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National Renewable Energy Laboratory
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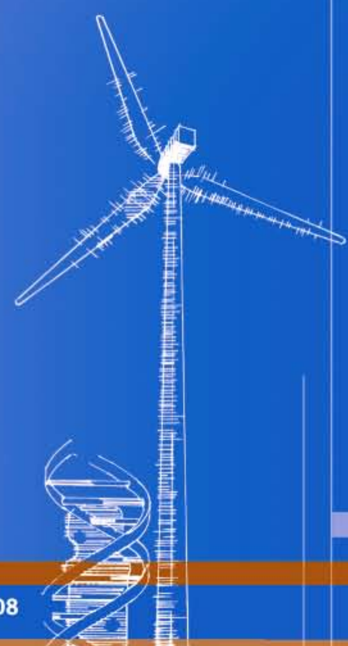
A Framework for State-Level Renewable Energy Market Potential Studies

Claire Kreycik, Laura Vimmerstedt, and Elizabeth Doris

Technical Report
NREL/TP-6A2-46264
January 2010



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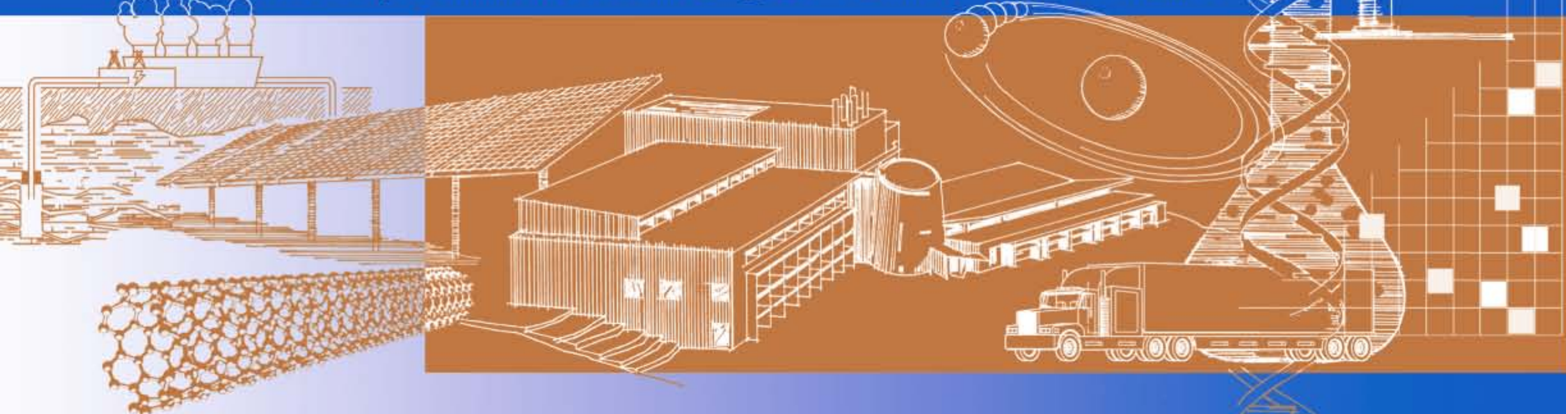

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National Renewable Energy Laboratory
1617 Cole Boulevard, Golden, Colorado 80401-3393
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Executive Summary

State-level policymakers are relying on estimates of the market potential for renewable energy resources as they set goals and develop policies to accelerate the development of these resources. Therefore, accuracy of such estimates should be understood and possibly improved to appropriately support these decisions.

This document provides a framework and next steps for state officials who require estimates of renewable energy market potential. The report gives insight into how to conduct a market potential study, including what supporting data are needed and what types of assumptions need to be made. The report distinguishes between goal-oriented studies and other types of studies, and explains the benefits of each.

Renewable energy market potential is defined as the quantity of renewable energy development that could be supported in a particular jurisdiction given the available resource, and given the technical, economic, and market constraints.

Market potential studies are useful to state decision makers because they can help shape renewable energy targets, can identify the lowest-cost options for reaching specific goals, or can serve as the basis for evaluating costs and benefits of renewable energy development. Based on a synthesis of the methodologies and approaches of various studies and an analysis of the evolution of the market potential study over the last decade, the following general conclusions were reached:

- Market potential studies must be grounded in comprehensive analysis of resource, technical, and economic potential.
- Recent market potential studies incorporate detailed scenario analysis with comprehensive projections of electricity, renewable energy credit (REC), and carbon market conditions, and future incentive levels. This level of detail provides perspective on different possible future investment environments, which in turn provides more realistic bounds for market potential.
- Uncertainty in the analysis can be minimized by focusing on a goal for renewable penetration, shortening the timeline for the analysis, or both.
- A final caveat: market potential estimates are hypothetical because of the large number of assumptions that go into them. Results should not be taken as projections for future renewable energy supply.

1 Introduction

Energy powers the United States; therefore, it is critical that policymakers know how much energy is available and at what cost. In a fossil-fuel-dominated energy system, this knowledge comes in terms of reserves (barrels of petroleum, tons of coal, or cubic feet of natural gas). These reserves are further defined by their market competitiveness–the quality of the resource, the cost of extraction, and the cost of competing energy resources. Similarly, a renewable energy potential study can be used to quantify reserve quantity, costs, and competitiveness for renewable resources.

State-specific renewable energy market potential studies can help identify opportunities for policy enhancement and future investments to advance economic development. Relevant to this application of the studies, the American Recovery and Reinvestment Act has provided funding for state energy initiatives and programs that will help states achieve energy goals, including renewable energy goals. Funds from the Recovery Act may be used to conduct market potential studies, which can provide key insight to decision makers and help shape their strategies and activities.

There are four basic types of renewable energy potential study, defined below:

- **Resource**—an estimate of the theoretical potential for renewable resources in a region. Resource potential studies address the quantity, timing of availability, geographic location, and trends in supply of renewable resources such as biomass, geothermal, hydro, ocean, solar, and wind.
- **Technical**—an estimate that limits potential by incorporating technical and land use limitations. Technical potential studies examine opportunities for conversion of these energy resources into useful forms using proven or assumed-to-be-developed technologies. A technical potential study provides an estimate of the maximum amount of feasible renewable energy development, not considering economic or market barriers.
- **Economic**—an estimate that limits potential by incorporating technology cost information and other economic indicators (including ancillary impacts). Economic potential studies also account for costs and cost-competitiveness of those technologies.
- **Market**—an estimate that limits potential by incorporating market acceptance considerations including demand, supply, commodity prices, regulations, incentives, barriers, investments, consumer response, and others. A common subtype is the goal-oriented market potential study that will be described in more detail below. Goal oriented potential studies identify the potential of renewable energy resources to meet a selected policy-driven goal.

The desired applications of renewable energy potential studies shape their design. These applications range from education and awareness of the public to developing policies and programs to promote renewable energy use in the jurisdiction. Table 1 summarizes the primary applications for potential studies. Actual studies can address one or, more frequently, a combination of applications.

Table 1. Applications for State-Level Renewable Energy Potential Studies

Outcome	Description	Applicable Type of Study
Baseline Availability Understanding	Develops and consolidates possible uses of, and resources for, renewable energy within the geographic area	Resource
Public Education and Awareness	• Consolidates information available within a geographic area for the general public • Raises awareness among the general public through accessible information tailored specifically to constituent needs	All
Scenario Development	Provides information based on variable assumptions regarding market development, technology pricing changes, and/or policy choices	Economic, Market
Target Setting	Assists in setting renewable energy targets for single resources or resource mixes	Economic, Market, Goal-Oriented
Economic Competitiveness of Renewable Technologies	Competes opportunities for renewable resources against each other or against fossil-based fuels	Economic
Business Development	Illustrates the value of renewable energy in a geographic location for potential investors	Market
Policy Opportunities	Identifies market development and incentive opportunities for public sector support	Market

Each type of study has appropriate applications. Detailed resource studies can encourage business interest in developing those resources and provide opportunities for the public and policymakers to better understand available resource opportunities. Market potential studies can estimate likely usage of renewable resources and technologies under selected scenarios, and the difference between economic and market potential can highlight possible opportunities for effective policy intervention. Comparison of economic and technical potential can identify opportunities for technical improvements that increase economic competitiveness of the technologies. Goal-oriented potential studies can assist policymakers in understanding the implications of targets and evaluating possible incentives to achieve those targets.

Among different types of potential studies, market potential studies provide the most practical and usable information for decision makers because they encompass market factors that may influence outcomes. Market potential estimates build upon inputs from the other types of studies to determine a realistic potential for renewable energy under a particular set of assumptions. These results are often presented as scenarios of future market development. The purpose of these studies is to offer policymakers and decision makers information about the likely development within a specified policy context.

Figure 1 shows how these types of studies relate to one another. Technical, economic, and market potential each depend on the limitations and constraints of the preceding type of potential in a sequential manner, as depicted in the figure. Each layered analysis adds additional assumptions about technologies, economics, and markets. In fact, economic and market potential studies can present the results as fractions of the total technical potential.

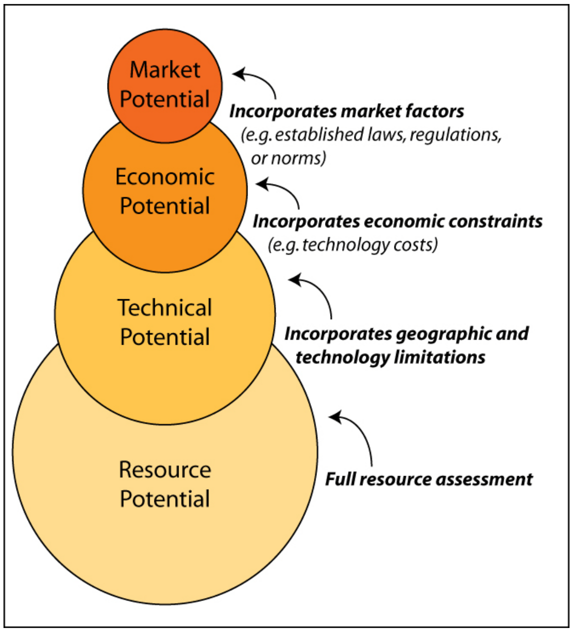

Figure 1. Types of potential studies

As the number of assumptions increases, variability in the range of possible outcomes increases. Whereas scenario analysis is valuable in the policy arena, holding underlying assumptions constant provides the most useable product for decision makers. By constraining resource and technical potential, decision makers can compare the impacts of different policy options on cost reduction and market penetration. Varying market assumptions, while holding all else constant, can also help bound market potential over a given timeframe.

Figure 1 also illustrates that market studies must build upon solid understanding of resource potential, because the resources vary by location and time, and their competitiveness varies by technology and market. Resource uncertainty, including climatic and weather system shifts and reallocation of land for alternative uses, can have a large impact on the economics and market situation for renewable energy. In the same vein, technology changes regarding performance (e.g., increased conversion efficiency) or cost (e.g., increased steel costs) can dramatically change the market impact that renewable energy can have. In short, renewable energy potential study types are interlinked and need to be used together to fully understand policy implications.

2 Methodology

State policymakers have been conducting or commissioning renewable energy market potential studies for more than 10 years. The methodologies supporting potential studies have evolved. We analyzed nearly two dozen studies to identify the issues and assumptions that need to be addressed in conducting market potential studies, the data needed to support them, and the next steps for states to pursue the development of them. Our purpose is to increase the usefulness of these studies to policymakers.

Section 4 delves into how best to conduct a state-specific market potential study. Specific considerations include framing the purpose and scope, and developing scenarios. Section 5 describes the goal-oriented study: its uses, benefits, and drawbacks.

3 Framework for Conducting a Market Potential Study

This section provides a framework for conducting market potential studies, with emphasis on maximizing usefulness and managing uncertainty. A step-by-step description of how to conduct a study is provided below and details are provided about how to frame a study and develop scenarios.

Process

1. Conduct background research, including a review of potential studies done in other states and regions. Background research can help in the development of assumptions and data sources for the area.
2. Frame the study; develop a clear research question to address a particular purpose.
3. Consider study scope and timeframe of the analysis.
4. Create an underlying estimate of technical potential by doing a full resource assessment and adding technical and geographical limitations.
5. Apply economic constraints, with consideration given to how state policy context influences technology costs.
6. Identify primary market drivers (e.g., fuel prices, future generation retirements, transmission requirements, and REC and carbon markets) and monetize them.
7. Evaluate policy or market scenarios to develop bounds for renewable energy market potential.

Framing a Study

Market potential studies are often developed in state energy offices for the purposes of planning and impact evaluation. By building upon resource assessment, and technological and economic potentials, market potential studies can identify costs, benefits, and economic impacts of particular policies, public sector investments, or investment environments. Market potential studies can assist in setting renewable energy targets for single resources or resource mixes, or conversely can evaluate the impact of a target on the market development. Furthermore, the studies also can help identify barriers to market penetration and opportunities for investments and incentives that could stimulate market development.

To maximize the impact of market potential studies, it is important to develop a clear and specific question. The box below describes common questions that market potential studies set out to answer:

Questions Answered by Market Potential Analysis

- What impact is a policy likely to have on market penetration of renewables?
- What do supply chain changes mean for market penetration?
- Where and in what technology should investment dollars be focused?
- What investments are likely to result in actual renewable energy projects?
- How aggressive should a renewable energy target be?
- Will the state reach its renewable energy target, and if so, with what mix of technologies?
- To what extent will renewable energy build-out require grid updates?

Scenario Development

Scenarios portray possible market conditions for renewables in future years. Information on cost reductions, policies, and markets is uncertain at best. Therefore, market potential results should be presented as scenarios, or possible future outcomes. This is also the case for other potential types, but because market studies have very specific and tangible results, there may be greater opportunity for misconceptions about their level of certainty.

Studies often characterize scenarios in terms of investment environment, comparing a base case, representing business as usual, with a case of accelerated development, caused by incentives, market conditions, and cost reductions. Alternatively, scenarios could be defined by the presence or absence of a market for greenhouse gas emissions mitigation. Many factors contribute to the quality of the investment environment, including commodity prices, consumer demand, greenhouse gas policy, government incentives, load growth, non-incentive regulation, transmission, and the difference in cost between renewable electricity and conventional electricity.

In the 2008 “Massachusetts Renewable Energy Potential” study, three theoretical scenarios were defined: Supported Development, Accelerated Development, and Market-based Development. The study commissioners, the Massachusetts Department of Energy Resources and the Massachusetts Technology Collaborative, developed sets of assumptions about the prices of natural gas, carbon, electricity, and RECs in the study period 2009 through 2020. The three scenarios also captured differences in the cost-competitiveness of renewables and availability of government incentives.

The Supported Development case estimates an unfavorable investment environment, offset by supportive government incentives and policies. The Market-based Development case assumes high economic returns to renewable energy development, tempered by minimal government incentive. The Accelerated Development case estimates favorable economics and high government incentives for renewables. As an example of the assumptions that need to be made to develop scenarios, the market and policy variables for this study are shown in Tables 2, 3, and 4. These assumptions were made strictly for this analysis and should not be used outside of the scenario framework.

Table 2. Massachusetts Supported Development Case

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Natural gas price ($/MMBtu)	12.80	11.28	9.18	8.04	8.23	8.33	8.78	9.23	9.99	10.65	11.14	11.37
Carbon Price ($/ton)	1.86	1.86	1.86	1.86	1.86	3.35	4.01	4.82	5.79	6.94	8.33	10.00
Wholesale Electricity Price (¢/kWh)	10.02	9.28	8.86	7.16	7.56	7.67	7.73	8.18	8.85	9.51	10.13	10.17
Retail Electricity Price (¢/kWh)	19.5	18.4	17.8	15.2	15.9	16.0	16.1	16.8	17.9	18.9	19.8	19.9
REC Price ($/MWh)	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68
PTC/REPI[a]	On	On	On	On	On	On	On	On	On	On	On	On

Table 3. Massachusetts Accelerated Development Case

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Natural gas price ($/MMBtu)	12.80	15.20	17.60	20.00	20.25	20.50	20.75	21.00	21.25	21.50	21.75	22.00
Carbon Price ($/ton)	1.86	6.24	10.61	14.39	19.37	23.74	28.12	32.49	36.87	41.25	45.62	50.00
Wholesale Electricity Price (¢/kWh)	10.60	12.81	15.02	17.22	17.67	18.12	18.56	19.01	19.45	19.90	20.34	20.79
Retail Electricity Price (¢/kWh)	20.4	23.6	26.7	29.5	30.1	30.7	31.2	31.8	32.4	32.9	33.5	34.0
REC Price ($/MWh)	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68	51.68
PTC/REPI	On	On	On	On	On	On	On	On	On	On	On	On

Table 4. Massachusetts Market-Based Development Case

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Natural gas price ($/MMBtu)	12.80	15.20	17.60	20.00	20.25	20.50	20.75	21.00	21.25	21.50	21.75	22.00
Carbon Price ($/ton)	1.86	6.24	10.61	14.39	19.37	23.74	28.12	32.49	36.87	41.25	45.62	50.00
Wholesale Electricity Price (¢/kWh)	10.60	12.81	15.02	17.22	17.67	18.12	18.56	19.01	19.45	19.90	20.34	20.79
Retail Electricity Price (¢/kWh)	20.4	23.6	26.7	29.5	30.1	30.7	31.2	31.8	32.4	32.9	33.5	34.0
REC Price ($/MWh)	51.68	49.96	48.23	46.51	44.79	43.07	41.34	39.62	37.9	36.18	32.73	31.01
PTC/REPI	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off

[a] Indicates the presence or absence of two federal incentives: the Production Tax Credit and the Renewable Energy Production Incentive program.

4 Goal-Oriented Studies

Of the market potential studies considered, many are focused on addressing the ability of a state to reach renewable energy goals. Specifically, these types of studies apply to renewable portfolio standard (RPS) policy development and planning. Because of its direct applicability to policy making, the goal-oriented study is considered in more depth and two case studies of goal-oriented studies are provided: the Western Governors' Association (WGA) 2005 market potential study[1] and the New Jersey Renewable Energy Market Assessment.

A possible benefit of this kind of analysis is that goal-oriented studies limit the number of assumptions needed. Goal setting reduces the uncertainty related to identifying market potential by imposing a target amount of market penetration, a time limitation, or both. Some goal-oriented studies set maximum limits for renewable penetration in the market. The associated analysis determines the least-cost resources and technologies for meeting that goal. Because the goal is for both an energy amount and a time, assumptions regarding technology development can be more targeted. For example, the WGA 2005 market potential study identifies least-cost solutions to reach a set capacity target.

Often, the feasibility of a goal or target is analyzed by setting a timeframe over which renewable development is analyzed. This type of study assesses different market and policy scenarios with respect to achieving a goal within a state context. Economic viability of various technologies is determined under these different scenarios, and supply curves are generated for each technology for the set time period. A limit for renewable penetration is not set, but rather the goal and its timeframe are used as benchmarks for evaluating different policy and market contexts. An example is the "New Jersey Renewable Energy Market Assessment" study, described in detail in below.

While these are significant benefits, there are two primary drawbacks to goal-oriented studies. First, goals, historically, have been set arbitrarily, and at best are educated policy "guesses" regarding economic and market actors. This can create an analytic environment in which goals that may not be realistic or economically feasible (even with market intervention) are analyzed and met. To minimize this effect, the results of initial analysis would inform the goal-setting policy process. Second, analyzing specifically toward goals with only cost as a decision factor for investors might not account for the all the benefits of renewable technologies. Incorporating monetary estimates of the benefits of renewable energy (e.g., impacts on carbon emissions, air quality, water, national security, price volatility for producers and consumers and/or economic growth) can minimize this problem, but is analytically challenging and may require deeper and more costly studies.

Case Study: Western Governors' Association's Clean and Diversified Energy Initiative Task Force Reports

In 2005, the WGA conducted a major goal-oriented study to assess the least-cost means for meeting a "clean energy" goal for the region. The study, which considered energy efficiency as well as a wide range of renewable energy resources, illustrates the power of goal-oriented studies to create an implementation plan for a larger market vision determined in a policy setting. It also

[1] Available at: http://www.westgov.org/

illustrates the importance of regional considerations and the possible importance of coordination between states. Conducting a wider regional analysis, may give a more accurate picture of how renewable energy market development might occur. Finally, regional studies may provide useful context and a coherent set of technical assumptions for state studies within the region.

The WGA brings together the governors of 19 states and the leadership of three U.S. Pacific islands to address policy issues specific to the West as well as promote the role of the West in the federal system. For 2005-2006, one focus of the association was to, "strengthen state and federal energy policy and systems." As a part of that focus, the WGA set a goal of increasing clean energy (renewable energy as well as advanced coal technologies) to a total of 30,000 megawatts (MW) in the region by 2015. A series of reports were developed by resource experts to determine if the goal could be met. In this set of studies, each resource type was given a portion of the goal and analysts studied the resource availability, the current economics for technologies to convert the resource to electricity, and the current market, to determine if the goal was attainable.

Table 5 summarizes the details of the individual resource studies, especially their base assumptions and general conclusions regarding the further potential for that resource. Both the figure and the table are high-level summaries of the detailed work of the WGA. For full details please refer to the reports.

Table 5. Summary of WGA Renewable Goal-Specific Analysis

Resource	Available Potential in 2015 (Report URL)
Biomass	10,000 MW at 8 ¢/kwh, (out of 15,000 MW of technical potential) (http://www.westgov.org/wga/initiatives/cdeac/Biomass-full.pdf)
Geothermal	5,600 MW (out of 13,000 MW of technical potential) (http://www.westgov.org/wga/initiatives/cdeac/Geothermal-full.pdf)
Solar	8,000 MW CSP and distributed PV, 2,000 MW solar hot water (http://www.westgov.org/wga/initiatives/cdeac/Solar-full.pdf)
Wind	5,000-9,125 MW without transmission additions 25,000 MW+ with transmission adjustments (http://www.westgov.org/wga/initiatives/cdeac/Wind-full.pdf)

Notes:

1. This is an overview table. Please refer to cited reports for detail.
2. Advanced coal technologies did not provide an estimate for their role in the WGA summary report.
3. Biomass for biofuels is not included in the WGA reports.
4. White Papers submitted to the Clean and Diversified Energy Committee indicate the potential for 43,000 MW of Combined Heat and Power based capacity as well as 20,000 MW of additional hydropower at existing sites.

Although not directly applicable to states, this regional study is useful to states both within and beyond the geographic study borders. The WGA study was compiled using the expertise of more than 250 analysts from a variety of different institutions. For states within the regional boundaries, this study provides a framework for individual states, including listings of data availability and general information regarding market barriers and technology economics in the region. The assumptions and methodologies, especially related to the technologies available for conversion of the resources to usable forms of electricity, may further apply to a broader state audience.

Another consideration for state policymakers when looking to the WGA reports is that the analysis is goal-based. The WGA asked the question, "Can the western states develop 30,000 MW of clean electricity by 2015?" The goal was broken down by resource and each analysis found that the resource could meet the goal. Almost all analytic outcomes found that additional capacity could be economically installed if advancing technology or additional technologies (e.g., hydroelectric, ocean power, and combined heat and power) were considered. States, especially those within the WGA study region, considering a renewable energy potential study should review the assumptions and methodologies used to develop those estimates, as well as the policy recommendations for meeting the goals as they develop state specific methodologies and assumptions for estimating renewable energy potential within their states.

Case Study: New Jersey Renewable Energy Market Assessment

In 2004, the New Jersey Board of Public Utilities commissioned Navigant Consulting to do a market potential study evaluating the state's ability to reach its RPS goals. Three targets are evaluated in the study: 300 MW of new Class I Renewables[2] by 2008, solar energy production of at least 120,000 megawatt-hours (MWh) per year in 2008 (equivalent to roughly 90 MW, the solar set aside in that year), and 20% of demand sourced from Class I Renewables in 2020.

To develop their market potential estimates, Navigant screened technologies according to their economic potential. Only those demonstrating substantial near-term market potential underwent a rigorous review by the project team. Those technologies were photovoltaics (PV), onshore wind, offshore wind, solid biomass combustion and gasification, landfill gas, and biogas from wastewater treatment.

Three market scenarios were created to evaluate the state's ability to reach the goals of 300 MW of Class I Renewables by 2008 and 20% demand reached through Class I Renewables by 2020. The scenarios embody a range of possible incentive levels: a Base Case, a Low Incentive and REC Price scenario, and a High Incentive and REC Price scenario. The scenarios are summarized in Table 6.

[2] Class I renewable energy is defined as electricity derived from solar energy, wind energy, wave or tidal action, geothermal energy, landfill gas, anaerobic digestion, fuel cells using renewable fuels, and—with written permission of the New Jersey Department of Environmental Protection—certain other forms of sustainable biomass (Database of State Incentives for Renewables & Efficiency 2009).

Table 6. New Jersey Market Potential Scenarios

Scenario	Production Tax Credit	Class I RPS Average market price for RECS	Class I RPS Average market price for solar RECS
Base Case	Extended through end of 2006 @ $18/MWh	$20/MWh	$150/MWh
Low Incentive and REC Price	Not extended	$6/MWh	$100/MWh
High Incentive and REC Price	Extended through end of 2006 @ $18/MWh	$45/MWh	$250/MWh

Market assumptions have a huge impact on the ability of a state to reach its renewable energy targets and/or reach its technical potential. For example, by 2020, the Base Case only resulted in 241 MW across all technologies and the Low Incentive and REC Price resulted in only 196 MW. However, the High Incentive and REC Price Case resulted in an estimated 2,660 MW of capacity by 2020. Another key uncertainty that makes the High Case significantly different from the other cases is the viability of offshore wind. In the High Case, offshore wind becomes economical earlier, and is a major contributor to total cumulative capacity installed.

Another key point is that scenarios can compare different incentive structures and their impact on market growth. The New Jersey study broke out the solar market, and evaluated how five solar incentive scenarios might help achieve a goal of 90 MW of customer-sited PV by 2008. The following five incentive scenarios were included:

5. Reference case with no state incentives, (does not meet goal)
6. Case with the 2004 rebate levels and Solar RECs (SRECs) at $100/MWh (meets goal)
7. Case with 50% of the 2004 rebate levels and SRECs at $100/MWh, (nearly meets goal)
8. Case with no state rebate, but SRECs at $250/MWh (does not meet goal)
9. Case with rebates that provide a constant net system cost of $2,500/kW for residential buyers and $2,400/kW for commercial buyers and SRECs at $100/MWh (meets goal).

This type of comparative analysis might help policymakers choose incentive levels and structures. Combining rigorous analysis of market penetration under different incentives with a market potential framework may be useful for other states to consider.

5 Conclusions

This paper defines the renewable energy potential study and describes its applicability to decision makers. Market potential studies can help meet three major policy objectives:

- Increase public understanding of renewable energy potential
- Establish appropriate goals for renewable energy market development and identify resources and technologies that will meet policy goals
- Estimate the potential for investment in renewable energy and develop appropriate incentives to encourage investment in renewable energy.

This analysis identifies important steps in the development of a market potential study. Comprehensive analysis, informed by background research and data collection, must be conducted to come up with estimates for resource, technical, and economic potential in order to inform a market potential estimate. Uncertainty can be managed and usefulness can be increased by properly framing the study, setting goals, or shortening the timeline for the analysis. Furthermore, scenario analysis within a market potential study increases applicability to policymakers. Detailed projections of electricity rates, REC market prices, carbon prices, incentives, and other variables can enhance the financial precision of the analysis. Detailed scenario analysis gives a comprehensive picture of different future investment environments, providing a more informative range for the market potential estimate.

Appendix A: Studies Analyzed

"Arizona Solar Electric Roadmap Study." January 2007. Prepared for the Arizona Department of Commerce, by Navigant Consulting, Inc. http://www.azcommerce.com/doclib/energy/az_solar_electric_roadmap_study_full_report.pdf

"New Jersey Renewable Energy Market Assessment." August 2004. Prepared for the New Jersey Board of Public Utilities (NJBPU) and Rutgers University Center for Energy, Economic and Environmental Policy (CEEEP), by Navigant Consulting, Inc., Sustainable Energy Advantage, and Boreal Renewable Energy Development. http://www.njcleanenergy.com/files/file/Final_Report.pdf

"Process Evaluation of the Renewable Energy Programs Administered and Managed by the New Jersey Board of Public Utilities." November 2004. Prepared for the NJBPU and CEEEP, By Aspen Systems Corporation. http://www.njcleanenergy.com/files/file/ExecutiveSummary.pdf

"Impacts of Environmental Externalities Upon Relative Costs of Renewable Technology & Impact of the Deployment of Renewable Generation on the Market Price of Electricity." Prepared for the NJBPU, by CEEEP. http://www.njcleanenergy.com/files/file/CEEEP_Impacts.pdf

"Analysis of a Renewable Portfolio Standard for the State of North Carolina" December 2006. Prepared for North Carolina Utilities Commission, by La Capra Associates, Inc.

Advance press release for the Florida market potential study. "Sun, wind energy potential high, but so is price." By Asjylyn Loder. 28 Nov 2008. Prepared for the Florida Public Service Commission, by Navigant Consulting, Inc.

"Massachusetts Renewable Energy Potential." August 2008. Prepared for Massachusetts Department of Energy Resources and Massachusetts Technology Collaborative, by Navigant Consulting.

"Massachusetts Renewable Portfolio Standard Cost Analysis Report." December 2000. Prepared for Massachusetts Department of Energy Resources, by La Capra Associates, Bob Grace, and Ryan Wiser.

"Massachusetts RPS: 2002 Cost Analysis Update - Sensitivity Analysis." December 2002. Prepared for Massachusetts Department of Energy Resources, by Bob Grace, La Capra Associates.

"A Study to Evaluate the Impacts of Increasing Wisconsin's Renewable Portfolio Standard: Methodology, Assumptions, Scenarios, and Results." October 2003. Prepared for the Wisconsin Division of Energy, by the Union of Concerned Scientists, Sustainable Energy Advantage, and La Capra Associates.

Western Governors' Association's Clean and Diversified Energy Initiative Task Force Reports. 2006. http://www.westgov.org/wga/initiatives/cdeac/cdeac-reports.htm#TaskForceReports

Appendix B: List of Data Resources

Note: This is a representative listing, and state studies should include data reviews of available state specific data.

Renewable Resource Data

NREL's GIS Team develops technology-specific GIS data for a variety of areas, as well as targeted analysis tools that can help determine availability of renewable energy resources.

GIS Datasets

Some datasets— in either high resolution or low resolution — are available for download through the GIS Web site (http://www.nrel.gov/gis/data_analysis.html). High-resolution datasets are available for specific states and technologies. Low-resolution datasets are available for Alaska, Hawaii, and the lower 48 states. These datasets are designed to be used in GIS software applications. High resolution wind datasets (at resolutions between 200 m and 1000 m cell sizes) are available for Alaska, Arkansas, California, Hawaii, Illinois, Indiana, Kansas, Kentucky, Michigan, Mid-Atlantic, Missouri, Nebraska, New England, North and South Dakota, Ohio, Oklahoma, Pacific Northwest, Puerto Rico and the Virgin Islands, and Southwest. These maps were developed by NREL and AWS TrueWind. For additional information, including state wind resource maps developed by other organizations, please visit http://www.windpoweringamerica.gov/

Dynamic Maps and Tools

United States Atlas of Renewable Resources: The Atlas is an interactive application of the renewable energy resources in the contiguous United States, Alaska and Hawaii. It illustrates the geographic distribution of wind, solar, geothermal, and biomass resources, as well as other pertinent information such as transportation network and administrative boundaries. Available at: http://www.nrel.gov/gis/maps.html

United States Solar Atlas: This map interface accesses monthly average PVWatts Version 2 - Dynamic Maps solar resource information for any given location in the United States. It also provides access to spreadsheets giving average monthly radiation for 14 different types of solar collectors. Data for individual collectors are also available for fixed, flat-plate (photovoltaic) collectors on five different orientations. Added features include a zoom tool, which allows the user to zoom to zip codes and latitude/longitude locations. Available at: http://www.nrel.gov/gis/solar.html

Solar Power Prospector Tool: This interactive Solar Power Prospector mapping tool allows users to examine, distribute, and analyze solar resource data for the United States and northern Mexico. It assists in making decisions about optimal locations for CSP plants. Users can explore temporal and spatial aspects of NREL's solar resource data and can download the resource data for use outside of the tool—for example, in the Solar Advisor Model (https://www.nrel.gov/analysis/sam/). Available at: http://mercator.nrel.gov/csp/

Bio-power Tool is an interactive geospatial application allowing users to view biomass resources, infrastructure, and other relevant information, as well as query the data and conduct initial screening analyses. Users can select a location on the map, quantify the biomass resources available within a user-defined radius, and then estimate the total thermal energy or power that could be generated by recovering a portion of that biomass. Available at: http://rpm.nrel.gov/biopower/biopower/launch

Virtual Hydropower Prospector (VHP): Idaho National Laboratory developed this GIS tool to assist decision makers in their assessment of natural streamwater energy resources in the United States. The result of an extensive study of hydropower resources in the United States, the VHP can be used at the state level. Available at: http://hydropower.inel.gov/prospector

Technology Data
NREL's Web site (http://www.nrel.gov/) provides up-to-date information on the most recent technologies for converting renewable energy to electricity and fuels.

Economic Information
State-level economic information is available through state economic offices, as well as the Federal Bureau of Economic Analysis (http://bea.gov/).

Market Information
The Department of Energy's Energy Information Agency and state energy offices are good sources for renewable energy market information and electricity market data, but detailed additional research on the local market barriers and opportunities to determine potential is probable.

General Energy Information
The Department of Energy's Energy Information Administration (http://eia.doe.gov) provides extensive historical energy information and projections for state-level energy use. The Web site also contains limited economic and population data.

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State-level policymakers are relying on estimates of the market potential for renewable energy resources as they set goals and develop policies to accelerate the development of these resources. Therefore, accuracy of such estimates should be understood and possibly improved to appropriately support these decisions. This document provides a framework and next steps for state officials who require estimates of renewable energy market potential. The report gives insight into how to conduct a market potential study, including what supporting data are needed and what types of assumptions need to be made. The report distinguishes between goal-oriented studies and other types of studies, and explains the benefits of each.

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