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Current Experience with Net Metering Programs

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CURRENT EXPERIENCE WITH NET METERING PROGRAMS

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Abstract

Net metering is a utility metering practice that encourages direct consumer investment in renewable energy technologies. Laws and regulations that establish net metering practices now exist in 22 states. Net metering enables electricity customers with small generators to receive a higher value for some or all of the electricity they generate. This is accomplished by allowing the electric meters of such customers to turn backward when there is more generation than demand. It effectively allows customers with small generators to use the electricity they generate to offset their usage over an entire billing period. This paper reports on the current status of net metering laws and rules in the United States. In particular, the extent of the net metering authority in each state is highlighted. Differing requirements for grid-interconnection have introduced significant variations in the actual implementation of net metering programs. Interconnection requirements from specific utilities are collected to understand how net metering programs have been affected.

I. Introduction

Net metering is a practice in which utilities measure and bill for the net electricity consumption or generation of their customers with small generating facilities.[1] This is accomplished either by allowing a meter to turn backward or by using two meters–one to record generation and one to record consumption and manually subtracting the two readings. Without net metering, small customer-owned generators are usually treated by electric utilities as if they were qualifying facilities (QFs) under the Public Utility Regulatory Policies Act of 1978 (PURPA) and subsequent implementation rules by the Federal Energy Regulatory Commission (FERC).[2] Such customers must enter a net purchase and sale agreement with the utilities. Utilities always install two meters for each account to record separately the net energy used by customers and the net excess energy produced by the customer. These customers pay retail rates for the energy they use, and the utilities reimburse customers at the utility's avoided cost for the energy they produce.[3] The differences between a utility's retail rate and the avoided cost can be substantial, as high as 10 cents (differential) per kilowatt-hour (kWh).

Under a net metering program, customers can use their generation to offset their consumption over the entire billing period, not just the instant there is a demand. The arrangement allows the customers to use the utility grid to "bank" their electricity produced at one time and consume it at another time. This form of energy exchange is especially useful for intermittent renewable energy technologies. It allows all or a substantially bigger portion of the customer-generated electricity to the receive retail price and thus increases the economic value of small renewable energy technologies for customers. The ability to "bank" electricity affords customers more flexibility in self-generating. Customers do not have to alter their

[1] Some states and utilities also use the term "net billing" to describe net metering, although net billing can apply to another practice in which customers who take utility power at several locations aggregate their electric bills from all locations.
[2] Code of Federal Regulations (CFR), Title 18, Part 292
[3] The avoided cost is the cost to the utility of generating the electricity or of purchasing it on 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.

consumption or install energy storage devices to maximize the value of their generation. The generating facility may be sized to match long-term energy consumption. On the other hand, customers with net purchase and sale agreements are more likely to install smaller generators so as not to exceed their instantaneous power demand.

Utilities may also benefit from net metering. By encouraging distributed customer generation through net metering, utilities can improve their distribution voltage profile and reduce system losses. In addition, net metering can help utilities minimize the administration cost for customers with small generating equipment.

Net metering programs exist because of state initiatives. PURPA encourages cogeneration and renewable energy technologies by requiring utilities to interconnect with cogenerators and renewable energy facilities and to purchase power generated by them. When designing rules to implement PURPA and FERC regulations, some states decided to take the intent of PURPA one step further by including net metering as an option for smaller generators. For example, the Arizona Public Utilities Commission (PUC) ordered net metering for QFs in 1981, and Minnesota enacted a net metering statute in 1983. Now, a total of 20 states have enacted net metering laws or regulations. In addition, individual utilities in at least two other states offer net metering tariffs to their customers.

II. Rationale for Net Metering Programs

The main objective for states implementing net metering programs is to encourage private investment in renewable energy resources. Other goals include stimulating local economic growth, diversifying energy resources, and improving the environment. 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 makes renewable energy technologies more economically attractive without requiring public funding. Net metering also addresses a perceived equity issue of utilities gaining an unfair advantage over customers by paying customers only avoided cost but charging them retail price for electricity.

Nevertheless, many utilities still oppose net metering programs for several reasons. Most do not want another state mandate imposed on them. Some maintain that paying retail prices for customer-generated electricity amounts to a subsidy because retail prices also include the costs of transmission and distribution, administration, and profits in addition to a utilities' energy cost. Others express concern about revenue losses. Some utilities oppose net metering because they believe it violates PURPA and FERC implementing rules by requiring utilities to pay higher than their avoided costs for QF generation. Other utility opposition to net metering includes safety issues and the loss of actual customer load information.[4]

On the other hand, there are a few utilities offering net metering without a commission order or a state law. Some of these utilities support net metering for renewables because they want to be seen as friendly to the environment and responsive to their customers' needs and concerns. For others, the primary motivation is avoiding the extra cost associated with installing and maintaining a second meter, processing separate accounts, and preparing payment checks for small generators.

[4] If a large number of customers were eventually to participate, a utility's ability to accurately predict peak customer demand based only on the meter readings may be reduced.

III. Existing Net Metering Programs

Currently, net metering programs are available in 22 states. These programs have three sources of implementation authority: state law, PUC orders, and individual utility tariffs. Six states have enacted net metering laws, and 14 other states have established net metering programs through regulatory processes. Utilities in Colorado and Pennsylvania chose to offer net metering at their own discretion without a prior commission order or state law. In addition, net metering legislation is pending in several other states. Table 1 summarizes various features of available net metering programs in the 22 states. Early net metering programs, except for Minnesota, were initiated by state PUCs through regulatory processes. However, the recent trend has been for states to establish net metering through legislative processes.

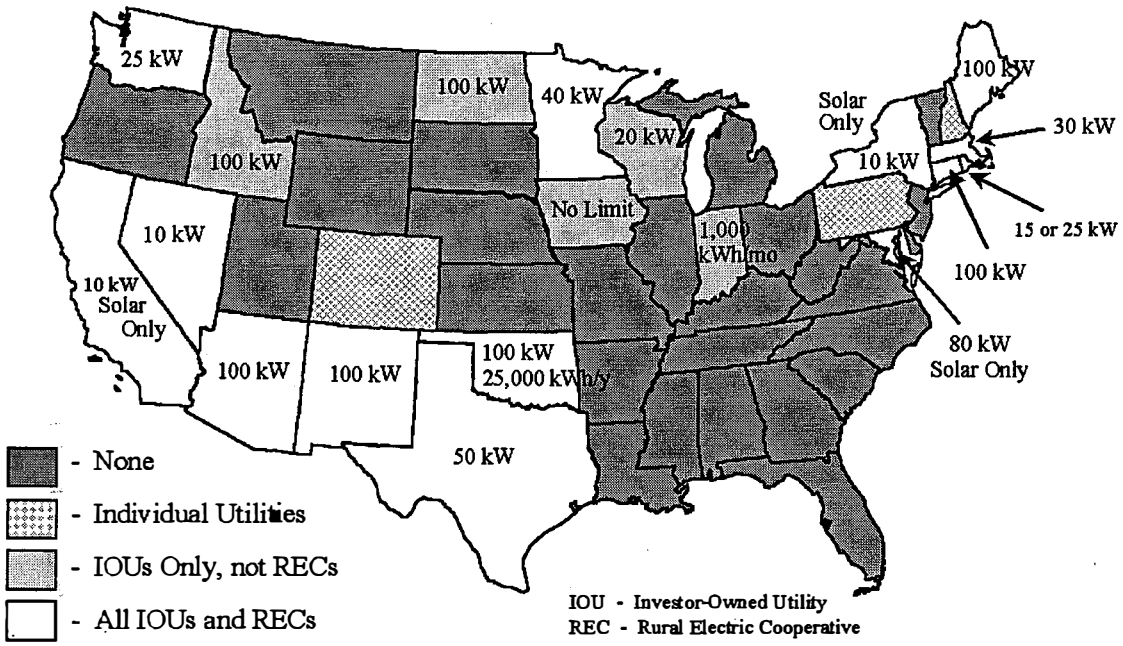

FIGURE 1. SCOPE OF NET METERING BY STATE WITH CAPACITY LIMITS NOTED.

Net metering programs established by state law are applicable to all utilities in the state, regardless of whether a utility is under the jurisdiction of the state utility commission. Net metering established by PUC orders apply only to utilities that are rate-regulated by the PUCs. Since many states do not rate-regulate rural electric cooperatives, the net metering option is often not available for rural customers even if the PUC has issued net metering orders.[5] However, rural customers are better candidates to install wind turbines than their urban counterparts because they are less constrained by issues such as zoning, noise, lack of space, visual impact, and safety. This leads to a disparity between the availability of net metering for solar and wind generation as shown in Figure 1, a map of net metering availability by state. Of the 22 states which offer net metering, four are solar-only states. In five of the remaining 18 states, only investor-

[5] There are rural electric cooperatives that will voluntarily follow PUC rulings even though they are not rate-regulated. For example, Wisconsin cooperatives are preparing to offer net metering to their customers despite the fact that they are not required to do so.

owned utilities are required to offer net metering. In two other states, net metering is limited to just one or two utilities. That leaves just 11 states in which net metering is universally available to rural residents, the most likely users of small wind turbines.

Various approaches have been taken to the treatment of net excess generation (NEG). Excess generation occurs when a customer-owned generator produces more electricity than the customer's total electricity demand during the utility's billing cycle. The magnitude of NEG depends on the size of the load, the capacity of the generating equipment, and the availability of renewable energy resources. The net metering states require utilities to purchase customers' NEG either at the utility's avoided cost or at the retail rate (MN and WI), or they let utilities take the NEG without paying anything to their customers. While PV systems seldom generate more electricity than a residential or commercial building can use during a month, a residential wind system in a good wind resource region can produce more energy than is consumed during a utility's monthly billing cycle. Thus, the treatment of the customer's NEG can significantly affect the economics of a small wind system.

Most states direct utilities to use their normal monthly billing cycle to determine the NEG, but New York and Washington direct their utilities to assess NEG annually. Annual assessment will only benefit users of renewable energy because energy produced during a high resource season of the year can be used to offset consumption during a low resource season.

Net metering generally is not available to customers on time-of-use (TOU) rates or demand charge rates. Current TOU meters for small customers do not turn backward. Besides the need for a second meter, applying net metering to TOU customers raises the issue of which time period (on peak or off peak) the energy should be credited to. Only New York currently allows TOU customers to have net metering options, but how the utilities will accomplish it is still being decided. In some cases, utilities require customers who exceed a particular threshold in monthly demand to switch from an energy-based tariff to a demand-charge tariff. Since demand charge meters typically do not run backwards, this may eliminate access to net metering. Even if the meter issue is resolved, renewable generation by a demand-charge customer will only offset the energy charge portion of the monthly bill, but not the demand charges. This will, of course, reduce the economic benefit of net metering.

Today's net metering programs have great diversity as to who is eligible to participate and under what conditions. 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 process. These compromises include 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 other ratepayers.

Utilities in several states have challenged net metering orders or petitioned the PUCs to terminate the net metering requirements. So far none has succeeded in overturning an existing net metering order.[6] Utility challenges have been based on the premise that net metering orders violate PURPA and often cite the FERC decision on Connecticut Light and Power, No. EL-93-55-000, which states that PURPA bars the states from requiring utilities to pay QFs the retail rate. PUCs of Maine[7] and Minnesota[8] did rule on the

[6] For example, although the Idaho PUC did modify its net metering order to restrict customer eligibility in 1997, it rejected the utility's request to terminate the net metering program.

[7] Maine Public Utilities Commission, Order: In Re. Petition Requesting Commission Intervention Regarding Efforts to Obtain Net Billing Purchasing Contract with Central Maine Power Company, Docket Nos. 97-513 & 97-532 (October 27, 1997).

PURPA issue related to net metering in 1997, and both upheld their net metering requirements. PUCs of both states found that net metering requirements do not violate PURPA because utilities are not required to purchase electricity from customers at a rate higher than utility avoided cost. They also ruled that the Connecticut Light and Power decision, which involves wholesale transactions, does not apply to retail metering and billing. Both PUCs maintain that the state has the right to establish alternative billing and metering practices for retail transactions and these rights are not preempted by PURPA. In March 1998, the Iowa Utilities Board withdrew a proposal to eliminate Iowa's existing net metering rule following a significant display of public support. However, the legal issues arising from net metering orders are not completely resolved, and utilities may continue their challenges at the state level. Another uncertainty is utility restructuring and retail competition. It is not clear at present what impact this will have on net metering programs.

IV. Utility Interconnection Requirements

Safety is the most critical concern of utilities when interconnecting small customer-owned generating equipment. Utility distribution systems are not designed to have generators. When customer-owned generators are interconnected to the distribution network, they become a safety concern for utilities because they may upset the coordination of protective devices or accidentally energize a supposedly "dead" circuit. Other technical issues with small generator interconnections include power quality, service reliability, equipment protection, and metering arrangements.

There are national standards to address the safety, power quality, reliability, and protection issues.[9] However, utilities have the discretion to establish their own criteria and guidelines based on these national and industrial standards. An investigation of interconnection criteria and guidelines of 13 utilities has shown that the scope of the rules are very similar, but that there are significant variations in the specific details such as allowable relay type and ranges of relay settings for fault monitoring and clearing.

Utilities require the customer-owned generating equipment and its installation to meet the National Electrical Code (NEC) and applicable local codes. Without an exception, utilities require all customer-owned small generators that are connected at the distribution voltage level to be off-line when the utility lines are out. Many give specific relay requirements and settings for how to accomplish this. Almost all utilities require the customers to install a manual, lockable disconnect switch that is accessible to utility personnel so they can isolate the customer-owned generating equipment. Requirements related to power quality (allowable flicker and harmonics) are also universal, but the specifications vary from one utility to the next. Some utilities want to inspect and test the customer's facilities before interconnection, and at a minimum, all utilities will explicitly mandate the right to do so. Differences exist in how utilities address service issues. For example, some utilities require a separate transformer for every customer with generating equipment while others will evaluate the need for such a transformer on a case-by-case basis. Another example is synchronizing devices; some utilities require them, but others leave this to customer discretion.

Utilities also differ on the meter arrangement in implementing net metering. Conventional electromechanical meters are capable of turning in both directions. Most utilities will simply use the existing meter when net metering is required. However, some utilities insist on using two meters to

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[8] Minnesota Public Utilities Commission, Re In the Matter of the Complaint of Ann Lanners Against Minnesota Valley Cooperative Light and Power Association, Docket No. E-123/C-95-1085 (March 31, 1997).

[9] For example, the following two are often referenced: *IEEE Recommended Practice for Utility Interface of Residential and Intermediate Photovoltaic (PV) Systems*, ANSI/IEEE Standard 929-1988 (R1991) and *IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems*, ANSI/IEEE Standard 519-1992.

accomplish net metering and ask the customers to pay the cost of the additional meter. Those utilities claim that running a typical residential customer meter in reverse may not have the accuracy required by state regulations and may result in billing disputes.

In summary, these variations in the interconnection requirements do present a barrier to net metering customers and to equipment manufacturers because individual installations may require custom engineering designs. A set of uniform interconnection standards is needed to encourage implementation of net metering practice.

Greater variation in utility interconnection requirements are found in areas that do not contribute directly to operational safety or service reliability. Utilities have proposed a variety of liability insurance, property easement, and legal indemnification requirements. Some utilities also demand metering calibration charges, engineering study fees, or standby charges. They may also require customers to keep records of all maintenance and operation. These additional requirements tend to reduce the incentive provided by net metering and may deter customers from participating. As an example, two California investor-owned utilities originally structured net metering contracts that set a substantial monthly customer charge and standby charge. This essentially made net metering unattractive until the California PUC banned the imposition of customer charges.[10]

State PUCs have widely varying attitudes toward these additional requirements. For example, PUCs of Oklahoma, California, and New York concluded that additional liability insurance was excessive and burdensome to net metering customers and do not allow utilities to require it. Maryland and Nevada net metering statutes specifically prohibit utilities from requiring additional liability insurance and additional testing if the customer's facilities meet applicable national and industry standards. On the other hand, Idaho PUC permits Idaho Power Company to require $1,000,000 liability insurance from its customers who want net metering. The New York Public Service Commission has chosen to disallow property easement provisions.[11]

The actual operating experience of customer-owned small generators does not justify the utility requirements for high liability insurance. In fact, there is no example of utility personnel injury or death resulting from a customer-owned generator accidentally energizing an otherwise "dead" utility line. The utility concerns of safety, power quality, and service reliability are legitimate, but the record suggests that the established industry standards adequately address these concerns.

V. Impact on Renewable Energy Technologies

When states develop net metering initiatives, the most frequently stated goal is to encourage direct customer investment in renewable energy technologies. Despite the fact that net metering programs for small renewable energy generating systems have been available in some states for more than 10 years, their actual impact on the renewable energy technology market has been limited. For example, in Minnesota where the first net metering law was enacted in 1983, there were 110 net metering customers (all but 3 are small wind systems) as of 1996.[12] We have found that exact numbers are not available in other states because utilities and state energy offices are not required to keep accurate records. Although no hard statistics exist about the number of customers and total installed capacities under net metering programs, the anecdotal information we have collected suggests that relatively few customers participate

[10] *Energy Efficiency News & Views*, V2#2, p. 8. June 1996.
[11] New York Public Service Commission, Order on Net Metering of Residential Photovoltaic Generation (issued and effective February 11, 1998).
[12] Minnesota Department of Public Service, 1997 Electric Utility Qualifying Facilities Report, November, 1997.

in these programs in other states. According to PUC staffs of several states and advocacy group members contacted for this work, it appears that net metering programs' small impact on the renewable energy market to date can be attributed to several factors:

1. Economics of Net Metering — Low electricity prices and high costs of small renewable energy systems are significant barriers. Repeated opinion polls and the experiences of utilities' green pricing and marketing programs have demonstrated the public's desire to support clean energy options and their willingness to pay more for them. However, the present monetary gap between costs and benefits needs to be narrowed further to attract a larger number of customers to net metering programs.

2. Lack of Public Awareness — A number of net metering programs are still in their infancy, and information about existing programs has not been made widely available since utilities usually do not actively promote them. So, in many cases, customers are not aware of their net metering option and/or the potential benefits.

3. Program Limitations and Restrictive Interconnection Requirements — The many limits of individual net metering programs noted in Table 1 reduce the overall opportunity. This is particularly true for wind energy because the programs in 11 states either restrict wind energy generation altogether or do not extend net metering to all rural customers. Various interconnection requirements demanded by utilities also act as barriers to small net metering customers.

VI. Conclusions and Recommendations

Net metering programs can be an appealing policy option for advancing renewable energy technologies. The programs enhance economic incentives to the owners of small renewable energy systems and encourage private investment in renewable energy technologies without requiring public funding. They are easy to implement and require no constant regulatory interaction or supervision after they are in place. The attractiveness of net metering in high electric rate regions may provide a boost for the renewable energy industry in those regions. And perhaps more importantly, as the cost of renewable energy technologies continues to decline, net metering programs will become more effective in facilitating widespread applications of small renewable energy systems.

However, net metering programs still face many obstacles and uncertainties. Although several states have enacted net metering programs for some time, their impact on renewable energy technologies has been small to date. The interconnection, liability insurance, and indemnification requirements demanded by utilities discourage net metering customers. Costs of small renewable energy systems are also a barrier. Wind energy technology is further hampered by the disparity in net metering availability for solar and wind generators. Some utilities may decide to challenge net metering orders again. A bigger uncertainty facing net metering programs is utility restructuring.

There are steps that can be taken by stakeholders to further net metering programs. A set of uniform interconnection standards will go a long way in facilitating the implementation of net metering. The renewable industry needs to work closely with utilities and standard-setting organizations in developing such standards. Increasing customer awareness of available net metering programs is also important to increase participation. Increased communication efforts by the renewable industry, utilities, state energy offices, PUCs, and advocacy groups could increase participation in net metering programs, yielding benefits to utilities, customers, and society.

VII. Acknowledgements

We wish to acknowledge Thomas J. Starrs of Kelso Starrs & Associates, and Kevin Porter of NREL for their peer review of this paper. Their insights and criticism have been most helpful. While Y. Wan has independently researched and confirmed the data contained in Table 1, we gratefully acknowledge the ongoing exchange of information with Mr. Starrs which has helped us make this table more current and accurate. We are also indebted to a prior publication by Mr. Starrs[13] for the format used in this table as well as for his excellent description of net metering.

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[13] Thomas J. Starrs (September 1996). *Net Metering: New Opportunities for Home Power.* Renewable Energy Policy Project, Issue Brief, No. 2. College Park, MD: University of Maryland

Table 1. Summary of State Net Metering Programs

State	Allowable Technology and Size	Allowable Customer	Statewide Limit	Treatment of Net Excess Generation (NEG)	Authority	Enacted	Scope of Program	Citation/Reference
Arizona	Qualifying facilities ≤ 100 kW	All customer classes	None	NEG purchased at avoided cost	Arizona Corporation Commission	1981	All IOUs and RECs	PUC Order Decision 52345, Docket 81-045
California	Solar only ≤ 10 kW	Residential only	0.1% 1996 peak	NEG purchased at avoided cost	Legislature	1995	All utilities in state	Senate Bill No. 656 (effective 1-1-96)
Colorado	Qualifying facilities ≤ 10 kW	All customer classes, Public Service of Colorado only	None	No purchase of NEG, excess is granted to utility	Utility tariff	1994	Public Service of Colorado Company	Safety, Interference and Interconnection Guidelines for Cogenerators, Small Power Producers, and Customer-Owned Generators
Connecticut	Renewables ≤ 100 kW Cogenerators ≤ 50 kW	All customer classes	None	NEG purchased at avoided cost	Public Utility Commission	1990	All IOUs, No REC in state.	CPUCA No. 159
Idaho	All technologies ≤ 100 kW	All customer classes	None	NEG purchased at avoided cost	Public Utility Commission	1980	IOUs only, RECs are not rate-regulated	Idaho PUC Order #16025 and #26750 (1997) Tariff sheets 86-1 thru 86-7
Indiana	Qualifying facilities ≤ 1,000 kWh/month	All customer classes	None	No purchase of NEG, excess is granted to utility	Public Utility Commission	1985	IOUs only, RECs are not rate-regulated	Indiana Administrative Code 4-4.1-7
Iowa	Renewables No limit per system	All customer classes	105 MW	NEG purchased at avoided cost	Iowa Utility Board	1993	IOUs only, RECs are not rate-regulated*	Iowa Administrative Code paragraph 199-15.11(5)
Maryland	Solar only ≤ 80 kW	Residential only	0.2% of 1998 peak	No purchase of NEG, excess is granted to utility	Legislature	1997	All utilities in state	Article 78, Section 54M
Maine	Qualifying facilities ≤ 100 kW	All customer classes	None	NEG purchased at avoided cost	Public Utility Commission	1987	All utilities in state (IOUs and RECs)	Code Me. R. Ch. 36, §1(A)(18) & (19). §4(C)(4)
Massachusetts	Qualifying facilities ≤ 30 kW	All customer classes	None	NEG purchased at avoided cost		1982	IOUs only, No REC in state	220 CMR §8.04(2)(C)
Minnesota	Qualifying facilities ≤ 40 kW	All customer classes	None	NEG purchased at utility average retail energy rate	Legislature	1983	All utilities in state	Minn. Stat. §216B.164
Nevada	Solar & Wind ≤ 10 kW	All customer classes	First 100 customers for each utility	No purchase of NEG, excess is granted to utility	Legislature	1997	All utilities in state	Nevada Revised Statute Ch. 704

Notes: IOU - Investor-owned utility
REC - Rural electric cooperative

- Except for the Linn County Electric Cooperative, which is rate-regulated by Iowa PUC.

Table 1. Summary of State Net Metering Programs (continued)

State	Allowable Technology and Size	Allowable Customer	Statewide Limit	Treatment of Net Excess Generation (NEG)	Authority	Enacted	Scope of Program	Citation/Reference
New Hampshire	Renewables ≤ 25 kW per system	Residential customers of Public Service of New Hampshire only	500 kW	No purchase of NEG, excess is granted to utility	Utility tariff	1994	Public Service of New Hampshire	PSNH Order No. 21,163
New Mexico	Qualifying facilities ≤ 100 kW	All customer classes	None	NEG purchased at avoided cost with additional customer charge, or no NEG purchase and no additional charge	Public Service Commission	1988	All utilities in state (IOUs and RECs)	PSC Rule 570
New York	Solar only ≤ 10 kW	Residential only	0.1% 1996 peak demand	Annualized NEG purchased at avoided cost	Legislature	1997	All utilities in state	Assembly Bill 8660--A
North Dakota	Renewables & cogeneration ≤ 100 kW	All customer classes	None	NEG purchased at avoided cost	Public Utility Commission	1991	IOUs only, RECs are not rate-regulated	North Dakota Admin. Code §69-09-07-09
Oklahoma	Renewables & cogeneration ≤ 100 kW and ≤ 25,000 kWh/year	All customer classes	None	No purchase of NEG, excess is granted to utility	Oklahoma Corporation Commission	1988	All utilities in state except for municipals and G&Ts	OCC Order 326195
Pennsylvania	Solar only (None specified)	Residential only	None	NEG purchased at average utility billing rate	Utility tariff	1996	PECO Energy Company	Supplement No. 5 to Tariff Electric PA PUC No.2
Rhode Island	Renewables & cogeneration ≤ 25 kW for larger utilities ≤ 15 kW for smaller utilities	All customer classes	None	NEG purchased at avoided cost	Public Utility Commission	1985	IOUs, No REC in state.	Supplementary Decision and Order, Docket No. 1549
Texas	Renewables only ≤ 50 kW	All customer classes	None	NEG purchased at avoided cost	Public Utility Commission	1986	All IOUs and RECs	PUC of Texas, Substantive Rules, §23.66(f)(4)
Washington	Solar, wind and hydropower ≤ 25 kW	All customer classes	0.1% of 1996 peak demand	Annualized NEG granted to utilities at the end of each calendar year	Legislature	1998	All utilities in state	House bill B 2773 Title 80 RCW
Wisconsin	All technologies ≤ 20 kW	All customer classes	None	NEG purchased at retail rate for renewables, avoided cost for non-renewables	Public Service Commission	1993	IOUs only, RECs are not rate-regulated by PSC	PSCW Order 6690-UR-107

Notes: IOU – Investor-owned utility
G&T – Generation and transmission cooperatives
REC – Rural electric cooperative

The original format for this table is taken from: Thomas J. Starrs (September 1996). *Net Metering: New Opportunities for Home Power.* Renewable Energy Policy Project, Issue Brief, No. 2. College Park, MD: University of Maryland