Is it Worth it?
A Comparative Analysis of Cost-Benefit Projections for State Renewables Portfolio Standards

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Introduction

State renewables portfolio standards (RPS) have emerged as one of the most important policy drivers of renewable energy capacity expansion in the U.S. Collectively, these policies now apply to almost 40% of U.S. electricity load, and may have substantial impacts on electricity markets, ratepayers, and local economies. As RPS policies have been proposed or adopted in an increasing number of states, a growing number of studies have attempted to quantify the potential impacts of these policies, focusing primarily on projecting cost impacts, but sometimes also estimating macroeconomic and environmental effects.

This report synthesizes and analyzes the results and methodologies of twenty-six distinct state or utility-level RPS cost impact analyses completed since 1998 (see Figure 1 and Appendix for a complete list of the studies). Together, these studies model proposed or adopted RPS policies in seventeen different states. We highlight the key findings of these studies on the costs and benefits of RPS policies, examine the sensitivity of projected costs to model assumptions, assess the attributes of different modeling approaches, and suggest possible areas of improvement for future RPS analysis.

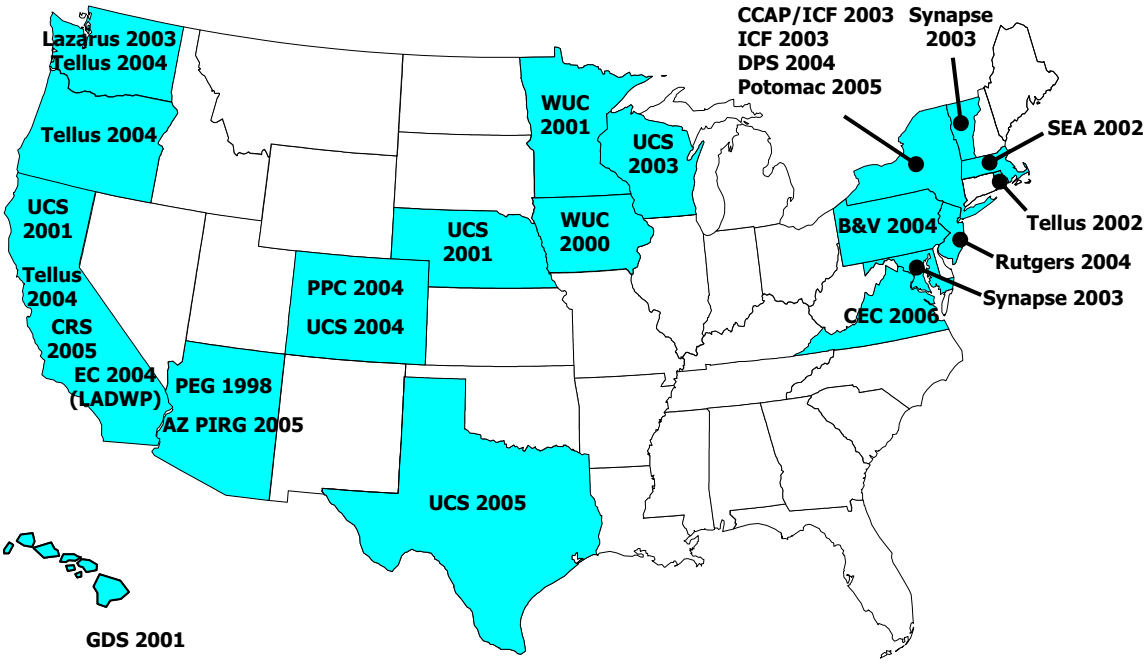

Figure 1. RPS Cost-Impact Studies Included in Report Scope

Key Findings

Projected rate impacts are generally modest. Over 70% of the RPS cost studies in our sample project base-case retail electricity rate increases of less than one percent in the year that each modeled RPS policy reaches its peak percentage target.[1] In five of those studies, electricity consumers are expected to experience cost *savings* as a result of the RPS policies being modeled. On the other extreme, eight studies predict rate increases above 1%, and two of these studies predict rate increases of more than 5%. Though most of the studies project relatively limited impacts on retail electricity rates, the wide range of impacts shown in Figure underscores the large variability among the studies' results. When translated to monthly electricity bill impacts for a typical residential customer, these impacts range from a savings of almost four dollars per month to an increase of over seven dollars per month.[2] However, the median bill impact across the studies in our sample is an increase of only $0.44 per month.

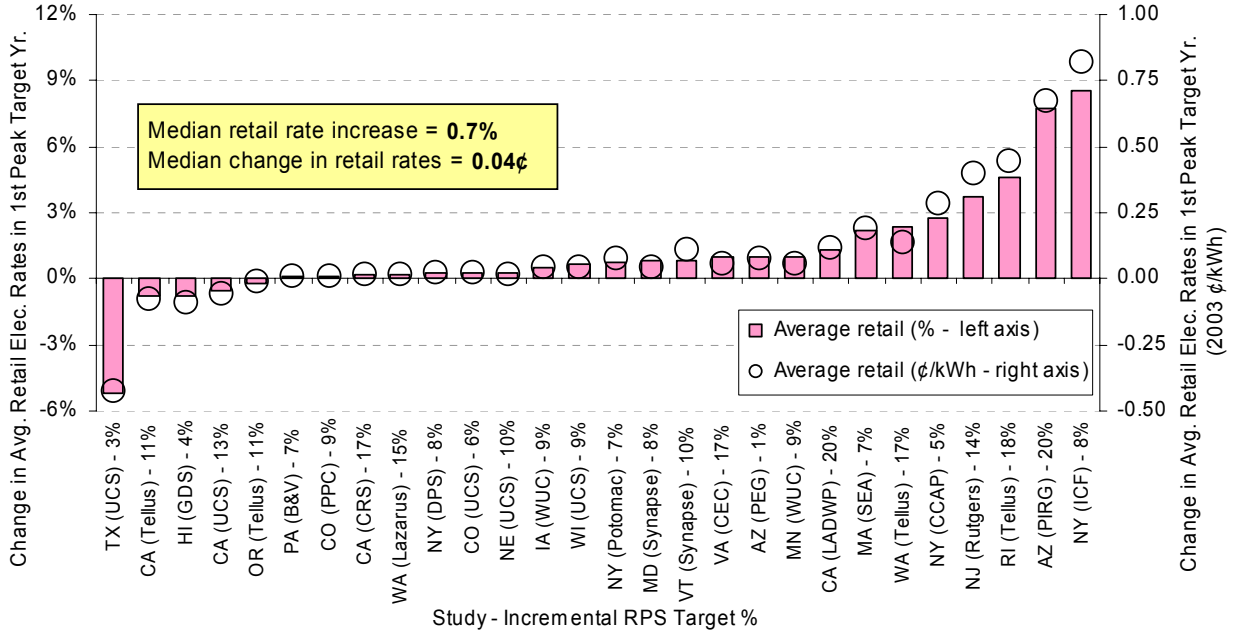

Figure 2. Projected RPS Electricity Rate Impacts by Cost Study

Wind is expected to be the dominant technology in meeting RPS requirements. Figure presents the projected mix of new renewable generation used to meet the modeled RPS policies (for the subset of studies that forecast the renewable technology mix). Perhaps not surprisingly, wind is expected to be the dominant technology, representing 61% of incremental RPS generation across all of these studies combined. Projected wind development is particularly

[1] We use the term "base case" to refer to the baseline RPS scenario, while we use the term "reference case" to refer to the business-as-usual, non-RPS scenario. We use data from the "peak target year" (e.g., 7% in 2012 for Massachusetts, 9% in 2010 for Minnesota, etc.) to compare most of the studies' projections because we believe it to be the most tractable and consistent method for comparing the long-term RPS impacts of studies that provide projected impacts in widely varying formats and timeframes. The direct cost impacts referred to here account for any reductions in wholesale electricity market prices that the studies may have modeled, but do not include any potential reductions in consumer natural gas bills.

[2] All cost figures in this report have been converted to 2003 dollars.

prevalent in the Midwest and Texas, accounting for 91% of expected incremental RPS generation in those states. Geothermal, which accounts for 18% of projected incremental generation across the studies, is a distant second, and almost all of the expected geothermal additions are from three California studies. Biomass co-firing and direct combustion account for approximately 9% of expected incremental generation, while hydro, landfill gas, and solar each comprise less than 3%.[3]

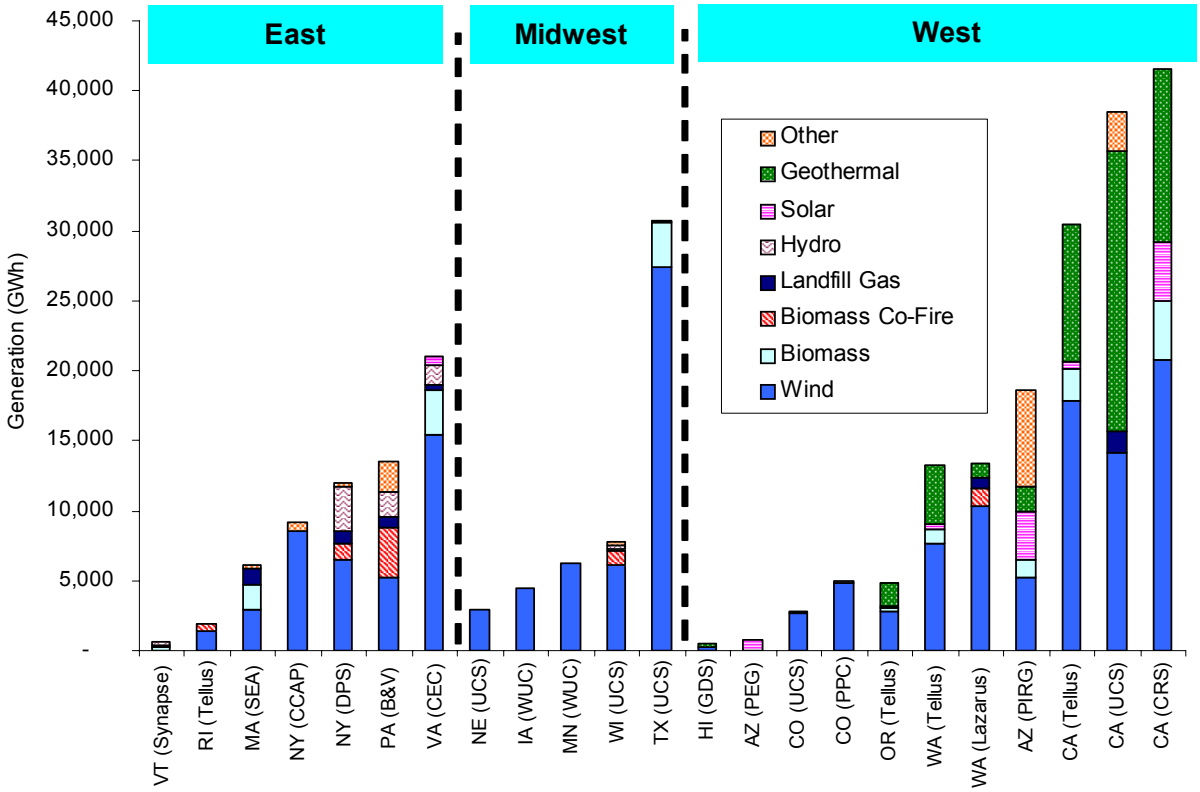

Figure 3. Incremental Renewable Energy Deployment by Study and Technology

Scenario analyses reveal significant cost sensitivity to input parameters. The majority of the studies we reviewed include some form of scenario analysis using input assumptions that differ from those used in the base case. The most commonly modeled scenarios are fossil fuel price uncertainty, the availability of the federal production tax credit, varying projections of renewable technology cost, and alternate RPS target levels. The prevalence of these scenarios implies – but does not prove – that projected RPS costs are more likely to be sensitive to these particular factors than to others. Due to the wide range of scenarios modeled and the different assumptions used within each type of scenario, it is difficult to draw definitive conclusions about the relative impact of different cost drivers. In most cases, the residential electricity bill impacts of the

[3] These percentages are purely intended for illustrative purposes. They do not represent the overall RPS mix that would be developed if RPS policies were adopted in all of the states for which cost studies have been performed. Renewable energy deployment data are not available for all states, and multiple cost studies exist in some states, thereby "double counting" the impacts of those states' RPS policies.

scenarios analyzed by the studies – as measured by changes from the base case RPS – are less than one dollar per month. Though such changes are not overwhelming, it is important to recognize that the median *base-case* residential electricity bill impact among the studies in our sample is just $0.44 per month. Therefore, even a one dollar per month change from this base case is sizable in percentage terms, and demonstrates significant cost sensitivity to input parameters.

Many public benefits of RPS policies are still not well understood. An increasing number of studies are modeling macroeconomic or public benefits of RPS policies. Roughly a quarter of the studies in our sample model the macroeconomic effects of RPS policies. All of these studies predict some level of net employment gain, but the magnitude of this impact varies widely and appears to depend more strongly on the assumptions of the studies than on the amount of incremental renewable generation required to meet the modeled RPS policies. About a quarter of the studies in our sample also model the risk mitigation benefits of RPS generation, estimating a broad range of reductions in wholesale electricity and natural gas prices. Over half of the studies we reviewed quantify potential environmental benefits, most commonly carbon dioxide (CO_2) emissions reductions. Most of these studies indicate that RPS generation is expected to displace CO_2 emissions primarily from natural gas plants. Although the spread of projected CO_2 abatement costs across the studies is extremely broad, a majority of these studies project CO_2 reduction costs that fall within the range of the U.S. Energy Information Administration's (EIA) projections of carbon reduction costs under various regulatory regimes (Wiser and Bolinger 2004).

Analysis assumptions are likely as or more important than the choice of model. In the absence of a universally accepted methodology for analyzing RPS cost impacts, the studies in our sample employ a diverse array of modeling approaches, ranging from simple spreadsheet models to highly sophisticated integrated energy models. This diversity in modeling approaches may be due in part to regional differences in RPS policies and electricity markets, as different situations call for different modeling approaches. However, the limited budgets and short timeframes that typically apply to RPS cost studies are probably the more important determinants of the modeling approach chosen, as the sophistication and detail of the analysis is likely to be constrained by these limiting factors. Though more sophisticated models can account for interesting and potentially significant price feedbacks and may be better received by policymakers and RPS stakeholders, it is not entirely clear that such models necessarily improve predictive accuracy. Given the significant uncertainty surrounding numerous RPS cost factors, it is likely that the assumptions governing these factors, such as the natural gas price forecast and the presumed availability of the production tax credit, are as or more important than the type of model used.

Studies appear to have underestimated both renewable technology costs and avoided fuel costs. The vast majority of studies we reviewed appear to have underestimated two major RPS cost factors: wind power capital costs and natural gas prices. Since wind is expected to be the dominant contributor to RPS generation requirements, wind cost assumptions are critically important for estimating the cost impacts of RPS policies. Since the studies did not anticipate the sudden leap in wind costs over the past two years, the wind capital cost assumptions in most of the studies, which typically fall between $800-1300/kW in the 2005-2010 timeframe, are

significantly below current costs (which are reportedly in the $1300-1800/kW range). This disparity between study expectations and current market reality suggests that (all else being equal) the actual cost impacts of state RPS policies may significantly exceed those estimated in our sample of studies, especially if higher wind costs persist. However, most, if not all, of the studies appear to have also substantially underestimated natural gas prices, which are perhaps the most important input to the avoided cost estimate of several studies.[4] Current natural gas prices (and near-term price expectations) are much higher than those assumed by the studies, as most of the studies rely on dated natural gas price forecasts projecting prices that are far lower than current price expectations. It is uncertain to what degree this apparent underestimate of natural gas prices will negate the effects of underestimating wind costs; the uncertainties involved with predicting these two inputs highlight the importance of performing scenario analysis.

Conclusions

With few exceptions, the long-term electricity rate impacts of RPS policies are projected to be relatively modest. When these electricity cost impacts are combined with possible RPS-induced natural gas price reductions and corresponding gas bill savings, the overall cost impacts are even smaller.

The large diversity of modeling methodologies and assumptions used to estimate RPS costs demonstrates that RPS cost analysis is still an evolving process, and that no standard template has yet to emerge. Moreover, like most prospective analyses of electricity markets, RPS cost analysis is an inherently uncertain practice, highlighting the importance of evaluating the sensitivity of projected RPS costs to uncertain input parameters.

Though this report focuses most heavily on RPS-induced rate impacts, an increasing number of studies are modeling the macroeconomic or other public benefits of RPS policies, either in addition to or exclusive of rate impacts. This recent emphasis on macroeconomic benefits suggests that RPS proponents are broadening their justifications of RPS policies.

RPS cost studies are becoming more sophisticated, but improvements are still possible. We identify a number of areas of possible improvement for future RPS cost studies:

- ***Improved treatment of transmission costs, integration costs, and capacity values:*** Transmission availability and transmission expansion costs have become among the most important barriers to renewable energy in many states, but these costs are often poorly understood and imprecisely modeled in RPS cost studies. The capacity value of renewable energy (wind, in particular), as well as the cost of integrating renewable energy into larger electricity systems, are likewise emerging as potentially important variables, and RPS cost studies must be careful to properly account for these potential costs and impacts.

- ***Consideration of competing RPS requirements:*** As the number of states that have adopted RPS policies continues to grow, the available supply in renewable energy in regions with

[4] This is not true of studies that assume that avoided costs will be effectively determined by the cost of non-natural - gas generators (i.e., coal-fired generators), but most of the studies in our sample have explicitly or implicitly assumed that avoided costs will be primarily determined by the cost of natural gas-fired generation.

limited renewable potential (e.g., New England) may become more costly due to increased demand. Future cost studies would be well served to consider renewable demand from existing and potentially new RPS policies in neighboring states and regions and evaluate the potential effect of this demand on RPS rate impacts.

- ***Estimating the future price of natural gas:*** Where possible, base-case natural gas price forecasts should be benchmarked to then-current NYMEX futures prices (Bolinger et al. 2006). Furthermore, given fundamental uncertainty in future gas prices, a healthy range of alternative price forecasts should be considered through sensitivity analysis. To calculate the potential secondary impacts of increased renewable energy deployment on natural gas prices, either an integrated energy model or the simplified tool developed by Wiser et al. (2005) might be used.

- ***Evaluation of coal as the marginal price setter:*** With high natural gas prices, some states are shifting away from natural gas towards other resources, especially coal. In such instances, new studies should investigate the possibility that RPS generation may increasingly displace coal-fired and other non-gas-fired generation. Such a shift would likely reduce the importance of natural gas bill savings, but could also increase the importance of carbon emissions reductions.

- ***Greater use of scenario analysis:*** The inaccuracy of long-term fundamental gas price forecasts from the EIA and other private sector firms in recent years underscores the importance of using scenario analysis to bound possible outcomes. Not only is the future cost of conventional generation unknowable, renewable technologies themselves are experiencing rapid changes, both of which render the long-term impacts of RPS policies highly uncertain. Such uncertainty can be evaluated, to a degree, through greater use of scenario analysis. Some of the variables that may be most appropriate for scenario analysis include renewable technology potential and costs, future natural gas prices, the period of PTC extension, and the potential impact of future carbon regulations.

- ***Consideration of future carbon regulations:*** As some states and regions begin to implement carbon regulations, renewable generators may stand to benefit. It is also possible that federal carbon regulations will be developed within the time horizon of state RPS policies. Although these trends may significantly reduce the incremental cost of renewable generation required by RPS policies, the risk of future carbon regulation has only been modeled by one of the studies in our sample. In future studies, we recommend that the risk of future carbon regulations be explicitly considered, at a minimum through scenario analysis.

- ***Accurate representation of RPS market structure:*** In some regions of the country, RPS compliance strategies based on short-term markets for renewable energy credits (RECs) have led to unexpected cost impacts. RPS cost studies should seek to adopt modeling approaches that are consistent with probable RPS market structures.

- ***More robust treatment of public benefits:*** Though an increasing number of studies have modeled macroeconomic benefits, the assumptions driving these analyses are often inconsistent, and the wide range of results may detract from the credibility of such studies.

More work is needed to identify the most feasible and defensible assumptions governing the public benefits of renewable energy, including the fossil fuel hedge value of renewable energy and the benefits of reduced carbon emissions, in addition to employment and economic development impacts.

Actual RPS costs may differ from those estimated in the RPS cost studies. Some of the assumptions in the RPS cost studies that may result in an underestimation of actual RPS costs include:

- Wind capital cost assumptions that appear too low in many cases, given recent increases in wind costs;
- Transmission and integration costs that are not fully considered in some instances;
- Use of an "average cost" approach to estimate incremental renewable generation costs in some situations when a ,marginal-cost-based approach may be more appropriate;
- Lack of full consideration for the potential demand for renewable energy from other sources;
- Increased likelihood that coal-fired generation will set wholesale market prices in some regions which, in the absence of carbon regulations, may make renewable generation less economic than when renewable energy is presumed to compete with natural gas; and,
- Expectations in some cases that the federal production tax credit (PTC) will be available indefinitely, which may be overly optimistic given the political uncertainty affecting PTC extension.

Conversely, a number of other cost study assumptions may result in an overestimation of actual RPS costs, including:

- Reliance on natural gas price forecasts that are almost universally substantially below current price expectations;
- Secondary natural gas and/or wholesale electric price reductions that have not been modeled in many of the studies;
- The potential for future carbon regulations, which are ignored in virtually every study in our sample; and
- Expectations in many cases that the PTC will only be available for either a very limited period or not at all, which may be overly conservative given the recent two-year extension of the PTC and the possibility for longer-term extension.

As states accumulate more empirical experience with RPS policies, future analyses should benchmark the cost projections from RPS cost studies against actual cost impacts as a way to inform future RPS modeling efforts.

Appendix. List of Reviewed RPS Cost-Impact Studies

State	Principal Author(s)	Year	Title
AZ	AZ PIRG Education Fund (AZ PIRG)	2005	Renewing Arizona's Economy: The Clean Path to Jobs and Economic Growth
AZ	Pacific Energy Group (PEG)	1998	Solar Portfolio Standard Analysis
CA	Union of Concerned Scientists (UCS)	2001	Powering Ahead: A New Standard for Clean Energy and Stable Prices in California
CA/OR/ WA	Tellus	2004	Turning the Corner on Global Warming Emissions: An Analysis of Ten Strategies for California, Oregon, and Washington
CA (LADWP)	Environment California (EC)	2004	Clean and Affordable Power: Updated Cost Analysis for Meeting a 20% Renewables Portfolio Standard by 2017 at LADWP
CA	Center for Resource Solutions	2005	Achieving a 33% Renewable Energy Target
CO	Public Policy Consulting (PPC)	2004	The Impact of the Renewable Energy Standard in Amendment 37 on Electric Rates in Colorado
CO	UCS	2004	The Colorado Renewable Energy Standard Ballot Initiative: Impact on Jobs and the Economy
HI	GDS Associates (GDS)	2001	Analysis of Renewable Portfolio Standard Options for Hawaii
IA	Wind Utility Consulting (WUC)	2000	Projected Impact of a Renewable Portfolio Standard on Iowa's Electricity Prices
MA	Sustainable Energy Advantage (SEA) & LaCapra	2002	Massachusetts RPS: 2002 Cost Analysis Update – Sensitivity Analysis
MD	Synapse Energy Economics	2003	The Maryland Renewable Portfolio Standard: An Assessment of Potential Cost Impacts
MN	Wind Utility Consulting (WUC)	2001	Projected Impact of a Renewable Portfolio Standard on Minnesota's Electricity Prices
NE	UCS	2001	Strong Winds: Opportunities for Rural Economic Development Blow Across Nebraska
NJ	Rutgers CEEEP	2004	Economic Impact Analysis of New Jersey's Proposed 20% Renewable Portfolio Standard
NY	Center for Clean Air Policy (CCAP)/ICF	2003	Recommendations to Governor Pataki for Reducing New York State Greenhouse Gas Emissions
NY	ICF Consulting	2003	Report of Initial Analysis of Proposed New York RPS
NY	NY Department of Public Service (DPS)	2004	Renewables Portfolio Standard Order Cost Analysis
NY	Potomac	2005	Estimated Market Effects of the New York Renewable Portfolio Standard
PA	Black & Veatch (B&V)	2004	Economic Impact of Renewable Energy in Pennsylvania
RI	Tellus	2002	Rhode Island RPS Modeling
TX	UCS	2005	Increasing the Texas Renewable Energy Standard: Economic and Employment Benefits
VA	Clean Energy Commercialization (CEC)	2005	A Portfolio-Risk Analysis of Electricity Supply Options in the Commonwealth of Virginia
VT	Synapse	2003	Potential Cost Impacts of a Vermont Renewable Energy Portfolio Standard
WA	Lazarus, Lazar, Hammerschlag	2003	Economics of a Washington Energy Portfolio Standard: Effects on Ratepayers
WI	UCS	2003	A Study to Evaluate the Impacts of Increasing Wisconsin's RPS