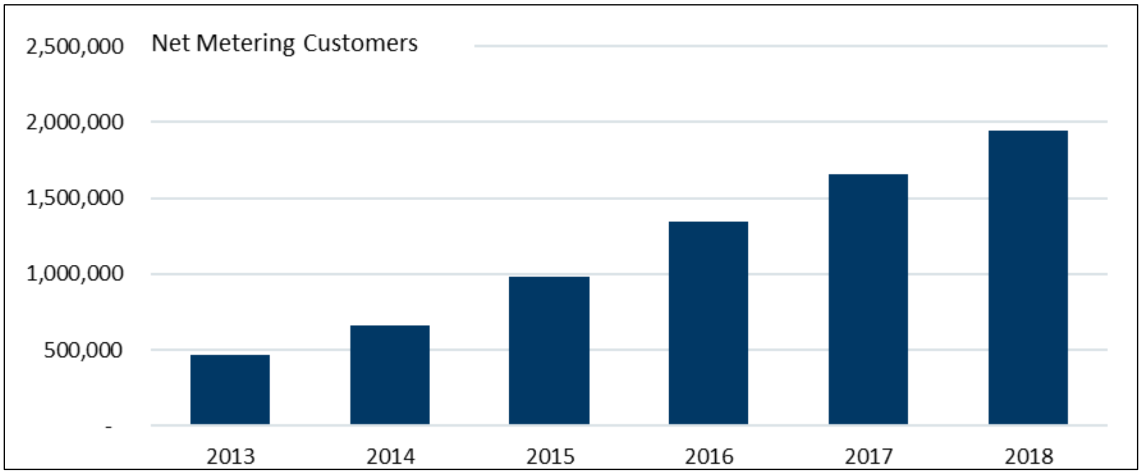
[6] For further discussion of these compensation approaches, see Owen Zinaman et al., *Grid-Connected Distributed Generation: Compensation Mechanism Basics*, NREL, October 2017, https://emp.lbl.gov/publications/grid-connected-distributed-generation.

[7] North Carolina Clean Energy Technology Center, *Net Metering*, April 2019, https://s3.amazonaws.com/ncsolarcen-prod/wp-content/uploads/2019/07/DSIRE_Net_Metering_April2019.pdf. The North Carolina Clean Energy Technology Center includes only net energy metering policies in its assessment of net metering, so it reports 40 states with net metering policies and 5 states with other related policies. Using the broader definition of this report, all 45 policies qualify as net metering. Other analyses may present different counts of state policies, depending on how they define net metering.

[8] EIA, *Form EIA-861M (formerly EIA-826) Detailed Data*, updated June 27, 2019, https://www.eia.gov/electricity/data/eia861m/, and EIA, *Electricity Data Browser*, accessed August 30, 2019, https://www.eia.gov/electricity/data/browser/.

[9] EIA, *Participation in Electric Net-Metering Programs Increased Sharply in Recent Years*, May 15, 2012, https://www.eia.gov/todayinenergy/detail.php?id=6270.

Figure 1. U.S. Net Metering Customers



Source: EIA, *Form EIA-861M (formerly EIA-826) Detailed Data*.

Notes: Customer count is summed for all technology types and customer types reported by EIA. U.S. total includes all states and the District of Columbia. EIA changed how data were reported beginning in 2013. For consistency, earlier data are not shown. Data in 2017 and 2018 include participation in virtual net metering (e.g., community solar), in which the distributed generation is not necessarily located on the customer's property.

Net metering participation can be measured in other ways, such as total net metering capacity or the amount of electricity delivered to the grid from net metering generators. According to the EIA data, these measures have seen average annual increases similar to customer count.[10]

Levels of net metering participation vary by state, as shown in **Figure 2**. In many states, less than 0.1% of electricity customers participate in net metering. Hawaii has the highest participation rate, with over 15% of customers participating in the state's net metering programs.[11] Some potentially relevant factors for the differences among states include design of state net metering policies, presence of other state policies such as renewable portfolio standards (which may incentivize renewable DG),[12] average electricity prices, and solar resource quality. A full analysis of the factors behind different state participation rates is beyond the scope of this report.

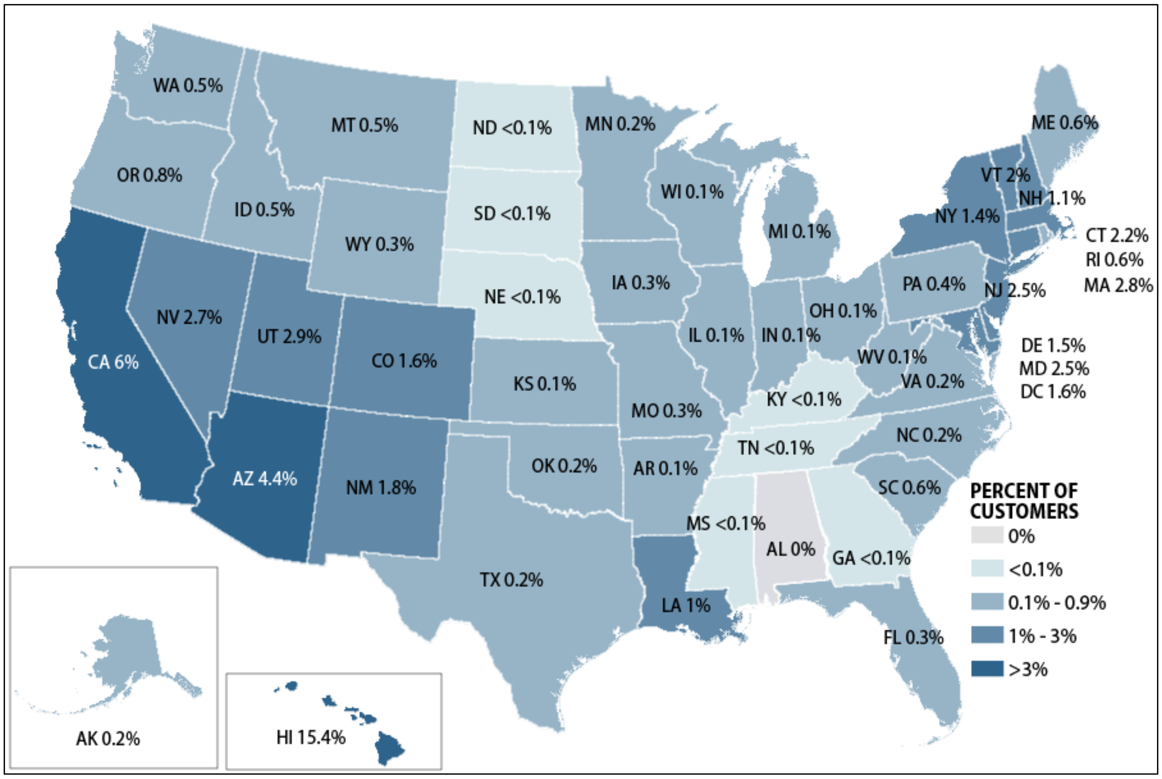
[10] EIA, *Form EIA-861M (formerly EIA-826) Detailed Data*, updated June 27, 2019, https://www.eia.gov/electricity/data/eia861m/.

[11] Hawaii's policy for compensating DG is different than many states, though it is similar to a net billing approach. See DSIRE, *Distributed Generation Tariffs*, updated November 28, 2018, https://programs.dsireusa.org/system/program/detail/596.

[12] For further discussion of renewable portfolio standards, see CRS Report R45913, *Electricity Portfolio Standards: Background, Design Elements, and Policy Considerations*, by Ashley J. Lawson.

Figure 2. 2018 Net Metering Participation Rates, by State

Share of Total Electricity Customers Participating in Net Metering



Source: CRS analysis of EIA, *Form EIA-861M (formerly EIA-826) Detailed Data*, updated June 27, 2019, https://www.eia.gov/electricity/data/eia861m/, and EIA, *Electricity Data Browser*, https://www.eia.gov/electricity/data/browser/.

Notes: Net metering customers include all technology types and customer types reported by EIA. Total electricity customers include all customer types. EIA did not report any net metering customers in Alabama for 2018.

Overview of Electricity Ratemaking

This section provides an overview of how electricity rates are set in general, in order to clarify major areas of debate for state net metering policies.

Electricity ratemaking is the process of allocating to customers the total costs that utilities incur when producing and delivering electricity. Many complexities and local factors influence ratemaking. A full discussion is beyond the scope of this report.[13] As an illustrative example, this section discusses typical ratemaking considerations for vertically-integrated investor-owned utilities.[14] In its service territory, this type of utility owns and operates all parts of the electricity system, from electricity generation to transmission and distribution to customers. State regulators

[13] For a discussion of the history, economic principles, and different options for ratemaking, see Jim Lazar, *Electricity Regulation in the U.S.: A Guide. Second Edition*, Regulatory Assistance Project, June 2016, https://www.raponline.org/knowledge-center/electricity-regulation-in-the-us-a-guide-2/.

[14] Utilities vary in the parts of the electricity system they own (i.e., generation, transmission, or distribution) and the types of regulators they have (e.g., state commissions, local governments, or electric co-operative member-elected boards). Despite these differences, most utilities charge rates reflecting total utility costs.

conduct the ratemaking process and approve rates that the utility can charge its customers. Regulators design rates so that utilities can recover their costs through customers' bill payments.[15] These costs generally include:

- the costs of building and operating power plants, including fuel costs and compliance with any applicable regulations (e.g., environmental, safety, reliability);
- the costs of building and maintaining transmission and distribution systems (i.e., the grid);
- regular utility operating costs, such as ensuring reliable grid operation (i.e., grid services) or collecting meter data for billing;
- any programmatic costs, such as bill relief for low-income consumers or implementation of other public policies; and
- a return on the utility investments (i.e., return on equity or ROE).

A common method for setting rates is to establish volumetric rates (sometimes called flat rates).[16] All customers within a given type, or customer class, will pay the same rate expressed in cents per kilowatt-hour (cents/kWh). The more electricity a customer uses, the higher a bill they will have. Customers' bills will vary each month based on the amount of electricity they consume. Regulators estimate a value for the volumetric rate that will allow the utility to recover its total costs, based on projections of total sales for all customer classes. In this way, the costs for electricity generation, transmission, distribution, and other utility expenses are shared among all customers.

Costs associated with customer service (e.g., billing, connections) sometimes are separated from the electricity rate and recovered in a separate customer charge. This charge would appear as a fixed value on the customer's bill and would not change from month to month. Customer charges are additional to rates. In other words, a customer's bill would have volumetric charges (rate times kWh consumed) plus a fixed customer charge.

Some customer classes, such as large industrial facilities or institutions, consume so much electricity that utilities might make special system modifications for them. In some cases, utilities recover these costs in a demand charge that is only paid by those high-consuming customers. Like customer charges, demand charges are generally additional to volumetric charges and do not typically change from month to month.

[15] Often, different types of customers, or customer classes, are charged different rates. For example, the per unit price for electricity delivered to an industrial customer is usually different than the per unit price delivered to a residential customer. Each of these rates requires regulatory approval, and the combined total of expected customer bill payments across all customer classes is designed to equal total utility costs (including a return on equity for investor-owned utilities).

[16] Other rate approaches include time varying rates (i.e., time of use rates), which reflect the variations in the cost of supplying electricity at different times (higher in the evening and lower overnight, for example), and block rates, which charge a different rate for electricity consumed above and below defined thresholds. These approaches are discussed in the context of distributed energy resources in NARUC, *Distributed Energy Resources Rate Design and Compensation*, November 2016, https://pubs.naruc.org/pub.cfm?id=19FDF48B-AA57-5160-DBA1-BE2E9C2F7EA0.

Net Metering Compensation

EPACT05 encouraged states to adopt net metering,[17] but the law did not specify how customers should be compensated. States with net metering have taken different approaches in implementing their policies, and many states have revised their compensation approaches in recent years. These decisions may affect DG markets. As one study from the National Renewable Energy Laboratory observed, "compensation mechanisms impact DG deployment because they strongly influence the value proposition of a DG investment for individual customers."[18]

This section describes some elements of states' approaches to implementing net metering.

Retail Rates for Net Metering Customers

A common approach to net metering is to compensate net metering customers at the utility's approved retail rate of electricity. This is frequently described as a net energy metering (NEM) policy, or simply net metering.

A 2019 review of state net metering policy revisions describes how state policymakers initially viewed the retail rate as a "close-enough proxy" for rate setting, as follows:

> Initially, NEM was largely understood to be an administratively simple, rough-justice approach that was acceptable at a time when markets for solar PV and other DG were uneconomic. In many of the initial decisions about NEM, policy makers assumed that the retail rate was a close-enough proxy for the value of solar or value of DG, and the total numbers of participating customers and kilowatt hours being credited at the retail price were relatively small ... the small number of participating customers multiplied by the small quantity of energy each would deliver to the grid, meant that any error associated with under- or over-estimating the true value would be small.[19]

Retail rates provide relatively high compensation for net metering generation (see **Figure 3**). As described above (under "Overview of Electricity Ratemaking"), this is because the retail rate for any electric utility customer reflects the total costs the utility incurs for delivering electricity, including generating electricity and maintaining the grid. Retail rates may encourage net metering participation to a greater extent than other compensation approaches because customers can recover the upfront costs of a DG system more quickly.

Some stakeholders have noted the possibility that compensating net metering customers at the retail rate may result in increased costs for non-net metering customers. This possibility, known as a cost shift or cross-subsidy, arises from the fact that the ratemaking process allocates total utility costs among all customers. Net metering customers generate electricity for their own consumption, which reduces the amount of utility-provided electricity they need (and, consequentially, the utility's costs to produce electricity). However, self-generation does not necessarily reduce the amount of other utility-provided services a customer uses (or, generally, the utility's costs to provide those services, such as maintaining the grid).[20] For example, solar net

[17] 16 U.S.C. §2621(d).

[18] Owen Zinaman et al., *Grid-Connected Distributed Generation: Compensation Mechanism Basics*, NREL, October 2017, https://emp.lbl.gov/publications/grid-connected-distributed-generation.

[19] Tom Stanton, *Review of State Net Energy Metering and Successor Rate Designs*, National Regulatory Research Institute, May 6, 2019, p. 7, https://pubs.naruc.org/pub/A107102C-92E5-776D-4114-9148841DE66B/.

[20] See Lisa Wood, *Value of the Grid to DG Customers*, Edison Foundation, October 2013, https://www.edisonfoundation.net/iei/publications/Documents/IEE_ValueofGridtoDGCustomers_Sept2013.pdf.

metering customers might consume electricity from the grid at night and derive reliability benefits from the grid even when the sun is shining.[21] Over time, rates for non-net metering customers could increase so the utility could recover the costs of maintaining the grid that are not recovered from net metering customers. Some stakeholders also have noted that residential net metering customers have tended to have higher incomes than non-net metering customers, raising potential equity concerns over cross-subsidies.[22]

Studies disagree on the extent to which non-net metering customers may be cross-subsidizing net metering customers. Studies have used different methodologies in estimating cross-subsidies, including which costs and benefits are included and over what timeframe the costs and benefits are considered. These methodological differences may help explain the lack of a consensus view on the magnitude of cross-subsidies. Also, any observed cross-subsidies may be affected by local factors, such as DG penetration and electricity demand growth, which may change over time. As a result, an estimate conducted in one state in one year cannot necessarily be extrapolated to all states in all future years. One synthesis of estimates conducted in or around 2015 found that net metering cost shifts range from $444 to $1,752 per net metering customer per year.[23]

Observers may disagree on how much of a cross-subsidy is large enough to warrant policy action. Net metering, and any associated cross-subsidies, is only one factor affecting electricity rates. A 2017 study assessed the potential rate effects of a variety of factors, including net metering, energy efficiency, natural gas prices, state renewable portfolio standards, the federal Clean Power Plan (which was never implemented), and utility capital expenditures.[24] That study found that the rate effects of DG would likely be increases between 0.03 cents/kWh and 0.2 cents/kWh, compared to increases up to 3.6 cents/kWh caused by other factors.[25]

The possible presence of a cost shift does not necessarily mean that non-net metering customers are transferring money to net metering customers. The extent to which this might occur would depend, among other things, on net metering participation rates and ratemaking decisions made by regulators. There could be a delay in addressing cost shifts through normal ratemaking processes because those processes have inherent time lags. Further, cost shifts are not unique to DG. As noted in a guide for state regulators, "cost shifting, or subsidies, is unavoidable in practical rate design but regulators endeavor to mitigate these effects in the larger context of the many, often conflicting, rate design principles."[26]

[21] Reliability requirements associated with solar energy are discussed further in CRS Report R45764, *Maintaining Electric Reliability with Wind and Solar Sources: Background and Issues for Congress*, by Ashley J. Lawson.

[22] Thomas Tanton, *Net Metering in the States: Moving Toward Equitable and Sustainable Policies for Electric Customers*, State Government Leadership Foundation, April 2018, http://sglf.org/wp-content/uploads/sites/2/2018/04/SGLF-Net-Metering-In-the-States-by-Thomas-Tanton-April-2018.pdf.

[23] Barbara Alexander, Ashley Brown, and Ahmad Faruqui, "Rethinking Rationale for Net Metering: Quantifying Subsidy from Non-Solar to Solar Customers," *Public Utilities Fortnightly*, October 2016.

[24] Utility capital expenditures might include costs to build new power plants or upgrades to electricity transmission and distribution systems.

[25] The study found that utility capital expenditures would have the largest potential rate effect of the factors studied. It also found that some factors, like energy efficiency, natural gas prices, and net metering, could lead to decreases in electricity rates, depending on scenarios and assumptions. Galen Barbose, *Putting the Potential Rate Impacts of Distributed Solar into Context*, Lawrence Berkeley National Laboratory, January 2017, https://emp.lbl.gov/publications/putting-potential-rate-impacts.

[26] NARUC, *Distributed Energy Resources Rate Design and Compensation*, November 2016, p. 67, https://pubs.naruc.org/pub.cfm?id=19FDF48B-AA57-5160-DBA1-BE2E9C2F7EA0.

Responses to Retail Rates Concerns

Some states are seeking to move from the "close-enough proxy" of the retail rate to more precise allocations of system costs and benefits to net metering customers. Often state policy debates focus on addressing concerns about potential cross-subsidies from retail rate compensation. Conceptually, states are exploring two options: adding fixed charges (e.g., customer charge, demand charge) to net metering customers' bills or changing the compensation rate. In practice, states are considering variations of these options, and some states have implemented one of these options or both at the same time.

Fixed Charges

Adding fixed charges to net metering customers' bills is meant to allow utilities to recover costs for grid maintenance and operation. At the same time, this approach might preserve some perceived advantages for compensating net metering customers at the retail rate (e.g., administrative simplicity, ease of understanding). Proponents of this approach typically include utilities and some advocates for low-income customers. They often assert that adding fixed charges (or other revisions like alternative compensation rates) reduces cost shifting and increases fairness.[27] Opponents typically include the solar industry and environmental advocates. They often contend that net metering promotes competition in the electricity industry and that fixed charges (or other revisions that would discourage DG) ignore societal benefits that DG (especially solar energy) can provide.[28] In addition, while the concept of adding fixed charges may be straightforward, determining a value for fixed charges that accurately reflects net metering customers' use of the grid has been complex and controversial in practice.

Alternative Compensation Rates

Some states have adopted an alternative compensation rate that attempts to represent the energy costs the utility avoids when net metering customers supply some of their own energy (see **Figure 3**). This approach, referred to in this report as an avoided cost rate, is sometimes called an energy rate, a wholesale rate, a supply rate, or variations of these terms. While the retail rate reflects all costs associated with producing energy, operating and maintaining the grid, and other utility expenses, an avoided cost rate primarily reflects costs associated with producing energy.[29] Some states also might consider network upgrades required to reliably integrate DG, especially solar PV.[30] Depending on circumstances, the avoided cost rate might be estimated by a regulator using an independent methodology or by referral to wholesale electricity markets.[31] Avoided cost rates are usually lower than retail rates.[32]

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[27] For example, Edison Electric Institute, *Solar Energy and Net Metering*, January 2016, https://www.eei.org/issuesandpolicy/generation/NetMetering/Documents/Straight%20Talk%20About%20Net%20Metering.pdf.

[28] For example, Zadie Oleksiw, "Punishing Solar Customers for Disrupting Outdated Electric Model Is Wrong," *The Hill*, October 10, 2018, https://thehill.com/opinion/energy-environment/410846-punishing-solar-customers-for-disrupting-outdated-electric-model.

[29] Avoided costs may also reflect some costs of maintaining the grid.

[30] The time-varying nature of solar energy creates unique operational challenges to the grid. See CRS In Focus IF11257, *Variable Renewable Energy: An Introduction*, by Ashley J. Lawson.

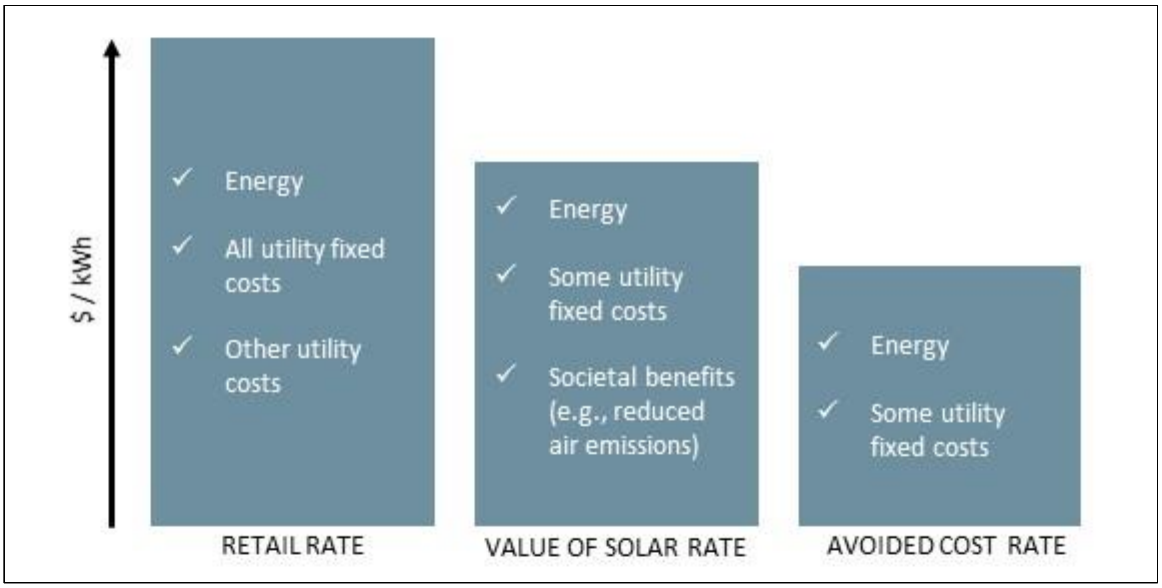
[31] In some cases, utility avoided costs might reflect non-energy factors. For example, some wholesale electricity market prices, known as locational marginal prices, can reflect costs associated with transmission congestion. Utility avoided cost rates are used in other electricity regulatory processes as well, such as implementing some sections of PURPA.

[32] For example, in 2019 Louisiana regulators approved a change from retail rate compensation to avoided cost

Another alternative compensation rate applies to net metering customers with installed solar PV. Under this method, net metering customers are compensated according to a value of solar (VOS) rate.[33] As illustrated in **Figure 3**, this approach reflects many of the same considerations as an avoided cost rate and, additionally, reflects estimated societal benefits associated with distributed solar PV (e.g., reduced air emissions). Solar advocates generally favor inclusion of societal benefits in all aspects of net metering policy and rate design.[34] Some states (and stakeholders) may consider reduced greenhouse gas emissions a benefit of distributed solar PV as well. VOS is often calculated to be larger than avoided cost rates but smaller than retail rates, though states could potentially determine a VOS rate greater than the retail rate, depending on the perceived benefits of solar included in the analysis. A related compensation rate applies to any distributed energy resource (DER), not just distributed solar generation, and reflects estimated grid and societal benefits of DERs. New York is one state taking this approach.[35]

Regardless of which rate is set (i.e., avoided cost or VOS) and how it is calculated, it could be applied in either a buy-all, sell-all net metering arrangement or a net billing arrangement (see definitions in the section "What Is Net Metering?").

Figure 3. Examples of Net Metering Compensation Rates



Source: CRS.

Notes: The compensation rate is how much a customer with distributed generation is paid for each unit of electricity produced. Generally, compensation rates that include more factors will have a higher monetary value,

compensation. Under prevailing market conditions, the compensation rate was estimated to change from around 10 cents/kWh to around 4 cents/kWh. Catherine Morehouse, "Louisiana Utilities to Pay Less for Rooftop Solar Power Under New Net Metering Rules," Utility Dive, September 13, 2019, https://www.utilitydive.com/news/louisiana-utilities-to-pay-less-for-rooftop-solar-power-under-new-net-meter/562834/.

[33] For further discussion and case studies of VOS design, see Mike Taylor et al., *Value of Solar: Program Design and Implementation Considerations*, NREL, March 2015, https://www.nrel.gov/docs/fy15osti/62361.pdf.

[34] Solar Energy Industries Association (SEIA), *Principles for the Evolution of Net Energy Metering and Rate Design*, May 2017, p. 2, https://www.seia.org/sites/default/files/NEM%20Future%20Principles_Final_6-7-17.pdf.

[35] See New York State Energy Research and Development Authority, *The Value Stack*, accessed September 3, 2019, https://www.nyserda.ny.gov/All%20Programs/Programs/NY%20Sun/Contractors/Value%20of%20Distributed%20Energy%20Resources.

> but actual rates will vary based on state circumstances. States could determine the value of solar to be greater than the retail rate, depending on which costs and benefits are considered. Compensation rates may be combined with other payments (or charges) that do not vary with the amount of electricity produced.

Points of debate about alternative compensation approaches have included which costs and benefits to consider, and how to quantify them. One challenge around quantification is that costs and benefits of DG can be time- and location-specific.[36] Another challenge is that costs and benefits might change as the level of DG penetration changes.[37] States vary in their approach to evaluating net metering, as evidenced by a 2018 analysis conducted for the U.S. Department of Energy (DOE). That analysis, which reviewed 15 state studies of net metering costs and benefits released between 2014 and 2017, noted that states used various assumptions, and that "the set of value categories included, and whether these categories represent costs or benefits, have a significant impact on the overall results of a given study."[38]

Other State Net Metering Policy Provisions

In addition to differing in net metering compensation, state net metering policies differ in a variety of other aspects. Some differences pertain to provisions on program caps, source eligibility, credit retention, and system ownership. Provisions in these areas can affect deployment of DG.

Program Caps

Program caps, sometimes called aggregate capacity limits, set limits on the number of customers or amount of generation capacity that may participate. Program caps can be expressed in units of power (e.g., megawatts; MW),[39] a percentage of electricity demand over some period of time, or other measures as determined by a state. The choice of whether to have program caps and, if so, how to define them can affect the amount of DG that a state's net metering policy might promote.[40] Program caps may be established to reduce risks to the electricity system, such as potential reliability risks from DG, or reduce the likelihood that cross-subsidies would occur. Caps also might reduce the potential for sales losses or other negative financial impacts for utilities.[41] On the other hand, program caps might create a barrier to achieving other policy goals, for example the renewable energy goals that some states have.

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36 This challenge is discussed further in Richard L. Revesz and Burcin Unel, "Managing the Future of the Electricity Grid: Distributed Generation and Net Metering," *Harvard Environmental Law Review*, vol. 41, no. 1 (2017), pp. 43-108, https://harvardelr.com/volume-41-number-1-2017/.

37 States with penetration levels above some threshold level may require distribution system upgrades which could change the cost-benefit analysis for DG. One study suggests this threshold is in the range of 5% - 10% of customers. Jim Lazar and Wilson Gonzalez, *Smart Rate Design for a Smart Future*, Regulatory Assistance Project, July 2015, https://www.raponline.org/wp-content/uploads/2016/05/rap-lazar-gonzalez-smart-rate-design-july2015.pdf.

38 ICF, *Review of Recent Cost-Benefit Studies Related to Net Metering and Distributed Solar*, May 2018, p. 3, https://www.icf.com/blog/energy/value-solar-studies.

39 Sometimes kilowatts (kW). 1 MW = 1,000 kW.

40 For further discussion, see J. Heeter, R. Gelman, and L. Bird, *Status of Net Metering: Assessing the Potential to Reach Program Caps*, NREL, September 2014, https://www.nrel.gov/docs/fy14osti/61858.pdf.

41 For most investor-owned utilities, profits are directly proportional to sales, so sales loss is a concern for them. Some states set rates so that utility profits are directly proportional to certain performance metrics and unrelated to sales volume. In these cases, sales loss may be less of a concern for utilities.

Source Eligibility

States specify which generation sources can participate in net metering, often based on capacity limits (i.e., generator size) and technology type. Solar energy is the dominant energy source for net metering capacity, but some states allow other energy types to participate as well. Whether a non-solar project will participate is usually due to cost factors, but other factors such as customer type (e.g., residential, commercial, or industrial) and location (e.g., urban, rural) may be influential as well. For example, combined heat and power facilities might be attractive mostly to large commercial and industrial customers that use steam. Distributed wind projects might be attractive mostly to farms or other customers with relatively large acreage.

Credit Retention

Net metering customers often have periods when their electricity consumption exceeds their generation and periods when the opposite is true. When net metering generation exceeds consumption, net metering customers can deliver this surplus generation to the grid. Many state net metering policies compensate net metering customers in some way for the total amount of electricity they generate, but some states only compensate the surplus generation (i.e., the amount delivered to the grid). Typically, if a net metering customer has a surplus over an entire billing period, the customer receives a credit on the next bill. States have different provisions for how long credits can carry over.[42] Credit retention policies can determine the extent to which customers might reduce their total electricity costs to $0.

System Ownership

Many net metering customers have a single generator located behind a single electricity meter. A single-family home with a rooftop solar installation is one example. Other arrangements are possible though, and some states allow these. Aggregate net metering applies to single customers with multiple electricity meters on their property, for example farms, municipalities, or school districts. Shared net metering applies to multiple customers associated with the same net metering generation capacity, for example participants in community solar projects (sometimes called solar gardens). A version of shared net metering called virtual net metering applies when the shared project is located onsite, for example multi-family dwellings.[43]

A related policy is whether third party participation is allowed. In third party participation arrangements, such as solar leasing and power purchase agreements, the solar system is owned by an entity other than the electricity consumer on whose property the system is installed.

Areas of Congressional Interest

Some Members of Congress have introduced legislation addressing aspects of states' net metering policies. Some proposals would influence state policies directly. For example, S.Amdt. 3120 in the 114th Congress would have limited the ability of state regulators to move net metering

[42] Some examples are provided by National Conference of State Legislatures, *State Net Metering Policies*, updated November 20, 2017, http://www.ncsl.org/research/energy/net-metering-policy-overview-and-state-legislative-updates.aspx.

[43] Further discussion of aggregated and shared options is available at Institute for Local Self-Reliance, *Net Metering*, updated January 30, 2012, https://ilsr.org/rule/net-metering/. The ILSR website uses the term net metering to refer to a buy-all, sell-all option.

customers to lower compensation rates or to add fixed charges to their bills. S.Amdt. 3053, also in the 114th Congress, would have required state regulators to consider the extent to which their net metering policies created cross-subsidies. H.R. 4175 in the 116th Congress would require states to consider adopting net billing policies for community solar.[44]

Other legislation would require studies to better understand the costs and benefits of net metering. For example, in a committee report on an FY2017 appropriations bill, Congress requested a DOE study on "the costs and benefits of net-metering and distributed solar generation to the electrical grid, utilities and ratepayers."[45] DOE transmitted the report to Congress in 2019.[46] In the 116th Congress, S. 346 and H.R. 1009 would require the National Academies of Sciences, Engineering, and Medicine to study various aspects of net metering such as alternative incentives for DG, net metering planning and operating techniques, and consumer and industry incentives for net metering.

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Disclaimer

[44] Not all states that have adopted net metering currently include community solar. For details, see Interstate Renewable Energy Council, *Shared Renewables Policy Catalog*, October 2018, https://irecusa.org/regulatory-reform/shared-renewables/shared-renewables-policy-catalog/.

[45] U.S. Congress, Senate Committee on Appropriations, *Energy and Water Development Appropriations Bill, 2017*, to accompany S. 2804, 114th Cong., 2nd sess., April 14, 2016, S.Rept. 114-236, p. 59.

[46] DOE, *Review of Recent Cost-Benefit Studies Related to Net Metering and Distributed Solar*, February 21, 2019; transmitted to Congress on May 14, 2019.