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The Role of State Policy in Renewable Energy Development

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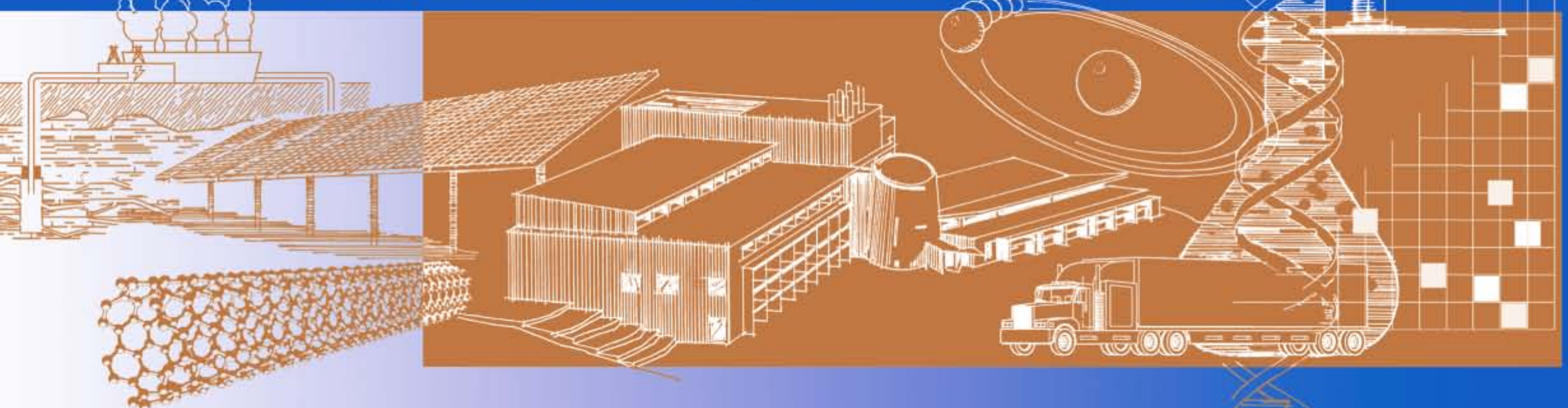

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THE ROLE OF STATE POLICY IN RENEWABLE ENERGY DEVELOPMENT

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ABSTRACT

State policies can support renewable energy development by driving markets, providing certainty in the investment market, and incorporating the external benefits of the technologies into cost/benefit calculations. Using statistical analyses and policy design best practices, this paper quantifies the impact of state-level policies on renewable energy development in order to better understand the role of policy on development and inform policy makers on the policy mechanisms that provide maximum benefit. The results include the identification of connections between state policies and renewable energy development, as well as a discussion placing state policy efforts in context with other factors that influence the development of renewable energy (e.g. federal policy, resource availability, technology cost, public acceptance).

INTRODUCTION

There are success stories of how policy has resulted in increased development in specific situations, as well as a field of literature on policy design practices. However, the generalization of lessons learned in specific cases and the application of design practices to inform effective policy design and implementation in other jurisdictions has not been accomplished. It is necessary to fill the gaps between case studies and a quantitative understanding of policy impact, as increased interest in renewable energy is resulting in a growing list of policies for promoting renewable energy. This research establishes the importance of quantitative understanding of generalized policy impact to inform state policy makers of the opportunities and limitations of policy in developing renewable energy resources.

Three primary elements form the results of this work: 1) understanding the current status of renewable electricity development at the state level; 2) identifying policies, and elements within policies, that lead to renewable energy development; and, 3) identifying and defining the broader contextual factors that influence renewable energy development in order to place the policy discussion within the broader context.

The paper begins with an overview of development trends at the state level. Those quantitative trends are then used in statistical analyses that aim to link policy implementation and actual development. The discussion then moves to contextual factors other than policy that affect renewable energy development, and concludes with the presentation of overall next steps for research to better understand the role of policy in renewable energy development and inform state policy makers on the impact of policies to promote renewable energy within individual state contexts.

QUANTITATIVE TRENDS IN RENEWABLE ENERGY DEVELOPMENT

This section summarizes the status of electrical generation from renewable resources in the United States Department of Energy's Energy Information Administration (EIA) state data from 2006. The goal of the review is to provide state policy makers with a variety of metrics to inform their understanding of current and historical clean energy market penetration in their state, relative to other states. Due to space limitations, only an overview of the complete analysis is given here.

The states were ranked in several ways to account for differences in resource availability amongst the states and to highlight various factors. Rankings were done for 2006 generation data based on generation (in MWh), generation from renewable resources as a percentage of total generation, generation per capita, and generation per gross state product (GSP). Furthermore, indication of the 'most improved' states are provided by ranking the states according to the change in capacity from 2001 to 2006, using the same catagories, i.e. generation (in MWh), generation from renewable resources as a percentage of total generation, generation per capita, and generation per GSP. To reflect resource differences among states and to address the challenges of understanding how states take advantage of available local resources, the rate of change in renewable generation is presented by individual resource, with the exception of solar, due to the insufficiency of data.

The metric used is percentage increase over time. The strength of this metric is that it lends more weight to growth in states reporting little or no renewable energy in the beginning year. While the actual improvements may be small in terms of actual capacity development, they represent large strides in the transition to a clean energy economy. In addition to other factors, the size and economic context of the state can be a large determinate of the level of renewable energy development. To begin to address the contextual differences between states in a quantitative way, state renewable energy generation is normalized for population and gross state product to address economic contexts of individual states.

The definition of renewable energy used here includes biomass, geothermal, hydroelectric, solar (central), and wind, as defined and tracked by the EIA. Also included are distributed solar capacity data as tracked by the Interstate Renewable Energy Council (Sherwood 2008).

2006 Renewable Energy Generation Trends

Table 1 displays the EIA-collected data for grid-connected renewable electricity generation for the top five states in 2006, in total megawatt hours (MWh). The dataset includes generation from biomass, geothermal electricity, non-distributed solar, and wind. Distributed solar data are not collected by EIA, so are not included in this table.[1]

Considering all renewable resources in the dataset, Washington ranks first with nearly 72 terawatt hours (TWh). Large-scale hydroelectric generation resources are more developed than most renewable resources and are removed from the dataset in **Table 2** to better illustrate the development of other renewable resources at the state level. When hydroelectric resources are not included, California becomes the highest ranked with 24 TWh, and generates more than three times the renewable generation of any other state. Nonhydroelectric renewable generation in Arizona, Missouri, Alaska, and Delaware was less than 100,000 MWh in 2006.

Table 1. Total On-Grid Renewable Energy Generation (2006)

Rank	State	MWh
1	Washington	84,510,138
2	California	71,937,993
3	Oregon	39,720,153
4	New York	29,951,143
5	Idaho	11,941,587

[1] Distributed solar capacity is tracked by IREC USA and those data are referenced later in this report.

Table 2. Total Non-hydroelectric Renewable Electricity Generation (2006)

Rank	State	MWh
1	California	23,890,613
2	Texas	7,833,733
3	Florida	4,372,475
4	Maine	3,974,084
5	Alabama	3,905,741

Percentage of Total Generation

Percentage of total in-state generation is a normalizing metric to add context to the state progress toward renewable-based electricity development. **Table 3** presents the renewable percentages including hydroelectric resources for the top 5 states, and **Table 4** presents percentages without hydroelectric. When hydroelectric is included, northwestern states generate more than three-quarters of in-state generation from renewable resources. Large-scale hydroelectric developments are the primary contributors to this generation. Removing large-scale hydroelectric from consideration – in order to focus on developing markets – no state produces more than 25% of electricity from renewable resources, and most states generate less than 5%.

Table 3. Percentage of Total State Electricity Generation: All Renewable Resources (2006)

Rank	State	% Total State Generation
1	Idaho	89.2%
2	Washington	78.1%
3	Oregon	74.5%
4	South Dakota	49.7%
5	Maine	49.1%

Table 4. Percentage of Total State Electricity Generation: Non-hydroelectric Renewable Resources (2006)

Rank	State	% Total State Generation
1	Maine	23.63%
2	California	11.02%
3	Vermont	6.35%
4	Minnesota	5.74%
5	Iowa	5.40%

Generation per Capita

Generation per capita is another normalizing metric to gain insight into trends. States with smaller populations and large renewable generation top this list. When all renewable resources are considered, hydroelectric resource use in the northwestern states launches Washington, Montana, and Oregon to more than 10 MWh of generation per person (**Table 5**). When those resources are removed, Maine has the highest generation per person at 3 MWh/capita, with the vast majority of states generating less than 1 MWh per capita (**Table 6**).

Table 5. Renewable Electricity Generation (2006): MWh/Capita

Rank	State	MWh/Capita
1	Washington	13.257
2	Montana	11.253
3	Oregon	10.761
4	Idaho	8.158
5	Maine	6.276

Table 6. Non-hydroelectric Renewable Electricity Generation (2006): MWh/Capita

Rank	State	MWh/Capita
1	Maine	3.022
2	Wyoming	1.480
3	Alabama	0.851
4	Iowa	0.826
5	Vermont	0.725

Generation per Gross State Product (GSP)

Normalizing for economic context provides further insights into renewable electricity generation. **Tables 7 and 8** normalize generation using gross state product (GSP), a traditional measure of state economic output. Similar to population analyses, states with relatively small output and high renewable generation will top this list. To rank higher, more economically productive states would need to generate a larger amount of renewable-based electricity.

Table 7. Renewable Generation per Gross State Product (MWh/$M, 2006 GSP)

Rank	State	MWH/$M
1	Montana	329.63
2	Washington	287.91
3	Oregon	262.52
4	Idaho	239.28
5	Maine	175.68

Table 8. Non-hydroelectric Renewable Generation per Gross State Product (MWh/$M, 2006 GSP)

Rank	State	MWH/$M
1	Maine	84.60
2	Wyoming	25.68
3	Alabama	24.32
4	Iowa	19.80
5	Vermont	18.58

Changes in Renewable Energy Generation Development by Resource (2006 and 2001-2006)

This section presents resource-specific renewable energy development at the state level, as well as changes between 2001 and 2006. All data, with the exception of solar, is presented from EIA data available in the 2006 Renewable Energy Annual (EIA 2008).

Attempting to rank state resource development while qualitatively normalizing resource availability factors, this section provides individual resource tables to identify states leading in specific resource development in 2006 as well as highlighting growth within recent years. This "most improved" ranking system intends to identify states that have excelled at individual resource development, but whose accomplishments may be overlooked when mixed in with all states and all resources. It is a way of identifying and recognizing state efforts in developing economically feasible in-state resources.

For each resource, a ranking was done for 2006 generation in MWh, as well as for "most improved" 2001-2006 for:

- Total Generation
- Percentage of Total In-State Generation
- Generation per Capita
- Generation per Gross State Product

Summary points resulting from this analysis follow:

Biomass

Biomass sources can be defined as agricultural crops and residues; dedicated energy crops (herbaceous and tree species); forestry products and residues; residues and byproducts from food, feed, fiber, wood, and materials processing plants [sawdust from sawmills, black liquor (a byproduct of paper making), cheese whey (a byproduct of cheese-making processes), and animal manure]; post-consumer residues and wastes, such as fats, greases, oils, construction and demolition wood debris and other urban wood waste, municipal solid wastes/wastewater, and landfill gases (Milbrandt 2008). The EIA definition includes landfill gas/MSW biogenic, wood, and derived fuels (2003a, 2008).

California generated the most biomass-based electricity in 2006, followed by Florida, Maine, Alabama and Georgia. In total, 19 states produced more than 1 million MWh from biomass-based electricity. Generation was not reported or reported as zero for eight states and all of the territories. Recent developments of biomass-based electricity are occurring in the central and southern United States, where there is a wealth of resource (Milbrandt 2005).

Kentucky has experienced the largest increase in total electric generation from biomass during the period studied, followed by Nebraska and South Carolina. All other states with documented generation from biomass sources increased generation by less than 100% or demonstrated negative growth during this period. Kentucky also experienced a substantially larger increase in percent of biomass-based electricity used than any other state between 2001-2006. Nineteen of the 44 states showed positive improvements for this metric.

Kentucky increased biomass generation per capita by a factor of 56.5, an unprecedented rate. Twenty states experienced an increase in per capita electricity generation from biomass sources, while twenty-three states experienced a decrease. Kentucky also leads the states in the generation per gross state product (GSP), with six other states also making positive improvements during the period.

Hydroelectric

The northwestern states of Washington, California, Oregon produced the most conventional hydroelectricity in 2006. The northeastern states of Massachusetts, New Jersey and Connecticut experienced the most growth in hydroelectricity from 2001 to 2006, although the mature status of the market results in fewer large growth states. Northeastern states may also rank high on the growth list because of relatively small market penetration in 2001 as compared to 2006. Northwestern state generation also increased in this time period, possibly as a result of efficiency gains in generation or expansion of facilities. In general, hydroelectric generation increases kept pace with population growth. In some states, however, economic growth outstripped hydroelectric production increases during the five-year period.

Geothermal

Data collection on geothermal is limited to large-scale generation in this dataset, and therefore there is no direct geothermal included. According to the EIA data, only four states generated electricity from geothermal resources during the study period (**Table 19**).

Table 19. Geothermal Generation (2006)

Rank	State	MWh
1	California	12,821,434
2	Nevada	1,343,711
3	Hawaii	212,276
4	Utah	190,608

This is not a comprehensive list of states with resources, but the only states with reported generation. Of these, Utah experienced the greatest increase in generation during the period, with nearly 25% more MWh generated in 2006 than in 2001.

Only Nevada and Utah made positive gains in increasing the percentage of in-state generation from geothermal sources during these five years. Utah experienced the largest increase in generation per capita, while Hawaii and Nevada saw decreases. All four states experienced a decrease in geothermal electricity generation per GSP during the 2001 to 2006 period, indicating that economic growth outstripped geothermal electricity production increases during these five years.

Distributed Solar

EIA does not report data on capacity from distributed solar electricity production, primarily photovoltaics (PV). However, data was drawn from recent literature providing on- and off-grid capacity installation estimates by state for 2007 (Sherwood 2008).

California is the leading state for PV capacity installations (328.8 MWdc), with six times the capacity than subsequent states of New Jersey (43.6 MWdc), Arizona (18.9 MWdc), Nevada (18.8 MWdc), New York (15.4 MWdc), and Colorado (14.6 MWdc) follow in installed capacity. All but six states have less than 5 MW installed.

Wind

Renewable electricity generation from wind has increased dramatically between 2001 and 2006, as a result of market and policy changes, as well as technology development, availability, and increasing volatility in traditional fossil markets. In addition to expansion of generation in states, 11 states that had no wind-based generation in 2001 had developed generation by 2006[2].

Texas, California, Iowa and Minnesota rank highest in terms of reported wind generation in 2006. Considering percent change, South Dakota and Nebraska experienced the largest increase in total generation between 2001-2006, while Vermont and Alaska were the only two states experiencing a decrease in wind generation during this period. Twenty-three states increased the portion of total in-state electricity generated by wind during the period. Of these, South Dakota shows the most improvement with an increase of more than 170-fold.

Of the 23 states that increased wind generation per capita, South Dakota and Nebraska experienced substantially larger increases than all other states. Two states, Vermont and Alaska, experienced a decrease in wind generation per capita. Twenty-three states increased generation per capita between 2001-2006, with South Dakota experiencing the largest increase, at more than 12,000%. Per capita wind generation in both Vermont and Alaska decreased during the period.

Summary of Trends

The following trends in renewable resource-based electricity development were observed:

- Hydroelectric resources provided the largest portion of renewable energy development in the United States in 2006. However, the share of hydroelectric is shrinking due to growth in development of other renewable energy resources and maximization of the larger-scale hydroelectric resources.
- Between 2001 and 2006, wind resource represents the largest growth in renewable generation nationwide.

[2] There are three states (Idaho, Montana, and New Jersey) in which wind generation reporting began in 2006. The improvements and successes of these states should not be ignored; but, because there is no base-year generation with which to compare the 2006 data, they are not considered in the "most improved" analysis. However, they are likely to be most improved in later-year datasets.

- Growth in electricity from biomass is primarily occurring in the southeastern areas of the United States, coincident with resource availability.
- Renewable energy growth during this period was generally outstripped by population growth and economic growth as measured by gross state product (GSP).
- According to EIA data, between 2001 and 2006:
    - 24 states increased electricity generation from biomass resources,
    - 23 states from wind electricity production,
    - 4 states from geothermal electricity production, and
    - 2 states from large-scale solar electricity production.

Data and method limitations in identifying trends:

- In general, the EIA dataset is considered the most comprehensive source for electricity generation information in the United States and it is the primary source for trends information in this report (with noted exceptions). There are a number of challenges in collecting renewable electricity generation at the state level, but those are not the focus here. Instead, the strength of the dataset as a nationwide comparable source regarding definitions and data collection techniques are the reasons for its use.
- Data for distributed solar electricity resource development are limited by lack of collection by EIA. (Solar PV data are the only presented in this report that are not from the EIA. Data presented are installed capacity for 2007, collected by the Interstate Renewable Energy Council using established methodologies described in Sherwood 2008).
- Data on renewable-based electricity generation in the U.S. territories is limited. EIA data were supplemented with direct contact to territory energy offices, but the authors received no additional data.
- Most recent data are from 2006. Significant market changes between 2006 and 2008 are expected to have an impact on renewable energy generation and will be reported in later versions of NREL's State of the States report.
- "Most Improved" rankings provide information on the largest growth rates between 2001 and 2006, leading to heavier weighting of states that began the development of the particular renewable resource in that time frame. The purpose is to acknowledge the challenge of early-stage development. The analysts are considering alternative and additional methods for future reports.

THE ROLE OF POLICY IN RENEWABLE ENERGY DEVELOPMENT: STATISTICAL ANALYSES

The variation in the relative importance of the factors leading to renewable energy development makes identifying generally effective policy mechanisms at the state level challenging. The value of using quantitative methods to explore the role of polices in development is that of supporting maximum impact of government intervention for development of renewable energy. The information in this section is a high-level statistical analysis to aid the understanding of the connection between policy and renewable energy development.

Several steps were taken to refine the data before conducting the analyses. First, policies that impact renewable energy were identified and defined (i.e. tax incentives, equipment certification, green power purchasing, portfolio standards, etc.). Next, best practices in policy design were identified and their applicability to this study defined. Most state policies were considered in the analyses simply if they were being implemented. However interconnection and net-metering policies, can be designed in a way that discourages renewable energy growth; thus only those that receive a ranking of C or better according to the Network for New Energy Choices definition (NNEC, 2008) are considered in this analysis.

The list of policies considered is drawn from the Database of State Incentives for Renewables and Efficiency (DSIRE 2008), and definitions are compiled from the DSIRE database and select other resources.

Several sets of statistical analyses were conducted to identify relationships between the implementation of policy and actual development. The first set identifies correlations between the individual policies designed to support renewable energy development and the development trends presented in the previous sections of this paper.

A statistical T-test is used, which compares the means of renewable energy generation (or capacity, etc.) for states that have a particular policy or set of policies implemented, and states that do not. The output of the test shows whether the difference in the means is statistically significant at a specified level (.05 or 0.1 level) of analysis. If the means are significantly different, then the null hypothesis - that the implementation of a policy and the actual generation of renewable energy are not related - may be rejected. The output also provides a "t-value" which indicates how confidently you can reject the null hypothesis.

The second set of analyses compares the same development trends with combinations of policies categorized using the tenants of market transformation theory. Market transformation studies the effects of policy and other integrated factors in transforming markets. It is typically discussed in relation to energy efficiency technologies, however it provides useful insight into the role of policy in transforming other markets. Market transformation focuses on creating a sustainable market place using low cost policies that (1) restructure the market by removing barriers or (2) make technologies more accessible (through, for example, financial incentives that can eventually be withdrawn).

To prepare for the second set of analyses, renewable energy policies were categorized as either market preparation (barrier reduction) policies or as policies that improve the accessibility of technologies. The categorization is shown in Table 20, below.

Table 20. Categorization of Policies According to Tenants of Market Transformation

Market Preparation (Barrier Reduction) Policies	
Contractor Licensing	Line Extension Analysis
Equipment Certification	Net Metering
Generation Disclosure	Public Benefit Fund w/RE
Interconnection	Renewable Portfolio Standard
Land Access	Voluntary/Mandatory Green Power
Technology Accessibility Policies	
Corporate Tax Incentives	Property Tax Incentives
Grants	Rebates
Loans	RE Production Incentives
Personal Tax Incentives	Sales Tax Incentives

Correlation analysis is used to indicate whether an increase in the number of policies of a specified type is related to an increase in actual generation. Thus, this analysis indicates whether there is a significant correlation between increased levels of renewable energy generation and 1) the implementation of market preparation policies as group, 2) the implementation of market transformation policies as a group, and/or the total number of policies implemented.

The third set of analyses combines policies into portfolios, based on identified policy best practices and understandings of policy interactions from the literature. The goal is to investigate the effectiveness of particular combinations of policies that are theorized to complement each other to result in more effective policy solutions[3]. The policy portfolios investigated are:

Portfolio 1: RPS + line extension analysis + interconnection standards + green power purchasing

Portfolio 2: Tax incentives + line extension analysis + interconnection standards

Statistical Analyses Results

Before discussing the results of the analyses, it is important to note that causation between policy and generation cannot be assumed. In other words, the results of these analyses do not necessarily prove that the policies were the direct cause of increased renewable energy generation. The statistical analyses only show that states that have implemented certain policies or groups of policies have significantly more renewable energy generation than those that have not implemented those policies.

The results of the first set of analyses indicate significant relationships between the implementation of some individual state policies and the level of in-state renewable energy-based electricity generation.

Higher total renewable energy generation is significantly related to the implementation of the following individual policies:

- RPS
- Production incentive
- Generation disclosure
- Interconnection
- Land Access

The results of the second set of analyses indicate a significant correlation between states implementing market preparation (barrier reduction) policies and high levels of renewable energy development (for both non-hydro renewable generation and total renewable energy generation). A significant correlation was also found between the implementation of high numbers of total policies from both categories and high levels of development. However, no correlation was found between the implementation of only technology accessibility policies and high levels of development.

These results illustrate the importance of implementing market preparation/barrier reduction policies. They suggest that incentive policies (technology accessibility policies) alone do not lead to significant renewable energy development, and that they must be combined with barrier-reduction policies in order to make a significant difference in the development of renewable energy.

The findings of the third set of analyses indicate that the concept of policy portfolios warrants more research. No relationship was found for the combination of policies defined in portfolio 2 (tax incentives, line extension analysis, and interconnection). However, T-test analyses indicate that *the combination of policies defined in Portfolio 1 (RPS, line extension, interconnection and green power purchases policies) is significantly related to higher levels of non-hydroelectric renewable energy generation.*

It is interesting to note that the relationship between this combination of policies and the level of generation is stronger than for the individual policies on their own, and that the

[3] See Hurlbut, 2008 and Cory, et. al, 2009. More information about the background research and understandings that lead to the selection of these portfolios will be provided in NREL's upcoming State of the States 2009 report. The identification of effective portfolios is a topic of on-going NREL research.

relationship is specifically with non-hydroelectric renewable generation, rather than all renewable fuel types. This supports the theory that the policies defined in Portfolio 1 are an effective combination of policies to support the development of non-hydro renewable energy.

Table 21 provides the statistical values for the results reported here.

Table 21. Results from the Statistical Analyses: The Relationship between Policy and Development

Independent Variable	Dependent Variable	T Value	P Value
Individual Policy Analysis			
RPS	Total RE generation	-1.89	0.07
Production Incentive	Total RE generation	-1.94	0.109
Generation disclosure	Total RE generation	-1.94	0.0758
Interconnection policies	Total RE generation	-2.03	0.0634
Land Access	Total RE generation	-0.87	0.0703
**Line extention analysis*	*Total RE generation*	*0.36*	*0.7175*
Market Transformation Correlation Analysis			
Independent Variable	**Dependent Variable**	**Coefficient**	**P Value**
Market Preparation (Barrier Reduction) Policies	Total RE generation	0.37802	0.0068
	Non-hydro RE generation	0.29729	0.036
**Technology Accessibility Policies*	*Total RE generation*	*0.20434*	*0.1546*
All Policies	Total RE generation	0.3425	0.0149
	Non-hydro RE generation	0.27501	0.0533
Portfolio Analysis			
Independent Variable	**Dependent Variable**	**T Value**	**P Value**
Portfolio 1: RPS + Line extention analysis + Green Power Purchasing + Interconnection	Non-Hydroelectric RE generation	2.28	0.0633
**Portfolio 2: Grants + Loans + 3 of 4 tax incentives*	*Total RE generation*	*-1.22*	*0.2274*

** Not statistically significant*

FACTORS INFLUENCING RENEWABLE ENERGY DEVELOPMENT

The generation trends discussed in the initial section of this paper result from a variety of interwoven factors that influence renewable energy development. The primary focus of this study is the role of policy in renewable energy development at the state level (described above). Because the benefits of renewable energy are primarily a public good, policy can be a major driver for development of resources (e.g., DOE 2008, Bezdek 2007, McLaren Loring 2006). However, the importance of other drivers, and their interactions with policy, cannot be overlooked. What follows is a list of contextual factors that also influence renewable energy development. As made evident in their descriptions, many of the issues overlap and intertwine.

- **Resource availability.** One of the most obvious influencing factors affecting renewable energy development is resource availability. If a physical resource is not available, development cannot progress. In the case of renewable resources, however, a more relevant question is that of the economic feasibility of tapping the resource. States that import electricity or the fuels to produce electricity, as well as states that have high electricity costs, may have more incentive to develop the local renewable resources. This factor is inexorably linked to the issues of technology availability and cost.
- **Technology cost.** Even in areas of excellent resource, technology price can be the limiting factor in development. As resource availability decreases, the cost of developing incremental units of a technology becomes more expensive, even if technology cost remains constant. This is the link between resource availability and technology cost. Policies can bring down costs through incentives or by encouraging research and development. Cost of renewable technologies, as well as those they compete with in also linked to the broader economic context. [4]
- **Economic context.** The broader economic context may influence the development of renewable energy in several ways. High costs of traditional generation may make the economics of renewable energy more favorable (e.g., DOE 2008 and Bezdek 2007). States with higher gross state products may choose to direct more funds to clean energy development, even when issues such as the high cost of importing fossil fuels or electricity is not a driving factor. The ability to pay for clean energy is tied to the willingness to pay, which is an issue of social acceptance of the technologies.
- **Social acceptance/opposition.** The level of public support can greatly influence renewable energy development. It has been demonstrated that organized opposition efforts with strong leadership can seriously hinder renewable energy development. Opposition may focus around issues such as aesthetics, effects on wildlife, or land and water use. Early involvement of relevant stakeholders and attention to a

[4] In the solar industry, concern surrounding silicon (a key element in module production) shortages drove market prices up in the early years of the century (Gartner 2005). Wind technology suffered similar price increases in 2006, with demand for wind as well as competing steel (a key element in tower construction) leading to turbine shortages drove prices higher and reduced development (DOE 2007).

democratic decision making process can ease public concerns around renewable energy projects (McLaren Loring 2006). The leadership of an influential champion who identifies mutually beneficial opportunities and rallies public support is also valuable (EST 2006, McLaren Loring 2006).

- **Ownership structure.** The ownership structure of proposed projects can affect whether owners are able to obtain necessary financing and take advantage of incentives. The ownership structure may even affect the acceptability of the project in the public view; locally owned and community-owned projects may be more favorably received (McLaren Loring 2006).
- **Financing.** The design and availability of financing mechanisms can great affect renewable energy project development. There are several common barriers to obtaining financing for renewable energy projects. Financing institutions may view new or rapidly developing technologies as overly risky; project developers may be new in the market and, thus, have little credit worthiness; and financing fees and administrative procedures may be prohibitive to small developers. Policy measures can address these barriers and make financing available to a broader spectrum of projects representing a variety of ownership structures (UNEP 2008, Goldman 2007).

Given that many of the above contextual factors are interrelated and site specific, it is difficult to determine their relative impact on the development of renewable energy. The presence or absence of one factor can intensify or nullify the importance of other factors. In addition, the interactions involve continuous feedback mechanisms. Making changes in one factor generally impacts other factors. For example, lowering technology costs through research may change the economic viability of tapping the resource; or public opposition to projects may be lessened if financing mechanisms encourage community ownership schemes.

Quantifying the impacts of the various factors is challenging, and there are limits to the value of generalizing. The value of quantification is in developing a better understanding the costs and benefits of policies and informing policy makers regarding the potential impact of policies. The renewable energy market is rapidly expanding (DOE 2008), and state policy makers are working to implement policies with quantifiable impacts. Without understanding the role of policy in development at the state level (and possibly the site level), the impact of policies cannot be accurately projected.

Concluding that the complications of quantifying the interaction of these contextual factors are too challenging to overcome denies policy makers a potentially valuable level of understanding of the influences on development. While the uncertainties should not be oversimplified, understanding the roles in different contexts contributes to effective policy design.

OVERVIEW OF RESULTS AND NEXT STEPS

The results of this report show that there is a quantifiable connection between state-level policy and renewable energy development. The connection is made more complex by the contextual factors within which policies are set, including resource availability, technology cost, economic context, public acceptance, and ownership and financing structures.

The following observations of this research suggest many areas of future research that would aid in the a better understanding of the role of state policy in renewable energy development – those suggestions conclude each of the observations.

- *There is a quantified connection between policy and renewable energy development.* Understanding the details of the connection to better inform policy development at the state level is the primary next step.
- *In addition to policy, there are many other factors driving the development of renewable energy resources at the state level.* Better understanding the role of each of these factors, and the way they are manifested in specific states, will provide insight and understanding into the development of renewable energy resources. Continued investigation of the various factors influencing renewable energy development will be included in forthcoming reports.
- *Research on policy best practices is currently design-based, not results-based.* Further investigation into policy outcomes and better understanding of policy design elements that are applicable across state contextual factors are critical to informing the development of state policies that are more effective in increasing renewable energy. In addition, methodologies to better understand the connection between policy design and differences in overall impact are being developed. Results-based policy design and policy portfolios will be addressed in forthcoming research.

Follow-on research will refine and expand this study to provide further understanding of the:

- current state of renewable energy development;
- impacts of policy on recent development;
- impacts of contextual factors affecting renewable energy development;
- impacts of individual policies and policy portfolios;

The DOE-funded, NREL-implemented State Clean Energy Policies Analysis (SCEPA) project, as well as future versions of this report, will build on and develop next steps. The project teams appreciate input and participation by stakeholders. More information can be found on the SCEPA website: http://www.nrel.gov/applying_technologies/scepa.html.

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State policies can support renewable energy development by driving markets, providing certainty in the investment market, and incorporating the external benefits of the technologies into cost/benefit calculations. Using statistical analyses and policy design best practices, this paper quantifies the impact of state-level policies on renewable energy development in order to better understand the role of policy on development and inform policy makers on the policy mechanisms that provide maximum benefit. The results include the identification of connections between state policies and renewable energy development, as well as a discussion placing state policy efforts in context with other factors that influence the development of renewable energy (e.g. federal policy, resource availability, technology cost, public acceptance).

15. SUBJECT TERMS

state policy; renewable energy; RE investment; RE markets; policy makers; federal policy; RE technologies; resource availability; policy design; renewable portfolio standard; RPS

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