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## **Building a Market for Small Wind: The Break-Even Turnkey Cost of Residential Wind Systems in the United States**

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PRESENTED AT GLOBAL WINDPOWER 2004  
CHICAGO, ILLINOIS  
MARCH 29 – 31, 2004

**Environmental Energy  
Technologies Division**

**April 2004**

**Download from <http://eetd.lbl.gov/EA/EMP>**

This work was supported by the Office of Energy Efficiency and Renewable Energy, Wind & Hydropower Technologies Program of the U.S. Department of Energy under Contract No. DE-AC03-76SF098.

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**BUILDING A MARKET FOR SMALL WIND:  
THE BREAK-EVEN TURNKEY COST OF RESIDENTIAL WIND SYSTEMS  
IN THE UNITED STATES**

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**PRESENTED AT GLOBAL WINDPOWER 2004  
CHICAGO, ILLINOIS**

WIND ENERGY FOR FARMS, HOMES, AND SMALL BUSINESSES  
TUESDAY, MARCH 30, 2004  
10:30 AM – 12:00 PM

## **Abstract**

Although small wind turbine technology and economics have improved in recent years, the small wind market in the United States continues to be driven in large part by state incentives, such as cash rebates, favorable loan programs, and tax credits. This paper examines the state-by-state economic attractiveness of small residential wind systems. Economic attractiveness is evaluated primarily using the break-even turnkey cost (BTC) of a residential wind system as the figure of merit. The BTC is defined here as the aggregate installed cost of a small wind system that could be supported such that the system owner would break even (and receive a specified return on investment) over the life of the turbine, taking into account current available incentives, the wind resource, and the retail electricity rate offset by on-site generation. Based on the analysis presented in this paper, we conclude that: (1) the economics of residential, grid-connected small wind systems is highly variable by state and wind resource class, (2) significant cost reductions will be necessary to stimulate widespread market acceptance absent significant changes in the level of policy support, and (3) a number of policies could help stimulate the market, but state cash incentives currently have the most significant impact, and will be a critical element of continued growth in this market.

## **Introduction**

The market for small wind systems in the United States, often defined as systems less than or equal to 100 kW that produce power on the customer side of the meter, is small but growing steadily. The installed capacity of domestic small wind systems in 2002 was reportedly 15-18 MW, though the market is estimated to be growing by as much as 40 percent annually (AWEA, 2002). This growth is driven in part by recent technology advancements and cost improvements and, perhaps more importantly, by favorable policy incentives targeted at small wind systems that are offered in several states. The most recent comprehensive study of small wind market potential in the U.S., conducted in 1981, estimated that there was a market potential for 3.8 million small wind systems in rural residential grid-connected applications (Osborn and Downey, 1981). This study focused only on rural and agricultural applications, and these markets have likely changed due to the shifting demographics and economics of rural communities over the past two decades. The 2002 U.S. Small Wind Industry Roadmap estimates that the number of grid-connected homes in the U.S. with adequate space and wind resource for a small wind system was 7.6 million in 2000 and will rise to 15.1 million in 2020 (AWEA, 2002).

Currently, over half of all states have incentive policies for which residential small wind installations are eligible. These incentives range from low-interest loan programs and various forms of tax advantages to cash rebates that cover as much as 60 percent of the total system cost for turbines 10 kW or smaller installed in residential applications. Most of these incentives were developed to support a range of emerging renewable technologies (most notably PV), and were therefore not specifically designed with small wind systems in mind. As such, the question remains as to which incentive types provide the greatest benefit to small wind systems, which sizes of small wind systems are best suited to various incentives, and how states might appropriately set the level and type of incentives in the future. Furthermore, given differences in incentive types and levels across states, as well as variations in retail electricity rates and other

factors, it is not immediately obvious which states offer the most promising markets for small wind turbine manufacturers and installers, as well as potential residential system owners.

This paper begins to address these critical needs. Specifically, the paper presents results from a Berkeley Lab analysis of the impact of existing and proposed state and federal incentives on the economics of *grid-connected, residential* small wind systems. The Berkeley Lab Small Wind Analysis Tool (SWAT) calculates the customer break-even turnkey cost (BTC) and simple payback of residential wind systems in order to compare system economics across all 50 states. Related methodological work in this area has been conducted for customer-sited and commercial photovoltaic systems (Herig et al, 2002 and 2003), and there is ongoing work to document the customer economics of small wind systems within individual states (Jimenez et al, 2002; Forsyth et al, 2000; Clean Power Research, 2003). Building on this existing work, we developed SWAT as a simple policy analysis tool capable of incorporating various policy incentive types and structures. Importantly, SWAT is not meant as an alternative to the type of more detailed characterization available from more site-specific analyses (see, e.g., the Clean Power Estimator at [www.windpoweringamerica.gov](http://www.windpoweringamerica.gov)). Instead, our emphasis is on developing a simple tool to compare the average customer economics of small wind across states given different existing and possible future policy incentive types and levels, for an audience largely consisting of state and federal policymakers and related stakeholders. In addition, this tool will allow stakeholders in the small wind industry to identify states suited for targeted outreach programs, due to their favorable combination of incentives and other factors. Over the longer-term, the state-by-state analysis of customer economics presented here, combined with information on the location of potential residential adopters, may assist policymakers and market analysts in more accurately quantifying the number of homes for which a small wind system would be affordable at different installed cost targets and incentive levels.

## State Incentives for Small Wind

Historically, state incentives for small wind have been reasonably modest, and have included various forms of tax incentives (sales and property tax reduction, as well as income tax credits) and low interest loan programs. More recently, however, 15 states have created renewable energy funds, most often funded through a small “surcharge” on electricity rates. These states are expected to collect over \$3.5 million from 1998-2012, to be used to support renewable energy development (Wiser et al, 2002). A small fraction of these funds will be used to provide critical incentive support to the small wind market.

This analysis covers state incentives that directly affect the cash flow of residential customers that purchase and install a small wind system. The important but indirect benefits of other state policies, such as streamlined siting and permitting regulations, are not accounted for, though the existence of such policies may be critical to the growth of the small wind market. Table 1 below summarizes the range of state policies covered in this analysis.

**Table 1. State Incentives Included in This Analysis**

Incentive Type	Number of Programs	States with Programs
Cash Incentives	10	CA, DE, IL, MT, NJ, NY,

		RI, TN, VT, WI
Income Tax Credits or Deductions	11	AZ, CA, HI, ID, MA, MT, NC, ND, OR, RI, UT
Property Tax Exemptions	11	IN, KS, MN, MT, NV, NY, ND, OR, SD, TX, WI
Sales Tax Exemptions	9	AZ, IA, MA, MN, NV, NJ, RI, VT, WA
Low-Interest Loan Programs	10	CT, ID, IA, MN, MT, NE, NY, OH, OR, WI

Cash incentives include rebates upon system installation and production-based incentives based on kilowatt-hour production over time. Rebate programs offer customers either a refund of a percentage of the total system cost (generally capped at a maximum dollar amount) or a flat dollar refund, in the form of a total dollar amount or a dollar value per kilowatt (often capped at a maximum percentage of total system cost). Production-based cash incentives reward system owners based on measured production (e.g. Tennessee) or expected production (e.g. Wisconsin).<sup>1</sup>

As we will show, existing cash incentives of these types offer the largest economic benefit to customers, and are currently available for small residential wind systems in 10 states.<sup>2</sup> These incentives are typically offered as a way to encourage early adoption and “jump-start” the market for an emerging technology, and for that reason the incentive amount in some programs is structured to decline over time or after a certain number of systems have been installed. Cash incentive programs have been highly influential in the small wind market in recent years, covering as much as 40% to 60% of the installed system cost. Over 200 grid-connected small wind systems have been installed under the California small wind rebate program in the past 5 years, though growth in the California small wind market may decrease as the incentive levels follow their scheduled decline.

Income tax credits (ITC) may also be an effective way to provide a partial refund on investment in a small wind system, and ITCs are currently available in 10 states (in addition, Idaho offers an income tax deduction). The ITC amounts range from 5 to 35 percent of the system cost, though many states have absolute dollar caps that can be limiting.

Sales and property tax payments on a small wind system can be significant, although the dollar value of these payments is highly variable by state. Most states that offer property tax exemptions do so in one of three forms: (1) a universal exemption that applies to all customers in a state, (2) a regulation that gives local authorities the option to exempt a system, or (3) an abatement that assesses the value of the renewable energy system at an amount equivalent to a less expensive conventional (non-renewable) system.. In this analysis only universal exemptions are considered, which are currently available in 11 states. Sales tax exemptions are currently available in 9 states, and all but two of these states exempt the full system cost.

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<sup>1</sup> Note that the Wisconsin incentive is provided as an up-front rebate, but a rebate that is linked to expected production based on the specific turbine used and the wind resource regime.

<sup>2</sup> Of these 10 states, Vermont is the only state to offer cash incentives for off-grid systems. The programs in the other states are primarily funded through a surcharge on electric rates, explaining why only grid-connected systems are eligible for the incentives.

Ten states currently offer low-interest loan programs that can be used to help finance residential wind systems. These programs offer loans ranging from \$10,000 up to the full system cost, and loan rates vary from 0 to 6 percent depending on the program. Some loan programs have income or family size eligibility requirements and are therefore not available to all consumers.<sup>3</sup>

There are few federal incentives available for small, grid-connected residential wind systems. One incentive that is available is the USDA's Section 9006 grants, which offer up-front incentives of up to 25% of the cost of certain eligible wind systems in rural installations.<sup>4</sup> Due in part to outreach and communication hurdles, many eligible small wind customers in the U.S. did not take advantage of this policy during its first year of availability in 2003. The target residential customers for the USDA grants are farmers and ranchers who have demonstrated financial need, and we have chosen not to include this incentive in our analysis here because the market targeted by these grants is highly specific. Future work will incorporate an economic analysis of the USDA farm grants for eligible customers.

## **The Small Wind Analysis Tool**

The Berkeley Lab Small Wind Analysis Tool (SWAT) is a spreadsheet-based cash-flow model that calculates the customer economics of residential, grid-connected wind systems in each U.S. state in different wind resource regimes. The primary purpose of the model is to analyze the effects of existing state incentives (such as those discussed in the previous section) on the economics of small wind systems. In addition, SWAT can incorporate potential future federal income tax incentives and federal grant or rebate programs (e.g., USDA Section 9006 grants), as well as possible new state-level incentives. The tool is specifically designed to help policymakers choose combinations of incentives that will effectively spur the market for residential, grid-connected wind systems.

SWAT calculates the break-even turnkey cost (BTC) and the simple payback period of a small, residential wind system in each state and wind resource class. The BTC is defined as the aggregate system installed system cost that would balance total customer payments and revenue over the life of the system, allowing the customer to "break-even" and earn a specified rate of return on their small wind "investment." The total customer costs are incurred through system capital payments under different financing structures (cash payment, personal or low-interest loan, or a home mortgage option), operation and maintenance (O&M) costs, and property tax payments if applicable. Customer revenue is derived from available financial incentives and the avoided retail cost of electricity.

The results presented in this paper are based on a 10 kW turbine size, and results for alternative system sizes would be expected to vary somewhat. The assumed turbine's annual energy production under different wind resource classes is based on a grid-connected Bergey 10 kW

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<sup>3</sup> For example, energy conservation loans offered through the Connecticut Housing Investment Fund have interest rates that vary between 1 and 6 percent based on family size, income, and location.

<sup>4</sup> At the time of this writing grant applications for 2004 are not available; these incentive values are based on 2003 amounts. For more information go to <http://www.rurdev.usda.gov/rbs/farmbill/index.html>.

Excel power curve and a Rayleigh wind distribution.<sup>5</sup> The turbine power output is de-rated by the average state elevation above sea level and a 15 percent turbulence factor, to correspond to net turbine power output determined through system testing at the National Renewable Energy Laboratory.<sup>6</sup> In the base-case scenario, all energy produced by the turbine is assumed to offset the average state retail electricity rate, meaning that either a net metering program is in place or the system is sized such that its output will not exceed the minimum customer load.<sup>7</sup>

Additional key assumptions of SWAT include the following:

- Federal and state income tax rates correspond to an annual household income of \$100,000 (which results in a 25 percent federal rate). State ITCs or deductions are considered taxable income for federal tax calculations.
- The total amount of a tax credit is always less than a customer's total tax liability, thereby allowing the customer to fully utilize available tax incentives.
- Cash rebates are not considered taxable income.
- State incentives are taken at 2004 values and only residential incentives are considered.
- Rebates and policies that apply only to customers of small utilities within a state (such as municipal utilities that cover a small percentage of the population) are not included.
- State low-interest loan programs apply only if the resulting BTC under the loan program is higher than the BTC for a system that is financed privately. For state loan programs that set interest rates in relation to "market rates," the market rate is assumed to be 8 percent, equivalent to the rate assumed here for a personal loan.
- Property tax rates vary by state and by county, and were calculated from a sample of property tax rates in 800 U.S. cities.<sup>8</sup> The annual taxable value of the wind system is determined by a straight-line depreciation method with a salvage value of one-tenth the original system cost at the end of the system's assumed lifetime. Annual property tax payments are tax deductible.
- Inflation rates for O&M payments and offset electricity costs are taken from the 2003 Annual Energy Outlook GDP Chain-Type Price Index. These rates average 2.5 percent annually over the 25-year AEO forecast period.<sup>9</sup>

Additional assumptions used in the base-case analysis are presented in Table 2 below. These assumptions are reasonably aggressive, with a lengthy system lifetime, a high tower height, moderate O&M costs, and a nominal assumed rate of return of 8%. Sensitivity cases were performed for each of these parameters, and the results of the base-case and sensitivity cases are presented in the next section.

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<sup>5</sup> Annual production was calculated using the WindCad Turbine Performance Model, prepared by Bergey Windpower Co. for the National Renewable Energy Laboratory.

<sup>6</sup> Personal communication with Mike Bergey 6/24/03.

<sup>7</sup> Average statewide residential electricity rates were taken from the EIA publication "Current and Historical Monthly Retail Sales, Revenue, and Average Revenue per Kilowatt-Hour by State and by Sector." Values from May 2002 through April 2003 were averaged to produce annual average electricity rates. Electricity price escalation rates for the residential sector vary by census division according to the 2003 Annual Energy Outlook. Although this study focuses on grid-connected systems, it should be noted that off-grid households might value electricity at prices significantly higher than those paid by grid-connected retail electricity customers.

<sup>8</sup> <http://verticals.yahoo.com/cities/categories/proptaxrate.html>

<sup>9</sup> [http://www.eia.doe.gov/oiaf/archive/aeo03/aeotab\\_20.htm](http://www.eia.doe.gov/oiaf/archive/aeo03/aeotab_20.htm)



**Table 2. Input Assumptions for SWAT Base-Case Scenario**

System Assumptions	
System Lifetime	25 years
Tower Height	30 meters
O&M Costs	1.5 ¢/kWh
Financial Assumptions	
Financing Option	Cash Purchase
Required Rate of Return (BTC only)	8 percent

## Results

This section presents results from several SWAT policy scenarios. Results are given for a class 3 wind resource in the 25 states with the most favorable BTC results, unless otherwise noted.

### Base-Case Results

Figure 1 below presents BTC results for the base-case scenario for wind classes 2 through 4. Results show that the economic attractiveness of small, grid-connected residential wind systems is highly variable by state. Most states would require a turnkey installed cost of less than \$2/Watt at a class 3 (or below) site to provide their owners an 8 percent return on their investment over the system lifetime. This compares to typical installed costs of 10kW residential wind systems of \$4-\$5/Watt, and shows that residential, grid-connected small wind installations are not strictly economical in most states, absent aggressive policy actions.

Of the 10 most attractive states, only two (Hawaii and Maine) do not provide cash incentives, and the economic attractiveness of these two states is due in large part to high retail electricity rates (16¢/kWh and 13¢/kWh respectively). New York and California have the highest BTC, driven primarily by favorable rebate programs, and augmented by high retail electricity rates. In a Class 3 wind regime, 10 kW residential wind systems in New York could be installed at a cost of over \$5/Watt and still provide an 8% return to residential system owners over the assumed 25-year system life, given our base case assumptions. Installed system costs of over \$3/Watt could be supported at class 3 wind sites in two additional states: California and New Jersey. With installed costs that generally range from \$4 to \$5/Watt, it is only in New York that typical 10 kW systems can be sold strictly on an economic basis under our base-case assumptions and with existing incentive policies in place.

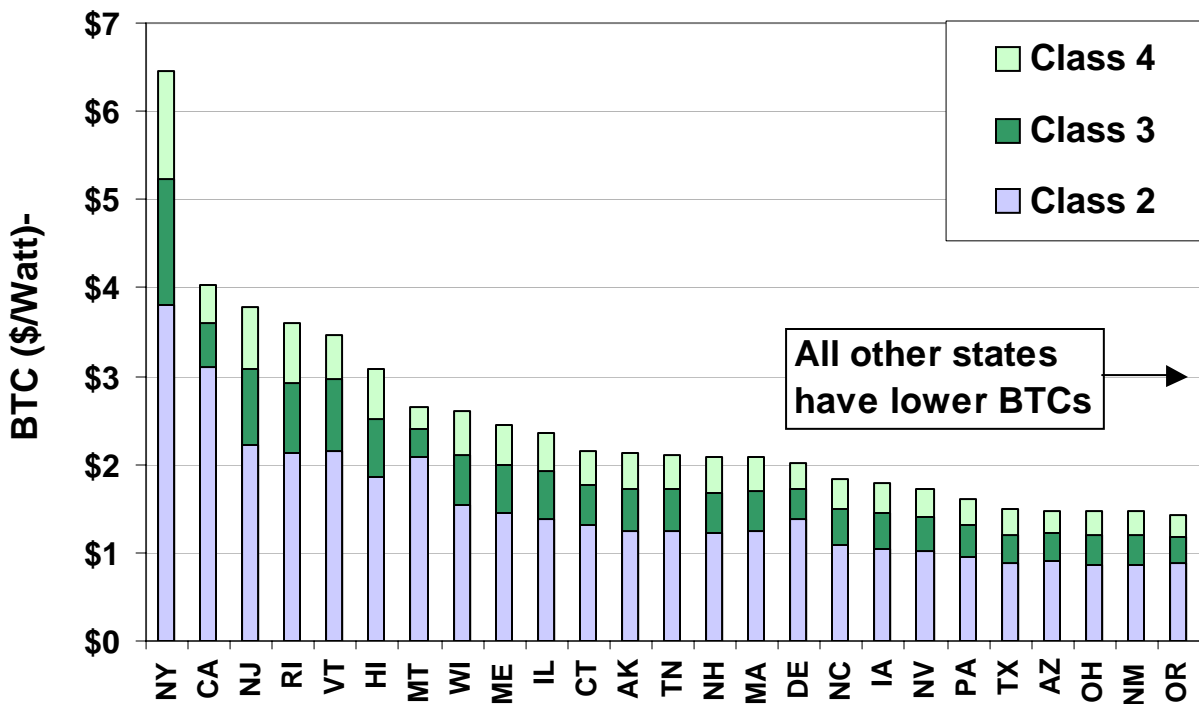


Figure 1. BTC Results for SWAT Base-Case Scenario

Figure 2 confirms these findings, using simple payback as the figure of merit instead of BTC, and focusing on Class 3 wind resource areas. As shown, at an installed cost of \$4.00/Watt, there are 6 states that provide a customer payback of less than 20 years, with no states having a simple payback of less than 10 years.

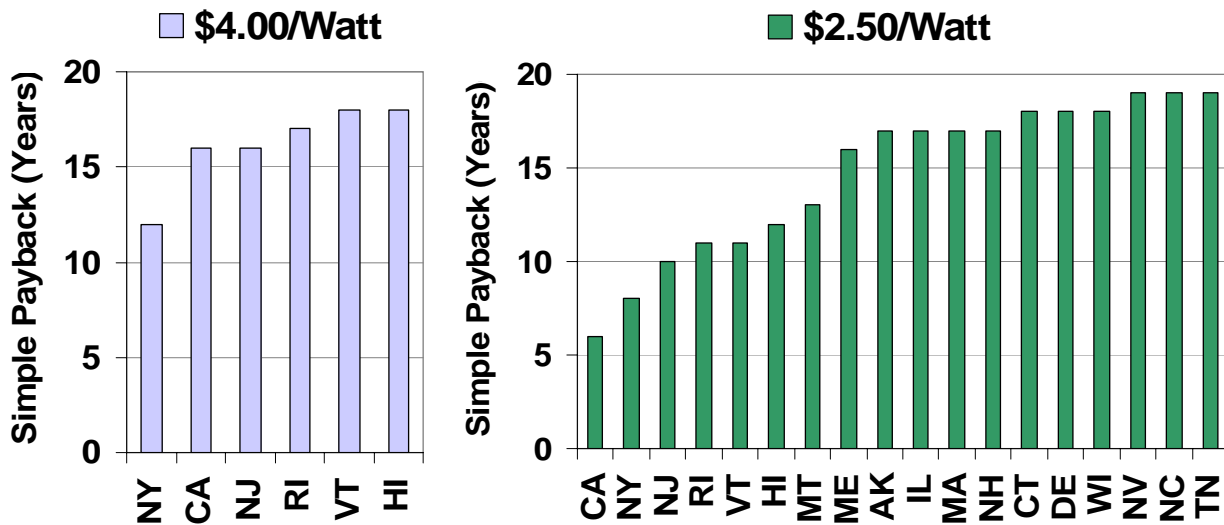


Figure 2. Simple Payback Results for SWAT Base-Case Scenario (Installed Costs Of \$4.00/Watt and \$2.50/Watt, Class 3 Resource)

This analysis also illustrates the importance of continued technological progress and scale economies of manufacturing. If technological improvements and an increase in market scale can drive installed costs to \$2.50/Watt, the market for small wind systems will broaden considerably, and 18 states will achieve simple paybacks of fewer than 20 years with existing incentives in place. In California, the payback period is reduced by more than half when the installed cost target drops to \$2.50/Watt (assuming 2004 incentive levels), as California's \$/Watt rebate structure becomes an increasing share of the total system cost, as opposed to rebate programs structured as a percentage of total system cost. These results strongly suggest that a vibrant small wind market in the U.S. will require both continued policy support and technical developments that lower installed system costs.

### **State Cash Incentives**

State cash incentives – typically structured as rebates on installed system costs – are found to be the most significant factor in the economics of residential wind systems. In particular, state cash incentives such as grants, rebates, or production incentives are the biggest drivers for states with high BTCs. Figure 3 shows the contribution of individual state cash incentive programs to total system BTC. In New Jersey, Montana, and Tennessee the addition of the state cash incentive program more than doubles the customer BTC at a class 3 site.<sup>10</sup>

In some instances, states with similar rebate programs vary significantly in BTC. For example, the New Jersey and New York state rebate programs are two of the most favorable in the country.<sup>11</sup> The BTC in New York state, however, is much higher than in New Jersey, due primarily to New York's property tax exemptions and higher average state electricity rates, which increase the amount that a customer is able to pay (and still break even) in the absence of any financial incentives.

Figure 4, meanwhile, shows the incremental rebate required in each state (above the current incentive levels) to achieve a \$4/Watt customer BTC. As shown, many states would need to implement rebate programs of \$2 to \$3/Watt to meet this target.

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<sup>10</sup> The change in BTC with and without a state rebate is not necessarily correlated on a one-for-one basis with the rebate amount. This is because, with a sizable rebate, the BTC will increase. This increase in the BTC, however, will effectively increase the assumed property tax payments (and affect other variables), thereby reducing the BTC somewhat.

<sup>11</sup> NYSEDA's New York Energy Smart<sup>SM</sup> program refunds 50 percent of the project costs with a maximum rebate value of \$100,000 for systems 500 W to 10 kW. The New Jersey Clean Energy Program offers \$5/Watt or a maximum of 60 percent of the project costs in the most favorable rebate tier for 10kW system; for the system cost ranges covered in this analysis, the New Jersey rebate is effectively 60 percent.

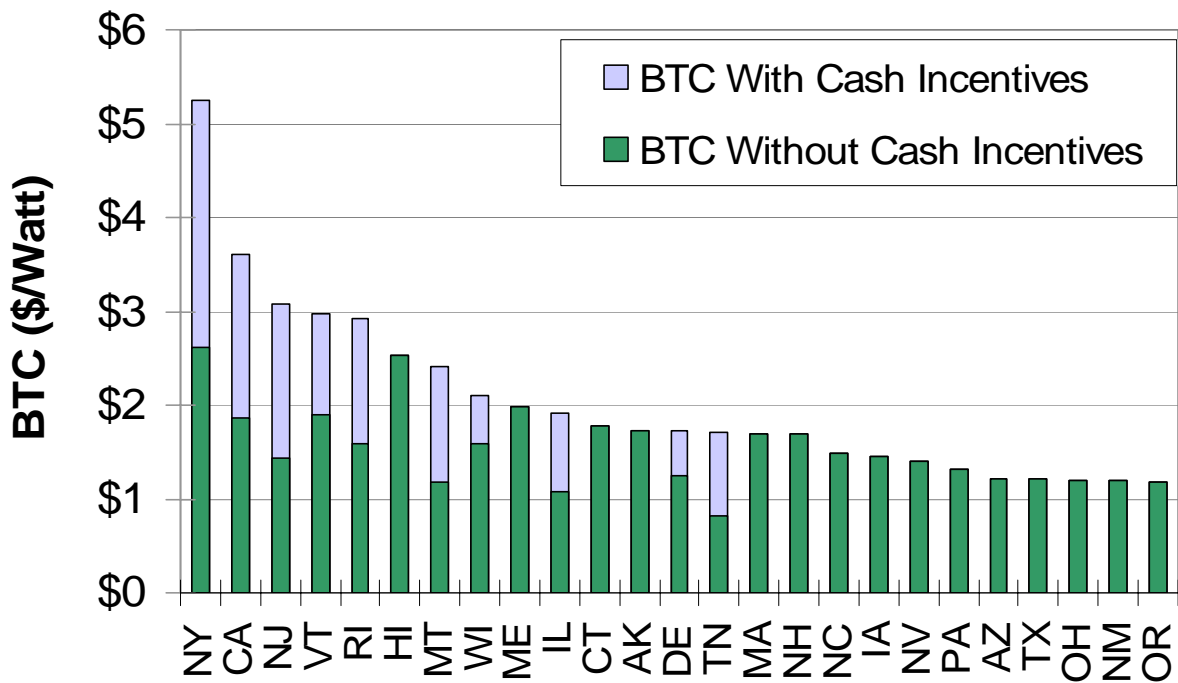


Figure 3. BTC Results With and Without State Cash Incentives (Class 3 Resource)

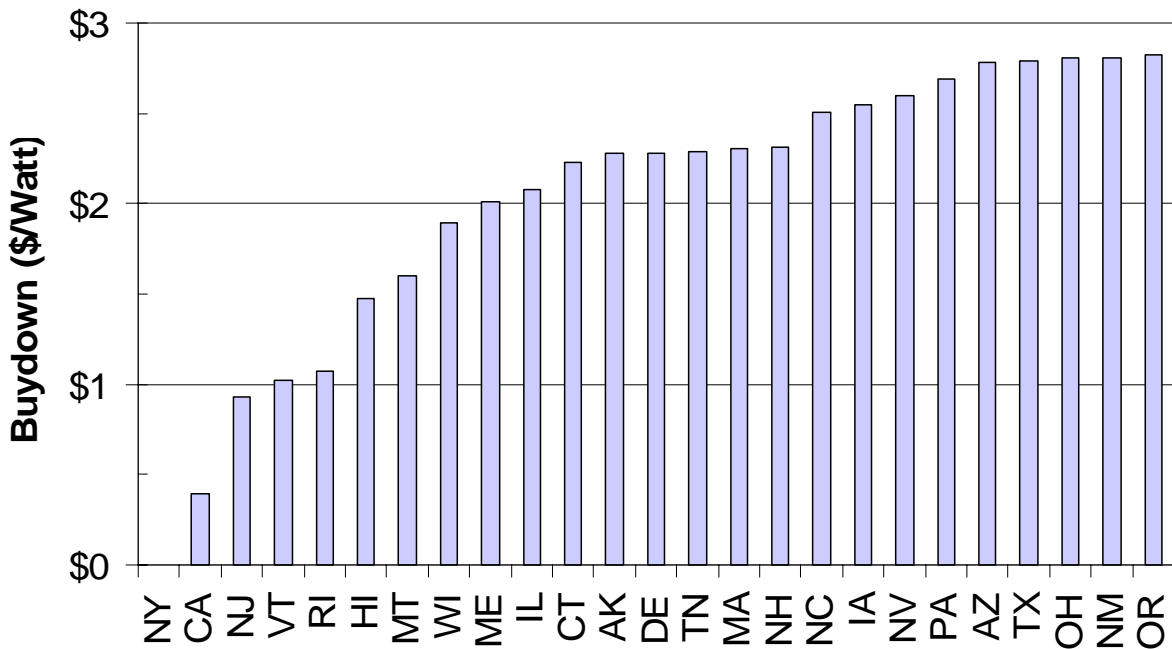


Figure 4. Incremental Rebate Required to Achieve \$4/Watt BTC (Class 3 Resource)

## Other State Policies

State property tax exemptions, ITCs, and low-interest loan programs are also important contributors – though less so than cash incentives – to an increased customer BTC in many states. Property tax payments on residential wind systems, when required, can amount to \$0.75 to \$1/Watt over the system lifetime for an initial system cost of \$4/Watt, though property tax rates are highly variable and total payments are lower in most states. Our analysis shows that property tax exemptions can increase the customer BTC by as much as \$1/Watt.

In this analysis, existing state ITCs are generally shown to be too low to have much of an impact on customer BTC, often because the dollar caps are limiting (on a \$/Watt basis) for the 10 kW system analyzed here. North Carolina offers the most favorable state income tax credit program at 35% of the system cost and a high maximum cap of \$10,500. However, this credit increases the customer BTC by less than \$0.40/Watt at a class 3 site in our analysis.

Low-interest loan programs in certain states can increase the affordability of a small wind system for eligible residential customers. The terms of existing low-interest loan programs vary significantly across states, but the most favorable programs (those that offer a 0% interest rate, such as New York) can increase the customer BTC by almost \$1/Watt over an alternative cash purchase in which an 8% return on investment is required.<sup>12</sup>

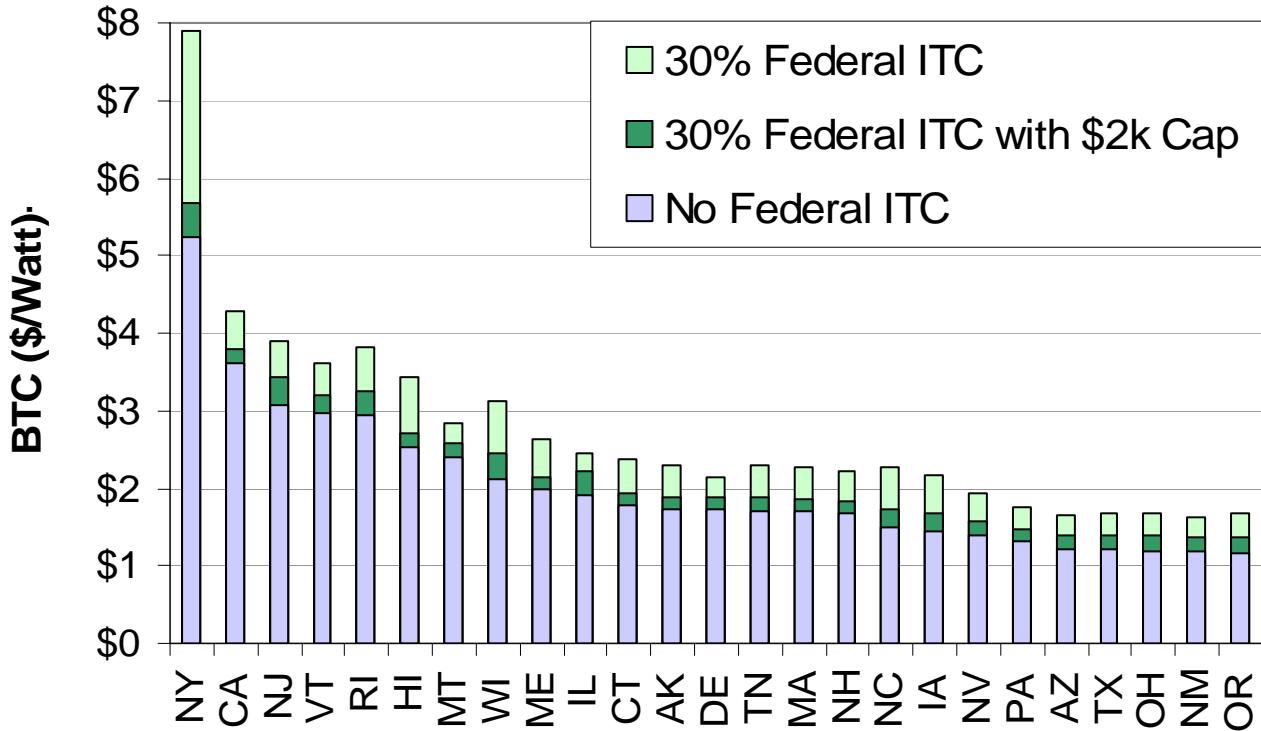
## Federal Income Tax Incentives

As part of the federal energy bill currently under discussion, the U.S. Congress has proposed a federal ITC for residential wind systems set at 30 percent of the system cost, with a maximum limit of \$2,000.<sup>13</sup> Figure 5 shows the effect on state BTC of this proposed federal ITC, with and without the \$2,000 cap. As shown, the federal ITC can make a significant difference to customer BTC. The \$2,000 cap is severely binding for 10 kW systems, however, because such systems typically cost \$40,000 to \$50,000 installed. A 30% ITC with no cap, or with a higher cap, would be significantly more valuable to residential customers considering 10 kW wind systems. (Much smaller systems, which cost less overall, would not necessarily hit the \$2,000 cap, so removal of the cap would not greatly impact those systems.)

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<sup>12</sup> This is because the customer's opportunity cost of capital is presumed to be 8%, which is well above 0%.

<sup>13</sup> *Energy Policy Act of 2003*, 108<sup>th</sup> Cong., 2<sup>nd</sup> session. Placed on calendar in Senate February 23, 2004.



**Figure 5. Federal Income Tax Credit With and Without a Maximum Limit (Class 3 Resource)**

### Alternative Financing Scenarios

The base-case results presented above assume that systems are purchased in cash, unless a state low-interest loan program results in a higher BTC. Figure 6, below, presents sensitivity cases in which financing assumptions are varied, taking a California Class 3 wind regime as an example. This figure demonstrates that financing assumptions can have a moderate impact on the BTC, which can vary by as much as \$0.80/Watt. A cash purchase (equivalent to the base-case scenario) results in a customer BTC of approximately \$3.50/Watt, and this amount is increased under a low-interest loan or a home mortgage scenario. The low-interest loan terms assumed for this example are a 10-year loan period with 2 percent interest. Interest rates under current state low-interest loan programs for small wind systems range from 0 to 6 percent, with an average of about 3 percent.<sup>14</sup> The home mortgage financing option (30-year loan term and a 6 percent interest rate) offers an incremental benefit due to the longer loan terms and the effect of tax-deductible interest payments. The system BTC under a personal loan (10 year loan term and 8 percent interest rate) is approximately equivalent to a cash purchase, because the customer required rate of return is assumed to be 8 percent in the base-case scenario. Table 3 summarizes the assumptions for the alternative financing cases.

<sup>14</sup> Many state low-interest loan programs will vary with the market interest rate, and some offer different rates depending on customer eligibility.

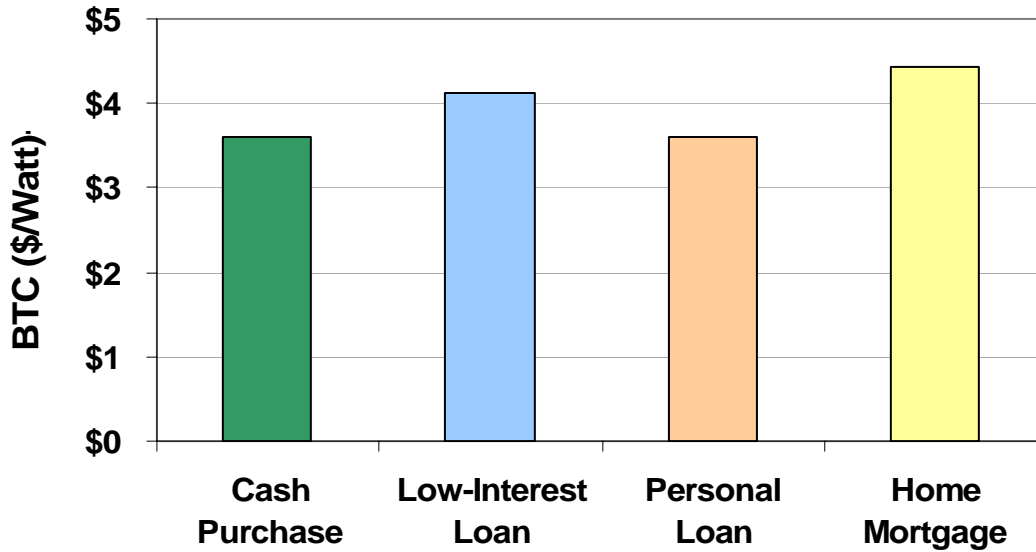


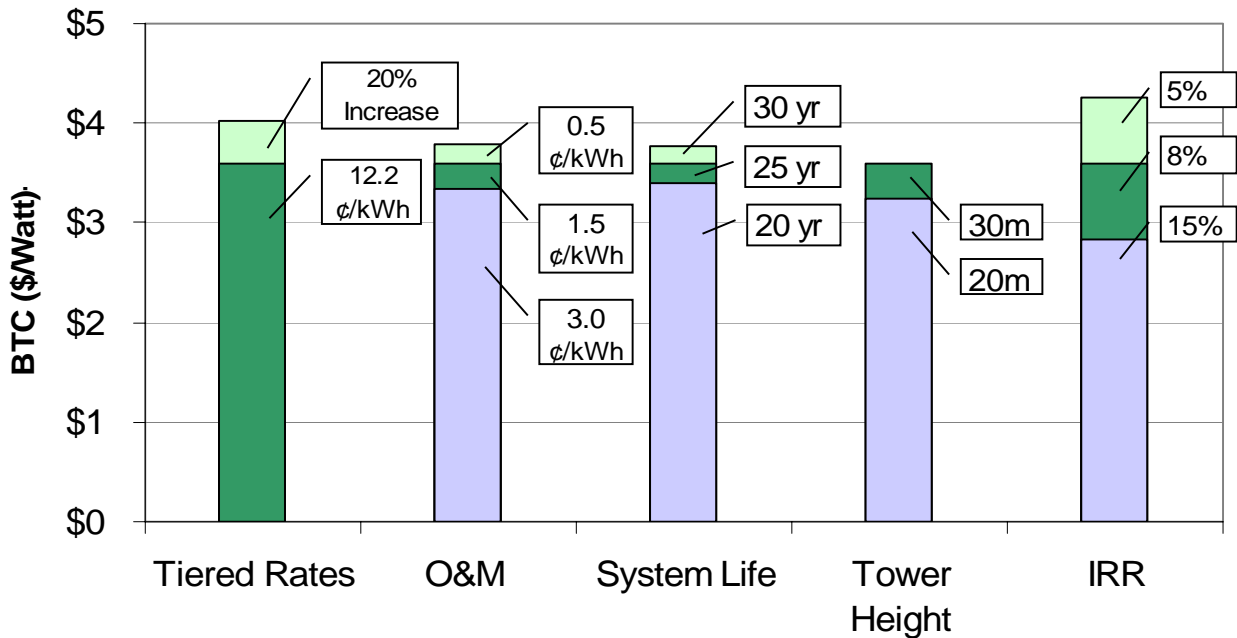
Figure 6. Alternative Financing Scenarios for a California Class 3 Resource

Table 3. Assumptions for Alternative Financing Scenarios

Financing Scenario	Assumptions
Low-Interest Loan	10 year life and 2% interest rate
Personal Loan	10 year life and 8% interest rate
Home Mortgage	30 year life and 6% interest rate (with tax-deductible interest payments)

### Additional Sensitivities

Actual turbine installations may vary from the base-case assumptions used in the previously reported analysis. Additional sensitivities were therefore performed for select system assumptions, again using a California class 3 resource as the example case. Figure 7 presents the results from sensitivities on state retail electricity rates, O&M costs, system lifetime, tower height, and customer required internal rate of return (IRR). The dark bars in the figure correspond to results using the base-case assumptions.



**Figure 7. Sensitivities on Base-Case Input Assumptions for California Class 3 Resource**

These results show that customer BTC is most sensitive to a change in electricity rates or the customer IRR, while O&M costs, system lifetime, and tower height are shown to impact the BTC more moderately. In California, and some other states, tiered rates ensure that some customers will see much higher marginal electricity rates than the average. If a small wind system is able to offset an electricity rate that is 20% higher than the average statewide residential rate, the BTC increases by \$0.40/Watt. This is approximately equal to the increase in BTC if O&M costs are reduced from the highest cost case (3.0¢/kWh) to the lowest cost case (0.5¢/kWh). The range of input values shown here for system lifetime and tower height have a smaller impact; each result in a change of customer BTC of approximately \$0.35/Watt. The most significant effect comes from the assumed customer IRR which varies between 5% and 15% in this sensitivity analysis. A 15% IRR drives the customer BTC down to \$2.84/Watt, while a 5% IRR allows for a BTC of \$4.25/Watt in this California class 3 example.

## Conclusion

Results from SWAT show that the economics of residential, grid-connected small wind systems are highly variable by state and wind resource class. Attractive markets for small residential wind systems are limited to a small number of states that have higher electricity rates and/or provide aggressive state- and utility-based incentives. In the existing environment, only New York provides a customer BTC above \$4/Watt in a class 3 wind resource regime, and only 6 states have BTCs above \$2.50/Watt. In the current policy environment, significant turbine system cost reductions would be necessary to stimulate widespread market acceptance. For



example, 18 states would offer system paybacks under 20 years if system installed costs were \$2.50/Watt.

A number of state and federal policies could help stimulate the market, but state cash incentives currently have the most significant impact, and will be a critical element of continued growth in the small wind market. Other policies such as property tax exemptions, state and federal ITCs, and low-interest loan programs can have a significant impact on customer BTC, but these policies are less important than cash incentives. The proposed 30% federal ITC would increase affordability of small wind systems across all states, but a \$2,000 cap would be very limiting for larger residential systems.

The results of this analysis can help determine which states currently provide the most attractive markets for residential wind systems, or are the best candidates for targeted outreach and consumer education programs. In addition, these results help to quantify the impact of existing and proposed policy incentives on small wind economics in different states. This information may help policymakers explore the impact of different policy types and levels on customer economics, and thereby make decisions on how best to support the growth of the small wind industry.

## **Acknowledgements**

This study was funded by the Office of Energy Efficiency and Renewable Energy, Wind & Hydropower Technologies Program of the U.S. Department of Energy under Contract No. DE-AC03-76SF098. We appreciate the guidance and support of our project manager, Jack Cadogan. The authors would also like to thank Mike Bergey, Roger Clark, Heather Rhodes-Weaver, and Mick Sagrillo for their time and helpful contributions to this project.

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