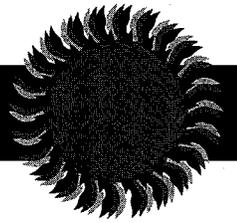


**TOPICAL ISSUES BRIEF**



# **Net Metering Programs**

Yih-huei Wan



**National Renewable Energy Laboratory**  
A national laboratory of the  
U.S. Department of Energy

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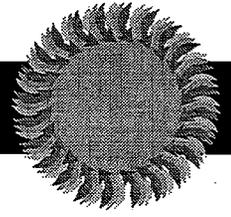
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# **Net Metering Programs**

**Yih-huei Wan**

**Prepared for:**

**Office of Utility Technologies  
Energy Efficiency and Renewable Energy  
U.S. Department of Energy**



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## Abstract

There has been a recent surge of interest from the renewable energy industry and environmental groups in net metering.<sup>1</sup> The reason for this interest is that net metering is a simple, low-cost, and easily administered method to encourage direct customer investment in renewable energy technologies. The renewable energy industry supports net metering because it removes an economic disincentive for potential customers by increasing the value of the electricity generated by renewable energy technologies. Environmental groups support net metering because it promotes clean energy production.

The concept of net metering programs is to allow the electric meters of customers with generating facilities to turn backwards when their generators are producing more energy than the customers' demand. Net metering allows customers to use their generation to offset their consumption over the entire billing period, not just instantaneously. This offset would enable customers with generating facilities to receive retail prices for more of the electricity they generate. Without a net metering program, utilities usually install a second meter to measure any electricity that flows back to the utility grid and purchase it at a rate that is much lower than the retail prices.

The strength of net metering lies in its simplicity: the use of a single meter. It does not need constant regulatory interaction or supervision after the program is in place. No requirements are made of utilities. It allows customers to make renewable energy technology choices and only impacts the customer's meter. As a policy option, net metering provides economic incentives to encourage renewable energy technologies without public

funding. Because more of the customer-generated electricity can receive a utility's retail price, it can lower the economic threshold of small renewable energy facilities.

There are various net metering programs in the country. Most are available to customer-owned small generating facilities only, some further restrict the eligibility to renewable energy technologies. This Topical Issues Brief discusses how these net metering programs have been implemented by different utilities and states, what the rationales are behind many net metering programs, and what the potential impact of net metering may be on the deployment of renewable energy technologies.

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# Net Metering Programs

## I. Introduction

Net metering is the practice of using a single meter to measure the difference between the total generation and total consumption of electricity by customers with small generating facilities by allowing the meter to turn backward. Without net metering, small customer-owned generators are usually treated by electric utilities as other qualifying facilities (QFs) under the Public Utility Regulatory Act of 1978 (PURPA) and subsequent implementation rules by the Federal Energy Regulatory Commission (FERC).<sup>2</sup> As QFs, the customers enter a simultaneous purchase and sale agreement with the utilities.

With a simultaneous purchase and sale agreement, utilities will install two meters for each QF: one to record energy used by the customer and one to record energy produced by the customer's generating facilities that flows into the utility grid. Under the two-meter plan, if customers who own generating facilities cannot use electricity the instant it is generated, the excess electricity will flow into the utility grid through the second meter. Customers pay retail rates for the energy they use, and the utilities reimburse customers for the energy that flows into the utility grids at the utility's avoided energy cost.<sup>3</sup> The differences between utility's retail rate and avoided energy cost can be substantial. In some instances, they are as high as 10 ¢ per kilowatt hour (kWh). In addition to lowering the economic value of self-generation, this arrangement also makes many customers feel that the utilities have gained an unfair advantage.<sup>4</sup>

Net metering can increase the economic value of small renewable energy technologies for customers. It allows the customers to use the utility grid to "bank" their energy: producing electricity at one time and consuming it at another time. This form of energy exchange is especially useful for renewable energy technologies. For example, a residential customer with a small wind or photovoltaic (PV) system would produce electricity when the wind is blowing and the sun is shining and consume electricity at another time when it is needed. This banking ability affords self-generating customers more flexibility. They do not have to alter their consumption or install

energy storage devices to maximize the value of their generation. They also have more latitude in sizing their generating facilities because they do not have to precisely match the load to minimize excess generation.

Utilities may also benefit from net metering. When customers generate electricity during high system demand periods they improve a utility's system load factor. PV systems are good examples of technologies that improve a utility's system load factor by generating electricity during high demand periods. By encouraging distributed customer generation through net metering, utilities can also improve their distribution voltage profile and reduce losses. More significantly, under net metering, utilities can reduce their administration costs because there is only one meter to read and no special accounting for customers with small generating equipment.

Net metering programs exist because of state initiatives. Few non-utility generators existed before the enactment of PURPA, and utilities dealt with these scattered, customer-owned generators (many of them were small wind systems) on a case-by-case basis. PURPA encourages cogeneration and renewable energy technologies by requiring utilities to interconnect with cogenerators and renewables and purchase the power generated by them. When designing regulations to implement PURPA and FERC rules, some state public utility commissions (PUCs) took the intent of PURPA one step further by including net metering as an option for smaller QFs. For example, in 1981, Arizona Corporation Commission allowed net metering for small QFs of 100 kilowatts (kW) or less, and Massachusetts PUC ordered net metering in 1982.

Minnesota was the first state to enact a net metering statute in 1983. Since then, 13 additional states have enacted net metering laws or regulations: California, Connecticut, Idaho, Indiana, Iowa, Maine, New Hampshire, New Mexico, North Dakota, Oklahoma, Rhode Island, Texas, and Wisconsin.<sup>5</sup> In addition, one utility in Colorado offers net metering tariffs to their customers without a commission order or state law.

This brief is organized in five sections. Section II discusses existing net metering programs and how they are implemented by utilities and states. The state motivations and rationales for enacting net metering laws or regulations are examined in Section III, and Section IV explores the potential impact of net metering on renewables. Section V provides conclusions and recommendations.

## II. Net Metering Programs

Today's net metering programs have a number of characteristics in common that define who is eligible to participate and under what conditions. Several of the programs limit the eligible participants to retail customers that own generating facilities using only renewables.

Net metering programs have three sources of implementation authority: state law, PUC orders, and individual utility tariffs. The programs required by a state law are applicable to all utilities in the state, regardless of whether a utility is under the jurisdiction of the state utility commission or not. Only two states have enacted laws to require electric utilities to offer net metering programs: Minnesota in 1983 and California in 1995. Public utility commissions in 14 states have issued orders requiring utilities to file net metering tariffs: Arizona, Connecticut, Idaho, Indiana, Iowa, Maine, Massachusetts, New Hampshire, New Mexico, North Dakota, Oklahoma, Rhode Island, Texas, and Wisconsin. Generally, only rate-regulated utilities in those states are affected by such orders. One utility in Colorado offered a net metering tariff on their own as part of their guidelines for interconnecting small QFs.

Table 1 on the next page summarizes various features of state net metering programs. Detailed descriptions of individual state net metering programs are included in the Appendix. Whether required by state statutes or PUC orders, utilities file special tariffs to implement net metering programs.

### Eligible Generating Technologies

Most net metering programs are available to customer-owned QFs (cogenerators that meet certain efficiency standards or generators that use renewable energy resources). Eligible technologies vary according to state. For example, California allows only solar energy generating facilities.<sup>6</sup> Iowa,<sup>7</sup> New Hampshire, and Texas restrict the eligible technologies to renewables only. On the other hand, Idaho and Wisconsin allow all customer-

owned generators regardless of energy source to be eligible for net metering.

### Eligible Customer Classes

Two states, California and New Hampshire, limit their net metering programs to a utility's residential customers. Facilities must be customer-owned and installed on the customer's premises. Programs in other states are available to all customers who meet the QF requirements.

### Individual Capacity Limitations

Most net metering programs set a limit on allowable individual generating capacity. California, and Colorado restrict their individual capacities to 10 kW or less, while Arizona, Connecticut, Idaho, Maine, New Mexico, North Dakota, and Oklahoma allow QFs and cogenerators up to 100 kW. Most of the other states set limits within this range. Two states set energy limits for net metering. Indiana has a total generation limit of 1,000 kWh per month. Oklahoma allows 60,000 kWh per year for net metering in addition to its capacity limit. Only Iowa has no capacity limits on individual installations.

### Total Generating Capacity Limitations

In addition to capacity limitations on individual installations, three states established limits on the overall capacity for each utility. California, for example, limits the total generating capacity under the net metering program to 0.1% of each utility's 1996 peak demand, which amounts to a total of 53.3 megawatts (MWs) statewide. Iowa set a statewide cap of 105 MW. Each utility's share of the 105 MW is fixed and is based on its estimated contribution to the state's peak demand. New Hampshire set an initial statewide capacity limit of 500 kW for net metering.

### Treatment of Excess Generation

Excess generation occurs when a customer-owned generator produces more electricity than the customer's total electricity demand during a utility's billing cycle. The amount of excess generation depends on the size of the load and the installed generating equipment. Most rooftop PV systems seldom generate more electricity than that a residence or a commercial building can use during a month. However, a residential wind system in a good wind resource region may produce between 20% to 40% more

**Table 1. Summary of State Net Metering Programs**

State	Allowable Technology	Allowable Customer	Allowable Capacity	Statewide Limit	Treatment of Net Excess Generation (NEG)	Authority	Enacted	Citation/Reference
Arizona	Renewables only	All customer classes of Arizona Public Service	≤ 10 kW	None	NEG purchased at avoided cost	Arizona Corporation Commission	1993	Tariff EPR-4
	Qualifying facilities	All customer classes of Tucson Electric Power	≤ 100 kW		NEG purchased at fixed rate		1996	Tariffs No. 101 & No. 102
California	Solar only	Residential only	≤ 10 kW	0.1% 1996 peak	Annualized NEG purchased at avoided cost	Legislature	1995	Senate Bill No. 656 (effective 1-1-96)
Colorado	Qualifying facilities	All customer classes of Public Service of Colorado	≤ 10 kW	None	No purchase of NEG, excess is granted to utility	Utility tariff	1994	Safety, Interference and Interconnection Guidelines for Cogenerators, Small Power Producers, and Customer-Owned Generators
Connecticut	Renewables & cogenerators	All customer classes	≤ 50 kW for cogenerators ≤ 100 kW for renewables	None	NEG purchased at avoided cost	PUC	1990	CPUCA No. 159
Idaho	All technologies	All customer classes	≤ 100 kW	None	NEG purchased at applicable retail rate	PUC	1986	Idaho PUC Order #16025 Tariff sheets 86-1 thru 86-7
Indiana	Qualifying facilities	All customer classes	≤ 1,000 kWh/month	None	No purchase of NEG, excess is granted to utility	PUC	1985	Indiana Administrative Code 4-4.1-7
Iowa	Renewables	All customer classes	No limit per system	105 MW	NEG purchased at avoided cost	PUC	1993	Iowa Administrative Code paragraph 15.11(5)
Maine	Qualifying facilities	All customer classes	≤ 100 kW	None	NEG purchased at avoided cost	PUC	1987	Code Me. R. Ch. 36, §1(A)(18) & (19). §4(C)(4)
Massachusetts	Qualifying facilities	All customer classes	≤ 30 kW	None	NEG purchased at avoided cost	PUC	1982	220 CMR §8.04(2)(C)
Minnesota	Qualifying facilities	All customer classes	≤ 40 kW	None	NEG purchased at average retail utility energy rate	Legislature	1983	Minn. Stat. §261B.164(3)
New Hampshire	Renewables	Residential only	≤ 25 kW per system	500 kW	No purchase of NEG, excess is granted to utility	PSC of NH	1994	PSNH Order No. 21,163
New Mexico	Qualifying facilities	All customer classes	≤ 100 kW	None	1. No purchase of NEG, no additional customer charge 2. NEG purchased at avoided cost with additional customer charge	PSC of NM	1988	PSC Rule 570
North Dakota	Renewables & cogenerators	All customer classes	≤ 100 kW	None	NEG purchased at avoided cost	PUC	1991	North Dakota Administrative Code §69-09-07-09
Oklahoma	Renewables & cogenerators	All customer classes	≤ 100 kW and ≤ 60,000 kWh / year	None	No purchase of NEG, excess is granted to utility	Oklahoma Corporate Commission	1988	OCC Order 326195
Rhode Island	Renewables & cogenerators	All customer classes	≤ 25 kW for larger utilities ≤ 15 kW for smaller utilities	None	NEG purchased at avoided cost	PUC	1985	Supplementary Decision and Order, Docket No. 1549
Texas	Renewables only	All customer classes	≤ 50 kW	None	NEG purchased at avoided cost	PUC	1986	PUC of Texas, Substantive Rules, §23.66(f)(4)
Wisconsin	All technologies	All customer classes	≤ 20 kW	None	NEG purchased at retail rate for renewables, avoided cost for non-renewables	PSC	1993	PSCW Order 6690-UR-107

Note: Format of this table is similar to the Table 4 in the REPP Issue Brief, September 1996, No. 2, by Thomas J. Starrs.

energy than the load during a utility's monthly billing cycle.<sup>8</sup>

Most net metering programs require utilities to buy back the excess generation at the utility's avoided cost. In most cases, the buy-back rate includes only the utility's fuel cost without a capacity component. Arizona, California, Connecticut, Iowa, Maine, Massachusetts, North Dakota, New Mexico, Rhode Island, Texas, and Wisconsin all use this approach for non-renewable generation.

Under California's net metering program, net excess generation may be calculated yearly if both the local utility and the customer agree to it. Within a given year, excess generation in one month is carried over to the next as a credit. Customers still pay their normal monthly bill if there is no excess generation for the month, but utilities only issue a payment for excess generation at the end of the year. Annualized energy accounting will practically eliminate the issue of net excess generation for a normal size system and all electricity generated by customers can be applied to offset their own consumption.

Under Idaho's net metering program, utilities buy back excess generation at the applicable retail rate of the customer class. The same is true in Wisconsin, if a customer-owned generator uses renewable resources. In Minnesota, excess generation is purchased at the utility's average retail rate.

In Colorado, Indiana, New Hampshire, New Mexico, and Oklahoma, utilities that offer net metering programs do not purchase any excess generation from customers. Excess generation, if any, simply flows into the utility grid without compensation. If a customer requests that a utility purchase the power they produce, they are treated as QFs under PURPA. They must install and maintain two meters and establish simultaneous purchase and sale agreements with the utility.

### **Other Features of Net Metering Programs**

All net metering programs require customer-owned generating facilities to meet applicable safety and power quality standards established by the National Electric Code and other standard-setting agencies. Nevertheless, many utilities, with the approval of state utility commissions, have established their own electrical interconnection requirements. Some of these requirements could be an economic barrier to small customer-owned

generators, because costs of meeting them is relatively high for small facilities.

### **III. Rationale for Net Metering Programs**

The main reason for states to implement a net metering program is to encourage private investment in renewable energy resources. It is worth noting that although only four states explicitly limit the eligible generating technologies to renewables while most other states specify QFs for their net metering programs, the low individual system capacity limits set by those states makes cogeneration applications impractical for most customers. This in effect constrains the eligible generating technologies to renewables under their net metering programs.

The appeal of net metering arises from its simplicity: the use of a single (existing) electric meter for customers with small generating facilities. After the program is implemented, no regulatory interaction or supervision is needed. As a policy option, it provides economic incentives to support renewable energy technologies that do not require public funding.

Many state legislators and utility regulators realize that customers who have installed or who are considering the installation of a grid-connected renewable energy facility are not driven solely by cost considerations. For those customers, noneconomic factors, such as environmental protection and self-sufficiency, also motivate them to adopt renewable energy. Net metering provides a financial incentive to those customers by lowering the economic threshold for small renewable energy facilities.

In addition, net metering programs address an equity issue perceived by many customers under the two-meter arrangement. Customers feel the utilities gain an advantage by charging them retail price for the electricity they consume but only paying them lower avoided energy cost for the electricity they feed into the utility's grid. This situation can impede the market of small wind power systems in rural areas.<sup>9</sup>

### **Stakeholder Motivation**

State legislatures in California and Minnesota, along with many state utility regulators, consider net metering programs to be a sound policy option. In addition to encouraging customer-owned renewable energy

generators, their objectives include promoting renewable energy, diversifying a state's energy resource mix, stimulating local economies, and simplifying the procedure and reducing the costs of interconnecting small customer-owned generators. Political leaders in these states are convinced that net metering programs have the potential to achieve these goals with little or no costs to the utility rate payers and general public.

Nevertheless, most utilities still oppose net metering programs for several reasons. Many do not want another state mandate imposed on them. Others fear the revenue losses due to the higher retail rates they have to pay for customer-generated electricity. Some utilities oppose net metering because of the PURPA requirement. PURPA and FERC rules require utilities to purchase power from qualifying cogeneration and small power production facilities at the utilities avoided cost. Utilities in New York, for example, claim that net metering is a violation of PURPA and FERC rules, because it requires utilities to pay higher than their avoided costs for QF generation. In California, one utility claims that net metering programs are a subsidy to customers who install and operate their own generators. Others claim there will be a loss of actual generation and customer load information if a large number of customers were eventually to participate, because the meter readings no longer represent the real load of a given area for utilities. Several utilities in New York also oppose net metering legislation on the ground of safety issues.<sup>10</sup>

On the other hand, a few utilities offer the net metering option to customers who own and operate small wind and PV systems without a commission order or a state net metering law. Some utilities support the net metering option for renewables because they want to be seen as friendly to the environment and responsive to their customers' needs and concerns. For other utilities, the extra cost associated with installing and maintaining a second meter, processing separate accounts, and preparing payment checks for small generators is the primary motivation.

### **Electric Utility Industry Restructuring**

Although most utilities would rather not have a net metering program imposed on them by the state legislature or PUC, their perspective on net metering may change as the utility industry enters a more competitive environment. For example, Southern California Edison Company decided to offer its net metering program as a

customer service option.

The impact of utility restructuring on net metering programs is not clear at present. The California net metering law specifies that its net metering will comply with future restructuring legislatures and PUC orders. However, because of their simplicity, most net metering programs will not likely be affected by the restructuring of the electric utility industry. Regardless of what approach the industry eventually takes to restructure itself, there will still be a meter for each customer account, and an entity will have to read the meter, administer the account, and provide the customer services. Net metering simply allows the meters of customers with generating facilities to turn backward so that all the electricity they generate can be used to first offset their own consumption. This is the strength of net metering. It affords customer choice and impacts only the customer's meter. No requirements are made of the utilities.

### **Legislative Process**

Because of the nature of the political process, every net metering program represents some sort of compromise reached by various stakeholders during the legislative or regulatory processes. Such compromises are reflected in limits on facility size, program size, customer classes, and allowable technologies. These limits are designed to ensure that the net metering program will have a minimal impact on utilities and rate payers. All existing programs have some or all of these constraints.

Recent legislative activities suggest that although effective communication and strong grassroots support are necessary for moving a net metering law through the state legislative process, they are not always sufficient to guarantee its final success. In New York, a net metering initiative led by business and environmental groups including the Solar Energy Industries Association (SEIA), New York SEIA, independent power producers, the Natural Resources Defense Council, the Sierra Club and others, resulted in a net metering bill passed by both New York State Assembly and Senate. However, utilities did not support the legislation and Governor Pataki, citing the safety concerns of utilities, vetoed the legislation.

In Hawaii, where electric rates are as high as 20¢ per kWh and good solar resources and state tax incentives exist, a net metering program would make grid-connected PV systems cost effective. A recent study of niche markets for grid-connected PV showed that a break-even cost for

PV systems in Hawaii could be as high as \$7.50 per watt,<sup>11</sup> which is substantially higher than the current installed system price of about \$6.00 per watt. A true net metering program in Hawaii has the potential to open up the market for PV. Although the net metering concept receives wide support in Hawaii, utilities there were able to influence the legislative process and change the program from net metering to a purchase and sale arrangement, significantly lowering its value for small renewable energy systems.

#### IV. Impact on Renewable Energy Technologies

Net metering programs for small renewable energy generating systems have been available in some states for more than 10 years, but their impact on the market for renewable energy technologies has been limited. Exact numbers are not available because utilities and state energy offices do not keep accurate records of net metering participants. Although no hard statistics exist about the number of customers and total installed capacities under these programs, the anecdotal information collected for this report suggests that very few customers participate in net metering programs.

It is too early to assess the effect of California's net metering law on residential PV installations because the law only became effective on January 1, 1996. Analysts expect that, initially, only those customers who have already installed PV systems will take advantage of the new net metering law by switching to the net metering tariff.

The fact that there are only a small number of participants in net metering programs can be attributed to three factors:

1. *Communication.* Information on net metering programs has not been made widely available, and utilities do not actively promote their net metering programs. In many cases, customers are not aware of their net metering options and/or the potential benefits offered by net metering programs, which make renewables only slightly more expensive.

2. *Economics.* Low electricity prices and high costs of small renewable energy systems are important considerations influencing residential customer behavior regarding participation in net metering programs. The lack of direct financing available to residential customers to purchase

renewable energy generating facilities is another economic consideration. A recent study of niche markets for grid-connected PV systems shows that in all states but Hawaii the break-even prices for small PV systems are less than \$5.00 per watt after considering retail electric rates, available state tax incentives, and solar resources. The installed cost of a small, grid-connected PV systems is currently about \$6.00 per watt. The existing net metering programs have not created a mass market for small wind system either despite the current installed cost of \$2.50 - \$3.00 per watt.

3. *Interconnection Requirements.* Utilities often establish interconnection guidelines requiring additional protection equipment and liability insurance that add significant cost to small generating facilities. The majority of state statutes and regulatory orders for net metering do not directly specify guidelines for utility tariffs, service contracts, or interconnections. In addition utilities may include large interconnection and service fees as part of their net metering tariffs. These fees will reduce the incentives provided by the net metering programs. Two of the larger California investor-owned utilities originally structured net metering contracts that set a substantial monthly customer charge and standby charge on net metering customers. This essentially made net metering unattractive until the California PUC banned the imposition of customer charges.<sup>12</sup> Existing utility interconnection guidelines may also act as a barrier to small net metering customers. For example, one California utility requires overcurrent, overvoltage, undervoltage, underfrequency, overfrequency, and ground fault sensing devices for non-utility generators of 41 kW or larger. For generators of 41 kW or less, only the ground fault sensing device is removed from the requirement list. The relative cost of meeting those requirements is much greater for small systems than it is for larger systems that cannot participate in net metering programs.

#### V. Conclusions and Recommendations

Although the impact of net metering programs on renewable energy technologies has been small to date, programs initiated at the state level remain an appealing policy option. The programs enhance economic incentives to the owners of small renewable energy generating facilities without requiring any public funding. Their attractiveness in high electric rate regions may provide a boost for the renewable energy industry in those regions. Additionally, net metering programs will become more

attractive as the costs of renewable technologies continue to decline.

As discussed earlier, many customers who have installed renewable energy facilities are motivated by noneconomic factors. For those customers, cost-effectiveness is not measured by break-even cost alone. They are willing to pay a premium for a cleaner environment. Nonetheless, economics are important to many customers and a net metering program can improve the economic aspect of their decision and afford additional market opportunities for renewable energy technologies.

In general, net metering programs established under state statutes contain more favorable terms for net metering customers than those ordered by state PUCs. For example, the Minnesota net metering law requires utilities to buy back excess generation at average retail rates and the proposed New York net metering bill will prohibit utilities from making additional requirements on controls, tests, and liability insurance. A net metering program established by state statute allows more customer participation because it applies to all utilities, not just those under the jurisdiction of the PUC. In addition, net metering established under state authority may avoid conflicts with PURPA as claimed by utilities.<sup>13</sup>

California's net metering law could serve as a model for other states because it has several desirable features. The annual accounting of excess energy is most useful to consumers. With this option, the generating systems can be sized more precisely to match customer load based on the annual load factor thus minimizing the excess generation.

Finally, increasing customer awareness of available net metering programs is an important step in increasing participation. Many consumers do not know about the advantages and availability of net metering programs because utilities do not actively promote them. Increased communication efforts by the renewable industry, utilities, state energy offices, PUCs, and advocacy groups could substantially increase participation in net metering programs, yielding benefits to utilities, customers, and the society at large.

## VI. Notes

1. Some states and utilities also use the term net billing to describe net metering. Net billing can apply to another utility practice in which customers who both take

utility power and produce power from their own generators at several different locations, aggregate their electric bills from all locations.

2. Code of Federal Regulations (CFR), Title 18, part 292.

3. The avoided energy cost is the cost to the utility if the utility would generate the electricity or purchase it from the bulk power market. The avoided cost is much lower than the electricity retail rate because it does not include the transmission and distribution costs, state and local taxes, and the utility's profits.

4. Bergey, Michael L.S. "Comments on the Maturation and Future Prospects of Small Wind Turbine Technology," Bergey Windpower Company, Norman, Oklahoma, presented at the A.S.E.S. Solar '90 Conference, March 22, 1990.

5. Hawaii enacted a statute (Act 205), entitled Net Energy Metering, in June 1996. Although entitled "net energy metering," the practice specified by the law is much different from practices in other states. Hawaii's net energy metering law mandates the use of two meters (one to record total consumption and the other to record total generation). Customer generators are billed for the electricity they use at the utility retail rate, and the utility credits the customer generators for the electricity they generate at a rate determined by the PUC based on the utility's incremental cost of energy. This requirement prevents the customers from using generation to offset their own consumption, thus denying customers the most important benefit of net metering. This situation is no different from the purchase requirement in PURPA and FERC rules that mandates utilities purchase power from QFs. Therefore, it is more appropriate to classify the Hawaii net metering law as a simultaneous purchase and sale agreement for small customer-owned generators rather than a net metering law. (Starrs, T.J., Kelso Starrs & Associates, L.L.C., letter to Maurice Kaya, Energy Resources & Technology Division, DBEDT, July 24, 1996.)

6. Other renewable energy technologies were removed from its net metering bill as one of several legislative compromises, following strong utility opposition.

7. The net metering order by the Iowa State Utility Board includes all eligible renewable energy technologies except geothermal.

8. Personal communication with Michael Bergey, Bergey Windpower Company, Norman, Oklahoma, January 13, 1997.

9. Personal communication with Michael Bergey, Bergey Windpower Company, Norman, Oklahoma, January 13, 1997.

10. Several utilities consider the solid-state switching devices built into PV inverters not very reliable, and they prefer the conventional hardware switches and breakers for disconnecting PV systems whenever a fault occurs in the utility grid. However, utilities would be prohibited by New York's proposed net metering bill from requiring net metering customers to install any additional control and protection equipment if the net metering customer's generation facilities meet all applicable safety and power quality standards established by the National Electric Code and the Underwriters Laboratory (UL).

11. Wenger, H., Herig, C., Taylor, R., Eiffert, P., and Perez, R., "Niche Markets for Grid-Connected Photovoltaics," IEEE Photovoltaic Specialists Conference, Washington, D.C., May 13-17, 1996.

12. *Energy Efficiency News & Views*, V2#2, p. 8. June 1996.

13. Starrs, Thomas J. "Net Metering: New Opportunities for Home Power," REPP Issue Brief, No. 2, September 1996.

## Appendix

### Arizona's Net Billing Rules

On July 27, 1981, Arizona Corporation Commission Decision No. 52345 allowed net metering for QFs (under PURPA and FERC rules) of 100 kW or less. Excess customer generation would be purchased by utilities at the avoided cost. However, no tariffs were filed by the utilities to implement the net metering. In 1993, then Arizona Corporation Commission Chairman Renz Jennings urged Arizona Public Service Company (APS) to file a net metering tariff. The result was EPR-3, which became effective February 4, 1994. Only three customers signed up for EPR-3. It was frozen for those customers in 1996 and replaced with EPR-4 which was effective on July 1, 1996.

EPR-3 limited the eligible technologies to solar energy only, but EPR-4 allows all renewable energy technologies. All other provisions are identical between EPR-3 and EPR-4. Both tariffs limit the installed capacity to 10 kW or less, not the 100 kW permitted under the 1981 order. A single non-ratcheted meter is allowed to turn backward to register the net energy consumed or produced during a normal billing cycle. Customers buy electricity from APS at the standard retail rate for their class. Excess generation is purchased at APS's avoided energy cost. No special interconnection requirement is imposed.

In addition, Tucson Electric Power Company (TEP) filed two tariffs effective March 1, 1996, for power purchased from QFs with 100 kW or less capacity that included net metering options. Tariff No. 101 is for non-firm power purchase, and Tariff No. 102 is for firm power purchase. Customers under either tariff can take service from TEP at the applicable standard retail rate. Net excess generation, if any, will be purchased by TEP at a specified seasonal rate: 4.4 ¢/kWh May through October or 3.5¢/kWh November through April for Tariff No. 101, and 4.84¢/kWh May through October or 3.85 ¢/kWh November through April for Tariff No. 102.

### California's Net Metering Law

California's net metering law (Senate Bill No. 656) requires every utility in the state (whether or not it is subject to the jurisdiction of the commission) that offers residential electrical service to develop a net metering tariff for its residential customers who own and operate a

solar electrical generating facility with a capacity of 10 kW or less. The solar electrical generating facilities must be located on the customer's premises and intended primarily to offset the customer's own electricity usage. The net metering law became effective on January 1, 1996. The purposes of California's net metering law are to encourage private investment in renewable energy resources, stimulate in-state economic growth, enhance energy resource diversity, and reduce utility interconnection and administrative costs.

The net metering law of California allows utilities to either calculate the net energy for a normal billing period or annualize the net energy measurement period. If the net metering is done over a utility's normal billing cycle, the excess energy supplied by the customer-generator will be compensated for at the utility's avoided energy cost. If the net energy measurement is annualized, the customers still pay their normal monthly bill when they use more electricity than they produce during the billing cycle. Excess generation, if any, can be carried over to the next billing cycle as credit. At the end of the annual period, any excess generation from the customer-generator will be purchased by utilities at their avoided energy costs.

In addition to the 10-kW limit on each individual customer-generator, the total generating capacity owned and operated by eligible customer-generators in each utility's service area for net metering is limited to 0.1% of the utility's peak demand forecast for 1996. Total net metering capacity in California can reach 53.3 MW under this law. The following table lists the maximum net metering capacity of California utilities.

**Table 2. California's Net Metering Capacity**

	1996 Peak Demand (MW)	Net Metering Capacity (MW)
Pacific Gas & Electric	17,426	17.0
Northern California Municipals	2,200	2.2
Sacramento Municipal Utility District	2,556	2.6
Southern California Edison	19,725	20.0
Los Angeles Department of Water and Power	6,057	6.1
San Diego Gas & Electric	3,608	3.6
Burbank, Glendale, Pasadena	787	0.8
Others	960	1.0
California	53,319	53.3

This law became effective on January 1, 1996. There is not enough information yet to assess its impact on small PV systems in California.

### **Colorado's Net Metering Program**

Net metering is not required by the state, but the Public Service Company of Colorado has had a net metering option for small QFs of 10 kW or less since 1994. The net metering option is specified in the company's Safety, Interference and Interconnection Guidelines for Cogenerators, Small Power Producers, and Customer-Owned Generators, revised April 1994. A single meter is allowed to run backward to register net customer consumption or net generation. Any excess generation during the normal billing cycle is granted to the utility without compensation. The company cited reducing administration and account costs as the reason for implementing net metering for small QFs. Less than three customers are on the net metering program.

### **Connecticut's Net Metering Order**

Net metering in Connecticut was established by the Department of Public Utility Control under CPUCA No. 159 and has been effective since 1990. QFs with a generating capacity as much as 50 kW—and 100 kW if renewable energy resources are used—are eligible for net metering. Excess generation is purchased at the utility's avoided cost. The net metering program in Connecticut is intended to encourage customer installation of renewable energy systems. However, the program does not appear to have had any effect in promoting small renewable energy systems in Connecticut. Currently, there are no customers in the net metering program.<sup>1</sup>

### **Hawaii's Net Energy Metering Law**

Hawaii's net energy metering law (Act 205) was enacted in June 1996. Hawaii's Net Energy Metering Act does not allow customer-generators to offset their own electricity consumption directly with one meter. Instead, it mandates a two-meter arrangement; one to measure the electricity supplied by the utility and another to measure the electricity generated by the customer. Customer-generators will be billed for the electricity consumption at the utility approved retail rate and the utility will credit the customer generators for the electricity they generate at a rate to be determined by the PUC based on the utility's incremental cost of energy. This practice is really not much different from that of the QF interconnection

requirement mandated by PURPA and FERC rules.

Only residential customers with solar, wind, or micro-hydro electric energy generating facilities of 10 kW or less are eligible for Hawaii's net energy metering program. Act 205 further set the total capacity limit under the net metering program to 0.1% of a utility's peak demand.

### **Idaho's Net Metering Order**

Idaho's net metering program has been available since 1986. The enabling order was Idaho Public Utilities Commission Order No. 16025 issued in 1980. The final tariffs implementing the net metering (tariff sheets 86-1 through 86-7) were approved in 1986. There are no restrictions on generation technologies, but the generating capacity must be 100 kW or less. Under Idaho's net metering program, the excess generation is purchased by utilities at the applicable retail rate of the customer class. Because of low electricity rates in Idaho, there are only two customers under the net metering program. (The average residential rate of Idaho was only 5.3 ¢/kWh in 1995.<sup>2</sup>)

Idaho Power Company, an investor-owned utility, petitioned the Idaho PUC to abolish the net metering tariff. The PUC proposed to modify the tariff so that utilities can buy back excess generation at the avoided cost but has not made a final rule on this.<sup>3</sup>

### **Indiana's Net Billing Order**

Net metering is available in Indiana under the 170 Indiana Administrative Code 4-4.1-7 issued in 1985. QFs that generate less than 1000 kWh per month can request the net metering option. Excess generation is granted to the utilities. If the qualifying facility can generate more than 1000 kWh a month, it may request that the utility purchase its generation, but two meters will be installed to measure the production and usage. The utility will buy back the energy at the avoided cost. About 20 small wind power facilities statewide have signed up for this program.<sup>4</sup>

### **Iowa's Net Billing Order**

Net metering is available in Iowa under the Iowa Administrative Code Paragraph 15.11(5), first issued by the Iowa State Utility Board (ISUB) in 1991. After some minor revisions, the final order became effective on

June 23, 1993. Its purpose is to encourage alternative energy production in Iowa. The order requires rate-regulated electric utilities in Iowa to offer parallel operation and net energy metering to qualifying alternative energy production (AEP) facilities and qualifying small hydro facilities. Currently, five investor-owned utilities are subject to this order: Interstate Power Company, Iowa Electric Light & Power Company, Iowa-Illinois Gas & Electric Company, Midwest Power Company, and Iowa Southern Utilities Company.

The qualifying AEP facility is defined as an electricity production facility that derives 75% or more of its primary energy input from solar energy, wind, waste, agricultural crops and residues, refuse-derived fuel, or wood burning. Geothermal is not included in the alternative energy list. QFs under 1978 PURPA, 18 CFR Part 292, Subpart B and small hydro facilities are not precluded from being a qualifying AEP under Iowa's net billing order, but they are not the same. The AEP facilities must enter into a contract with the utility to participate in the net metering program. Utilities are obligated to interconnect with the qualifying AEPs using a single meter monitoring only the net amount of electricity sold or purchased from them. Net metering is done monthly.

Qualifying AEP or small hydro facilities purchase electricity from utilities at the tariffed rate. Net excess electricity is sold to utilities at a uniform statewide rate based on the utility's avoided cost. There is a kW capacity component and a kWh energy component in the uniform statewide rate. The kW capacity rate depends on the length of the contract between the qualifying AEP or small hydro facilities and the utilities and is adjustable to a maximum of \$25.15 per kW. It is applied to the monthly available AEP generating capacity, which is determined by dividing kWh delivered to the utility during the month by number of hours in the month. The kWh energy rate is fixed at \$0.0257 per kWh. Alternatively, utilities and qualifying AEP and small hydro facilities may choose to operate in a simultaneous purchase and sale arrangement under which all electricity produced by the QF is sold to the utility at a fixed or negotiated buyback rate, and all electricity by used the QF is sold to the facility at the utility's tariffed rate (i.e., no net metering).

There is no limit on the installed capacity of individual qualifying AEP or small hydro facilities, but there is a 105-MW cap on the total alternate energy generating capacity in Iowa under this order. The 105-MW capacity cap is divided among the five rate-

regulated utilities according to the utility's estimated percentage share of Iowa's peak demand. Utilities are not required to purchase more than their share of the 105 MW under this rule. The following table lists each utility's share of the 105 MW.

	<b>% Share of Iowa Peak</b>	<b>MW</b>
Interstate Power Co.	13.09%	13.5
Iowa Electric Light & Power Co.	24.07	25.3
Iowa-Illinois Gas & Electric Co.	12.28	12.9
Midwest Power Co.	40.29	42.3
Iowa Southern Utilities Co.	10.27	10.8

### **Maine's Net Metering Program**

Net metering in Maine has been available since 1987. It is ordered by Maine Public Utilities Commission through Code ME R. Ch. 36, Sections 1(A)(18) and (19), Section 4(C)(4). QFs with a generating capacity less than 100 kW can qualify for the net metering program. Excess generation is purchased at the utility's avoided cost. There are no limits on how many customers can qualify—or on total capacity—under the net metering program.

### **Massachusetts' Net Metering Program**

QFs (under PURPA and FERC rules) with a generating capacity of 30 kW or less are eligible for net metering in Massachusetts. The net metering program was ordered by the Department of Public Utilities through 220 Code of Massachusetts Regulation (CMR), Section 8.04(2)(C), in 1982. Excess generation is purchased at the utility's avoided cost. The intent of the program is to encourage small power production facilities and diversify the resource mix of the state. Very few customers have signed up for the net metering programs. Almost all of them are small cogenerators using diesel engine/generator sets.'

### **Minnesota's Net Billing Law**

Net metering in Minnesota is authorized under Section 216B.164 of the Minnesota Statutes and Section 7835.3300 of the Minnesota Department of Public Service Rules. It has been effective since 1983 and applies to all Minnesota electric utilities, including cooperative electric associations and municipal electric utilities.

The intent of the Minnesota net metering law is to give the maximum possible encouragement to cogeneration and small power production, consistent with protection of the ratepayers and the public. QFs under FERC CFR 18, Part 292, with a capacity of 40 kW or less, are eligible for net metering. Net excess generation during the normal billing cycle is purchased by utilities at the average retail energy rate.

Nongenerating utilities that have a sole-source contract with a municipal power agency or a generation and transmission utility may treat its purchase of any net input from QFs under the net metering law as being made on behalf of its supplier. The supplier shall reimburse the nongenerating utility for any additional costs incurred in making the purchase.

There is no restriction on total capacity under Minnesota's net metering law, but only a few small hydro facilities and wind turbine operators have signed up for it.

### **New Hampshire's Net Metering Order**

In New Hampshire, net metering is available for QFs (under PURPA and FERC rules) if it is mutually agreed to by the utility and the affected QF (DE 80-246, Supplemental Order No. 14,797, March 20, 1981). It is primarily for QFs that intend to offset their own consumption with generating facilities and is handled on a case by case basis.

The net metering program for residential customers in New Hampshire is called net energy billing and is available only to customer-owned renewable energy facilities of 25 kW or less. The program was ordered by the New Hampshire PUC on April 1, 1994 (Order 21,163 PSNH). The order further restricts the total installed generating capacity in New Hampshire under the net energy billing program to 500 kW. Net billing can be done with a single meter or two meters. In the event of dual meters, the customer will be required to provide a suitable socket to permit the utility to install a second meter. The utility will not pay the customer for excess generation in any billing period, nor will such excess generation be credited toward future monthly bills. It is estimated that there are 16 customers with 158 kW of renewable generation that qualify for the net energy billing program in New Hampshire.

### **New Mexico's Net Metering Rule**

Net metering in New Mexico is authorized by the New Mexico Public Service Commission Rule 570 governing the interconnection of cogeneration and small power production facilities that meet the criteria for QFs under FERC CFR Title 18, Part 292.203. It is an option for QFs with a capacity of 100 kW or less that primarily intend to serve their own loads (called load displacement option). There will be no additional customer charge for this option. However, utilities will not pay for any excess energy produced by the QFs. Another option under Rule 570 is to install two meters to calculate net energy consumed or supplied by the QFs. The QFs will be paid for excess energy at the utility's energy rate only. An additional customer charge to cover the added costs of billing and administration will be included in the tariff. Rule 570 has been in effect since June 30, 1988. The number of customers participating in the net metering program is unknown. It is estimated to be extremely small.<sup>6</sup>

### **New York's Proposed Net Metering Bill**

New York's net metering bill (an act to amend the public service law) was passed by the New York Assembly in May 1996 but was vetoed by the governor in November 1996. The bill would have established a net metering program for the utility's residential customers who own and operate solar electric generating facilities of not more than 10 kW. It limited the total installed solar electric generating capacity to 0.1% of each utility's 1997 peak demand as forecasted by the Public Service Commission (PSC). The capacity limit was to be reviewed by the PSC in 2005 to determine whether it should be increased in the future. (The 1997 noncoincidental peak demand forecast for New York state is 29,691 MW.)

New York's bill would have required all utilities in the state (investor-owned, publicly owned, municipally owned, and cooperatives) to offer net metering programs to eligible customers and that they not impose any charges or fees not imposed to other non-net metering customers. Furthermore, the bill specifically stated that if the residential solar generation facilities met all applicable safety and power quality standards established by the National Electric Code and the Underwriters Laboratories (UL), then utilities could not require the net metering customers to install additional controls, perform or pay for additional tests, or purchase additional liability insurance. This was a unique feature of New York's net metering bill.

In addition to prohibiting utilities from imposing extra charges and requiring additional equipment, New York's net metering bill also required the utilities to annualize the period during which the net energy measurement was calculated. If the customer-owned solar generating facility produced more electricity than it consumed during one month, the excess generation would have been carried over to the next month as a credit. At the end of the annual period, the utilities would have purchased any remaining excess generation at the utility's avoided cost.

### **North Dakota's Net Metering Order**

Net metering has been available in North Dakota since 1991 under the North Dakota Administration Code, Section 69-09-07-09. Customer-owned renewable energy generators or QFs under 100 kW are eligible. Utilities are to install a single meter to measure the net electricity consumption or production of such customers. Excess generation by customer-owned generators will be purchased by utilities at the avoided cost. There is no limit on the total capacity under the net metering program.

### **Oklahoma's Net Billing Order**

Net metering has been available in Oklahoma since 1988 under the Oklahoma Corporate Commission Order 326195. Utilities under the jurisdiction of the Oklahoma Corporate Commission (investor-owned utilities and Rural Electric Administration [REA] cooperatives) are required to file a net billing tariff for customer-owned renewable energy generating facilities rated 100 kW or less.

For eligible customer-owned generating facilities, utilities must allow parallel operation with a single meter to register the net energy consumed. Other than industry standard protection devices and normal customer charges that apply to all customers in the same class, utilities are not allowed to make additional requirements or extra charges for the interconnection of the customer-owned generating facilities. However, utilities are not required to purchase any electricity from customers under the net billing program. Meters are read monthly. Excess generation, if any, is granted to the utilities. There is no limit on how many customers can participate in this program, nor a cap on the total installed generating capacity under the net metering program.

Customers can require utilities to purchase the electricity they generate. In this case, utilities will install

two meters to register generation and consumption separately. The utility buyback rate is based on avoided cost.

Although all renewable energy sources are eligible for the net metering program, only wind generating systems have been connected. Oklahoma Electric Cooperative, the largest distribution REA cooperative in Oklahoma, has 21 wind power generators, ranging from 1 kW to 20 kW, connected to its system with the net billing arrangement. Customer generations rarely exceed their consumption.<sup>7</sup>

### **Rhode Island's Net Metering Order**

A net metering program for customer-owned small renewable generating facilities and cogenerators has been available in Rhode Island since 1985 under the Public Utility Commission Supplementary Decision and Order, Docket No. 1549. The program's original purpose was to encourage small wind generators, but customers with renewable energy generating facilities are eligible for net metering. Excess generation during the normal billing cycle is purchased by the utility at the avoided cost. There are four investor-owned utilities in Rhode Island. Two of them, Blackstone Valley Electric and Narragansett Electric Company, are considered larger utilities. Customers of the larger utilities can install renewable generating facilities with a capacity of as much as 25 kW and still qualify for the net metering. Block Island Power Company and Newport Electric Corporation are considered smaller utilities for the net metering program. Customers of the smaller utilities can only install facilities with as much as 15 kW of renewable energy generating capacity for the net metering program. Since the order became effective in 1985, only a few small wind generators have signed up for the program.

### **Texas' Net Metering Order**

Net metering is ordered by the Public Utility Commission of Texas under Substantive Rules, Section 23.66(f)(4), which became effective in 1986. The order requires utilities to offer a net metering option to QFs of 50 kW or less, using renewable energy resources. Utilities will install a single meter for such customers and allow the meter to turn backward to register the net energy consumption or production by the customers. Net consumption is billed at the applicable tariff and excess generation by the customers during a billing cycle is purchased by utilities at the avoided cost (fuel cost only,

no capacity component). Texas initiated the net metering program 10 years ago to promote small wind power and PV markets in the state. There is no statewide limit on the number of customers or total capacity under the net metering program. There are approximately 25 small wind generators currently under the net metering program.

### **Wisconsin's Net Billing Order**

Net metering in Wisconsin is authorized by Public Service Commission of Wisconsin (PSCW) Order 6690-UR-107, issued December 29, 1992, and effective January 1, 1993. The order applies to all utilities under the jurisdiction of PSCW. Wisconsin's net metering applies to all customer-owned electric generation facilities that are interconnected with the utility's power supply, are rated at 20 kW or less, and have entered into a parallel generation contract with the utility. If a customer has more than one generator, the generator's ratings shall be summed. This sum shall not exceed 20 kW.

Energy flowing from the customer's generation facilities into the electrical system of the utility shall be permitted with the utility's electric meter allowed to run backward. If the amount of energy supplied to the utility exceeds the amount of energy consumed, the customer will receive a credit on his monthly bill equal to the net excess kilowatt-hours of energy received by the utility multiplied by the Energy Credit Rate, including any applicable adjustment for cost of fuel, or the customer will receive a check for this amount issued by the utility. Any credits to the customer shall be reduced by the monthly customer charge of the standard applicable rate schedule. Actual issuance of a check payable to the customer shall not occur until the amount due the customer exceeds \$25. For customers with time-of-use rate, a second time-of-use meter has to be installed and the on-peak purchases and sales will be netted separately from off-peak purchases and sales. For renewable resource generators, the energy credit rate is the customer's retail rate. For nonrenewable resource generators, the energy credit rate is the utility's avoided cost (PG-2 rate).

### **Notes to Appendix**

1. Mark Quinlan, Rates Division, Connecticut Department of Public Utilities, telephone conversation, August 12, 1996.

2. Energy Information Administration, *Electric Power Annual 1995*, Volume 1, July 1996.

3. Tony Jones, Idaho Public Utilities Commission, telephone conversation, August 19, 1996.

4. Jerry Webb, Chief Engineer, Indiana Utility Regulatory Commission, telephone conversation, August 1, 1996.

5. Theo MacGregor, Massachusetts Department of Public Utilities, telephone conversation, August 19, 1996.

6. John Curl, New Mexico Public Service Commission, July 30, 1996.

7. Paul Enouen, Engineering Manager, Oklahoma Electric Cooperative, telephone conversation, July 31, 1996.



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