A CASE STUDY: THE ECONOMIC COST OF NET METERING IN MARYLAND: WHO BEARS THE ECONOMIC BURDEN?

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ABSTRACT

The Maryland legislature approved net-metering legislation for residential consumer generators with photovoltaic systems during 1997. Before the legislation passed, the Maryland Energy Administration (MEA) examined its potential economic impact on both the affected utilities and consumer ratepayers--with and without net-metered PV systems. The MEA discovered that the impact on the affected utility is minimal when the net-metered PV capacity is limited to a small percentage of utility peak load. The analysis also determined that the cost burden on other customers under a net-metered scenario is likewise limited. For Maryland's largest investor-owned utility, the maximum amount of any cross-subsidy (or cost) on a per customer basis is 46 cents annually. Furthermore, our analysis showed that when distribution system savings and environmental externalities are incorporated, net-metered customers may actually subsidize other utility customers. The MEA analysis also determined that about 50% of the value of the energy produced is lost if net metering is not available to those customers with grid tied PV systems. Over the long term, most if not all of any potential cost is borne by other residential customers, not utility shareholders. Finally, the additional cost burden to the utility under net metering--compensating the consumer at the retail rate versus the avoided cost rate–is less than expected when one considers the administrative costs associated with a dual-metered billing approach.

1. INTRODUCTION AND BACKGROUND

The economic feasibility of small-scale PV generation depends on three primary factors: the system start-up (turnkey) costs, the availability of attractive financing terms, and favorable utility metering and interconnection policies. The first two are arguably the most important, and fortunately, both the turnkey costs of PV systems and financing availability are improving each year. This is due to a myriad of factors including improvements in technology, economies of scale in manufacturing, greater industry experience and tightening economic competition between manufacturers.

Interconnection and metering standards, however, are vitally important in determining whether consumers will choose to pay a premium for clean, renewable, solar energy. Net-metering, which allows the customer to offset their electricity consumption with their own generation over the whole billing period using a single, bi-directional meter, offers the most attractive terms to the consumer. Under net metering, the customer pays for the net electricity consumed over the course of the billing period at the retail rate, although excess generation may be met with a reimbursement at the utility's avoided cost. Net metering has been generally accepted as one of the best, unobtrusive ways for states to encourage consumers to purchase renewable energy systems. As such, numerous states have enacted net-metering laws.

In the 1997 session of the Maryland General Assembly, the legislature passed net metering legislation for the use of photovoltaic systems on residences throughout the State. The legislation required all utilities to allow the use of a single meter to register forward and reverse flows of power. This metering scheme allows the utility to track the net amount of power consumed by the residential customer and that put onto the utility electric grid during those times when customer production exceeds usage.

In response to economic concerns by utilities and as part of the promotion of this legislation, the MEA undertook an analysis of the economics of net metering from other customers' perspectives and the potential economic impact on a given utility under assumed worst case variables. That analysis determined that the impact on other customers is inconsequential if the net metering legislation incorporates a maximum cumulative amount of allowed installations based on a small percentage of utility peak load.

The MEA also analyzed the cost burden on other customers applying traditional rules of cost allocation under utility rate making. The general conclusions are that for the State's largest utility, the maximum amount of any cross-subsidy (or cost) on a per customer basis is 46 cents per year (less than 4 cents per customer per month). When the approximate value for certain distribution system savings and environmental externalities are incorporated, net metered customers may even subsidize other utility customers. It is important to note that the subsidy is one that occurs between customers and does not affect a utilities earnings or shareholders. From the solar customer's perspective, however, net metering can increase the economic value of their PV system by up to 50%.

This paper describes in detail the economic analyses performed by the MEA in advance of the passage of Maryland's net metering law. It shows that net metering's benefits to the State's electricity consumers, commercialization of solar and renewables, as well as the environment at large, far outweigh the negative economic consequences, such as lost revenues, which have typically concerned utilities. The policy concern generated by net metering that one group of consumers may subsidize another also proves to be limited in scope, especially if one tallies the true social benefits of solar energy, such as their low environmental impact. It is the author's opinion that net metering should be viewed as a no-regrets approach to stimulate investments in national residential photovoltaic and renewable energy markets.

2. UTILITY CONCERNS WITH NET METERING POLICIES

Utilities have not generally been very supportive of net metering programs for obvious reasons. Facing a difficult and unpredictable regulatory climate, utilities do not want yet another state mandate to deal with. Probably the most likely reason utilities oppose net metering in their service areas is that there is nothing in it for them except lost consumer revenues, which they require to cover the fixed costs of their capital plant and equipment investments, including transmission and distribution infrastructure. Some utilities opine that paying retail prices for customer-generated electricity is tantamount to a subsidy because retail prices also include the costs of transmission and distribution, administration, and profits in addition to a utilities' energy generation cost. These utilities would suggest that their avoided cost is the more appropriate reimbursement to these consumers.

The economic based concerns can be avoided, however, if the total amount of consumer generation is limited to a small percentage of a utility's peak capacity. These concerns were addressed in the Maryland 1997 net metering law, which limits the total amount of PV that can be net-metered to 0.2% of the utility peak load or approximately 34 megawatts statewide. Limiting the total net-metered capacity to a small portion of overall generation capacity ensures the cross-subsidization debate is limited to a diminimus amount to the non-net-metered customers. Within that debate, this small cross subsidy can be erased if environmental benefits are included in the calculus.

3. ECONOMIC ANALYSIS–THE MARYLAND EXAMPLE

3.1 Analysis and Assumptions

The State of Maryland was cognizant of these issues when it decided to formulate and enact its net metering legislation. The Maryland law limits the total amount of PV that can be "net-metered" to 0.2 percent of the utility peak load or approximately 34 megawatts statewide. The approach of placing a cap on the size of statewide renewable generation will minimize the revenue lost by state electric utilities.

The cap provides other ancillary benefits as well. The limit assures that long-term system stability concerns, which may occur when PV penetrates the distribution grid at 10-20% or higher, cannot enter the net-metering policy debate. [1] Powerplants normally do not display a correlation between plant availability and system loads. For PV systems, on the other hand, weather conditions which may affect system demand loads also influence system output. Thus, there is a correlation between PV generation and load profile, which must be modeled to determine the ability of PV to contribute to distribution capacity and reliability. PV generation and load conditions may correlate seasonally, daily and hourly. A wide geographic distribution of PV systems assures that if insolation conditions at one or a few sites is poor, due to meteorological phenomena, the other sites are still productive. Increasing the penetration of distributed PV generation sites limits this advantage since sites are in greater proximity to one another, and therefore, the correlations increase. The aforementioned 0.2 percent cap on net-metered capacity of limits PV generation to well below this 10-20% threshold. On the other hand this limit represents a sufficiently large market share for the PV industry.

The MEA performed a thorough analysis of the potential effect of the net metering policy. For the purpose of simplifying our analysis, we concentrated on the area served by Baltimore Gas and Electric (BGE), Maryland's largest utility that serves over 33% of the state's capacity. BGE's peak capacity as of 1994 comprised 6038 MW so under the net-metering legislation, the maximum amount of net-metered capacity is 12,076kW. Given solar insolation conditions in Maryland, the total solar energy that can be produced with this 12,076kW of installed capacity over the course of a year is 18,676,862 kWh. The MEA conservatively estimates that under worst case conditions, 50 percent (9,338,431kWh) of this capacity would likely be sold back to the utility. Since Maryland's net metering law does not provide compensation for excess generation above that "netted" over the billing period, it is fair to assume residential systems will be sized to provide something less than 100% of the customers annual load.[3]

3.2 Results of Our Analysis

Table 1 shows the results of our economic analysis. If the program reaches its maximum installed capacity under the assumption that 50 percent of PV generation is sold back to the utility, the total internal ratepayer shared cost is $590,779. BGE capacity savings from Schedule X (avoided cost) tariffs amount to $142,054.20 if the net-metering program is fully subscribed at 12,076kWh. Subtracting the two figures the total net cost to BGE amounts to $448,725.

TABLE 1: ECONOMIC ANALYSIS

6,038 MW		BGE Peak Capacity
0.20% peak		Maximum percentage under net metering law
12,076kW		Maximum PV allowed under net metering law
18,676,862kWh		Total solar electricity produced at program maximum-annually[1]
	50% factor	Conservative estimate of maximum electricity swapped/sold back to utility
9,338,431kWh		Electricity swapped/sold back to utility (annually)
	$0.0873/kWh	BGE average residential rate
	$0.0241/kWh	BGE avoided cost rate (Sched. X)(avg.)
	$0.0633/kWh	delta $/kWh
$590,779		Total internal ratepayer shared cost if program reaches maximum subscription (energy only)
	$142,054	BGE capacity savings (from Schedule X)
($448,725)		**Net annual savings (cost) to BGE (excludes distribution DSM credits)**
	978,951	**Total BGE residential customers**
($0.46)		**Savings (cost) per year to other BGE customers**
($0.0383)		**Savings (cost) monthly to other BGE customers**

Taking this figure and dividing it by the number of residential customers in the BGE service area yields a cross subsidy (cost) of approximately 46 cents to each BGE customer. This simple analysis shows, then, that BGE's lost revenues due to net metering are minimal even when the program is fully subscribed. Thus, the utility concern about large revenue losses is unfounded. It is also unlikely that the program will reach its full subscription in the near future given the economics of solar energy and present trends in the electricity industry.

It is important to note that the net-metering debate is not about whether the utility should pay anything for the solar generated electricity but instead, the rate that they should pay. For BGE, the rate that is on file with the utility regulator for non-utility generation is their avoided cost rate, or 2.41 cents per kWh. Net metering provides the customer with a value of 8.73 cents per kWh, or 6.33 cents over avoided cost. The debate is over the 6.33 cents differential, and, just as importantly, what is the cost to capture that differential.

4. ENVIRONMENTAL CONSIDERATIONS

The issue of subsidization is not limited to just the internal cross payments between ratepayers. Although less defined, net metered customers provide environmental cross subsidies back to their non-net-metered counterparts as well. The energy produced by net metered solar generators offsets the generation which ordinarily would have been produced by traditional, polluting fuel sources, such as nuclear or fossil energy. Therefore, the MEA decided to incorporate environmental considerations into its PV net-metering analysis described above. Our hypothesis was that the "actual" cost to the utility ($448,725), or the cross-subsidy between Maryland consumers ($0.46) could be reduced or even eliminated if environmental considerations were included. This can be done by taking the amount of utility generation offset by the solar generation under net metering and assigning externality values based on the generation fuel mix.

The MEA turned to the power generation externality literature to derive these figures. There are numerous externality studies in existence, and due to different analytical methods or data sources, they rarely agree. In light of this reality, the MEA looked at two environmental analyses, a Pace University study (1990) and one performed by the U.S. Department of Energy (Oak Ridge National Laboratory) and Resources for the Future (1995). Pace University's study uses a damage-based approach and bases its values on a literature review of previous studies, taking their estimates as givens and multiplying them by economic values. The ORNL/RFF study takes a more complex approach, opting for a damage function approach. This method is based around an engineering characterization of the emissions, and models the emission pathway, taking into account changes in pollutant concentrations, impacts and damages. In general, the earlier literature-review studies, such as the Pace analysis, estimate larger emission concentrations and impacts than the more recent studies, such as the ORNL/RFF. [2]

4.1 Results of Our Analysis

For this analysis, the MEA aggregated Maryland electric generation by utility generator and assigned externality ($) figures based on fuel source using values derived from the two studies. Maryland electric generation is derived from the following fuel types: coal (58%), oil (7%), gas (4%), nuclear (26%), and hydro (4.4%) The whole of Maryland electricity generation is assigned a weighted average externality figure ($0.408983 for the DOE/ORNL "low" case and $46.018 for Pace Univ.) which is multiplied by the amount of generation offset by PV-generated power under net metering (18,676,862 kWh). Table 2 lists these figures converted into dollars and incorporated into the economic analysis contained above. When externality costs from the Pace and DOE studies are figured in, the net annual cost to BG&E under net metering ($448,725) is either reduced or completely eliminated and replaced with a surplus. In the "low externalities" DOE study, the incorporation of environmental costs into our analysis reduces the cross subsidy or cost from the $0.46 above to $0.45, a marginal reduction. On the other hand, the "high externalities" Pace study shows that net metered customers actually subsidize other electricity consumers, with a surplus of $0.42 going to each non-generating BGE customer.

Environmentalists and renewable energy advocates have faced an uphill battle in their attempts to incorporate social cost "externality" pricing into the policy making process. The difficulty in assigning externality values to pollution emitters is reflected in the literature, which makes use of a whole host of approaches and methodologies with widely

TABLE 2: EXTERNALITY ANALYSIS RESULTS

Net annual savings (cost) to BGE			($448,725)
Total PV generation at program maximum	18,676,862 kWh		
Weighted externality average (DOE low)/1000	$0.408988		
Environmental benefits (low) DOE-study		$7,638.52	
Total PV generation at program maximum	18,676,862 kWh		
Weighted externality average (Pace high)/1000	$46.018		
Environmental benefits (high) Pace University study		$859,471.85	
Net annual savings (cost) to BGE-DOE study (low)			($441,086.42)
Net annual savings (cost) to BGE-Pace study (high)			$410,746.91
Total BGE customers		978,951	
Savings (cost) per year to other consumers DOE study (low)			($0.45)
Savings (cost) per year to other consumers Pace study (high)			$0.42
Savings (cost) per month to other consumers DOE study (low)			($0.0375)
Savings (cost) per month to other consumers Pace study (high)			$0.035

ranging results. This is why, to be fair, the MEA chose to use both high and low externality cases. Economic reality probably lies somewhere in between the two studies. It is reasonable to assume, however, that when the environmental benefits of statewide PV generation are included, the monthly cost (cross-subsidy) issue of net-metering ($0.0383) per customer is definitely marginalized.

5. NET METERING FROM THE SOLAR CONSUMER PERSPECTIVE

Heretofore, we have examined net metering, as promulgated in the Maryland law, solely from the standpoint of the electric utility and the community as a whole. We have attempted to show that under a prudently designed policy, which addresses utility concerns, that net metering is far from an economic burden, and depending on the methods of economic analysis and accounting employed, may even benefit the utility and ratepayers. However, the economic benefit to the consumer generator via net metering is much less difficult to quantify than is the potential detriment to the utility or debate for the policymaker. The MEA decided to complete its analysis by examining what an hypothetical consumer would face both with and without net metering. Table 3 shows the conditions and results of our analysis. In our hypothetical test case, we sized a 1.6kWp PV system that cost $5/watt, and assumed the following: a thirty year mortgage term; a homeowner tax rate of 30 percent; 50 percent offset of monthly electricity consumption; an annual 30 year capacity rate of $60.95; a capacity performance factor of 19 percent; and 2080 BGE on-peak hours under Schedule X.

5.1 Results of Our Analysis

The results show that under our conservative, or "worst case" scenario, nearly 50 percent of the value of solar energy produced by the consumer is lost if net metering is not available. This result hinges on the amount of solar electricity put back onto the grid. The lower the percentage of consumer generation put back onto the grid, the less valuable net metering is to the customer. The potential utility customer cross-subsidy is also reduced. Conversely, an increasing percentage put back onto the grid makes net metering more valuable from the customer's perspective. In Maryland, however, the customer must size the system so as not to produce excess solar electricity during the billing period as the utility is under no obligation to allow credits to roll over to the next bill. In this context it is improbable that a customer's system sized to these constraints would ever put more than 50% back onto the grid. The savings which accrue to the customer with net metering versus without amounts to a delta of $6.53. Other things being equal, this is the amount that the utility would recoup by using a dual-metered approach and compensating the consumer PV generator at its avoided cost rate. However, one must take into account the added cost of installing a second meter, and the administration costs associated with processing an entirely new set of accounts, including site meter reading and billing. Based on Maryland rate cases, a standard figure for such administrative costs stands at $10-30 monthly, as opposed to the $6.53 charge per customer under a net-metered approach. If the utility is responsible for installing the second meter as well, the economic case against net-metering becomes even more difficult to prove. On the other hand, if the consumer is forced to bear the cost of the second meter, which may occur under PURPA guidelines for private generators, it is cheaper just to give the power they produce away to the utility without any compensation whatsoever.

TABLE 3: NET METERING FROM CUSTOMER PERSPECTIVE

PV System size	1.6 kW	2475 kWh	Annual PV system production
PV System cost	$8,400 (with tax)	206 kWh	Monthly average production
Finance rate	7.50%		
Monthly payment	$58.73		
After tax mo. payment	$41.11	0.199373855 $/kWh	
SAVINGS			
Average monthly usage kWh	900		
Monthly electric bill (BGE)	$78.59		
PV system offset consumption	103	kWh	
PV system offset consumption	$9.00		
Net electric bill - monthly	$69.58		
Energy swapped(sold) back to utility	103	kWh	
Additional savings w/ net metering	$9.00		
Payment without net metering	$2.48	at BGE's avoided cost	
Total savings with net metering	**$18.01**		
savings without net metering	**$11.48**		
Net-metering difference	$6.52		
Annual "overpayment" to solar generator (energy)		$78.27	
BGE annual capacity payment (if made)		$18.82	
NET under (over) payment		($59.45)	

CONCLUSION

The purpose of this study has been to analyze the impacts of state net metering policies on three parties: the affected utility generator, the group of net-metered consumers, and the rest of the state's electricity ratepayers. Our findings indicate that net metering, when limited to a small percentage of utility peak capacity, does not unduly disadvantage the utility in the net-metered customer's service territory. Using our analysis of the area served by Baltimore Gas and Electric, Maryland's largest investor-owned utility, the revenues lost only amount to $448,725 or less than 4 cents monthly per ratepayer. This represents either a cost to BGE or a cross subsidy made to the utility from the other non-generating customers.

In our opinion, PV power generation represents a public good, since it protects the environment by offsetting the harmful emissions produced by traditional in-state power plants. Thus, we factored in environmental externality "benefits" into the analysis utilizing two well regarded studies, from DOE and Pace University. The results show that the costs or cross subsidies resulting from the Maryland net metering program may be reduced or wholly eliminated.

Finally, we examined the benefits of net metering to the aspiring consumer solar generator, who is willing to front the higher cost of PV. Without net metering, this consumer's monthly payback is nearly cut in half. Furthermore, we noted that a dual metered approach is actually less cost-effective for the utility than the net-metered alternative since it required administrative costs for an additional set of consumer accounts.

With polls of electric consumers repeatedly indicating an interest in and, when available, a preference for electricity produced from solar energy, these minimal costs, borne by the other ratepayers on the system, seem well within the amounts listed in "willingness to pay" surveys. Net-metering represents a low-cost, no-regrets way to promote power from renewable energy sources.[4]

NOTES:

[1] William B. Marcus et. al., "NASUCA Photovoltaic Training Manual" PVEP, 1996. pp. 45-6.
[2] Russell Lee, "Externalities Studies: Why are the Numbers So Different?" Oak Ridge National Laboratory: pps. 1-4.
[3] PV capacity data for Maryland was obtained from Richard Perez in the Delmarva Power Study.
[4] Barbara C. Farhar and Ashley H. Houston, "Willingness to Pay for Electricity from Renewable Energy": National Renewable Energy Laboratory, September 1996. pp. 1-3.