Texas' Clean Energy Economy

Where We Are. Where We're Going. What We Need to Succeed.

A REPORT FOR THE CYNTHIA AND GEORGE MITCHELL FOUNDATION

BILLY HAMILTON CONSULTING

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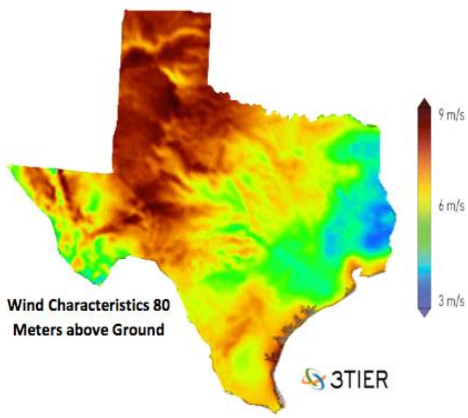
Executive summary

As we enter the second decade of the 21st century, Texas has an opportunity to lead the nation in shaping the new energy economy. Drawing on our history as the global leader in the energy industry, Texas has enormous technical, financial and educational expertise in energy exploration and production. We have an opportunity to harness our state's expertise and our can-do attitude to ensure that we emerge as the leading clean energy economy in the United States and the world.

Texas Wind Potential



Source: United States Department of Energy and 3TIER, Inc.

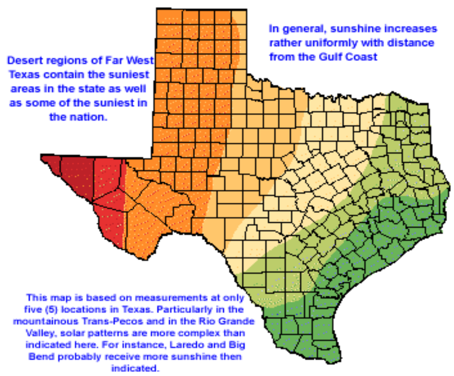
Texas, with her windswept prairies, breezy coast, tall pines and sunny skies, is blessed with an ideal climate and terrain for generating electricity from the wind, sun and plants. Thanks to forward-looking policies enacted over the last ten years, Texas already leads the nation in wind generation, producing 2.6 million Megawatt hours (MWh) in April 2010 alone, enough to power 2.3 million homes for a month. In 2009, nearly a third of all wind power in the U.S. came from Texas.

Just as Texas has continued to lead the traditional energy industry by constantly innovating and adapting to changing demands, our state now has the opportunity to increase our economic gains by supporting an expanded, diversified clean energy sector. In the coming years, Texas will compete head-to-head with other states and countries to manufacture, install and maintain more wind power and other large-scale sources of clean energy such as solar and biomass. The good news, as demonstrated by the findings in this report, is that with minimal investment clean energy can become an even greater economic engine for Texas, creating jobs and prosperity for our state.

The Pew Charitable Trust has found that clean energy investment worldwide will top $200 billion this year, and it seems clear that this is a growing industry that carries with it not only the promise of new sources of energy, but also of jobs and investment. However, to maximize the economic benefits that the clean energy economy can bring to Texas, we will need to institute coherent long-term state policies that support and encourage this sector of our energy economy.

This report examines the factors that affect our state's energy economy – rising demand for electricity, continued volatility in global energy markets, declining costs for clean energy sources such as wind, solar and biomass, the possibility of a regulatory price on carbon emissions, competition with other states and the concerns of average Texans over their electric bills -- and presents three possible scenarios for our state's clean energy economy over the next decade. With state policies that incentivize the development of a diversified clean energy economy, as Texas has done in the past to promote high technology, bio-medical research and other cutting edge industries, we can build a strong clean energy sector and maintain our leadership in the race for a new energy economy.

Texas Solar Potential



Source: Texas State Energy Conservation Office

Texas, along with numerous other states and countries, stands at a critical juncture. Texas used state policy to jumpstart our wind industry, and over the last decade our state went from having virtually no clean energy to being the national leader in that sector. Continued innovation is the key to maintaining our leadership. Over the next few years, some states and countries will institute policies that offer the right business climate, tax structure, workforce, and quality of life to develop a clean energy industry. Clean energy jobs, including manufacturing, will flow to the largest markets that present the best business environment for success, and significant research and workforce training dollars traditionally follow. This report is designed to help Texans decide how to compete and win in the race for those benefits.

Benefits of a Clean Energy Economy

The Texas Clean Energy Economy: Where we are. Where we're going. What we need to succeed. is sponsored by The Cynthia and George Mitchell Foundation as part of their ongoing effort to spur the development of clean energy markets in Texas and meet the state's energy needs while reducing pollution and growing the economy.

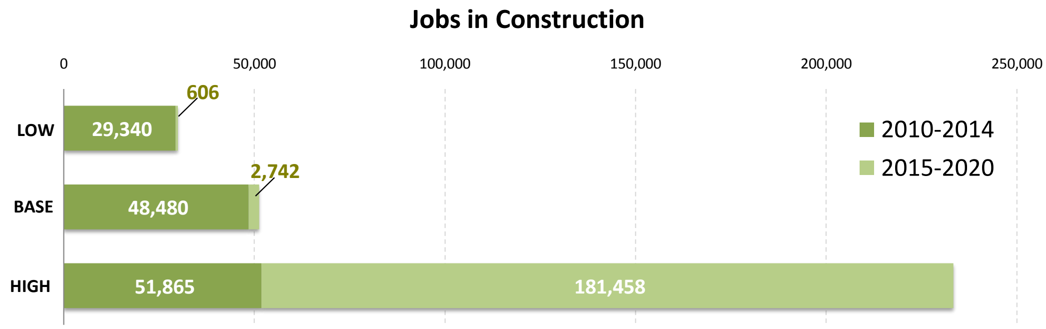
The study explains how state policies that support growing the clean energy sector of our state's economy can provide our citizens with economic opportunities that create jobs, increase our gross state product (GSP) and increase local and state tax revenue. The study analyzes three scenarios – a Low Range estimate, a Baseline and a High Range.

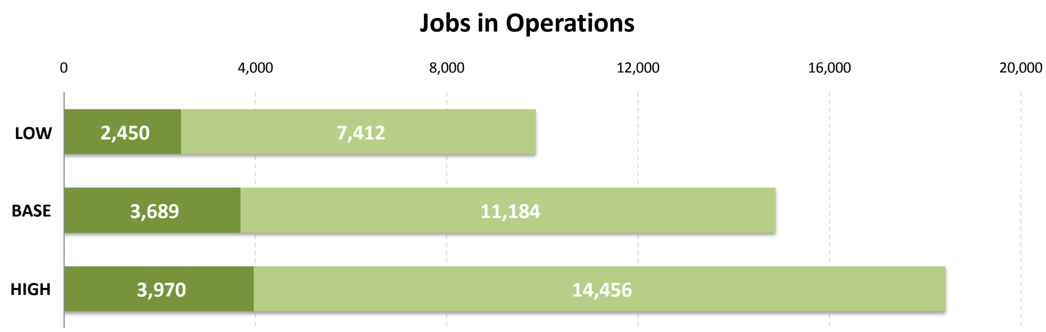
The Low Range scenario is based on Texas' share of U.S. renewable electric generating capacity at its low point of 2.2 percent in 2004. This scenario would apply if Texas chooses not to innovate and clean energy development in Texas lags compared to more sustained policy commitments by other states and countries. While the clean energy sector would continue to be a steady source of job creation and economic growth, it would not thrive as in the other scenarios.

The Baseline scenario is based on Texas' 8.6 percent share of U.S. renewable electric generating capacity in 2009. Assuming that Texas would invest enough to maintain its share of U.S. clean energy capacity through 2020, Texas employment in the clean energy sector would increase by 6,000 jobs per year from 2010 to 2020, for a total of more than 51,000 construction jobs and nearly 15,000 operations jobs for the decade. Texas gross state product (GSP) would increase by $802 million annually, while state and local governments would gain an additional $177 million per year in new tax revenues, or more than $350 million per biennium. These are strong economic benefits for Texans, but we can do more with coherent state clean energy policies.

The High Range scenario is based on Texas's 29.7 percent share of the increase in U.S. renewable electric generation capacity during the state's wind power expansion from 2004 to 2009, plus an expanded Renewable Portfolio Standard (RPS) of 13,000 MW of renewable-based power and a set-aside for 3,500 MW of solar photovoltaic (PV) energy. If the state chooses to support the clean energy sector at this level, the economic benefits would be spectacular. If the 2011 Texas Legislature decides to raise the state's RPS to 13,000 MW of clean power and sets aside 3,500 MW for solar photovoltaic energy, as the High Range scenario assumes, the state's economic gains would be exponentially greater than the Baseline scenario. Job gains would jump to 22,900 per year; Texas GSP would increase by $2.7 billion per year. State and local tax revenues would increase by $279 million per year, or more than half a billion dollars per biennium.

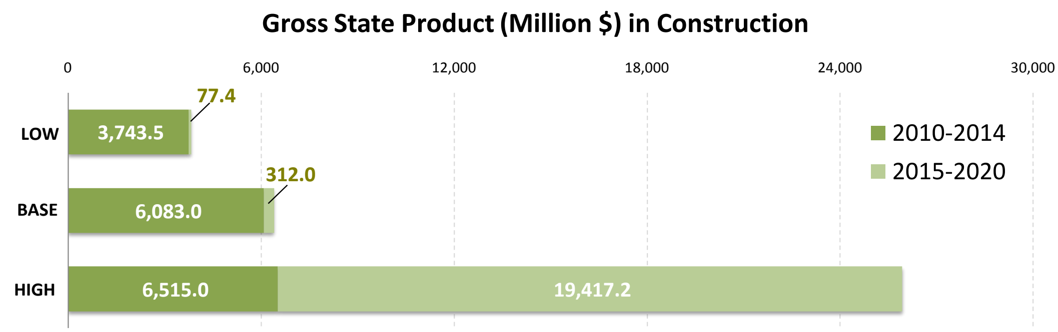
Economic Benefits of Expanded Clean Energy Development – Job Creation

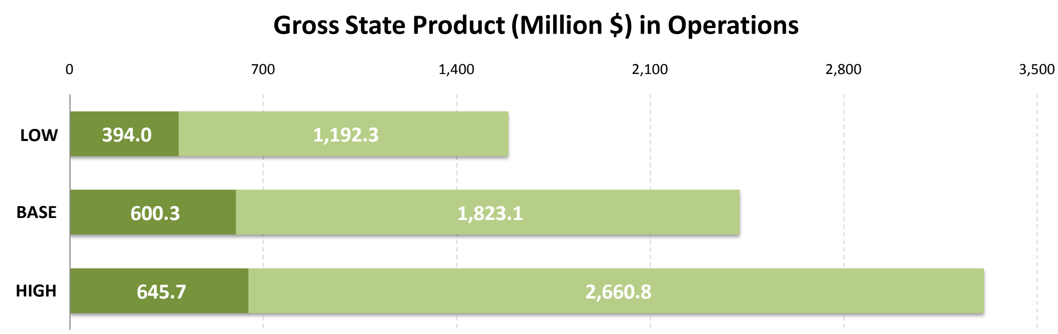




Source: Billy Hamilton Consulting

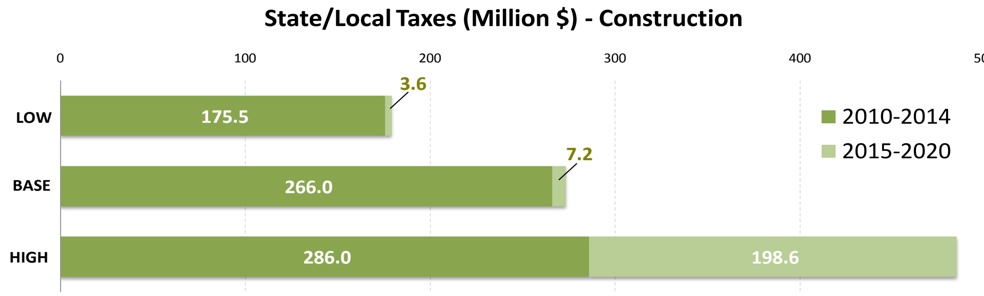
Economic Benefits of Expanded Clean Energy Development – GSP Increase

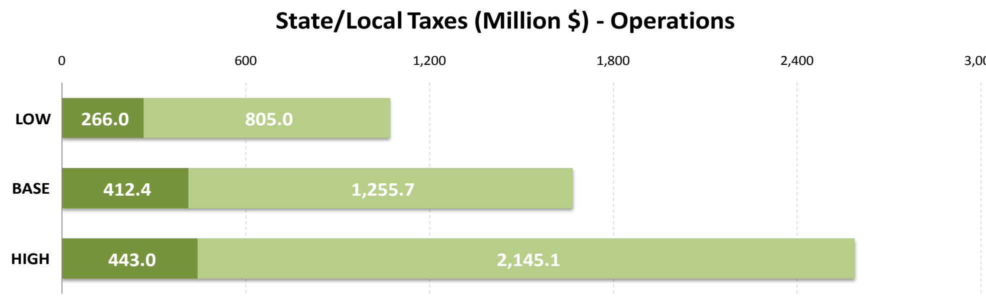




Source: Billy Hamilton Consulting

Economic Benefits of Expanded Clean Energy Development – Tax Revenue





Source: Billy Hamilton Consulting

These job creation numbers, if achieved, would contribute up to 25 percent of all new jobs in Texas over the next decade. The High Range scenario (achievable with an RPS of 13,000 MW and a 3,500 MW set-aside for solar) would create an average of 22,900 jobs per year for the next decade. Based on Texas Workforce Commission data on new job creation in Texas over the past decade, the High Range would contribute 18% of all new jobs created in Texas. When compared to other estimates of job growth in Texas such as the U.S. Bureau of Labor Statistics, the High Range scenario would contribute between 15 and 25 percent of the average annual number of new jobs in Texas.

Another benefit of the clean energy economy is that rural Texas would see important gains in jobs, prosperity and tax revenue. Indeed, the job gains resulting from this sort of investment make it an ideal economic development policy for Texas' small towns and rural counties.

The economic development findings of this report, significant as they are, understate the promise that an expanded, diversified clean energy economy holds for Texas. For example, the report's three scenarios do not include the very real possibility of a regulatory price on carbon emissions. Likewise, the report does not attempt to quantify the likely significant increase in manufacturing jobs in Texas related to expanded investment in clean energy.

With its 10 million households, if the state of Texas were to adopt innovative state energy policies in addition to the existing human and natural capital of Texas, our state would be the logical destination for new clean energy manufacturing facilities. As in other industries, clean energy manufacturers will likely gravitate to the largest markets where state policies encourage the growth and success of the industry. Investments in research and workforce development traditionally seek out the same markets. For all these reasons, the economic contributions of the clean energy sector to the Texas economy would likely significantly exceed the High Range scenario projections.

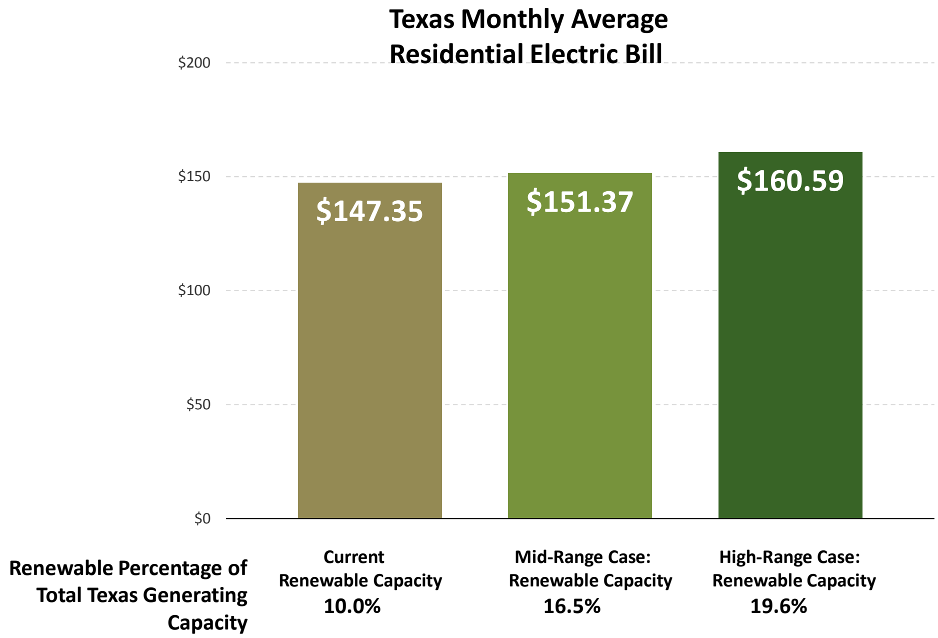
Small Investment, Big Rewards

A central finding of the report is that a minimal investment in clean energy development – about the price of a single postage stamp per day for the average family – will allow Texans to claim the benefits forecast in the High Range scenario described above.

Under the High-Range scenario, the state's clean energy generating capacity would increase nearly 20 percent, in addition to the tremendous job gains, growth in state productivity and increased tax revenues discussed above. The cost to average Texans under the High-Range scenario would be an increase in their electric bills of about one cent per kilowatt hour – just over $13 a month, almost exactly equal to the cost of one postage stamp a day.

For an even smaller investment, the Baseline scenario – which would cost the average residential consumer less than four-tenths of a cent per kilowatt hour, or about $4 a month by 2020 – would increase the state's clean energy generating capacity to 15 percent. As discussed above and in the report, this moderate scenario would create 6,000 new jobs per year and generate gains in state productivity as well as increased state and local tax revenues.

Minimal Impact of Increased Clean Energy on Texans' Monthly Electric Bill



Source: Billy Hamilton Consulting: U.S. Department of Energy, Energy Information Administration, Electric Power Annual 2008 and Annual Energy Outlook 2010 Appendices

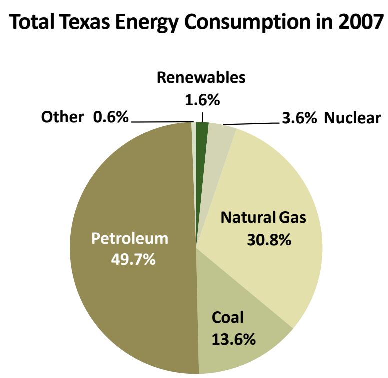
For most Texans, these incremental changes of a few cents per day would be an attractive investment to reap the job creation and other returns that the clean energy economy can create over the next decade and beyond. However, the report acknowledges that these investments, while small, could impose a financial burden on low-income Texans, the elderly and the disabled. The report notes that numerous public policies, such as the System Benefit Fund administered by the Public Utility Commission, provide assistance for these Texans. Currently the System Benefit Fund has a balance of $610 million, which is more than adequate to provide appropriate support for low-income, elderly and disabled Texans so that they will not be adversely impacted. Texas lawmakers may also choose to consider additional safeguards so that vulnerable Texans are held harmless.

As would be expected from a relatively new sector of the energy industry, renewable energy costs have historically been higher than traditional fuels. To help improve the understanding of these cost factors and how they may affect the development of the clean energy economy in Texas, this report examines national data on the cost of various sources of clean energy to provide a more thorough cost comparison with traditional fuels.

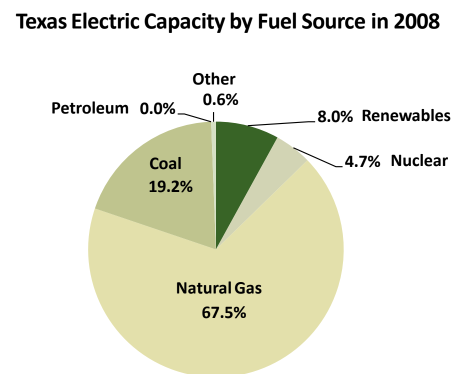
Costs for clean energy have declined steadily over the last 30 years as clean energy technology improved, and the trend is expected to intensify. For example, the cost of wind energy declined from about 30-45 cents per kWh in 1980 to as low as 5 cents per kWh today. Wind, solar PV and biomass all have experienced significant drops in cost as their technology continues to advance.

The data show that wind and biomass are the least costly clean energy sources, and are quickly becoming competitive with natural gas and coal, the two primary fuels for electricity generation in Texas. Solar power has historically been more expensive, but its costs are coming down as well. Overall, the cost differences between clean and traditional energy are less extreme than critics often imply and the differential continues to decline steadily.

Total Energy Consumption and Electricity Capacity by Fuel Source



Source: U.S. Energy Information Administration, State Energy Data System



Source: U.S. Energy Information Administration

In keeping with the report's conservative approach, the cost estimates described above do not factor in a number of variables that will likely accelerate the downward trend in costs of clean energy relative to traditional energy. Although federal climate change legislation is not likely soon, EPA or other regulators could take action in the near-to-medium term that would put a price on carbon emissions and cause a spike in the cost of traditional fuels. In addition, as clean energy technologies continue to mature and clean energy markets expand, economies of scale in the sector will accelerate the decline in prices for clean energy.

Challenges Facing the Clean Energy Sector

The report also examines a number of challenges related to the development of clean energy sources, including the intermittency of supply—i.e., the sun shines in the day and the wind tends to blow hardest best at night—as well as the need to develop a transmission infrastructure that can move power from remote areas of the state to high-demand urban areas.

The report notes that while these and other hurdles will require a concerted effort to overcome, none are insurmountable. Indeed, energy supply experts are already developing solutions to some problems – longer-lasting energy storage units, for example. Texas has already begun to make investments to overcome transmission problems for clean energy by tying the developing wind farms of West Texas into the state electrical grid using the CREZ system. The development of a new generation of plug-in hybrid and all-electric vehicles may also help balance electric demand. Because many motorists likely will re-charge their vehicle batteries at night, electric vehicles will likely create new demand for what has been under-utilized nighttime generating capacity.

Where We Stand Now

Americans have been aware of the need to find alternative sources of energy since the OPEC oil embargo in 1973. Some progress has been made at both the state and national levels, such as the successful RPS policies that have supported the growth of the wind industry in Texas, but greater benefits from clean energy will require a more sustained and coherent approach to energy policy.

Due to our state's large population and energy-intensive industries, Texas leads the nation in total energy consumption, accounting for more than 10 percent of total U.S. energy use. In 2007, Texas consumed 11,834.5 trillion Btus of energy from all sources, with nearly half of this total coming from oil, 30.8 percent comes from natural gas and 13.6 percent from coal.

Much of the fossil fuel consumption in Texas is related to industrial uses and electric power generation. In total, fossil fuels represent more than 94 percent of the energy consumed in the state. Nuclear power accounts for about 4 percent of total consumption, and renewable sources—primarily biomass, wind and hydroelectric—make up about 2 percent of total energy consumption in Texas.

When we isolate the fuels that generate electricity in Texas, clean energy already plays a significant role. From being virtually non-existent in Texas just 10 years ago, clean energy – primarily wind -- has expanded so rapidly that it now provides eight percent of the electricity capacity in Texas. Natural gas provides about two-thirds of the state's electric power, coal about 20 percent and nuclear about 5 percent.

In addition, our state's demand for energy is expected to rise, and rise faster than the nation as a whole, over the coming years. Given our state's ongoing need for greater and greater energy resources, clean energy sources such as wind, solar and biomass can help us meet our future energy needs. By definition, these sources do not have large, ongoing fuel costs, since they produce energy from readily available sources – namely wind and sunlight – which Texas has in abundance. These sources also offer the advantage of producing lower carbon emissions and other pollutants, which helps control air quality costs in our urban areas.

The development of clean energy is going to be a force in creating jobs and investment in the years ahead. Clean energy can play a crucial role in helping Texas meet its large and constantly growing power needs. Given the commitment to clean energy in other countries—and indeed in many other states—the clean energy sector is going to develop with or without Texas' participation. However, the economic potential of the clean energy sector presents an opportunity for Texas to exploit the full potential of the clean energy economy and continue to lead the nation in energy. As a state, the time is ripe to invest in policies that will spur greater development of Texas-based clean energy, meet our power needs and employ Texans in this fast-growing sector of our energy industry.

The Role of State Policy in Developing Clean Energy

The 2011 Texas Legislature will have a range of policy tools at its disposal to support and encourage an expanded, diversified clean energy sector. The chapter of the report entitled "Clean Energy Policies" discusses the various policies that states around the country are using and provides information for Texans to make wise choices about their policy options.

Over the past decade, the primary mechanism for incentivizing our state's clean energy capacity has been the Renewable Portfolio Standard (RPS), a policy that requires electric utilities to produce a specified amount of electricity – either measured in megawatts or as a percentage of their total generating capacity -- from renewable sources. Texas was a national leader in enacting its first RPS in 2000, and the Texas clean energy sector responded quickly. The RPS policy enacted in 2000 required that Texas utilities, based on their market share, have 2,000 MW of new renewable energy capacity installed by 2009.

In 2005, encouraged by a strong positive response to the 2000 RPS, Texas lawmakers increased the state's RPS requirement to 5,880 MW by 2015, with a 500 MW target for non-wind resources. Five years ahead of the deadline, Texas wind power along has already surpassed that goal. The success of the RPS approach creates an opportunity for Texas to continue using this proven method to incentivize further expansion and diversification of the clean energy sector.

The report makes a series of recommendations for Texas' RPS, including:

- Change the RPS measurement from megawatts of installed capacity to a percentage of overall generation within a target year, so that the RPS can keep pace with increasing electric demand in Texas;

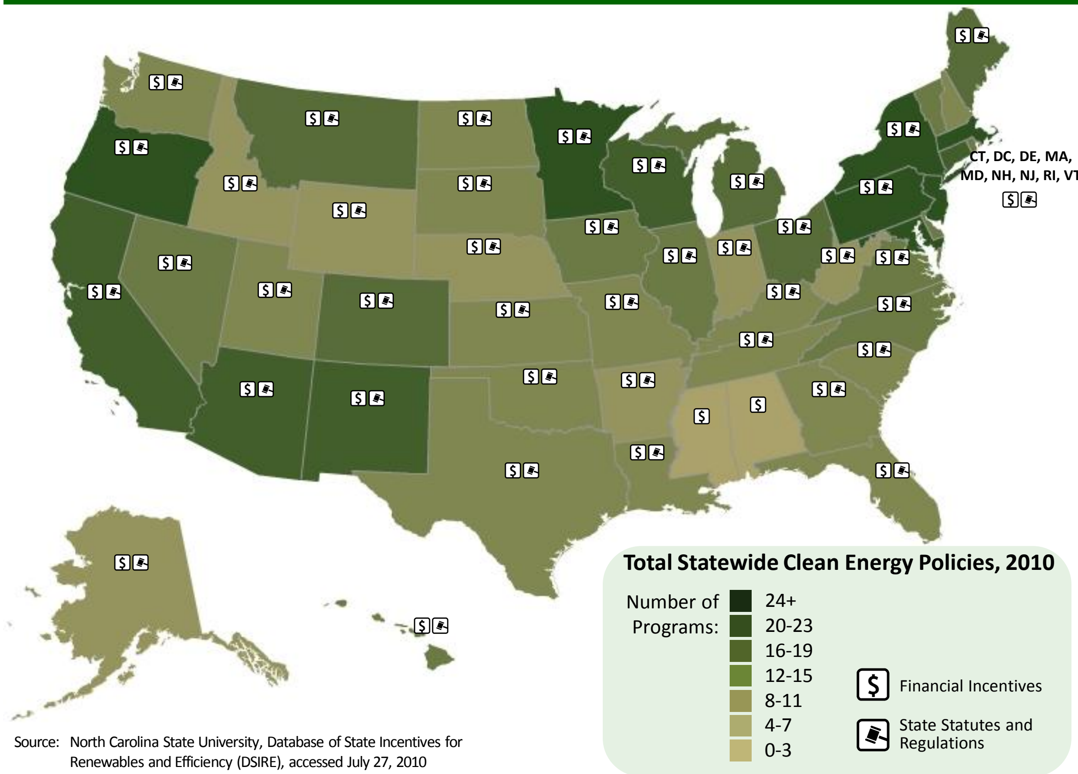
- Set RPS targets in 5-year increments to 2035, with a benchmark of at least 25 percent clean energy by 2025; and
- Make RPS targets mandatory.

The report also considers additional policy options, such as:

- Expanding financial incentives for clean energy, such as rebates, bond programs, or exemptions for clean energy devices and installation costs from state and local sales taxes; and
- Enacting a statewide net metering program.

The report also explores an array of obstacles posed by different levels of government regulation, as well as the effect of lapses in federal and state policies that were originally intended to promote the clean energy economy. This point—the periodic lapses in federal and state policy—can be especially problematic for the successful development of clean energy in the years ahead. For example, wind energy has grown at a rapid pace nationally in the last decade except during periods following a lapse in the federal Production Tax Credit. When Congress renews the tax credit, wind energy develops again. Similarly, Texas could face attrition of our leading role in the clean energy economy if we choose not to update the RPS standard, which has successfully incentivized wind development in the last decade, and we do not institute other policies such as net metering and tax policies that support the expansion and diversification of the clean energy sector.

States Are Competing to Attract Clean Energy



Source: North Carolina State University, Database of State Incentives for Renewables and Efficiency (DSIRE), accessed July 27, 2010

In this context, the report reviews various federal and state policies to expand and diversify the clean energy industry. The report catalogs the array of policies that states have undertaken to promote a clean energy economy. The report describes policies which have been successful and which policies Texas does—and does not—currently have. The report includes a detailed discussion of the leading options including tax incentives and net metering, which would encourage the installation of solar and wind energy devices on individual homes and businesses by allowing property owners to sell their excess generating capacity back into the power grid.

Clear-Cut Choices

Oil and natural gas have been centerpieces of the Texas economy for over a century. Although the energy industry is changing to incorporate clean energy like wind, solar and biomass, the energy industry will continue to be a linchpin of our state's economic prosperity. Thus, the question for Texas policymakers becomes how best to develop the emerging clean energy sector of our energy economy, so that Texas remains a leader in the new energy economy, as we have always been a leader in the traditional one.

Over the past decade, with the initial RPS policy in place, Texas has begun the task of extending its historic leadership of the energy industry into the clean energy sector, becoming the largest single producer of wind energy in the country. But the development of clean energy in Texas is still in its early stages, and small, strategic investments now can dramatically impact the growth of the industry in the next decade and beyond. The data and analysis compiled in this report demonstrate that small, incremental investments in the clean energy sector of the Texas economy would pay dividends in the form of new jobs, increased economic prosperity and a surge in state and local tax revenues. In addition, a number of factors such as the potential to attract clean energy manufacturing and the attendant investments in research and workforce training will likely make the economic benefits significantly greater than this report estimates.

However, just as in the traditional energy industry, Texas must continue to innovate in order to maintain its leadership in the clean energy sector. Other states, without a prominent traditional energy sector and perhaps more willing to explore new energy sources, are positioning themselves to move ahead, especially where Texas is vulnerable. We have developed wind resources and some biomass, but we have accomplished little in promoting solar energy, either for large-scale generation or for distributed use by homes or businesses. Competition against surrounding states and even foreign countries for new jobs and investment is nothing new. Whether Texas participates or not, the race is on to attract investment and economic benefits in the clean energy economy. It makes no sense for our state, the traditional leader in the energy industry, to choose to be left out of the economic promise of the clean energy economy.

Texas has made investments that have successfully incentivized the growth of our high tech, bio-tech and other cutting-edge industries. The state has undertaken policies to stimulate its natural gas sector and other important state industries, and we have used the RPS policy to turn Texas into a national leader in the wind industry in just 10 years. Now, Texas has the opportunity to make the same type of investment to develop a diversified clean energy economy and extend our historic leadership in the global energy economy into this new sector of the industry. This report provides data, analysis and recommendations to enable lawmakers, regulators and average Texans to make informed decisions about how to develop the clean energy economy in Texas.

1. The case for clean energy

Key points:

1. **In addition to satisfying environmental concerns about carbon emissions, clean energy also enhances energy security.**

2. **The U.S. does have abundant supplies of coal, but coal-fired power plants emit pollution.**

3. **Nuclear power has potential as a relatively inexhaustible energy source, but the development of nuclear power to date has proved more difficult and expensive than projections initially suggested.**

4. **In addition to the environmental and energy security benefits, greater development of renewable energy – especially for electricity generation – is clearly in our nation's economic interests.**

5. **Texas, in particular, is uniquely blessed with an abundance of wind, sunshine and open land, attributes ideally suited for the generation of electricity from renewable sources of energy.**

Renewable energy is derived from resources that are not depleted by human use, such as the sun, wind and flowing water. These resources can be converted into electricity through various technologies. Some of these technologies are mature, such as hydropower and biomass. Others, such as wind turbines and solar photovoltaics, are developing but have not yet achieved the efficiency and market penetration of a mature technology. Although geothermal energy is produced from geological sources, it too is often included as a renewable energy resource. The key renewable resources as they are used in this report are shown in Table 1.

TABLE 1: AN OVERVIEW OF CLEAN ENERGY SOURCES				
	■	■	■ ■ ■ ■	■ ■ ▲
	Wind	**Photovoltaic**	**Geothermal**	**Thermal Solar**
Principle	Two of three propeller-like blades, mounted on a rotor, run wind turbines.	A semiconductor cell (usually silicon) converts sunlight to electricity.	The natural heat of the earth warms up an under-ground circulation system.	A surface absorbs and transfers heat radiated from the sun to a fluid.
Advantages	High investment rate. No CO2 emissions.	High investment rate. No CO2 emissions.	Energy bill reduction. No CO2 emissions.	Energy bill reduction. No CO2 emissions.
Disadvantages	Landscape (large areas); Noise	Needs large panel surface. Used cells are hazardous material.	Needs outside surface. High installation cost. Needs electricity to run heat pump.	Needs large panel surface. Used cells are hazardous material.
Site Constraints	Needs high wind intensity.	Depends on daily sun duration and solar intensity.	Greatest efficiency in areas of volcanic activity.	Depends on daily sun duration and solar intensity.
	■ ■ ■ ▲	■	■ ■ ■	■
	Wood (Biomass)	**Ocean**	**Waste**	**Hydroelectricity**
Principle	Burning wood produces steam to run a turbine or is used directly.	Tide flows and swells run turbines.	Methane from waste decomposition is used to produce heat or run turbine.	Falling water runs turbine.
Advantages	Feedstock can be waste wood. No CO2 emissions.	High production rate. No CO2 emissions.	Uses waste as a resource. No CO2 emissions.	High production rate. No CO2 emissions.
Disadvantages	Problematic at an industrial scale.	Landscape for larger coastline infrastructure. Community and economic use loss (tourism). Biodiversity harm.	Biogas needs to be "cleansed" of corrosive hydrogen sulfide.	Water basin disruption. Loss of (or creation of) community and economic use. Biodiversity harm.
Site Constraints	Distnace to wood production zones.	Needs accessible coastline. High tidal fluctuation.	Distance ot landfill or manure production areas.	Availability of water resource.
Direct Application	■ electricity production ▲ on site use only	■ industrial process	■ heating or cooling buildings	■ warming water

Source: Adapted from Quercy Energies, California Energy Commission Glossary.

Table 1: An Overview of Clean Energy Sources

The case for clean energy is often framed in terms of the power source's role in promoting a cleaner environment and reducing pollution.[1] Renewable energy is by its nature "carbon neutral" in the sense that it does not lead to increased carbon emissions. It also does not produce other forms of air pollution like sulfur dioxide and nitrogen oxide, which, like carbon dioxide, are byproducts of burning fossil fuels like oil and coal. For that reason, replacing fossil fuels with clean energy sources wherever possible will reduce emissions and produce a cleaner environment.

But that is not the entire story. Another critical reason to focus on renewable energy is security. Consider this: More than half of Texans have never lived in a time when the nation's supply of energy was truly secure, not subject at least to some vulnerability from supply disruptions or unexpected price spikes. In 1972, the price of oil was $3 a barrel and had been relatively stable for more than a century (Figure 1): then came the 1973 OPEC oil embargo. By the end of 1974, the price of oil had quadrupled. Energy prices have not been entirely stable—and supplies have not been entirely secure—since.

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[1] Energy efficiency and conservation are also important aspects of a comprehensive state or national energy policy. However, they are beyond the scope of this study.

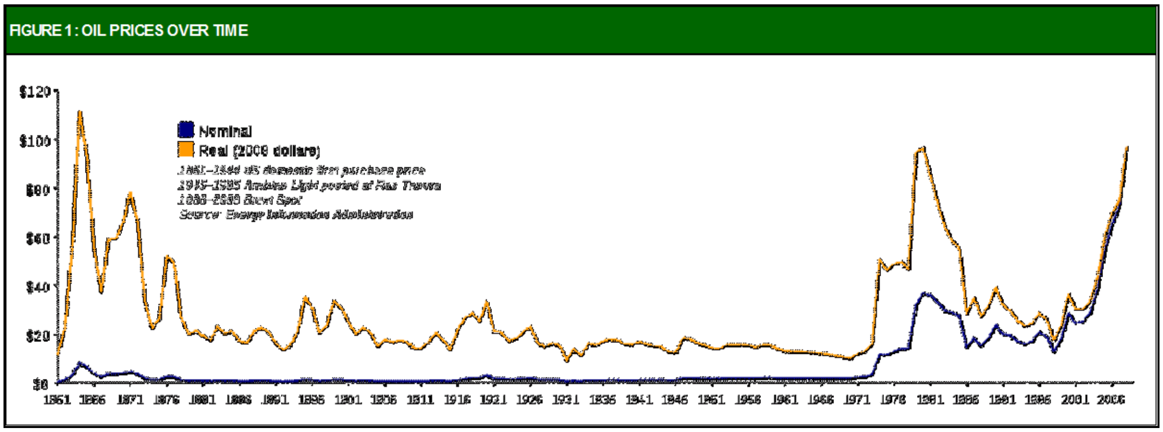

Figure 1: Oil Prices over Time

The OPEC embargo interrupted the flow of oil causing severe gasoline shortages and long lines at gas stations and exposing America's growing dependence on foreign sources of energy. Following the oil embargo, the idea of energy independence captured the public imagination and became a prominent focus of public policy. The embargo sparked the creation of a comprehensive federal energy program to address the nation's energy needs. Since the 1970s, the federal clean energy program has grown rapidly to include basic and applied R&D and federal participation in demonstration projects, commercialization and education. In addition, the federal government instituted various incentives, such as business and residential tax credits, and created a market for non-utility-produced electric power through the Public Utility Regulatory Policies Act (P.L. 95-617).

The national commitment, however, proved to be short-lived. During the 1980s, the cumulative effect of increased automobile fuel efficiency combined with increased oil supplies from the Trans-Alaska Pipeline System created a surplus of oil on the world market. The OPEC oil cartel faltered and so did prices. The price of oil dropped back below $10 per barrel, and the national enthusiasm for energy independence waned.

Despite Congress's ongoing support for a broader, more aggressive renewable energy program, federal spending for these programs fell steadily until the late 1990s. In the meantime, consumption of all types of energy, whether in the form of gasoline at the pump or electricity by homeowners continued to rise (Figure 2). Over the past four years, this trend has shifted, driven by rising energy prices and national recession. Electricity consumption per capita in the U.S. has decreased by about one percent per year; however, overall consumption has continued to trend upward. Power consumption is projected to hit 4,333,631 million kilowatt hours by 2013, averaging an annual growth rate of just over 1.9 percent for the next few years compared to 1.5 percent per year from 2004-2008.

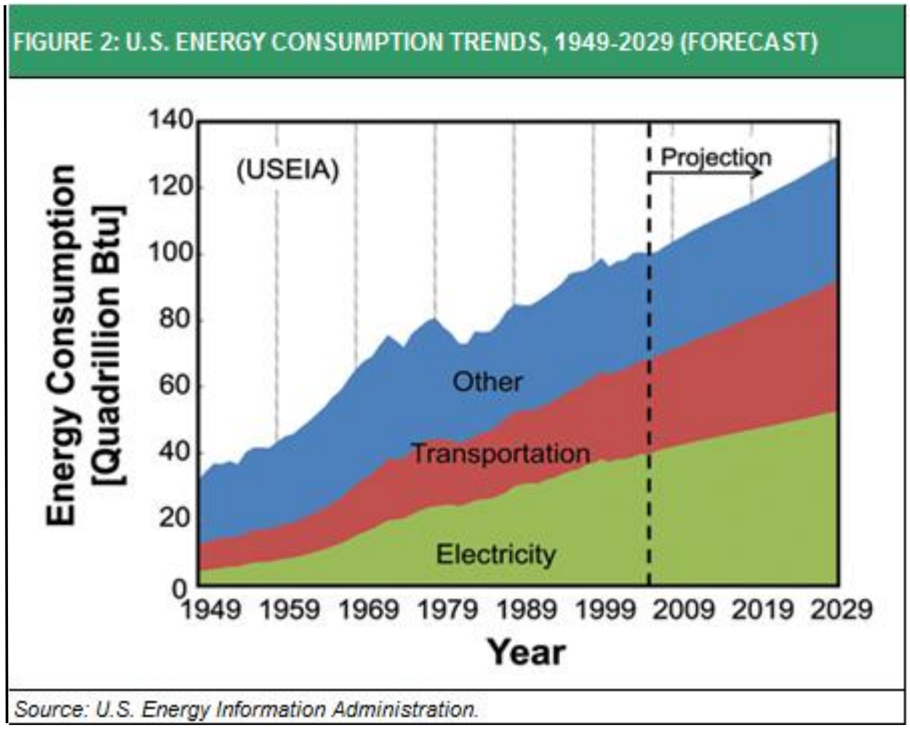

Figure 2: U.S. Energy Consumption Trends, 1949-2029 (Forecast)

Nearly 30 years after the OPEC embargo, the September 11, 2001 terrorist attacks created fresh interest in energy independence. Today, however, the debate has expanded from simple security of supply: even if supplies were stable and secure, the U.S. would need alternatives in the long run. Oil and natural gas are finite resources and eventually will be depleted. Even though advanced drilling technology has made it possible to tap new fossil fuel reserves, the cost of finding and developing these energy sources will only increase over time. At some point in the future, these resources will not be available at any price. Moreover, environmental disasters like the *Deepwater Horizon* spill underscore the inherent risks and costs associated with pushing the search for new fossil fuel resources to the edge of our current technological capabilities.

Some alternatives to oil and natural gas, such as nuclear power and coal, carry their own risks and costs. Nuclear power has potential as a nearly inexhaustible energy source, but its implicit dangers leave many Americans skeptical. In any case, nuclear power development to date has proven more difficult and more expensive than initial projections. A 2003 Massachusetts Institute of Technology study of the market potential of nuclear power in the U.S. found that it was not competitive with coal or natural gas for electricity generation. A 2009 update of the study found that this situation had not markedly improved, in part because of the costs associated with adding new nuclear power facilities: "While the U.S. nuclear industry has continued to demonstrate improved operating performance, there remains significant uncertainty about the capital costs, and the cost of its financing, which are the main components of the cost of electricity from new nuclear plants."[2] The report also found that "the estimated cost of constructing a nuclear power plant has increased at a rate of 15% per year heading into the current economic downturn."

In the case of coal, there are abundant supplies in the U.S., but coal-burning power plants are the nation's largest source of carbon dioxide (CO_2) emissions. Coal-fired power plants also emit pollution that increases asthma attacks and worsens environmental problems like acid rain, haze and smog. Coal remains cheap today, but would be hit hardest by any policy to put a price on carbon. Its future viability rests on the development of carbon capture and storage technologies (CSS). While burning coal is relatively cheap if the byproducts of pollution are discounted, sequestering CO_2 can be expensive—more expensive, in fact, than simple energy efficiency measures and some renewable power options.[3] But recent findings by researchers at the University of Houston and Texas A&M University suggest another problem—it could prove exceedingly difficult to find enough space to store the captured carbon underground.[4] The research concludes that governments wanting to use CCS have overestimated its value and says it would take a reservoir the size of a small U.S. state to hold the CO_2 produced by one power station.[5]

Finally, it is in the nation's economic interest to encourage clean energy development. Domestic sources of energy would allow the U.S., an energy-importing country, to reduce energy imports, thus reducing the trade deficit. It would also free up fossil fuels for other critical uses besides burning, such as petrochemical production. Such results could be achieved either by a reduction in overall energy demand or through the substitution of clean energy for fossil fuels. Within the U.S., Texas is uniquely suited to take advantage of a wide array of renewable options–after all, the three things Texas has in abundance are wind, sunshine and open land.

Renewable energy may also prove to be a growth engine for future jobs and investment, a point this report examines in detail. The sector is small now, relative to other areas of the national and state economies, but the use of clean energy sources inevitably will grow in coming years for the reasons already mentioned. Texas has had success with the development of wind resources, but as this report will show, it lags behind in other clean energy areas, most notably in solar energy development.

The race to create a clean energy economy is an economic competition, whether we acknowledge it or not. In 1997, the European Union began setting ambitious targets for clean energy generation. The commission stated that renewable sources such as solar, wind, hydro and biomass should constitute 12 percent of the total European energy consumption by this year,

[2] Massachusetts Institute of Technology, *The Cost of Nuclear Power*, an Interdisciplinary MIT Study, original study 2003, updated in 2009. Available at: http://web.mit.edu/nuclearpower/pdf/nuclearpower-update2009.pdf

[3] Mohammed Al-Juaied and Adam Whitmore, "The Realistic Cost of Carbon Capture," Harvard Kennedy School, Discussion Paper 2009-08, July 2009. Available at: http://belfercenter.ksg.harvard.edu/files/2009_AlJuaied_Whitmore_Realistic_Costs_of_Carbon_Capture_web.pdf

[4] Terry MacAlister, "US research paper questions viability of carbon capture and storage," *The Guardian*, April 25, 2010. Available at: http://www.guardian.co.uk/business/2010/apr/25/research-viabilty-carbon-capture-storage

[5] There are about 600 coal-fired power plants currently operating in the United States. There are not, of course, 600 small states.

2010. In 2001, this target expanded to 22 percent of electricity generation in 2010. Recognizing their own huge demands for energy in the coming decades, China and India are undertaking similarly extensive renewable energy development. Neither the U.S.—nor Texas—should walk away from this challenge.

In fact, the expanding clean energy industry is already affecting state economies. Research by the Pew Charitable Trusts in 2009 found that "despite a lack of sustained policy attention and investment, the emerging clean energy economy has grown considerably—extending to all 50 states, engaging a wide variety of workers and generating new industries."[6] Pew found that the clean energy sector had been hit by the recession like other parts of the economy, but investments and job creation in clean technology on the whole fared better than other sectors. Job growth in the industry in the preceding decade was 15.5 percent compared to 6.7 percent in the overall economy, and the industry attracted $717 million in venture capital investments between 2006 and 2008. In 2007, more than 68,200 businesses across all 50 states and the District of Columbia accounted for about 770,000 jobs, improving the bottom line in terms of economic growth and environmental sustainability. Looking forward, the clean energy economy has tremendous potential for growth, as investments continue to flow from both the government and the private sector, if federal and state policymakers push for reforms that will both promote economic development and improve the environment.

Of special importance in Texas is the potential of renewable energy to contribute to the often-overlooked area of rural economic development. Wind and solar technologies require a large amount of open land, and they have begun to find a home in rural America where they can add jobs, add to local tax bases and provide critical supplemental income to American farmers. For example, the Department of Energy studied the potential impact of its program to expand the use of wind energy in the United States, Wind Powering America. It concluded that if the program realizes its goals, it will create $60 billion in capital investment in rural America, provide $1.2 billion in new income for farmers and rural landowners, and create 80,000 new jobs over the next 20 years.[7]

For all these reasons and more, the idea of American energy independence has returned to the forefront of the national policy agenda. But realizing the need and taking the actions necessary to create change is stubbornly difficult. The U.S. alone consumes over 20 million barrels per day—almost 25% of global demand. Fortunately, the nation—and Texas—is not without alternatives. By developing the clean energy economy, we can produce more of our energy needs here in the U.S., develop sources of power that will not be depleted in the future and reduce the level of carbon emissions over time. And, we can achieve all this while reaping the economic benefits of reshaping the energy economy.

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[6] Pew Center on the States, *The Clean Energy Economy*, June 2009. Available at: http://www.pewcenteronthestates.org/uploadedfiles/clean_economy_report_web.pdf

[7] U.S. Department of Energy, National Renewable Energy Laboratory, *Wind Energy for Rural Economic Development*, August 2004. Available at: http://www.nrel.gov/docs/fy04osti/33590.pdf

There are, however, several problems with moving in this direction. We have been developing and refining fossil fuel-based energy production for more than a century. Clean energy is near the beginning of the development curve and on the current playing field cannot compete with conventional technologies. Fortunately, the costs of clean energy have come down over time, and are continuing to fall, thanks in large part to policy incentives (Figure 3). For example, the cost of wind power has declined from about 30-45 cents per kilowatt-hour in 1980 to less than five cents in some cases today.

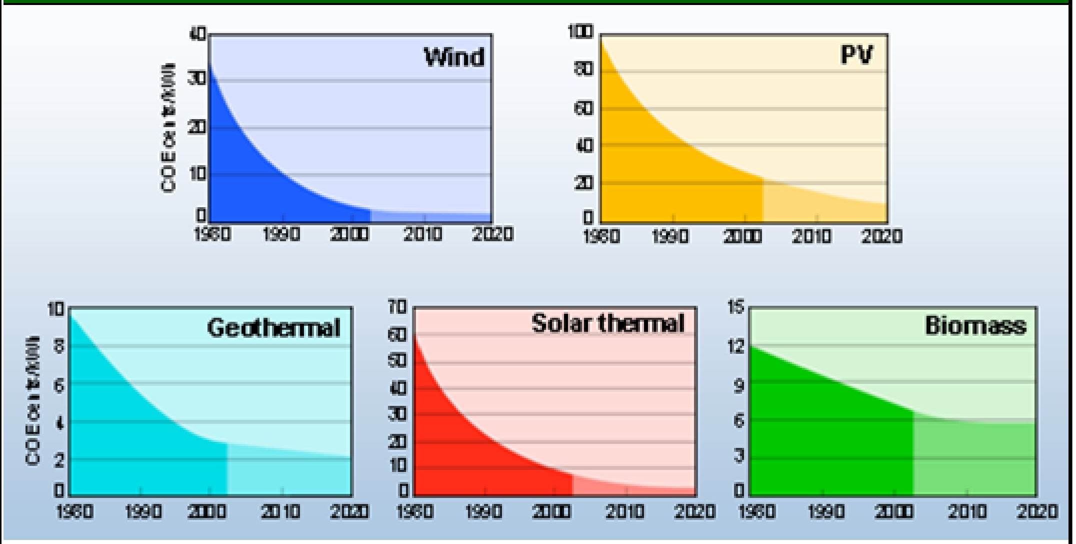
For this reason, public policy must figure into the development of clean energy. If Americans believe that we must find energy resources to supplement fossil fuels then there is a public role in encouraging these technologies to develop and mature. In other words, public policies, in the form of incentives or renewable portfolio standards for utilities, may carry some costs, but they also carry enormous potential benefit for the future of the country and of Texas.

In public debates over the role of renewable energy, people are too often given to glittering generalizations—"We already have a renewable energy base." "Solar energy is too expensive." "These options will raise costs for business and harm economic development." The trouble with these generalities is that they do not take account of the facts. Without the facts, it is impossible to create policies that will benefit Texas.

This report will address the facts on the clean energy economy in Texas. It contains only the key information on renewable energy: its costs, its potential benefits and its future. With a better understanding of the realities of renewable energy—not the propaganda on one side or the other, but the facts—we will be better placed to answer questions like these:

- How does the cost of renewable sources of energy stack up against other conventional sources?
- What role can renewable energy sources play in the state's future?
- Which policies are standing in the way of effective renewable energy development in Texas?
- Which policies should the state pursue to promote renewable development?
- What is the economic payoff for renewable energy development and how does it compare to the costs?

FIGURE 3: RENEWABLE ENERGY COST TRENDS
LEVELIZED CENTS/KWH IN CONSTANT 2000 DOLLARS



Source: National Renewable Energy Laboratory, 2002.

Note: These graphs reflect historical cost trends but do not reflect precise historical data.

Figure 3: Renewable Energy Cost Trends

New technologies that can do more work with fewer inputs have driven economic growth since the Industrial Revolution. This fundamental dynamic will be no different in the case of renewable energy, but the need for innovative technology will be even more pressing as global demand for energy--along with water, food and every other vital commodity--continues its relentless rise. Sustaining the national and Texas economy is all about getting the energy needed at the lowest possible price. But, it is reckless to discuss energy costs without considering the scarcity that will make clean energy increasingly important in the nation's future.

2. Energy supply and demand in Texas

Key points:

1. **The U.S. has done little to promote clean energy, which still only accounts for a small percentage of America's electricity generation, and has fallen behind other countries.**

2. **Texas is not only a major energy producer, it is a significant and growing consumer of energy – more than any other state.**

3. **Texas has enormous potential to develop clean energy—if it provides sufficient incentives and pursues other public policies to promote it.**

4. **How will Texas meet its growing demand for power, while keeping up with national projections calling for renewable resources of energy to satisfy 45 percent of the country's electricity demand by 2035?**

5. **Pursuing a diversified fuel source strategy will help mitigate the effects of price volatility, and keep Texas' energy supply and demand in better balance.**

Since the late 1970s, renewable energy sources have been of interest to policy makers primarily because of their potential to reduce or displace fossil fuel in electric power generation. Despite a relatively high level of interest over an extended number of years and a variety of policies aimed at promoting the use of renewable resources, these technologies still account for only a small percentage of U.S. electricity generation. Throughout the 1990s, clean energy played a larger role in electricity generation in the U.S. than it did in Europe. But during that period, major European nations—and particularly Germany—were much more aggressive in promoting the expansion of renewable sources, and the share of these technologies in European electricity generation has risen accordingly. It is now almost double that of the U.S.

The example provided by the European nations demonstrates—and many analysts believe—that even with current technologies, non-hydroelectric clean energy have the potential to play a much larger role in the U.S. than they currently do. The question is how to bring that about in a way that makes sense from both a policy and an economic standpoint.

Recognizing the long-run benefits of renewable development and seeking to understand the policies needed to bring about further use of the resources, the National Governors' Association in 2008, appointed a panel of the nation's governors to examine the potential and challenges of clean energy and energy efficiency for the states. When they looked at the challenges states will face in meeting current and future energy needs, their conclusions were brief and succinct: "Meeting today's electricity needs depends on resolving these challenges: satisfying growing demand while curbing greenhouse gas emissions."[8] There is no simple answer to these challenges: the size and scope of the need is massive and resolving the problems of CO_2 and other fossil fuel emissions is difficult. Success in this area of public policy is a matter of finding the right balance between supply and demand and using the energy available in ways that cause the least impact on the environment.

Resolving these competing objectives is, and will be, a major challenge for Texas. The state has a storied past as the nation's most important energy-producing state. It leads the nation in fossil fuel reserves. Texas crude oil reserves represent almost one-fourth of the U.S. total, and Texas natural gas reserves account for almost a third of the U.S. total. It is also a major nuclear power generating state with two large nuclear plants. It has significant coal reserves, although nearly all of the coal mined in Texas is lignite, the lowest grade of coal, and is used in plants where it is produced. Texas also has enormous potential for renewable energy resources—wind, solar and biomass in particular.

However, Texas is not only a major energy producer; it is also the nation's leading energy consumer, accounting for more than one-tenth of total national energy use. Not only does it have a large and growing population that consumes increasing amounts of energy, but it is the home of many energy-intensive industries including aluminum, chemicals, forest products, glass and petroleum refining. A sizable portion of the state's economy depends on the ready availability of electrical power, and future economic development depends on the state's ability to continue meeting what will almost certainly be a growing demand for power.

Texas is well positioned to strike the right energy balance for the future if it pursues the right policies and strategies and recognizes that there is no single solution to meeting future energy needs. The successful state will mix and match energy sources to achieve the best possible balance of reliable, affordable energy and a clean, healthy environment.

Energy Demand in Texas Is Large and Growing

According to the U.S. Energy Information Administration (EIA), renewable energy resources (excluding wood used for home heating) supplied about 7.3 quadrillion Btus of energy in 2008, equal to about 7.4 percent of the nation's 99.3 quadrillion Btu in total energy demand (Figure 4). (This includes not just electrical power generation but all forms of energy use in the

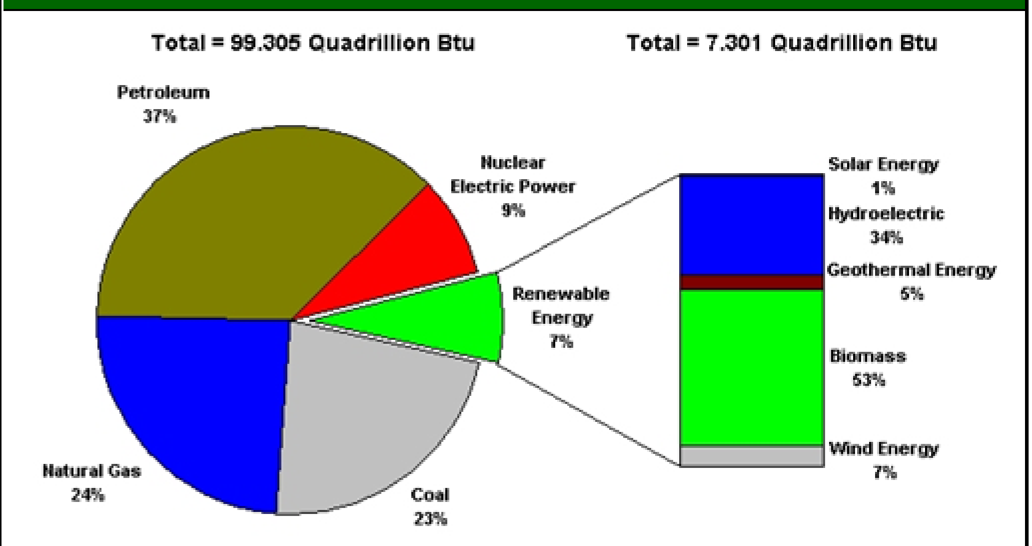
[8] National Governors' Association, *Securing a Clean Energy Future: A Governor's Guide to Clean Power Generation and Energy Efficiency*, July 2008. Available at: http://www.nga.org/Files/pdf/0807CLEANPOWER.PDF

country.) Of the 7.4 percent total, about 2.5 percent is provided by large-scale hydroelectric power. Industrial uses of clean energy, supplied primarily by biofuels, account for a sizable portion of the total as well, representing just less than 20 percent of total renewable energy consumption. In total, biomass in all its forms—biofuels, waste and wood-derived fuels accounted for more than half of all renewable energy consumption.

Fast-growing wind energy accounted for less than one percent of total power but has seen rapid growth in recent years. Its use increased by 50.7 percent from 2007 to 2008, according to the EIA data. Geothermal accounts for about 0.4 percent of U.S. energy consumption, and solar about 0.1 percent. As might be expected, fossil fuels contribute 84 percent of total consumption, with oil the predominant source followed by natural gas and coal. Nuclear power accounts for nine percent of total consumption.

Due to its large population and energy-intensive industries, Texas leads the nation in total energy consumption, accounting for more than 10 percent of total U.S. energy use. In 2007, the latest year for which comprehensive data are available, Texas consumed 11,834.5 trillion Btus of energy from all sources. Almost half of this total comes from oil, 30.8 percent from natural gas and 13.6 percent from coal. Four-fifths of the natural gas use is related to industrial and electrical generation uses. Coal is also predominantly used in electricity production. In total, fossil fuels represent more than 94 percent of the energy consumed in the state in 2007 (Table 2, next page). Nuclear power accounts for about four percent of total consumption, and renewable sources—primarily biomass, wind and hydroelectric—make up just under two percent.

FIGURE 4: U.S. ENERGY CONSUMPTION BY SOURCE, 2008
(QUADRILLIONS OF BTUS)



Source: U.S. Energy Information Administration, Office of Coal, Nuclear, Electric and Alternative Fuels.

Figure 4: U.S. Energy Consumption by Source, 2008

Texas has been a leader in the production of wind energy, and yet despite this, the percent of total consumption supplied by clean energy in the state lags behind the national total considerably. The cause lies in the energy-intensive nature of the Texas economy which consumes huge amounts of fossil fuel-derived energy in production processes for the petrochemical industry and other applications. Partly because of this industrial mix, an enormous amount of the energy consumed in the state is used for electrical power generation.

Texans consume more electricity than any other state—about 30 percent more than California, the next largest consumer.[9] To meet this demand, Texas had 10.4 percent of the nation's electricity generating capacity in 2008, or about 105,000 megawatts (MW). Natural gas fueled 67.5 percent of the state's electrical capacity; nuclear, 4.7 percent; coal, 19.2 percent; other sources, 0.6 percent; and renewable energy sources, including conventional hydroelectric, 8 percent.

TABLE 2: TEXAS ENERGY CONSUMPTION BY ENERGY SOURCE, 2007 (TRILLIONS OF BTUS)

Energy Source	2007	Percent of Total
Total	11,834.500	100.0%
Coal	1,609.100	13.6%
Natural Gas	3,641.400	30.8%
Petroleum	5,886.900	49.7%
Nuclear Electric Power	429.500	3.6%
Biomass	85.600	0.7%
Geothermal, Solar and Wind	91.200	0.8%
Hydroelectric	16.300	0.1%
Net Interstate Flows and Other	74.600	0.6%
Fossil Fuels	*11,137.400*	*94.1%*
Renewables	*193.100*	*1.6%*

Source: U.S. Energy Information Administration, State Energy Data System.

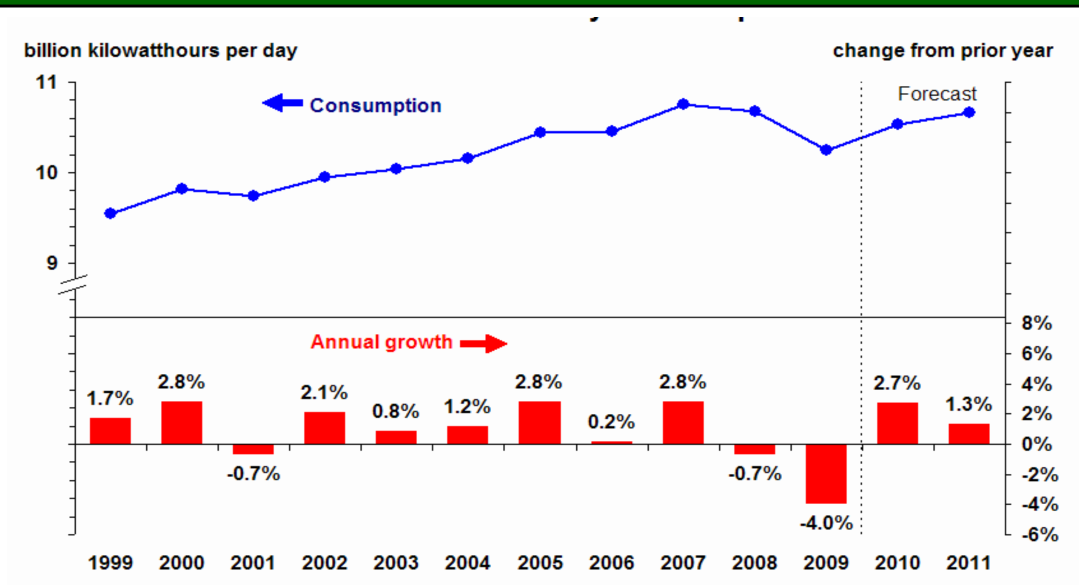
Table 2: Texas Energy Consumption by Energy Source, 2007

Electric energy demand comes from all sectors of the large and growing Texas economy. For example, nearly 21 percent of the nation's industrial customers of electricity are in Texas.[10] The state's large share of industrial customers and the energy-intensive nature of some of its industries such as aluminum, chemicals and petroleum refining contribute to a larger share of electricity consumption than in many states. Altogether, Texas industries consume about 10 percent of the nation's retail sales of electricity.[11] The residential sector in Texas, however, consumes the largest share of electricity retail sales within the state—38.5 percent, followed by the commercial sector with 35.2 percent and the industrial sector with 26.3 percent.

[9] Department of Energy, Energy Information Administration, "Electric Power Monthly," March 2010, pp. 23 and 107. Available at: http://tonto.eia.doe.gov/ftproot/electricity/epm/02261003.pdf.
[10] U.S. Department of Energy, Energy Information Administration, *Electric Power Annual, 2008*, State Data Tables: "1990-2008 Number of Retail Customers by State by Sector," (Excel spreadsheet), January 21, 2010. Available at: http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html.
[11] U.S. Department of Energy, Energy Information Administration, "Retail Sales of Electricity to Ultimate Customers by End-Use Sector, by State," March 15, 2010. Available at: http://www.eia.doe.gov/cneaf/electricity/epm/table5_4_b.html. (Data for 2009 are preliminary.)

Nationally, electricity demand slowed because of the impact of the national recession in 2009; however, this slowdown is passing as the economy recovers. In May 2010, the Department of Energy reported that total consumption of electricity across all sectors is projected to grow by 2.7 percent during 2010 and by 1.3 percent next year (Figure 5). The U.S. Department of Energy's (DOE) projections indicate that electricity retail sales will increase nationally by about 25 percent from 2008 to 2035. In addition, the direct-use consumption by industrial and commercial users that generate their own electricity will more than double, bringing the total increase to nearly 30 percent. The residential sector will increase consumption by 23.8 percent from 2008 to 2035, the commercial sector by 42 percent and the industrial sector by 3.4 percent.[12] Although electric consumption among all sectors is projected to increase, the residential sector is expected to improve in terms of energy efficiency.

FIGURE 5: U.S. TOTAL ELECTRICITY CONSUMPTION, 1999-2011 (FORECAST)



Source: U.S. Energy Information Administration, Short-Term Energy Outlook, May 2010.

Figure 5: U.S. Total Electricity Consumption, 1999-2011 (Forecast)

DOE projects that US residential energy consumption will *decline* by 31 percent per square foot from 2008 to 2035. However, this trend will be offset by new construction. The department is projecting that average housing square footage will grow by 19.6 percent over the same period. In addition, although energy consumption per household will decline by 17.5 percent, the number of households will grow by 29.5 percent. Consequently, residential

[12] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2010*, "Early Release: Year-by-Year Reference Case Tables (2008-2035)," (Table A4: Residential Sector Key Indicators and Consumption), (Excel spreadsheet), December 14, 2009. Available at: http://www.eia.doe.gov/oiaf/aeo/aeoref_tab.html.

electricity use will grow by 23.8 percent despite the significant improvement in energy efficiency.[13]

In contrast, the department projects that the commercial sector will increase its energy consumption per square foot by 1.2 percent from 2008 to 2035. In addition, commercial square footage will increase by 40.3 percent leading to an increase in electricity consumption of 42 percent for that sector. The industrial sector, on the other hand, will increase its electricity consumption by only 3.4 percent despite an increase of 44 percent in the present dollar value of its shipments. The department projects that combined heat and power, primarily from biofuels, will reduce purchased electricity per dollar value of shipments by 28.2 percent.[14]

The Electric Reliability Council of Texas (ERCOT) has projected the 10-year compounded growth rate for electricity consumption in Texas to be 2.04 percent and peak demand to rise at an average of rate of two percent annually from 2009 to 2019.[15] From 2002 to 2008, the compounded annual growth rate in ERCOT's service region was 1.85 percent for consumption and 1.73 percent for peak demand.[16] The growth rate translates into about a 22 percent increase in generation and new power needed to meet projected peak demand increases from 2009 to 2019—about 23,000 MW assuming the current fuel mix.

Here is the critical point for future state policy: This growth rate is almost double the projected national growth rate for the same period. A demand growth rate that is double the national average will present new challenges for Texas. The state will need to multiply its current efforts just to keep up with national projections that renewable resources will satisfy 45 percent of new demand by 2035.

Electricity Generation and Renewable Resources

Of the top five nations with the greatest percent of total capacity coming from clean energy, excluding conventional hydroelectric, the U.S. tied China for fourth place in its share of capacity devoted to clean energy sources at about 4 percent in 2009. However, it ranked first in total capacity with 53.4 gigawatts (GW). Spain and Germany ranked first and second in their

[13] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2010*, "Early Release: Year-by-Year Reference Case Tables (2008-2035)," (Table 4: Residential Sector Key Indicators and Consumption), (Excel spreadsheet), December 14, 2009. Available at: http://www.eia.doe.gov/oiaf/aeo/aeoref_tab.html. (Calculations based on table.)

[14] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2010*, "Early Release: Year-by-Year Reference Case Tables (2008-2035)," (Table: Industrial Sector Key Indicators and Consumption), (Excel spreadsheet), December 14, 2009. Available at: http://www.eia.doe.gov/oiaf/aeo/aeoref_tab.html. (Calculations based on table.)

[15] Electric Reliability Council of Texas, "About ERCOT." Available at: http://www.ercot.com/about/: and *2009 ERCOT Planning: Long-Term Hourly Peak Demand and Energy Forecast*, May 1, 2009, pp. 1-2. Available at: http://www.ercot.com/content/news/presentations/2010/2009_Planning_Long-Term_Hourly_Demand_Energy_Forecast-av2009.pdf

[16] Electric Reliability Council of Texas, *2009 ERCOT Planning: Long-Term Hourly Peak Demand and Energy Forecast*, May 1, 2009, p. 3. Available at: http://www.ercot.com/content/news/presentations/2010/2009_Planning_Long-Term_Hourly_Demand_Energy_Forecast-av2009.pdf. (Rate calculated from charted historical data.)

share of electricity generated from renewable energy with 30 percent and 29 percent, respectively, and India ranked third with 9 percent.[17]

TABLE 3: CLEAN ENERGY EFFORTS OF THE TOP FIVE NATIONS, 2009 (EXCLUDES CONVENTIONAL HYDROELECTRIC		
Country	**Percent of Total Capacity**	**Total Renewable Capacity (GW)**
Spain	30%	22.4
Germany	29%	36.2
India	9%	16.5
U.S.	**4%**	**53.4**
China	4%	52.5
Source: The Pew Charitable Trusts.		

Table 3: Clean Energy Efforts of the Top Five Nations, 2009

In addition to these nations, a number of other nations ranked high in their renewable energy efforts, although their total capacity is lower since their population and economies are smaller. Portugal, for instance, derived 35.9 percent of its electricity needs met by wind and solar last year.[18] Denmark derived 24 percent of its generating capacity from renewable sources in 2008, mostly from wind.[19]

Investor-owned electric companies, municipalities and electric cooperatives generate most electricity consumed in the U.S., although industry produces about 3.3 percent nationally and 8.7 percent in Texas. Production by the industrial sector is largely for direct use by the industry that generates it and is usually in the form of combined heat and power where both electricity and heat come from a single heat source.

Texas had 10.4 percent of the nation's electricity generating capacity in 2008, or about 105,000 megawatts (MW). Natural gas fueled 67.5 percent of the state's electrical capacity; nuclear, 4.7 percent; coal, 19.2 percent; other sources, 0.6 percent; and renewable energy sources, including conventional hydroelectric, 8 percent. About 88.6 percent of capacity from renewable sources came from wind, or 7,427 MW.[20]

The U.S. added 19,477 MW of new generating capacity from all sources in 2009. Texas' share was 3,537 MW, or 18.2 percent of the total. In 2009, wind provided more added generating capacity in Texas than any other source—1,757.5 MW. Wind accounted for 49.7 percent of the

[17] The Pew Charitable Trusts, *Who's Winning the Clean Energy Race? Growth, Competition and Opportunity in the World's Largest Economies*, 2010, pp. 6, 26, 28, 29, 36 and 39. Available at: http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Global_warming/G-20%20Report.pdf.
[18] Mario de Queiroz, "Racing for Renewables," *IPS*, February 2, 2010. Available at: http://ipsnews.net/news.asp?idnews=50193.
[19] Danish Energy Agency, *Energy Statistics 2008*, p. 13. Available at: http://www.ens.dk/en US/Info/FactsAndFigures/ Energy_statistics_and_indicators/Annual%20Statistics/Documents/Energy%20Statistics%202008.pdf.
[20] U.S. Department of Energy, Energy Information Administration, "1990 - 2008 Existing Nameplate and Net Summer Capacity by Energy Source, Producer Type and State (EIA-860)" January 21, 2010. Available at: http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html. (Data final for 2008.)

total added; other renewable sources, 0.6 percent; and natural gas and lignite, another 49.7 percent. Nationally, wind accounted for 41.7 percent of total added capacity.[21]

The rapid growth of wind capacity in Texas has made national headlines over the last several years. Texas added 7,264 MW of wind capacity from 1999 to 2009, about 25 percent of total new generating capacity added in the state from all sources; nearly all of the remainder was from natural gas.[22] As of December 2009, Texas had 9,185 MW of generating capacity from wind. Other than the various forms of biomass, it is the most important Texas renewable energy source at the present time.

In December 2009, the Electric Reliability Council of Texas, which comprises 85 percent of the electric load and 75 percent of the land mass in Texas, projected the generating capacity from wind in Texas at 9,216 MW for 2010.[23] ERCOT has also identified potential wind resources of 11,456 MW by 2011 and 34,773 MW by 2015; however, these data are speculative and can change substantially as many projects do not come to fruition and much may depend on the market reaction to federal policy changes related to renewable energy made under the American Recovery and Reinvestment Act—the federal stimulus bill passed in 2009.

Using a somewhat longer time horizon, the Department of Energy estimates that the electric generation from renewable sources will grow by 518.3 gigawatt hours (GWh) from 2008 to 2035 nationally.[24] The largest increase will come from wood and other biomass, which will increase by 251.4 GWh. Electricity fueled by wind will increase from about 52.2 GWh in 2008 to 196.5 GWh by 2013 but then will level off and increase to only 217.8 GWh by 2035.[25]

The Outlook for the Electrical Power Fuel Mix and Emissions

The fuel mix actually used to generate electricity can look quite different from the capacity mix. Fuel prices, the age and efficiency of generating plants and the intermittency of fuel sources such as wind can affect which fuel producers rely on for generation. In 2009, Texas produced 47.4 percent of its electricity from natural gas, 35.1 percent from coal, 10.5 percent from nuclear power, 1.5 percent from other sources and 5.6 percent from renewable energy. In comparison, the U.S. relies more heavily on coal, nuclear power and hydroelectric generation. Nationally, electric production totaled four million GWh in 2009, of which Texas produced 396,000 GWh, about 10 percent of the total.[26]

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[21] U.S. Department of Energy, Energy Information Administration, "Report No.: DOE/EIA-0226 (2010/03): ES3 New and Planned U.S. Electric Generating Units by Operating Company, Plant and Month," (Data from December 2009), March 15, 2010. Available at: http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html
[22] U.S. Department of Energy, Energy Information Administration, "1990-2008 Existing Nameplate and Net Summer Capacity by Energy Source, Producer Type and State (EIA-860)," January 21, 2010. Available at: http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html.
[23] Electric Reliability Council of Texas, *Report on the Capacity, Demand and Reserves in the ERCOT Region*, December 2009.Available at: http://www.ercot.com/content/news/presentations/2010/2009CDR_DecUpdate.pdf. (Data calculated from tables.)
[24] A gigawatt hour (GWh) is equal to one billion watt hours or 1,000 megawatt hours.
[25] U.S. Department of Energy, Energy Information Administration, "*Annual Energy Outlook Early Release Overview: Year-by-Year Reference Case Tables* (2008-2035)," (Table 16), December 14, 2009. Available at: http://www.eia.doe.gov/oiaf/aeo/aeoref_tab.html.
[26] U.S. Department of Energy, Energy Information Administration, "Electric Power Monthly," (Compiled from state-by-state Excel spreadsheets.). Available at: http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html.

While still small relative to the overall level of electrical generation from all sources, Texas exceeds the national average in aggregate for production using renewable sources other than hydropower. Electricity produced from renewable energy other than hydroelectric represented less than six percent of the total electricity generation in Texas for 2009; however, the daily and monthly totals can vary, again depending on a variety of factors. For example, on February 28, 2010, high winds in West Texas brought electricity production from wind to 22 percent of the total generated.[27] In summer months, when demand is peaking, however, system planners count on only 8.7 percent of wind generating capacity to meet demand.[28]

The increase in wind generating capacity in Texas, across the nation and worldwide has fueled hope for a fuel mix more reliant on renewable energy in the future. Wind capacity has been more than doubling every three years worldwide and increased by 39.3 percent from 2008 to 2009 in the U.S. The U.S. ranks first in the world in wind capacity at 35.2 GW.[29] Although most of the growth has been in large wind farms, the small, on-site wind market also has expanded with about 10,500 small wind turbines sold in the U.S. in 2008.[30]

Although projections for the U.S. indicate a large increase in renewable energy capacity, the U.S. Department of Energy has concluded that it will not be sufficient to keep pace with increasing demand, much less replace existing capacity. The department bases its projections on business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations.[31]

The department's projections indicate that electricity generation, including end-use generation, will increase nationally by about 30 percent from 2008 to 2035, or 1,148 GWh. The projections indicate that renewable resources will meet just under half of this new demand, and they also show that, if forecast trends are met, the nation will use more coal, natural gas and nuclear power than it does today as well.

If the use of coal increases as projected, emissions will also increase. DOE projections indicate that energy-related carbon dioxide emissions from electric power will increase by 275 million metric tons or 11.7 percent nationally. The electric power industry's percent share of emissions will also increase from 41 percent to 42 percent.[32] This is part of the dilemma for Texas as it looks to promote a cleaner environment. The state ranks first among the states in electricity production from coal. It also ranks first in carbon dioxide emissions from electricity generation,

[27] Peter Behr, "Is Texas Writing the Book on Wind Power?" *The New York Times*, April 8, 2010. Available at: http://www.nytimes.com/cwire/2010/04/08/08climatewire-is-texas-writing-the-book-on-wind-power-35036.html.
[28] Electric Reliability Council of Texas, *Report on the Capacity, Demand and Reserves in the ERCOT Region*, pp. 4 and 13. Available at: http://www.ercot.com/content/news/presentations/2010/2009CDR_DecUpdate.pdf. (Data calculated from table.)
[29] World Wind Energy Association, *World Wind Energy Report 2009*, March 2010, pp. 3 and 16. Available at: http://www.wwindea.org/home/images/stories/worldwindenergyreport2009_s.pdf.
[30] American Wind Energy Association, *Annual Wind Industry Report 2009*, Year Ending 2008, p. 18. Available at: http://www.awea.org/publications/reports/AWEA-Annual-Wind-Report-2009.pdf.
[31] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook*, "Early Release Overview," December 14, 2009. Available at: http://www.eia.doe.gov/oiaf/aeo/overview.html#elecgen.
[32] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook*, "Early Release Overview," December 14, 2009. Available at: http://www.eia.doe.gov/oiaf/aeo/overview.html#elecgen

contributing 252,055 metric tons, 10.2 percent of the nation's total, in 2008. The state ranks second in nitrogen oxide emissions and fifth in sulfur dioxide emissions from electricity production.[33] Texas has three metropolitan areas that currently do not meet federal air quality standards for eight-hour ground-level ozone: Houston-Galveston-Brazoria, Dallas-Fort Worth and Beaumont-Port Arthur. This underscores the need for greater efforts in the field of clean energy, not just as a matter of having new sources of power but also in cleaning up the environmental consequences of the current fuel mix.

Electricity Prices

Table 4 shows comparative electricity price data by sector for Texas and the U.S. as a whole for 2009. The Texas average retail price for electricity for all sectors in 2009 was 10.18 cents per kilowatt hour (kWh), compared with a national average of 9.89 cents per kWh. Prices among the states ranged from 6.08 per kWh in Wyoming to 21.21 cents per kWh in Hawaii. Texas ranked 16th among the states. Average prices in the residential and transportation sectors were higher in Texas than the national average, but were lower for the commercial and industrial sectors.[34] In areas of Texas where customers may choose providers, residential retail rates can vary from 7.8 cents per kWh to 14.3 cents per kWh, depending on the provider and the offer terms.

TABLE 4: AVERAGE RETAIL PRICE OF ELECTRICITY BY SECTOR, 2009
(Cents/kWh)

	Residential	Commercial	Industrial	Transportation	Average
Highest State	$0.242	$0.219	$0.181	$0.146	$0.212
Texas	**$0.127**	**$0.098**	**$0.070**	**$0.098**	**$0.102**
Lowest State	$0.076	$0.065	$0.043	--	$0.061
U.S. Average	$0.446	$0.102	$0.068	$0.112	$0.099
Texas Rank	**15**	**17**	**19**	**12**	**16**

Source: U.S. Department of Energy.

Table 4: Average Retail Price of Electricity by Sector, 2009

The Department of Energy projections indicate that the average price of electricity will decline in real terms (with adjustment for price inflation) nationwide and remain below nine cents per kWh in 2008 dollars through 2020, rising to 10.2 cents per kWh in 2035, primarily due to

[33] U.S. Department of Energy, Energy Information Administration, "Texas," April 8, 2010. Available at: http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=TX and "State Ranking 6: Carbon Dioxide Emissions by the Electric Power Industry, 2008," April 15, 2010. Available at: http://tonto.eia.doe.gov/state/state_energy_rankings.cfm?keyid=86&orderid=1.
[34] U.S. Department of Energy, Energy Information Administration, "Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State," (Table 5.6.B), March 15, 2010. Available at: http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_b.html.

forecast changes in natural gas prices.[35] This represents a base case for forecasting purposes, and forecasters have to start somewhere; however, the likelihood of this projection proving to be accurate is dubious at best, particularly for oil and natural gas.

There are several reasons to believe that electrical prices are likely to be higher than the Department of Energy's base case scenario. One is simple historical experience. Figure 6 tracks constant dollar changes in prices for the three major fossil fuels and electricity since April 1993. The chart illustrates the extreme volatility of oil and, to a lesser extent, natural gas over this period. Oil prices are set by the world market, and natural gas prices tend to move along with them, although the development of new high-cost gas reserves in the U.S. during the 1990s and early 2000s had a moderating effect on price fluctuations for that resource. Fluctuations in coal are much less volatile, because it primarily produced and consumed in the U.S. Electricity costs have been similarly stable in real terms. The assumed trend in oil prices in particular is likely to be higher in coming years because economic development in China, India and other emerging nations will push up prices. Natural gas should follow such price trends to a degree, although it may not be as heavily affected given the emergence of high-cost shale gas as a resource.

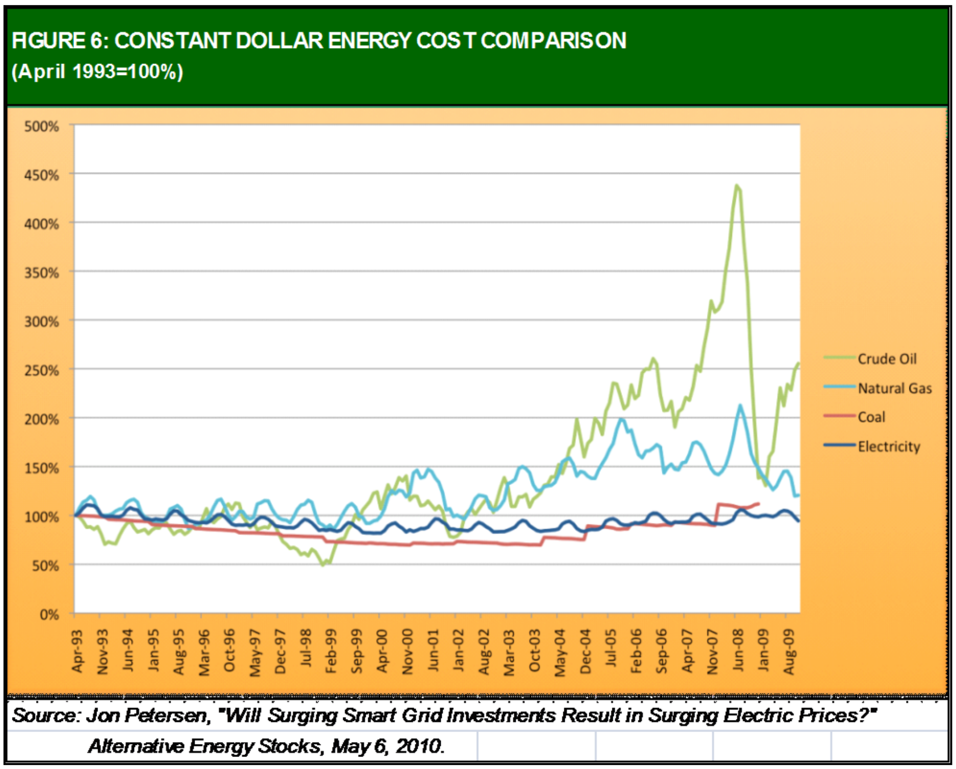


Figure 6: Constant Dollar Energy Cost Comparison

[35] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 201*, "Early Release Overview," p. 4. Available at: http://www.eia.doe.gov/oiaf/aeo/pdf/overview.pdf.

The effects on electricity prices are more complex. They will, certainly, be affected by the cost of the fossil fuel sources discussed above, but other issues will also factor into the outlook. One critical factor may be carbon mitigation requirements that seem likely to be imposed on the coal mining and electric power industries in coming years. There are also likely to be, according to experts, large amounts of capital spending associated with the transition to a smart grid power system, and largely unpredictable demands as more of the transportation sector shifts, at least in part, from fossil fuels to electricity. Even clean energy will impose new costs on the electric power industry, both to integrate them into the fuel mix and to develop the transmission and storage infrastructure needed to make them fully reliable additions to generating capacity. The only conclusion that can be draw from this is that electricity prices are very likely to climb, and the increase could be significant, particularly in the early years of a smart-grid build out. A continuation of flat real prices is a hopeful outlook but also an unlikely one.

Price uncertainty can dampen investment, especially in deregulated areas like Texas, a problem that can translate to reduced reserve capacity margins. The reserve margin is the percentage by which available capacity exceeds peak demand; sufficient margins are critical to prevent grid failure. ERCOT has recommended a target of 12.5 percent but projects its reserve margin to fall from 21.8 percent in 2010 to 10.2 percent by 2015.[36]

Distributed generation can increase the reliability of the grid network and provide electricity for homes and businesses during a grid failure. It can also contribute to grid stability by meeting peak demand needs and reducing the need to build new transmission lines.

No single energy resource will be able to fully meet the state's growing demand. As the data on recent additions to capacity suggest, it will take a combination of generation sources and a greater use of other strategies like energy efficiency and conservation. The key will be how we develop and encourage the various energy sources in the future. The state needs to bear in mind the twin challenge that the National Governors' Association has laid out—to satisfy growing demand and to curb greenhouse gas emissions.

While electricity generation is critical to operating American homes, businesses and industries, it also is a leading source of airborne pollution. Electricity accounts for the largest portion of U.S. emissions—about 40 percent—ranking ahead even of the transportation sector, which is most often associated with poor air quality in urban areas. Moreover, one estimate found that U.S. electric power CO_2 emissions are projected to grow by more than 20 percent between now and 2030. Coal, which accounts for almost 20 percent of electric power generation in Texas, has the highest CO_2 emission rate among the fossil fuels. It emits 1.7 times more carbon per unit of energy than natural gas when burned.[37]

[36] Electric Reliability Council of Texas, *Report on Existing and Potential Electric System Constraints and Needs*, December 2009, p. 27. Available at: http://www.ercot.org/content/news/presentations/2010/2009_Constraints_ and_Needs_Report_21DEC2009.pdf and *Report on the Capacity, Demand and Reserves in the ERCOT Region*, December 2009. Available at: http://www.ercot.com/content/news/presentations/2010/2009CDR_DecUpdate.pdf.

[37] Pew Center on Global Climate Change, *Addressing Emissions from Coal Use in Power Generation*, Congressional Policy Brief, Fall 2008. Available at: http://www.pewclimate.org/docUploads/Coal.pdf

It is unrealistic to believe that the state or the nation as a whole will move dramatically away from its reliance on fossil fuels in the short term, but we need to recognize the importance of developing other sources so that our current levels of reliance can be stabilized and ultimately reduced. Renewable energy presents the best opportunity to achieve this goal. Renewable energy sources like wind, solar, geothermal and hydroelectric, rely on fuels that are abundant and have little additional cost once upfront capital requirements are met. Efficient and cleaner power generation can help to meet electricity demand growth and manage greenhouse gas emissions simultaneously. Transitioning to clean energy also creates economic opportunities by stimulating state and regional economies in new ways that can promote the development of new industries and new jobs. Finally, pursuing a diversified fuel source strategy will also be important in reducing the price volatility as well as risks to reliability and will help to keep energy supply and demand in better balance.

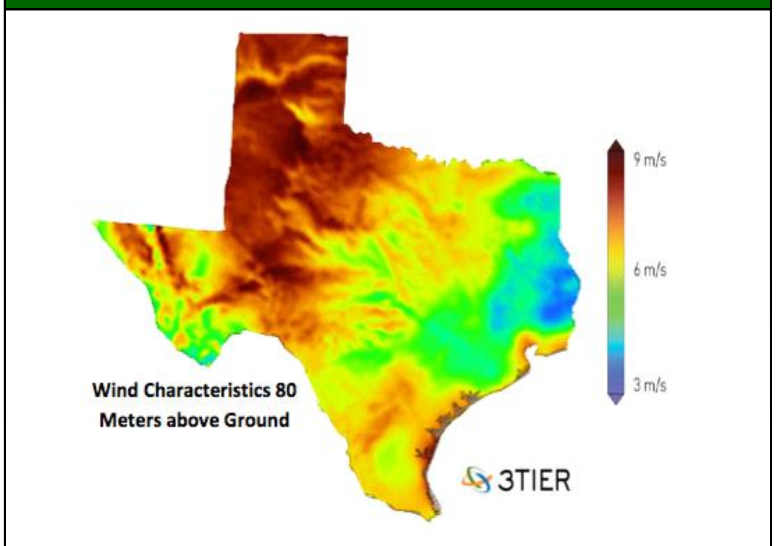
3. Texas' renewable energy potential

Key points:

1. **This chapter explores the potential for wind, solar and other forms of renewable energy including biomass energy, hydroelectric power and geothermal energy, and provides an assessment of each source's viability for meaningful development.**

2. **With current technology, much of Texas' future renewable energy development will be derived from wind, solar and biomass, although each of these technologies must overcome problems as they grow in significance.**

FIGURE 7: TEXAS WIND POTENTIAL



Source: Wind Coalition.

Figure 7: Texas Wind Potential

In Texas today, when it comes to clean energy development, wind energy is king. The state has large, remote areas with consistent wind that are well-suited to wind farm development (Figure 7). As a result, Texas leads the nation in wind energy.

Texas also has extensive undeveloped solar resources (Figure 8). Solar radiation is available throughout the state in quantities sufficient to power distributed solar systems such as solar water heaters and off-grid photovoltaic panels. As in the case of large wind farms, large-scale solar power plants are likely to be sited predominantly in remote areas of West Texas that receive very high levels of sunlight throughout the year.

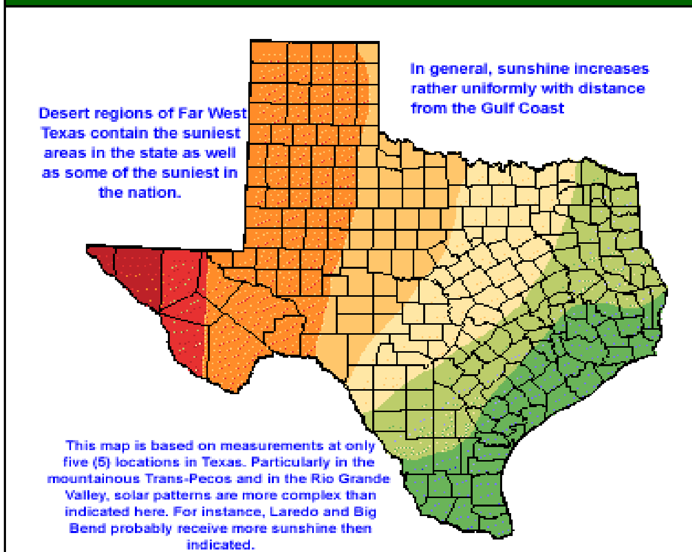
To date, however, solar development in Texas has lagged behind other states like California. One major obstacle to large-scale solar development is the large capital costs involved in the creation of solar farms which can run into hundreds of millions of dollars. This is a sizable investment compared to the relatively lower cost of wind farms, and especially when compared to the significantly lower costs for natural gas- and coal-fired power facilities.

Biomass also offers significant potential in Texas. Biomass energy is produced from plant or animal matter that is either burned directly or converted to fuel through various processes. However, one major issue stands in the way of further biomass development. Unlike solar or wind farms which locate in remote areas, biomass requires agricultural land or products that have many other uses. The Texas State Energy Conservation Office puts it succinctly:

> Perhaps the most important factor to remember about biomass' potential role in the energy sector is that, again unlike most clean energy, stiff competition will always exist for both the biomass and the requisite land resource to grow it. This is often encapsulated in the five 'f's' of biomass usage: food, feed, fiber, forage, and fuel. Fuel–growing biomass to burn it—will normally be the least valuable on this list. Even among wastes derived from biomass, higher value applications may diminish their use as fuel: manures have value as fertilizers; waste paper can be recycled; cottonseed hulls find their way into oil drilling muds, wood chips into landscape mulches, restaurant greases into pet food. Although many specialists have envisioned a role for biomass in which it is grown extensively and solely for fuel (energy crops), it is probable that this can only happen with at least some valued dual use or co-product derived from the crop.[38]

Although it played an important role in the spread of electrification in Texas during the 20th century, hydroelectric power supplies only a small fraction of Texas' power supply today, and that percentage is shrinking as total generating capacity grows. According to state reports, Texas has some potential for additional hydroelectric power, but there are no current plans to develop it. Significant legal and regulatory impediments, such as land acquisition and environmental protection, are major factors in any major hydroelectric project. Additionally, reservoirs are typically built and managed first as municipal water supply and flood control systems and only second for power production. This fact lowers the

FIGURE 8: TEXAS SOLAR POTENTIAL



Source: Texas State Energy Conservation Office.

Figure 8: Texas Solar Potential

[38] Texas State Energy Conservation Office, "Texas Renewable Energy Resources—Biomass." Available at: http://www.infinitepower.org/resbiomass.htm

potential impact of hydroelectric development on the state's energy future.

Other renewable sources also have less potential in Texas. One example is geothermal energy. Geothermal energy is derived from the heat generated by the earth's interior. Heat from molten rock beneath the earth's surface or from natural radioactive decay is transferred to rock and water closer to the surface. This heat can be tapped to turn power turbines and generate electricity. Historically, geothermal power has been limited to areas near tectonic plate boundaries, such as those along the U.S. west coast. Although recent technological advances have expanded the range and size of viable resources, Texas does not possess easily accessible geothermal resources with the high temperatures required to generate electricity. It does, however, possess some low-temperature hydrothermal reserves that have seen limited use.

Another less-promising renewable resource for the state is ocean energy, despite the state's 367 miles of shoreline. At present there are three possible sources of ocean energy: tides, waves and ocean temperature differentials (ocean thermal energy conversion, or OTEC). None are significant resources in Texas and, to date, have not been commercially exploited elsewhere.[39] Tidal energy facilities capture water at high tide and release it at low tide. But Texas, with a median Gulf Coast tidal range of just 1.3 feet, does not have the large tides necessary for such a system to be feasible. Gulf Coast waves tend to dissipate close to shore due to relatively shallow waters. This has hindered development since potential facilities would have to locate far from shore, and their electricity would have to be transmitted significant distances to land. Finally, the closest potential OTEC site to Texas is more than 100 miles offshore, an even larger transmission problem.

Much of the future of renewable energy generation will concentrate wind and solar, and to a lesser extent, biomass. These have the largest potential and the greatest promise. However, especially in the case of solar and wind, there are problems that will have to be overcome as they grow in importance to the power grid. This is only one of the challenges that clean energy development faces in Texas. The next chapter of the report will examine these challenges in detail.

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[39] Texas State Energy Conservation Office, "Texas Renewable Energy Resources—Water." Available at: http://www.infinitepower.org/reswater.htm

4. Challenges facing renewable energy development

Key points:

1. **Challenges to clean energy in Texas fall under five basic categories: transmission; intermittency; permitting and siting; supporting industrial infrastructure; and cost.**

2. **New CREZ transmission lines and advancements in energy storage units should help compensate for the inherent intermittency of wind and solar power.**

3. **Siting and permitting for renewable projects is less of a problem in Texas than in many other states.**

4. **The need for supporting infrastructure and a skilled workforce for clean energy depends on Texas' willingness to capitalize on this emerging industry.**

5. **Clean energy costs will have the greatest impact in determining the future of renewable energy projects in Texas and around the nation.**

It is without question that renewable energy offers many benefits to Texas in meeting its future needs for energy and providing a new source of jobs and investment. There are, however, several challenges to the development of these energy sources that must be addressed. The challenges come down to five factors: transmission, intermittency, patchwork structure of permitting and siting regulations, the supporting industrial infrastructure and cost.

Transmission and intermittency are related to the stage of development and the nature of the major renewable sources, specifically wind and solar energy. They will be resolved to some extent by the development of the energy infrastructure and improvements in technology over time. The third issue, the permitting and siting patchwork, has to do with the many levels of government involved in approving potential renewable projects, although this is less of a problem in Texas than in other states. While this challenge confronts all electrical generation projects—some far more than clean energy projects—it still imposes an impediment to efficient development of these resources. The fourth factor—supporting infrastructure—is less an issue with the availability of the technology than of the state's ability to capitalize to the fullest extent possible on the developing clean energy economy. Finally, and most importantly, the cost factor is both more complicated and more controversial than the other four issues but also will have the greatest impact on the future success of renewable energy projects in Texas and nationally. How these challenges are met goes to the heart of just how far these energy sources can go in reducing our national dependence on fossil fuels over time.

Transmission—Getting Power to the People

Power transmission is an obstacle for some renewable technologies, like wind and solar, because they tend to be located in more remote locations, often at considerable distance from where the power is actually used. This implies the need for new transmission capacity to deliver the energy to load centers and to consumers. In this regard, our national electricity grid is integral to the shift to a clean energy-based economy. The current grid configuration is generally acknowledged to be unable to handle the growth in electricity demand expected over the next few decades in any case and requires modernization. This provides a prime opportunity to adjust for efficient clean energy development. Grid modernization, as it does occur, should be designed to be compatible with growing renewable energy generation. The transmission grid would have to be expanded and upgraded in wind-rich areas and across the existing system to deliver wind energy to many demand centers and to provide improved interconnectivity between different regions of the U.S.

In this regard, it is important to recognize the special problems facing wind development, largely because wind power sites tend to be the most remotely located and are often outside the normal power grid. For this reason, wind development will require large investments in transmission. Meeting this challenge will be a critical factor in future clean energy development in the U.S. Much of the current development of clean energy in the U.S. has come from wind generation, and forecasts indicate that will continue to be the case over the next two decades.[40]

It is possible to get some idea of the scope of the challenge by looking at projections of transmission expansion under various scenarios. For example, to explore the possibility of more aggressive levels of wind deployment, the U.S. Department of Energy, in collaboration with its national laboratories and the wind industry, recently completed a major technical and economic feasibility study of wind power based on a scenario assuming 20 percent of the nation's electricity supplied by wind by 2030.[41] Since wind energy still accounts for less than two percent of total U.S. electricity generation, the study found, unsurprisingly, that reaching 20 percent wind generation would require a dramatic commitment to increasing wind capacity.

The study concluded that 305 GW of wind capacity and more than 12,000 miles of new transmission lines would be needed by 2030 to meet the 20 percent goal. The numbers are large, but not inconceivably large given the likely investment in the transmission grid in coming decades. The report notes that compared to other generation sources, the 20 percent wind scenario would imply higher initial capital costs—to install wind capacity and associated

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[40] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2010*, April 2010. Available at: http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2010).pdf

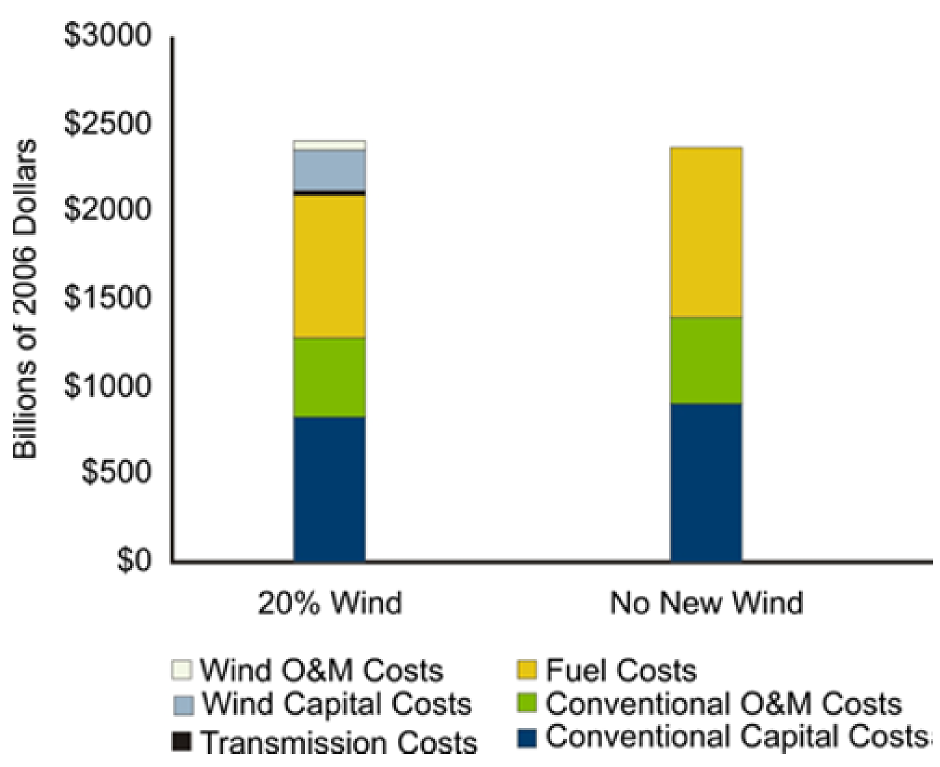
[41] U.S. Department of Energy, *20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply*, DOE/GO-102008-2567, July 2008. Available at: http://www1.eere.energy.gov/windandhydro/pdfs/41869.pdf

transmission infrastructure—but would offer lower ongoing energy costs for operations, maintenance and fuel. The report concludes that "the 20% Wind Scenario could require an incremental investment of as little as $43 billion net present value (NPV) more than the base-case scenario involving no new wind power generation (No New Wind Scenario). This would represent less than 0.06 cents (6 one-hundredths of 1 cent) per kilowatt-hour of total generation by 2030, or roughly 50 cents per month per household. The base-case costs are calculated under the assumption of no major changes in fuel availability or environmental restrictions. In this scenario, the cost differential would be about 2% of a total NPV expenditure exceeding $2 trillion." Figure 9 illustrates the differential costs between the 20 percent wind scenario and one that assumes business as usual.

These direct costs could also be offset by a number of possible benefits, including lower fossil fuel prices, environmental gains, water savings, rural economic development and additional jobs in the renewable energy sector. Perhaps of greatest importance, achieving 20 percent wind would reduce the carbon footprint of the electricity sector. The analysis shows an annual reduction of 225 million metric tons of carbon by 2030, roughly equal to a fifth of expected electricity-sector carbon emissions by that time. The carbon emissions that would be avoided represent an economic cost of $13 per ton of CO_2 equivalent, reflecting a significant savings.

Competitive Renewable Energy Zones. Texas, recognizing the importance of wind energy for the state's future energy needs, has already taken some steps to deal with the transmission issues. The state Legislature passed Senate Bill 7 in 1999, which restructured the state's electric industry and established a renewable portfolio standard (RPS) for electric power generation, with the intent to install more than 2,000 megawatts (MW) of generating capacity from renewable energy technologies by January 1, 2009. S.B. 7 made no provision for transmission to interconnect the newly-mandated renewable sources, and this factor ultimately limited the effectiveness of the Texas renewable portfolio standard.

FIGURE 9: INCREMENTAL INVESTMENT IN WIND REQUIRED FOR 20% PENETRATION



Source: U.S. Department of Energy, 20% Wind Energy by 2030, July 2008.
O&M = operations and maintenance.

Figure 9: Incremental Investment in Wind Required for 20% Penetration

As the wind industry expanded in succeeding years, subsequent legislation made the interconnection issue even more imperative. Enacted by the Legislature in 2005, Senate Bill 20 raised the required amount of renewable power generation to 5,880 MW, to be installed by January 1, 2015 with a target of 500 MW from non-wind renewable resources. It also required the Public Utility Commission (PUC) to set a target of 10,000 MW of renewable generation capacity to be installed by January 1, 2025. The non-wind provision indirectly promotes solar power and biomass in Texas and potentially provides farmers and ranchers with new revenue sources from the use of crops and animal waste to produce energy.

In this case, transmission issues were not overlooked. The other important provision of S.B. 20 was to provide for a transmission plan for remote regions handicapped by lack of a transmission infrastructure, the goal being to increase transmission capacity to get clean energy from remote areas to the state's urban centers.

The legislation provided for the creation of Competitive Renewable Energy Zones (CREZs) to provide transmission infrastructure to prime renewable energy areas even before wind farms or other renewable facilities are developed. In July 2007, after evaluating the potential for wind-generation in about 25 areas in the state, the PUC designated eight areas as CREZs. Eventually, these were combined into five zones in the areas around McCamey in Uptown County, Abilene and Sweetwater and the Panhandle (Figure 10). In progress now, the CREZ effort eventually will increase Texas' current level of wind generation capacity to 18,456 MW. Increased transmission infrastructure connecting the CREZ with the ERCOT grid will allow for greater development of the state's wind resources.

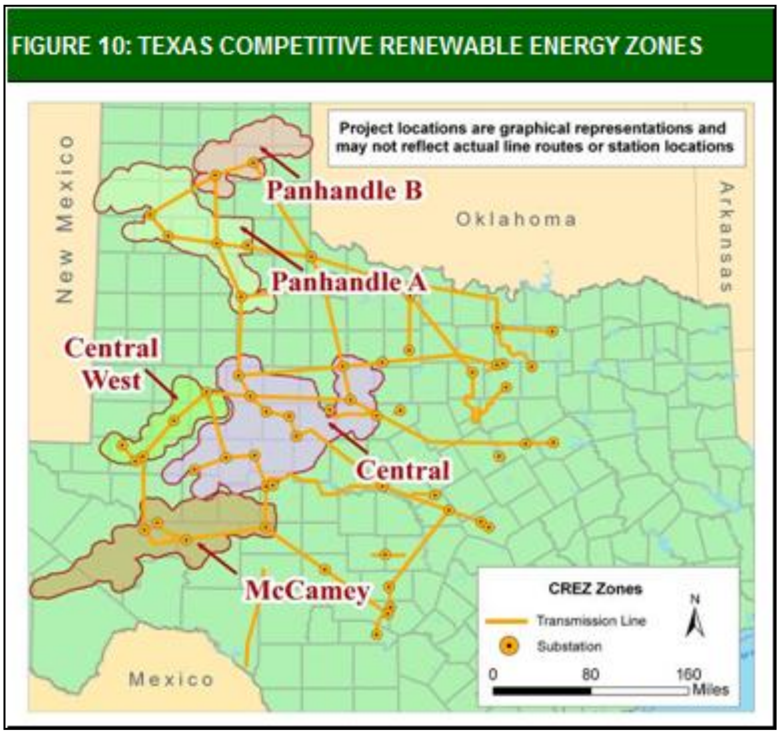


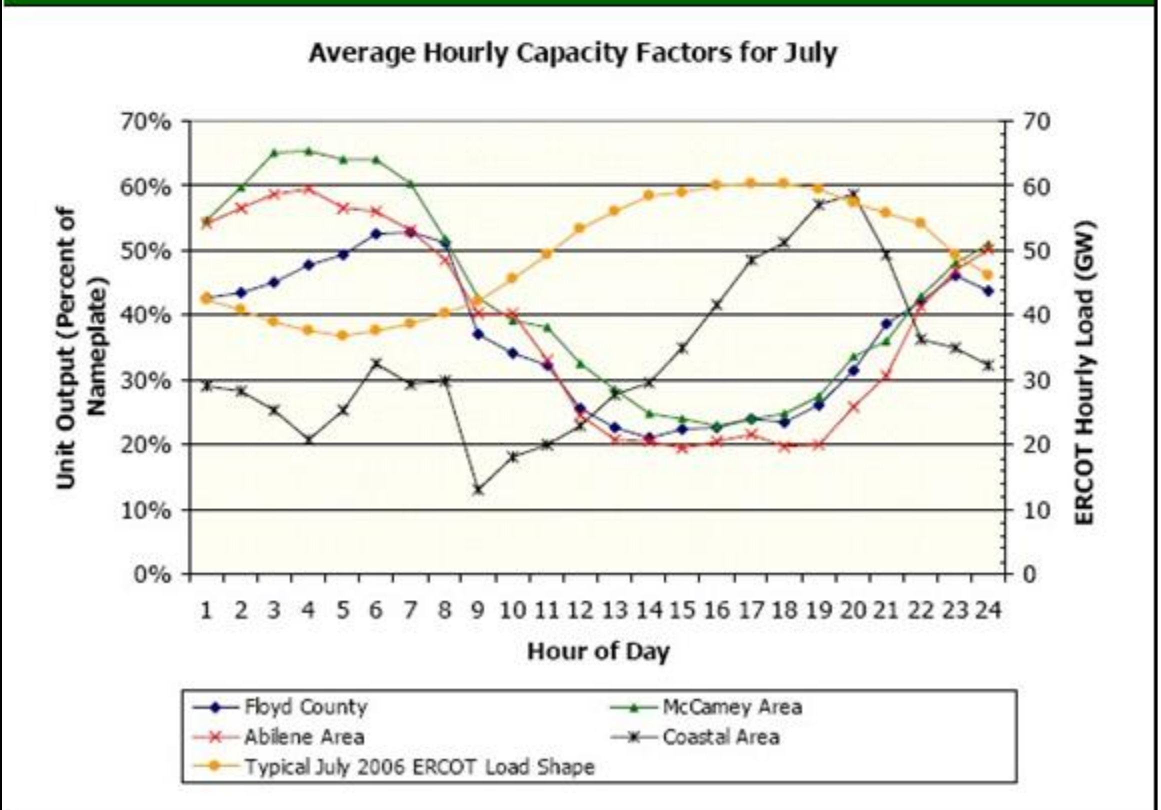
Figure 10: Texas Competitive Renewable Energy Zones

Intermittency—When the Wind Blows and the Sun Shines

A second challenge for renewable in base load electricity generation is the predictability of supply. As noted earlier, wind and solar energy sources in particular flow intermittently or at varying rates. Solar radiation falls nearly to zero at night and is affected by cloud cover and air conditions during the day. In many locations, its seasonal distribution pattern—stronger in the summer, weaker in the winter—does not complement heating needs. Similarly, wind generation in Texas tends to be the greatest at night and lowest during the daytime, dropping sharply in the morning when load is rising and increasing sharply in the evening when load is falling. The inverse relationship is stronger in the summer than during other seasons, again the inverse of electrical demand patterns.

Because electrical generation and consumption with the grid system must remain in balance to maintain stability, this pattern of variability can present substantial challenges to incorporating large amounts of wind power. Intermittency and the non-dispatchable nature of wind energy production can raise costs for regulation, incremental operating reserve and (at higher levels of use) could require an increase in energy demand management.[42] This pattern and its relationship to the ERCOT grid requirements can be seen in Figure 11, which shows the shifting levels of hourly capacity in the state's Competitive Renewable Energy Zones compared to ERCOT's load shape—the cyclical rise and fall of electrical demand in the ERCOT region. The match is far from perfect.

FIGURE 11: AVERAGE HOURLY WIND GENERATING CAPACITY TEXAS COMPETITIVE RENEWABLE ENERGY ZONES, 2006



Source: Electric Reliability Council of Texas

Figure 11: Average Hourly Wind Generating Capacity, Texas CREZs, 2006

Other Renewables. Hydroelectric power generally is stable but varies seasonally depending on water supply. In the case of river-driven hydroelectric power, these variations can change over the course of a few weeks, while for reservoir-based hydro, there are fewer short-

[42] Dispatchable generation refers to sources of electricity that can be dispatched at the request of power grid operators—that is, they can be turned on or off on demand. Natural gas generating plants are an example of a dispatchable electrical power source.

term problems. There is, however, the general question of whether there is sufficient precipitation coming into the reservoirs in which the system operates. One major concern in this regard is the recent pattern of drought that Texas has experienced which could impact reliability, but the hurdles to more extensive use of hydroelectric power in Texas go beyond that issue. As noted earlier, significant legal and regulatory impediments, such as land acquisition and environmental protection, limit more extensive development of hydroelectric power in the state. The other major water-based renewable source, wave energy, can deviate significantly from its average level. However, in the short term, this is not an issue in Texas due to the limited development of this technology to date.

One major renewable source where intermittency is not a problem is biomass, since it comes from plant and animal materials that are generally available once a supply is secured. Using biomass—or fuels derived from biomass—as a source of energy entails burning it to yield heat that can then drive engines or generate electricity. In this sense, biomass more closely resembles a fossil fuel than it does the other energy technologies: its energy is chemical in nature and not susceptible to variability problems like wind and solar.

Wind Intermittency in the ERCOT Grid. Intermittency can pose a significant issue when renewable energy is applied to the overall power grid. That wind production can drop suddenly is a point that is already well understood by the Texas power industry. On February 26, 2008, because of a sudden drop in wind turning turbines, wind production in the ERCOT supply region dropped from over 1,700 MW to 300 MW within a three-hour period.[43] Traditional power plant operators, who would normally provide more power on short notice, failed to provide power as promised. ERCOT was able to avoid blackouts by asking large industrial customers to cut back on power use.[44] On the other hand, when the wind blows too hard, and wind turbines produce more electricity than the grid can accommodate, the producers in West Texas must shut down the wind turbines.

With this problem in mind, one major challenge for the clean energy industry is to find ways of storing energy so that it is not wasted, as well as other approaches to stabilizing energy supplies. Ironically, just weeks before the Texas wind event, plans were announced to install 24 Wärtsilä 20V34SG reciprocating engines fueled by natural gas at a site 50 miles southwest of San Antonio. This plant is designed to help compensate for the effects of wind intermittency. Other options involve large-scale electricity storage technologies, such as pumped hydropower, compressed air energy storage and utility-scale batteries. These systems are expensive or limited to a few available sites, but over time, the technology should improve and costs should come down. In addition, the integration of distributed generation sites, such as disbursed wind or solar farms, which are always producing some power and will never go completely down, are a key to reliability.

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[43] Electric Reliability Council of Texas (ERCOT), "ERCOT Demand Response Program Helps Restore Frequency Following Tuesday Evening Grid Event," Austin, Texas, February 27, 2008. (Press release.) Available at: http://www.ERCOT.com/news/press_releases/2008/nr02-27-08.html.

[44] These so-called "demand-response" customers get reduced electric rates in exchange for cutting power on short notice.

Still, until these technologies develop, some backup to clean generation will be needed. To help quantify the need for additional ancillary services provided by gas-fired units to follow wind variability, ERCOT commissioned a report by GE Energy to look at the effects of large-scale wind penetration on its system. William O. ("Bill") Bojorquez, vice president of system planning for ERCOT, said at the time that indications were that the grid could need a 20 to 23 percent increase in gas-fired capacity to meet the effects of the variability in wind generation. "When wind dies off in the morning and load picks up, there might be some significant ramping requirements," he said. The evening hours are another time when gas plants likely would be called on to regulate the grid as winds rise and loads fall. Not surprisingly, the GE Energy study found that increased penetration of renewable sources would impose new planning demands on ERCOT, although none were insurmountable. In its report, the company came to this conclusion:

> An overall observation in this study is that through 5,000 MW of wind generation capacity, approximately the level of wind capacity presently in ERCOT, has limited impact on the system. Its variability barely rises above the inherent variability caused by system loads. At 10,000 MW wind generation capacity, the impacts become more noticeable. By 15,000 MW, the operational issues posed by wind generation will become a significant focus in ERCOT system operations. However, the impacts can be addressed by existing technology and operational attention, without requiring any radical alteration of operations.[45]

Studies of the Intermittency Problem. Indeed, there is ample evidence that the intermittency problem may be overstated given effective planning and forecasting of electricity demand and the availability of adequate reserves from other sources. In addition, there are solutions to the intermittency problem. Since the general shape of electrical demand in a given area is known, if new wind or solar farms with adequate transmission capability are planned correctly, they can be sited to produce more power when it is most needed. For instance, in ERCOT's CREZ study, illustrated in part in Figure 11, wind along the southern Gulf Coast was found to be a much better match for the ERCOT load shape than wind in other areas, although the average capacity factor was considerably lower than Panhandle wind.[46] Energy planners can use this knowledge to improve the overall capacity and reliability of the resource. There is also the potential to balance wind and solar resources which are complementary in when they are most effective in providing energy to the power grid—solar during peak load daytime hours and wind in the evening.

The potential to plan effectively for the integration of renewable sources is supported by national studies of the issue. For example, the Western Wind and Solar Integration Study (WWSIS) released in May 2010 looked at the operational impact up to 35 percent energy penetration of wind, photovoltaics (PVs) and concentrating solar power (CSP) on the power

[45] GE Energy, *Analysis of Wind Generation Impact on ERCOT Ancillary Services Requirements*, Executive Summary, March 28, 2008. Available at: http://www.uwig.org/AttchA-ERCOT_A-S_Study_Exec_Sum.pdf

[46] Electric Reliability Council of Texas, *Analysis of Transmission Alternatives for Competitive Renewable Energy Zones in Texas*, ERCOT System Planning, Attachment A, December, 2006.

system operated by the WestConnect group of utilities in Arizona, Colorado, Nevada, New Mexico and Wyoming.[47] The study was done in response to the DOE study mentioned earlier that found few technical barriers to 20 percent wind generation by 2030. Among other questions, WWSIS examined the operating impact of a 35 percent penetration and how it could be accommodated.

The technical analysis performed in the study concluded that it was feasible for the WestConnect region to accommodate 30 percent wind and five percent solar energy penetration with some adjustments. According to the study's conclusions: "This requires key changes to current practice, including substantial balancing area cooperation, sub-hourly scheduling, and access to underutilized transmission capacity. WWSIS finds that both variability and uncertainty of wind and solar generation impacts grid operations. However, the uncertainty (due to imperfect forecasts) leads to a greater impact on operations and results in some contingency reserve shortfalls and some curtailment, both of which are relatively small." It could generally be covered because the greater use of wind generation resulted in more available non-renewable backup reserves, the study found. Therefore, commitment of additional reserves is not needed to cover the increased variability.

The Utility Wind Integration Group (UWIG), a group whose members include utilities and associated corporations with an interest in wind energy power generation, looked at utility company studies of wind energy intermittency in states ranging from New York to California in a 2006 study. The group also summarized these studies in cooperation with the three large utility trade associations—the Edison Electric Institute (EEI), the American Public Power Association (APPA), and the National Rural Electric Cooperative Association (NRECA). Among its conclusions from this review: "Wind resources have impacts that can be managed through proper plant interconnection, integration, transmission planning, and system and market operations." It found that wind energy could be effectively integrated up to a very large share of total electrical generation because of expected improvements in technology as well as by incorporation of effective planning that recognizes the inherent characteristics of the energy source." Since wind is primarily an energy—not a capacity—source," the group concluded, "no additional generation needs to be added to provide back-up capability provided that wind capacity is properly discounted in the determination of generation capacity adequacy. However, wind generation penetration may affect the mix and dispatch of other generation on the system over time, since non-wind generation is needed to maintain system reliability when winds are low."[48]

Everyone knows that the wind blows at some times and not at others and that the sun is out only part of the day. However, those simple truths should not be used to gloss over the more complex reality of power industry planning. Intermittency will be raised as an issue whenever there is an effort to expand renewable energy development, but there is not real evidence from

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[47] National Renewable Energy Laboratory, *Western Wind and Solar Integration Study*, prepared for NREL by GE Energy, May 2010. Executive summary available at: http://www.nrel.gov/wind/systemsintegration/pdfs/2010/wwsis_executive_summary.pdf

[48] Utility Wind Integration Group, *Utility Wind Integration State of the Art*, Reston, Virginia, 2006. Available at: http://www.uwig.org/UWIGWindIntegration052006.pdf.

the studies that have examined the issue that it presents an insurmountable or unusually expensive hurdle over time. All power generation technologies present technical problems, and the problems presented by clean energy sources can be effectively managed with relatively accurate forecasting of power availability versus demand, adequate planning and the availability of either spinning reserves or, as the technology develops, various large-scale storage technologies to hold power in reserve to meet short-run variability supply. The evidence suggests that this very prominent challenge to expanded use of renewable energy *is* an issue, but it is less of an issue for electrical power planners than it is as a matter of public misperception.

Permitting and Related Issues—Cutting Through the Red Tape

Getting new renewable projects sited, permitted and interconnected to the grid is challenging, involving federal, regional, state and local jurisdictions. Reaching consensus on how to allocate the costs of new transmission can be difficult. Before construction and installation can begin, most clean energy projects need approval and permits for the desired site. Larger facilities often have other issues that must be addressed, including environmental and other permits from the federal government and the affected states as well as various local approvals. The process can be time-consuming and expensive, involving extensive studies, lengthy reports and time-consuming review and public consultation processes.

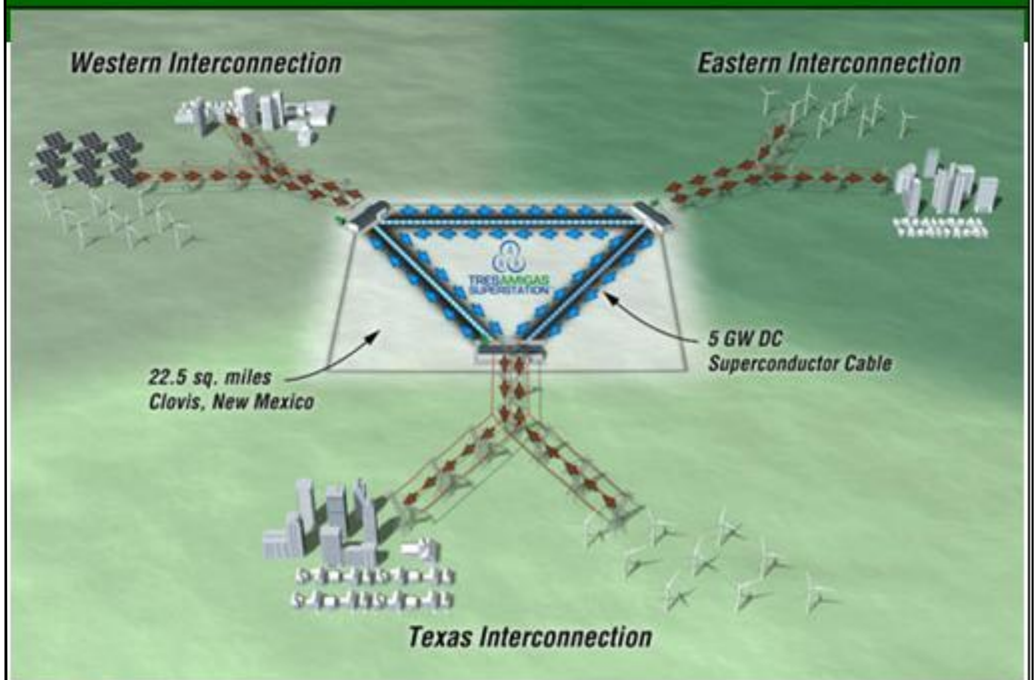
One specific problem with efficient development of the renewable energy infrastructure nationally is that permit criteria, applications and review processes are inconsistent across various jurisdictions. States have found that there is a need to increase efforts to develop an integrated strategy for working across jurisdictions and federal agencies to ensure swift and comprehensive review and permitting. One analysis found that a wind farm proposal could fall into the bailiwick of any one of eight federal agencies, and that there is no streamlined process for coordinated action.[49]

The Texas Interconnection. This is, however, less of a problem in Texas than in many other states. Since 1935, the majority of Texas utilities have opted to isolate themselves from interstate connection and thus from federal regulation over rates, terms and conditions of electrical transmission. Managed by ERCOT, they now provide more than 85 percent of the state's electrical load, covering 75 percent of its land area. This significantly reduces the number of regulatory hoops that utilities have to go through in Texas and is at least partly responsible for the rapid development of clean energy in Texas. "If you go to either of the other two grids you've got to get 20-something state utility commissions to agree on something," B.J. Stanbery, the founder of the Austin-based solar manufacturer HelioVolt, told a reporter in a November 2009 interview. "In Texas, we've only got one to persuade. Now, that's a big benefit."[50]

[49] National Governors Association, *Securing a Clean Energy Future: A Governor's Guide to Clean Power Generation and Energy Efficiency*, *2008*. Available at: http://www.nga.org/Files/pdf/0807CLEANPOWER.PDF
[50] Jennifer Bogo, "Lone Star Energy: Why Texas Will Resist the Call for a Unified Grid," *Popular Mechanics*, December 18, 2009. Available at: http://www.popularmechanics.com/science/energy/solar-wind/4333893

This could become more of an issue for Texas in the future. For example, the *Tres Amigas* "superstation" proposed for Clovis, New Mexico, has proposed building a three-way link between the three separate electrical grids that cover the U.S. and much of Canada—the Eastern Interconnection, the Western Interconnection and the Texas Interconnection (Figure 12). The three systems currently have minor linkages, but if *Tres Amigas* comes about, it would represent a substantial expansion, allowing large amounts of power to be moved among the three systems.

FIGURE 12: TRES AMIGAS SUPERSTATION AND ELECTRIC GRID LINKAGES



Source: American Semiconductor.

Figure 12: Tres Amigas Superstation and Electric Grid Linkages

In Texas, ERCOT is already developing upgraded transmission lines that will come near the proposed *Tres Amigas* site, so an interconnection would make sense economically.[51] There is, however, concern that the proposal will run aground on federal-state jurisdictional issues.[52] The Texas Interconnection, managed by ERCOT, is wholly within Texas and predominantly under the jurisdiction of Texas law. Considerable effort has been devoted by state policymakers and utilities to maintaining the state's authority over the system, and some analysts speculate that lawmakers or state regulators could veto any proposal that threatens the state's jurisdiction over ERCOT and the Texas Interconnection. The interconnection issue lies in the future: it represents a

[51] Michael Giberson, "Tres Amigas Proposes Three-way Transmission Link," *Alternative Energy Stocks*, November 11, 2009. Available at: http://www.altenergystocks.com/archives/electric_grid/
[52] Jennifer Bogo, "Lone Star Energy: Why Texas Will Resist the Call for a Unified Grid," *Popular Mechanics*, December 18, 2009. Available at: http://www.popularmechanics.com/science/energy/solar-wind/4333893

difficult tradeoff between efficiency within the national electrical power system and the level of regulatory controls in Texas.

Current links between ERCOT and non-Texas power systems are minimal and have been allowed without a significant change in state jurisdiction over the system. The large scale of trade possible under the *Tres Amigas* proposal gives the Federal Energy Regulatory Commission (FERC) a choice: either to reconsider the current jurisdiction divisions or to waive jurisdiction over power sales in Texas if the state joins the national grid. Tres Amigas is proactively seeking an opinion from FERC stating that the project would not upset existing jurisdictional boundaries around ERCOT. As the nation moves, almost inevitably, to more integration of the three major electrical grids in the lower 48 states—the Eastern, Western and Texas Interconnects—jurisdictional issues are likely to become more common and more complex.

Environmental Impacts and Public Opposition. Another issue is environmental impact concerns associated with some clean energy projects. Inevitably, new construction and development have environmental impacts, and environmental review is indispensable to understand a project's impact on wildlife habitats, endangered species, water supply and air quality. Regulations set by the Endangered Species Act and the Clean Water Act—among others—are necessary but sometimes cumbersome considerations for clean energy development.

One of the goals of new infrastructure to connect areas of high renewable energy potential to regions of the country with the greatest demand is to advance the environmental goal of reducing our nation's fossil fuel-based gas emissions and to promote a shift to a low-carbon economy. Supporters argue that federal permitting of new projects that require environmental impact statements under the National Environmental Policy Act should not only consider greenhouse gas emissions resulting from those projects, but also the projected reduction of emissions resulting from the projects' completion. Thus, when weighed against high-carbon energy development projects, clean energy projects should be accelerated given their longer-term carbon production benefits, which mitigate the environmental impacts of the projects.

Taken as a whole, the environmental impact of renewable energy is estimated to be far less than that of fossil fuels, particularly in terms of water use and land disturbance. Renewable electricity-generating technologies are estimated to use tens of billions fewer gallons of water than traditional steam-turbine based thermoelectric power plants. Coal mining is estimated to disrupt almost 1,000,000 acres of U.S. land each year.[53] In contrast, a Department of Energy scenario that examines the effects of producing 20 percent of our nation's electricity from wind by 2030 concluded that wind farms would cause a one-time disruption of 247,000-617,500 acres—if, that is, they cannot be sited on previously disturbed lands, such as Brownfield sites. A Brownfield site is any commercial or industrial site that is vacant or under-utilized and on which there has been some sort of contamination. Among the states, California's Energy Commission has advocated locating new renewable energy generation on Brownfield sites because reusing the land reduces environmental degradation.

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[53] U.S. Department of Energy, *20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply*, July 2008. Available at: http://www1.eere.energy.gov/windandhydro/pdfs/41869.pdf

Finally, development of a transmission infrastructure and clean energy projects themselves may be complicated by public opposition. Even though new construction of renewable energy facilities and transmission lines arguably offers significant environmental benefits, any new construction risks facing public opposition for aesthetic, economic or environmental reasons. Some early wind farms, for example, faced opposition because of the level of bird kills the turbines caused. In other cases, noise is an issue, although new technologies and siting decisions have overcome some of these criticisms. Objections often involve charges that new construction will obstruct views and reduce property values, and could harm endangered species and habitats. One project that faced widespread public opposition is the offshore wind farm known as Cape Wind in Cape Cod, Massachusetts, in the Nantucket Sound. The project was first proposed in 2001, and its developer has spent years fighting public claims that the farm would be a visual eyesore, negatively affect tourism to the region, and threaten birds, bottom-dwelling fish and boat navigation. The project received final approval from the federal government in April 2010, but only after almost a decade of debate and opposition.

Distributed Generation. Distributed generation, or on-site clean energy generation at homes and businesses, typically requires fewer permit processes compared to large-scale generation facilities. However, there are some permitting requirements. Although Texas state laws and local policies generally favor the use of clean energy sources, neighborhood and homeowners' associations have, in some cases, resisted the installation of solar or wind equipment. Like a majority of states Texas has tax exemptions for solar and wind energy devices under the property tax, but that does not mean that local groups uniformly embrace the use of the technologies in their neighborhoods.[54]

Several Texas cities have programs, often in conjunction with local utilities, to encourage installation of solar energy. For example, in North Texas, TXU Energy announced in February that it was pairing up with a California-based company, SolarCity, to launch a residential solar energy program that doesn't require homeowners to put up any money in advance. There is no upfront cost for installation. Instead, homeowners can make monthly lease payments on the solar panels. Utility officials said that the savings on electric bills generally can be expected to exceed the monthly lease cost. Similarly the City of Austin's municipal utility, Austin Energy, offers solar photovoltaic rebates and commercial incentives to encourage customers to install solar energy systems. As of March 2010, Austin Energy said that it has supported more than 1,050 customer-owned solar energy systems, 70 commercial projects, 24 municipal projects, 28 school installations and six libraries. Together, these comprise more than four megawatts of generation capacity. In addition, more than 35 new solar installation companies have developed in Austin.

Supporting Infrastructure

Another issue that the U.S. and Texas will have to address is how to build the infrastructure and skilled workforce needed to support the young clean energy industry. Despite the political and economic advantages of revamping the nation's electricity infrastructure, the

[54] Texas Property Tax Code, Subsection C, Section 11.11.

U.S. has not yet adequately invested a clean energy workforce, including engineers, manufacturers and construction workers who are experts in the technology. A 2006 study by the National Renewable Energy Laboratory identified the shortage of skills and training as a leading non-technical barrier causing a bottleneck in the future growth of the clean energy and energy-efficiency industries. This skills shortage is occurring even as the American Public Power Association reports that half of current utility workers will retire within the next decade. Policymakers must work to remedy this shortfall through comprehensive and clean-energy-specific workforce training programs.

Also uncertain is the degree to which the U.S. has been successful in promoting the research and development and manufacturing infrastructure needed to produce renewable energy technology in this country. A common criticism of the industry is that much of the associated manufacturing of components is currently done abroad. The most well publicized example of this charge is a recent report by the American University Investigative Reporting Workshop, claiming that money from the 2009 stimulus bill, touted as helping support the renewable energy industry in the U.S., "continues to flow overseas, despite Congressional criticism and calls for change." The Workshop reported in October of last year that more than 80 percent of the first $1 billion in grants to wind energy companies went to foreign firms. An updated report in February claimed: "Since then, the administration has stopped making announcements of new grants to wind, solar and geothermal companies, but has handed out another $1 billion, bringing the total given out to $2.1 billion and the total that went to companies based overseas to more than 79 percent."[55]

A couple of points are important to make about this charge. First, the story, according to supporters of renewable energy, misses the real facts, a point recently made by the American Wind Energy Association:

> "Media is missing the boat, and for that matter the opportunity to get American jobs, by being so wrapped up in the name on someone's work uniform. German, Danish, Spanish, Asian, Indian and American companies are all part of building an American manufacturing industry for wind. Try this one on for size: almost all wind turbine manufacturers that supplied the U.S. in 2008 have American manufacturing facilities already in the ground or publicly announced—GE, Vestas, Siemens, Suzlon, Gamesa, Clipper, Mitsubishi, Acciona, Fuhrlander, DeWind, and EWT; and even more manufacturers are opening up U.S shops in the near future. These are our household names—building turbines in America, for America. . . . We [the U.S.] went from domestically producing less than 25% of the value wind turbines here in America a few years ago, to 50% today and we are just getting started. Since the wind installations also increased dramatically during those same few years, our domestic manufacturing capabilities have

[55] Russ Choma, "Renewable energy money still going abroad, despite criticism from Congress," American University Investigative Reporting Workshop, February 8, 2010. Available at: http://investigativereportingworkshop.org/investigations/wind-energy-funds-going-overseas/story/renewable-energy-money-still-going-abroad/

actually increased 12-fold since 2004 to keep up and expand our domestic content."[56]

In a global economy, it is less important from the standpoint of national interest which company produces the needed technology than that the actual work occurs in this country—and that the work actually proceeds to meet the larger, long-term goal of reducing fossil fuel dependence which is "exporting" billions more dollars abroad daily than the renewable energy industry will in a year.

This is a case where both supporters and critics have their points but where both miss the real concern. The clean energy industry is still developing. If we are worried as a country about creating a clean energy economy and retaining jobs, it is critical to focus on creating the skills and infrastructure needed by industry here in the U.S., otherwise the expertise, technology and ultimately the profits will go overseas. Focusing on the stimulus bill obscures that, although the U.S. had a relatively weak year in clean energy development in 2009, it still dominates the other large industrial nations on the basis of venture financing and technology innovation, according to a study of G-20 nation clean energy efforts conducted by the Pew Charitable Trusts.[57]

Texas already has some valuable resources in the area of clean energy innovation. Texas Tech University has had a Wind Resource Center for 40 years, dating back to the devastating Lubbock tornado in 1970. Part of the center's mission focuses on wind power.[58] It focuses on four main areas of wind power research: wind characterization and wind turbine reliability and performance; how turbines react and interact with each other; using wind power to pump and desalt water; and increasing wind power education and workforce development.

In addition, in May, the Texas Tech University System, along with the Innovate Texas Foundation and The Wind Alliance, announced the formation of a National Institute for Renewable Energy (NIRE), an independent public-private collaboration that "will work to solve key scientific and technology challenges facing the wind power industry."[59] NIRE will operate a for-profit business component that will design, construct and operate research wind farms, selling the power generated in the commercial marketplace to fund a non-profit research center, according to the University. The Institute also will provide services to industry partners and offer an industry consortium which will be managed by The Wind Alliance. Start-up funding for NIRE is being developed from contributions by many of the economic development organizations in West Texas.

Also part of the NIRE effort is the National Wind Resource Center (NWRC), also recently established by Texas Tech to serve as the research center for the initiative with, according to the

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[56] American Wind Energy Association, Into the Wind Blog, "More on U.S. wind manufacturing, jobs and non-U.S. companies," November 13, 2009. Available at: http://www.awea.org/blog/Index.php?mode=viewid&post_id=252

[57] Pew Charitable Trusts, *Who's Winning the Clean Energy Race: Growth, Competition and Opportunity in the World's Largest Economies*, 2010. Available at: http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Global_warming/G-20%20Report.pdf

[58] Texas Tech University, "Wind Research Center Celebrates 40 Years of Finding Solutions," May 6, 2010. Available at: http://today.ttu.edu/2010/05/wind-research-center-celebrates-40-years-of-finding-solutions/

[59] Texas Tech University, "Texas Tech Announces Formation of National Institute for Renewable Energy, May 24, 2010. Available at: http://www.depts.ttu.edu/uc/windenergy/pdf/NIRE%20TTU%205-24-2010.pdf

university, support from many of the nation's leading research universities, each using its areas of expertise in the renewable energy sector.[60] Organizationally, the goal is for NIRE to provide an ongoing funding mechanism for NWRC based on a model incorporating the NIRE public-private partnership and using revenue from the energy sales envisioned to result from the renewable energy research facilities. Additionally, the university says that NWRC will pursue competitive public funding to achieve its research initiatives.

Finally, West Texas A&M University in Canyon also has its own wind program, the Alternative Energy Institute (AEI). It was, according to the university, formed in 1977 as an outgrowth of wind energy research begun at West Texas in 1970. Its main emphasis is wind energy, though some of its research and education programs are include solar energy. The current program includes wind data collection, turbine evaluation, research, classes, seminars, workshops and consulting, according to the AEI.

The larger issue of adequate skills and manufacturing infrastructure will be determined with greater clarity in the coming years—today, the realities in the market are what they are. There are major manufacturers that have corporate headquarters all over the world. However, that situation is far from static. Much is at stake and will depend on national and state policies. A 2009 study by the Political Economy Research Institute at the University of Massachusetts-Amherst in partnership with the Center for American Progress found that investing $150 billion in clean energy produces a net gain of 1.7 million new jobs and reduces the unemployment rate by one full percentage point, from the current 9.4 percent down to 8.4 percent.[61] The underlying fact is that renewable energy will be needed to meet future demands for electricity. Where the future investment and job creation to meet that demand takes place will be decided partly by business decisions and partly by the strategies followed by each country—and in this country, by each state—in promoting the development of the industry and in developing a skilled workforce to meet the industry's future demands. Those critical issues are far from decided.

Cost Factors

The major clean energy sources present a different business model than fossil fuel-based power generation. Clean energy sources are initially capital-intensive, but have much lower operating costs over time with little or no fuel costs compared to fossil-fuel plants. They provide a fixed investment not affected over time by fuel price fluctuations. As Columbia University economist Geoffrey Heal has written, "If we build a wind (or other renewable) power station today, we are providing free electricity to its users for the next forty years: if we build a coal fired power station today, we are meeting the capital costs but leaving our successors over its forty year life to meet the large fuel costs and the external costs associated with its pollution."[62]

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[60] Texas Tech University, National Wind Resource Center. See http://www.thenwrc.org/

[61] Robert Pollin, Jeannette Wicks-Lim & Heidi Garrett-Peltier, *Green Prosperity: How Clean Energy Policies Can Fight Poverty and Raise Living Standards in the United States*, University of Massachusetts, Amherst, June 2009. Available at: http://www.peri.umass.edu/fileadmin/pdf/other_publication_types/green_economics/green_prosperity/Green_Prosperity.pdf

[62] Geoffrey Heal, "The Economics of Renewable Energy," National Bureau of Economic Research, Working Paper 15081 (June 2009). Available: http://www.nber.org/papers/w15081

At one level, the need for and cost of renewable investment becomes almost a matter of philosophical debate: What is the social value of reducing reliance on fossil fuels and the associated reduction of greenhouse emissions? The value of reducing national reliance on fossil fuel from a security point of view is subjective. The question of reducing greenhouse gas and other emissions is another area that is subject to personal point of view, although there is general agreement that air befouled by excessive pollutants is unhealthy and ultimately undesirable. Unfortunately, the scientific literature does not provide much quantification of what the social costs of emissions are—or rather it does, but the results vary widely depending on assumptions, which are ultimately based on subjective perceptions of social cost.

Two estimates demonstrate the range of opinion regarding the social cost of CO_2 emissions. One, by Yale University professor William Nordhaus, puts the social cost of CO_2 emissions at about $8 a ton.[63] At the other end of the scale is the *Stern Review on the Economics of Climate Change*, a 700-page report produced for the British government in October 2006 by economist Nicholas Stern, chair of the Grantham Research Institute on Climate Change and the Environment at the London School of Economics. Stern concludes that "the social cost of carbon today, if we remain on a BAU [business as usual] trajectory, is of the order of $85 per tonne of CO_2—higher than typical numbers in the literature, largely because we treat risk explicitly and incorporate recent evidence on the risks, but nevertheless well within the range of published estimates."[64]

An easier question—though still complex—is whether clean energy is an attractive proposition from the standpoint of private investment. In that analysis, at least, the issue of imputed social costs do not arise except to the degree that they are captured as part of government policy. Of course, the simple answer to this question is that certainly clean energy projects must be reasonable investments given current market conditions and the structure of government energy policy because investments have grown fairly briskly for a decade and continue to do so. That is, however, disingenuous since it carries renewable energy development to a certain, potentially minor, point needed to comply with federal and state renewable energy requirements and not much further. For renewable energy technologies to achieve electric power penetration levels of 20-30 percent as envisioned in the DOE and Western Wind and Solar Integration studies mentioned earlier, real market factors much be taken into account. Heal looked at the issue in his study of the economics of renewable energy for the National Bureau of Economic Research and identified four parameters that enter into the cost equation: the cost of oil and other fossil fuels, the cost of carbon emissions or equivalently the extent to which external costs are internalized by government policy, the cost of capital and the incentives available to producers.

Fossil Fuel Prices. Fossil fuels present possibly the most difficult part of the equation. Prices for oil and natural gas, in particular, have been volatile for years. In recent years, there has been an overall upward trend in prices, which favors clean energy development, but this overall

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[63] William Nordhaus, *A Question of Balance: Weighing the Options on Global Warming*, Yale University Press, 2009.
[64] Nicholas Stern, *Stern Review on the Economics of Climate Change*, London, H.M. Treasury, 2006. Available at: http://webarchive.nationalarchives.gov.uk/+/http:/www.hm-treasury.gov.uk/sternreview_index.htm

upward trend has not eliminated volatility. Research suggests that the major increase in fossil fuel prices in 2007 and 2008 partly explains the increased investment in clean energy in that period. The decline in prices in 2008 and 2009 was a factor in the drop in investment in following periods, along with the decline in the availability of capital caused by recession, currency fluctuations and increases in the cost of steel and copper.

The recent slowdown in clean energy development in the U.S. has been significant relative to rest of the world. The United States dropped to second place among G-20 members with a total investment of $18.6 billion in 2009, down 42 percent from 2008 levels. The Pew Charitable Trust studied these trends and attributed them to several causes.[65] It concluded that tight credit and the lack of a strong national policy framework have constrained investment. Also, ethanol investments that fueled progress in 2006 and 2007 waned in 2008 and 2009. However, next generation biofuels, energy efficiency and the smart grid saw investment gains. "The 2009 enactment of long-term production tax credits (wind) and investment tax credits (solar) helped salvage what could have been a disastrous year for U.S. clean energy investments," the report concluded. It also found that investments are poised to rise again in 2010, when one-third of the clean energy stimulus funding is due to be spent, and that the U.S. dominates the other large industrial nations on the basis of venture financing and technology innovation but lags in manufacturing.

Carbon Pricing. The role of carbon prices is more straightforward. At present, the cost of carbon is effectively zero. There is no market price attached to the external effects of fossil fuel use in the United States today, and as a result, the market does not factor the costs of these external effects into market calculations. If carbon price is to be a factor in business decisions, it will come from government, possibly through a carbon tax or other policies. Part of the reason clean technologies struggle to be price competitive with coal in particular is that the cost of emissions is not factored into the pricing equation. Heal concluded that the missing carbon cost is equal to about five cents per kilowatt hour. Its inclusion would make clean energy far more competitive. Industry sources indicate that the mere expectation of the imposition of a price on carbon probably contributed, along with the recession, to a drop in investment in coal-fired plants in the U.S. in the last two years.[66]

Capital Costs. The third issue Heal mentions is the cost of capital. As noted earlier, this is a particularly critical issue because the costs associated with clean energy investment are largely capital costs. Those costs are higher for clean generation than those of fossil fuel power generation, and they affect projects early in their lifespan. This can be seen in Table 5, which shows comparative capital costs for various types of electricity generation technologies.

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[65] Pew Charitable Trusts, *Who's Winning the Clean Energy Race: Growth, Competition and Opportunity in the World's Largest Economies*, 2010. Available at: http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Global_warming/G-20%20Report.pdf

[66] See, for example, Keith Johnson, "Power Play: HSBC on the Coming Carnage in Power Generation," *Wall Street Journal*, July 10, 2009. Available at: http://blogs.wsj.com/environmentalcapital/2009/07/10/power-play-hsbc-on-the-coming-carnage-in-power-generation/

TABLE 5: COMPARATIVE CAPITAL COSTS, NEW GENERATING TECHNOLOGIES, 2016
(2008$ PER MEGAWATT HOUR)

Technology	Capacity Factor (%)	Levelized Capital Cost
Conventional Coal	85	$69.2
Advance Coal	85	$81.2
Natural Gas Fired:		
– Conventional Combined Cycle	85	$92.6
– Advanced Combined Cycle	87	$22.9
– Advanced Combined Cycle with Carbon Capture and Storage	87	$43.8
– Conventional Combustion Turbine	30	$41.1
– Advanced Combustion Turbine	30	$38.5
Advanced Nuclear	90	$94.9
Wind	34.4	$130.5
Wind–Offshore	39.3	$159.9
Solar Photovoltaic	21.7	$376.8
Solar Thermal	31.2	$224.4
Geothermal	90	$88.0
Biomass	83	$73.3
Hydroelectric	51.4	$103.7

Source: Energy Information Administration, Annual Energy Outlook, 2010.

Table 5: Comparative Capital Costs, New Generating Technologies, 2016

The measure used in the table is levelized capital cost, which will be discussed in greater detail in the next chapter of the report. However, capital costs factor into a broader measure called levelized cost of electricity (LCOE). LCOE provides a common way to compare the cost of energy across technologies because it takes into account the installed system price and associated costs such as financing, land, insurance, transmission, operation and maintenance and depreciation, among other expenses. The LCOE is calculated as the net present value of total life cycle costs of the project divided by the quantity of energy produced over the system life. As Table 5 shows, the lowest levelized capital cost factor is found in natural gas-fired systems and the highest in solar photovoltaic, with other technologies falling along this continuum.

Capital costs are not working to the advantage of renewable energy development at this time. Certainly, capital costs are important at any time, but the economic downturn has hit the sector hard due to its heavy dependence on credit, according to an analysis by Booz & Company last year.[67] There are a couple of mitigating factors that should be considered, though. First, the cost of the high-end technologies is coming down over time, while applications like coal-fired and most natural gas-fired plants are mature and may, in fact, become more expensive if new generation technology requires carbon capture and sequestration technologies. Second, capital costs cannot be considered in isolation, as will be examined in the next section. While renewable plants have higher initial costs, they have much lower ongoing operating and maintenance costs and the real issue from an investment standpoint is the overall long-term cost of the investment when all cost factors are included.

It also is important to recognize that the LCOE calculation is extremely sensitive to small changes in input variables, and results can vary widely depending on the base assumptions. One

[67] Booz & Company, "Federal RPS: Too Much of a Good Thing?" presentation in Savannah, Georgia, February 6, 2009.

example of this presented in Table 5 is capacity. The net capacity factor of a power plant is the ratio of the actual output of a power plant over a period of time—for example, a year—and its output if it had operated at what is known as the "full nameplate capacity" for the entire time—in other words, at its maximum output. To calculate the capacity factor, the total energy the plant produced during a given period of time is divided by the energy the plant would have produced at full capacity. Because of the intermittency problem discussed earlier, the capacity factor is lower for most renewable technologies except geothermal facilities, and therefore the cost of capital as a function of capacity is higher. As technology advances, this relationship may change. For example, using tracking technology on solar photovoltaic projects to maximize radiant exposure could significantly increase capacity.

While capital costs have come down dramatically for clean energy technologies in the last 20 years and will continue to fall according to industry experts, they are higher than most fossil fuel technologies at this point. In addition, the capital costs are front-loaded on most projects. Considering the tight credit markets in the last two years, the cost of capital remains an issue with which clean energy projects must contend.

Incentives and Regulations. The final issue associated with investments in renewable energy is the fiscal "carrots and sticks" to encourage renewable development. On the stick side are renewable portfolio standards that require utilities to add renewable sources to their generation mix. On the carrot side are the various tax and other incentives designed to encourage investment. The potency of these governmental carrots and sticks in encouraging investment in renewable sources should not be underestimated. Indeed, the DOE in its 2010 energy outlook observed: "Regional additions of renewable generating capacity depend for the most part on State RPS [renewable portfolio standard] programs."[68]

Texas has been a leader in alternative energy development, not simply because the conditions favor wind development, but because it was relatively early among the states in setting a renewable portfolio standard. Similarly, generous feed-in tariffs for solar energy have helped to make Germany the leading nation in solar equipment production. As the gap between renewable and fossil fuel generating technologies narrows over time, these incentives become more powerful in their ability to stimulate investment in clean energy projects.

The federal production tax credit (PTC) has been a major driver of wind power development over the past several years. However, the sporadic nature of renewals of the tax credit has had a clear impact on investment in clean energy, contributing to a boom-bust cycle of development that has plagued the wind industry. This is demonstrated in Figure 13 which shows new U.S. wind capacity by year from 1992 through 2008. The figure, developed by the American Wind Energy Association, highlights the effect on annual installed capacity in the years following the expiration of the federal production tax credit in 1999, 2001 and 2003. In each case, capacity installed dropped dramatically the next year.

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[68] U.S. Department of Energy, *Annual Energy Outlook 2010*, April 2010, p. 70. Available at: http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2010).pdf

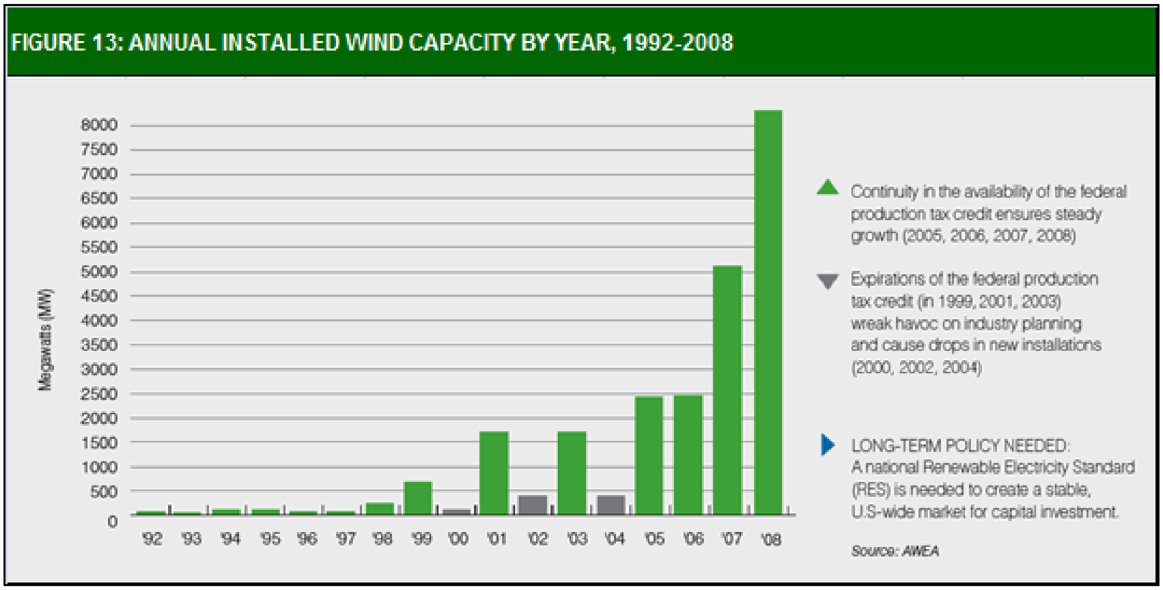


Figure 13: Annual Installed Wind Capacity by Year, 1992-2008

The most recent lapse in the PTC at the end of 2003 came on the heels of a strong year in U.S. wind energy capacity growth. In 2003, the industry added 1,687 megawatts of capacity—a 36 percent annual increase. Without the PTC during most of 2004 because of Congressional inaction, wind development decreased dramatically to less than 400 MW—a five-year low. When the PTC lapsed in 2001, Texas saw minimal new capacity added in 2002, while U.S. capacity grew by 10 percent, down from 66 percent the previous year. In 2003, when the PTC lapsed again, Texas experienced another year of no new capacity in 2004—essentially installed capacity was equal to the previous year. With the PTC re-instated, 2005 was the best year ever for U.S. wind energy development with 2,431 MW of new capacity—a 43 percent increase over the previous record year established in 2001. Likewise, Texas installed capacity increased by 54.3 percent over 2004, and in 2006, with the PTC firmly in place, the state recorded a further 37 percent increase.

For the immediate future, this issue should be mitigated by the federal stimulus legislation adopted by Congress last year. The American Recovery and Reinvestment Act of 2009 (H.R. 1), signed into law by President Obama on February 17, 2009, extended the production tax credits (PTC) and investment tax credits (ITC) and added a new incentive—Treasury grants taken in lieu of tax credits—designed to promote the growth of clean energy despite the economic downturn. Companies that generate wind, solar, geothermal, and "closed-loop" bioenergy (using dedicated energy crops) are eligible for the PTC which provides a 2.1-cent per kilowatt-hour (kWh) benefit for the first 10 years of a renewable energy facility's operation. Other technologies, such as "open-loop" biomass—using farm and forest wastes rather than dedicated energy crops—incremental hydropower, small irrigation systems, landfill gas and municipal solid waste, can benefit from a lesser value tax credit of one-cent per kilowatt hour.

The production tax credit for wind, which is the largest producer of renewable energy to date and has the greatest impact on the federal budget, was extended an additional two years, until the end of 2012. The PTC for incremental hydroelectric, geothermal, municipal solid waste and bioenergy was extended until the end of 2013. Also extended through 2013 were the production tax credit provision for electricity produced by wave and tidal energy. This marks just the fourth time that the PTC has been extended by Congress before it had been allowed to expire.

Businesses and individuals who buy solar energy systems previously had been eligible to receive an investment tax credit of 30 percent against their federal income tax liabilities. ARRA extends this option for solar facilities. It also allows other eligible technologies to receive the ITC in lieu of the PTC. This measure is designed to promote the development of renewable energy in instances of economic uncertainty where a PTC is not as attractive to developers as the ITC.

A final incentive established for the first time by the bill is a grant system administered by the Treasury Department. In lieu of tax credits, wind, biomass, geothermal and solar projects can receive a grant of up to 30 percent of the basis of the property's value. Other eligible renewable technologies can receive a grant of up to 10 percent. The grant system was developed to maintain the growth of the renewable energy sector despite the economic downturn, primarily because many renewable developers were not as profitable, they did not have the income tax liabilities. Thus, the tax credits had little value to them. The intent is that with grants in lieu of tax credits now available, renewable energy developers will continue their investments.

The stops and starts in federal policy may be inevitable, but they present a problem for the long-term development of clean energy in the United States. Short-term extensions of federal tax provisions will allow the industry to continue its development, but may be insufficient to sustain long-term growth of industry until the associated technologies mature and penetrate the market, which will eventually bring down costs. The planning and permitting process for new wind facilities, for example, can take up to two years or longer to complete. As a result, some developers that depend on the PTC to improve a facility's cost effectiveness may hesitate to start a new project due to the uncertainty that the credit will still be available when the project is completed.

Whatever course federal policies may follow in the future, renewable energy investments will continue so long as the market remains viable. That depends on the cost of the technologies relative to other methods of electrical power generation once all considerations, including federal and state incentives, are factored in. The next chapter examines the essential question in this formulation: Exactly how do the costs of renewable energy stack up against other technologies when the differences in the business models of the technologies are taken into account? To answer that question, it is necessary to take a closer look at the standardized method of comparison mentioned earlier—the levelized cost of electricity.

5. The Levelized Cost of Electricity

Key points

1. **Analysis of several levelized cost of electricity (LCOE) studies shows that some renewable energy technologies, such as wind and biomass, are already competitive with conventional electricity generation technologies.**

2. **Natural gas, coal and biomass facilities are currently the cheapest fuels for electricity, although wind projects produce favorable results in three out of five studies reviewed.**

3. **Biomass is a proven commercial option, with more than 11,000 MW of installed capacity, and can be used in baseload power generation.**

4. **Traditional fuel technologies are vulnerable to possible shifts in the price of carbon emissions, which could significantly affect levelized price comparisons as the U.S. moves closer to some sort of carbon pricing regime, as is widely expected.**

5. **The growth of the clean energy sector will depend on continued technological development and increased production to lower costs.**

Each electrical generation technology has its own unique cost structure. This makes comparisons among technologies difficult, since variations in costs can be a function of such diverse factors as technology, fuel requirements, land costs, project scale, operating time period, cost of capital and many other factors. Consequently, comparative studies are rare, often proprietary and become outdated quickly.

One analytical tool that can be used to compare alternative technologies is the levelized cost of electricity (LCOE). As the Energy Information Administration explains: "Levelized costs can be useful when comparing different technology options to satisfy a given duty cycle requirement. For example, levelized cost could be used to determine the lowest cost new capacity available to satisfy a need for baseload power that would be expected to operate at a 70 percent capacity factor or higher."[69]

Conceptually, LCOE is the net present value of a project's total life-cycle costs divided by the quantity of power produced over the system life. It reflects the constant price per unit of

[69] U.S. Department of Energy, Energy Information Administration, "2016 Levelized Cost of New Generation Resources from the *Annual Energy Outlook 2010*," 2010. Available at: http://www.eia.doe.gov/oiaf/aeo/pdf/2016levelized_costs_aeo2010.pdf

energy that would allow the hypothetical investment to break even. In other words, the present discounted value of energy produced times the levelized cost equals the present discounted value of the fixed and variable costs over the investment's life cycle. In simple form, then, this is the formula for the calculation.

$$\mathrm{LCOE} = \frac{\text{Total Life Cycle Costs}}{\text{Total Energy Production}}$$

LCOE results are usually expressed in constant, inflation adjusted costs per kilowatt hour. This is not a simple calculation to make. It requires making dozens of assumptions about each plant on factors from financing structure to the future cost of fuel inputs. The results are given in current or inflation-adjusted dollar values depending on the study. In the examples discussed in this study, both the constant and current dollar estimates are for either 2008 or 2009. All of the examples also depend heavily on forecasts of input and technology costs, and are only as good as the forecasts on which they are based. Different cost projections can result in different LCOEs for a single technology.

Levelized Cost Comparisons

Despite all of these qualifications, the LCOE calculation is one of the clearest ways to compare costs across technologies. In this regard, Table 6 (below) shows a comparison of five recent estimates of LCOE reflecting a range of assumptions and results. The studies shown in the first two columns, by the DOE's Energy Information Administration and the Electrical Power Research Institute, are national studies that were developed without regard to specific geographic siting and without the consideration of state and federal tax incentives for clean energy projects. The third study, by Lazard, is also general in scope but uses a sensitivity technique to examine levelized costs given a range of assumptions. The last two columns, both specific to California, include explicit assumptions about federal and state tax credits and other incentives. This accounts for some of the difference in the LCOEs that each study found.

The results in Table 6 have been color coded to more clearly illustrate the range of variations among the studies for individual technologies. Since the studies use different assumptions, they produce different results and are representative of the range of results found in levelized cost studies generally. The comparison leads to several striking conclusions. First, the lowest cost technologies are natural gas, coal and biomass, although wind projects produce favorable results in three out of five of the studies, including the two studies that factor in federal and state incentives. At the other end of the spectrum, the most expensive technologies are solar photovoltaic and solar thermal, mainly because of high capital costs. Other technologies like nuclear and hydroelectric produce mixed cost results and fall into the middle of the range of technologies in most of the estimates.

Among the key renewable technologies, wind is the lowest cost, ranging in the three national studies from 5.7 cents per kilowatt hour to about 14.9 cents. This latter figure is found in the EIA *Annual Energy Outlook 2010* and is probably an overstatement as it relates to Texas since it basically combines projected levelized costs in the various regions where wind energy costs can vary significantly, apparently depending on the availability of desirable wind farm locations over the next five years. In its analysis, EIA points out: “For example, regional wind costs range from $91/MWh [9.1 cents per kilowatt hour] in the region with the best available resources in 2016 to $271/MWh [27.1 cents per kilowatt hour] in regions where the best sites have been claimed by 2016. Costs for wind may include additional costs associated with transmission upgrades needed to access remote resources, as well as other factors that markets may or may not internalize into the market.”

A more useful approach is the Lazard study which offers a range of costs for each technology based on multiple scenarios and considers various federal and state incentives. For example, the firm’s wind estimates range from 5.7 cents per kilowatt to 11.3 cents. The primary differences in the two scenarios are assumptions about: capital costs; EPC (engineering, procurement and construction) costs; and the capacity of the resulting unit. These variables lead to differences in the estimated levelized cost over time.

TABLE 6: LEVELIZED COST OF ELECTRICITY, VARIOUS STUDIES (CENTS PER KILOWATT HOUR)					
Technology	Electric Power Research Institute Base Year: 2015 (12/08 Constant $)	Energy Information Administration Base Year: 2016 (2008 Constant $)	Lazard* Base Year: 2010 (2009 Constant $)	California Energy Commission* Base Year: 2009 (2009 Nominal $)	San Francisco PUC* Base Year: 2009 (2009 Nominal $)
		COLOR KEY	$0.080 or less		
			$0.081-$0.11		
			$0.111-or higher		
Conventional Coal	N/A	$0.100	$0.078-$0.144	N/A	N/A
Advanced Coal (No Carbon Capture)	$0.066	$0.111	$0.074-$0.135	N/A	N/A
Advanced Coal (With Carbon Capture)	$0.086	$0.129	N/A		
IGCC--Integrated Gasification Combined Cycle (Without Carbon Capture)	$0.071	N/A	$0.069-$0.096	$0.117	N/A
CTCC--Combustion Turbine Combined Cycle** (Natural gas @ $8-10/MM Btu)	$0.074-$0.089	$0.083	$.073-$0.100	$0.114	N/A
Nuclear	$0.084	$0.119	$0.074-$0.135	N/A	N/A
Wind	$0.099	$0.149	$0.057-$0.113	$0.0655-$0.0724	$0.058-$0.086
Wind--Offshore	N/A	$0.191	N/A	N/A	N/A
Biomass	$0.077-$0.090	$0.111	$0.065-$0.113	$0.10.40-$0.1083	N/A
Geothermal	N/A	$0.116	$0.058-$0.093	$0.0789-$0.0831	$0.068-$0.073
Hydroelectric	N/A	$0.120	$0.067-$0.0865	N/A	$0.090
Solar Thermal	$0.225-$290	$0.257	$0.129-$.206	$0.225	$0.164
Solar Photovoltaic	$0.456	$0.396	$0.131-$0.196	$0.262	$0.246

Sources: Electrical Power Research Institute, Program on Technology Innovation: Integrated Generation Technology Options, Technical Update, November 2009.
U.S. Department of Energy, Energy Information Administration, "Levelized Cost of New Generating Technologies, 2016" Annual Energy Outlook, 2010.
Lazard, "Levelized Cost of Energy Analysis, Version 3.0," June 2009.
California Energy Commission, 2009 Comparative Cost of California Central Station Electricity Generation Technologies Report, January 2010.
City and County of San Francisco, Levelized Cost of Electricity Associated With Out-of-City Renewable Energy Resources Considered Supply Candidates for the City and County of San Francisco, September 2009.

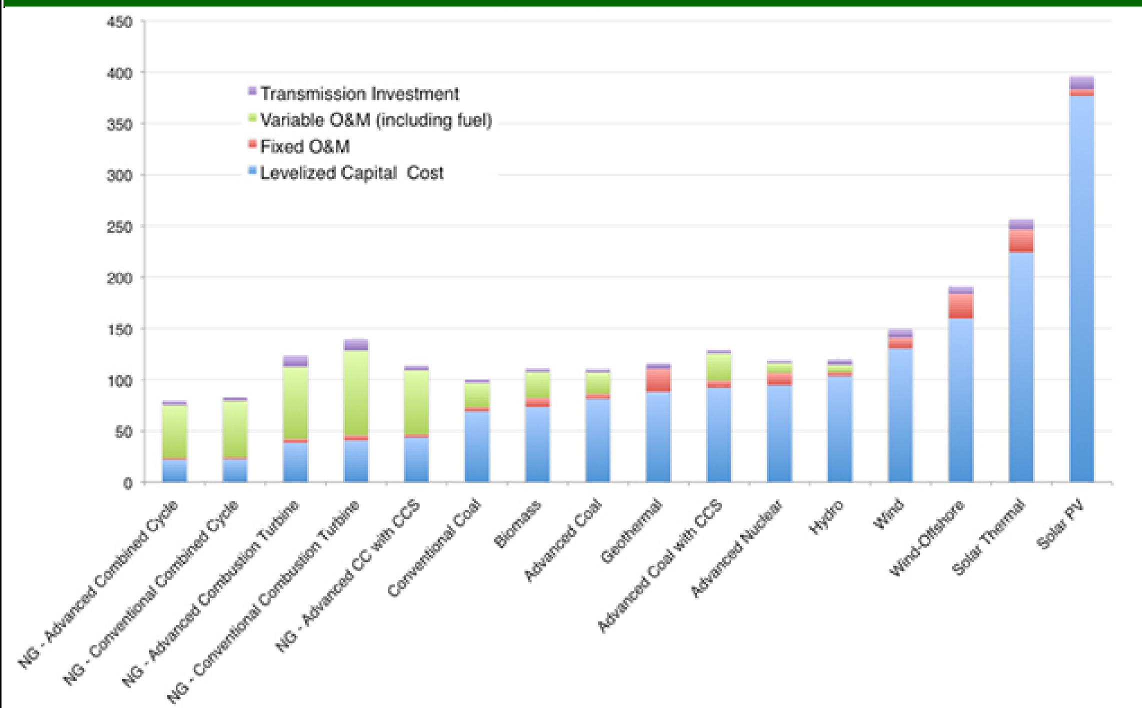
** Include federal and state government incentives.*
Note: (1) Some categories collapse two technologies, such as geothermal--flash steam and geothermal--binary cycle, producing a range. Some estimates are presented as ranges.
(2) These are intended to show a range of levelized prices. Underlying assumptions may vary significantly and estimates are, therefore, imperfectly comparable.

Table 6: Levelized Cost of Electricity, Various Studies

Among the technologies, the most expensive option is solar photovoltaic, which ranges in the three national studies from 13.1 cents per kilowatt hour to 45.6 cents per kilowatt hour in the Electrical Power Research Institute study. (The EIA estimate is in much the same range as the EPRI estimate.) This high cost estimate in the two national studies is driven heavily by capital cost estimates and a low capacity factor for a large-scale photovoltaic facility. On the other hand, the authors of the EPRI report acknowledge that photovoltaic (PV) applications have gained considerable ground in distributed uses, that is, on commercial buildings and homes. On the issue of large-scale facilities, the authors conclude: "However, although large-scale bulk-power PV (>50MW) facilities remain uncompetitive with other intermediate and peaking supply technologies, there has been a growing trend in some markets toward new PV projects being developed in the 10 MW and larger capacity range."[70] The high capital cost is related to the relative maturity of the technology—solar technology for large-scale application has come down in price over time but is still expensive relative to other technologies.

This disparity in solar technology capital costs compared to other generating technologies can be seen in Figure 14 which shows the EIA levelized estimates disaggregated into their major component parts—capital cost, variable operating and maintenance costs (including fuel), fixed operating and maintenance costs and transmission investment.

FIGURE 14: ESTIMATED LEVELIZED COST OF NEW ELECTRICITY GENERATION TECHNOLOGIES IN 2016 ($ 2008/MEGAWATT HOUR)



Source: U.S. Energy Information Adminstration, Annual Energy Outlook 2010.

Figure 14: Estimated Levelized Cost of New Electricity Generation Technologies

Another critical issue not reflected in the EIA estimates, is the impact of federal and state incentives. For example, the Lazard study, which found a levelized range for solar photovoltaic of 13.1 cents per kilowatt to 19.6 cents per kilowatt hour, reflects the effects of the federal production tax credit, investment tax credit and accelerated asset depreciation. It also assumes 2.5 percent annual escalation for the production tax credit.

[70] Electrical Power Research Institute, *Program on Technology Innovation: Integrated Generation Technology Options, Technical Update*, November 2009, p. 8-10.

These factors make a significant difference in the levelized cost of a project, greatly mitigating the cost differentials. In its analysis, Lazard is considerably more bullish on the short-term outlook for solar, recognizing that it has a potential role in providing peaking energy product because its intermittency corresponds well to the daily electrical demand curve. In the Lazard analysis, the authors note: "Setting aside the legislatively-mandated demand for solar and other Alternative Energy resources, solar is becoming a more economically viable peaking energy product in many areas of the U.S., and, as pricing declines, could become economically competitive across a broader array of geographies."[71] The Lazard analysis says, however, that this observation does not take into account the full cost of transmission and backup generation systems needed to provide reliability as the use of solar expands. As an example, they found that peak pricing in New York was about 16.3 cents per kilowatt hour, well within range of their estimates for low-end solar photovoltaic. In contrast, they found peak pricing levels in Dallas to be about 11 cents per kilowatt hour, below the currently viable cost of solar photovoltaic. Houston, though, was found to have peak prices of 13.8 cents per kilowatt hour, within range of some low-end solar photovoltaic technologies based on their levelized pricing results.

The other major non-fossil fuel energy source used in Texas is biomass. Biomass is a more mature technology than solar and is a proven commercial electricity generation option with more than 11,000 MW of installed capacity, the second largest source of non-hydroelectric renewable power generation behind wind. The levelized cost estimates in Table 6 reflect the more widespread application of the technology and its relatively high capacity factor, with LCOEs ranging from 6.5-11.3 cents per kilowatt hour in the studies, comparable with natural gas and coal-fired facilities. Beyond a lower cost, biomass' major advantage is that it can be used in base load power generation, unlike intermittent technologies like wind and solar. Nationally, most of today's biomass power plants are direct-fired systems that are similar to many coal-fired power plants. There are three primary classes of biomass-to-thermal energy systems: direct biomass fired, co-fired with coal and gasification of biomass into synthesis gas (syngas). The range of cost for a biomass unit, which is reflected in the estimates in Table 6, largely reflects the variations in cost among these different types of biomass generation.

LCOE Sensitivity Analysis

One other point of analysis that the Lazard study includes is an examination of the sensitivity of the levelized costs to changes in various factors, including fuel prices, carbon emissions prices, federal tax incentives, capital costs and the cost of capital. These sensitivity analyses illustrate several important points that could affect the actual costs of clean electricity generation over the next several years.

As might be expected, clean energy sources are insensitive to fuel prices, while the costs of conventional fossil fuel generation technologies are highly sensitive, particularly natural gas and coal generation. Nuclear is also sensitive to fuel price fluctuations, but less so than coal or natural gas. The fossil fuel technologies are also very sensitive to possible shifts in the price of

[71] Lazard, "Levelized Cost of Energy Analysis, Version 3.0," June 2009, p. 5. Available at: http://blog.cleanenergy.org/files/2009/04/lazard2009_levelizedcostofenergy.pdf

carbon emissions. This could become a larger factor in levelized price comparisons as the U.S. moves closer to some sort of carbon pricing regime. A carbon tax or cap-and-trade legislation would significantly affect the LCOE of fossil fuels, particularly in the absence of carbon capture technology. Of course, the required addition of carbon capture technology would have its own effect on the costs of the fossil fuel plants, particularly coal-fired plants. The sensitivity estimates in the Lazard analysis are based on a carbon emission cost of $30 per ton and do not, of course, affect the carbon-free clean energy technologies In contrast, the clean energy technologies are highly sensitive to changes in federal tax incentives. Lazard notes: "U.S. federal tax subsidies remain an important component of the economics of Alternative Energy generational technologies (and government incentives are important in all regions), notwithstanding high prevailing fossil fuel prices." They also note that future cost reductions in the technologies have the potential to allow the technologies to approach "grid parity" without subsidies, although, again, that discounts the cost of the incremental transmission and back-up generation that may be needed to make the broader use of these technologies feasible.

Two other major sensitivities, as already mentioned, are capital costs and the associated cost of financing—that is, how much it costs to build a facility and how much it costs to finance it, two different but interrelated issues. Because of the high capital investment requirements of some of clean energy technologies—particularly large-scale solar—the cost effectiveness of the technologies in electricity generation portfolios is more fragile than other power generation technologies. The recently disrupted capital markets and reduced availability of credit were found to have a greater relative impact on clean energy technologies. By the same token, Lazard found that the long-term outlook, given normally functioning markets, is for falling capital costs as the technologies mature. Again, this is especially true for solar applications which are expected to undergo significant technological refinement. On the other hand, the long-term outlook for fossil fuel and nuclear plants is for rising costs of capital from higher construction costs and, of course, potentially steeply rising fuel costs.

Examined across the various estimates, the levelized cost estimates show that some clean energy technologies are already competitive with conventional generation technologies. Wind and biomass are clear examples. Other clean energy generation technologies are improving in their cost competitiveness, but their prominence in the energy market in the future will depend on technological development and increased production to lower the cost of financing and thus, their levelized cost.

Lastly, a few caveats about levelized estimates should be mentioned. Levelized cost estimates are more straightforward for some technologies than for others. Certain technologies have costs that are very location specific—hydroelectric power, for example. For other technologies, variations in assumptions about future government policies could produce differing cost results—requiring the addition of carbon capture and storage technology to fossil fuel plants or the end of federal tax incentives for renewable energy being the most prominent examples. Costs for these technologies cannot easily be compared from one location to another, and the in case of CCS requires very careful examination of what components are and are not included in any estimates, according to experts on levelized cost estimates. Some studies have also suggested that differences in the performance characteristics of dispatchable plants—that is, sources of electricity that can be dispatched at the request of power grid operators—and non-dispatchable plants, like wind and solar, mean that comparing costs between them is inappropriate—or at least uninformative.

Shimon Awerbuch raised a final objection to levelized cost comparisons that could have significant implications for clean energy sources in a 2000 article in *Energy Policy*.[72] In the article, Awerbuch argued that levelized cost estimates—which are, in effect, created from the ground up—do not adequately differentiate for price risk, which he believes should be factored into the implicit cost of fossil fuel options. He argues that while fuel price risk hedging strategies do exist in the industry, they are not 100 percent effective and impose a cost on the fossil fuel technologies that is both real and ignored by LCOE estimates. He says that if generating companies correctly valued risk, then seemingly high-cost but zero fuel-price-risk technologies such as wind and solar would already be competitive.

[72] Shimon Awerbuch, "Investing in photovoltaics: risk, accounting and the value of new technology," *Energy Policy*, Volume 28, Issue 14, pp. 1023-1035.

6. The Effect of Clean Energy on Electric Prices

Key points

1. **The LCOE projections in Chapter 5, while useful for comparing technologies, do not tell us how an increase in clean energy will affect retail prices among industrial, commercial and residential electricity consumers.**

2. **Additional projections, based on data and forecasts by the U.S. Department of Energy's Energy Information Administration (EIA), suggest greater use of clean energy in Texas will not cause dramatic increases in retail prices.**

3. **Continued advancements in technology, as well as the uncertainty of fossil fuel prices and the likelihood of some sort of carbon pricing scheme, could make the economics of clean energy even more compelling over time.**

4. **Numerous public policies, such as the System Benefits Fund administered by the Public Utility Commission, provide assistance for low-income, elderly and disabled Texans so that they will not be adversely impacted by incremental increases in electricity costs from clean energy.**

It is difficult to connect an electrical bill for a business or residence to the levelized cost estimates discussed in the preceding chapter. LCOE estimates represent an estimated actual cost over the life of a facility which then gets divided up among the sectors that use electrical power—industrial, commercial and residential. Industrial power costs the least per kilowatt hour, and residential is the most expensive. To understand how changes in the renewable energy mix in electrical generation affect retail prices, it is necessary to make a further series of projections using a model of state energy usage and costs based on historical state data and on national forecasts developed by the U.S. Department of Energy's Energy Information Administration in its *Annual Energy Outlook 2010*.

To test the sensitivity of electricity prices to a change in the state energy mix, three cases were examined. The first case, the Base Case, assumes no change in the mix of sources to generate electricity.

The second case, the Mid-Range scenario, assumes that renewable energy will grow to 16.5 percent of the state energy mix by 2020. This is projected from the assumptions in the EIA reference case from the *Annual Energy Outlook* and represents the addition of 8,358 megawatts of renewable power between 2010 and 2020, an increase of about 77 percent from the total renewable power in place in Texas in 2009, a growth rate slightly above five percent a year on average. More than 90 percent of this increased capacity would come from wind energy, reflecting the historical trend in Texas clean energy development and the price structure of the leading renewable energy technologies. However, there would be smaller additions for biomass, solar thermal and solar photovoltaic over the period as well.

The third scenario, or High Range estimate is based on two key assumptions—much higher growth rates than are predicted in the national energy outlook reference case and, more importantly, the imposition of additional state or federal policies to encourage clean energy development, specifically solar technology. This scenario assumes that clean energy grows more quickly than the base case, pushed along by higher assumed level of economic growth and therefore demand.

FIGURE 15: SHARE OF TOTAL GENERATING CAPACITY FROM RENEWABLE ENERGY SOURCES FORECAST FOR 2020

Base Case: No Change from 2009		Mid-Range Case		High-Range Case	
Coal	19.2%	Coal	17.5%	Coal	16.8%
Hydroelectric	0.6%	Hydroelectric	0.6%	Hydroelectric	0.6%
Natural Gas	67.5%	Natural Gas	61.4%	Natural Gas	59.1%
Nuclear	4.7%	Nuclear	4.3%	Nuclear	4.1%
Solar	0.2%	Solar	0.1%	Solar	2.9%
Geothermal	0.0%	Geothermal	0.0%	Geothermal	0.0%
Other Biomass	0.1%	Other Biomass	0.3%	Other Biomass	0.6%
Other Gases	0.2%	Other Gases	0.2%	Other Gases	0.2%
Petroleum	0.2%	Petroleum	0.4%	Petroleum	0.2%
Wind	7.1%	Wind	15.2%	Wind	15.5%
Wood Derived	0.2%	Wood Derived	0.0%	Wood Derived	0.0%

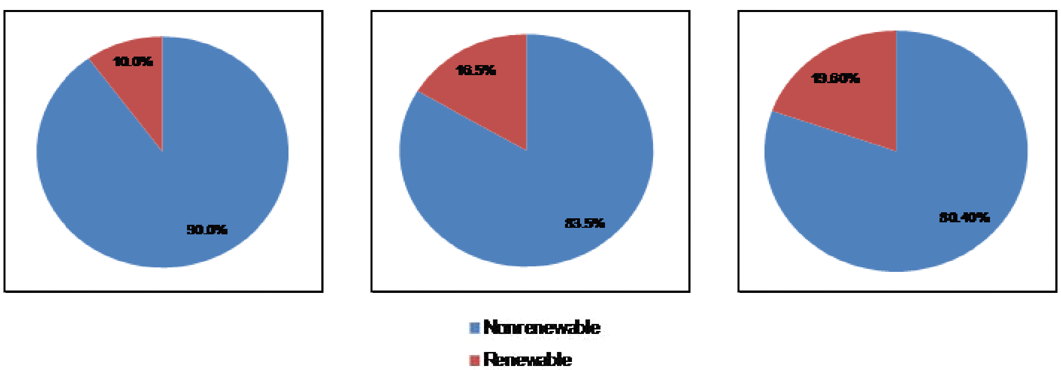


Figure 15: Renewable Share of Total Generating Capacity -- Forecast

The basis of this scenario is the assumed addition of a Texas renewable portfolio standard that would require the addition of 3,500 megawatts of solar power by the year 2020. This would be in addition to the current RPS requirements under state law. In this case, 12,616 megawatts of renewable energy would be added to the state electrical power mix, an increase that more than doubles the amount of renewable power in Texas and substantially alters the mix of clean energy, greatly increasing the role of solar energy relative to wind. The share of total power generation accounted for by renewable sources would increase to just less than 20 percent of the state total, reflecting virtually no growth in other generating forms over the ten-year period. This increase represents an average annual growth rate of 7.3 percent over the forecast period, and may, in fact, exceed the probable growth in demand for new capacity in the state over the period. However, the scenario is used here primarily to illustrate the effects of a greater concentration of solar development on electricity prices in the state given the cost of the technology over the period.

The estimates' pricing assumptions begin with the EIA's estimates of levelized cost for various technologies discussed in the preceding chapter. The price estimates are then adjusted to reflect current federal and state renewable energy incentives with one addition—a new RPS for solar development in Texas in the High Range scenario only. In effect, the model simulates the changing cost structure based on the forecasts of economic growth and projected changes in the overall state electrical generation portfolio in the state. The price results for all scenarios are expressed in 2008 constant dollars to eliminate the effects of differing inflation assumptions underlying the three economic scenarios on which the estimates are based. These inflation-adjusted costs can be compared to see the difference in retail costs associated with changes in the overall electrical generating mix. Table 7 on the following page compares the two scenarios that assume growth in renewable generating capacity—the Mid-Range and High Range scenarios—to the Base Case, which assumes no change in the renewable mix over the next decade, to estimate the effect of greater renewable use in the state on overall prices. This is shown as an increase in cost per kilowatt hour. Also shown is an estimate of the effects on the average residential electrical bill in Texas based on consumption estimates from the Energy Information Administration's *Electric Power Annual* data tables.[73]

[73] U.S. Department of Energy, Energy Information Administration, *Electric Power Annual, 2008*, January 2010. Available at: http://www.eia.doe.gov/cneaf/electricity/epa/epa.pdf

TABLE 7: PRICE EFFECTS OF INCREASED RENEWABLE ENERGY USE IN TEXAS FORECASTS FOR 2020 (2008 CONSTANT DOLLAR VALUES) (1)	Base Case--Current Renewable Capcity (2)	Mid-Range Assumptions (3)	High Range Estimates with Solar RPS (4)
Renewables as a % of Total Texas Generating Capacity	10%	16.50%	19.60%
Average Levelized Price Per Megawatt--Total Capacity Mix	$91.87633	$95.45869	$103.61921
% Change from Base Case	---	3.90%	12.78%
Increase in Cost Per Kilowatt Hour	---	$0.0036	$0.0117
Change in Residential Average Monthly Bill (2008 $)	---	$4.05	$13.27

Source: Billy Hamilton Consulting: U.S. Department of Energy, Energy Information Administration, Electric Power Annual, 2008 and Annual Energy Outlook, 2010, Appendices.

Note: Estimates assume a continuation of federal and state production incentives currently in place.

(1) Dollar values are given in 2008 constant dollars. The actual prices could vary with the rate of inflation and the change in world energy prices, which vary in each economic case examined above. For that reason, the values are set at a constant dollar value.)
(2) Base case assumes no change in renewable energy's role in Texas electricity generation from 2009 level.
(3) Mid-Range estimate is projected for Texas based on U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook, 2010, Reference Case against which various economic and policy drivers can be tested. It is a base economic and energy supply and demand forecast.
(4) The high range estimates follow a high-range EIA growth forecast with one exception. It assumes that the State of Texas imposes a 3,500 megawatt Renewable Portfolio Standard for solar power generation by the year 2020. This requirement does not currently exist and is simply included as a policy option to test the impact of an increase in solar energy generation on electricity prices.

Table 7: Price Effects of Increased Renewable Energy Use in Texas

As the table shows, an increased mix of renewable energy would have some effects on prices, though the effect would be relatively minor, particularly in the Mid-Range case. Under the Mid-Range case, the overall price of electricity is estimated to increase by less than $0.004 per kilowatt hour, representing about a 2.7 percent increase *over the decade* in the constant-dollar cost of electricity above the current average price in Texas, which was 13.04 cents per kilowatt hour in 2008.[74] This increase would add about $4.05 to the average monthly residential electric bill, which averaged $147.35 in Texas in 2008. This increase again would occur over the course of the decade as the additional renewable capacity is brought online.

Even this figure may be an overstatement, though. It uses EIA Reference case assumptions about the cost of wind energy generation over this period, which significantly affects the result because of wind's importance in the Texas renewable energy mix. The EIA estimate, as discussed in the preceding chapter, is one of the highest among the recent studies of the cost of renewable technology. If the Lazard estimates also discussed in the preceding chapter were used as the basis of the analysis, the change in cost would be only about $0.001 per kilowatt hour, or even less if the low-end case were used. This would translate into a price increase of about one percent in constant dollar residential electric costs over the decade.

[74] *Electric Power Annual*, 2009, p. 68.

What this shows is that any analysis of the future cost of energy generation depends heavily on the outlook for two factors: the price of fossil fuel as the current choice for the majority of electrical power generation and the price of the clean energy technology being examined. The first of these two factors, the cost of fossil fuels, is not likely to follow the path in the EIA estimates. The EIA Reference case, for example, assumes that economic recovery and the increased demand for oil will produce an average annual increase in real world oil prices of approximately 0.7 percent from 2008 to 2020 and 1.4 percent from 2020 to 2035. Oil prices rebound following the global recession to $95 per barrel in 2015 and $133 per barrel in 2035 in real 2008 dollars. The probability of at least some price shocks over the next decade seems more likely than the possibility of a modest, steady increase in real, inflation-adjusted prices. This increase could be further affected by requirements for the application of more extensive carbon capture technology, although the EIA reference case assumes some increase in such investment. On the other hand, the cost of wind and other power generating technologies could fall more sharply than forecast, meaning the likely cost per kilowatt hour under this scenario could be less than the Mid-Range estimate of $0.004 per kilowatt hour.

With its focus on solar energy development the effect on electricity prices of the High-Range case will be more substantial. This is directly related to the inconsistency of solar technology cost projections. The EIA forecast for solar photovoltaic facilities is projected to cost almost three times more than wind energy and more than four times more than gas turbine power generation. As Table 7 shows, a greatly increased reliance on large-scale solar generation would result in an increased cost of just over one cent per kilowatt hour over the decade. This implies an increase over the decade in the average monthly residential electricity bill of about $13.27.

For most Texans, these incremental changes of a few cents per day would be an attractive investment to reap the job creation and other returns that the clean energy economy can create over the next decade and beyond. However, these investments, while small, could impose a financial burden on low-income Texans, the elderly and the disabled. Numerous public policies, such as the System Benefit Fund administered by the Public Utility Commission, provide assistance for these Texans. Currently the System Benefit Fund has a balance of $610 million, which is more than adequate to provide appropriate support for low-income, elderly and disabled Texans so that they will not be adversely impacted. Texas lawmakers may also choose to consider additional safeguards so that vulnerable Texans are held harmless.

In assessing these estimates, two important caveats should be noted. First, the increase in cost described would not be immediate. They would accrue over time as new capacity is brought online. If anything, the estimates may overstate the likely cost since utilities would not simply substitute new power capacity for old in base load generation. To determine the best technology for each type of demand—base, intermediate or peaking load—energy planners evaluate the technologies based on their individual economics. Solar, for example, might be more justifiable—and more efficient as a power alternative—if it were used mainly during the peak-load daytime hours when it is readily available and when retail kilowatt hour prices are considerably higher than the average price per kilowatt hour.

Second, while the estimates are predicated on increasing costs of fossil fuels, they do not assume either a future price shock, as already noted, or significant new measures to impose a cost on carbon emissions. The EIA Reference case assumes a three-percentage point increase in the cost of capital is added when evaluating investments in greenhouse gas-intensive technologies such as coal-fired power plants without carbon capture and sequestration (CCS) technology and coal-to-liquids plants. The three percent adjustment is similar to a $15 per ton carbon dioxide emissions fee when investing in a new coal plant without CCS technology and is half the assumption tested in the Lazard sensitivity analysis described in the preceding chapter and is therefore fairly conservative. Nonetheless, this adjustment represents an implicit hurdle added to greenhouse gas-intensive generation facilities. Thus, the levelized capital costs of coal-fired plants with CCS are higher than most current coal projects, narrowing the gap between these facilities and those that rely on clean energy sources. Even allowing for this pricing assumption, one effect of greater use of clean energy would be to reduce the level of CO_2 emissions by displacing some other types of power generation, notably coal. Emissions from coal-fired power plants typically account for four-fifths of CO_2 emissions by electric power plants, according the Department of Energy.

The analysis suggests that a significant expansion of the use of renewable energy sources in the Texas electrical power mix will not cause dramatic increases in retail prices, particularly if most of the increase is based on wind power generation. Solar power presents a more expensive proposition, but the cost differentials are not extraordinarily large. Again, improvements in technology and the uncertainty of fossil fuel prices could make the economics of solar energy development more compelling over time.

7. Clean energy policies

Key policy options

1. **Develop a more aggressive set of renewable energy portfolio standards that changes the standard measure from capacity to a percentage of generation; sets targets in five-year increments through 2035; establishes targets for non-wind and distributed generation; makes all targets mandatory; and extends participants to include all retail electric providers.**

2. **Consider a more extensive range of financial incentives that exempt the installation of clean energy devices from the state and local sales taxes; create a franchise tax credit for clean energy production and a property tax exemption for large generating facilities that use renewable energy; and encourage the continuation of federal tax incentives beyond 2016.**

3. **Enact a statewide net metering program that requires utilities to purchase electricity from distributed renewable energy generators at a price that is comparable to time-of-day rates; provides new homebuyers the option of financing renewable energy improvements; and prevents HOAs' from prohibiting the addition of clean energy options to existing structures.**

4. **Review direct cash incentive policies in light of other states' recent initiatives, including those that establish a clean energy bond program to support the state's new PACE program and include Texas counties; allow the existing revolving loan program to include government buildings; and support low-interest loans to renewable energy manufacturers that locate or expand in Texas.**

5. **Study methods for implementing a feed-in tariff system through a review of other states' and countries' best practices.**

Developing technologies like wind and solar face significant market barriers, in large measure because the market cost of carbon emissions is not reflected in power generation costs. To ensure that alternative technologies have the opportunity to develop in this tilted market situation, it is important to have policies that help make renewable technologies more affordable. There are several tools that can be used to achieve greater market parity. Federal and state tax policies that favor clean energy development are one important way of leveling the playing field. Another is setting standards. Setting minimum standards has long been an effective and essential method for achieving many of society's critical goals, such as increasing vehicle and appliance efficiency, company environmental performance and building and product safety.

Thus, states and the federal governments can use a variety of means of promoting clean energy production in the light of market realities. The federal government has used tax policy to encourage clean energy development since the 1970s. Most recently, Congress included $21 billion of energy-related initiatives in the American Recovery and Reinvestment Act (ARRA)—the federal stimulus bill (Figure 16). Among these is a three-year extension of the Production Tax Credit (PTC) for electricity derived from wind facilities through 2012, as well as for geothermal, biomass, hydropower, landfill gas, waste-to-energy and marine facilities through 2013. It also provides project developers of wind, geothermal, biomass and other technologies eligible for the PTC with the option of using instead the 30 percent Investment Tax Credit (ITC). In addition, project developers can now apply for a grant from the Treasury Department in lieu of the ITC. The grant equals up to 30 percent of the cost of eligible projects that start construction in 2009 or 2010.

Many states have their own tax-based incentives and also impose renewable portfolio standards (RPS) that require a certain level of renewable energy generation by target dates. They take other steps like net metering, which encourage distributed clean energy generation by individuals and businesses. These approaches have been particularly useful when used in tandem with federal incentives. For example, the production tax credit for wind has incentivized the most new wind capacity in states that also have a RPS. The RPS, in combination with tax incentives and other policy approaches, can create a market for renewable technologies that are commercially viable or close to viable by reducing their competitive disadvantage in the early stages of the project. Complementary policies, including net metering and other financial incentives, are also needed to encourage the development of higher cost renewable emerging technologies with significant long-term potential such as solar photovoltaics. The combination of setting minimum standards, while providing incentives for exceeding standards, has proven to be a cost-effective approach to improving performance.

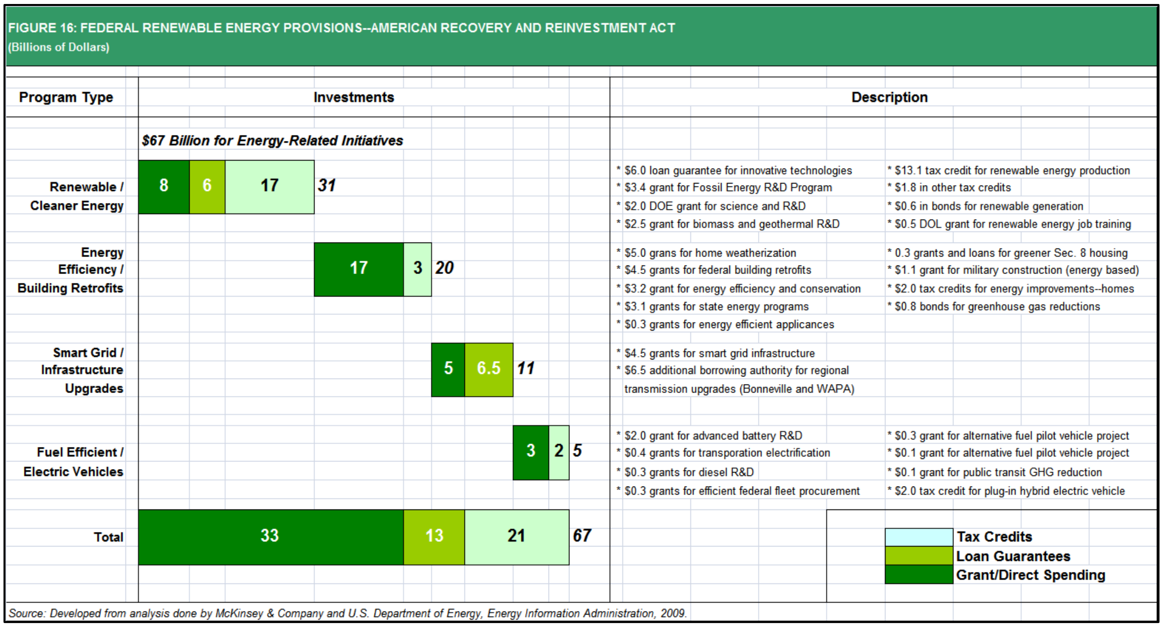


Figure 16: Federal Renewable Energy Provisions -- ARRA

Texas has set goals for clean energy use, removed barriers to development and provided financial incentives. These actions, along with market forces, have resulted in a marked increase in clean energy use in the state, particularly from wind. On the other hand, the market has not responded sufficiently to meet increases in future needs without a substantial reliance on nonrenewable sources. It also has not positioned the state to compete in clean energy research and development and manufacturing. The state's solar industry and market is especially underdeveloped compared with other western states.

Moreover, efforts in the 2009 legislative session to increase the clean energy sector's momentum largely failed as the state wrestled with difficult budget issues and conflicting policy goals. The economic downturn has also slowed market and industry development despite assistance from the federal ARRA. The hesitancy that this uncertainty has created are especially damaging for this new market. To prevent the loss of this industry in Texas, the state will need to assert its commitment to clean energy. Setting ambitious targets, encouraging markets, and removing impediments, in addition to establishing financial incentives, are policy strategies that can propel the state forward.

To better understand how these various policies could be used to shape the future direction of the clean energy economy in Texas, this section of the report examines the various approaches and how they are applied in other states and nationally.

Renewable Portfolio Standards

Renewable portfolio standards are requirements set for electricity generation from renewable energy sources to be met by utilities by a certain date. Standards are important because they can drive renewable energy growth and provide a stable market for project investors. Thirty-three states, including Texas, have set standards, although four states have voluntary programs. Texas' standard applies only to investor-owned competitive retailers. Municipalities and electric cooperatives can opt-in to the standards and several have. Instead of participating in the state's program, municipal utilities in San Antonio and Austin have opted to set their own, higher standards. Many other states, including California, require all utilities to participate.[75]

Texas was one of the early states to adopt a renewable portfolio standard (RPS).[76] Texas created its first RPS as part of electric industry restructuring legislation in 1999 (Senate Bill 7). At that time, the standard mandated the construction of certain amounts of clean energy capacity in the state. This prompted the industry to accelerate its production on Texas sites. Qualifying sources under the standard include solar, wind, geothermal, hydroelectric, tidal energy and biomass, including landfill gas. Also eligible were clean energy sources at customer sites that offset electricity demand, such as the installation of photovoltaic panels and solar water heating.

The state's original RPS mandated that electricity providers (competitive retailers, municipal electric utilities and electric cooperatives) collectively generate 2,000 megawatts (MW) of additional clean energy by 2009. The Legislature increased the standard from 3,880 MW in 2005 and added two voluntary provisions—that 500 MW of the total developed after September 1, 2005, come from sources other than wind and that the means be developed to achieve 10,000 MW from renewable sources by 2025.[77] Each provider is required to obtain new renewable energy capacity based on its market share of energy sales times the renewable capacity goal. For example, a competitive retailer with 10 percent of the Texas retail electricity sales in 2010 would be required to obtain 200 megawatts of renewable energy capacity.

The program has been remarkably successful. As the State Energy Conservation Office has observed, "The state of Texas estimates that more megawatts of renewable energy have come on-line as a result of the RPS program than in the past 100 years. After the RPS was implemented, Texas wind corporations and utilities invested $1 billion in wind power, creating jobs, adding to the Texas Permanent School Fund and increasing the rural tax base."[78] Texas has increased capacity from all sources by 41,000 MW in the ERCOT area since 1999.[79]

One important feature of the Texas standard is that it sets hard targets for renewable generation—so many megawatts by a target date. As Table 8 demonstrates most other states use a standard that requires a percentage of retail sales be from renewable sources, rather than a

[75] U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, "Database of State Incentives for Renewables & Efficiency: Portfolio Standards/Set Asides for Renewable Energy." Available at: http://www.dsireusa.org/incentives/index.cfm?SearchType=RPS&&EE=0&RE=1; and "Texas: Renewable Generation Requirement." Available at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_ Code=TX03R&re=1&ee=0.
[76] The Iowa Alternate Energy Production law in 1983 required the state's investor-owned utilities to purchase electricity from renewable energy projects and was the earliest RPS.
[77] 25 Tex. Admin. Code, §25.173. Available at: http://www.puc.state.tx.us/rules/subrules/electric/25.173/25.173.pdf.
[78] Texas State Energy Conservation Office, "Texas Renewable Portfolio Standard." Available at: http://www.seco.cpa.state.tx.us/re_rps-portfolio.htm
[79] Electric Reliability Council of Texas, *Report on Existing and Potential Electric System Constraints and Needs*, December 2009, p. 23. Available at: http://www.ercot.com/content/news/presentations/2010/2009_Constraints_and_Needs_Report_21DEC2009.pdf.

specific megawatt capacity, thus insuring that the requirements for renewable energy grow along with overall energy demand. For example, Oregon's standard requires that one quarter of retail sales in 2025 come from renewable sources, and California's standard ensures that 33 percent of total capacity comes from renewable energy sources by 2030. The unfortunate reality is that once translated into percentages, Texas' standard appears much weaker than those in most other states.[80] In addition to goals for renewable sources besides wind, several states, such as Arizona, also require a certain percentage of the renewable portfolio to be from distributed generation, such as rooftop solar photovoltaics.

TABLE 8: STATE RENEWABLE PORTFOLIO STANDARDS

State	Amount	Year	State	Amount	Year
Arizona	15%	2025	New Hampshire	23.80%	2025
California	33%	2030	New Jersey	22.50%	2021
Colorado	20%	2020	New Mexico	20%	2020
Connecticut	23%	2020	New York	24%	2013
Delaware	20%	2019	North Carolina	12.50%	2021
Hawaii	20%	2020	North Dakota	10%	2015
Illinois	25%	2025	Oregon	25%	2025
Iowa	105 MW		Pennsylvania	8%	2020
Kansas	20%	2025	Rhode Island	16%	2019
Maine	40%	2017	South Dakota	10%	2015
Maryland	20%	2022	**Texas**	**5,880 MW**	**2015**
Massachusetts	15%	2020	Utah	20%	2025
Michigan	10%	2015	Vermont	10%	2013
Minnesota	25%	2025	Virginia	12%	2022
Missouri	15%	2021	Washington	15%	2020
Montana	15%	2015	Wisconsin	10%	2015
Nevada	20%	2015			

Note: North Dakota, South Dakota, Vermont and Virginia have voluntary programs. Texas has a voluntary goal of 10,000 MW by 2025 and 500 MW from renewable sources other than wind by 2015 (from 2005). The table excludes Ohio and West Virginia, which include coal and other nonrenewable sources.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council.

Table 8: State Renewable Portfolio Standards

Texas' 2015 standard represented about 5.8 percent of installed capacity in 2005 when the Legislature set it, but will decline to about five percent by the 2015 deadline due to overall system capacity growth. The 2025 target is about 10 percent of current capacity, but as total capacity increases given projected growth rates, the percentage could decline to as little as seven percent or less of capacity depending on the amount of capacity growth. The target of 500 MW for renewable sources other than wind translates into 0.4 percent or less of total capacity by 2015.

[80] U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, "Database of State Incentives for Renewables & Efficiency: States with Renewable Portfolio Standards." Available at: http://apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm#chart.

In any case, Texas should reconsider the 2015 RPS target in light of the state's success in the renewable energy field. Texas has already surpassed its 5,880 MW standard for 2015 and is close to achieving its 2025 goal target of 10,000 MW from renewable sources. On the other hand, the state is far from meeting its substantially more modest 2015 target of 500 MW from sources other than wind since most renewable energy investment in the state has focused on wind energy. According to monitoring reports, the state has added only about 69.3 MW in non-wind capacity since 2005—35 MW from landfill gas, 34.9 MW from biomass, 1.0 MW from solar and has lost 1.6 MW of hydroelectric power since 2005.[81]

Supporters of renewable energy—and anyone that has closely studied the state's future demands for energy—could reasonably argue that the state, which has been a leader in this field, should push its standards higher. In this context, a goal that is sometimes mentioned is a 25 percent renewable portfolio standard by 2025. To meet that sort of ambitious standard given projected growth rates in demand, Texas would need to have enough capacity from renewable sources to produce more than 50,000 MWh in total demand. Table 9 below illustrates one scenario that could meet this demand given current capacity factors.

TABLE 9: SAMPLE RENEWABLE CAPACITY MIX TO MEET A 25-PERCENT RENEWABLE PORTFOLIO STANDARD BY 2025

Type	2009 Capacity Factor	Renewable Mix Needed (MW)	Percent of Total
Biomass	20.80%	3,115	6.00%
Landfill Gas	56.40%	1,149	2.20%
Solar	42.70%	3,035	5.90%
Wind	23.40%	44,307	85.90%
Total		**51,607**	**100.00%**

Note: Capacity factors and demand estimates based on data from the Electric Reliability Council of Texas and the U.S. Department of Energy.

Table 9: Sample Renewable Capacity Mix, 25% RPS

Consider what a challenge such a goal would be. The state currently has 124 MW of biomass capacity with 84 MW of it from landfill gas and about 40 MW from other biomass sources. ERCOT has identified about 243.7 MW of planned and potential biomass generating capacity through 2015. The 84 MW landfill gas plants are located at sites representing about half of the state's 600 million tons of landfill waste.[82] Texas also has about 40 MW of generating capacity from other biomass sources. The East Texas Electric Cooperative recently announced

[81] Texasrenewables.com, "Existing/New REC Capacity Report." Available at: https://www.texasrenewables.com/publicReports/rpt5.asp. (Data reported as of May 3, 2010.)
[82] U.S. Environmental Protection Agency, "Energy Projects and Candidate Landfills." Available at: http://www.epa.gov/lmop/projects-candidates/index.html and "LMOP landfill and project database, sorted by state, project status and landfill name," (Excel spreadsheet). Available at: http://www.lmop.documents/xls.lmopdata.xls. (Calculations based on spreadsheet data.)

plans to increase that total to 90 MW by building a 50 MW biomass generating plant in Woodville using wood by-products. The $190 million project received $40 million from federal Clean Renewable Energy Bonds last year.[83] The true potential for biomass in Texas is large and largely untapped but not well quantified, making planning more difficult.

Building on these existing resources, Texas would need to add about 3,440 MW of capacity from clean sources each year to meet the standard in the table above by 2025, almost twice the 1,799 MW added in 2009, most of which came from wind. The state clearly has the potential to reach a 25 percent standard if it increases its efforts, but it is an ambitious target that would require modifications to current state policy and a significant new commitment to renewable energy. The state, however, has put in place many of the ingredients that would be necessary to meet this ambitious goal.

The Electric Reliability Council of Texas already has identified a potential for nearly 35,000 MW of onshore wind capacity by 2015.[84] In 2008, the Public Utility Commission of Texas (PUC), at the direction of the Legislature, established plans to add 2,900 miles of transmission lines to reach wind energy sites that currently do not link effectively to the power grid. The investment of nearly $5 billion will carry wind-powered electricity from West Texas and the Panhandle to metropolitan areas, enough to accommodate nearly 18,500 MW of electricity.[85]

Other states are also providing evidence of what can be done in this area. Offshore wind and tidal energy also have potential along the Gulf Coast. The nation's first offshore wind farm, off the Massachusetts coast, gained federal permit approval in April of this year, having previously gained state and local approvals. It should begin operating within two years. In addition, the California Energy Commission projects ocean wave generation will be cost-effective by 2018.[86]

California also is on track to fulfill its Million Solar Roofs Initiative that will add about 3,000 MW of solar capacity in ten years from 2007 to 2017.[87] Texas has about 11 million residential and commercial electricity customers, which is fewer than California's 14 million, but Texas clearly has the potential to match California's aggressive efforts in this area with the right

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[83] Derrill Holly, National Rural Electric Cooperative Association, "Texas Co-op Strikes Deal for Biomass," August 7, 2009, http://www.ect.coop/power-supply/renewable-energy/texas-gt-strikes-deal-for-biomass and National Rural Electric Cooperative Association, "Electric Cooperatives Awarded $458,204,555 in Clean Renewable Energy Bond Allocations," October 30, 2009, http://www.nreca.org/PressRoom/Releases/20091030CREB.htm.

[84] Electric Reliability Council of Texas, *Report on the Capacity, Demand and Reserves in the ERCOT Region*, December 2009. Available at: http://www.ercot.com/content/news/presentations/2010/2009CDR_DecUpdate.pdf.

[85] Public Utility Commission of Texas, "PUCT-CREZ Home Page." Available at: http://www.texascrezprojects.com/default.aspx.

[86] U.S. Department of Interior, "Secretary Salazar Announces Approval of Cape Wind Energy Project on Outer Continental Shelf off Massachusetts," April 28, 2010, available at: http://www.doi.gov/news/doinews/Secretary-Salazar-Announces-Approval-of-Cape-Wind-Energy-Project-on-Outer-Continental-Shelf-off-Massachusetts.cfm and California Energy Commission, *2009 Comparative Cost of California Central Station Electricity Generation Technologies Report*, January 2010, p. 17. Available at: http://www.energy.ca.gov/2009publications/CEC-200-2009-017/CEC-200-2009-017-SF.PDF.

[87] Environment California, "California's Million Solar Roofs Initiative." Available at: http://www.environmentcalifornia.org/energy/million-solar-roofs/fact-sheet2/legislation.

incentives. Moreover, projections discussed earlier in this report suggest that large-scale solar will become more cost effective for deployment in Texas within the coming decade.[88]

Renewable Energy Credits

It is one thing to create a renewable portfolio standard and another to create a method for its efficient use and enforcement. States that adopt RPS policies currently use two methods of verifying compliance with the policy. One approach is to examine the "chain of custody" in electricity contracts, relying on contracts for electricity in which the generating units and their attributes (clean/conventional in a general sense) are specified.[89] A second approach is to unbundle the attributes from the underlying electricity and to allow them to be traded in the form of Renewable Energy Credits (REC). Compliance can then be verified by reviewing the RECs owned and retired by the entities affect by the renewable standard.

Texas pioneered the REC approach in 2001. The Texas Public Utility Commission was given the responsibility for implementing the renewable energy credit program, and it, in turn, established ERCOT as the program administrator. In effect, RECs are stock-like certificates that correspond to actual megawatts of renewable energy. Each REC represents one megawatt-hour of renewable energy produced. Under the Texas program, retail electric providers must acquire and retire RECs based on their load-ratio share of the renewable portfolio standard annual mandate. Electric providers may also voluntarily retire RECs to substantiate claims of clean energy to consumers.

The REC trading system created great flexibility in the development of renewable energy projects. The renewable energy capacity required by the electricity sellers can be provided directly or through the REC market. If a utility earns extra credits, it can sell the credits to utilities that need credits to meet the RPS requirements. This enables electricity providers that do not own or purchase enough renewable energy capacity to purchase credits instead of capacity. National research on how the states have approached the REC came to the following conclusions about how such programs have worked:

- Trading RECs is not as cumbersome or exacting as trading electricity.
- RECs may seek the highest value, and find buyers more easily than bundled renewable electricity.
- RECs can usually be banked for a period of months or even years, thereby helping to avoid issues of intermittency and load-matching between seller and buyer.
- The use of RECs may reduce some transmission costs to the extent that they allow projects to avoid electricity delivery over constrained paths.

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[88] U.S. Department of Energy, Energy Information Administration, *Electric Power Annual 2008*—"State Data Tables: 1990-2008 Number of Retail Customers by State by Sector," (Excel spreadsheet), January 21, 2010. Available at: http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html.

[89] Edward A. Holt and Ryan Wiser, "The Treatment of Renewable Energy Certificates, Emissions Allowances, and Green Power Programs in State Renewables Portfolio Standards," Ernest Orlando Lawrence Berkeley National Laboratory, April 2007. Available at: http://eetd.lbl.gov/ea/emp/reports/62574.pdf

- Use of RECs may reduce RPS compliance costs by widening the geographic scope of eligible renewable energy projects.
- RECs can be more easily tracked for RPS compliance purposes.[90]

RECs in Texas are issued quarterly, based on meter readings. The REC market is administered by ERCOT, the Texas electric grid operator. Penalties for non-compliance with the RPS requirements are enforced by the PUC. The PUC has the authority to cap the price of RECs and may suspend the standard if necessary to protect the reliability and operation of the grid. Utilities retired 6.74 million mandatory credits in 2008, compared with 3.4 million in 2007. Voluntary credits grew to 6.77 million from 1.6 million. REC prices varied from $1 to about $5 during 2008 depending on demand. The state's trading market was operating in the range of $13 million to $65 million.[91]

Program compliance has been good, although state law allows the PUC to establish an alternative compliance payment when utilities do not have sufficient credits to meet their clean energy requirements or to meet the non-wind portion. To date, the commission has refrained from issuing such an order. ERCOT found that retailers were out of compliance with standards by only 37,622 RECs in 2007. Retailers who are out of compliance are subject to an administrative penalty of $50 per MWh.

In addition, to provide an incentive to meet the 2015 non-wind target, the state originally issued "compliance premiums" for each non-wind REC, effectively doubling the compliance value of non-wind resources installed in 2008 or later. The PUC is currently considering a rule that if passed would make the 500 MW target mandatory.

In most states that address ownership of RECs, the customer generating electricity from renewable sources retains ownership; however, some states grant ownership to the utility or require shared ownership. The deregulated nature of Texas' system means that REC ownership is open to negotiation. For instance, some Texas utilities may require REC owners to relinquish credits in exchange for rebates on solar equipment. As a tradable commodity, RECs can be valuable, increase in value over time and help offset costs of renewable energy equipment. In recognition of this, the Interstate Renewable Energy Council (IREC) argues that utilities should pay a fair market price.[92]

[90] Holt and Wiser, p. 3.
[91] Electric Reliability Council of Texas, "ERCOT Renewable Energy Credit Program Most Active in US: Update," April 1, 2009. Available at: http://www.ercot.com/news/press_releases/2009/nr04-01-09. Electric Reliability Council of Texas, "ERCOT Renewable Energy Credit Program Most Active in US: Update," April 1, 2009. Available at: http://www.ercot.com/news/press_releases/2009/nr04-01-09 and "ERCOT's 2008 Annual Report on the Texas Renewable Energy Credit Trading Program: Attachment A," p. 20. Available at: https://www.texasrenewables.com/staticReports/Annual%20Report/2008_Report.doc.
[92] Interstate Renewable Energy Council, "Connecting to the Grid: State and Utility Net Metering Rules for Distributed Generation," March 2010, p. 27. Available at: http://irecusa.org/wp content/uploads/2010/03/March_2010_NM_Table.doc.

Financial Incentives

As noted earlier, the existence of market failures like the lack of carbon prices and other barriers to investments that benefit society is the primary reason for public policy intervention. In many cases, workable, reasonably low-cost policies can be implemented that either eliminate or largely offset market barriers. In this regard, financial incentives have played an especially important role in the development of clean energy resources in the United States. When coupled with federal initiatives, state incentives can create a catalyst that multiplies results. States have a wide variety of financial incentive tools that they can use to stimulate clean energy production and markets, including tax incentives and direct cash awards, sometimes aimed specifically at industry recruitment.

Most states, including Texas, now offer some mix of financial incentives to stimulate the clean energy investment. However, the recent unprecedented expansions in federal commitment to clean energy in the American Recovery and Reinvestment Act, although mostly time-limited, mean that states now have an opportunity to launch additional policies that could trigger more extensive development of clean energy options in the state and promote the development of clean energy-related businesses.

Federal incentives apply nationwide. What is critical to individual states is how their particular policies develop. The American Wind Energy Association, for instance, has found that states that offer consumer incentives of $2 per watt of capacity have a much higher share of small wind sales.[93] As a relatively new economic development opportunity, the clean energy industry offers substantial potential for new jobs and growth in personal income and gross state product.

To gain momentum for clean energy industries in Texas, the state will need to pay close attention to competitive incentives offered in other states and nations. This section discusses the major financial incentives offered by states and how they compare to Texas' current policies. The range of potential financial incentives by state is summarized in Table 10.

[93] American Wind Energy Association, *AWEA Small Wind Turbine Global Market Study: Year Ending 2008*, p. 6. Available at: http://www.awea.org/smallwind/pdf/09_AWEA_Small_Wind_Global_Market_Study.pdf.

TABLE 10: FEDERAL AND STATE FINANCIAL INCENTIVES FOR RENEWABLE ENERGY DEVELOPMENT									
	Program Source Key		State	Utility	Local	Non-Profit			
	Tax							Industry	
State	Sales	Personal	Business	Property	Rebates	Grants	Loans	Support	Bonds
Federal									
Alabama							U		
Alaska									
Arizona									
Arkansas					U				
California					U/L		U/L		
Colorado	L				U/L	L	U/L		
Connecticut					U	L	N		
Delaware									
Florida					U/L		U		
Georgia					U		U		
Hawaii					U		U/L		
Idaho						N			
Illinois					U	L/N			
Indiana						U			
Iowa							U		
Kansas									
Kentucky					U		L/N		
Louisiana									
Maine							N		
Maryland				L	L				
Massachusetts					U		U/N		
Michigan					U				
Minnesota					U	U	U		
Mississippi					U		U		
Missouri					U		U		
Montana									
Nebraska									
Nevada					U				
New Hampshire					U		N		
New Jersey							U		
New Mexico									
New York				L	U		L		
North Carolina							U		
North Dakota									
Ohio					N		U/L		
Oklahoma							U		
Oregon									
Pennsylvania					U/L	U/L	U/L		
Rhode Island							N		
South Carolina							U		
South Dakota									
Tennessee							U		
Texas					L	U			
Utah									
Vermont						U	N		
Virginia									
Washington						N			
West Virginia									
Wisconsin					U	U	U/L		
Wyoming					U				
District of Columbia									
Total States/DC	28	24	26	34	46	29	47	22	3

Note: Some states have programs run by more than one source--state, local, utility or non-profit. Property taxes in most states are local taxes, but exemptions are often provided through statewide legislation. Some states permit local options.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, Database of State Incentives for Renewables & Efficiency, "Loan Programs for Renewable Energy."

Table 10: Federal and State Financial Incentives for Renewable Energy

Tax Incentives

Tax incentives offer broad-based stimulus to development and so governments, consumers and affected industries find them attractive. Because clean energy development is relatively new in Texas, it has not generated major revenue streams from the tax system that new or expanded tax incentives would disrupt. On the other hand, development would generate additional new tax revenue over time through job growth and spending.

Tax incentives include credits, deductions, exemptions and abatements from personal and corporate, sales and use and property taxes. Credits reduce taxes owed on a dollar-for-dollar basis, usually providing the most potent incentive. Deductions reduce the gross amount of income to which taxes are applied. The actual value of a tax deduction, therefore, depends on tax rates and so is attractive but less so than credits. Exemptions are similar to deductions in that no taxes apply to income or purchases used for a stated exempt purpose; however, an exemption can be a powerful incentive when all of an entity's income is exempted from tax. Abatements are rate reductions or the complete or partial elimination of tax liability, often for a limited period of time.

Personal Income Tax. The federal personal income tax credit for renewable energy devices is primarily directed at distributed systems purchased for use by individual consumers. It covers solar, wind turbines, geothermal heat pumps and fuel cells, covering 30 percent of the cost of these systems through 2016. In addition, the government has recently removed the dollar limit for systems beginning in 2009.[94] A separate 30 percent credit of up to $1,500, which is available until the end of 2010, applies to biomass stoves and their installation labor costs.

In addition to the federal incentives, 24 states currently offer some form of personal income tax incentive for the purchase of renewable energy technology.[95] Since Texas does not have a personal income tax, it obviously does not offer incentives in this area.

Sales Tax. Sales taxes are taxes imposed on the sale of certain goods and services. About 45 states have sales taxes, including Texas. Currently, 28 of these states have some type of sales tax incentive—an exemption, rebate or abatement—for at least some renewable energy technologies involved in electricity production, some for residential and others for residential and commercial purchases. Texas, however, does not offer any sales tax incentives for renewable energy, although the Legislature considered bills last session for solar and small wind energy.[96]

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[94] U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, Database of State Incentives for Renewables & Efficiency, "Federal Incentives/Policies for Renewable Energy: Residential Renewable Energy Tax Credit," February 18, 2010. Available at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US37F&re=1&ee=0.

[95] U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, "Database for State Incentives for Renewables & Efficiency—Personal Tax Incentives for Renewable Energy." Available at: http://www.dsireusa.org/incentives/index.cfm?SearchType=Personal&EE=0&RE=1.

[96] U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, "Database for State Incentives for Renewables & Efficiency—Sales Tax Incentives for Renewable Energy," http://www.dsireusa.org/incentives/index.cfm?SearchType=Sales&EE=0&RE=1; and Texas 81st Legislature, H.B. 1417. Available at: http://www.capitol.state.tx.us/BillLookup/History.aspx?LegSess=81R&Bill=HB1417; H.B. 2226, http://www.capitol.state.tx.us/BillLookup/History.aspx?LegSess=81R&Bill=HB2226; and S.B. 619, http://www.capitol.state.tx.us/BillLookup/History.aspx?LegSess=81R&Bill=SB619.

The most "successful" of the legislation proposed in the 2009 legislation session was House Bill 2226, which was passed out of committee and sent to the Calendars Committee, although it was never set for floor consideration. It was a limited bill. The bill would have created a sales tax holiday for certain renewable energy equipment, a period during which the equipment would be exempt from sales tax. The bill covered the sale of solar energy or wind energy devices for noncommercial home or personal use if the sales take place during a period beginning on the Saturday prior to the last Monday in May and ending on the last Monday in May. Texas currently has sales tax holidays for school supplies, clothing and for energy star appliances. One benefit of the holiday approach is that it limits the cost to the state. The fiscal estimates accompanying H.B. 2226 indicated that the clean energy holiday would have reduced sales tax collections by about $278,000 in fiscal 2010.

Other bills proposed eliminating the tax on certain clean energy purchases altogether, a considerably more expensive proposition from the standpoint of state finances. House Bill 1417 proposed a sales tax exemption for the sale, use or installation of a "renewable energy system" and any equipment directly related to the system. A renewable energy system was defined as a solar or wind-powered system that is used as "a primary or auxiliary power system to supply the energy needs of a farm or a person's residence homestead." Based on state fiscal note estimates for the bill, the cost to the state would have been about $17.2 million in the first year and about $20 million annually thereafter. The bill never was voted out of committee largely because the cost associated with it.

Despite these costs, a sales tax exemption makes sense, whether it is a complete exemption or sales tax holiday. Sales tax holidays have stimulated purchasing on certain days of the year since it gives consumers an opportunity to take advantage of an 8.25 percent price reduction (the state tax rate is 6.25 percent plus an additional two percent in local tax in most urban areas). A full exemption would be more costly but when added to the 30 percent federal income tax credit that individuals receive for renewable energy investments, it could certain help to improve the attractiveness of renewable energy purchases by those considering this option.

The states that have sales tax exemptions for renewable technologies vary broadly in what they cover and the types of consumers that qualify. The various policies are summarized in the state sales tax incentive table below. Some states have very limited, targeted exemptions. Two good examples are South Carolina, which exempts technology for hydrogen and fuel cells only and Georgia, whose exemption is limited to biomass technology only. Some, such as New York and North Carolina, limit the exemptions to residential purchases, as was proposed in the 2009 Texas legislation. However, most extend the exemption at least to commercial purchases and often to commercial, industrial and utility transactions. The laws in place cover a range of clean energy technologies, including wind, solar, biomass and others. Nevada has one of the broadest laws related to renewable energy, although it does not grant a full exemption from the sales tax. Instead, a purchaser is only required to pay a reduced sales tax rate of 2.6 percent (through June 30, 2011) and 2.25 percent (effective July 1, 2011-June 30, 2049). The law covers virtually all types of renewable energy products plus facilities for the transmission of renewable energy located in the state.

TABLE 12: STATE SALES TAX INCENTIVES FOR CLEAN ENERGY PURCHASES

State	Technology	Sectors	Incentive
Arizona	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Solar Pool Heating, Daylighting	Commercial, Residential, General Public/Consumer	100% of sales tax on eligible equipment
California	Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Small Hydroelectric, Other Distributed Generation Technologies	Industrial	100% competitive exemption on sales and use tax on manufacturing equipment for renewable energy, renewable energy equipment, combined heat and power and alternative transportation based on several criteria including job creation and environmental impact (limited funding)
Colorado	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Geothermal Electric, Other Renewables (not specified)	Commercial, Industrial, Residential, General Public/Consumer, Nonprofit, Local Government, State Government, Agricultural, Institutional, Retail Supplier	100% of sales tax on sales, storage, and use of components used in the production of alternating current electricity from a renewable energy source
Connecticut	Solar Water Heat, Solar Space Heat, Photovoltaics, Geothermal Heat Pumps, Other Distributed Generation Technologies	Commercial, Residential, General Public/Consumer, Installer/Contractor	100% exemption on equipment and labor
Florida	Solar Water Heat, Solar Space Heat, Photovoltaics, Geothermal Heat Pumps, Other Distributed Generation Technologies	Commercial, Residential, General Public/Consumer, Installer/Contractor	100% exemption
Florida (2)	Fuel Cells, Ethanol, Biodiesel	Commercial, Residential, General Public/Consumer	100% refund of sales and use tax
Georgia	Biomass	Commercial, Residential, General Public/Consumer	100% exemption
Idaho	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, CHP/Cogeneration	Commercial, Industrial, Residential	100% refund of sales tax for equipment serving a facility capable of generating at least 25 kW
Illinois	Wind	Commercial	100% exemption of Retailers' Occupation Tax for building materials incorporated into a facility generating at least 500 kW
Iowa	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Solar Pool Heating	Commercial, Residential, General Public/Consumer, Agricultural	100% exemption
Kentucky	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, similar renewable resources	Commercial	100% of sales and use tax, up to 50% of capital investment, for facilities generating > 50kW for solar power and >1 MW for other renewable sources and minimum capital investment of $1 million
Maine	Wind	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Agricultural	100% sales and use tax refund for community projects of 10 MW or less
Maryland	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Residential Wind, Geothermal Heat Pumps	Commercial, Residential, General Public/Consumer	100% exemption
Maryland (2)	Biomass	Commercial, Residential	100% exemption if used for heating
Massachusetts	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Geothermal Heat Pumps	Residential	100% exemption
Minnesota	Solar Water Heat, Solar Space Heat, Photovoltaics	Commercial, Residential, General Public/Consumer	100% exemption for all components, including panels, wiring, pipes, pumps and racks
Nebraska	Wind	Commercial, Residential, Nonprofit, Utility, Tribal Government, Agricultural	100% exemption
Nevada	Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Municipal Solid Waste, Facilities for the transmission of electricity produced from renewable energy or geothermal resources located in state, anaerobic digestion, fuel cells using renewable fuels	Commercial, Industrial, Utility, Agricultural, (Renewable Energy Power Producers)	Abatement to rate of 2.6 % (effective through June 30, 2011) and at the rate of 2.25 % (effective July 01, 2011 - June 30, 2049) for equipment generating at least 10 MW
New Jersey	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Solar Pool Heating	Commercial, Residential, General Public/Consumer	100% exemption
New Mexico	Solar Thermal Electric, Photovoltaics, Geothermal Electric, CHP/Cogeneration	Construction, Installer/Contractor, Retail Supplier, Systems Integrator	100% of gross receipts from sale and installation of at least 1 MW
New Mexico (2)	Landfill Gas, Biomass, Municipal Solid Waste, CHP/Cogeneration, Hydrogen, Anaerobic Digestion, Ethanol, Methanol, Biodiesel, Microturbines	Commercial, Industrial	100% of value may be deducted for purposes of calculating Compensating Tax due
New Mexico (3)	Solar Thermal Electric, Photovoltaics, Wind	Installer/Contractor, Retail Supplier, Systems Integrator	100% exemption
New Mexico (4)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics	Installer/Contractor, Retail Supplier, Systems Integrator, Solar Distributors	100% of gross receipts from sale and installation of solar energy systems
New York	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics	Residential	100% exemption
North Carolina	Geothermal Heat Pumps (also applies to certain efficiency technologies)	Residential, Multi-Family Residential	100% sales tax exemption on certain Energy Star appliances
Ohio	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal	Commercial, Industrial	100% exemption
Rhode Island	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Geothermal Heat Pumps, Solar Pool Heating	Commercial, Residential, General Public/Consumer	100% exemption for solar electric systems, inverters for solar electric systems, solar thermal systems, manufac- tured mounting racks and ballast pans for solar collectors, geothermal heat pump, and wind turbines and towers
South Carolina	Fuel Cells, Hydrogen	Commercial, Industrial	100% exemption for equipment used to produce or research hydrogen fuel cells
South Dakota	Wind	Commercial, Industrial	Maximum of 55% for sales and use or excise taxes paid for wind facilities, transmission lines and facilities that manufacture or distribute wind or transmission components
Utah	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Anaerobic Digestion	Commercial, Industrial, Utility	100% exemption for facilities of 20 kW or greater or for expansions of 1 MW or greater and generally includes wind turbines, generating equipment, control and monitoring systems, power lines, substation equipment, lighting, fencing, pipes, and other equipment for locating power lines and poles
Vermont	Solar Water Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, CHP/Cogeneration, Anaerobic Digestion, Fuel Cells using Renewable Fuels	Commercial, Residential, General Public/Consumer, Agricultural	100% of sales tax for systems up to 250 kilowatts (kW), to micro-combined heat and power (CHP) systems up to 20 kW, and to solar water-heating systems and may be grid-tied or off-grid
Washington	Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Fuel Cells, Anaerobic Digestion, Tidal Energy, Wave Energy	Commercial, Residential, General Public/Consumer	100% exemption for capacity greater than 1 kW and includes labor and services
Wisconsin	Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Solar Pool Heating, Anaerobic Digestion	Commercial, Industrial, Residential, General Public/Consumer	100% exemption from sales and use tax for eligible purchases
Wyoming	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Small Hydroelectric, Fuel Cells using Renewable Fuels	Commercial, Industrial, Utility, Projects Tied to an Existing Transmission Grid	100% exemption on wind turbines, generating equipment, control and monitoring systems, power lines, substation equipment, lighting, fencing, pipes and other equipment for locating power lines and poles

Notes: Does not include local or private sector incentives. Many of these incentives also apply to energy efficiency. Certain other specifics may apply to incentives, including time limits. Some states extend the exemption to local governments or allow them to enact the exemption voluntarily. New Mexico has a gross receipts tax rather than a sales tax.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, Database of State Incentives for Renewables & Efficiency, "Sales Tax Incentives for Renewable Energy."

Table 11: State Sales Tax Incentives for Clean Energy Purchases

One of the newest and most aggressive laws aimed at creating what is known as a "green tech economy" was signed by California Governor Arnold Schwarzenegger on March 25, 2010. The legislation, S.B. 71, excludes from California sales tax the purchase of equipment used to manufacture products to generate energy from alternative sources, such as solar, wind and biomass. The California Alternative Energy and Advance Transportation Financing Authority will administer the exemption program by evaluating applications for exclusions. The exemption would also apply for the purchase of tangible personal property used for the design, manufacture, production or assembly of advanced transportation technologies. This includes emerging commercially competitive transportation related technologies identified by the Authority, including: (1) intelligent vehicle highway systems; (2) advance telecommunications for transportation; (3) command, control and communications for public transit vehicles and systems; (4) electric vehicles and ultra-low emission vehicles; (5) high-speed rail and magnetic levitation passenger systems; and (6) fuel cells.

S.B. 71 requires the Authority to evaluate project applications for sales tax exclusion based on the extent to which the project (a) develops manufacturing facilities or produces equipment in California; (b) creates benefits that equal or exceed the benefits to the project applicant and other participants; (c) creates permanent jobs in California; (d) results in reduction in greenhouse gases or water pollution, and increase in energy efficiency or production in energy consumption beyond requirements set by state or federal law; (e) reduces unemployment existing in the area in which the proposed project is to be located; and (f) meets any other factors the Authority deems appropriate.

Under the terms of the legislation, a “project” includes land, building, improvement, machinery and equipment that uses or is designated to use clean energy source, or that is used for the design, technology transfer, manufacture, production, assembly, distribution or service of advance transportation technologies or an arrangement for the purchase, including the prepayment, or sale of energy derived from alternative sources (such as solar, biomass, wind, geothermal, hydroelectricity under 30 megawatts, or other sources of energy which reduce the use of fossil and nuclear fuels).

Such a bill would have less effect in Texas than in California since Texas already exempts machinery used in production from the sales tax where California previously did not. However, there can be little doubt that the goal of the California program is to attract manufacturing related to renewable energy and high tech transportation systems. When he signed the bill, Schwarzenegger said: “California is leading the way with the largest green economy in the nation, creating jobs when they’re needed the most and proving to the world that we can protect our environment and build a stronger economic future at the same time. . . . SB 71 will expand our clean tech industry and bring the green jobs and businesses we need to rebuild California’s economy—we’re sending a clear message to every entrepreneur and innovator that it pays to invest in a clean future for California.”

Business Taxes. The federal government offers a 30 percent Business Energy Investment Tax Credit for solar, fuel cells and small wind systems, and a 10 percent credit for geothermal, microturbines and combined heat and power through 2016. The American Recovery and Reinvestment Act greatly expanded the credit, including the types of eligible technologies and either removing or extending limits.[97] The government also offers a Renewable Electricity Production Tax Credit based on kilowatt-hour production for wind facilities placed in service by 2012 and several renewable sources other than solar placed in service by 2013. The federal tax

[97] U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, Database for State Incentives for Renewables & Efficiency—Business Energy Investment Tax Credit (ITC).” Available at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US02F&re=1&ee=0.

code also includes other tax advantages for facilities qualifying for the credit, including accelerated depreciation.

The business tax deductions or credits offered by state governments cover a wide range of technologies, industrial sectors, incentive maximums or other provisions. Most states that offer an incentive choose a tax credit. Currently, 26 states offer some type of corporate tax incentive for renewable energy investment, production or. Texas' business franchise tax is the state's equivalent to the corporate income taxes levied in other states, but the Texas tax, familiarly called the margin tax, is applied to a much different tax base, taxable margin.[98] One of the few exemptions in the tax, which was only enacted in 2006, allows entities to deduct 10 percent of the cost of a solar energy device from their taxable income; the amortization must be for at least five years. A "solar energy device" for purposes of the statute includes solar water heat, solar space heat, solar thermal electric, solar thermal process heat, photovoltaic's and wind.[99]

Texas also exempts businesses that solely manufacture, sell or install solar energy devices from the franchise tax.[100] This exemption means eligible businesses pay no state taxes on any of their taxable margin under the state's recently revised tax base. This reduces risk in a relatively new market with a weak history and uncertain future demand.

Six states—Florida, Iowa, Maryland, New Mexico, Utah and Washington—have tax credits for electricity production from renewable energy; Texas does not have a business tax credit or deduction for this purpose.

Property Tax. Currently, 34 states, including Texas, offer property tax exemptions for renewable energy properties. Texas exempts the amount of appraised property value that arises from the installation or construction of a solar or wind-powered device, including biomass or anaerobic digestion. The taxpayer must use the device for the production and distribution of energy primarily for on-site use or for storing that energy. The state property tax table below summarizes the key property tax provisions affecting renewable energy in the states.

Although most states that exempt renewable technologies from sales tax have similar property tax policies, several also exempt other renewable technologies, such as hydroelectric and geothermal from property taxation. As noted in the section on Renewable Portfolio Standards, to meet its projections for renewable capacity other than wind, the state will need to maximize its available incentives for all renewable energy technologies. States also offer a variety of property tax incentives that encourage the development of large generating facilities using renewable energy, including exempting percentages of appraised value, assuming value to be the same as for non-renewable facilities, exempting facilities until production begins, capping valuation per kW of percentage of installed cost, controlling valuation increases by year of production, and basin value on production in lieu of property.

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[98] Texas taxes businesses on their "taxable margin," a tax base defined as the difference between their total revenues (gross receipts) and their cost of goods sold or wages and benefits. Businesses have the option to choose between the two deductions in computing taxable margin.

[99] Texas Tax Code, §171.107. Available at: http://www.statutes.legis.state.tx.us/Docs/TX/htm/TX.171.htm.

[100] Texas Tax Code, §171.056. Available at: http://www.statutes.legis.state.tx.us/Docs/TX/htm/TX.171.htm.

TABLE 13: STATE PROPERTY TAX INCENTIVES FOR CLEAN ENERGY

State	Technology	Sectors	Incentive
Arizona	Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Other nonpetroleum renewable sources	Utility, Other entities that generate, transmit or distribute -- but do not use -- eligible electricity	Renewable-energy equipment assessed at 20% of its depreciated cost
Arizona (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Solar Cooling, Solar Pool Heating, Daylighting, Anaerobic Digestion, Small Hydroelectric	Commercial, Industrial, Residential	100% of increased value
California	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Solar Mechanical Energy	Commercial, Industrial, Residential	100% of system value; 75% of system value exemption for dual-use equipment
Colorado	Solar Water Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Other Renewables (not specified)	Commercial, Industrial, Residential, General Public/Consumer, Agricultural	Property or sales tax rebates or credits; amount varies by local option; administered by cities and counties
Colorado (2)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Anaerobic Digestion	Commercial, Utility	Varies depending on rate set annually by the Division of Property Taxation; applies to utilities connected to transmission lines only; based on installed cost—assessed the same as non-renewable facilities
Connecticut	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Fuel Cells, Geothermal Heat Pumps, Tidal Energy, Wave Energy, Ocean Thermal, Geothermal Direct-Use	Commercial, Industrial, Residential, Multi-Family Residential, Agricultural, (Note: exemption for Class I resources applies only to residential dwelling with four or fewer units)	100% exemption for renewable energy property
Idaho	Wind, Geothermal Electric	Commercial	100% exemption of property taxes, but must pay production tax based on 3% of energy sales
Illinois	Wind	Commercial, Industrial, Utility	Valuation: $360,000/MW (annually adjusted for inflation) for commercial wind devices larger than 500 kW; Depreciation: Up to 70% of the trended real property cost basis
Illinois (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics	Commercial, Industrial, Residential	Special assessment makes solar energy systems equivalent to conventional energy systems for appraisal purposes
Indiana	Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Wind, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Solar Pool Heating, Geothermal Direct-Use	Commercial, Industrial, Residential	100% exemption for installed system
Iowa	Wind	Commercial, Industrial, Residential, Agricultural	Wind property and plants are not assessed until completed and value of property cannot increase for five years unless an ordinance has been adopted at local option and applied for that provides a special valuation beginning at 0% of the net acquisition cost in the first assessment year and increasing annually by five percentage points to a maximum of 30% of the net acquisition cost in the 7th and succeeding years
Iowa (2)	Landfill Gas, Biomass, Anaerobic Digestion	Commercial, Industrial, Residential, Agricultural	100% exemption for 10 years
Iowa (3)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind	Commercial, Industrial, Residential, Agricultural	100% exemption for 5 years; exemption applies to on-site use and net-metered when used primarily on-site
Kansas	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric	Commercial, Industrial, Residential	100% exemption for equipment and personal property used to collect, refine, treat and transport landfill gas to a pipeline
Louisiana	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Solar Pool Heating	Residential	100% exemption
Maryland	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Geothermal Heat Pumps, Solar Space Cooling	Commercial, Industrial, Residential, Multi-Family Residential, Low-Income Residential, Agricultural	Varies by jurisdiction; property tax credit may be available for up to 3 years at local option
Maryland (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Daylighting, Small Hydroelectric	Commercial, Industrial	Varies by jurisdiction; property tax credit may be available for green buildings at local option
Maryland (3)	Solar Water Heat, Solar Thermal Electric, Photovoltaics, Wind	Commercial, Industrial, Residential	100% property tax exemption for solar and wind energy property generated on site or net-metered
Maryland (4)	Solar Space Heat, Geothermal Heat Pumps, Geothermal Direct-Use	Commercial, Industrial, Residential	Eligible property assessed at no more than the value of a conventional system
Massachusetts	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Hydroelectric	Commercial, Industrial, Residential, Agricultural	100% exemption for 20 years; hydro exempt if making a payment in lieu of taxes at 5% of gross income
Michigan	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Fuel Cells, CHP/Cogeneration, Miniturbines, Stirling Engines, Hybrid Vehicles, Batteries, Storage, Thermoelectric Energy, Solar Pool Heating, Anaerobic Digestion, Renewable Fuels, Microturbines	Commercial, Industrial	100% personal property exemption; 2 MW limit for single systems; 10 MW limit for combination of technologies; no limit for wind, photovoltaics and fuel cells; established to support manufacturing, research, development and commercialization
Michigan (2)	Biomass, Anaerobic Digestion	Agricultural	100% exemption from real and personal property taxes
Minnesota	Photovoltaics, Wind	Commercial, Residential	Excludes value added by photovoltaics from real property and by wind-energy systems from all real and personal property, although land remains taxable; production tax in lieu of property tax on large (>12 MW) wind-energy systems taxed at 0.12 cents/kWh, less for smaller systems and exempt for <250 KW and <2 MW for political subdivisions; lower rates may be negotiated at local level
Montana	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Fuel Cells using Renewable Fuels	Commercial, Industrial	Taxable value for plants of 1 MW or more reduced by 50% for 5 years after operation begins; reduction in taxable value declines each year thereafter until there is no reduction in tenth year; if owned by a wholesale generator or other electricity producer, the tax would otherwise by 6 percent of assessed value; if owned by an electric cooperative, the tax would otherwise be 3 percent of assessed value value
Montana (2)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Fuel Cells using Renewable Fuels	Commercial, Industrial	100% exemption for generating facilities with nameplate capacity of <1 MW for 5 years after operation begins
Montana (3)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, Municipal Solid Waste, Solar Pool Heating, Anaerobic Digestion, Small Hydroelectric, Fuel Cells using Renewable Fuels, Geothermal Direct-Use	Commercial, Industrial, Residential, Multi-Family Residential, Agricultural	100% exemption for 10 years based on maximum investment of $20,000 for single family, and on investment of $100,000 for multi-family, nonresidential
Montana (2)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Fuel Cells using Renewable Fuels	Commercial, Industrial	100% exemption for generating facilities with nameplate capacity of <1 MW for 5 years after operation begins. $20,000 for single family, and on investment of $100,000 for multi-family, nonresidential
Montana (3)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, Municipal Solid Waste, Solar Pool Heating, Anaerobic Digestion, Small Hydroelectric, Fuel Cells using Renewable Fuels, Geothermal Direct-Use	Commercial, Industrial, Residential, Multi-Family Residential, Agricultural	100% exemption for 10 years based on maximum investment of
Nevada (3)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Municipal Solid Waste, Geothermal Direct-Use	Commercial, Industrial, Residential	100% exemption for value added by qualified renewable energy system
New Hampshire	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Wood-Fired Central Heating Systems	Residential	Varies (local option) for value added for renewable energy technologies
New Jersey	Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Resource Recovery, Tidal Energy, Wave Energy, Geothermal Direct-Use	Commercial, Industrial, Residential	100% of value added by on-site renewable system
New Mexico	Solar Water Heat, Solar Space Heat, Photovoltaics	Residential	100% of value added by solar energy systems, but will be taxed after a property is sold

TABLE 13: STATE PROPERTY TAX INCENTIVES FOR CLEAN ENERGY--CONT'D.

State	Technology	Sectors	Incentive
New York	Solar Water Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps	Residential	100% of the value added to the residence; does not apply to special assessments
New York (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Solar Pool Heating, Daylighting, Anaerobic Digestion	Commercial, Industrial, Residential, Agricultural	100% exemption for 15 years; local governments may opt out
North Carolina	Solar Water Heat, Solar Space Heat, Solar Space Cooling	Commercial, Industrial, Residential	May not be assessed at value higher than conventional equipment
North Carolina (2)	Solar Thermal Electric, Photovoltaics	Commercial, Industrial, Residential, Agricultural	Exempts 80% of the appraised value of solar electric systems from taxation
North Dakota	Wind	Commercial, Investor-Owned Utility	70% or 85% reduction in property taxes on centrally-assessed wind turbines, depending on project circumstances, resulting in property assessed at 1.5% of assessed value until 2015
North Dakota (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Geothermal Electric, Geothermal Heat Pumps, Storage Technologies, Geothermal Direct-Use	Commercial, Industrial, Residential	100% exemption from local assessments for 5 years for devices on new or existing structures
Oregon	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Methane Gas, Solar Pool Heating, Geothermal Direct-Use	Commercial, Industrial, Residential	100% of the value added
Pennsylvania	Large Wind	Commercial, Industrial, Agricultural	100% of system value exempted, but provides alternative income valuation method
Rhode Island	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Small Hydroelectric	Commercial, Industrial, Residential, Agricultural	Exemption varies at local option
Rhode Island (2)	Solar Water Heat, Solar Space Heat, Photovoltaics	Residential	Assessed at no more than conventional energy systems
South Dakota	Wind	Commercial	Alternative tax assessment method for 5 MW or more: $3/kW of capacity and 2% of the gross receipts of the wind farm; partial rebate available for cost of transmission line and collector system equipment that is located in SD and serves an eligible facility
South Dakota (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Hydrogen, Solar Pool Heating	Commercial, Industrial, Residential, Agricultural	$50,000 or 70% of the assessed value of eligible property, whichever is greater up to maximum size of 5 MW
South Dakota (3)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, Ethanol	Commercial, Industrial, Residential, Agricultural	Commercial: 50% exemption; Residential: 100% exemption; 100% exemption for 3 years, declining percentage for 3 years thereafter; applies only to on-site energy systems
South Dakota (4)	Wind	Commercial	Alternative tax assessment method for systems of < 5 MW takes only the base, foundation, tower and substations into account (turbine and blades excluded); discretionary property tax formulas may not be assessed
Tennessee	Wind	Commercial, Industrial, Utility	67% exemption; may not be taxed at more than one-third of installed cost
Texas	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Storage Technologies, Solar Pool Heating, Anaerobic Digestion	Commercial, Industrial, Residential	100% exemption for value added for on-site use or storage. Also renewable energy can qualify for substantial tax abatements and value limitations by local governments.
Vermont	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, CHP/Cogeneration, Anaerobic Digestion, Small Hydroelectric, Fuel Cells using Renewable Fuels	Commercial, Industrial, Residential, Agricultural	100% municipal real and personal property exemption, including land of ½ acre or less, by municipal option; state property taxes still apply
Virginia	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics	Commercial, Industrial, Residential	Varies at local option
West Virginia	Wind	Utility	Property tax basis effectively reduced to about 25% of assessed value
Wisconsin	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Solar Pool Heating	Commercial, Industrial, Residential	100% of value added

Notes: Does not include local or private sector incentives. Many of these incentives also apply to energy efficiency. Certain other specifics may apply to incentives, including minimum and maximum capacities, time limits, variable maximums, ownership requirements and other specifications.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, "Database of State Incentives for Renewables & Efficiency--Property Tax Incentives for Renewable Energy."

Table 12: State Property Tax Incentives for Clean Energy

Texas has two statutes related to property tax abatements and value limitations that have been used successfully to attract wind energy development in various counties in the state. They are identified by their chapters in the Property Tax Code—Chapters 312 and 313 projects.

Chapter 312 allows cities, counties and special districts (e.g., community college districts, water supply districts) to create reinvestment zones and enter into property tax abatement agreements with companies for up to 10 years. Because it is less likely that a wind or solar project will be built in a city, developers tend to concentrate on county tax abatements. Since it is local tax dollars that are at stake, the cities and counties are free to make whatever agreement they want within the 10-year window. In the 11th year, the developer begins to pay tax but only on the remaining value of the property after normal depreciation.

School districts, which are the largest source of property taxes in the state, are a different matter. Anything that lowers their taxable values effectively increases the state's school finance costs so they cannot enter into regular abatement agreements but can enter into value limitation agreements under a separate provision, Chapter 313. Known as the Texas Economic Development Act, the Chapter 313 program is intended to attract large businesses, such as manufacturers and renewable energy projects that are willing to make the required amount of investment and create new jobs that meet certain wage and benefit requirements. That chapter allows school districts to grant tax limitations on appraised value for up to eight years on investments in certain types of businesses—manufacturing, research and development, renewable electric generation, clean coal, nuclear energy and computer data centers.

Under the program, a qualifying property goes on the tax rolls at full value for two years, usually during the construction phase of the project, followed by the eight-year abatement, which applies to maintenance and operating taxes only and not to the school district's debt-service taxes, which the company receiving the abatement has to pay. Once the limitation is granted, the company gets an additional incentive in the form of a tax credit on taxes paid in the first two years on the portion of the appraised value in excess of the limitation. To qualify, a project in a rural area must create at least 10 new permanent jobs. In urban areas, the requirement is 25 jobs. District can offer minimum property value limitation from $1 million to $100 million depends on the size of local tax base and its rural or urban status.

Like most economic development incentives, these programs are not without controversy. Opponents believe they represent an unnecessary loss of revenue to local governments and the state. A common criticism is that under the school district program, the school district decides on the value limitation but effectively, the state winds up paying the cost. This is compounded in critics' minds by a particular provision in the statute that allows, in effect, school districts to use the system to gain a significant financial advantage. In some cases, the law allows school districts to enter into limitation agreements in exchange for a promise by the developer to make some form of payment in lieu of taxes, such as money paid to the local government to build a school or finance some other project. Basically, a district can have its cake and eat it, too, by granting an abatement and then getting up to 40 percent of the money back as a separate payment. For the state, though, it's as though the full abatement was given, and the school finance formulas makes up the full loss and not the loss less the payment made by the developer.

Despite the objections, there can be little doubt that the Chapter 312 and 313 provisions have been highly effective economic development tools and have a leading role in attracting renewable energy development—mainly wind—to Texas. They have also figured prominently in rural economic development efforts because of the lower, $1 million investment threshold for rural areas. The Comptroller of Public Accounts, the state's chief tax collector, was directed by the legislature to study the program and report on the results last year.[101] The agency found that 90 projects had been approved through June 2008 of which 68—75 percent—were energy projects. Sixty-one of those—just over two-thirds of all projects approved—involved wind energy. There were no solar projects on the list.

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[101] Texas Comptroller of Public Accounts, *Report of the Texas Economic Development Act*, January 2009. Available at: http://www.texasahead.org/lga/teda2008/TEDA2008-96-1359.pdf

One final problem with current property tax practice in the state that inhibits long-term investment in particularly in solar energy projects uncovered by this research is the depreciation schedule used in appraising renewable energy properties. Property is appraised for tax purposes in Texas by county-level appraisal districts. The problem is how they depreciate renewable assets. Most counties appraise solar and wind projects based on straight-line depreciation over a 20-year period. That makes some sense because that's the useful life of a solar project. However, it plays havoc with the economics of the technology because of the high up-front capital costs. The result is that the project's investors wind up with a very large assessed value on the tax rolls and a potentially high property tax bill on a property that produces only a fairly limited annual income. One example of a project in Texas would require an up-front capital investment of $250 million and produce an annual income stream of $11-12 million. In addition, the income stream declines over time because the solar facilities lose about one-half percent in efficiency a year. Even with all of the federal incentives, it makes for a more risky investment. It also helps to explain why wind has been more successful, not just in Texas but nationally. A comparably sized wind farm might require an investment of less than a hundred million dollars, and the cost of the technology also is lower, giving wind projects a price advantage.

One possible solution for improving the property tax situation is to mandate that an accelerated depreciation schedule be used for renewable properties so that it more closely mimics the depreciation for high-tech investments like semiconductor plants which also require considerable initial capital investment, but which depreciate much more quickly. Under current schedules, a solar farm will have a higher value after 10 years than a semiconductor plant which may initially cost four or five times more. Semiconductor plants are depreciated in six years with three percent residual value, while solar farms depreciate over two decades with a residual value of better than 20 percent, according to one economic development expert.

Direct Cash Incentives

Governments and utilities use direct cash incentives to stimulate the market and investment. These include rebates, buy-downs, loans and grants, which reduce up-front costs, and production-based incentives, which provide a revenue stream.

Rebates are incentive payments made after purchase or installation whereas buy-downs reduce the bottom-line cost before purchase; they are easy to administer and popular with consumers due to their immediate benefit and simple application process.

Loans and grants usually involve a more complicated application, and so are more cumbersome for the applicant and administrator, but can fully fund up-front costs. From the consumer's viewpoint, grants are better than loans, and so can be a more powerful tool to stimulate immediate investment; however, from a funding standpoint, loan repayment means that the same funds can recycle and stimulate investment indefinitely.

Governments can also finance loans through bonds, essentially using the government's credit to finance low-interest loans. Production-based incentives reward actual energy output and mean that financing can be stretched over many years.

Despite their advantages, most direct cash incentives, especially from state governments, can be difficult to initiate since they require a funding source and can have uncertain duration due to budget shortfalls. Applications can overwhelm budgets and result in market uncertainty. The federal stimulus legislation provides substantial and unprecedented direct cash incentive funding to assist states and businesses with these issues.

Rebates and Buy-Downs. Forty-six states offer a rebate program with an ongoing source of funding that includes rebates for some type of renewable energy equipment. Unlike the tax incentives discussed above, the programs often emanate from one or more sources—the state, local governments, utilities and, in the case of Ohio, from non-profits. For their part, states primarily use funds from utility ratepayers to finance ongoing rebate programs by adding a small service charge to utility bills, usually about $0.002 per kilowatt-hour, and placing it into a "public benefits fund."[102] New Hampshire also uses portfolio standards compliance payments, and Vermont and Wyoming use settlements from energy companies.

The Texas legislature considered a similar measure for solar in 2009, but it died near the end of the session. The bill would have established a fee of $0.00065 per kWh for residential and commercial customers and $40 per month for industrial customers. The rebate would have been up to 20 higher for devices manufactured within the state. Schools also would have benefited from a 25 percent set aside during the first two years of the program.[103] The bill would have generated about $250 million per year for rebates, based on residential and commercial electricity consumption and the number of industrial customers.

Texas has recently had a limited one-time state rebate program funded through the federal stimulus legislation. This program and others like it in other states have operated or will operate only for a brief time. The ARRA has provided states with $300 million for rebate programs to replace appliances with new, energy-efficient ones. Texas received $23.3 million, which the state has already awarded.[104] Several states, including Texas, have included renewable energy appliances, such as solar water heaters, in the types of appliances eligible for the rebate.

These short-term, limited-funding rebate programs operated on a first-come, first-serve basis which can quickly overwhelm state systems, leading to consumer frustration. Additionally, if structured so that applicants do not have to purchase the product before receiving a rebate reservation, many people may choose not to buy the product. In Texas, such a program used up

[102] U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, "Database of State Incentives for Renewables & Efficiency—Glossary." Available at: http://www.dsireusa.org/glossary/
[103] Texas 81st Legislature, S.B. 545. Available at: http://www.capitol.state.tx.us/BillLookup/History.aspx?LegSess=81R&Bill=SB545.
[104] Texas Comptroller of Public Accounts, State Energy Conservation Office, "Energy Efficiency Appliance Rebate Program." Available at: http://www.secostimulus.org/rebate/index.php.

the available funds on the first day. The program received 2,400 Web hits per second and 1,000 calls per minute but made only 39,000 reservations before the funding ran out.[105]

Structuring a program as a lottery so that applicants must purchase the product before receiving a chance to win a rebate may increase the possibility that more people may buy the product. It may also provide an application window of up to several months, which could keep programs from being overwhelmed. Coupling the rebate opportunity with a sales tax holiday for renewable energy products would further maximize the incentive.

In addition to state programs, utilities often offer rebate programs. In Texas, investor-owned utilities budgeted almost $10 million for photovoltaic systems and some additional funds for thermal solar and geothermal heat pumps in 2010. Municipal utilities allocated at least $6.5 million. At present, national sources show about two dozen rebate programs operated by Texas utilities that offer consumer rebates for a range of energy-efficient purchases ranging from solar water heaters (Austin, Bryan, CPS Energy, Oncor Electric Delivery, Sunset Valley) to much more extensive rebates covering primarily business and residential solar systems. For example, Austin energy offers both residential solar photovoltaic rebates and solar water heating rebates. El Paso Electric, Texas-New Mexico Power and Entergy Texas have pilot photovoltaic rebate programs, while several American Electric Power companies offer solar photovoltaic rebates.

Grants. The chief federal grant program at present was created by the federal stimulus legislation in 2009. The ARRA created the Renewable Energy Grants program that businesses eligible for the federal Renewable Electricity Production Tax Credit may use in lieu of the federal Energy Investment Tax Credit. The grant applies to 30 percent of the cost for solar, small wind turbines, renewable energy electricity generating facilities and fuel cells and 10 percent for all other energy sources. Funding for the program has exceeded more than $1 billion nationally.[106] In September 2009, the U.S. Department of Energy announced a second round of grants in lieu of investment tax credits in which Texas companies received $296 million of about $550 million awarded.[107]

The U.S. Department of Agriculture administers the Rural Energy for America Program (REAP) Grants program that pays up to 25 percent of project costs and has current appropriations of $60 million. The U.S. Department of Energy also administers a small grant program for tribal governments.

ARRA provided substantial funding to state energy offices to finance renewable energy development. The U.S. Department of Energy sent $3.1 billion to states to use for renewable energy technologies as well as energy efficiency and conservation. Texas' share was $218.8 million, $52 million of which is financing a competitive grant program for renewable energy

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[105] Texas Comptroller of Public Accounts, State Energy Conservation Office, "Texans Swarm Appliance Rebate Program; Guaranteed Reservation List and Waitlist Have Filled Up," April 7, 2010, http://www.texaspowerfulsmart.org/media/100407-rebate.php.
[106] U.S. Department of Energy, "American Recovery and Reinvestment Act." Available at: http://www1.eere.energy.gov/recovery/.
[107] U.S. Department of Energy, "Treasury, Energy Surpass $1 Billion Milestone in Recovery Act Awards for Clean Energy Projects," September 22, 2009. Available at: http://www1.eere.energy.gov/recovery/news_detail.html?news_id=15495.

technologies.[108] Texas also has two other grant programs administered by the Department of Rural Affairs.

Twenty-four states have some form of grant program. In addition to the programs listed for Texas, the state also has the Texas Enterprise Fund, a general grant fund for industry recruitment that can apply to renewable energy manufacturers. The fund has provided one grant to HelioVolt, a solar thin-film photovoltaic manufacturer located in Austin.[109]

Loans and Bonds. Bonds use a government's credit to finance projects that the state can pay back over time with anticipated revenue or savings offsets. States that have good bond credit ratings can pay off bonds at a lower interest rate than businesses or individuals usually receive, thus stimulating investment in projects with high up-front costs like clean energy; in addition, bonds offer a way to accomplish clean energy projects involving government entities by paying for themselves over time in lower utility bills.

Another type of bond known as a tax-credit bond allows the borrower who issues the bond to pay back only the principal of the bond, and the bondholder receives tax credits in lieu of the traditional bond interest. This provides for more affordable investments since the government subsidizes a portion of the interest cost.

The federal government has five loan-related programs that support renewable energy development. Two provide tax-credit bonds and three provide loan guarantees or insurance. Since its creation in 2005, the Clean Renewable Energy Bonds program has allocated a total of $3.4 billion in tax-credit bonds to governmental bodies, public power providers and electric cooperatives that apply, most of it recently.[110] Of the total, Texas received an allocation of $65 million through the East Texas Electric Cooperative, Inc. Funds from the Energy Improvement and Extension Act of 2008, and ARRA financed the program.[111]

The Qualified Energy Conservation Bond program is similar except that the federal government makes allocations to state and local governments based on population rather than application review; the government has increased the allocation volume cap from $800 million to $3.2 billion and Texas' share is $252.4 million.

The U.S. Department of Energy's Loan Guarantee program provides up to $10 billion in loan guarantees for energy efficiency, renewable energy and advanced transmission and

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[108] Texas Comptroller of Public Accounts, State Energy Conservation Office, "State Energy Program (SEP)." Available at: http://www.secostimulus.org/sep/index.php; and "Distributed Renewable Energy Technology Program--$52 Million." Available at: http://www.secostimulus.org/sep/renewable/index.php.

[109] Texas Governor's Office, "Texas Enterprise Fund (TEF) as of February 28, 2010." Available at: http://governor.state.tx.us/files/ecodev/TEF_Listing.pdf. Available at: http://governor.state.tx.us/files/ecodev/TEF_Listing.pdf.

[110] Details on federal and state loan programs from: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, "Database of State Incentives for Renewables & Efficiency—Federal Incentives/Policies for Renewable Energy: Energy-Efficient Mortgages," August 3, 2009. Available at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US36F&re=1&ee=0.

[111] .U.S. Department of the Treasury, "Treasury Allocates $2.2 Billion in Bonds for Renewable Energy Development," October 27, 2009. Available at: http://www.ustreas.gov/press/releases/tg333.htm.

distribution projects. The U.S. Department of Agriculture's Rural Energy for America Loan Guarantee program is similar, providing guarantees up to $25 million per loan. The Energy Efficient Mortgage program insures loans for renewable energy improvements that lenders add to mortgages through the Federal Housing Administration and Department of Veterans Affairs.

Only three states have financing authorities that issue bonds for renewable energy projects. Idaho's program allows utilities and non-utilities to receive financing for renewable energy production, including generation and transmission. Illinois' program applies to nonprofit institutions and commercial entities, as long as the project serves a public purpose. New Mexico confines its program to schools and state governments.

States may also allow local governments to participate in bond programs. In 2008, California developed the Property-Assessed Clean Energy (PACE) bond program and market, in which nineteen states, including Texas, now participate.[112] California has recently proposed a program to standardize PACE programs and to set up a $50 million fund to assist PACE bond program development statewide by further lowering interest costs.[113]

Texas enacted its version of the PACE law in 2009 allowing municipalities to finance property owners' renewable energy technologies, as well as energy efficiency improvements, on a voluntary, long-term basis through an increase in the owner's property tax, secured by a lien.[114] No up-front costs for property owners, up to 20 years for payback, automatic transfer of debt to the next property owner, no cost to taxpayers and no sales tax costs on purchases by municipalities make this option especially attractive.

Up to $453 million in ARRA stimulus funds are available nationally to municipalities for this type of program.[115] In addition, Texas' cities and counties are receiving $163.1 million in direct allocations and another $45.6 million through the state for energy efficiency and for clean energy technologies for government buildings.[116]

Thirty-nine states have some type of loan program. Texas has a Building Efficiency and Retrofit Program that has received $134.8 million in ARRA funding. The program provides revolving loans to governmental entities for energy efficiency improvements that can include some distributed renewable energy technologies.[117] Texas considered adding a $4 million pilot revolving loan program to retrofit public schools with solar energy in 2009, but the bill failed near the end of the legislative session.[118]

[112] "PACE Financing: Property-Assessed Clean Energy Explained," http://pacefinancing.org/.
[113] Getsolar.com, "California Bill Could Offer Statewide Solar Financing Option," February 26, 2010. Available at: http://www.getsolar.com/blog/california-bill-could-offer-statewide-solar-financing-option/3795/.
[114] Tex. H.B. 1937, 81st Leg., Reg. Sess. (2009). Available at: http://www.legis.state.tx.us/BillLookup/history.aspx?LegSess=81R&Bill=HB1937.
[115] "PACE Financing: Property-Assessed Clean Energy Explained: Available at: http://pacefinancing.org/.
[116] Texas Comptroller of Public Accounts, State Energy Conservation Office, "Energy Efficiency and Conservation Block Grant (EECBG) Program." Available at: http://www.secostimulus.org/eecbg/index.php.
[117] Texas Comptroller of Public Accounts, State Energy Conservation Office, "Building Efficiency and Retrofit Program $134.8 Million," http://www.secostimulus.org/sep/building/index.php.
[118] Texas 81st Legislature, S.B. 598. Available at: http://www.capitol.state.tx.us/BillLookup/History.aspx?LegSess=81R&Bill=SB598 and S.B. 545, http://www.capitol.state.tx.us/BillLookup/Actions.aspx?LegSess=81R&Bill=SB545.

Production Awards and Feed-in Tariffs. The federal Renewable Energy Production Incentive (REPI) offers an incentive payment for electricity generated and sold to another entity from newly qualified clean energy facilities established by governmental entities, public utilities and non-profit electric cooperatives. The incentive payments equal 2.1 cents per kilowatt hour for ten years, subject to annual appropriations. In 2007, Congress appropriated about $4.5 million for the program.

States can offer incentives to stimulate electricity generation from clean sources by requiring utilities to pay what are known as "feed-in tariffs." These tariffs can be defined as the price per unit of electricity that a utility or supplier has to pay for renewable electricity from private generators, with the government regulating the tariff rate. They have been commonly used in Europe to boost renewables, while Ontario's recently enacted tariff will pay the highest price in North America—$0.80 per kWh for electricity from rooftop solar systems smaller than 10 kW, much higher than in the U.S. and will pay the highest prices for wind energy in North America. The plan is intended to enable Ontario to close its coal plants by 2014.[119] Ontario credits the tariffs for landing the $7 billion investment signed in January this year for a consortium led by Samsung C&T Corporation and Korea Electric Power Corporation to build 2,500 MW of clean energy and bring 16,000 new jobs to the region.[120]

Some clean energy supporters have advocated more extensive use of feed-in tariffs by the states.[121] They claim that the high, fixed-rate payments associated with feed-in tariffs, which help cover the comparatively higher cost of renewables production, are more likely to get the clean energy industry off the ground than the policies most states now pursue. To date, though, feed-in tariffs have had fairly limited application in the U.S. They either are or have been considered in several states, and at least four states—California, Hawaii, Oregon and Vermont—have some form of feed-in tariff while another four states use direct payments based on generated electricity.

California's public utility commission approved a limited feed-in tariff in 2008, and in October 2008, a statewide feed-in tariff for small solar panel generators was signed into law. The proposal seeks to expand the market for solar energy in the state, already one of the most active, by requiring California utilities to buy power from solar-panel generators of 1.5-3.0 megawatts in size, at set rates above what the utilities would pay for wholesale power from conventional sources.

As might be expected, utilities have not wholeheartedly embraced the program, and even the solar industry has criticized it. Some solar companies said the bill's pricing scheme would create a feed-in tariff of about 15 to 17 cents a kilowatt-hour, which they said would not be high

[119] Paul Gipe, "Ontario Launches Comprehensive System of Feed-in Tariffs," *RenewableEnergyWorld.com*, September 25, 2009. Available at: http://www.renewableenergyworld.com/rea/news/article/2009/09/ontario-launches-comprehensive-system-of-feed-in-tariffs?cmpid=rss.
[120] Kevin Grandia, "Samsung-led Group Drops $7 Billion on Green Energy in Ontario, Canada," *EnergyBoom.com.* Available at: http://www.energyboom.com/policy/samsung-drops-7-billion-green-energy-ontario-canada.
[121] The Pew Charitable Trusts, *Who's Winning the Clean Energy Race? Growth, Competition and Opportunity in the World's Largest Economies*, 2010, pp. 10 and 14. Available at: http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Global_warming/G-20%20Report.pdf.

enough to spur significant investment. However, others said the program would create opportunities for lower-cost projects for which there currently is no market. Supporters of the legislation, including the California Solar Energy Industries Association, have said the bill's feed-in tariff will be high enough for schools, local governments, farms, warehouses and other low-cost property owners to take advantage of it.

The feed-in tariff program in Oregon is a pilot program. In June 2009, the established a pilot solar volumetric incentive rate and payment program with legislation. Under this incentive program, small-scale solar producers are paid for the kilowatt-hours generated over a 15 year period, at a rate set at the time a system is initially enrolled in the program. The Oregon Public Utility Commission established rates and rules for the program in May 2010. The law requires that the program must be offered by the three investor-owned utilities in Oregon and will be administered by the utilities, though the PUC will periodically re-evaluate rates. The program costs are recoverable in utility rates and utility-owned systems are not allowed to receive the incentive. The pilot program has an installation cap limited to an aggregate cap of 25 megawatts (MW) of solar photovoltaics, with a maximum system size cap of 500 kilowatts. The aggregate program cap will be spread equally over four years, with 6.25 MW of capacity being eligible to receive the incentive each year. The aggregate cap is divided up among the state's utilities based on their 2008 retail sales revenue.

In May 2009, Vermont enacted the Vermont Energy Act, which requires all Vermont retail electricity providers to purchase electricity generated by eligible renewable energy facilities through the Sustainably Priced Energy Enterprise Development (SPEED) Program. The program allows owners of small renewable energy facilities to sign long-term contracts for the sale of power produced by their facilities. The act applies to renewable energy systems commissioned on or after September 30, 2009, that are up to 2.2 megawatts in capacity. It allows for power purchase contracts of 10-20 years in duration for most renewable energy projects and up to 25 years in duration for solar energy projects. The act sets a statewide limit of 50 megawatts for such contracts, but that limit also includes any new, similar-sized renewable power facilities built by the state's utilities.

The Vermont tariff does not solely target solar energy development as the programs in California and Oregon. The legislation which created the program set differentiated standard rates but allowed the Vermont Public Services Board to adjust them. The rates at this time are: 24 cents/kW for solar, 12.26 cents/kW for hydroelectric, 14.1 cents/kW for methane derived from agriculture, nine cents/kW for methane derived from landfill and 11.82 cents for certain wind energy generation. The legislation's intent is to produce rates that provide sufficient incentive for the rapid deployment of small renewable power facilities but that avoid being excessive. The long-term contracts under the program are 25 years for solar and 15 to 20 years for all other technologies. As a condition of participating, the renewable energy credits (RECs) generated are transferred to the retail electric provider that purchases the power from the renewable energy producer, except in the case of a facility using methane from agricultural operations. In that case, the plant owner retains ownership of the RECs and may sell them if desired. However, retail electric providers and owners of renewable energy facilities are allowed to enter voluntary contracts with different terms than the standard offer contract terms at their discretion.

Hawaii's feed-in tariff program went into effect in September of last year after a decision by the Hawaii Public Utilities Commission. The feed-in tariff will be offered by the three investor-owned utilities and was created in accordance with the Hawaii Clean Energy Initiative goals originally set in 2008. As in Vermont, several renewable energy technologies are eligible for the feed-in tariff, including solar photovoltaics, concentrating solar power, on-shore wind and in-line hydropower. Qualified projects under the program will receive a fixed rate over a 20-year contract. The PUC must still set the rate for different renewable energy technologies. This program will be reviewed by the PUC two years after the start of the program and every three years thereafter.

Finally, the tariff concept has, unusually, been tried in at least one city. The city of Gainesville, Florida, approved what the local newspaper called the "nation's first solar feed-in tariff ordinance" last year. Under the program, city residents with photovoltaic panels on their roofs will get 32 cents a kilowatt-hour when they produce energy. (By contrast, homeowners in Florida were paying an average 12 cents a kilowatt hour for their electricity in this time period, according to federal statistics.)

Although Texas does not have a feed-in tariff, Green Mountain Energy, an investor-owned provider operating in the competitive area of the state, buys excess generation for the first 500-kilowatt hours per month at the same rate it charges customers and at 50 percent of the rate beyond that amount.[122]

Incentives for Industry Recruitment. The federal government and 22 states, including Texas, offer some type of specific incentive to encourage manufacturing and development of renewable energy. Incentives are usually tax-related, such as tax credits or exemptions, or provide financing, such as grants.

Net Metering

Much of the interest in renewable energy sources focuses on large-scale power generation, but distributed generation—on-site renewable energy generation at homes or businesses—has the potential to be an important part of the overall clean energy equation. Net-metering is a simplified method of metering the energy consumed and produced at a home or business that has its own renewable energy generator, typically a small solar or wind system or a home fuel cell. Under net metering, excess electricity produced by the renewable generator spins the home or business electricity meter backwards, effectively banking the electricity until it is needed by the customer. This provides the customer with full retail value for all the electricity they produce.

[122] Green Mountain Energy, "Green Mountain Energy Launches *Renewable Rewards* Buy-Back Program," May 2009. Available at: http://www.greenmountainenergy.com/news/press_kit/2009/may/Gr%20Mtn%20Renew%20Rewards%20Release%205%206%2009.pdf.

Many states adopted net metering in the early 1980s as a way of implementing Section 210 of the federal Public Utility Regulatory Policies Act (PURPA) which required that utilities buy the output of qualifying small power production facilities. Other states have adopted net metering because it provides a simple, easily administered way of compensating consumers for their power generation, particularly where the customer is unsophisticated, the generating unit is small and the output of the unit cannot closely track the customer's demand, as with wind and solar energy. Other states have adopted net metering to subsidize the use of environmentally friendly renewable technologies. Texas, though, is one of the few remaining states that have no net metering provisions statewide.

Under existing federal law, utility customers can use the electricity they generate to supply their own power needs, offsetting electricity they would otherwise have to purchase from the utility at the retail price. However, if the customer produces excess electricity beyond their own needs and net metering is not allowed, the utility purchases the excess electricity at the wholesale or "avoided cost" price, which is considerably lower than the retail price. The excess energy is metered using an additional meter that must be installed at the customer's expense. Net metering simplifies this arrangement by allowing the customer to use any excess electricity to offset electricity used at other times during the billing period. In other words, the customer is billed only for the net energy consumed during the billing period. The American Wind Energy Association provides this consumer example: "

> For example, if a home's (utility-connected) small wind turbine produces more electricity than the home can use, the excess electricity is sent back into the distribution system to be used by someone else. This excess generation can cause the small-turbine owner's home electric meter to spin backwards to indicate essentially 'negative' electricity usage, effectively 'banking' excess production. Net metering allows such a customer to be credited at the end of the billing period, usually a month or sometimes a year, for any 'net; consumption or production of electricity. Since a single meter is used to measure in- and out-flow, the customer automatically receives compensation from the utility for any excess electricity produced at the full retail electricity rate.[123]

Especially when combined with other incentives, such as rebates and tax exemptions, net metering is a highly effective means to encourage clean energy development. As of April 2010, 43 states require utilities to offer some level of net metering. Texas is one of seven states that does not, although it requires investor-owned utilities to purchase electricity from customers if they request it in non-deregulated areas and allows other utilities to do so.

Nationally, net-metering customers increased by 43 percent from 2007 to 2008, from nearly 49,000 to about 70,000; there were less than 5,000 customers in 2002.[124] In 2008, California

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[123] American Wind Energy Association, "Net Metering," undated. Available at: http://www.awea.org/pubs/factsheets/netmetfin_fs.pdf
[124] U.S. Department of Energy, Energy Information Administration, "Net Metering and Green Pricing Customers by End Use Sector," January 21, 2010. Available at: http://www.eia.doe.gov/cneaf/electricity/epa/epat7p5.html.

represented 65.3 percent of total net metering customers nationally, nearly 46,000. In the absence of a statewide policy, Texas had only 991 net metering customers, about 1.4 percent. Of the Texas total, 850 were municipal and electric cooperative electric customers, mostly associated with Austin Energy, and only 141 were customers of investor-owned electric companies.[125]

Of more than 30 retail electric providers in the state, few offer to buy electricity from distributed renewable sources. Finding which ones do and what their policies are is a difficult task because the Web site that the Public Utility Commission established to provide consumer information on utilities' pricing subsequent to deregulation has no information on utilities willing to purchase electricity from distributed generators. A bill that would rectify this deficiency died near the end of the 2009 legislative session.[126]

Web searches for Texas providers offering net metering revealed four programs. None of the providers were investor-owned utilities in areas not subject to deregulation, even though the state requires providers to respond to net metering requests in those areas. Of the four that offer versions of net metering, Austin Energy's program provides a credit for excess power on a customer's next electric bill based on the current power charge.[127] San Antonio City Public Service also offers a credit for excess generation on the customer's next monthly bill.[128] In May 2009, Green Mountain Energy, an investor-owned provider known for its "green" offerings, began a net metering program, buying excess generation for the first 500-kilowatt hours (kWh) per month at the same rate it charges customers for electricity and at 50 percent of the rate beyond that amount. In Texas, Green Mountain directly serves residential electricity customers who live in a deregulated utility service territory. Finally, Entergy, another investor-owned utility operating in Texas, pays for excess generation based on monthly average energy cost, plus a multiplier of 1.94 per kWh for summer months and 1.82 for winter months.[129]

Net Metering Trends. Although 43 U.S. states, plus the District of Columbia and Puerto Rico, currently have net metering policies, there is wide variation in the details of individual state policies. Common variables include: eligible technologies, eligible customer classes, limits on individual system size, limit on aggregate capacity of net-metered systems in a utility's service territory, treatment of customer net excess generation (NEG), types of utilities affected and REC ownership.

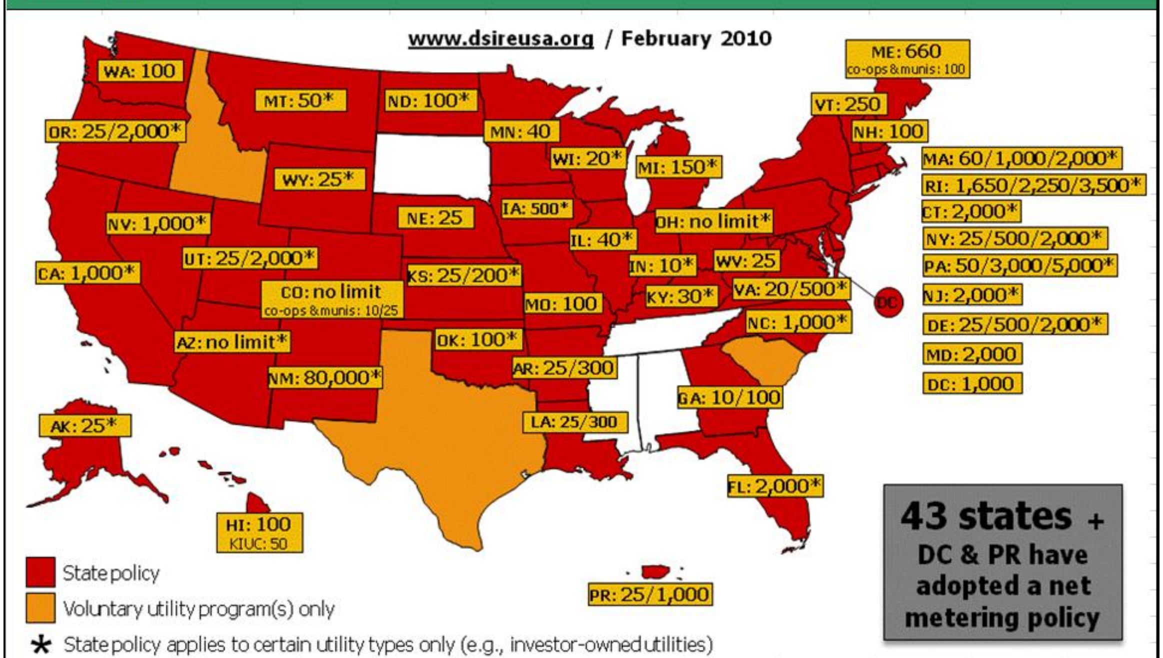
Figure 17 summarizes net metering standards by state. For each state, normally one or two numbers are shown in the figure. The lower number is the individual system limit, typically for residential consumers, and the larger number is the limit for non-residential or commercial

[125] U.S. Department of Energy, Energy Information Administration, "Form EIA-861 Final Data File for 2008," File5, Excel spreadsheet. Available at: http://www.eia.doe.gov/cneaf/electricity/page/eia861.html.
[126] Texas 81st Legislature, H.B. 1243. Available at: http://www.capitol.state.tx.us/BillLookup/History.aspx?LegSess=81R&Bill=HB1243.
[127] Austin Energy, "Distributed Generation from Renewable Resources Rider." Available at: http://www.austinenergy.com/About%20Us/Rates/distributedGenerationFromRenewableSources.htm.
[128] Open Energy Info, "San Antonio City Public Service – Distributed Generation Program (Texas)," January 11, 2010. Available at: http://en.openei.org/wiki/San_Antonio_City_Public_Service_-_Distributed_Generation_ Program_(Texas).
[129] Entergy, "Net Metering." Available at: http://www.entergy-texas.com/your_home/net_metering.aspx and "Schedule III Rate Schedules," Available at: http://www.entergy-texas.com/content/price/tariffs/sqf.pdf.

consumers. Capacity totals in the figure are given in kilowatts rather than megawatts. For example, the amounts given for Louisiana are 25/300. Where three numbers are shown in the figure for a state, the third number usually relates to some variation in the designation of users, and again there is considerable variation from state to state. For example, Massachusetts law provides for several categories of net-metering facilities. "Class I" facilities are generally defined as systems up to 60 kW in capacity. "Class II" facilities are defined as systems greater than 60 kW and up to one megawatt in capacity that generates electricity from agricultural products, solar energy or wind energy. "Class III" facilities are systems greater than one megawatt and up to two MW that generate electricity from agricultural products, solar energy or wind energy.

Pennsylvania allows net metering for certain systems up to five MW, and New Mexico allows net metering for systems up to 80 MW. There is no stated capacity limit in Arizona, Colorado or Ohio. In other cases, states limit systems to a certain percentage—for example, 120 percent of the customer's load—so that customers do not intentionally oversize their systems. In addition, some states have established individual system capacity limits that vary by utility type, system type or customer type. All state net metering policies include solar and most states have extended net metering to a variety of other clean energy systems as well.

FIGURE 17: NET METERING POLICIES AND CAPACITY LIMITS BY STATE
(FEBRUARY 2010)



Note: Numbers indicate individual state capacity limits on individual customers in kilowatts. Some limits vary by customer type, technology and/or application.

Source: U.S. Department of Energy, Database for State Initiatives for Renewables and Efficiency, February 2010.

Figure 17: Net Metering Policies and Capacities by State

Some states, such as Pennsylvania, recently have either clarified or enhanced provisions governing the treatment of net excess generation at the end of a billing period. Many states now allow customers to carry net excess generation credits forward to the following billing period at the full retail value of a kWh, either indefinitely or during a 12-month period. In addition, almost all states that have addressed REC ownership for net-metered systems, including Arkansas, Colorado and Florida, have ruled that RECs belong to the customers. The issue of REC ownership has become increasingly important as utilities seek to meet renewable portfolio standard obligations, and as discussed earlier, in many cases, RECs have become valuable commodities.

Several states, including Nevada and New Mexico, allow net metering for electric customers on a time-of-use (TOU) tariff. TOU is a rate structure that prices electricity at different rates reflecting the changes in the utility's costs of providing electricity at different times of the day or year. However, while this option could be economically beneficial for owners of solar energy systems in many instances, it apparently has proven difficult to design TOU tariffs that actively promote solar generation.

Finally, a handful of states recently have expanded net metering by allowing meter aggregation for multiple systems at different facilities on the same piece of property owned by the same customer. A small number of states, including California, allow "virtual" meter aggregation, where customers in certain circumstances can net meter multiple systems at different facilities on different properties owned by the same customer. In addition, "community net metering" or "neighborhood net metering," which allows for the joint ownership of a solar energy system by different customers, is in effect or under development in Massachusetts and a few other states.

Impediments to Net Metering. Net metering policies have not always been welcomed by utilities. The policies require utilities to pay consumers the retail price for wholesale power. The retail rate utilities charge includes not only the marginal cost of power but also recovers costs incurred by utilities for transmission, distribution, generating capacity and other utility services not provided by the customer-generator. Critics of the policy argue that it requires utilities to pay high costs for what is often low-value power. Power from wind and photovoltaic systems is intermittent, cannot be scheduled or dispatched reliably to meet system requirements. Even those forms of customer-based generation that could technically be dispatched at times when utilities need the power do not need to enter into operating agreements with utilities to obtain net metering under most state net metering mandates.

Net meters allow customers to under-pay the fixed costs they impose on the system. A utility has to install sufficient facilities to meet the peak requirement of the consumer and recover the costs of those facilities through a kWh charge. When the net meter rolls backwards, it understates the total energy used by the consumer, and thus understates the consumer's impact on the fixed costs of the system. It also understates the consumer's total share of other fixed charges borne by all consumers such as taxes, stranded costs, transition costs and public benefits charges.

The concept, thus, is a useful policy approach in search of a balance. Utilities have reasonable concerns about the financial aspects of the policy, and that is one explanation for the diversity of limitations on net metering capacity in the various state programs summarized earlier. However, problematic as it may be to utilities, net metering can be an effective tool for encouraging consumers to install distributed power generation. In fact, without the incentive, in many cases, the cost of renewable energy systems is an impediment for small consumers. In this regard, cumbersome or ineffective state net metering policies and interconnection procedures can bring the development of distributed generation by renewable sources to a standstill even when cost considerations for the consumer are not a barrier. Several states have policies that are highly supportive of net metering, but state comparisons generally reveal a hodgepodge of arbitrary and restrictive policies that can inhibit the market development of net metering and clean energy options.

In this regard, the map of net metering states shown in Figure 17 illustrates one of the major problems—limits on individual system capacity, which can be as low as 10 kW, effectively barring many potential participants from being able to access the option. Texas does not limit net metering but has a two MW maximum system capacity for interconnection of distributed renewable generation. New Mexico has by far the most generous cap—80 MW.

Another common restriction is a limit on net metering as a percentage of a utility's aggregate generating capacity or peak demand. Although 19 states have no limits, including Texas (which effectively eliminates any significant use of the policy through other means), many still do. California's recent experience illustrates the problem. California's clean energy policies, including net metering, have generated considerable success in recent years. By 2009, net metering had approached the aggregate capacity limit established in the state's law. Once reached, utilities would no longer add net metering customers or pay for excess generation, which would negatively affect the solar industry, consumers and state goals for renewable energy use. After an extended debate between solar development supporters and the utilities, the state raised the cap on solar energy generated from net metering from 2.5 percent to five percent of a utility's aggregate peak demand.[130]

When signing the bill in February this year, Governor Schwarzenegger pointed out that the amount of solar sold in 2008 was double that of the previous year and that 2009 sales were double that of 2008.[131] Although increasing the cap will temporarily spur clean energy use and give a reprieve to the solar industry in California, at the current pace of development, the state will likely face the struggle again in a few years.

Load Limits, Pricing and Excess Generation Restrictions. Arizona limits net metering to 125 percent of a customer's electricity load and Colorado to 120 percent. Ohio further limits net metering to the customer's electricity load. Although Texas does not impose such a limit,

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[130] California Legislative Council, A.B. 510. Available at: http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_0501-0550/ab_510_bill_20100226_chaptered.pdf.
[131] Environment News Service, "California Raises Solar Net Metering Cap," February 27, 2010. Available at: http://www.ens-newswire.com/ens/feb2010/2010-02-27-091.html.

deregulated utilities, municipalities and electric cooperatives are free to require one or simply not allow the practice in any meaningful way.

Although most states allow customers to collect credits for electricity that they generate to offset their own use, usually simply by running their meter backwards, some require crediting at a wholesale or avoided cost rate, which means that customers must generate much more electricity than they use to maintain a cost balance. In Texas, the Public Utility Commission recently changed its rules so that investor-owned retail electricity providers in areas not affected by deregulation must purchase any outflow of electricity, not just excess generation, at the avoided cost rate. This rate is much lower than that required under previous rules.[132]

In areas where provider choice is available—and for electric cooperatives and municipalities—the retail electric provider that offers net metering theoretically negotiates a rate with a customer; in practice, however, the provider simply offers a rate and customers can take it or leave it. Although acknowledging that recent statute changes inadvertently contributed to the rule changes, net-metering advocates view them as a major step backwards for Texas and highlighted Texas as a case study of "worst practices" in net metering policy development.[133]

Some states allow customers to collect payment at the retail or time-of-use rate for excess electricity generated beyond their own requirements, but many states place restrictions on excess generation. Several states force customers to forego any credit or reimbursement for excess generation, allowing the utility to take and re-sell the electricity without any rollover of credit or compensation whatsoever; others allow the utility to keep any excess remaining at the end of the year.

Rhode Island recently changed a similar requirement, shifting a customer's net excess generation credit at the end of the year from the utility to the Rhode Island Renewable Energy Low-Income Fund. Some states require indefinite carryover without an annual settlement, allow only an avoided-cost or wholesale rate, which is much less than retail, or impose an arbitrary reduced rate.

Meter Restrictions. Texas recently received a "D" for its interconnection standards from a national consortium of net-metering advocacy organizations. The state received this score partly because it recently required a separate meter to measure electricity outflow to the grid for renewable distributed generation, rather than just running the standard meter backwards. Separate outflow meters are expensive for customers, and advocates consider them an unnecessary expense.[134] New meters in Texas range from about $50-$150 and refurbished meters about $15-$50.

[132] 16 Tex. Admin. Code, §25.242 (g) (2). Available at: http://info.sos.state.tx.us/pls/pub/readtac$ext.TacPage?sl=T&app=9&p_dir=F&p_rloc=139495&p_tloc=14932&p_ploc=1&pg=2&p_tac=&ti=16&pt=2&ch=25&rl=242

[133] Network for New Energy Choices, The Vote Solar Initiative, the Interstate Renewable Energy Council, the North Carolina Solar Center and the Solar Alliance, *Freeing the Grid: Best and Worst Practices in State Net Metering Policies and Interconnection Procedures*, November 2009, pp. 12 and 88-90. Available at: http://www.newenergychoices.org/uploads/FreeingTheGrid2009.pdf.

[134] 16 Tex. Admin. Code, §25.213. Available at: http://info.sos.state.tx.us/pls/pub/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=16&pt=2&ch=25&rl=213; Network for New Energy Choices, The Vote Solar Initiative, the Interstate Renewable Energy Council, the North

Other Restrictions. Some states vary restrictions according to renewable technology, customer class or type of utility.[135] Some have various legal, technical or administrative requirements that may be unnecessary and burdensome; at the least, other states somehow manage their programs without them. Texas, for instance, requires an external disconnect switch, which the National Renewable Energy Laboratory has found redundant to UL-listed inverters.

Best Practices. In a state-by-state study of net metering practices, *Freeing the Grid: The Best and Worst State Net Metering Policies and Interconnection Procedures*, the Network for New Energy Choices, The Vote Solar Initiative, the Interstate Renewable Energy Council, the North Carolina Solar Center and the Solar Alliance, have provided guidelines for states that want to move forward on net metering. Table 13 on the following page summarizes their recommendations.

The study recommends using the Interstate Renewable Energy Council's net metering model rules for states, a resource that New Jersey and Colorado used in recent revisions to their policies. The study also recommends the Council's model interconnection procedures, which incorporate best practices of states, the Federal Energy Regulatory Commission, the National Association of Regulatory Utility Commissioners and the Mid-Atlantic Distributed Resources Initiative.

Opportunities and Barriers

Texas also has other opportunities to encourage clean energy that it has not pursued. Two common sense alternatives are missed opportunities to date: requiring builders to offer homebuyers clean energy options for new homes and prohibiting property owners' associations from barring clean energy additions to homes.

Several states are currently considering legislation that would require builders to offer solar options for new homes, including them in the financing of the home. New Jersey has passed such a requirement for builders developing 25 homes or more and California has passed one for 50 homes or more. New Mexico requires solar-ready wiring in all new homes.[136] Texas considered a bill in the 2009 legislative session that would have produced a system similar to California's, but it died near the end of the session.[137]

Carolina Solar Center and the Solar Alliance, *Freeing the Grid: Best and Worst Practices in State Net Metering Policies and Interconnection Procedures*, November 2009, pp. 12 and 88-90. Available at: http://www.newenergychoices.org/uploads/FreeingTheGrid2009.pdf.

[135] Interstate Renewable Energy Council, "Connecting to the Grid: State and Utility Net Metering Rules for Distributed Generation," March 2010. Available at: http://irecusa.org/wp-content/uploads/2010/03/March_2010_NM_Table.doc.

[136] Trevor Hughes, "More states want solar power to be option on new homes," *USA Today*, April 6, 2009. Available at: http://www.usatoday.com/money/industries/energy/2009-04-06-solar-ready_N.htm.

[137] Texas 81st Legislature, S.B. 545. Available at: http://www.capitol.state.tx.us/BillLookup/History.aspx?LegSess=81R&Bill=SB545.

TABLE 13: BEST PRACTICES IN STATE POLICY TO ENCOURAGE DISTRIBUTED ENERGY GENERATION

Best Practices in Net Metering

- Allow net metering system size limits to cover large commercialand industrial customers' loads; systems at the 2 MW level are no longer uncommon.
- Do not arbitrarily limit net metering as a percent of a utility's peak demand.
- Allow monthly carryover of excess electricity at the utility's full retail rate.
- Specify that customer-sited generators retain all renewable energy credits for energy they produce.
- Allow all renewable technologies to net meter.
- Allow all customer classes to net meter.
- Protect customer-sited generators from unnecessary and burdensome red tape and special fees.
- Apply net metering standards to all utilities in the state, so customers and installers fully understand the policy, regardless of service territory.

Best Practices in Interconnection Procedures

- Set fair fees that are proportional to a project's size.
- Cover all generators in order to close any state-federal jurisdictional gaps in standards.
- Screen applications by degree of complexity and adopt plug-and-play rules for residential-scale systems and expedited procedures for other systems.
- Ensure that policies are transparent, uniform, detailed and public.

  Prohibit requirements for extraneous devices, such as redundant disconnect switches, and do not require additional insurance.
- Apply existing relevant technical standards, such as IEEE 1547 and UL 1741.
- Process applications quickly; a determination should occur within a few days.
- Standardize and simplify forms.

Source: Source: Network for New Energy Choices, The Vote Solar Initiative, the Interstate Renewable Energy Council, the North Carolina Solar Center and the Solar Alliance, Freeing the Grid: Best and Worst State Net Metering Polices and Interconnection Procedures, 2009 Edition, November 2009.

Table 13: Best Practices to Encourage Distributed Generation

Of new homes built in the U.S. with EnergyStar ratings in 2008, Texas ranked fourth with 41 percent. Although the state has made strides in this area compared to other states, the data beg the question as to why an EnergyStar rating is not currently required for all new homes—or at least those built by developers. Requiring builders to allow solar options for buyers of new EnergyStar homes would be a logical next step in promoting the development of on-site renewable energy development in the state.

Another barrier to solar development in Texas and other states is the tendency of many homeowners' associations to prohibit solar or small wind devices on homes. The problem is widespread enough in Texas that the Legislature almost passed bills in 2009 that would have prevented the practice; however, they died at the end of the session.[138] On the national level, the Solar Energy Industries Association is attempting to get federal legislation passed to eliminate this problem.

A final opportunity worth noting is the option of allowing third-party ownership of distributed generation. Instead of investing in central power plants, investors buy solar for property owners and sell the electricity to them for a fixed price over the life of the installation. In December 2008, the state Public Utility Commission deferred to the Legislature for a decision on whether a company engaged in these activities would be an electrical generating facility, which could dampen investment, but the legislature failed to act.[139] The status of municipalities and electric cooperatives that would not want to open themselves up for competition and thus become deregulated further complicates the picture. The issue remains undecided.

Policy Options

The projected growth in electricity demand in Texas and the ongoing need to replace older, inefficient plants means that Texas will need to build significant generating capacity in the next 25 years. Increasing environmental concerns and fuel price instability suggest that clean energy solutions provide a good option for filling a large percentage of this demand. Although Texas has increased its use of wind energy in particular, the state is far from a meeting its new demand needs with clean sources,, much less replacing existing generating facilities.

Although Texas can meet its clean energy demand by continuing to buy most of its products from other states and nations, the state could benefit from developing its own industry. Not only could renewable energy manufacturing keep dollars in Texas, the state could also compete for national and international markets. Texas' recent history in attracting clean energy manufacturing, however, has been largely unsuccessful.

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[138] Texas 81st Legislature, S.B. 236. Available at: http://www.capitol.state.tx.us/BillLookup/Text.aspx?LegSess=81R&Bill=SB236; S.B. 237, http://www.capitol.state.tx.us/BillLookup/Text.aspx?LegSess=81R&Bill=HB1976; SB. 545, http://www.capitol.state.tx.us/BillLookup/Actions.aspx?LegSess=81R&Bill=SB545; and H.B. 1976, http://www.capitol.state.tx.us/BillLookup/Actions.aspx?LegSess=81R&Bill=HB1976;

[139] Elizabeth Souder, "Rebates, purchase plans and Legislature contribute to a brighter day for solar power," *The Dallas Morning-News*, February 21, 2009. Available at: http://vrvoice.org/cms/images/IFCD_Newspaper/dmn-022109-rebatesforsolarpower.pdf.

To make Texas more competitive to manufacturers, the state should improve the Texas market as well as improve its direct incentives to manufacturers. To improve the market, the state will need to develop policies that set aggressive goals, remove barriers and increase incentives. Among the policies the state should undertake are the following:

Develop a more aggressive set of renewable energy portfolio standards.

Revising the current RPS is critical to moving the state toward a clean energy future. Texas' current standards could jeopardize the state's progress by generating complacency and remove the state from successful competition with other states and nations. The current standards fail on several counts. First, using megawatt capacity targets as a standard ignores overall capacity growth, which can mean that the percentage of electricity from clean sources produced in the target year can be much lower than originally envisioned. Second, the voluntary nature of the standard for non-wind resources has also had a weak response. Third, Texas' standard for 2025 is voluntary and does not communicate the long-term price signal needed to motivate serious, long-term planning and investment. Further, limiting requirements to investor-owned retailers in competitive markets ignores municipally owned utilities, electric cooperatives and investor-owned utilities in noncompetitive markets that could contribute substantially to the state's renewable energy mix.

The absence of a compliance payment for failure to meet standards may also contribute to complacency in the future. Finally, the lack of a state guarantee that REC ownership will stay with the generator contributes to uncertainty that can dampen investment.

To maximize the potential that standards offer, the state would need to:

- Change its standard measure from capacity (MW) to a percentage of generation in the target year;
- Set targets at five-year increments to 2035 with at least 25 percent by 2025;
- Establish targets for non-wind and distributed generation;
- Make all targets mandatory;
- Extend required participants to include all electric retailers;
- Establish a compliance payment for retailers who are out-of-compliance with standards; and
- Ensure that future REC ownership stays with the customer generator.

Consider a more extensive range of financial incentives.

Although Texas' franchise tax exemption for manufacturers, sellers and installers of solar energy is a powerful incentive for development, the most powerful driver of industry growth is demand. Texas' demand has been slightly more than static in all areas other than large wind generating capacity. If Texas is to grow its clean energy industry in areas other than wind and compete with other states, it will need to take advantage of new, but time-limited, federal tax incentives by maximizing its tax and other financial incentives for these technologies.

To maximize tax incentives for clean energy, Texas would need to:

- Exempt clean energy devices and installation costs from the state and local sales tax;
- Replace the current 10 percent franchise tax deduction for solar devices with a full 100 percent credit and expand the clean energy technologies that are eligible for the credit;
- Create a franchise tax credit for clean energy production;
- Expand the types of clean energy technologies that apply to the current property-tax exemption for value added by renewable systems;
- Require only a one-time application for property tax exemption on renewable energy technology as provided in House Bill 1328 in the last legislative session which failed to pass;
- Create a property tax exemption for large generating facilities that use renewable energy;
- Consider requiring that solar and wind energy properties be appraised by local central appraisal districts on an accelerated depreciation schedule that helps to mitigate the high capital costs of the programs early enough to allow solar projects, in particular, to be profitable over a 20-year life cycle; and
- Encourage the continuation of federal tax incentives beyond 2016.

Texas should also consider direct cash incentive policies like those that have had a profound effect on clean energy development in other states To maximize potential of direct cash incentives, Texas should:

- Establish statewide rebates for clean energy that decline over time;
- Establish a clean energy bond program to support the state's new PACE[140] program and to expand the capacity of the state's existing revolving loan program, the LoanStar program, for government buildings to accommodate renewable energy, and back low-interest loans to renewable energy manufacturers that locate or expand here; and
- Expand the PACE program to counties.

Enact a statewide net metering program.

Most states are a long way from making net metering desirable for their citizens. Even California and New Jersey, arguably the most successful programs nationally, have certain restrictive policies that inhibit development. Nevertheless, California's success has made substantial gains in creating a vibrant solar energy industry for the state. Unless Texas

[140] Pending federal modification to resolve the current issues.

undertakes a serious statewide net metering program soon, the state may lose the opportunity to build a solar energy market and accompanying industry that would be competitive with states like California. A new, diverse and widespread energy industry holds substantial promise for the state's future economic development. When Texas first implemented deregulation, it recognized that new electric providers would never get a toehold without setting a temporary price floor for the existing monopoly providers. As a result, Texas now has many providers able to compete without protection. What the state missed was toehold protection for the smallest sellers—utility customers that generate their own electricity.

Even outside the deregulated environment, Texas will need to change direction, reverse recent policy directions that are dampening and impeding momentum, and free Texans to respond to the net metering market. In addressing all of these issues, Texas can navigate the complexities of net metering and avoid the pitfalls of other states by taking advantage of readily available model guidelines and expertise.

To maximize the potential that net metering offers, Texas should:

- Establish net metering statewide by requiring utilities purchasing outflow to pay for the separate outflow meter and reading;
- Require utilities to purchase electricity from distributed renewable energy generators at a price that is at least comparable to time-of-day retail rates;
- Provide buyers of new homes with the option to install and finance renewable energy;
- Prevent property owners' associations from prohibiting clean energy options added to existing structures; and
- Require new homes to be built with wiring for solar;
- Provide for third-party financing of distributed renewable energy by exempting third parties from generating facilities' definitions and exempting municipalities and electric cooperatives from deregulation for allowing the practice.

Consider implementing a feed-in tariff system in the state.

It is certainly unlikely that the state will adopt a feed-in tariff in the short run. However, feed-in tariffs may become a more prominent policy option in the next few years, and Texas should be ready to consider it. A thorough study of the issue could bring best practices to light and expose potential problems, allowing the state to stay ahead of the curve should the policy become a serious prospect.

The above recommendations are made with the understanding that Texas faces a serious budget challenge in the 2011 legislative session, and this will limit what lawmakers are willing to do to encourage clean energy development. However, some policies like net metering and revised renewable portfolio standards will not affect state general fund revenue, and most of the tax provisions have, at worst, only a limited budget impact. The most expensive alternatives are those that increase exemptions or exclusions under the sales and business franchise taxes.

The central policy question is whether Texas will lead or take a back seat in the development of the clean energy economy. Texas can benefit from the jobs and investment that almost inevitably will follow the industry in the years to come or it can watch other, more aggressive states take the lead and reap the benefits. Make no mistake: there are significant benefits if the state is willing to craft the correct policies. The next chapter looks at these benefits: the impact of the clean energy economy on jobs, personal income and gross state product.

8. The economic impact of clean energy in Texas

Key points

1. **Increased development of clean energy holds enormous potential to create jobs and provide significant tax revenues to state and local governments, while also reducing airborne pollutants from traditional power plants.**

2. **Extending and expanding the state's Renewable Portfolio Standard is essential to achieve a greater share of its total electricity generation from renewable sources.**

3. **A modest investment in wind and solar energy would create 6,000 jobs per year from 2010 to 2020 and increase the state's GSP by $802 million annually. State and local governments also would collect an additional $177 million per year in tax revenues.**

4. **Making a stronger commitment to renewable energy would produce results nothing short of spectacular. By raising the state's RPS to accommodate another 13,000 megawatts of power, including 3,500 megawatts in new solar photovoltaic energy, Texas' economic gains would more than *triple*, with job gains of up to 22,900 per year, an additional $2.7 *billion* per year in GSP, and roughly $279 million more per year in state and local taxes.**

If Texans want to maintain a healthy environment, we must attract more clean energy to the state. Clean energy creates jobs and income for Texans and additional tax revenues for state and local governments. This chapter estimates the economic and fiscal impacts of attracting additional clean electric generation to Texas. These impacts can be significant and could help power the Texas economy over the next decade.

The next section will review trends in renewable electric generation capacity in Texas from 2000 through 2009, with a special emphasis on wind power. The second and third sections will use the National Renewable Energy Laboratory's (NREL) Jobs and Economic Development Impact (JEDI) model to estimate Texas jobs and gross state product created by building and operating wind and solar photovoltaic electric generation plants in Texas. From these economic impacts, the impact on state and local taxes can also be calculated. The fifth section provides three alternative projections of renewable energy generation from 2010 to 2020 based on the U.S. Energy Information Administration (EIA) projections for the nation and three sets of assumptions about Texas' future share of US renewable energy generation capacity. The sixth section uses the plant-specific wind and solar photovoltaic economic and fiscal impacts, along with Texas clean energy capacity projections, to estimate the economic and fiscal impacts of clean energy on the economy and state and local governments from 2010-2020. The last section of the chapter reviews the results of this research and suggests potential changes in the state's renewable portfolio standard (RPS) needed to accommodate the growth of renewable energy projected in the chapter.

Clean Energy Generation in Texas—an Overview

At the beginning of the 21st century, clean electric generation was virtually unknown in Texas. According to the Energy Information Administration, in 2000, only 1.3 percent of the state's electric generation capacity was from renewable resources, with almost all of this capacity coming from hydroelectric sources.

Over the next four years, this situation began to change. Texas gradually began to attract wind power investments, mainly because of the high wind potential in West Texas. From 2001 through 2004, clean energy increased to about two percent of total Texas electric generating capacity. After 2004, however, the growth of wind power in Texas greatly accelerated. From 2004 to 2009, Texas' wind generating capacity increased almost eight-fold to a total of 9,915 megawatts, and the state's renewable share of total electric generating capacity increased from two to 10 percent, almost reaching the national renewable energy rate of 12.2 percent in 2009. In general, there were four causes underlying this swift ascent: (1) rapidly rising natural gas prices, (2) the availability of the federal renewable energy Production Tax Credit (PTC), (3) Texas's establishment of renewable portfolio standards, and (4) the availability of Chapter 312 and Chapter 313 property tax reduction programs discussed at length in the preceding chapter. At the end of the period, in 2009, wind power accounted for more than 90 percent of Texas renewable electric generating capacity, and additions of renewable energy resources accounted for an amazing 36.8 percent of the total additions to electricity generating capacity over the course of the decade.

TABLE 14: TEXAS RENEWABLE ELECTRIC NET SUMMER GENERATING CAPACITY, BY ENERGY SOURCE, 2000-2009 (Megawatts)

Energy Source	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change 2000-09
Biomass	185	110	115	149	148	187	188	223	232	250	65
Geothermal	0	0	0	0	0	0	0	0	0	0	0
Hydro Conventional	697	697	697	699	668	673	681	673	673	673	-24
Solar	1	1	0	0	0	0	0	0	0	1	0
Wind	173	925	1,085	1,286	1,286	1,755	2,738	4,490	7,476	9,915	9,742
Total Renewable Capacity	**1,056**	**1,733**	**1,897**	**2,134**	**2,102**	**2,615**	**3,607**	**5,386**	**8,381**	**10,839**	**9,783**
Total Generating Capacity	**81,895**	**87,956**	**94,488**	**99,594**	**101,104**	**101,046**	**100,754**	**101,938**	**104,966**	**108,503**	**26,608**
Renewable Share	1.3%	2.0%	2.0%	2.1%	2.1%	2.6%	3.6%	5.3%	8.0%	10.0%	36.8%

Source: U.S Energy Information Administration, "Electric Power Monthly," 2000- 2008 and Electric Reliability Council of Texas, 2009.

Table 14: Texas Renewable Electric Net Summer Generating Capacity by Source

During the second half of the 2000s, the rapid growth of wind power overshadowed smaller changes in other clean generation sources. Hydropower has stayed about the same at around 670-680 megawatts, and biomass, mostly from burning lumber mill residues, has increased from 187 megawatts in 2005 to 250 megawatts in 2009. Unlike some other states like California, Texas has not yet developed much solar energy, although the projections later in this chapter will consider the effects of building and operating additional solar power in Texas.

Because of the rapid growth of wind power, Texas is now in the forefront of total clean electric generation capacity. As can be seen from Table 15 on the next page, Washington, California and Oregon rank the highest in total renewable energy capacity, largely thanks to availability of hydroelectric resources. However, if hydroelectric is excluded, Texas would rank first among the states in clean energy capacity.

The Economic and Tax Effects of Wind Electric Generation

To develop a baseline understanding of the economic and tax effects of renewable energy development in Texas, it is useful to begin by understanding plant-level parameters for the two most prominent large-scale renewable sources, wind and solar. To do this Billy Hamilton Consulting accessed the latest National Renewable Energy Laboratory (NREL) Job and Economic Development Impact (JEDI) model and used it as the basis of a Texas-specific model.[141] To produce the Texas economic and fiscal impacts shown here, the inputs into the basic JEDI model were revamped specifically to mirror the structure of the Texas economy and the development of the clean energy industry. This modified model was used to examine various investment options to develop a clear picture of how renewable energy development can affect the state economy.

[141] The Jobs and Economic Development Impact (JEDI) model is a tool that estimates the economic impacts of constructing and operating power generation and biofuel plants at the local (usually state) level. Based on project-specific or default inputs (derived from industry norms), JEDI estimates the number of jobs and economic impacts to a local area that could reasonably be supported by a power generation project.

TABLE 15: TOTAL STATE-BY-STATE RENEWABLE NET SUMMER CAPACITY BY ENERGY SOURCE AND STATE, 2008
(Megawatts)

State	Rank	Biomass			Geothermal	Hydroelectric Conventional	Solar/PV	Wind	Total
		Waste		Wood and Derived Fuels[3]					
		Landfill Gas/MSW[1]	Other Biomass[2]						
Washington	1	36	-	296	-	21,333	1	1,333	22,999
California	2	399	126	596	1,940	10,041	408	2,357	15,866
Oregon	3	20	18	215	-	8,363	-	1,065	9,681
Texas	4	72	30	130	-	673	-	6,963	7,867
New York	5	328	-	37	-	4,301	-	707	5,373
Alabama	6	-	-	574	-	3,272	-	-	3,846
Tennessee	7	8	2	165	-	2,635	-	29	2,838
Montana	8	-	-	17	22	2,620	-	149	2,809
Iowa	9	11	3	-	-	131	-	2,661	2,807
Arizona	10	4	-	32	-	2,720	9	-	2,766
Georgia	11	7	44	621	-	2,032	-	-	2,704
Idaho	12	-	-	71	17	2,367	-	117	2,572
North Carolina	13	18	-	324	-	1,960	1	-	2,302
Minnesota	14	128	55	161	-	176	-	1,362	1,881
Colorado	15	3	10	-	-	665	11	1,063	1,752
South Dakota	16	-	-	-	-	1,463	-	193	1,656
Arkansas	17	5	5	292	-	1,321	-	-	1,623
Oklahoma	18	16	-	63	-	851	-	689	1,618
Pennsylvania	19	390	-	108	-	748	-	361	1,607
South Carolina	20	32	-	220	-	1,337	-	-	1,590
Maine	21	53	36	612	-	721	-	42	1,465
Virginia	22	269	-	418	-	677	-	-	1,364
Nevada	23	-	-	-	201	1,048	79	-	1,328
North Dakota	24	-	10	-	-	486	-	752	1,248
Wisconsin	25	72	1	232	-	488	-	356	1,148
Illinois	26	133	13	-	-	33	-	962	1,140
Florida	27	463	176	354	-	55	-	-	1,048
Wyoming	28	-	-	-	-	303	-	626	929
Kentucky	29	15	-	47	-	817	-	-	880
Michigan	30	161	-	231	-	249	-	124	765
Maryland	31	132	-	3	-	590	-	-	725
Missouri	32	5	-	-	-	552	-	163	720
New Hampshire	33	29	-	140	-	494	-	24	687
Kansas	34	-	-	-	-	3	-	665	668
West Virginia	35	-	-	-	-	264	-	330	594
Louisiana	36	-	14	380	-	192	-	-	586
New Mexico	37	-	6	-	-	82	-	494	582
Massachusetts	38	264	9	26	-	259	-	2	560
Alaska	39	-	-	-	-	400	-	3	403
Vermont	40	3	-	76	-	317	-	5	401
Utah	41	5	-	-	33	255	-	19	311
Nebraska	42	6	5	-	-	273	-	25	308
Connecticut	43	166	-	-	-	122	-	-	287
Indiana	44	39	-	-	-	60	-	131	229
Mississippi	45	-	-	229	-	-	-	-	229
Hawaii	46	60	49	-	31	24	1	64	228
New Jersey	47	187	20	-	-	4	4	8	222
Ohio	48	41	-	64	-	101	-	7	213
Rhode Island	49	24	-	-	-	4	-	-	28
Delaware	50	7	-	-	-	-	-	-	7
U.S. Total		**3,611**	**631**	**6,734**	**2,244**	**77,879**	**514**	**23,847**	**115,459**

Source: U.S. Energy Information Administration.

[1]Total capacity whose primary energy source is landfill gas or MSW.
[2]Agriculture byproducts/crops, sludge waste, and other biomass solids, liquids and gases.
[3]Black liquor, and wood/woodwaste solids and liquids.
MSW = Municipal Solid Waste.
PV = Photovoltaic.
\- = No data reported.

Table 15: Total State-by-State Renewable Capacity

Based on this modified Texas JEDI model, Table 16 shows the estimated economic and fiscal impacts of constructing and operating a 100 megawatt, $203 million wind electrical generation plant in the state. Economic impacts are estimated in two distinct phases. During the one-to-two year construction phase, Texas gains a total (direct, indirect and induced) of 551 jobs and $70.3 million in Gross State Product (GSP). Most of these new jobs will be generated in construction (387 jobs), with manufacturing (59 jobs) and trade, services and government (106 jobs) adding the rest. Since relatively few people will be need to staff the plant once it is constructed, the economic impact of operating the plant is lower. During the 10-year operations phase a total of 23 new jobs and $3.7 million in GSP will be generated per year.

Although the Texas-specific tax calculations are complex, here is a simplified explanation of how these estimates were made. For the construction phase, the state sales tax impact of building a $203 million plant was estimated based on the taxable portion of the construction costs ($31.9 million in foundation materials) and the 6.25 percent state sales tax rate. According to tax policy experts with the Comptroller of Public Accounts, the state's chief tax collector, under the state and local sales tax Texas currently taxes the concrete foundation of any electrical generating plant but not the equipment (in the case of wind generation plants, the turbines, blades, towers and other equipment) added above it. Construction-related labor is not taxed. In the case of local sales tax, city and special district sales taxes usually do not apply, and for this reason, the sales tax revenue estimate is based on the 0.5 percent county sales tax in the rural areas where Texas wind plants normally have been located. Based on these calculations, direct state and local sales tax collection will total $2.15 million over the course of construction.

For the operations phase, the most important Texas-specific consideration is that, for local property tax purposes, almost all wind generation plants in the state have Texas Chapter 313 school district and Chapter 312 county tax abatement agreements, which greatly reduce the plants' taxable value. Thus, although the construction of wind generation plants has significant economic impacts on local areas, the state, and local property tax receipts over the next 10 years of operations end up being significantly less than if the plants were taxed at market value.

For purposes of the property tax portion of the analysis, it was necessary to establish some tax parameters. An analysis of seven proposed Texas wind generation plants with Chapter 312 and 313 agreements indicated that, in general, these agreements reduce the taxable value of the plants by 50 to 70 percent from market value over 10 years. Without the property tax agreements in place, a wind project of this size, once operating, would pay approximately $706,900 per year in local property taxes over 10 years. Under the Chapter 313 school district agreements, wind generation operators generally pay taxes based on the construction cost of the plan in the first year and on the depreciated market value of the plant in the 10th year of operations. In years two through nine, they generally pay taxes based on the agreed-on capped value of the plant, usually $10 million based on state data on the agreements. For Chapter 312 county tax agreements, the amount of tax reduction varies greatly from plant to plant, and it was necessary to make some simplifying assumptions based on the seven examples reviewed.

TABLE 16: ECONOMIC AND FISCAL IMPACTS OF WIND ELECTRIC GENERATION IN TEXAS (NAMEPLATE CAPACITY = 100 MEGAWATTS)

Plant Cost and Characteristics	Costs	Texas Estimated Share of Costs	
Construction Cost (Million $)	**$203.2**	21%	
Foundation	$45.2	76%	
Materials	$31.9	85%	
Labor	$13.3	56%	
Turbines and Other Equipment	$152.3	3%	
Turbines	$91.1	3%	
Blades	$21.3	3%	
Towers	$23.6	3%	
Transportation	$16.3	3%	
Other Construction Costs	$5.7	71%	
Operating Costs (per year)	$33.9	6%	
Debt & Equity Payments	$30.6	0%	
Materials, Services and Labor	$3.3	62%	
Economic and Fiscal Impacts	**Impacts**	**Direct**	**Indirect and Induced**
Jobs (Direct, Indirect, and Induced)			
Construction Phase	551	146	405
Construction	387	60	327
Manufacturing	59	22	36
Trade, Services & Government	106	64	42
Operations (per year)	23		
GSP (Million $)			
Construction Phase	$70.3	$19.4	$50.8
Operations	$3.7	$2.2	$1.5
State and Local Taxes (Thousand $)	**Tax Revenues**	**Direct**	**Indirect and Induced**
State Government			
Sales (Construction Phase)	$2,935.15	$1,993.75	$941.40
Franchise (per year)	$221.70	$0.00	$221.70
Local Governments			
Sales Tax (construction phase)	$362.57	$153.37	$209.20
Property Tax (per year)	$2,275.90	$706.90	$1,569.00
State and Local (Combined from Above)			
Sales Tax (construction phase)	$3,297.72	$2,147.12	$1,150.60
Franchise Tax (per year)	$221.70	$0.00	$221.70
Property Tax (per year)	$2,275.90	$706.90	$1,569.00
Phase			
Construction	$3,297.72	$2,147.12	$1,150.60
Operations (per year)	$2,497.60	$706.90	$1,790.70

Source: National Renewable Energy Laboratory Wind JEDI Model and Billy Hamilton Consulting estimates.

Table 16: Economic and Fiscal Impacts of Wind Electric Generation in Texas

For the multiplier effects of the construction and operation of the plant on the local and state economies, this analysis uses JEDI Texas-specific indirect and induced GSP impacts multiplied by the appropriate tax coefficient for state sales and franchise and local sales and property taxes. These tax coefficients were developed as part of this analysis based on state and local tax revenues as a percent of Texas gross state product for the years 2000 through 2009. In total, the multiplier effects of the construction and operation of the plant will add approximately $1.2 million during the construction phase and $1.8 million per year during the operations phase to state and local treasuries.

Thus, the state and local tax calculations show that during the construction period, state and local tax revenues will total just under $3.3 million, including $2.9 million in state sales tax and $0.4 million in local sales tax revenues. During the operations period, a total $2.5 million per year will be collected, with $0.2 million per year of this total coming from the state franchise tax, assuming it applies under the state exclusions for renewable energy under the tax, and with local property taxes not eliminated by the various abatement programs adding $2.3 million annually.

The Economic and Tax Effects of Solar Photovoltaic Electricity Generation

The next step in the analysis is to better understand the economic and tax consequences of construction of a solar photovoltaic plant in Texas. In order to generate electricity, solar photovoltaic (PV), which directly transmits sunlight into electricity, is the most efficient technology. According to experts at the U.S. Energy Information Administration, the older solar thermal technology traditionally has been used to heat water for residential swimming pools. For this part of the analysis, the NREL JEDI solar PV electricity generation model was accessed for a large commercial plant and updated for Texas-specific parameters. To produce the Texas economic and fiscal impacts shown here, inputs into the JEDI model were modified to assume that none of the solar modules installed in the Texas plant will be supplied by Texas producers. This is a disappointing but reasonable assumption based on actual conditions in the current market. According to the EIA in 2008, none of the domestic shipments of photovoltaic cells and modules came from Texas producers, while 72 percent of the domestic shipments originated in Ohio, Michigan and California.

Another major factor in this analysis is the actual type of solar photovoltaic installation involved. In this case, it is assumed the plant would be a large-scale distributed generation facility, most likely at a large business. This approach was necessary because of the limitation on the expected creation of large-scale solar projects in the short run. According to the EIA, almost all of the photovoltaic electric generating plants projected to be constructed nationally from 2010 through 2020 will be for end-use generating facilities.

Based on the modified Texas JEDI model thus created based on these assumptions, Table 17 below shows the estimated economic and fiscal impacts of constructing and operating a 7.5 megawatt, $52.2 million solar photovoltaic plant in the state. Economic impacts are estimated in two distinct phases. During the one to two year construction phase, Texas will gain a total (direct, indirect and induced) of 319 jobs and $34.1 million in Gross State Product (GSP). Most of these new jobs will be generated in construction (89 jobs) and trade, services and government (230 jobs). Since relatively few people are needed to staff the plant once it is constructed, the economic impact of plant operations is much lower. During the 10-year operations phase analyzed, a total of four new jobs and $0.5 million in GSP will be generated per year.

According to Comptroller tax policy experts, Texas currently applies the sales tax only to concrete foundation of any electrical generating plant and not to the equipment—in the case of solar photovoltaic plants the modules and other equipment—added above it. Construction-related labor is not taxed. Since, photovoltaic electric generating facilities typically are mounted on the ground (or in the case of on-site facilities on rooftops), they do not require large supporting structures; there are limited or no foundation materials to be taxed. Thus, Texas state and local governments are expected to gain negligible sales tax revenues from the construction of the photovoltaic electric generation plant.

TABLE 17: ECONOMIC AND FISCAL IMPACTS OF SOLAR PHOTOVOLTAIC ELECTRIC GENERATION IN TEXAS (NAMEPLATE CAPACITY = 7.5 MEGAWATTS)			
Plant Cost and Characteristics	**Costs**	**Texas Estimated Share of Costs**	
Construction Cost (Million $)	**$52.2**	50%	
Foundation	$0.0	0%	
Modules and Other Equipment	$34.1	24%	
Modules	$25.9	0%	
Other Equipment	$8.2	100%	
Labor	$4.9	100%	
Other Construction Costs	$13.2	100%	
Operating Costs (per year)	$0.1	100%	
Debt & Equity Payments	$0.0	0%	
Materials, Services and Labor	$0.1	100%	
Economic and Fiscal Impacts	**Impacts**	**Direct**	**Indirect and Induced**
Jobs (Direct, Indirect, and Induced)			
Construction Phase	319	197	123
Construction	89	63	27
Manufacturing	0	0	0
Trade, Services & Government	230	134	96
Operations (per year)	4	0	0
GSP (Million $)			
Construction Phase	$34.1	$19.0	$15.1
Operations	$0.5	$0.1	$0.4
State and Local Taxes (Thousand $)	**Tax Revenues**	**Direct**	**Indirect and Induced**
State Government			
Sales (Construction Phase)	$279.00	$0.00	$279.00
Franchise (per year)	$103.80	$0.00	$103.80
Local Governments			
Sales Tax (construction phase)	$62.00	$0.00	$62.00
Property Tax (per year)	$465.00	$0.00	$465.00
State and Local (Combined from Above)			
Sales Tax (construction phase)	$341.00	$0.00	$341.00
Franchise Tax (per year)	$103.80	$0.00	$103.80
Property Tax (per year)	$465.00	$0.00	$465.00
Phase			
Construction	$341.00	$0.00	$341.00
Operations (per year)	$568.80	$0.00	$568.80

Source: National Renewable Energy Laboratory JEDI Solar Photovoltaic Model and Billy Hamilton Consulting estimates.

Table 17: Economic and Fiscal Impacts of Solar PV Electric Generation in Texas

For the operations phase, the most important consideration is that under Section 11.27 of the Texas Tax Code, renewable energy plants that that generate energy primarily for on-site uses are exempt from all local property taxes. Again, this is based on the EIA's conclusion that almost all of the photovoltaic electric generating plants projected to be constructed nationally from 2010 through 2020 will be for end-use generating facilities. Thus, unlike the wind energy estimates discussed earlier, new photovoltaic electric generation facilities are expected to pay relatively little local property taxes in the state. For the multiplier (indirect and induced) effects of the construction and operation of the plant on the local and state economies, this analysis uses JEDI Texas-specific indirect and induced GSP impacts multiplied by the appropriate tax coefficient for state sales and franchise and local sales and property taxes. These tax coefficients were developed based on state and local tax revenues as a percent of Texas gross state product for the years 2000 through 2009. In total, the multiplier effects of the construction and operation of the plant will add approximately $0.3 million during the construction phase and $0.6 million per year during the operation phase to state and local coffers.

Thus, the state and local tax calculations show essentially all of the gain from the construction of new photovoltaic electric generating facilities in Texas will come from economic multiplier effects and not from the direct payment of sales, franchise and property taxes to state and local governments.

Alternative Texas Clean Electric Generation Capacity Projections

With a baseline understanding of the consequences of developments in the major renewable energy alternatives, this section builds on that work by creating alternative Texas renewable electric generation capacity projections in order to estimate the potential economic and fiscal impacts of additional renewable capacity in the state over the next decade. As can be seen from Table 18, even in their base case projections, the Energy Information Administration expects significant growth in U.S. renewable electric generation capacity over the next ten years.

Overall, renewable energy's share of total national electric generating capacity is expected to increase from 12.7 percent in 2010 to 16.3 percent in 2020. From 2010 to 2020, the EIA expects a total of 44.1 gigawatts of renewable electric generating capacity to be added, with most of this increase concentrated in wind power (27.2 gigawatts), solar photovoltaic (8.0 gigawatts) and in biomass (7.3 gigawatts). Because the federal renewable energy production tax credit for wind and bioenergy and the investment tax credit for solar energy are scheduled to phase out from 2012 through 2016 under current federal law, the EIA expects 88 percent of all US renewable electric capacity additions from 2010 to 2020 will be concentrated in the first half of the decade—while the incentives can be confidently predicted to be in place.

TABLE 18: PROJECTED U.S. RENEWABLE ELECTRIC GENERATION SUMMER CAPACITY ESTIMATES, 2010-2020 (MEGAWATTS)									
	Generation Capacity			Change			Share of U.S. Generating Capacity		
Source	2010	2015	2020	2010-2015	2015-2020	2010-2020	2010-2015	2015-2020	2010-2020
Biomass	11,289	15,849	18,583	4,560	2,734	7,294	1.1%	1.5%	1.7%
Geothermal	2,490	3,242	3,242	752	0	752	0.2%	0.3%	0.3%
Conventional Hydropower	77,195	77,720	77,720	525	0	525	7.4%	7.3%	7.2%
Solar Thermal	611	866	886	255	20	275	0.1%	0.1%	0.1%
Solar Photovoltaic	2,116	8,212	10,131	6,096	1,919	8,015	0.2%	0.8%	0.9%
Wind	38,972	65,707	66,171	26,735	464	27,199	3.7%	6.1%	6.1%
Total Renewable	**132,673**	**171,596**	**176,733**	**38,923**	**5,137**	**44,060**	**12.7%**	**16.1%**	**16.3%**
Total Generating Capaci	**1,046,500**	**1,068,900**	**1,082,300**	**22,400**	**13,400**	**35,800**	**100.0%**	**100.0%**	**100.0%**
Source U.S. Energy Information Administration, Annual Energy Outlook, 2010, Reference Case Projection.									

Table 18: Projected U.S. Renewable Electric Generation Summer Capacity

As the next step, in order to project Texas renewable energy capacity additions, three alternative scenarios based on the Texas share of U.S. clean electric generation capacity were developed based on recent historical data. These alternative scenarios can be seen in Table 19 below. The low projection is based on Texas' share of U.S. renewable electric generating capacity at its low point of 2.2 percent in 2004. This case would apply if renewable energy development fell off in the state compared to more rapid development in other states, caused, perhaps, by a flagging commitment to renewable portfolio standards in Texas relative to more aggressive commitments elsewhere. The second, more probable baseline projection is based on Texas' 8.6 percent of U.S. renewable electric generating capacity after the wind energy boom in the second half of the 2000s. Finally, the high projection is based on Texas's 29.7 percent share of the increase in US renewable electric generation capacity during the state's wind boom.

TABLE 19: TEXAS ALTERNATIVE SHARES OF PROJECTED U.S. RENEWABLE ELECTRICITY GENERATION CAPACITY			
	Low	Base	High
Energy Source	2004	2009	2004-09
Biomass	1.5%	2.2%	6.2%
Geothermal	0.0%	0.0%	0.0%
Hydro Conventional	0.9%	0.9%	1.6%
Solar Thermal	0.0%	0.2%	0.5%
Solar Photovoltaic	0.0%	1.9%	1.9%
Wind	19.9%	29.6%	31.9%
Share of US Renewable Capacity	**2.2%**	**8.6%**	**29.7%**
Share of US Total Generating Capacity	**10.5%**	**10.6%**	**11.4%**
Source: US Energy Information Administration and Billy Hamilton Consulting estimates.			

Table 19: Texas Alternative Shares of Projected U.S. Renewable Capacity

It is important to note that in its projections for the nation's Electricity Market Module Regions, the EIA expects very little of the additional renewable electricity capacity additions from 2010 to 2020 to occur in the Electric Reliability Council of Texas region, which covers a significant portion of the state. This is because, according to *Annual Energy Outlook 2010*, "regional additions of renewable generating capacity depend for the most part on State RPS (Renewable Portfolio Standards)." Thus, since according to ERCOT, Texas already has exceeded its RPS standard, the EIA does not expect additional renewable energy capacity to be located in the region. The Texas clean electric generating capacity projections in this report assume that when it meets in 2011, the Texas legislature will increase the state's RPS to accommodate the projections in this report. It is difficult to underscore how important the commitment to a growing renewable portfolio standard is if the state is to achieve a greater share of its total electricity generation from clean sources.

Texas clean electric generating capacity was then projected by multiplying the EIA reference case forecast by the three alternative Texas renewable energy shares of US generating capacity. In addition, for the high case projection, Texas photovoltaic electric generating capacity was increased by 3,500 megawatts during 2015-20 based on the expectation that in addition to raising the state's RPS generally, the Texas legislature would also include a mandatory RPS of 3,500 megawatts for solar photovoltaic technology. The purpose of making this assumption is to show the economic effects of such an RPS requirement. In the absence of such a requirement, solar development in the state is likely to be modest over the forecast period as the baseline case suggests.

The resulting projections of Texas renewable electric generating capacity are shown in Table 20 below. In each of the cases, the wind power expansion dominates Texas renewable energy capacity gains. From 2010 through 2020, in the base case, 8,040 megawatts in wind electric generating capacity are expected to be added in the state. For solar photovoltaic technology, the gains are much smaller. In the base case, only 152 megawatts of solar generating capacity will be added from 2010 to 2020. In the high case projection, however, because of the addition 3,500 megawatts of photovoltaic generating capacity, solar generating capacity is expect to increase by 3,652 megawatts over the 2010-2020 period. Finally, biomass also makes small contributions, with base case electric generating capacity increasing by 161 megawatts during the period.

TABLE 20: ALTERNATIVE PROJECTIONS OF TEXAS RENEWABLE ELECTRIC GENERATION SUMMER CAPACITY, 2010-2020 (MEGAWATTS)			
Low Projection			
Source	**2010-15**	**2015-20**	**2010-2020**
Biomass	69	42	111
Geothermal	0	0	0
Conventional Hydropower	5	0	5
Solar Thermal	0	0	0
Solar Photovoltaic	0	0	0
Wind	5,325	92	5,418
Total Renewable	**5,399**	**134**	**5,534**
Base Projection			
Source	**2010-15**	**2015-20**	**2015-2020**
Biomass	100	60	161
Geothermal	0	0	0
Conventional Hydropower	5	0	5
Solar Thermal	0	0	1
Solar Photovoltaic	116	36	152
Wind	7,903	137	8,040
Total Renewable	**8,124**	**234**	**8,358**
High Projection			
Source	**2010-15**	**2015-20**	**2010-2020**
Biomass	283	170	453
Geothermal	0	0	0
Conventional Hydropower	8	0	8
Solar Thermal	1	1	3
Solar Photovoltaic	116	3,536	3,652
Wind	8,517	148	8,665
Total Renewable	8,926	3,855	12,781
Source: Billy Hamilton Consulting.			

Table 20: Alternative Projections of Texas Renewable Capacity

As a final step in the analysis, the five-year projections of Texas renewable electric generating capacity were linearized by year in order to obtain a more accurate, time-specific projection of the economic and fiscal impacts of clean energy in Texas. Most importantly, as can be seen from Tables 21 and 22, although the construction of clean energy facilities is divided evenly by year during 2010-15 and 2015-20, the total generating capacity of facilities in operation increases year-to-year as additional capacity is added. For example, in the base case for wind energy, average of 1,581 megawatts in capacity is added annually from 2010 to 2015, and 27 megawatts per year from 2015 to 2020. But, through the construction process, a total of 8,040 megawatts of wind electric generating capacity will be operating by 2020.

TABLE 21: TEXAS WIND ELECTRICITY GENERATION, PREDICTED SCHEDULING UNDER MODEL ASSUMPTIONS, 2010-2020 (MEGAWATTS)														
							Low Projection							
Phase	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2010-15**	**2015-20**	**2010-2020**
Construction	1,065.0	1,065.0	1,065.0	1,065.0	1,065.0	18.4	18.4	18.4	18.4	18.4	18.4	5,325.0	92.0	5,417.0
Operations	0.0	1,065.0	2,130.0	3,195.0	4,260.0	5,325.0	5,343.4	5,361.8	5,380.2	5,398.6	**5,417.0**	5,325.0	92.0	5,417.0
							Base Projection							
Phase	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2010-15**	**2015-20**	**2010-2020**
Construction	1,580.6	1,580.6	1,580.6	1,580.6	1,580.6	27.4	27.4	27.4	27.4	27.4	27.4	7,903.0	137.0	8,040.0
Operations	0.0	1,580.6	3,161.2	4,741.8	6,322.4	7,903.0	7,930.4	7,957.8	7,985.2	8,012.6	**8,040.0**	7,903.0	137.0	8,040.0
							High Projection							
Phase	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2010-15**	**2015-20**	**2010-2020**
Construction	1,703.4	1,703.4	1,703.4	1,703.4	1,703.4	29.6	29.6	29.6	29.6	29.6	29.6	8,517.0	148.0	8,665.0
Operations	0.0	1,703.4	3,406.8	5,110.2	6,813.6	8,517.0	8,546.6	8,576.2	8,605.8	8,635.4	**8,665.0**	8,517.0	148.0	8,665.0
Source: Billy Hamilton Consulting.														

Table 21: Texas Wind Electricity Generation, Predicted in Model, 2010-2020

TABLE 22: TEXAS SOLAR PHOTOVOLTAIC ELECTRICITY GENERATION, PREDICTED SCHEDULING UNDER MODEL ASSUMPTIONS, 2010-2020 (MEGAWATTS)														
							Low Projection							
Phase	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2010-15**	**2015-20**	**2010-2020**
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0
							Base Projection							
Phase	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2010-15**	**2015-20**	**2010-2020**
Construction	23.2	23.2	23.2	23.2	23.2	7.2	7.2	7.2	7.2	7.2	7.2	116.0	36.0	152.0
Operations	0.0	23.2	46.4	69.6	92.8	116.0	123.2	130.4	137.6	144.8	**152.0**	116.0	36.0	152.0
							High Projection							
Phase	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2010-15**	**2015-20**	**2010-2020**
Construction	23.2	23.2	23.2	23.2	23.2	707.2	707.2	707.2	707.2	707.2	707.2	116.0	3,536.0	3,652.0
Operations	0.0	23.2	46.4	69.6	92.8	116.0	823.2	1,530.4	2,237.6	2,944.8	**3,652.0**	116.0	3,536.0	3,652.0
Source: Billy Hamilton Consulting.														

Table 22: Texas Solar Electricity Generation, Predicted in Model, 2010-2020

For solar photovoltaic in the base case, an average of 23 megawatts are added per year from 2010 to 2015 and an average of seven megawatts are added per year from 2015 to 2020, bringing total Texas photovoltaic electric operating capacity up to 152 megawatts in 2010. However, in the high case, the increase is much steeper. Total photovoltaic electric generating capacity will increase by the same 23.2 megawatts per year from 2010 to 2015, but because of the assumed addition of 3,500 megawatts of generating capacity, it will increase by an average of 707 megawatts per year from 2015-2020. In this case, total Texas photovoltaic operating capacity will reach a total of 3,652 megawatts by 2020.

For purposes of this analysis, the potential economic and fiscal impacts of biomass or other renewable energy technologies were not included. Although the National Renewable Energy Laboratory does have a model for ethanol production, there is no comparable model for biomass electrical generation. Obviously, the economic and fiscal impacts of biomass electric generation technology need further investigation. Based on the known projections, the real additions by those technologies are likely to be small in relation to wind and solar in any event, and their exclusion means that the estimates here present a conservative picture of Texas' renewable energy potential. The fiscal and economic impacts of projected gains in other renewable electric generating technologies such as hydropower and solar thermal were very small and were not considered.

Projected Economic and Fiscal Impacts

In the future, continued growth of clean electric generating capacity will produce significant impacts on the Texas economy and state and local taxes. In the base case, as Table 23 on the following page shows, the addition of 8,040 megawatts of wind generation capacity will create an average of 5,400 jobs per year in Texas from 2010 through 2020. During this period, Texas' gross state product will increase by an average of $730 million per year as a result of clean energy development, while the state and local governments will gain an average of $169 million per year in tax revenue.

For solar photovoltaic electrical generation, the results are generally much smaller. In the base case, from 2010 through 2020, the addition of 152 megawatts of generating capacity will increase Texas employment by 640 per year, while gross state product and state and local taxes increase by $72.1 million and $7.8 million, respectively, per year. But in high projection, the results are much more dramatic. If Texas adds another 3,500 of solar photovoltaic generating capacity, Texas employment will increase by 17,100 per year, while gross state product will increase by $1.9 billion annually from 2010 to 2020. Under this scenario, the state of Texas and local governments will gain an average $98 million per year in tax revenues.

Putting this all together, it is clear that the continued development of clean wind and solar energy will play an important part in the growth of the Texas economy over the next 10 years. In the most likely scenario, clean energy will increase Texas employment by 6,000 jobs per year from 2010 to 2020. Texas gross state product will increase by $802 million annually, while the state and local governments will enjoy an additional $177 million per year in tax revenue.

If the state chooses to make a stronger commitment to renewable energy as reflected in the high growth scenario the results would be much more spectacular. If the state legislature meets in 2011 and decides to raise the state's renewable energy portfolio standard to mandate another 13,000 megawatts of power, setting aside 3,500 megawatts of the standard for solar photovoltaic energy, the state's economic gains will more than triple. In this case, job gains would jump to 22,900 per year, Texas gross state product would increase by $2.7 billion per year, and state and local taxes will increase by $279 million per year. Obviously, setting the stage to allow more clean energy to locate within the state would be a clear benefit for the Texas economy, not only directly but also in the related industries that it would encourage, which the high case reflects.

Table 23: TEXAS ECONOMIC AND FISCAL EFFECTS OF ADDITIONAL RENEWABLE ENERGY ELECTRIC GENERATING CAPACITY, 2010-2020 (MEGAWATTS)

	Year											Average Annual Impact		
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2010-15	2015-20	2010-2020
Jobs														
Low Scenario														
Construction	5,868	5,868	5,868	5,868	5,868	101	101	101	101	101	101	5,868	101	2,723
Operations	0	245	490	735	980	1,225	1,229	1,233	1,237	1,242	1,246	490	1,235	896
Total	5,868	6,113	6,358	6,603	6,848	1,326	1,330	1,335	1,339	1,343	1,347	**6,358**	**1,337**	**3,619**
Base Scenario														
Construction	9,696	9,696	9,696	9,696	9,696	457	457	457	457	457	457	9,696	457	4,657
Operations	0	369	738	1,107	1,475	1,844	1,852	1,860	1,868	1,876	1,884	738	1,864	1,352
Total	9,696	10,065	10,434	10,803	11,171	2,302	2,310	2,318	2,325	2,333	2,341	**10,434**	**2,321**	**6,009**
High Scenario														
Construction	10,373	10,373	10,373	10,373	10,373	30,243	30,243	30,243	30,243	30,243	30,243	10,373	30,243	21,211
Operations	0	397	794	1,191	1,588	1,986	2,155	2,325	2,494	2,663	2,833	794	2,409	1,675
Total	10,373	10,770	11,167	11,564	11,961	32,228	32,398	32,567	32,737	32,906	33,076	**11,167**	**32,652**	**22,886**
Gross State Product (Million $)														
Low Scenario														
Construction	$748.7	$748.7	$748.7	$748.7	$748.7	$12.9	$12.9	$12.9	$12.9	$12.9	$12.9	$748.7	$12.9	$347.4
Operations	$0.0	$39.4	$78.8	$118.2	$157.6	$197.0	$197.7	$198.4	$199.1	$199.7	$200.4	$78.8	$198.7	$144.2
Total	$748.7	$788.1	$827.5	$866.9	$906.3	$210.0	$210.6	$211.3	$212.0	$212.7	$213.4	**$827.5**	**$211.7**	**$491.6**
Base Scenario														
Construction	$1,216.6	$1,216.6	$1,216.6	$1,216.6	$1,216.6	$52.0	$52.0	$52.0	$52.0	$52.0	$52.0	$1,216.6	$52.0	$581.4
Operations	$0.0	$60.0	$120.1	$180.1	$240.1	$300.1	$301.6	$303.1	$304.6	$306.1	$307.6	$120.1	$303.9	$220.3
Total	$1,216.6	$1,276.7	$1,336.7	$1,396.7	$1,456.8	$352.1	$353.6	$355.1	$356.6	$358.1	$359.6	**$1,336.7**	**$355.9**	**$801.7**
High Scenario														
Construction	$1,303.0	$1,303.0	$1,303.0	$1,303.0	$1,303.0	$3,236.2	$3,236.2	$3,236.2	$3,236.2	$3,236.2	$3,236.2	$1,303.0	$3,236.2	$2,357.5
Operations	$0.0	$64.6	$129.1	$193.7	$258.3	$322.9	$371.1	$419.3	$467.6	$515.8	$564.1	$129.1	$443.5	$300.6
Total	$1,303.0	$1,367.5	$1,432.1	$1,496.7	$1,561.3	$3,559.1	$3,607.3	$3,655.6	$3,703.8	$3,752.0	$3,800.3	**$1,432.1**	**$3,679.7**	**$2,658.1**
State/Local Taxes (Mil $)														
Low Scenario														
Construction	$35.1	$35.1	$35.1	$35.1	$35.1	$0.6	$0.6	$0.6	$0.6	$0.6	$0.6	$35.1	$0.6	$16.3
Operations	$0.0	$26.6	$53.2	$79.8	$106.4	$133.0	$133.5	$133.9	$134.4	$134.9	$135.3	$53.2	$134.2	$97.4
Total	$35.1	$61.7	$88.3	$114.9	$141.5	$133.6	$134.1	$134.5	$135.0	$135.5	$135.9	**$88.3**	**$134.8**	**$113.7**
Base Scenario														
Construction	$53.2	$53.2	$53.2	$53.2	$53.2	$1.2	$1.2	$1.2	$1.2	$1.2	$1.2	$53.2	$1.2	$24.8
Operations	$0.0	$41.2	$82.5	$123.7	$165.0	$206.2	$207.4	$208.7	$209.9	$211.1	$212.4	$82.5	$209.3	$151.7
Total	$53.2	$94.4	$135.7	$176.9	$218.2	$207.4	$208.7	$209.9	$211.1	$212.4	$213.6	**$135.7**	**$210.5**	**$176.5**
High Scenario														
Construction	$57.2	$57.2	$57.2	$57.2	$57.2	$33.1	$33.1	$33.1	$33.1	$33.1	$33.1	$57.2	$33.1	$44.1
Operations	$0.0	$44.3	$88.6	$132.9	$177.2	$221.6	$275.9	$330.3	$384.7	$439.1	$493.5	$88.6	$357.5	$235.3
Total	$57.2	$101.5	$145.9	$190.2	$234.5	$254.7	$309.1	$363.5	$417.9	$472.3	$526.6	**$145.9**	**$390.7**	**$279.4**

Source: Billy Hamilton Consulting

Table 23: Texas Economic and Fiscal Effects of Additional Renewable Capacity

Conclusion—a Sound State Clean Energy Strategy Begins with a Stronger Renewable Portfolio Standard

Based on the results of the above models, it is apparent that if the state increases its renewable portfolio standard sufficiently, an additional 6,000 clean energy-related jobs will be created in the state per year from 2010 to 2020. But, if the state chooses to pursue a more aggressive path and raises its RPS by 13,000 megawatts, reserves 3,500 megawatts of this total for photovoltaic electric generation capacity, the state's annual job gain would jump to 23,000 annually. This shows the power of clean energy incentives to attract new jobs to the state.

Finally, since the state has already surpassed its current RPS standard, it makes more sense to follow most other states by setting a standard based on the percentage of total electric generating capacity. For our purpose, a RPS standard of 22-25 percent would probably be sufficient to accommodate the high-side projection of Texas clean energy capacity additions outlined in this paper. Among other major states, California, Illinois, New Jersey and New York all have RPS standards ranging from 22.5 percent (New Jersey) to 33 percent (California). To achieve the economic benefits that obviously are possible, it will be necessary to make the same level of commitment to clean energy.

In 2000, only one percent of Texas electric generating capacity was from clean sources, by 2009, thanks to the rapid growth of wind power, this share had increased to 10 percent. With the continued growth of wind generating facilities and an emerging solar photovoltaic industry, this share could reach 22 percent in 2020. This would result in a solid victory for both the Texas economy and the environment.

Conclusion

Oil and natural gas have been a central part of the Texas economy for more than a century. Although the Texas energy industry will change over time—and especially over the next two or three decades—the industry's central role in the Texas economy will continue. More clean energy will not change that central role – rather, clean energy can guarantee that the Texas energy industry continues to create jobs and prosperity for future generations of Texans.

Texas has long been a leader in the global energy industry. Similarly, we have been a leader in renewable energy development in the past decade because our state's leaders were willing to invest in developing alternative sources of energy. Texas has enormous technical, financial and educational expertise in energy exploration and production. We have an opportunity to harness our state's expertise and our can-do attitude to ensure that we emerge as the leading clean energy economy in the United States and the world.

Texas, with her windswept prairies, breezy coast, tall pines and sunny skies, is blessed with an ideal climate and terrain for generating electricity from the wind, sun and plants. But the development of clean energy in this state is still in its early stages. Texas has developed wind resources and some biomass resources, but it has accomplished very little in promoting solar energy, either for large-scale generation or for distributed use by homes or businesses.

Other states, without a prominent energy sector and perhaps more mindful of the cost of fossil fuel as a result, are positioning themselves to move ahead. In the coming years, Texas will compete head-to-head with other states and countries to manufacture, install and maintain more wind power and other large-scale sources of clean energy such as solar and biomass. The good news, as demonstrated by the findings in this report, is that with minimal investment clean energy can become an even greater economic engine for Texas, creating jobs and prosperity for our state.

Three major themes emerge from the findings and conclusions in this report. First, continued reliance on traditional fuels makes our state vulnerable to energy security concerns that can be dangerous and costly. Second, there are environmental issues that should be addressed, and renewable energy can play a vital role in addressing those concerns.

And finally, the report shows that renewable energy development is going to be a force in creating jobs and investment in the years ahead. The study explains how state policies that support the clean energy sector of our state's economy can create jobs, increase our gross state product (GSP) and increase local and state tax revenue. The study analyzes three scenarios – a Low Range estimate, a Baseline and a High Range.

In the Low Range, although the clean energy sector would continue to be a steady source of job creation and economic growth, it would not thrive as in the other scenarios. The Baseline scenario would increase Texas gross state product (GSP) by $802 million annually, while state and local governments would gain an additional $177 million per year in new tax revenues, or more than $350 million per biennium. These are strong economic benefits for Texans, but we can do more with coherent state clean energy policies.

If Texas chooses to support the clean energy sector with stronger state policies, the High Range scenario demonstrates that the economic benefits would be spectacular. If the 2011 Texas Legislature decides to raise the state's RPS to 13,000 MW of clean power and sets aside 3,500 MW for solar photovoltaic energy, as the High Range scenario assumes, the state's economic gains would be exponentially greater than the Baseline scenario. Job gains would jump to 22,900 per year, Texas GSP would increase by $2.7 billion per year, and state and local tax revenues would increase by $279 million per year, or more than half a billion dollars per biennium.

These job creation numbers would contribute up to 25 percent of all new jobs in Texas over the next decade. And the economic development findings of this report, significant as they are, understate the promise that an expanded, diversified clean energy economy holds for Texas. If the state of Texas with its 10 million households were to adopt innovative state energy policies, in addition to the existing human and natural capital of Texas, our state would be the attractive and logical destination for new clean energy manufacturing facilities. As in other industries, clean energy manufacturers will likely gravitate to the largest markets where state policies encourage the growth and success of the industry, and investments for research and workforce development traditionally seek out the same markets. For all these reasons, the economic contributions of the clean energy sector to the Texas economy would likely significantly exceed the High Range scenario projections.

Given the commitment to renewable energy in other states and countries, this development is going to happen whether Texas participates or not. It makes no sense for this state, a traditional leader in the energy industry, to be left out of the economic promise of the clean energy economy. As a state, we need to promote policies that will lead not just to the greater development of Texas-based clean energy to meet our power needs. As a state, we need to seize the opportunity to create jobs and prosperity by investing in this growing sector of the energy industry.

Opponents may argue that clean energy is too expensive. However, the costs of clean energy in Texas are not as great as opponents claim – about a postage stamp a day for the average Texas family -- even before considering how carbon pricing would affect cost comparisons between traditional fuels and clean energy. Costs for clean energy have declined steadily over the last 30 years as clean energy technology improved, and the trend is expected to intensify. Overall, the cost differences between clean and traditional energy are less extreme than critics often imply and the differential continues to decline steadily.

For most Texans, these incremental changes of a few cents per day would be an attractive investment to reap the job creation and investment gains that the clean energy economy can create over the next decade and beyond. However, existing programs such as the System Benefits Fund, which currently has a balance of $610 million, is available to provide appropriate support for low-income, elderly and disabled Texans so that they will not be adversely impacted.

The report also examines a number of challenges related to the development of clean energy sources, including the intermittency of supply—i.e., the sun shines in the day and the wind tends to blow hardest best at night—as well as the need to develop a transmission infrastructure that can move power from remote areas of the state to high-demand urban areas. However, Texas has already begun to make investments to overcome transmission problems for clean energy by tying the developing wind farms of West Texas into the state electrical grid using the CREZ system, and the development of a new generation of plug-in hybrid and all-electric vehicles may also help balance electric demand.

The report makes a series of recommendations for Texas' clean energy policy, including:

- An enhanced, mandatory RPS measured as a percentage of overall capacity that sets targets in 5-year increments, with a benchmark of at least 25 percent clean energy by 2025;
- Expanding financial incentives for clean energy, such as rebates, bond programs or exemptions from state and local sales taxes for clean energy devices and installation costs; and
- Enacting a statewide net metering program.

Texas has used investments to incentivize the growth of our high tech, bio-tech and other cutting-edge industries. We have used the RPS policy to turn Texas into a national leader in the wind industry in just 10 years. Now, Texas has the opportunity to make the same type of investment to develop a diversified clean energy economy and extend our historic leadership in the global energy economy into this new sector of the industry. With the choices we make in the next few years, we can accept the status quo or make the kind of bold investments that have made Texas a global energy leader for the last hundred years. There is a clear business case for leading rather than following the development of the clean energy economy. Developing new sources of energy to power the Texas economy is a sound business proposition, and it is common sense. The choice is ours.

Appendix: Federal and state policies to encourage clean energy development

Table A-1: Federal and State Business Tax Incentives for Clean Energy

Table A-2: State Rebate Programs for Clean Energy

Table A-3: State Grant Programs for Clean Energy

Table A-4: Federal and State Clean Energy Loan Programs

Table A-5: Federal and State Production Awards for Clean Energy

- Similar federal and state summary tables for sales and property taxes are included in the main body of the report.

TABLE A-1: FEDERAL AND STATE BUSINESS TAX INCENTIVES FOR CLEAN ENERGY

State	Technology	Sectors	Incentive
Federal (1)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, CHP/Cogeneration, Solar Hybrid Lighting, Microturbines, Geothermal Direct-Use	Commercial, Industrial, Utility	Tax credit of 30% for solar, fuel cells and small wind; 10% for geothermal, microturbines and CHP with maximum of Fuel cells: $1,500 per 0.5 kW; Microturbines: $200 per kW; Small wind turbines placed in service 10/4/08 - 12/31/08: $4,000; Small wind turbines placed in service after 12/31/08: no limit; All other eligible technologies: no limit; credit available through 2016
Federal (2)	Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Hydrokinetic Power (i.e., Flowing Water), Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal	Commercial, Industrial	Tax credit of 2.1¢/kWh for wind, geothermal, closed-loop biomass; 1.1¢/kWh for other eligible technologies; generally applies to first 10 years of operation
Federal (3)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Solar Hybrid Lighting, Anaerobic Digestion, Microturbines, Geothermal Direct-Use	Commercial, Industrial	Deduction through the Modified Accelerated Cost-Recovery System (MACRS), many renewable technologies are classed as five-year or seven-year properties for purposes of depreciation
Federal (4)	Solar Water Heat, Solar Space Heat, Photovoltaics	Residential, Multi-Family Residential	Excludes 100% of public utility subsidies for purchase of renewable energy technologies from income for tax purposes
Arizona	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Solar Cooling, Solar Pool Heating, Daylighting	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Agricultural, Institutional	Credit of 10% of installed cost up to $25,000 for any one building in the same year and $50,000 in total credits in any year
Florida	Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, CHP/Cogeneration, Hydrogen, Tidal Energy, Wave Energy, Ocean Thermal	Commercial	Credit of $0.01/kWh for electricity produced from 1/1/2007 through 6/30/2010 up to no maximum specified for individual projects; Maximum of $5 million per state fiscal year for all credits under this program
Florida (2)	Fuel Cells, Hydrogen, Ethanol, Biodiesel	Commercial	Credit of 75% of all capital costs, operation and maintenance costs, and research and development costs
Georgia	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Daylighting	Commercial, Industrial, Multi-Family Residential, Agricultural	Credit for renewable energy systems: 35% up to $500,000 for PV, solar thermal electric, active space heating, biomass, wind and $100,000 for solar hot water, Energy Star-certified geothermal heat pumps
Hawaii	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind	Commercial, Residential, Multi-Family Residential	Credit for Solar Thermal and PV: 35% and Wind: 20% (up to maximum by technology and property type)
Hawaii (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Wave Energy, Ocean Thermal	Industrial	100% tax credit over five years up to $2,000,000 and 80% of tax liability over five years for equity investment in a qualified high-tech business (includes renewable energy)
Iowa	Landfill Gas, Wind, Hydroelectric, Self-generators	Commercial, Industrial, Residential, Local Government	100% exemption on replacement generation tax for self-generators, landfill gas and wind; reduced rate for large hydro
Iowa (2)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydrogen, Anaerobic Digestion	Commercial, Industrial, Schools, Rural Electric Cooperative, Agricultural, Institutional	Credit of 1.5¢/kWh or 1.0¢/kWh for 10 years after facility begins producing energy (credit may be applied to personal or corporate taxes and sales and use tax)
Kentucky	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Geothermal Heat Pumps, Combination Active Solar Space-Heating and Water Heating System	Commercial, Industrial, Agricultural	Credit for PV: $3/W DC and
			All other systems: 30% of eligible costs (up to $1,000 per taxpayer for installations on multi-family residential rental units or commercial property; $500 for single family residential rental unit)
Kentucky (2)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric	Commercial	Credit of 100% state income or limited liability tax and up to 100% sales and use tax exemption
Louisiana	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Solar Pool Heating	Commercial, Residential, Multi-Family Residential	Credit of 50% of the first $25,000 of the cost of each system up to $12,500 per installed system
Maryland	Biodiesel	Commercial, Industrial	Credit of $0.03/gallon up to $500 per year
Maryland (2)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Co-firing, Anaerobic Digestion	Commercial, Industrial, Residential, Utility, Agricultural	Credit of $0.0085/kWh ($0.005/kWh for co-fired electricity) up to $2.5 million (total credit during five-year period)
Maryland (3)	Photovoltaics, Wind, Fuel Cells	Commercial, Industrial, Multi-Family Residential	Credit of 20-25% PV; 25% Wind; 30% Fuel Cell; Allowable project costs may not exceed $3/watt for PV, and $1,000/kW for fuel cells
Massachusetts	Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Wind	Commercial, Industrial	100% deduction for unit or system, including labor
Massachusetts (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Wind	Commercial, Industrial	100% exemption from the tangible property portion of the excise tax
Montana	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Fuel Cells using Renewable Fuels	Commercial, Industrial	Credit of 35%; participant investment must be greater than or equal to $5,000
New Mexico	Solar Thermal Electric, Photovoltaics, Geothermal Electric	Commercial	Credit of 6% against personal, corporate, gross receipts, compensating, or withholding taxes up to $60 million
New Mexico (2)	Geothermal Heat Pumps	Commercial, Residential, Agricultural	Credit of 30% up to $9,000 per system; Annual aggregate cap of $2 million in total corporate and personal tax credits
New Mexico (3)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Municipal Solid Waste, Anaerobic Digestion	Commercial, Industrial	Credit of 0.01/kWh for wind and biomass; $0.027/kWh (average) for solar (Wind and biomass: First 400,000 MWh annually for 10 years (i.e. $4,000,000/year); Solar electric: First 200,000 MWh annually for 10 years (annual amount varies); Statewide cap: 2,000,000 MWh plus an additional 500,000 MWh for solar electric)
New Mexico (4)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Daylighting	Commercial, Residential, Multi-Family Residential	Credit varies based on the square footage of the building and the certification level
New York	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Fuel Cells, Daylighting	Commercial, Construction, Multi-Family Residential	Credit varies by project
North Carolina	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Heat Pumps, Spent pulping liquor, Solar Pool Heating, Daylighting, Anaerobic Digestion, Ethanol, Methanol, Biodiesel	Commercial, Industrial	Credit of 35% up to $2.5 million per installation
North Dakota	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, Anaerobic Digestion, Renewable Fuels, Fuel Cells using Renewable Fuels	Commercial, Industrial	Credit of 15% (3% per year for five years)
Ohio	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Municipal Solid Waste, CHP/Cogeneration	Commercial, Industrial	100% exemption from corporate franchise tax, state sales and use, and property taxes for property used to replace fossil-fuels, recover waste heat or steam or convert solid waste to energy
Oklahoma	Solar Thermal Electric, Photovoltaics, Wind, Hydroelectric, Geothermal Electric	Commercial	Credit of 50% of certified project costs of renewable energy generation, renewable energy equipment manufacturing, high efficiency combined heat and power, wind projects over 10 MW; all other projects: 35%
Oregon	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Hydrogen, Industrial Waste, Ethanol, Methanol, Biodiesel, Fuel Cells using Renewable Fuels	Commercial, Industrial, Construction, Multi-Family Residential, Agricultural, Equipment manufacturers	Credit of 35% to 50% up to $20 million for renewable energy equipment manufacturing facilities; $3.5 million for wind projects over 10 MW (amount declines by year); $10 million for other renewable energy generation projects; $9,000-$12,000 per home for homebuilders
Rhode Island	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Geothermal Heat Pumps	Residential	Credit for residential applications only of 25% of costs up to $15,000 for PV, active solar space heating and wind; $7,000 for solar hot water and geothermal
South Carolina	Landfill Gas, Biomass, CHP/Cogeneration, Anaerobic Digestion	Industrial	Credit of 25% of eligible costs up to $650,000 per year; credit may not exceed 50% of tax liability
South Carolina (2)	Solar Water Heat, Solar Space Heat, Photovoltaics, Solar Cooling, Daylighting, Small Hydroelectric	Commercial, Residential	Credit of 25% of eligible costs up to $3,500, or 50% of taxpayer's tax liability, whichever is less
Texas	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind	Commercial, Industrial	Franchise tax deduction of 10% of amortized cost from apportioned margin (Texas franchise tax is similar to corporate income tax in other states.)
Texas (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind	Commercial, Industrial	Total exemption from franchise tax for companies in Texas engaged solely in the business of manufacturing, selling, or installing solar energy devices
Utah	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Solar Pool Heating, Anaerobic Digestion	Commercial, Residential, Construction, Installer/Contractor, Multi-Family Residential	Residential: credit of 25%, up to $2,000; Commercial: wind, geothermal electric, and biomass systems 660 kW or greater: 0.35¢/kWh ($0.0035/kWh) for 4 years; Other commercial systems: 10% up to $50,000
Vermont	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Solar Hybrid Lighting	Commercial, Industrial	Credit of 30% for property placed in service on or before 12/31/2010 for C-corporations
Washington	Solar Using Photovoltaics or Silicon	Commercial, Industrial	Reduced Business and Operations tax rate to 0.2904% from 0.484% for manufacturers, installers and sellers
Washington (2)	Renewable Energy	Utility	Credit of 100 percent on their Public Utility Tax for payments of up to $5,000 to customers for renewable energy electrical production
West Virginia	Wind	Utility	Reduction of Business and Occupations tax from 40% to 12% of generating capacity (effective rate is about 30% of effective rate for other new generating units)

Notes: Does not include local or private sector incentives. Many of these incentives also apply to energy efficiency. Certain other specifics may apply to incentives, including minimum capacities, time limits, variable maximums, ownership requirements, carryover provisions and other specifications.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, "Database of State Incentives for Renewables & Efficiency--CCorporate Tax Incentives for Renewable Energy;" Washington State Department of Revenue, "Renewable Energy Tax Incentives."

TABLE A-2: STATE REBATE PROGRAMS FOR CLEAN ENERGY			
State	**Technology**	**Sectors**	**Incentive**
California	Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Fed. Government, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional, (All customers of PG&E, SDG&E, SCE; Bear Valley eligible only for NSHP)	Includes several rebate programs; rebate varies by sector and system size; $3.2 billion over 10 years beginning in 2006; funded by utility ratepayers
California (2)	Wind, Fuel Cells, Advanced Storage Technologies	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Fed. Government, Institutional	Wind: $1.50/W; Fuel cells: $2.50/W to $4.50/W, depending on fuel Advanced Energy Storage systems coupled with eligible SGIP technologies: $2/W; An additional 20% will be awarded to projects that utilize systems manufactured in California; 2010 Funding: PG&E: $36 million; SCE: $28 million; So Cal Gas: $11 million; SDG&E: $8 million
California (3)	Small Wind, Fuel Cells using Renewable Fuels	Commercial, Industrial, Residential, Schools, Low-Income Residential, Agricultural, Institutional	Emerging Renewables Rebate - Wind: $3.00/W for first 10 kW; $1.50/W for increments >10 kW and <30 kW; Fuel cells: $3.00/W; Rebates for eligible renewable energy systems installed on affordable housing projects are available at 25% above the standard rebate level up to 75% of the system's installed cost
Connecticut	Photovoltaics	Residential, Multi-Family Residential	Residential: $1.75/watt (PTC rating) for first 5 kW; $1.25/W (PTC) for next 5 kW, adjusted based on expected performance; maximum of Residential: $15,000; Incentives will be subject to a maximum of the customer's average annual or expected electric usage; funding from ratepayers and ARRA
Delaware	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Geothermal Heat Pumps, Fuel Cells using Renewable Fuels	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, Agricultural, Institutional	Delmarva: Up to 25% of costs generally, 35% for non-profits/government; DEC: Up to 33.3% of costs for PV and wind-electric, generally 50% for others; Munis: Generally up to 33.3% of costs, except 50% of cost for solar water heating (Dover and Seaford have different incentive levels for some technologies); maximums vary by utility and technology; funding from utility ratepayers
Hawaii	Solar Water Heat	Commercial, Residential	Residential: $750; Commercial: $125 per deferred kW, plus $0.05/kWh for retrofits and $0.06/kWh for new construction; funded by utility ratepayers
Maryland	Geothermal Heat Pumps	Commercial, Residential	$500 per ton up to Residential: $3,000; Non-residential: $10,000; funding from greenhouse gas emission auctions under the Regional Greenhouse Gas Initiative, but most funding this year is from ARRA
Maryland (2)	Solar Water Heat, Solar Thermal Process Heat, Photovoltaics	Commercial, Residential, Nonprofit, Local Government	Rebate for Solar PV: $0.25 - $1.25/W DC up to $10,000; Solar Water Heating: 30% of the installed cost up to $2,000; funded by appropriations supplemented by funds from carbon emission allowance auctions as part of the Regional Greenhouse Gas Initiative and ARRA
Maryland (3)	Solar Water Heat, Photovoltaics	Commercial, Industrial, Nonprofit	PV: $500/kW up to $50,000; SHW: 15% of installed cost up to $25,000; funded by appropriations supplemented by funds from carbon emission allowance auctions as part of the Regional Greenhouse Gas Initiative and ARRA
Maryland (4)	Wind	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, Fed. Government, Agricultural, Institutional	First 5 kW: $2,800 per kW; Capacity above 5 kW: $2,100 per kW up to lesser of $20,000 or 50% of net installation cost after other incentives; funded by carbon emission allowance auctions as part of the Regional Greenhouse Gas Initiative and ARRA
Massachusetts	Photovoltaics	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Fed. Government, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional	$1.00 - $2.10/W DC up to Residential: $10,500; Commercial: $5,500 (per host customer), up to $250,000 per parent company; funded by utility ratepayers
Massachusetts (2)	Wind	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Multi-Family Residential, Institutional	Initial incentive: $1,000 + $1.25/W up to $4/W ($40,000); funded by utility ratepayers
Nevada	Photovoltaics, Wind, Small Hydroelectric	Commercial, Residential, Nonprofit, Schools, Local Government, State Government, Agricultural, Other Public Buildings	Solar (Step 1, 2010-2011 program year): Schools and public and other property, including non-profits and churches: $5.00 per watt AC; Residential and small business property: $2.30 per watt AC; Wind (Step 1, 2010-2011 program year): Residential, small business, agriculture: $3.00 per watt; Schools and Public Buildings: $4.00 per watt; Small Hydro (Step 1, 2010-2011 program year): Non-net metered systems: $2.80/W; Net metered systems: $2.50/W; funding from utility ratepayers
New Hampshire	Photovoltaics, Wind	Residential	$3/watt DC up to $6,000 or 50% of system costs, whichever is less; funded by Renewable Portfolio Standard (RPS) alternative compliance payments
New Jersey	Heat pumps, Central Air conditioners	Residential	IOU customers: $300 - $600 (varies by efficiency); Muni/Co-op customers: $300 or $400 (varies by measure); funded by utility ratepayers and ARRA
New Jersey (2)	Geothermal Heat Pumps	Residential, Low-Income Residential	Maximum rebate of $2,000 or $10,000 depending on efficiency improvement; funded by utility ratepayers and ARRA
New Jersey (3)	Photovoltaics, Landfill Gas, Wind, Biomass, CHP/Cogeneration, Anaerobic Digestion, Fuel Cells using Renewable Fuels	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Multi-Family Residential, Institutional	Generally $0.15 - $5/W DC (varies by technology, capacity and applicant type); wind incentives determined by estimated system performance ($/estimated annual kWh); maximums apply; funded by utility ratepayers; total funding of $64.6 million for 2010
New Jersey (4)	Geothermal Heat Pumps	Commercial, Industrial, Schools, Local Government, Construction, State Government, Fed. Government, Institutional	Varies widely by equipment type, size and efficiency; maximums apply; funded by utility ratepayers
New Jersey (5)	Photovoltaics, (Includes Panels, Inverters and Racking Systems for Photovoltaic Systems)	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Multi-Family Residential, Agricultural, Institutional	Varies by equipment type, sector, and system size; total incentive may be from $0.05 - $0.55/W DC; funded by utility ratepayers; $1 million budget
New Jersey (6)	Solar Water Heat	Residential	$1,200; funded by utility ratepayers
New York	Distributed Generation Technologies	Multi-Family Residential, Low-Income Residential	Rebate amount varies by income eligibility and efficiency level; funded by utility ratepayers; Program budget: Regular Multifamily: $26.1 million (July 1, 2006 - June 30, 2011); Low-Income Multifamily: $114.6 million (July 1, 2006 - June 30, 2011); funded by utility ratepayers
New York (2)	Passive Solar Space Heat, Geothermal Heat Pumps, Daylighting	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Fed. Government, Multi-Family Residential, Agricultural, Institutional,	50-75% of incremental costs, depending on type of project up to Up to $850,000 for upstate residents, and $1.65 million for Con Edison customers (not including bonus incentives); Program budget: $53 million; funded by utility ratepayers
New York (3)	Fuel Cells	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Institutional	Varies by size, sector, and performance, includes capacity and performance incentives up to Small systems (less than 25kW): $50,000; Large systems (25kW or greater): $1 million; Program budget: Available: $1.8 million (April - June 2010); funded by ratepayers

TABLE A-2: STATE REBATE PROGRAMS FOR CLEAN ENERGY--CONT'D.			
State	**Technology**	**Sectors**	**Incentive**
New York (4)	Biomass, Geothermal Heat Pumps	Residential	10% of project costs up to $3,000; funded by utility ratepayers
New York (5)	Wind	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Fed. Government, Agricultural, Institutional	Base incentive: lesser of $3,500/meter of rotor diameter or $3,500/kW of rated capacity at 11 m/s; maximum of $25,000; funded by ratepayers
New York (6)	Photovoltaics	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Institutional, (Must be customer of investor-owned utility in NY)	$1.75/watt DC; Incentive may be reduced for potential production losses associated with shading, system orientation, tilt angle, and other factors; rebate up to lesser 50% of costs or Residential: $13,750; Non-residential: $112,500; Non-profit, government schools: $56,250; funded by ratepayers
Oregon	Geothermal Heat Pumps	Commercial, Industrial, State Government, Agricultural, Institutional, Data Centers	$150-$4,000, varies by type and size; funded by utility ratepayers
Oregon (2)	Wind	Commercial, Residential, Nonprofit, Schools, Local Government, State Government	Rebate amount varies
Oregon (3)	Geothermal Heat Pumps	Residential	Heat Pumps: $200 - $450, depending on efficiency and previous heating system; funded by utility ratepayers
Oregon (4)	Geothermal Heat Pumps	Industrial, Agricultural, Manufacturing, Water/Wastewater Treatment	Rebate varies depending on technology; awarded per kilowatt-hour saved by project; funded by utility ratepayers
Oregon (5)	Solar Water Heat, Photovoltaics, Geothermal Heat Pumps	Residential, Builders, Contractors	Rebate for new homes; amount varies based on number of energy efficient measures installed; can range from $125 to $8,400; funded by utility ratepayers
Oregon (6)	Small Wind	Commercial, Residential, General Public/Consumer, Nonprofit, Local Government, State Government	Residential: Lesser of $4,500 per meter of rotor diameter, or $4,500 per kW-DC of the wind turbine up to $35,000 Commercial: Lesser of $3,750 per meter of rotor diameter, or $4,000 per kW-DC of the wind turbine up to $60,000; funded by utility ratepayers
Oregon (7)	Photovoltaics	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Agricultural, Institutional	Rebate depends on utility and customer class; maximum of Residential (Homeowner): $20,000 per site; Residential (Third Party): $5,000 - $10,000 per site; Commercial, Industrial, or Third Party (per-site lifetime cap for systems up to 200 kW): $100,000 - $600,000; Nonprofit, Go's: $150,000 - $200,000; funded by utility ratepayers
Oregon (8)	Solar Water Heat, Solar Pool Heating	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Agricultural, Institutional	Buy-down varies by sector, water heating fuel, and electric or gas provider; maximum of $1,500 for residential solar water heaters; $1,000 for residential pool heating; 35% of system cost for commercial
Pennsylvania	Solar Water Heat, Solar Space Heat, Photovoltaics	Commercial, Residential, Low-Income Residential, Agricultural	Residential PV: $1.75/W DC up to lesser of $17,500 or 35% of installed costs; Commercial PV: $0.25 - $0.75/W DC (varies by system size) up to lesser of $77,500 or 35% of installed costs; Solar Thermal: 25% of installed cost up to $2,000 for residential, $20,000 for commercial; Low-income (PV and solar thermal): 35% of installed cost; funding from state bonds
Vermont	Solar Water Heat, Photovoltaics, Wind, Micro-hydro	Commercial, Residential, Schools, Local Government, State Government, Multi-Family Residential, Low-Income Residential, Agricultural	PV: $1.75/W DC for individuals/businesses, schools, farms, government; $3.50/W DC for multi-family, low-income; Solar water heaters: $1.75 per 100 Btu/day for individuals and businesses, schools, farms, government; $3.50/100 Btu/day for multi-family, low-income; Wind: $2.50/watt - $4/watt for individuals or businesses, low-income multi-family; $4.50/watt DC if owned by schools, farms, or government entities; Micro-hydro: $1.75/3 ft-gal/min for individuals and businesses; $3.50/3ft-gal/min; maximums apply; funded by memoranda of understanding with Entergy Nuclear VT and Entergy Nuclear Operations, appropriations and ARRA
Wisconsin	Geothermal Heat Pumps, Daylighting	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Institutional	Rebate varies up to $350,000 per project; $750,000 per customer per year for all Focus on Energy incentives; funded by utility ratepayers
Wisconsin (2)	Geothermal Heat Pumps, Daylighting	Commercial, Industrial, Nonprofit, Schools, Local Government, Construction, State Government, Tribal Government, Fed. Government, Agricultural	Varies by equipment type; funded by utility ratepayers
Wisconsin (3)	Geothermal Heat Pumps	Residential, Multi-Family Residential	Varies by equipment type and whether new or existing, residential or multi-family residential; funded by utility ratepayers
Wisconsin (4)	Solar Water Heat, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Solar Pool Heating	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Multi-Family Residential, Agricultural, Institutional	Varies by technology and type of project; funded by utility ratepayers
Wyoming	Photovoltaics, Wind, Geothermal Heat Pumps, Photovoltaics as part of a hybrid system	Residential	PV and small wind: $2,000 per installed kW DC; Geothermal heat pumps: $2,000 per installed ton; funded up to $10,000 or 50% of project costs, whichever is less; funded by EXXON settlement and ARRA

Note: Some additional requirements or limits may apply. Many of these incentives also apply to energy efficiency. Includes state programs or state authorized programs only.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, "Database of State Incentives for Renewables & Efficiency--Financial Incentives for Renewable Energy."

TABLE A-3: FEDERAL AND STATE GRANT PROGRAMS FOR CLEAN ENERGY			
State	**Technology**	**Sectors**	**Incentive**
Federal	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Solar Hybrid Lighting, Hydrokinetic, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal, Microturbines	Commercial, Industrial, Agricultural	30% of property that is part of a qualified facility, qualified fuel cell property, solar property, or qualified small wind property; 10% of all other property up to $1,500 per 0.5 kW for qualified fuel cell property; $200 per kW for qualified microturbine property; 50 MW for CHP property, with limitations for large systems
Federal (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Renewable Transportation Fuels, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Hydrogen, Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal, Renewable Fuels, Fuel Cells using Renewable Fuels, Microturbines, Geothermal Direct-Use	Commercial, Schools, Local Government, State Government, Tribal Government, Rural Electric Cooperative, Agricultural, Public Power Entities	Grant amount varies up to 25% of project cost; funding of $70 million for FY 2011 and FY 2012
Federal (3)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps	Tribal Government	Grant amount varies
Alabama	Landfill Gas, Biomass, Municipal Solid Waste	Commercial, Industrial, Schools, Local Government, State Government, Agricultural	Grant up to $75,000 in interest subsidy payments to help defray the interest expense on loans to install approved biomass projects
Alaska	Solar Water Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, CHP/Cogeneration, Hydrothermal, Waste Heat, Transmission or Distribution Infrastructure, Anaerobic Digestion, Tidal Energy, Wave Energy, Geothermal Direct-Use	Commercial, Local Government, Utility, Tribal Government, Only Available for In-State Projects	Grant amount varies; assistance for feasibility studies, reconnaissance studies, energy resource monitoring, and work related to the design and construction of eligible facilities requires legislative approval; funded through legislative appropriations; $125 million in FY2009 and another $50 million in FY 2010
Colorado	Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Fuel Cells, Small Hydroelectric, Renewable Fuels, Other Distributed Generation Technologies	Commercial, Industrial, Residential	Grant amount varies; original funding from gaming and severance taxes; new funding from ARRA; $2 million available
Connecticut	Photovoltaics, Landfill Gas, Wind, Biomass, Fuel Cells, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Low-Income Residential, Institutional	Grant amount varies by technology up to $800,000 per project for PV projects (for non-profits); $4 million per project for other eligible projects, (Plus, for certain projects southwestern CT approved by 6/30/08, a production incentive of 2¢/kWh.); funding of $66.24 million through 2010
Delaware	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Renewable Fuel Vehicles, Geothermal Electric, Fuel Cells, Municipal Solid Waste, Hydrogen, Daylighting, Anaerobic Digestion, Renewable Fuels, Ethanol, Methanol, Biodiesel	Commercial, Institutional	Grant amount varies up to 35% cost of qualifying projects up to $250,000 per project for researching, developing or improving renewable energy technology
Delaware (2)	Passive Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Hydroelectric, Fuel Cells, Biodiesel Manufacturing Facilities, Storage, Conversion and Conditioning Equipment	Commercial, Institutional	Grant up to 25% of eligible equipment costs with maximum of $200,000 per general project and $3,000 (residential) or $20,000 (non-residential) for passive solar project that demonstrates the market potential for renewable technologies and accelerates the commercialization of these technologies
Illinois	Landfill Gas, Biomass, CHP/Cogeneration, Biogas (methane produced by livestock manure and waste, municipal waste water sludge, segregated organic wastes), Anaerobic Digestion, Other Distributed Generation Technologies	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Agricultural, Institutional, Other Association	Grant amount up to 50% of project cost Feasibility Studies: $2,500; Biogas to Energy Systems: $225,000; Biomass to Energy Systems: $500,000. Projects must be part of a combined heat and power system.
Indiana	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Municipal Solid Waste, CHP/Cogeneration, Anaerobic Digestion, Small Hydroelectric	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Agricultural, Institutional	Grant amount of 50% of project costs up to $100,000
Iowa	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Renewable Transportation Fuels, Municipal Solid Waste	Commercial, Industrial, Nonprofit, Transportation, Agricultural, Institutional	Grant amount varies; maximum based on available funds
Kentucky	Solar Water Heat, Biomass, Anaerobic Digestion	Agricultural	25% of project costs up to $10,000; funded by ARRA
Maine	Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Municipal Solid Waste, Tidal Energy	Nonprofit, Schools, Rural Electric Cooperative, Quasi-Municipal Corporations and Districts	Varies by project up to $50,000 for small-scale demonstration projects
Maryland	Photovoltaics	Local Government, State Government	$1,000 per kW DC; funded by ARRA; $6.2 million for FY 2010 and $2 million for FY 2011
Massachusetts	Solar Water Heat, Solar Space Heat, Wind, Biomass, Hydroelectric, CHP/Cogeneration, Other Distributed Generation Technologies	Local Government	Custom incentive, amount will vary up to $1 million
Massachusetts (2)	Wind	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional	Up to $260,000 for private and $400,000 for public entities (this is subject to change); 50% of energy must be used on site; 20% cost share for feasibility studies and 25% cost share for design and construction projects; no cost share required for public entities
Massachusetts (3)	Hydroelectric, Small Hydroelectric	Commercial, Industrial, Nonprofit, Local Government, State Government, Tribal Government, Fed. Government, Institutional	Design & Construction: 50% of costs up to $600,000; Feasibility study: 80% of costs up to $40,000
Massachusetts (4)	Wind	Commercial, Nonprofit, Local Government, Construction, State Government, Tribal Government, Fed. Government, Institutional	75% of eligible project costs up to $55,000
Michigan	Biomass, Renewable Transportation Fuels	Nonprofit, Schools, Local Government, State Government	Grant amount varies
Michigan (2)	Solar Water Heat, Photovoltaics, Wind, Fuel Cells, Anaerobic Digestion	Commercial, Nonprofit, Schools, Local Government, State Government	Grant amount varies
Minnesota	Solar Space Heat, Biodiesel	Low-Income Residential	Grant amount varies up to $4,700
Minnesota (2)	Solar Water Heat, Solar Space Heat, Photovoltaics	Local Government	$10,000 - $150,000 up to lesser of 75% of installed cost or $150,000; budgeted at $487,500 for FY 2010 and $585,000 for FY 2011
New Jersey	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Hydrogen, Other Low-Emission Advanced Renewables, Tidal Energy, Wave Energy, Ocean Thermal, Fuel Cells using Renewable Fuels	Commercial, Industrial	$100,000 - $500,000 up to $500,000; at least 50% matching funds required; funded at $6 million for 2009; subject to appropriations, $3 million annually in additional funding through 2012; funded by the New Jersey Societal Benefits Charge (SBC)
New York	Solar Water Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps	Low-Income Residential	General: up to 50% of costs up to $5,000 for single-homes, $10,000 per building for 2-4 family units; National Grid gas customers: up to 60% of costs up to $6,000 for single homes, $12,000 for 2-4 family units; funded by Systems Benefit Charge
New York (2)	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Fuel Cells, Geothermal Heat Pumps, Other Alternative Fuel Vehicles, Refueling Stations	Nonprofit, Schools, Local Government, Institutional	Grant amount 100% of project costs up to $1 million; funded by ARRA with $75 million beginning in 2009
North Carolina	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Heat Pumps, CHP/Cogeneration, Hydrogen, Renewable Energy Technologies, Tidal Energy, Wave Energy, Renewable Fuels, Other Distributed Generation Technologies	Commercial, Nonprofit, Local Government, State Government, Agricultural, Institutional	Grant amount varies up to $100,000; funded by appropriations and ARRA; funding increased from $950,000 to $5 million due to ARRA

TABLE A-3: FEDERAL AND STATE GRANT PROGRAMS FOR CLEAN ENERGY--CONT'D.			
State	**Technology**	**Sectors**	**Incentive**
Ohio	Lighting, Lighting Controls/Sensors, Chillers , Furnaces , Boilers, Heat pumps, Central Air conditioners, CHP/Cogeneration, Compressed air, Energy Mgmt. Systems/Building Controls, Building Insulation, Windows, Motors, Motor-ASDs/VSDs, Comprehensive Measures/Whole Building, Custom/Others pending approval	Commercial, Industrial	Grant of 50% of project cost up to $250,000
Ohio (2)	Solar Water Heat, Solar Space Heat	Multi-Family Residential, Low-Income Residential	Market Rate Housing: $30/kBtu per day or 50% of cost
			Affordable Housing: $50/kBtu per day or 50% of cost
			Affordable LEED/Energy Star Housing: 50% of cost
Ohio (3)	Landfill Gas, Biomass, Fuel Cells, CHP/Cogeneration, Reciprocating Engines, Anaerobic Digestion, Microturbines, Other Distributed Generation Technologies	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Fed. Government, Agricultural, Institutional	25% of project cost up to $100,000
Ohio (4)	Solar Water Heat, Photovoltaics, Wind	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Agricultural, Institutional	Maximum grant for Non-residential Renewable Energy (traditional ownership): $150,000; Non-residential Renewable Energy (third-party ownership): $200,000
Ohio (5)	Photovoltaics	Residential	$3.00/Watt DC installed capacity up to $25,000 per residence
Ohio (6)	Wind	Residential	Lesser of $2/kWh (AC) of estimated annual system output or 50% of eligible cost up to $25,000
Oregon	Commercial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Institutional	Commercial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Institutional	Grants for feasibility studies; amount varies by project up to $50,000; funded by $1 million from settlement with Reliant Energy; must repay grant if project completes and becomes profitable
Oregon (2)	Biomass, Hydroelectric, Geothermal Electric, Wave Energy, Fuel Cells using Renewable Fuels	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Agricultural	Grant amount varies up to 50% of costs and usually under $40,000 total; used for grant writing, feasibility studies, or technical assistance with design, permitting, or utility interconnection; funded by Oregon public purpose customer charge
Pennsylvania	Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, MSW Must be Waste-to-Energy, Anaerobic Digestion, Small Hydroelectric, Renewable Fuels, Geothermal Direct-Use	Commercial, Industrial, Nonprofit, Schools, Local Government	Varies by project, but program generally requires matching funds at least equivalent to DCED funding; Manufacturer Loans: $35,000 per job created within 3 years; maximum grant-Manufacturer Grants: $10,000 per job created within 3 years; Grants for distribution projects: $2 million.
Pennsylvania (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Bio-gas, Daylighting, Small Hydroelectric	Commercial, Residential	Grant amount varies by project, but program generally requires matching funds at least equivalent to DCED funding with maximum lesser of 10% of project costs or $500,000; total funding $25 million
Pennsylvania (3)	Wind, Geothermal Electric, Geothermal Heat Pumps	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government	Varies by project, but program generally requires matching funds at least equivalent to DCED funding; maximum of Manufacturer Grants: $5,000 per job created within 3 years
			Grants for distribution projects: $1 million
			Grants for feasibility studies: 50% of cost up to $175,000
Pennsylvania (4)	Wind, Geothermal Electric, Geothermal Heat Pumps	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government	Varies by project, but program generally requires matching funds at least equivalent to DCED funding with maximum of Manufacturer Grants: $5,000 per job created within 3 years
			Grants for distribution projects: $1 million
			Grants for feasibility studies: 50% of cost up to $175,000
Pennsylvania (5)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Daylighting, Small Hydroelectric	Schools	Determined on a case-by-case basis but usually $25,000
Pennsylvania (6)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Renewable Transportation Fuels, Fuel Cells, Geothermal Heat Pumps, Coal-Mine Methane; Waste Coal, Anaerobic Digestion, Small Hydroelectric, Other Distributed Generation Technologies	Commercial, Industrial, Nonprofit, Schools, Local Government, Agricultural	$1.5 million per project, some cost-share required; offered $21 million in 2009
Pennsylvania (7)	Wind, Geothermal Heat Pumps	Commercial	Up to 50% of project costs with maximum incentive of $7,500
Pennsylvania (8)	Geothermal Heat Pumps	Commercial	25% of project cost up to $25,000; offered $3 million in 2009
Rhode Island	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal, Fuel Cells using Renewable Fuels	Commercial, Industrial, Nonprofit, Schools, Local Government, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional	Varies by project up to $750,000 (maximum varies by project type)
Tennessee	Geothermal Heat Pumps	Schools, (K-12)	Varies depending on efficiency measure installed; funding appropriated from Excess State Lottery Funds (2008); may raise other funds
Tennessee (2)	Solar Water Heat, Photovoltaics, Wind, Solar Hybrid Lighting, Fuel Cells using Renewable Fuels	Commercial, Industrial	Grant of 40% up to $75,000
Texas	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Anaerobic Digestion, Tidal Energy, Wave Energy, Geothermal Direct-Use	Local Government, Non-Entitlement Governments Only	Grant amount varies; maximum not specified; matching funds % is part of evaluation process; funded from Federal Community Development Block Grant; administered by Department of Rural Affairs
Texas (2)	Wind, Other Renewables (In Conjunction With Wind)	Local Government	Grant amount varies up to $1.5 million for project used to power a reverse osmosis or other desalination facility or be used to pump brackish groundwater for treatment; cities must be less than 50,000 and counties less than 200,000; administered by Department of Rural Affairs
Texas (3)		Governmental entities	Distributed Renewable Energy Technology Grant Program - competitive grant program funded at $52 million by ARRA; $31.4 million awarded to date
Vermont	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, CHP/Cogeneration, Anaerobic Digestion, Small Hydroelectric, Microturbines	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, Agricultural, Institutional	Grant amount varies; funding of $2.5 million; funding from memoranda of understanding with Entergy and from ARRA
Wisconsin	Biomass, (Feasibility studies only for wind and solar technologies), Anaerobic Digestion	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Agricultural, Institutional	Varies by technology and estimated energy production; Implementation Grants: Lesser of $250,000 or 25% of costs (except 35% for school or municipal biomass combustion);
			Feasibility Studies: Lesser of $10,000 or 50% of costs; Total: $750,000 aggregate for all incentives to any individual or business during each program year (Jan. 1, 2010 - Dec. 31, 2010); funding from utilities required to spend 1.2% of gross operating revenue on energy efficiency and renewable energy

Note: Some additional requirements or limits may apply. Many of these incentives also apply to energy efficiency. Includes state programs or state authorized programs only. Does not include public awareness/education grants.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, Database of State Incentives for Renewables & Efficiency, "Financial Incentives for Renewable Energy."

TABLE A-4: FEDERAL AND STATE CLEAN ENERGY LOAN PROGRAMS			
State	**Technology**	**Sectors**	**Incentive**
Federal	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Hydrokinetic Power, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Local Government, State Government, Tribal Government, Municipal Utility, Rural Electric Cooperative	Clean Renewable Energy Bonds of $2.4 billion allocated as of 2009
Federal (2)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Hydrokinetic Power, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Local Government, State Government, Tribal Government	Qualified Renewable Energy Bonds allocated by state and local government population; $3.2 billion allocated as of 2009
Federal (3)	Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Hydroelectric, Geothermal Electric, Fuel Cells, Daylighting, Tidal Energy, Wave Energy, Ocean Thermal, Biodiesel	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Agricultural, Institutional, Any non-federal entity, Manufacturing Facilities	Loan guarantee amount varies; program focuses on projects with total project costs over $25 million; full repayment is required over a period not to exceed the lesser of 30 years or 90% of the projected useful life of the physical asset to be financed
Federal (4)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Renewable Transportation Fuels, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Hydrogen, Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal, Renewable Fuels, Fuel Cells using Renewable Fuels, Microturbines, Geothermal Direct-Use	Commercial, Agricultural	Loan guarantee amount varies up to $25 million per loan guarantee
Federal (5)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Daylighting	Residential	Federal Housing Authority and Veterans Administration insures portion of mortgages involving renewable technologies and energy efficiency
Alabama	Passive Solar Space Heat, Solar Water Heat, Photovoltaics, Wind, Biomass, CHP/Cogeneration, Daylighting, Small Hydroelectric, Other Distributed Generation Technologies	Schools, Local Government	Zero interest loans up to $500,000 for 10 years (paid back through utility cost savings) from State Revolving Loan Fund
Alaska	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Municipal Solid Waste	Local Government, Municipal Utility, Independent Power Producers	Varies depending on funding
California	Locally determined	Commercial, Industrial, Residential, Multi-Family Residential, Agricultural	PACE program for counties, cities and areas within cities at locally determined amounts, rates and terms using bonds, local government funds and third-party lenders
California (2)	CHP/Cogeneration, Other Distributed Generation Technologies	Schools, Local Government, Public Hospitals	Low-interest (1% or 3%) loan of lesser of 100% of project costs or $3 million for 15 years from original $20 million appropriation and $25 million ARRA funds
Colorado	Solar Water Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, Daylighting, Small Hydroelectric, Ethanol, Biodiesel, Fuel Cells using Renewable Fuels	Commercial, Industrial, Residential, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional	PACE program locally determined incentive for counties, cities and towns from bonds
Connecticut	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps	Residential, Multi-Family Residential	Loans of $400 - $25,000 (one- to four-family units); $2,000 - $60,000 (multi-family of five or more units) at 1%, 3% or 6% interest up to 10 years
Connecticut (2)	Photovoltaics, Wind, Fuel Cells, CHP/Cogeneration	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Fed. Government, Agricultural, Institutional	Loan amount varies; interest rate not to exceed prime rate; total loan portfolio not to exceed aggregate funding of $150 million
Florida	Locally determined	Commercial, Residential	PACE program locally determined incentive for municipalities and counties through bonds
Hawaii	Locally determined	Commercial, Residential	PACE program locally determined incentive for counties through bond issuance
Hawaii (2)	Photovoltaics, Wind, Biomass, Hydroelectric, Ethanol, Biodiesel	Agricultural, Aquacultural	Loan of 85% of the project cost up to $1,500,000 with 3% interest rate for agriculture and 5% interest rate for aquaculture greater than the state's interest cost, with up to 40-year term using existing revolving loan funds
Idaho	Solar Water Heat, Solar Space Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Heat Pumps, CHP/Cogeneration, Geothermal Direct-Use	Commercial, Residential, Schools, Local Government, State Government, Agricultural, Institutional, Hospitals	Residential: $1,000 to $15,000 Commercial: $1,000 to $100,000 Agricultural: Up to $100,000 Renewable Loans: Up to $100,000 Schools, Hospitals, Healthcare Facilities: Up to $100,000 At 4% interest with 5-year term
Illinois	Locally determined	Commercial, Industrial, Residential, Agricultural, Property Owners	PACE program locally determined incentive for cities, villages and incorporated towns through locally determined funding source
Indiana	Solar Water Heat, Geothermal Heat Pumps	Residential	$2,000 - $10,000 with rate of 6% up to 72 months
Iowa	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric	Commercial, Industrial, Residential, Utility	Loan of 50% of financed project cost up to $1,000,000 for most applicants, but $500,000 for non-rate regulated gas and electric utilities at 0% interest for up to 20 years funded from $5.9 million from investor-owned utilities and $5 million from sale of bonds
Iowa (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Renewable Transportation Fuels, Geothermal Heat Pumps	Nonprofit, Schools, Local Government, State Government, Institutional	Loan and terms vary by project; funding from oil overcharge funds, appropriations and technical assistance fees
Kansas	Photovoltaics, Wind, Other Distributed Generation Technologies	Commercial, Residential, Multi-Family Residential	Revolving loan program Residential Projects: $20,000 maximum loan Commercial and Industrial Projects: $30,000 maximum loan (up to 15 years and up to 4% interest rate); funding from ARRA
Kansas (2)	Solar Water Heat, Solar Thermal Electric, Photovoltaics, Wind	Commercial, Industrial	State may provide up to $5 million in financing to a solar or wind research, development, engineering or manufacturing project with investment of at least $30 million; bond retired from payroll tax withholding on new jobs created
Kentucky	Solar Water Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Anaerobic Digestion	State Government	Minimum $50,000 low-interest loan; $14.2 million funding from ARRA
Louisiana	Solar Water Heat, Solar Space Heat, Photovoltaics, Geothermal Heat Pumps	Residential	Loan for 50% of costs up to $6,000 up to 5 years as a consumer loan or second mortgage
Maine	Solar Water Heat, Solar Space Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Heat Pumps, * Pending rules by Efficiency Maine Trust, Geothermal Direct-Use	Commercial, Industrial, Residential, Property Owners	PACE program for municipalities funded from Grants, federal Qualified Energy Conservation Bonds, federal Clean Renewable Energy Bonds; financing to be determined by Efficiency Maine Trust
Maryland	Solar Water Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Municipal Solid Waste, Anaerobic Digestion, Tidal Energy, Geothermal Direct-Use	Nonprofit, Schools, Local Government, Hospitals	$300,000 per loan through March 1, 2010; larger projects may be considered a case-by-case basis after this date; Current average interest rate is 2%; payback of 10 years or less; financing from state appropriations of $1.5 million per fiscal year; 20% reserved for non-profits through March 1, 2010
Maryland (2)	Locally determined	Commercial, Residential, Low-Income Residential	PACE program for counties, municipal corporations; maximum financing amount locally determined; financing from bonds
Maryland (3)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Solar Pool Heating, Daylighting	State Government	Revolving loan program with 0% interest; 1% administrative fee; financing from Oil Overcharge Restitution Trust funds, Regional Greenhouse Gas Initiative proceeds
Maryland (4)	Specific technologies not identified	Commercial, Industrial	Loan amount varies; financing from ARRA
Massachusetts	Wind	Commercial, Nonprofit, Local Government, Construction, State Government, Tribal Government, Fed. Government, Institutional	75% of eligible project costs up to $250,000 for unsecured loan at prime plus 2% and funded by the Massachusetts Renewable Energy Trust at $39 million from FY09-FY13
Minnesota	Solar Water Heat, Photovoltaics, Wind, Geothermal Electric, Geothermal Heat Pumps, Geothermal Direct-Use	Commercial, Industrial, Residential, Multi-Family Residential	PACE program for cities, counties and towns for loan term that may not exceed the lesser of the weighted average of the useful life of improvements or 20 years; interest rates locally determined, but must be sufficient to cover program costs and financed by bond issuance, other unspecified

TABLE A-4: FEDERAL AND STATE CLEAN ENERGY LOAN PROGRAMS--CONT'D.			
State	**Technology**	**Sectors**	**Incentive**
Minnesota (2)	Wind, Biomass, Anaerobic Digestion	Agricultural	Rural Finance Authority provides up to 45% of loan; provides up to $300,000 of loan principal; maximum term of 10 years; interest rate of 4.5% as of September 2009
Minnesota (3)	Biomass, Anaerobic Digestion	Agricultural	Rural Finance Authority participation limited to 45% of loan principal; RFA can provide up to $250,000 of loan principal; 10 year maximum loan term; RFA portion at zero-interest
Minnesota (4)	Solar Water Heat, Photovoltaics, Geothermal Heat Pumps	Residential	Loan amounts vary by project up to $35,000 ($2,000 minimum); loan terms from 1 - 20 years at a fixed rate of 5.75%; maximum household income of $96,500; financed by the Minnesota Housing and Finance Agency (MHFA)
Minnesota (5)	Wind, Biomass, Solar-powered equipment; other on-farm energy production	Agricultural, Farms Only	Loan amount varies up to $40,000 per farm family ($160,000 for joint projects); fixed interest rate (currently 3%) for up to 7 years; financing from the Sustainable Agriculture Revolving Loan Fund
Minnesota (6)	Photovoltaics, Wind, Biomass, Anaerobic Digestion	Agricultural	Rural Finance Authority provides up to 45% of loan; RFA provides up to $40,000 of loan principal; maximum term of eight years; RFA portion at lesser of 4% or half of lender's effective rate for the non-RFA portion
Mississippi	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, CHP/Cogeneration	Commercial, Industrial	Loans of $15,000 - $300,000 at 3% below prime rate; 7-year repayment term; financing from Oil overcharge restitution funds from the U.S. Department of Energy
Missouri	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass	Schools, Local Government, Institutional	Loan varies by project up to $1 million; 0% interest, 1% loan origination fee; Terms of up to 10 years; financed from Petroleum Violation Escrow (PVE) Funds of $10 million for 2010
Montana	Solar Water Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Heat Pumps, Small Hydroelectric, Fuel Cells using Renewable Fuels, Geothermal Direct-Use	Commercial, Residential, Nonprofit, Schools, Local Government	Loan amount varies up to $40,000 for up to 10 years; 4.0% interest rate for 2010; Revolving Loan Fund is financed by air quality penalties
Nebraska	Solar Water Heat, Solar Space Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Municipal Solid Waste, Skylights	Commercial, Residential, Nonprofit, Local Government, Multi-Family Residential, Agricultural	Loan amount varies--Residential: $35,000 - $75,000; Non-Residential: $75,000 - $175,000; Maximum payback term is 15 years for building improvements and 10 years for all other projects; financing from $95 million in Oil Overcharge Funds; ARRA; Total $194 million; program buys half the loan at 0% interest making the loan's total interest at half the market rate
Nevada	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Solar Pool Heating, Small Hydroelectric	Commercial, Industrial, Residential, Multi-Family Reside	PACE program for cities, counties, towns
New Hampshire	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Not specified, Other Distributed Generation Technologies	Commercial, Nonprofit	Typical loans will range from $10,000 to $500,000; maximum not specified; for-profit commercial businesses rates vary between 2.75% to 4% depending on the length of the loan (3 to 10 years); for non-profit entities terms are customized based on need, but in general 2% to 2.5% loans for between 3 to 10 years are available; financing from The American Recovery and Reinvestment Act (ARRA) and State Energy Program (SEP) budget of $3.5 million
New Hampshire (2)	Not specified, Other Distributed Generation Technologies	Local Government	Loans not specified; flexible terms, structured out of energy savings; financing from Greenhouse Gas Emissions Reduction Fund (RGGI) at $1.5 million
New Hampshire (3)	Solar Water Heat, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Other Distributed Generation Technologies	Commercial	$10,000 minimum; maximum term of seven years; interest rate is prime rate minus 1% (floating)
New Jersey	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Resource-Recovery Facilities approved by the DEP, Anaerobic Digestion, Tidal Energy, Wave Energy, Fuel Cells using Renewable Fuels	Commercial, Industrial, Institutional	Loans vary up to $5 million, a portion of which may be issued as a grant; Grants: lesser of 80% of the amount requested or $2.5 million; 20% of amount requested for commercial building energy efficiency projects; Minimum of 50% of project costs must be covered by project sponsor(s) (includes federal funding); aggregate state public funding may not exceed 50% of project cost; 0% interest for term of up to 10 years; amortization up to 20 years; Projects that intend to utilize Solar Renewable Energy Certificates (SRECs) are only eligible to receive an interest-free loan; financing from Global Warming Solutions Fund at $25.7 million
New Jersey (2)	Geothermal Heat Pumps	Residential, Low-Income Residential	For Energy Savings between 5% and 25%: generally 10% rebate up to $2,000 or loan at 5.99%; income qualified 50% rebate up to $10,000 and 0% interest loan Energy Savings greater than 25%: generally 50% rebate up to $10,000 and loan at 0%; income qualified 75% rebate up to $10,000 and 0% interest loan Loans: $20,000 (5.99% interest); $10,000 (0% interest); minimum loan of $2,500; loans have a fixed interest rate for 3, 5, 7 or 10 years; rate varies based on project energy savings; financing from Societal Benefits Charge (supplemented with ARRA funds); $23.6 million (2009), not including ARRA funds
New Mexico	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Geothermal Electric, Geothermal Heat Pumps, Others (determined locally)	Commercial, Residential	PACE program for Renewable Energy Financing District: Counties, Cities, Towns, Villages; Solar Energy Improvement Special Assessments: Counties; Financing terms determined locally; Possible revenue sources: Renewable Energy Financing District: bonds, other; Solar Energy Improvement Special Assessments: private financial institutions
New York	Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Anaerobic Digestion, Geothermal Direct-Use	Commercial, Industrial, Residential, Nonprofit, Multi-Family Residential, Agricultural, Institutional	PACE program for counties, towns, cities and villages; loan amounts may not exceed 10% of the appraised real property value or cost of the qualified improvements; other terms locally determined; funding from Federal grants or credit support mechanisms
New York (2)	Solar Water Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps	Residential	Loans up to 100% of costs; $2,500 - $20,000 up to $15,000 or $20,000, depending on applicant's credit score; 5.99% APR; fixed loan terms of 3, 5, 7 and 10 years; Unsecured loan; funded from System Benefits Charge/state subsidizes interest rate
New York (3)	Solar Water Heat, Biomass, Geothermal Heat Pumps	Residential	Loan up to $20,000 generally; except $30,000 for ConEd customers; Up to 4.0% below the lender rate for ten years; rate adjusted to maintain a floor interest rate of 3.0%; funded from System Benefits Charge (SBC)
North Carolina	Locally determined	Commercial, Industrial, Residential, Multi-Family Residential, Low-Income Residential, Agricultural	PACE program for cities and counties; terms locally determined; financed from revenue bonds, general obligation bonds, general revenues
North Carolina (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, CHP/Cogeneration, Hydrogen, Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy	Commercial, Residential, General Public/Consumer	Allows cities and counties to set up revolving loan funds; loan amount not specified; interest rate can be no more than 8%; term can be no longer than 15 years; financing from Energy Efficiency and Conservation Block Grants from the federal government and the city's or county's unrestricted revenue
North Carolina (3)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric	Commercial, Industrial, Nonprofit, Schools, Local Government	`

TABLE A-4: FEDERAL AND STATE CLEAN ENERGY LOAN PROGRAMS--CONT'D.			
State	**Technology**	**Sectors**	**Incentive**
Ohio	Solar Water Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics	Commercial, Industrial, Residential, Multi-Family Residential, Low-Income Residential, Agricultural	PACE program for municipal corporations, townships to offer low-interest, 25-year loan using special obligation revenue bonds, state or federal grants
Ohio (2)	Solar Water Heat, Photovoltaics, Wind, Geothermal Heat Pumps	Residential	Provides a 3% rate reduction on a 5-year bank loan; Rate reduction only applies to first $25,000 and 5 years of the bank loan Interest earned from 2-year Ohio Treasury Certificate of Deposit at participating ECO-Link bank (similar to Linked Deposit programs); terms vary by bank
Oklahoma	Locally determined	Commercial, Industrial, Residential, Multi-Family Residential, Special Improvement District, Local Improvement District	PACE Loan for cities and counties; financing terms are locally determined; funding from bonds, loans from Oregon Department of Energy
Oklahoma (2)	Solar Water Heat, Photovoltaics	Commercial, Residential, Multi-Family Residential	Loan amount varies, depending on type of loan: Residential: $1,000 - $50,000; Small Business: $5,000 - $100,000; Financing terms vary, depending on type of loan
Oklahoma (3)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Small Hydroelectric, Renewable Fuels, Geothermal	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Rural Electric Cooperative	Loan amount typically $20,000 - $20 million; terms vary, generally in the range of 5 to15 years. The loan term must be within the expected life of the project; loan is funded from sale of bonds
Oklahoma (4)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind	Institutes of Higher Education	Loan varies up to $300,000; 1 to 6 year terms at 3% interest rate; financing through $1.1 million in oil overcharge restitution funds
Oregon	Locally determined	Commercial, Industrial, Residential, Multi-Family Residential, Special Improvement District, Local Improvement District	PACE program for cities and counties with locally determined financing terms from Bonds, loans from Oregon DOE
Oregon (2)	Solar Water Heat, Photovoltaics	Commercial, Residential, Multi-Family Residential	Loan amount varies, depending on type of loan; Residential: $1,000 - $50,000; Small Business: $5,000 - $100,000; Financing term varies, depending on type of loan; no loan fees, no closing costs, and offer preferred rates
Oregon (3)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Small Hydroelectric, Renewable Fuels, Geothermal Direct-Use	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Rural Electric Cooperative	Loans are typically $20,000 - $20 million; Financing terms vary -- generally in the range of 5 to 15 years. The loan term must be within the expected life of the project; $442 million to date
Pennsylvania	Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, MSW Must be Waste-to-Energy, Anaerobic Digestion, Small Hydroelectric, Renewable Fuels, Geothermal Direct-Use	Commercial, Industrial, Nonprofit, Schools, Local Government	Loan amount varies by project, but program generally requires matching funds at least equivalent to DCED funding; Manufacturer Loans: $35,000 per job created within 3 years; Manufacturer Grants: $10,000 per job created within 3 years; Loans for distribution projects: $5 million; Grants for distribution projects: $2 million; Grants for Energy Savings Contracts (ESCO): $500,000 Loan guarantee grants: Up to 75% of deficient funds up to $5 million; Fixed-rate loan (5% as of August 2009) to be repaid within 10 years; loans may be amortized over the life of the equipment, not to exceed 25 years; funding of $165 million from Alternative Energy Investment Fund (state issued bonds)
Pennsylvania (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Bio-gas, Daylighting	Commercial, Residential	Loan amounts vary by project, but program generally requires matching funds at least equivalent to DCED funding: Residential loans/loan guarantees: $100,000; Commercial loans/loan guarantees: $2 million; Grants: Lesser of 10% of project costs or $500,000; Loans at a fixed interest rate -- 4% as of August 2009 -- for up to 10 years; loans may be amortized over a period of up to 25 years; Funding from Alternative Energy Investment Fund (state issued bonds) with $25 million
Pennsylvania (3)	Solar Water Heat, Solar Thermal Process Heat, Photovoltaics	Commercial, Industrial, Nonprofit, Schools, Local Government	Loan varies by project, but program generally requires matching funds at least equivalent to DCED funding; Manufacturer loans: $35,000 per job created within 3 years; Manufacturer grants: $5,000 per job created within 3 years; Loans for distribution projects: Lesser of $5 million or $2.25/watt; Loans for solar thermal projects or R&D facilities: $5 million; Grants for distribution projects: Lesser of $1 million or $2.25/watt; Grants for solar thermal projects or R&D facilities: $1 million; Grants for feasibility studies: 50% of cost up to $175,000; Loan guarantee grants: Up to 75% of deficient funds up to $30 million; Loans at a fixed interest rate--5% as of August 2009--up to 10 years (equipment) or 15 years (real estate); Loan guarantee grants have a maximum term of 5 years; Alternative Energy Investment Fund (state issued bonds) $80 million
Pennsylvania (4)	Wind, Geothermal Electric, Geothermal Heat Pumps	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government	Loan varies by project, but program generally requires matching funds at least equivalent to DCED funding with maximum of: Manufacturer Loans: $35,000 per job created within 3 years; Manufacturer Grants: $5,000 per job created within 3 years; Loans for distribution projects: $5 million; Grants for distribution projects: $1 million; Grants for feasibility studies: 50% of cost up to $175,000 Loan guarantee grants: Up to 75% of deficient funds up to $5 million; Loans at a fixed interest rate (5% as of August 2009) up to 10 years (equipment) or 15 years (real estate); Loan guarantee grants have a maximum term of 5 years; Alternative Energy Investment Fund (state issued bonds); funding of $25 million
Pennsylvania (5)	Biomass, Geothermal Heat Pumps, "Alternative Energy Heating and Cooling Equipment Systems" (Excluding Solar)	Residential, Low-Income Residential	Loan of $1,000 - $35,000 (varies by loan type); 1 - 10 years term (varies by loan type) and funding of $17 million
Pennsylvania (6)	Not specified, but must meet general project eligibility criteria	Commercial, (no more than 100 full-time employees)	Loan Up to 75% of total eligible project cost up to $100,000 with 2% fixed interest; Maximum loan term of 10 years
Rhode Island	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal, Fuel Cells using Renewable Fuels	Commercial, Industrial, Nonprofit, Schools, Local Government, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional	Loan amount varies by project up to $750,000 (varies by project type); financing from Rhode Island Renewable Energy Fund (RIREF); financed $3 million in 2009
South Carolina	Photovoltaics, Biomass, Geothermal Heat Pumps, Other Renewables	Nonprofit, Schools, Local Government, State Government, Institutional	Loan of 100% of eligible project costs, from $25,000 to $500,000 with fixed annual rate set below Wall Street Journal prime rate; ten-year term
Tennessee	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric	Commercial, Industrial	Loan varies by project up to a maximum yet to be determined; terms yet to be determined; financed from Oil Overcharge Restitution Funds
Tennessee (2)	Geothermal Heat Pumps	Schools, (K-12)	Loan of $66/student at 3% interest for 7 years appropriated from $90 million from Excess State Lottery Funds (2008); Council may raise other funds
Texas	Decided by locally determined municipal official	Commercial, Industrial, Residential, Multi-Family Residential, Agricultural, Real Property	PACE program for municipalities with terms locally determined and funded by bonds, municipal funds
Texas (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Geothermal Heat Pumps	Schools, Local Government, State Government, Hospitals	Loan varies with maximum at $5 million and current interest rates are 3% APR. Loans repaid through energy cost savings. Projects must have an average payback of 10 years or less; funding through Petroleum Violation Escrow Funds of $98.6 million
Texas (3)	Rooftop Solar Water, Solar Space Heat, Geothermal Heat Pumps, Photovoltaics, Small Wind, Solar Thermal	Governmental Entities	Loans up to $10 million at 2% interest

TABLE A-4: FEDERAL AND STATE CLEAN ENERGY LOAN PROGRAMS--CONT'D.			
State	**Technology**	**Sectors**	**Incentive**
Vermont	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Daylighting, Small Hydroelectric	Commercial, Industrial, Residential, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional	PACE program for cities, towns and incorporated villages for financing that may not exceed 15% of assessed property value; combined amount of assessment and outstanding mortgages may not exceed 90% of assessed property value. In the case of an agreement with the resident owner of a dwelling, the maximum amount to be repaid for the project shall not exceed $30,000 or 15%, whichever is less; funding by bonds, payments collected for reserve fund
Vermont (2)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Fuel Cells, Geothermal Heat Pumps, CHP/Cogeneration, Anaerobic Digestion	Commercial, Residential, Nonprofit, Local Government	$50,000 - $500,000 with 2% interest rate; loan terms vary depending on project type; funding from Clean Energy Development Fund (CEDF) The American Recovery and Reinvestment Act (ARRA) FY 2010-2011
Virginia	Locally determined by ordinance	Commercial, Residential, Construction, Institutional	PACE program for Locally determined for any political subdivision authorized to levy fees or taxes with funding from Independent lending institutions, other revenue sources determined by local governments
Wisconsin	Locally determined	Residential	PACE program for local subdivisions with financing locally determined
Wisconsin (2)	Geothermal Heat Pumps	Residential	Loans of up to 100% of installation costs from $2,500 - $10,000 for unsecured loans with fixed interest rate of 9.99% for terms of 3, 5, 7, or 10 years with funding from Focus on Energy

Note: Additional requirements or limits may apply. Many of these incentives also apply to energy efficiency. Includes state programs or state authorized programs only.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, Database of State Incentives for Renewables & Efficiency, "Loan Programs for Renewable Energy."

A-5: FEDERAL AND STATE PRODUCTION AWARDS FOR CLEAN ENERGY			
State	**Technology**	**Sectors**	**Incentive**
Federal	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Local Government, State Government, Tribal Government, Municipal Utility, Rural Electric Cooperative, Native Corporations	Renewable Energy Production Incentive pays 2.1¢/kWh (subject to availability of annual appropriations in each federal fiscal year of operation) for 10 years; subject to availability of annual appropriations in each federal fiscal year of operation
California	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Municipal Solid Waste, Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal, Biodiesel, Fuel Cells using Renewable Fuels	Commercial, Industrial, Residential	Feed-in tariff based on market price adjusted by time-of-use, but participation in other incentive programs disallowed
Hawaii	Solar Thermal Electric, Photovoltaics, Wind, Hydroelectric, Small Hydroelectric	Commercial, Industrial, Residential	Feed-in tariff not yet determined
Maine	40	Commercial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Institutional	Choice of either 1.5 REC credit multiplier; or
			Small projects (1 MW DC or less): the lower of $0.10/kWh or project cost for solar, wind, hydro projects; to be determined on a case-by-case basis for other eligible renewable energy projects; Large projects (over 1 MW DC): Depends on the result of the bid process
Minnesota	Biomass, Hydroelectric, Anaerobic Digestion	Commercial, Residential, Nonprofit, Tribal Councils	1.0¢-1.5¢/kWh
			Other undetermined incentive for on farm biogas *not* used to produce electricity
Oregon	Photovoltaics	Commercial, Industrial, Residential	Feed-in tariff not yet determined
South Carolina	Landfill Gas, Biomass, CHP/Cogeneration, Anaerobic Digestion	Commercial, Industrial, Agricultural	$0.01 per kWh / $0.30 per therm up to $100,000 per taxpayer and aggregate limit of $2.1 million per fiscal year
Vermont	Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Municipal Solid Waste, Anaerobic Digestion, Small Hydroelectric	Commercial, Industrial, Agricultural, Owners of Qualified SPEED Resources	Feed-in tariff of Solar: $240/MWh; Hydro: $122.6/MWh; Agricultural Methane: $141.1/MWh; Landfill Methane: $90/MWh; Wind> 100 kW: $118.2/MWh; Wind< 100 kW: $214.8 MWh; Biomass: $125.0/MWh
Washington	Solar Thermal Electric, Photovoltaics, Wind, Anaerobic Digestion	Commercial, Residential, Nonprofit, Local Government, Utility	$0.12/kWh - $1.08/kWh through 6/30/2020, depending on project type, technology type and where equipment was manufactured up to $5,000/year

Note: Some additional limits may apply. Many of these incentives also apply to energy efficiency. Includes state programs or state authorized programs only. Does not include incentives related solely to Renewable Energy Credits.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, Database of State Incentives for Renewables & Efficiency, "Financial Incentives for Renewable Energy."

TABLE A-68: STATE AND FEDERAL RECRUITMENT INCENTIVES FOR CLEAN ENERGY DEVELOPMENT			
State	Technology	Sectors	Incentive
Federal	Solar Water Heat, Solar Thermal Electric, Photovoltaics, Wind, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Batteries and Energy Storage; Advanced Transmission Technologies that Support Renewable Energy Generation; , Renewable Fuels, Fuel Cells using Renewable Fuels, Microturbines	Commercial, Industrial, Manufacturing	30% of qualified investment; total amount of credits to be allocated not to exceed $2.3 billion
Arizona	Solar Water Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Solar Pool Heating, Anaerobic Digestion, Small Hydroelectric, Fuel Cells using Renewable Fuels	Commercial, Industrial	Amount of income or property tax credit varies, based on quantity and salaries of jobs created; no individual limit; the aggregate amount of income tax credits that may be approved state-wide is $70 million per taxable year.
California	Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Small Hydroelectric, Other Distributed Generation Technologies, Geothermal Direct-Use	Industrial	100% sales and use tax exemption for purchase of renewable energy equipment
Connecticut	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Fuel Cells, CHP/Cogeneration, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal, Other Distributed Generation Technologies	Commercial	Unsecured loan of up to $750,000 for demonstration projects; total of $4 million available
Connecticut (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Solar Pool Heating, Daylighting, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Commercial	Grants of up to $10,000; funded from oil overcharge restitution
Hawaii	Solar Thermal Electric, Photovoltaics, CHP/Cogeneration	Industrial, Installer/Contractor	Tax refund of up to $9,000 per new job created; must be a new-to-market or expanding Photovoltaic or Solar Thermal Manufacturer, Installation, and/or Repair Company in program area
Kansas	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Wave Energy, Ocean Thermal	Industrial	Tax credit of 100% up to $2,000,000 (over five years)
Maryland	Specific technologies not identified	Commercial, Industrial	Grant and loan amount not specified; $7 million total available
Massachusetts	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste	Commercial	Corporate excise tax deduction for any income -- including royalty income -- received from the sale or lease of a U.S. patent for alternative energy development and any income received from the sale or lease of personal or real property or materials manufactured in Massachusetts and subject to the approved patent
Massachusetts (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste	General Public/Consumer	Personal income tax deduction of 100% for any income received from the sale of a patent or royalty income from a patent deemed beneficial for alternative energy development.
Massachusetts (3)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Fuel Cells, Municipal Solid Waste, Power inverters, other related equipment, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Commercial, Industrial	Convertible loans up to $500,000 per company per 12-month period for companies in initial stage of development; $4.9 million has been invested
Michigan	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Renewable Transportation Fuels, Renewable Fuel Vehicles, Fuel Cells, CHP/Cogeneration, Miniturbines, Stirling Engines, Hybrid Vehicles, Batteries, Storage, Thermoelectric Energy, Solar Pool Heating, Anaerobic Digestion, Renewable Fuels, Microturbines	Commercial, Industrial	Nonrefundable tax credit from the states' business tax for businesses engaged in renewable energy research, development and manufacturing
Michigan (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Fuel Cells, CHP/Cogeneration, Miniturbines, Stirling Engines, Hybrid Vehicles, Batteries, Storage, Thermoelectric Energy, Solar Pool Heating, Anaerobic Digestion, Renewable Fuels, Microturbines	Commercial, Industrial	Payroll tax credit for businesses engaged in renewable energy research, development or manufacturing located in the NextEnergy Zone equal to their qualified payroll amount multiplied by their income tax rate for that year
Michigan (3)	Photovoltaics	Industrial	Tax credit of 25% against the Michigan Business Tax of the capital costs for building a qualifying PV manufacturing facility up to generally $15 million, but one certificate may be for up to $25 million. Total credits issued for all years may not exceed $75 million.
Michigan (4)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Solar Pool Heating, Anaerobic Digestion, Renewable Fuels	Commercial, Industrial, Local Government	Facilities within a state-designated Renewable Energy Renaissance Zones do not pay the Michigan Business Tax, state education tax, personal and real property taxes, or local income taxes (where applicable)
Montana	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Fuel Cells using Renewable Fuels	Commercial, Industrial	35% tax credit against individual or corporate income tax
Montana (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Municipal Solid Waste, CHP/Cogeneration, Hydrogen, Solar Pool Heating, Anaerobic Digestion, Fuel Cells using Renewable Fuels	Commercial, Industrial, Manufacturers	50% property tax abatement
New Jersey	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Balance of System Components, Anaerobic Digestion, Tidal Energy, Wave Energy, Fuel Cells using Renewable Fuels	Commercial, Industrial	Total (grants and loans): $3.3 million; grants: $300,000; loans: $3 million; 50% cost share required; loans at 0% interest for up to 10 years with three year deferral of principal repayment
New Mexico	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Fuel Cells, Municipal Solid Waste, Batteries, Hybrid Electric Vehicles, Electric Vehicles, Anaerobic Digestion, Fuel Cells using Renewable Fuels	Commercial, Industrial	Manufacturers' tax credit of up to 5% of taxpayer's qualified expenditures
New York	Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Fuel Cells, All Types of Renewable Electricity Generation, Energy Storage, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Commercial, Industrial	Grants up to $200,000; 50% cost share; funded by System Benefits Charge
New York (2)	Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Fuel Cells, Electric Storage Products for Grid-Connected Applications, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Commercial, Industrial	Grants vary up to: Facility and Site Characterization: lesser of 5% of project or $75,000 (50% cost share); Pre-production Development: lesser of 20% of project or $300,000 (50% cost share); Production Incentive Payment: up to $1,125,000, paid based on 25% of New York content of product sales over 5 years (75% cost share); Total: $1.5 million per project; funded by New York System Benefits Charge
Ohio	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, CHP/Cogeneration, Advanced Solid Waste, Electricity Storage, Advanced Nuclear, Anaerobic Digestion	Commercial, Industrial, Nonprofit, Local Government, State Government, Tribal Government, Fed. Government, Institutional	Grants of $50,000 to $2 million for advanced energy technology targeted to commercialization and production; funded by bonds
Oklahoma	Wind	Industrial	Income tax credit based on square footage of rotor swept area: $25.00/ft^2 for 2005 through 2012
Oregon	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Solar Pool Heating, Small Hydroelectric, Tidal Energy, Wave Energy	Commercial, Industrial	50% of eligible construction costs for a facility that will manufacture renewable energy systems, and includes the costs of the building, excavation, machinery and equipment costs (10% per year for 5 years) up to $20 million

TABLE A-6: STATE AND FEDERAL RECRUITMENT INCENTIVES FOR CLEAN ENERGY DEVELOPMENT--CONT'D.			
Pennsylvania	Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, MSW Must be Waste-to-Energy, Anaerobic Digestion, Small Hydroelectric, Renewable Fuels, Geothermal Direct-Use	Commercial, Industrial, Nonprofit, Schools, Local Government	Varies by project, but program generally requires matching funds at least equivalent to funding; Manufacturer Loans: $35,000 per job created within 3 years; Manufacturer grants: $10,000 per job created within 3 years; Loans for distribution projects: $5 million; Grants for distribution projects: $2 million; Grants for Energy Savings Contracts (ESCO): $500,000; Loan guarantee grants: Up to 75% of deficient funds up to $5 million
Pennsylvania (2)	Solar Water Heat, Solar Thermal Process Heat, Photovoltaics	Commercial, Industrial, Nonprofit, Schools, Local Government	Varies by project, but program generally requires matching funds at least equivalent to funding; Manufacturer loans: $35,000 per job created within 3 years; Manufacturer grants: $5,000 per job created within 3 years; Loans for distribution projects: Lesser of $5 million or $2.25/watt; Loans for solar thermal projects or R&D facilities: $5 million; Grants for distribution projects: Lesser of $1 million or $2.25/watt; Grants for solar thermal projects or R&D facilities: $1 million
			Grants for feasibility studies: 50% of cost up to $175,000; Loan guarantee grants: Up to 75% of deficient funds up to $30 million; Loans at a fixed interest rate -- 5% as of August 2009 -- up to 10 years (equipment) or 15 years (real estate); Loan guarantee grants have a maximum term of 5 years
Pennsylvania (3)	Wind, Geothermal Electric, Geothermal Heat Pumps	Commercial, Industrial, Nonprofit, Schools, Local Government	Varies by project, but program generally requires matching funds at least equivalent to funding; Manufacturer Loans: $35,000 per job created within 3 years; Manufacturer Grants: $5,000 per job created within 3 years; Loans for distribution projects: $5 million; Grants for distribution projects: $1 million; Grants for feasibility studies: 50% of cost up to $175,000; Loan guarantee grants: Up to 75% of deficient funds up to $5 million; Loans at a fixed interest rate (5% as of August 2009) up to 10 years (equipment) or 15 years (real estate); Loan guarantee grants have a maximum term of 5 years
Tennessee	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Hydrogen, "Clean Energy Technology", Solar Pool Heating, Anaerobic Digestion, Small Hydroelectric, Other Distributed Generation Technologies	Commercial, Industrial	99.5% sales and use tax credit; Taxpayer must make $100 million investment (minimum) and create 50 full-time jobs at 150% rate of Tennessee's average occupational wage
Texas	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind	Commercial, Industrial	100% exemption from franchise tax of all revenues of companies in Texas engaged solely in manufacturing, selling or installing solar energy devices (franchise tax is equivalent to corporate income tax)
Utah	Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Other Non-Renewable Alternative Energy Resources (see summary for list), Small Hydroelectric	Commercial, Industrial	Post-performance refundable tax credit up to 100% of new state tax revenues (including, state, corporate, sales and withholding taxes) over the life of the project (typically 5-10 years); evaluation includes several criteria including number and salaries of jobs created; long-term capital investment; amount of new tax revenue
Virginia	Solar Water Heat, Solar Space Heat, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Heat Pumps, Solar Pool Heating, Fuel Cells using Renewable Fuels, Geothermal Direct-Use	Commercial, Industrial	Green jobs tax credit of $500 per each job created with salary of $50,000 or more up to $175,000 total credit
Virginia (2)	Photovoltaics	Commercial, Industrial	Annual incentive grants of $0.75 per watt of panels sold with a maximum of 6 MW; funded for $4.5 million
Washington	Photovoltaics	Industrial	43% reduction of state's business and occupation (B&O) tax for manufacturers and wholesale marketers
Wisconsin	Solar Water Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Hydrogen, Energy Storage, Anaerobic Digestion, Renewable Fuels, Other Distributed Generation Technologies	Commercial, Industrial	Low-interest loans for manufacturers locating or expanding in the state; State contribution limited to 25% of project costs; Loans at 2% interest rate for 5-10 years (equipment) or 5-7 years (working capital); deferral of up to one year
Wisconsin (2)	Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Hydrogen, Renewable Substitutes for Petroleum-based Chemicals, Anaerobic Digestion, Renewable Fuels	Commercial, Industrial, Institutional	Grants and loans to businesses and researchers for development and commercialization of clean energy; grants require a 50% cost share; loans are offered at interest rates of 4% for up to 15 years and a maximum of 25% of project cost

Note: Some additional requirements and limits may apply. Does not include local or private sector incentives. Many of these incentives also apply to energy efficiency.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, Database of State Incentives for Renewables & Efficiency, "Financial Incentives for Renewable Energy."

TABLE A-1: FEDERAL AND STATE BUSINESS TAX INCENTIVES FOR CLEAN ENERGY

State	Technology	Sectors	Incentive
Federal (1)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, CHP/Cogeneration, Solar Hybrid Lighting, Microturbines, Geothermal Direct-Use	Commercial, Industrial, Utility	Tax credit of 30% for solar, fuel cells and small wind; 10% for geothermal, microturbines and CHP with maximum of Fuel cells: $1,500 per 0.5 kW; Microturbines: $200 per kW; Small wind turbines placed in service 10/4/08 - 12/31/08: $4,000; Small wind turbines placed in service after 12/31/08: no limit; All other eligible technologies: no limit; credit available through 2016
Federal (2)	Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Hydrokinetic Power (i.e., Flowing Water), Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal	Commercial, Industrial	Tax credit of 2.1¢/kWh for wind, geothermal, closed-loop biomass; 1.1¢/kWh for other eligible technologies; generally applies to first 10 years of operation
Federal (3)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Solar Hybrid Lighting, Anaerobic Digestion, Microturbines, Geothermal Direct-Use	Commercial, Industrial	Deduction through the Modified Accelerated Cost-Recovery System (MACRS), many renewable technologies are classed as five-year or seven-year properties for purposes of depreciation
Federal (4)	Solar Water Heat, Solar Space Heat, Photovoltaics	Residential, Multi-Family Residential	Excludes 100% of public utility subsidies for purchase of renewable energy technologies from income for tax purposes
Arizona	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Solar Cooling, Solar Pool Heating, Daylighting	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Agricultural, Institutional	Credit of 10% of installed cost up to $25,000 for any one building in the same year and $50,000 in total credits in any year
Florida	Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, CHP/Cogeneration, Hydrogen, Tidal Energy, Wave Energy, Ocean Thermal	Commercial	Credit of $0.01/kWh for electricity produced from 1/1/2007 through 6/30/2010 up to no maximum specified for individual projects; Maximum of $5 million per state fiscal year for all credits under this program
Florida (2)	Fuel Cells, Hydrogen, Ethanol, Biodiesel	Commercial	Credit of 75% of all capital costs, operation and maintenance costs, and research and development costs
Georgia	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Daylighting	Commercial, Industrial, Multi-Family Residential, Agricultural	Credit for renewable energy systems: 35% up to $500,000 for PV, solar thermal electric, active space heating, biomass, wind and $100,000 for solar hot water, Energy Star-certified geothermal heat pumps
Hawaii	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind	Commercial, Residential, Multi-Family Residential	Credit for Solar Thermal and PV: 35% and Wind: 20% (up to maximum by technology and property type)
Hawaii (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Wave Energy, Ocean Thermal	Industrial	100% tax credit over five years up to $2,000,000 and 80% of tax liability over five years for equity investment in a qualified high-tech business (includes renewable energy)
Iowa	Landfill Gas, Wind, Hydroelectric, Self-generators	Commercial, Industrial, Residential, Local Government	100% exemption on replacement generation tax for self-generators, landfill gas and wind; reduced rate for large hydro
Iowa (2)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydrogen, Anaerobic Digestion	Commercial, Industrial, Schools, Rural Electric Cooperative, Agricultural, Institutional	Credit of 1.5¢/kWh or 1.0¢/kWh for 10 years after facility begins producing energy (credit may be applied to personal or corporate taxes and sales and use tax)
Kentucky	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Geothermal Heat Pumps, Combination Active Solar Space-Heating and Water Heating System	Commercial, Industrial, Agricultural	Credit for PV: $3/W DC and
			All other systems: 30% of eligible costs (up to $1,000 per taxpayer for installations on multi-family residential rental units or commercial property; $500 for single family residential rental unit)
Kentucky (2)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric	Commercial	Credit of 100% state income or limited liability tax and up to 100% sales and use tax exemption
Louisiana	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Solar Pool Heating	Commercial, Residential, Multi-Family Residential	Credit of 50% of the first $25,000 of the cost of each system up to $12,500 per installed system
Maryland	Biodiesel	Commercial, Industrial	Credit of $0.03/gallon up to $500 per year
Maryland (2)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Co-firing, Anaerobic Digestion	Commercial, Industrial, Residential, Utility, Agricultural	Credit of $0.0085/kWh ($0.005/kWh for co-fired electricity) up to $2.5 million (total credit during five-year period)
Maryland (3)	Photovoltaics, Wind, Fuel Cells	Commercial, Industrial, Multi-Family Residential	Credit of 20-25% PV; 25% Wind; 30% Fuel Cell; Allowable project costs may not exceed $3/watt for PV, and $1,000/kW for fuel cells
Massachusetts	Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Wind	Commercial, Industrial	100% deduction for unit or system, including labor
Massachusetts (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Wind	Commercial, Industrial	100% exemption from the tangible property portion of the excise tax
Montana	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Fuel Cells using Renewable Fuels	Commercial, Industrial	Credit of 35%; participant investment must be greater than or equal to $5,000
New Mexico	Solar Thermal Electric, Photovoltaics, Geothermal Electric	Commercial	Credit of 6% against personal, corporate, gross receipts, compensating, or withholding taxes up to $60 million
New Mexico (2)	Geothermal Heat Pumps	Commercial, Residential, Agricultural	Credit of 30% up to $9,000 per system; Annual aggregate cap of $2 million in total corporate and personal tax credits
New Mexico (3)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Municipal Solid Waste, Anaerobic Digestion	Commercial, Industrial	Credit of 0.01/kWh for wind and biomass; $0.027/kWh (average) for solar (Wind and biomass: First 400,000 MWh annually for 10 years (i.e. $4,000,000/year); Solar electric: First 200,000 MWh annually for 10 years (annual amount varies); Statewide cap: 2,000,000 MWh plus an additional 500,000 MWh for solar electric)
New Mexico (4)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Daylighting	Commercial, Residential, Multi-Family Residential	Credit varies based on the square footage of the building and the certification level
New York	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Fuel Cells, Daylighting	Commercial, Construction, Multi-Family Residential	Credit varies by project
North Carolina	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Heat Pumps, Spent pulping liquor, Solar Pool Heating, Daylighting, Anaerobic Digestion, Ethanol, Methanol, Biodiesel	Commercial, Industrial	Credit of 35% up to $2.5 million per installation
North Dakota	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, Anaerobic Digestion, Renewable Fuels, Fuel Cells using Renewable Fuels	Commercial, Industrial	Credit of 15% (3% per year for five years)
Ohio	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Municipal Solid Waste, CHP/Cogeneration	Commercial, Industrial	100% exemption from corporate franchise tax, state sales and use, and property taxes for property used to replace fossil-fuels, recover waste heat or steam or convert solid waste to energy
Oklahoma	Solar Thermal Electric, Photovoltaics, Wind, Hydroelectric, Geothermal Electric	Commercial	Credit of 50% of certified project costs of renewable energy generation, renewable energy equipment manufacturing, high efficiency combined heat and power, wind projects over 10 MW; all other projects: 35%
Oregon	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Hydrogen, Industrial Waste, Ethanol, Methanol, Biodiesel, Fuel Cells using Renewable Fuels	Commercial, Industrial, Construction, Multi-Family Residential, Agricultural, Equipment manufacturers	Credit of 35% to 50% up to $20 million for renewable energy equipment manufacturing facilities; $3.5 million for wind projects over 10 MW (amount declines by year); $10 million for other renewable energy generation projects; $9,000-$12,000 per home for homebuilders
Rhode Island	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Geothermal Heat Pumps	Residential	Credit for residential applications only of 25% of costs up to $15,000 for PV, active solar space heating and wind; $7,000 for solar hot water and geothermal
South Carolina	Landfill Gas, Biomass, CHP/Cogeneration, Anaerobic Digestion	Industrial	Credit of 25% of eligible costs up to $650,000 per year; credit may not exceed 50% of tax liability
South Carolina (2)	Solar Water Heat, Solar Space Heat, Photovoltaics, Solar Cooling, Daylighting, Small Hydroelectric	Commercial, Residential	Credit of 25% of eligible costs up to $3,500, or 50% of taxpayer's tax liability, whichever is less
Texas	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind	Commercial, Industrial	Franchise tax deduction of 10% of amortized cost from apportioned margin (Texas franchise tax is similar to corporate income tax in other states.)
Texas (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind	Commercial, Industrial	Total exemption from franchise tax for companies in Texas engaged solely in the business of manufacturing, selling, or installing solar energy devices
Utah	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Solar Pool Heating, Anaerobic Digestion	Commercial, Residential, Construction, Installer/Contractor, Multi-Family Residential	Residential: credit of 25%, up to $2,000; Commercial: wind, geothermal electric, and biomass systems 660 kW or greater: 0.35¢/kWh ($0.0035/kWh) for 4 years; Other commercial systems: 10% up to $50,000
Vermont	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Solar Hybrid Lighting	Commercial, Industrial	Credit of 30% for property placed in service on or before 12/31/2010 for C-corporations
Washington	Solar Using Photovoltaics or Silicon	Commercial, Industrial	Reduced Business and Operations tax rate to 0.2904% from 0.484% for manufacturers, installers and sellers
Washington (2)	Renewable Energy	Utility	Credit of 100 percent on their Public Utility Tax for payments of up to $5,000 to customers for renewable energy electrical production
West Virginia	Wind	Utility	Reduction of Business and Occupations tax from 40% to 12% of generating capacity (effective rate is about 30% of effective rate for other new generating units)

Notes: Does not include local or private sector incentives. Many of these incentives also apply to energy efficiency. Certain other specifics may apply to incentives, including minimum capacities, time limits, variable maximums, ownership requirements, carryover provisions and other specifications.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, "Database of State Incentives for Renewables & Efficiency--CCorporate Tax Incentives for Renewable Energy;" Washington State Department of Revenue, "Renewable Energy Tax Incentives."

TABLE A-2: STATE REBATE PROGRAMS FOR CLEAN ENERGY			
State	**Technology**	**Sectors**	**Incentive**
California	Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Fed. Government, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional, (All customers of PG&E, SDG&E, SCE; Bear Valley eligible only for NSHP)	Includes several rebate programs; rebate varies by sector and system size; $3.2 billion over 10 years beginning in 2006; funded by utility ratepayers
California (2)	Wind, Fuel Cells, Advanced Storage Technologies	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Fed. Government, Institutional	Wind: $1.50/W; Fuel cells: $2.50/W to $4.50/W, depending on fuel Advanced Energy Storage systems coupled with eligible SGIP technologies: $2/W; An additional 20% will be awarded to projects that utilize systems manufactured in California; 2010 Funding: PG&E: $36 million; SCE: $28 million; So Cal Gas: $11 million; SDG&E: $8 million
California (3)	Small Wind, Fuel Cells using Renewable Fuels	Commercial, Industrial, Residential, Schools, Low-Income Residential, Agricultural, Institutional	Emerging Renewables Rebate - Wind: $3.00/W for first 10 kW; $1.50/W for increments >10 kW and <30 kW; Fuel cells: $3.00/W; Rebates for eligible renewable energy systems installed on affordable housing projects are available at 25% above the standard rebate level up to 75% of the system's installed cost
Connecticut	Photovoltaics	Residential, Multi-Family Residential	Residential: $1.75/watt (PTC rating) for first 5 kW; $1.25/W (PTC) for next 5 kW, adjusted based on expected performance; maximum of Residential: $15,000; Incentives will be subject to a maximum of the customer's average annual or expected electric usage; funding from ratepayers and ARRA
Delaware	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Geothermal Heat Pumps, Fuel Cells using Renewable Fuels	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, Agricultural, Institutional	Delmarva: Up to 25% of costs generally, 35% for non-profits/government; DEC: Up to 33.3% of costs for PV and wind-electric, generally 50% for others; Munis: Generally up to 33.3% of costs, except 50% of cost for solar water heating (Dover and Seaford have different incentive levels for some technologies); maximums vary by utility and technology; funding from utility ratepayers
Hawaii	Solar Water Heat	Commercial, Residential	Residential: $750; Commercial: $125 per deferred kW, plus $0.05/kWh for retrofits and $0.06/kWh for new construction; funded by utility ratepayers
Maryland	Geothermal Heat Pumps	Commercial, Residential	$500 per ton up to Residential: $3,000; Non-residential: $10,000; funding from greenhouse gas emission auctions under the Regional Greenhouse Gas Initiative, but most funding this year is from ARRA
Maryland (2)	Solar Water Heat, Solar Thermal Process Heat, Photovoltaics	Commercial, Residential, Nonprofit, Local Government	Rebate for Solar PV: $0.25 - $1.25/W DC up to $10,000; Solar Water Heating: 30% of the installed cost up to $2,000; funded by appropriations supplemented by funds from carbon emission allowance auctions as part of the Regional Greenhouse Gas Initiative and ARRA
Maryland (3)	Solar Water Heat, Photovoltaics	Commercial, Industrial, Nonprofit	PV: $500/kW up to $50,000; SHW: 15% of installed cost up to $25,000; funded by appropriations supplemented by funds from carbon emission allowance auctions as part of the Regional Greenhouse Gas Initiative and ARRA
Maryland (4)	Wind	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, Fed. Government, Agricultural, Institutional	First 5 kW: $2,800 per kW; Capacity above 5 kW: $2,100 per kW up to lesser of $20,000 or 50% of net installation cost after other incentives; funded by carbon emission allowance auctions as part of the Regional Greenhouse Gas Initiative and ARRA
Massachusetts	Photovoltaics	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Fed. Government, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional	$1.00 - $2.10/W DC up to Residential: $10,500; Commercial: $5,500 (per host customer), up to $250,000 per parent company; funded by utility ratepayers
Massachusetts (2)	Wind	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Multi-Family Residential, Institutional	Initial incentive: $1,000 + $1.25/W up to $4/W ($40,000); funded by utility ratepayers
Nevada	Photovoltaics, Wind, Small Hydroelectric	Commercial, Residential, Nonprofit, Schools, Local Government, State Government, Agricultural, Other Public Buildings	Solar (Step 1, 2010-2011 program year): Schools and public and other property, including non-profits and churches: $5.00 per watt AC; Residential and small business property: $2.30 per watt AC; Wind (Step 1, 2010-2011 program year): Residential, small business, agriculture: $3.00 per watt; Schools and Public Buildings: $4.00 per watt; Small Hydro (Step 1, 2010-2011 program year): Non-net metered systems: $2.80/W; Net metered systems: $2.50/W; funding from utility ratepayers
New Hampshire	Photovoltaics, Wind	Residential	$3/watt DC up to $6,000 or 50% of system costs, whichever is less; funded by Renewable Portfolio Standard (RPS) alternative compliance payments
New Jersey	Heat pumps, Central Air conditioners	Residential	IOU customers: $300 - $600 (varies by efficiency); Muni/Co-op customers: $300 or $400 (varies by measure); funded by utility ratepayers and ARRA
New Jersey (2)	Geothermal Heat Pumps	Residential, Low-Income Residential	Maximum rebate of $2,000 or $10,000 depending on efficiency improvement; funded by utility ratepayers and ARRA
New Jersey (3)	Photovoltaics, Landfill Gas, Wind, Biomass, CHP/Cogeneration, Anaerobic Digestion, Fuel Cells using Renewable Fuels	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Multi-Family Residential, Institutional	Generally $0.15 - $5/W DC (varies by technology, capacity and applicant type); wind incentives determined by estimated system performance ($/estimated annual kWh); maximums apply; funded by utility ratepayers; total funding of $64.6 million for 2010
New Jersey (4)	Geothermal Heat Pumps	Commercial, Industrial, Schools, Local Government, Construction, State Government, Fed. Government, Institutional	Varies widely by equipment type, size and efficiency; maximums apply; funded by utility ratepayers
New Jersey (5)	Photovoltaics, (Includes Panels, Inverters and Racking Systems for Photovoltaic Systems)	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Multi-Family Residential, Agricultural, Institutional	Varies by equipment type, sector, and system size; total incentive may be from $0.05 - $0.55/W DC; funded by utility ratepayers; $1 million budget
New Jersey (6)	Solar Water Heat	Residential	$1,200; funded by utility ratepayers
New York	Distributed Generation Technologies	Multi-Family Residential, Low-Income Residential	Rebate amount varies by income eligibility and efficiency level; funded by utility ratepayers; Program budget: Regular Multifamily: $26.1 million (July 1, 2006 - June 30, 2011); Low-Income Multifamily: $114.6 million (July 1, 2006 - June 30, 2011); funded by utility ratepayers
New York (2)	Passive Solar Space Heat, Geothermal Heat Pumps, Daylighting	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Fed. Government, Multi-Family Residential, Agricultural, Institutional,	50-75% of incremental costs, depending on type of project up to Up to $850,000 for upstate residents, and $1.65 million for Con Edison customers (not including bonus incentives); Program budget: $53 million; funded by utility ratepayers
New York (3)	Fuel Cells	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Institutional	Varies by size, sector, and performance, includes capacity and performance incentives up to Small systems (less than 25kW): $50,000; Large systems (25kW or greater): $1 million; Program budget: Available: $1.8 million (April - June 2010); funded by ratepayers

TABLE A-2: STATE REBATE PROGRAMS FOR CLEAN ENERGY--CONT'D.			
State	**Technology**	**Sectors**	**Incentive**
New York (4)	Biomass, Geothermal Heat Pumps	Residential	10% of project costs up to $3,000; funded by utility ratepayers
New York (5)	Wind	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Fed. Government, Agricultural, Institutional	Base incentive: lesser of $3,500/meter of rotor diameter or $3,500/kW of rated capacity at 11 m/s; maximum of $25,000; funded by ratepayers
New York (6)	Photovoltaics	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Institutional, (Must be customer of investor-owned utility in NY)	$1.75/watt DC; Incentive may be reduced for potential production losses associated with shading, system orientation, tilt angle, and other factors; rebate up to lesser 50% of costs or Residential: $13,750; Non-residential: $112,500; Non-profit, government schools: $56,250; funded by ratepayers
Oregon	Geothermal Heat Pumps	Commercial, Industrial, State Government, Agricultural, Institutional, Data Centers	$150-$4,000, varies by type and size; funded by utility ratepayers
Oregon (2)	Wind	Commercial, Residential, Nonprofit, Schools, Local Government, State Government	Rebate amount varies
Oregon (3)	Geothermal Heat Pumps	Residential	Heat Pumps: $200 - $450, depending on efficiency and previous heating system; funded by utility ratepayers
Oregon (4)	Geothermal Heat Pumps	Industrial, Agricultural, Manufacturing, Water/Wastewater Treatment	Rebate varies depending on technology; awarded per kilowatt-hour saved by project; funded by utility ratepayers
Oregon (5)	Solar Water Heat, Photovoltaics, Geothermal Heat Pumps	Residential, Builders, Contractors	Rebate for new homes; amount varies based on number of energy efficient measures installed; can range from $125 to $8,400; funded by utility ratepayers
Oregon (6)	Small Wind	Commercial, Residential, General Public/Consumer, Nonprofit, Local Government, State Government	Residential: Lesser of $4,500 per meter of rotor diameter, or $4,500 per kW-DC of the wind turbine up to $35,000 Commercial: Lesser of $3,750 per meter of rotor diameter, or $4,000 per kW-DC of the wind turbine up to $60,000; funded by utility ratepayers
Oregon (7)	Photovoltaics	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Agricultural, Institutional	Rebate depends on utility and customer class; maximum of Residential (Homeowner): $20,000 per site; Residential (Third Party): $5,000 - $10,000 per site; Commercial, Industrial, or Third Party (per-site lifetime cap for systems up to 200 kW): $100,000 - $600,000; Nonprofit, Go's: $150,000 - $200,000; funded by utility ratepayers
Oregon (8)	Solar Water Heat, Solar Pool Heating	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Agricultural, Institutional	Buy-down varies by sector, water heating fuel, and electric or gas provider; maximum of $1,500 for residential solar water heaters; $1,000 for residential pool heating; 35% of system cost for commercial
Pennsylvania	Solar Water Heat, Solar Space Heat, Photovoltaics	Commercial, Residential, Low-Income Residential, Agricultural	Residential PV: $1.75/W DC up to lesser of $17,500 or 35% of installed costs; Commercial PV: $0.25 - $0.75/W DC (varies by system size) up to lesser of $77,500 or 35% of installed costs; Solar Thermal: 25% of installed cost up to $2,000 for residential, $20,000 for commercial; Low-income (PV and solar thermal): 35% of installed cost; funding from state bonds
Vermont	Solar Water Heat, Photovoltaics, Wind, Micro-hydro	Commercial, Residential, Schools, Local Government, State Government, Multi-Family Residential, Low-Income Residential, Agricultural	PV: $1.75/W DC for individuals/businesses, schools, farms, government; $3.50/W DC for multi-family, low-income; Solar water heaters: $1.75 per 100 Btu/day for individuals and businesses, schools, farms, government; $3.50/100 Btu/day for multi-family, low-income; Wind: $2.50/watt - $4/watt for individuals or businesses, low-income multi-family; $4.50/watt DC if owned by schools, farms, or government entities; Micro-hydro: $1.75/3 ft-gal/min for individuals and businesses; $3.50/3ft-gal/min; maximums apply; funded by memoranda of understanding with Entergy Nuclear VT and Entergy Nuclear Operations, appropriations and ARRA
Wisconsin	Geothermal Heat Pumps, Daylighting	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Institutional	Rebate varies up to $350,000 per project; $750,000 per customer per year for all Focus on Energy incentives; funded by utility ratepayers
Wisconsin (2)	Geothermal Heat Pumps, Daylighting	Commercial, Industrial, Nonprofit, Schools, Local Government, Construction, State Government, Tribal Government, Fed. Government, Agricultural	Varies by equipment type; funded by utility ratepayers
Wisconsin (3)	Geothermal Heat Pumps	Residential, Multi-Family Residential	Varies by equipment type and whether new or existing, residential or multi-family residential; funded by utility ratepayers
Wisconsin (4)	Solar Water Heat, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Solar Pool Heating	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Multi-Family Residential, Agricultural, Institutional	Varies by technology and type of project; funded by utility ratepayers
Wyoming	Photovoltaics, Wind, Geothermal Heat Pumps, Photovoltaics as part of a hybrid system	Residential	PV and small wind: $2,000 per installed kW DC; Geothermal heat pumps: $2,000 per installed ton; funded up to $10,000 or 50% of project costs, whichever is less; funded by EXXON settlement and ARRA

Note: Some additional requirements or limits may apply. Many of these incentives also apply to energy efficiency. Includes state programs or state authorized programs only.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, "Database of State Incentives for Renewables & Efficiency--Financial Incentives for Renewable Energy."

TABLE A-3: FEDERAL AND STATE GRANT PROGRAMS FOR CLEAN ENERGY			
State	Technology	Sectors	Incentive
Federal	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Solar Hybrid Lighting, Hydrokinetic, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal, Microturbines	Commercial, Industrial, Agricultural	30% of property that is part of a qualified facility, qualified fuel cell property, solar property, or qualified small wind property; 10% of all other property up to $1,500 per 0.5 kW for qualified fuel cell property; $200 per kW for qualified microturbine property; 50 MW for CHP property, with limitations for large systems
Federal (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Renewable Transportation Fuels, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Hydrogen, Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal, Renewable Fuels, Fuel Cells using Renewable Fuels, Microturbines, Geothermal Direct-Use	Commercial, Schools, Local Government, State Government, Tribal Government, Rural Electric Cooperative, Agricultural, Public Power Entities	Grant amount varies up to 25% of project cost; funding of $70 million for FY 2011 and FY 2012
Federal (3)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps	Tribal Government	Grant amount varies
Alabama	Landfill Gas, Biomass, Municipal Solid Waste	Commercial, Industrial, Schools, Local Government, State Government, Agricultural	Grant up to $75,000 in interest subsidy payments to help defray the interest expense on loans to install approved biomass projects
Alaska	Solar Water Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, CHP/Cogeneration, Hydrothermal, Waste Heat, Transmission or Distribution Infrastructure, Anaerobic Digestion, Tidal Energy, Wave Energy, Geothermal Direct-Use	Commercial, Local Government, Utility, Tribal Government, Only Available for In-State Projects	Grant amount varies; assistance for feasibility studies, reconnaissance studies, energy resource monitoring, and work related to the design and construction of eligible facilities requires legislative approval; funded through legislative appropriations; $125 million in FY2009 and another $50 million in FY 2010
Colorado	Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Fuel Cells, Small Hydroelectric, Renewable Fuels, Other Distributed Generation Technologies	Commercial, Industrial, Residential	Grant amount varies; original funding from gaming and severance taxes; new funding from ARRA; $2 million available
Connecticut	Photovoltaics, Landfill Gas, Wind, Biomass, Fuel Cells, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Low-Income Residential, Institutional	Grant amount varies by technology up to $800,000 per project for PV projects (for non-profits); $4 million per project for other eligible projects, (Plus, for certain projects southwestern CT approved by 6/30/08, a production incentive of 2¢/kWh.); funding of $66.24 million through 2010
Delaware	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Renewable Fuel Vehicles, Geothermal Electric, Fuel Cells, Municipal Solid Waste, Hydrogen, Daylighting, Anaerobic Digestion, Renewable Fuels, Ethanol, Methanol, Biodiesel	Commercial, Institutional	Grant amount varies up to 35% cost of qualifying projects up to $250,000 per project for researching, developing or improving renewable energy technology
Delaware (2)	Passive Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Hydroelectric, Fuel Cells, Biodiesel Manufacturing Facilities, Storage, Conversion and Conditioning Equipment	Commercial, Institutional	Grant up to 25% of eligible equipment costs with maximum of $200,000 per general project and $3,000 (residential) or $20,000 (non-residential) for passive solar project that demonstrates the market potential for renewable technologies and accelerates the commercialization of these technologies
Illinois	Landfill Gas, Biomass, CHP/Cogeneration, Biogas (methane produced by livestock manure and waste, municipal waste water sludge, segregated organic wastes), Anaerobic Digestion, Other Distributed Generation Technologies	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Agricultural, Institutional, Other Association	Grant amount up to 50% of project cost Feasibility Studies: $2,500; Biogas to Energy Systems: $225,000; Biomass to Energy Systems: $500,000. Projects must be part of a combined heat and power system.
Indiana	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Municipal Solid Waste, CHP/Cogeneration, Anaerobic Digestion, Small Hydroelectric	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Agricultural, Institutional	Grant amount of 50% of project costs up to $100,000
Iowa	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Renewable Transportation Fuels, Municipal Solid Waste	Commercial, Industrial, Nonprofit, Transportation, Agricultural, Institutional	Grant amount varies; maximum based on available funds
Kentucky	Solar Water Heat, Biomass, Anaerobic Digestion	Agricultural	25% of project costs up to $10,000; funded by ARRA
Maine	Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Municipal Solid Waste, Tidal Energy	Nonprofit, Schools, Rural Electric Cooperative, Quasi-Municipal Corporations and Districts	Varies by project up to $50,000 for small-scale demonstration projects
Maryland	Photovoltaics	Local Government, State Government	$1,000 per kW DC; funded by ARRA; $6.2 million for FY 2010 and $2 million for FY 2011
Massachusetts	Solar Water Heat, Solar Space Heat, Wind, Biomass, Hydroelectric, CHP/Cogeneration, Other Distributed Generation Technologies	Local Government	Custom incentive, amount will vary up to $1 million
Massachusetts (2)	Wind	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional	Up to $260,000 for private and $400,000 for public entities (this is subject to change); 50% of energy must be used on site; 20% cost share for feasibility studies and 25% cost share for design and construction projects; no cost share required for public entities
Massachusetts (3)	Hydroelectric, Small Hydroelectric	Commercial, Industrial, Nonprofit, Local Government, State Government, Tribal Government, Fed. Government, Institutional	Design & Construction: 50% of costs up to $600,000; Feasibility study: 80% of costs up to $40,000
Massachusetts (4)	Wind	Commercial, Nonprofit, Local Government, Construction, State Government, Tribal Government, Fed. Government, Institutional	75% of eligible project costs up to $55,000
Michigan	Biomass, Renewable Transportation Fuels	Nonprofit, Schools, Local Government, State Government	Grant amount varies
Michigan (2)	Solar Water Heat, Photovoltaics, Wind, Fuel Cells, Anaerobic Digestion	Commercial, Nonprofit, Schools, Local Government, State Government	Grant amount varies
Minnesota	Solar Space Heat, Biodiesel	Low-Income Residential	Grant amount varies up to $4,700
Minnesota (2)	Solar Water Heat, Solar Space Heat, Photovoltaics	Local Government	$10,000 - $150,000 up to lesser of 75% of installed cost or $150,000; budgeted at $487,500 for FY 2010 and $585,000 for FY 2011
New Jersey	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Hydrogen, Other Low-Emission Advanced Renewables, Tidal Energy, Wave Energy, Ocean Thermal, Fuel Cells using Renewable Fuels	Commercial, Industrial	$100,000 - $500,000 up to $500,000; at least 50% matching funds required; funded at $6 million for 2009; subject to appropriations, $3 million annually in additional funding through 2012; funded by the New Jersey Societal Benefits Charge (SBC)
New York	Solar Water Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps	Low-Income Residential	General: up to 50% of costs up to $5,000 for single-homes, $10,000 per building for 2-4 family units; National Grid gas customers: up to 60% of costs up to $6,000 for single homes, $12,000 for 2-4 family units; funded by Systems Benefit Charge
New York (2)	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Fuel Cells, Geothermal Heat Pumps, Other Alternative Fuel Vehicles, Refueling Stations	Nonprofit, Schools, Local Government, Institutional	Grant amount 100% of project costs up to $1 million; funded by ARRA with $75 million beginning in 2009
North Carolina	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Heat Pumps, CHP/Cogeneration, Hydrogen, Renewable Energy Technologies, Tidal Energy, Wave Energy, Renewable Fuels, Other Distributed Generation Technologies	Commercial, Nonprofit, Local Government, State Government, Agricultural, Institutional	Grant amount varies up to $100,000; funded by appropriations and ARRA; funding increased from $950,000 to $5 million due to ARRA

TABLE A-3: FEDERAL AND STATE GRANT PROGRAMS FOR CLEAN ENERGY--CONT'D.

State	Technology	Sectors	Incentive
Ohio	Lighting, Lighting Controls/Sensors, Chillers , Furnaces , Boilers, Heat pumps, Central Air conditioners, CHP/Cogeneration, Compressed air, Energy Mgmt. Systems/Building Controls, Building Insulation, Windows, Motors, Motor-ASDs/VSDs, Comprehensive Measures/Whole Building, Custom/Others pending approval	Commercial, Industrial	Grant of 50% of project cost up to $250,000
Ohio (2)	Solar Water Heat, Solar Space Heat	Multi-Family Residential, Low-Income Residential	Market Rate Housing: $30/kBtu per day or 50% of cost Affordable Housing: $50/kBtu per day or 50% of cost Affordable LEED/Energy Star Housing: 50% of cost
Ohio (3)	Landfill Gas, Biomass, Fuel Cells, CHP/Cogeneration, Reciprocating Engines, Anaerobic Digestion, Microturbines, Other Distributed Generation Technologies	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Fed. Government, Agricultural, Institutional	25% of project cost up to $100,000
Ohio (4)	Solar Water Heat, Photovoltaics, Wind	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Agricultural, Institutional	Maximum grant for Non-residential Renewable Energy (traditional ownership): $150,000; Non-residential Renewable Energy (third-party ownership): $200,000
Ohio (5)	Photovoltaics	Residential	$3.00/Watt DC installed capacity up to $25,000 per residence
Ohio (6)	Wind	Residential	Lesser of $2/kWh (AC) of estimated annual system output or 50% of eligible cost up to $25,000
Oregon	Commercial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Institutional	Commercial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Institutional	Grants for feasibility studies; amount varies by project up to $50,000; funded by $1 million from settlement with Reliant Energy; must repay grant if project completes and becomes profitable
Oregon (2)	Biomass, Hydroelectric, Geothermal Electric, Wave Energy, Fuel Cells using Renewable Fuels	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Agricultural	Grant amount varies up to 50% of costs and usually under $40,000 total; used for grant writing, feasibility studies, or technical assistance with design, permitting, or utility interconnection; funded by Oregon public purpose customer charge
Pennsylvania	Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, MSW Must be Waste-to-Energy, Anaerobic Digestion, Small Hydroelectric, Renewable Fuels, Geothermal Direct-Use	Commercial, Industrial, Nonprofit, Schools, Local Government	Varies by project, but program generally requires matching funds at least equivalent to DCED funding; Manufacturer Loans: $35,000 per job created within 3 years; maximum grant-Manufacturer Grants: $10,000 per job created within 3 years; Grants for distribution projects: $2 million.
Pennsylvania (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Bio-gas, Daylighting, Small Hydroelectric	Commercial, Residential	Grant amount varies by project, but program generally requires matching funds at least equivalent to DCED funding with maximum lesser of 10% of project costs or $500,000; total funding $25 million
Pennsylvania (3)	Wind, Geothermal Electric, Geothermal Heat Pumps	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government	Varies by project, but program generally requires matching funds at least equivalent to DCED funding; maximum of Manufacturer Grants: $5,000 per job created within 3 years Grants for distribution projects: $1 million Grants for feasibility studies: 50% of cost up to $175,000
Pennsylvania (4)	Wind, Geothermal Electric, Geothermal Heat Pumps	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government	Varies by project, but program generally requires matching funds at least equivalent to DCED funding with maximum of Manufacturer Grants: $5,000 per job created within 3 years Grants for distribution projects: $1 million Grants for feasibility studies: 50% of cost up to $175,000
Pennsylvania (5)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Daylighting, Small Hydroelectric	Schools	Determined on a case-by-case basis but usually $25,000
Pennsylvania (6)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Renewable Transportation Fuels, Fuel Cells, Geothermal Heat Pumps, Coal-Mine Methane; Waste Coal, Anaerobic Digestion, Small Hydroelectric, Other Distributed Generation Technologies	Commercial, Industrial, Nonprofit, Schools, Local Government, Agricultural	$1.5 million per project, some cost-share required; offered $21 million in 2009
Pennsylvania (7)	Wind, Geothermal Heat Pumps	Commercial	Up to 50% of project costs with maximum incentive of $7,500
Pennsylvania (8)	Geothermal Heat Pumps	Commercial	25% of project cost up to $25,000; offered $3 million in 2009
Rhode Island	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal, Fuel Cells using Renewable Fuels	Commercial, Industrial, Nonprofit, Schools, Local Government, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional	Varies by project up to $750,000 (maximum varies by project type)
Tennessee	Geothermal Heat Pumps	Schools, (K-12)	Varies depending on efficiency measure installed; funding appropriated from Excess State Lottery Funds (2008); may raise other funds
Tennessee (2)	Solar Water Heat, Photovoltaics, Wind, Solar Hybrid Lighting, Fuel Cells using Renewable Fuels	Commercial, Industrial	Grant of 40% up to $75,000
Texas	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Anaerobic Digestion, Tidal Energy, Wave Energy, Geothermal Direct-Use	Local Government, Non-Entitlement Governments Only	Grant amount varies; maximum not specified; matching funds % is part of evaluation process; funded from Federal Community Development Block Grant; administered by Department of Rural Affairs
Texas (2)	Wind, Other Renewables (In Conjunction With Wind)	Local Government	Grant amount varies up to $1.5 million for project used to power a reverse osmosis or other desalination facility or be used to pump brackish groundwater for treatment; cities must be less than 50,000 and counties less than 200,000; administered by Department of Rural Affairs
Texas (3)		Governmental entities	Distributed Renewable Energy Technology Grant Program - competitive grant program funded at $52 million by ARRA; $31.4 million awarded to date
Vermont	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, CHP/Cogeneration, Anaerobic Digestion, Small Hydroelectric, Microturbines	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, Agricultural, Institutional	Grant amount varies; funding of $2.5 million; funding from memoranda of understanding with Entergy and from ARRA
Wisconsin	Biomass, (Feasibility studies only for wind and solar technologies), Anaerobic Digestion	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Agricultural, Institutional	Varies by technology and estimated energy production; Implementation Grants: Lesser of $250,000 or 25% of costs (except 35% for school or municipal biomass combustion); Feasibility Studies: Lesser of $10,000 or 50% of costs; Total: $750,000 aggregate for all incentives to any individual or business during each program year (Jan. 1, 2010 - Dec. 31, 2010); funding from utilities required to spend 1.2% of gross operating revenue on energy efficiency and renewable energy

Note: Some additional requirements or limits may apply. Many of these incentives also apply to energy efficiency. Includes state programs or state authorized programs only. Does not include public awareness/education grants.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, Database of State Incentives for Renewables & Efficiency, "Financial Incentives for Renewable Energy."

TABLE A-4: FEDERAL AND STATE CLEAN ENERGY LOAN PROGRAMS			
State	**Technology**	**Sectors**	**Incentive**
Federal	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Hydrokinetic Power, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Local Government, State Government, Tribal Government, Municipal Utility, Rural Electric Cooperative	Clean Renewable Energy Bonds of $2.4 billion allocated as of 2009
Federal (2)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Hydrokinetic Power, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Local Government, State Government, Tribal Government	Qualified Renewable Energy Bonds allocated by state and local government population; $3.2 billion allocated as of 2009
Federal (3)	Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Hydroelectric, Geothermal Electric, Fuel Cells, Daylighting, Tidal Energy, Wave Energy, Ocean Thermal, Biodiesel	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Agricultural, Institutional, Any non-federal entity, Manufacturing Facilities	Loan guarantee amount varies; program focuses on projects with total project costs over $25 million; full repayment is required over a period not to exceed the lesser of 30 years or 90% of the projected useful life of the physical asset to be financed
Federal (4)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Renewable Transportation Fuels, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Hydrogen, Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal, Renewable Fuels, Fuel Cells using Renewable Fuels, Microturbines, Geothermal Direct-Use	Commercial, Agricultural	Loan guarantee amount varies up to $25 million per loan guarantee
Federal (5)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Daylighting	Residential	Federal Housing Authority and Veterans Administration insures portion of mortgages involving renewable technologies and energy efficiency
Alabama	Passive Solar Space Heat, Solar Water Heat, Photovoltaics, Wind, Biomass, CHP/Cogeneration, Daylighting, Small Hydroelectric, Other Distributed Generation Technologies	Schools, Local Government	Zero interest loans up to $500,000 for 10 years (paid back through utility cost savings) from State Revolving Loan Fund
Alaska	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Municipal Solid Waste	Local Government, Municipal Utility, Independent Power Producers	Varies depending on funding
California	Locally determined	Commercial, Industrial, Residential, Multi-Family Residential, Agricultural	PACE program for counties, cities and areas within cities at locally determined amounts, rates and terms using bonds, local government funds and third-party lenders
California (2)	CHP/Cogeneration, Other Distributed Generation Technologies	Schools, Local Government, Public Hospitals	Low-interest (1% or 3%) loan of lesser of 100% of project costs or $3 million for 15 years from original $20 million appropriation and $25 million ARRA funds
Colorado	Solar Water Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, Daylighting, Small Hydroelectric, Ethanol, Biodiesel, Fuel Cells using Renewable Fuels	Commercial, Industrial, Residential, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional	PACE program locally determined incentive for counties, cities and towns from bonds
Connecticut	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps	Residential, Multi-Family Residential	Loans of $400 - $25,000 (one- to four-family units); $2,000 - $60,000 (multi-family of five or more units) at 1%, 3% or 6% interest up to 10 years
Connecticut (2)	Photovoltaics, Wind, Fuel Cells, CHP/Cogeneration	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Fed. Government, Agricultural, Institutional	Loan amount varies; interest rate not to exceed prime rate; total loan portfolio not to exceed aggregate funding of $150 million
Florida	Locally determined	Commercial, Residential	PACE program locally determined incentive for municipalities and counties through bonds
Hawaii	Locally determined	Commercial, Residential	PACE program locally determined incentive for counties through bond issuance
Hawaii (2)	Photovoltaics, Wind, Biomass, Hydroelectric, Ethanol, Biodiesel	Agricultural, Aquacultural	Loan of 85% of the project cost up to $1,500,000 with 3% interest rate for agriculture and 5% interest rate for aquaculture greater than the state's interest cost, with up to 40-year term using existing revolving loan funds
Idaho	Solar Water Heat, Solar Space Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Heat Pumps, CHP/Cogeneration, Geothermal Direct-Use	Commercial, Residential, Schools, Local Government, State Government, Agricultural, Institutional, Hospitals	Residential: $1,000 to $15,000 Commercial: $1,000 to $100,000 Agricultural: Up to $100,000 Renewable Loans: Up to $100,000 Schools, Hospitals, Healthcare Facilities: Up to $100,000 At 4% interest with 5-year term
Illinois	Locally determined	Commercial, Industrial, Residential, Agricultural, Property Owners	PACE program locally determined incentive for cities, villages and incorporated towns through locally determined funding source
Indiana	Solar Water Heat, Geothermal Heat Pumps	Residential	$2,000 - $10,000 with rate of 6% up to 72 months
Iowa	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric	Commercial, Industrial, Residential, Utility	Loan of 50% of financed project cost up to $1,000,000 for most applicants, but $500,000 for non-rate regulated gas and electric utilities at 0% interest for up to 20 years funded from $5.9 million from investor-owned utilities and $5 million from sale of bonds
Iowa (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Renewable Transportation Fuels, Geothermal Heat Pumps	Nonprofit, Schools, Local Government, State Government, Institutional	Loan and terms vary by project; funding from oil overcharge funds, appropriations and technical assistance fees
Kansas	Photovoltaics, Wind, Other Distributed Generation Technologies	Commercial, Residential, Multi-Family Residential	Revolving loan program Residential Projects: $20,000 maximum loan Commercial and Industrial Projects: $30,000 maximum loan (up to 15 years and up to 4% interest rate); funding from ARRA
Kansas (2)	Solar Water Heat, Solar Thermal Electric, Photovoltaics, Wind	Commercial, Industrial	State may provide up to $5 million in financing to a solar or wind research, development, engineering or manufacturing project with investment of at least $30 million; bond retired from payroll tax withholding on new jobs created
Kentucky	Solar Water Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Anaerobic Digestion	State Government	Minimum $50,000 low-interest loan; $14.2 million funding from ARRA
Louisiana	Solar Water Heat, Solar Space Heat, Photovoltaics, Geothermal Heat Pumps	Residential	Loan for 50% of costs up to $6,000 up to 5 years as a consumer loan or second mortgage
Maine	Solar Water Heat, Solar Space Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Heat Pumps, * Pending rules by Efficiency Maine Trust, Geothermal Direct-Use	Commercial, Industrial, Residential, Property Owners	PACE program for municipalities funded from Grants, federal Qualified Energy Conservation Bonds, federal Clean Renewable Energy Bonds; financing to be determined by Efficiency Maine Trust
Maryland	Solar Water Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Municipal Solid Waste, Anaerobic Digestion, Tidal Energy, Geothermal Direct-Use	Nonprofit, Schools, Local Government, Hospitals	$300,000 per loan through March 1, 2010; larger projects may be considered a case-by-case basis after this date; Current average interest rate is 2%; payback of 10 years or less; financing from state appropriations of $1.5 million per fiscal year; 20% reserved for non-profits through March 1, 2010
Maryland (2)	Locally determined	Commercial, Residential, Low-Income Residential	PACE program for counties, municipal corporations; maximum financing amount locally determined; financing from bonds
Maryland (3)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Solar Pool Heating, Daylighting	State Government	Revolving loan program with 0% interest; 1% administrative fee; financing from Oil Overcharge Restitution Trust funds, Regional Greenhouse Gas Initiative proceeds
Maryland (4)	Specific technologies not identified	Commercial, Industrial	Loan amount varies; financing from ARRA
Massachusetts	Wind	Commercial, Nonprofit, Local Government, Construction, State Government, Tribal Government, Fed. Government, Institutional	75% of eligible project costs up to $250,000 for unsecured loan at prime plus 2% and funded by the Massachusetts Renewable Energy Trust at $39 million from FY09-FY13
Minnesota	Solar Water Heat, Photovoltaics, Wind, Geothermal Electric, Geothermal Heat Pumps, Geothermal Direct-Use	Commercial, Industrial, Residential, Multi-Family Residential	PACE program for cities, counties and towns for loan term that may not exceed the lesser of the weighted average of the useful life of improvements or 20 years; interest rates locally determined, but must be sufficient to cover program costs and financed by bond issuance, other unspecified

TABLE A-4: FEDERAL AND STATE CLEAN ENERGY LOAN PROGRAMS--CONT'D.			
State	**Technology**	**Sectors**	**Incentive**
Minnesota (2)	Wind, Biomass, Anaerobic Digestion	Agricultural	Rural Finance Authority provides up to 45% of loan; provides up to $300,000 of loan principal; maximum term of 10 years; interest rate of 4.5% as of September 2009
Minnesota (3)	Biomass, Anaerobic Digestion	Agricultural	Rural Finance Authority participation limited to 45% of loan principal; RFA can provide up to $250,000 of loan principal; 10 year maximum loan term; RFA portion at zero-interest
Minnesota (4)	Solar Water Heat, Photovoltaics, Geothermal Heat Pumps	Residential	Loan amounts vary by project up to $35,000 ($2,000 minimum); loan terms from 1 - 20 years at a fixed rate of 5.75%; maximum household income of $96,500; financed by the Minnesota Housing and Finance Agency (MHFA)
Minnesota (5)	Wind, Biomass, Solar-powered equipment; other on-farm energy production	Agricultural, Farms Only	Loan amount varies up to $40,000 per farm family ($160,000 for joint projects); fixed interest rate (currently 3%) for up to 7 years; financing from the Sustainable Agriculture Revolving Loan Fund
Minnesota (6)	Photovoltaics, Wind, Biomass, Anaerobic Digestion	Agricultural	Rural Finance Authority provides up to 45% of loan; RFA provides up to $40,000 of loan principal; maximum term of eight years; RFA portion at lesser of 4% or half of lender's effective rate for the non-RFA portion
Mississippi	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, CHP/Cogeneration	Commercial, Industrial	Loans of $15,000 - $300,000 at 3% below prime rate; 7-year repayment term; financing from Oil overcharge restitution funds from the U.S. Department of Energy
Missouri	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass	Schools, Local Government, Institutional	Loan varies by project up to $1 million; 0% interest, 1% loan origination fee; Terms of up to 10 years; financed from Petroleum Violation Escrow (PVE) Funds of $10 million for 2010
Montana	Solar Water Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Heat Pumps, Small Hydroelectric, Fuel Cells using Renewable Fuels, Geothermal Direct-Use	Commercial, Residential, Nonprofit, Schools, Local Government	Loan amount varies up to $40,000 for up to 10 years; 4.0% interest rate for 2010; Revolving Loan Fund is financed by air quality penalties
Nebraska	Solar Water Heat, Solar Space Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Municipal Solid Waste, Skylights	Commercial, Residential, Nonprofit, Local Government, Multi-Family Residential, Agricultural	Loan amount varies--Residential: $35,000 - $75,000; Non-Residential: $75,000 - $175,000; Maximum payback term is 15 years for building improvements and 10 years for all other projects; financing from $95 million in Oil Overcharge Funds; ARRA; Total $194 million; program buys half the loan at 0% interest making the loan's total interest at half the market rate
Nevada	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Solar Pool Heating, Small Hydroelectric	Commercial, Industrial, Residential, Multi-Family Reside	PACE program for cities, counties, towns
New Hampshire	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Not specified, Other Distributed Generation Technologies	Commercial, Nonprofit	Typical loans will range from $10,000 to $500,000; maximum not specified; for-profit commercial businesses rates vary between 2.75% to 4% depending on the length of the loan (3 to 10 years); for non-profit entities terms are customized based on need, but in general 2% to 2.5% loans for between 3 to 10 years are available; financing from The American Recovery and Reinvestment Act (ARRA) and State Energy Program (SEP) budget of $3.5 million
New Hampshire (2)	Not specified, Other Distributed Generation Technologies	Local Government	Loans not specified; flexible terms, structured out of energy savings; financing from Greenhouse Gas Emissions Reduction Fund (RGGI) at $1.5 million
New Hampshire (3)	Solar Water Heat, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Other Distributed Generation Technologies	Commercial	$10,000 minimum; maximum term of seven years; interest rate is prime rate minus 1% (floating)
New Jersey	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Resource-Recovery Facilities approved by the DEP, Anaerobic Digestion, Tidal Energy, Wave Energy, Fuel Cells using Renewable Fuels	Commercial, Industrial, Institutional	Loans vary up to $5 million, a portion of which may be issued as a grant; Grants: lesser of 80% of the amount requested or $2.5 million; 20% of amount requested for commercial building energy efficiency projects; Minimum of 50% of project costs must be covered by project sponsor(s) (includes federal funding); aggregate state public funding may not exceed 50% of project cost; 0% interest for term of up to 10 years; amortization up to 20 years; Projects that intend to utilize Solar Renewable Energy Certificates (SRECs) are only eligible to receive an interest-free loan; financing from Global Warming Solutions Fund at $25.7 million
New Jersey (2)	Geothermal Heat Pumps	Residential, Low-Income Residential	For Energy Savings between 5% and 25%: generally 10% rebate up to $2,000 or loan at 5.99%; income qualified 50% rebate up to $10,000 and 0% interest loan Energy Savings greater than 25%: generally 50% rebate up to $10,000 and loan at 0%; income qualified 75% rebate up to $10,000 and 0% interest loan Loans: $20,000 (5.99% interest); $10,000 (0% interest); minimum loan of $2,500; loans have a fixed interest rate for 3, 5, 7 or 10 years; rate varies based on project energy savings; financing from Societal Benefits Charge (supplemented with ARRA funds); $23.6 million (2009), not including ARRA funds
New Mexico	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Geothermal Electric, Geothermal Heat Pumps, Others (determined locally)	Commercial, Residential	PACE program for Renewable Energy Financing District: Counties, Cities, Towns, Villages; Solar Energy Improvement Special Assessments: Counties; Financing terms determined locally; Possible revenue sources: Renewable Energy Financing District: bonds, other; Solar Energy Improvement Special Assessments: private financial institutions
New York	Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Anaerobic Digestion, Geothermal Direct-Use	Commercial, Industrial, Residential, Nonprofit, Multi-Family Residential, Agricultural, Institutional	PACE program for counties, towns, cities and villages; loan amounts may not exceed 10% of the appraised real property value or cost of the qualified improvements; other terms locally determined; funding from Federal grants or credit support mechanisms
New York (2)	Solar Water Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps	Residential	Loans up to 100% of costs; $2,500 - $20,000 up to $15,000 or $20,000, depending on applicant's credit score; 5.99% APR; fixed loan terms of 3, 5, 7 and 10 years; Unsecured loan; funded from System Benefits Charge/state subsidizes interest rate
New York (3)	Solar Water Heat, Biomass, Geothermal Heat Pumps	Residential	Loan up to $20,000 generally; except $30,000 for ConEd customers; Up to 4.0% below the lender rate for ten years; rate adjusted to maintain a floor interest rate of 3.0%; funded from System Benefits Charge (SBC)
North Carolina	Locally determined	Commercial, Industrial, Residential, Multi-Family Residential, Low-Income Residential, Agricultural	PACE program for cities and counties; terms locally determined; financed from revenue bonds, general obligation bonds, general revenues
North Carolina (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, CHP/Cogeneration, Hydrogen, Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy	Commercial, Residential, General Public/Consumer	Allows cities and counties to set up revolving loan funds; loan amount not specified; interest rate can be no more than 8%; term can be no longer than 15 years; financing from Energy Efficiency and Conservation Block Grants from the federal government and the city's or county's unrestricted revenue
North Carolina (3)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric	Commercial, Industrial, Nonprofit, Schools, Local Government	`

TABLE A-4: FEDERAL AND STATE CLEAN ENERGY LOAN PROGRAMS--CONT'D.			
State	**Technology**	**Sectors**	**Incentive**
Ohio	Solar Water Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics	Commercial, Industrial, Residential, Multi-Family Residential, Low-Income Residential, Agricultural	PACE program for municipal corporations, townships to offer low-interest, 25-year loan using special obligation revenue bonds, state or federal grants
Ohio (2)	Solar Water Heat, Photovoltaics, Wind, Geothermal Heat Pumps	Residential	Provides a 3% rate reduction on a 5-year bank loan; Rate reduction only applies to first $25,000 and 5 years of the bank loan Interest earned from 2-year Ohio Treasury Certificate of Deposit at participating ECO-Link bank (similar to Linked Deposit programs); terms vary by bank
Oklahoma	Locally determined	Commercial, Industrial, Residential, Multi-Family Residential, Special Improvement District, Local Improvement District	PACE Loan for cities and counties; financing terms are locally determined; funding from bonds, loans from Oregon Department of Energy
Oklahoma (2)	Solar Water Heat, Photovoltaics	Commercial, Residential, Multi-Family Residential	Loan amount varies, depending on type of loan: Residential: $1,000 - $50,000; Small Business: $5,000 - $100,000; Financing terms vary, depending on type of loan
Oklahoma (3)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Small Hydroelectric, Renewable Fuels, Geothermal	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Rural Electric Cooperative	Loan amount typically $20,000 - $20 million; terms vary, generally in the range of 5 to15 years. The loan term must be within the expected life of the project; loan is funded from sale of bonds
Oklahoma (4)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind	Institutes of Higher Education	Loan varies up to $300,000; 1 to 6 year terms at 3% interest rate; financing through $1.1 million in oil overcharge restitution funds
Oregon	Locally determined	Commercial, Industrial, Residential, Multi-Family Residential, Special Improvement District, Local Improvement District	PACE program for cities and counties with locally determined financing terms from Bonds, loans from Oregon DOE
Oregon (2)	Solar Water Heat, Photovoltaics	Commercial, Residential, Multi-Family Residential	Loan amount varies, depending on type of loan; Residential: $1,000 - $50,000; Small Business: $5,000 - $100,000; Financing term varies, depending on type of loan; no loan fees, no closing costs, and offer preferred rates
Oregon (3)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Small Hydroelectric, Renewable Fuels, Geothermal Direct-Use	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Rural Electric Cooperative	Loans are typically $20,000 - $20 million; Financing terms vary -- generally in the range of 5 to 15 years. The loan term must be within the expected life of the project; $442 million to date
Pennsylvania	Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, MSW Must be Waste-to-Energy, Anaerobic Digestion, Small Hydroelectric, Renewable Fuels, Geothermal Direct-Use	Commercial, Industrial, Nonprofit, Schools, Local Government	Loan amount varies by project, but program generally requires matching funds at least equivalent to DCED funding; Manufacturer Loans: $35,000 per job created within 3 years; Manufacturer Grants: $10,000 per job created within 3 years; Loans for distribution projects: $5 million; Grants for distribution projects: $2 million; Grants for Energy Savings Contracts (ESCO): $500,000
			Loan guarantee grants: Up to 75% of deficient funds up to $5 million; Fixed-rate loan (5% as of August 2009) to be repaid within 10 years; loans may be amortized over the life of the equipment, not to exceed 25 years; funding of $165 million from Alternative Energy Investment Fund (state issued bonds)
Pennsylvania (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Bio-gas, Daylighting	Commercial, Residential	Loan amounts vary by project, but program generally requires matching funds at least equivalent to DCED funding: Residential loans/loan guarantees: $100,000;
			Commercial loans/loan guarantees: $2 million; Grants: Lesser of 10% of project costs or $500,000; Loans at a fixed interest rate -- 4% as of August 2009 -- for up to 10 years; loans may be amortized over a period of up to 25 years; Funding from Alternative Energy Investment Fund (state issued bonds) with $25 million
Pennsylvania (3)	Solar Water Heat, Solar Thermal Process Heat, Photovoltaics	Commercial, Industrial, Nonprofit, Schools, Local Government	Loan varies by project, but program generally requires matching funds at least equivalent to DCED funding; Manufacturer loans: $35,000 per job created within 3 years; Manufacturer grants: $5,000 per job created within 3 years; Loans for distribution projects: Lesser of $5 million or $2.25/watt; Loans for solar thermal projects or R&D facilities: $5 million; Grants for distribution projects: Lesser of $1 million or $2.25/watt; Grants for solar thermal projects or R&D facilities: $1 million; Grants for feasibility studies: 50% of cost up to $175,000; Loan guarantee grants: Up to 75% of deficient funds up to $30 million; Loans at a fixed interest rate--5% as of August 2009--up to 10 years (equipment) or 15 years (real estate); Loan guarantee grants have a maximum term of 5 years; Alternative Energy Investment Fund (state issued bonds) $80 million
Pennsylvania (4)	Wind, Geothermal Electric, Geothermal Heat Pumps	Commercial, Industrial, Residential, Nonprofit, Schools, Local Government	Loan varies by project, but program generally requires matching funds at least equivalent to DCED funding with maximum of: Manufacturer Loans: $35,000 per job created within 3 years; Manufacturer Grants: $5,000 per job created within 3 years; Loans for distribution projects: $5 million; Grants for distribution projects: $1 million; Grants for feasibility studies: 50% of cost up to $175,000
			Loan guarantee grants: Up to 75% of deficient funds up to $5 million; Loans at a fixed interest rate (5% as of August 2009) up to 10 years (equipment) or 15 years (real estate); Loan guarantee grants have a maximum term of 5 years; Alternative Energy Investment Fund (state issued bonds); funding of $25 million
Pennsylvania (5)	Biomass, Geothermal Heat Pumps, "Alternative Energy Heating and Cooling Equipment Systems" (Excluding Solar)	Residential, Low-Income Residential	Loan of $1,000 - $35,000 (varies by loan type); 1 - 10 years term (varies by loan type) and funding of $17 million
Pennsylvania (6)	Not specified, but must meet general project eligibility criteria	Commercial, (no more than 100 full-time employees)	Loan Up to 75% of total eligible project cost up to $100,000 with 2% fixed interest; Maximum loan term of 10 years
Rhode Island	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal, Fuel Cells using Renewable Fuels	Commercial, Industrial, Nonprofit, Schools, Local Government, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional	Loan amount varies by project up to $750,000 (varies by project type); financing from Rhode Island Renewable Energy Fund (RIREF); financed $3 million in 2009
South Carolina	Photovoltaics, Biomass, Geothermal Heat Pumps, Other Renewables	Nonprofit, Schools, Local Government, State Government, Institutional	Loan of 100% of eligible project costs, from $25,000 to $500,000 with fixed annual rate set below Wall Street Journal prime rate; ten-year term
Tennessee	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric	Commercial, Industrial	Loan varies by project up to a maximum yet to be determined; terms yet to be determined; financed from Oil Overcharge Restitution Funds
Tennessee (2)	Geothermal Heat Pumps	Schools, (K-12)	Loan of $66/student at 3% interest for 7 years appropriated from $90 million from Excess State Lottery Funds (2008); Council may raise other funds
Texas	Decided by locally determined municipal official	Commercial, Industrial, Residential, Multi-Family Residential, Agricultural, Real Property	PACE program for municipalities with terms locally determined and funded by bonds, municipal funds
Texas (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Geothermal Heat Pumps	Schools, Local Government, State Government, Hospitals	Loan varies with maximum at $5 million and current interest rates are 3% APR. Loans repaid through energy cost savings. Projects must have an average payback of 10 years or less; funding through Petroleum Violation Escrow Funds of $98.6 million
Texas (3)	Rooftop Solar Water, Solar Space Heat, Geothermal Heat Pumps, Photovoltaics, Small Wind, Solar Thermal	Governmental Entities	Loans up to $10 million at 2% interest

TABLE A-4: FEDERAL AND STATE CLEAN ENERGY LOAN PROGRAMS--CONT'D.			
State	**Technology**	**Sectors**	**Incentive**
Vermont	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Daylighting, Small Hydroelectric	Commercial, Industrial, Residential, Multi-Family Residential, Low-Income Residential, Agricultural, Institutional	PACE program for cities, towns and incorporated villages for financing that may not exceed 15% of assessed property value; combined amount of assessment and outstanding mortgages may not exceed 90% of assessed property value. In the case of an agreement with the resident owner of a dwelling, the maximum amount to be repaid for the project shall not exceed $30,000 or 15%, whichever is less; funding by bonds, payments collected for reserve fund
Vermont (2)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Fuel Cells, Geothermal Heat Pumps, CHP/Cogeneration, Anaerobic Digestion	Commercial, Residential, Nonprofit, Local Government	$50,000 - $500,000 with 2% interest rate; loan terms vary depending on project type; funding from Clean Energy Development Fund (CEDF) The American Recovery and Reinvestment Act (ARRA) FY 2010-2011
Virginia	Locally determined by ordinance	Commercial, Residential, Construction, Institutional	PACE program for Locally determined for any political subdivision authorized to levy fees or taxes with funding from Independent lending institutions, other revenue sources determined by local governments
Wisconsin	Locally determined	Residential	PACE program for local subdivisions with financing locally determined
Wisconsin (2)	Geothermal Heat Pumps	Residential	Loans of up to 100% of installation costs from $2,500 - $10,000 for unsecured loans with fixed interest rate of 9.99% for terms of 3, 5, 7, or 10 years with funding from Focus on Energy

Note: Additional requirements or limits may apply. Many of these incentives also apply to energy efficiency. Includes state programs or state authorized programs only.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, Database of State Incentives for Renewables & Efficiency, "Loan Programs for Renewable Energy."

A-5: FEDERAL AND STATE PRODUCTION AWARDS FOR CLEAN ENERGY			
State	**Technology**	**Sectors**	**Incentive**
Federal	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Local Government, State Government, Tribal Government, Municipal Utility, Rural Electric Cooperative, Native Corporations	Renewable Energy Production Incentive pays 2.1¢/kWh (subject to availability of annual appropriations in each federal fiscal year of operation) for 10 years; subject to availability of annual appropriations in each federal fiscal year of operation
California	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Municipal Solid Waste, Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal, Biodiesel, Fuel Cells using Renewable Fuels	Commercial, Industrial, Residential	Feed-in tariff based on market price adjusted by time-of-use, but participation in other incentive programs disallowed
Hawaii	Solar Thermal Electric, Photovoltaics, Wind, Hydroelectric, Small Hydroelectric	Commercial, Industrial, Residential	Feed-in tariff not yet determined
Maine	40	Commercial, Residential, Nonprofit, Schools, Local Government, State Government, Tribal Government, Institutional	Choice of either 1.5 REC credit multiplier; or
			Small projects (1 MW DC or less): the lower of $0.10/kWh or project cost for solar, wind, hydro projects; to be determined on a case-by-case basis for other eligible renewable energy projects; Large projects (over 1 MW DC): Depends on the result of the bid process
Minnesota	Biomass, Hydroelectric, Anaerobic Digestion	Commercial, Residential, Nonprofit, Tribal Councils	1.0¢-1.5¢/kWh
			Other undetermined incentive for on farm biogas *not* used to produce electricity
Oregon	Photovoltaics	Commercial, Industrial, Residential	Feed-in tariff not yet determined
South Carolina	Landfill Gas, Biomass, CHP/Cogeneration, Anaerobic Digestion	Commercial, Industrial, Agricultural	$0.01 per kWh / $0.30 per therm up to $100,000 per taxpayer and aggregate limit of $2.1 million per fiscal year
Vermont	Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Municipal Solid Waste, Anaerobic Digestion, Small Hydroelectric	Commercial, Industrial, Agricultural, Owners of Qualified SPEED Resources	Feed-in tariff of Solar: $240/MWh; Hydro: $122.6/MWh; Agricultural Methane: $141.1/MWh; Landfill Methane: $90/MWh; Wind> 100 kW: $118.2/MWh; Wind< 100 kW: $214.8 MWh; Biomass: $125.0/MWh
Washington	Solar Thermal Electric, Photovoltaics, Wind, Anaerobic Digestion	Commercial, Residential, Nonprofit, Local Government, Utility	$0.12/kWh - $1.08/kWh through 6/30/2020, depending on project type, technology type and where equipment was manufactured up to $5,000/year

Note: Some additional limits may apply. Many of these incentives also apply to energy efficiency. Includes state programs or state authorized programs only. Does not include incentives related solely to Renewable Energy Credits.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, Database of State Incentives for Renewables & Efficiency, "Financial Incentives for Renewable Energy."

TABLE A-68: STATE AND FEDERAL RECRUITMENT INCENTIVES FOR CLEAN ENERGY DEVELOPMENT

State	Technology	Sectors	Incentive
Federal	Solar Water Heat, Solar Thermal Electric, Photovoltaics, Wind, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Batteries and Energy Storage; Advanced Transmission Technologies that Support Renewable Energy Generation; , Renewable Fuels, Fuel Cells using Renewable Fuels, Microturbines	Commercial, Industrial, Manufacturing	30% of qualified investment; total amount of credits to be allocated not to exceed $2.3 billion
Arizona	Solar Water Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Solar Pool Heating, Anaerobic Digestion, Small Hydroelectric, Fuel Cells using Renewable Fuels	Commercial, Industrial	Amount of income or property tax credit varies, based on quantity and salaries of jobs created; no individual limit; the aggregate amount of income tax credits that may be approved state-wide is $70 million per taxable year.
California	Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Small Hydroelectric, Other Distributed Generation Technologies, Geothermal Direct-Use	Industrial	100% sales and use tax exemption for purchase of renewable energy equipment
Connecticut	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Fuel Cells, CHP/Cogeneration, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal, Other Distributed Generation Technologies	Commercial	Unsecured loan of up to $750,000 for demonstration projects; total of $4 million available
Connecticut (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Solar Pool Heating, Daylighting, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Commercial	Grants of up to $10,000; funded from oil overcharge restitution
Hawaii	Solar Thermal Electric, Photovoltaics, CHP/Cogeneration	Industrial, Installer/Contractor	Tax refund of up to $9,000 per new job created; must be a new-to-market or expanding Photovoltaic or Solar Thermal Manufacturer, Installation, and/or Repair Company in program area
Kansas	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Wave Energy, Ocean Thermal	Industrial	Tax credit of 100% up to $2,000,000 (over five years)
Maryland	Specific technologies not identified	Commercial, Industrial	Grant and loan amount not specified; $7 million total available
Massachusetts	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste	Commercial	Corporate excise tax deduction for any income -- including royalty income -- received from the sale or lease of a U.S. patent for alternative energy development and any income received from the sale or lease of personal or real property or materials manufactured in Massachusetts and subject to the approved patent
Massachusetts (2)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste	General Public/Consumer	Personal income tax deduction of 100% for any income received from the sale of a patent or royalty income from a patent deemed beneficial for alternative energy development.
Massachusetts (3)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Fuel Cells, Municipal Solid Waste, Power inverters, other related equipment, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Commercial, Industrial	Convertible loans up to $500,000 per company per 12-month period for companies in initial stage of development; $4.9 million has been invested
Michigan	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Renewable Transportation Fuels, Renewable Fuel Vehicles, Fuel Cells, CHP/Cogeneration, Miniturbines, Stirling Engines, Hybrid Vehicles, Batteries, Storage, Thermoelectric Energy, Solar Pool Heating, Anaerobic Digestion, Renewable Fuels, Microturbines	Commercial, Industrial	Nonrefundable tax credit from the states' business tax for businesses engaged in renewable energy research, development and manufacturing
Michigan (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Fuel Cells, CHP/Cogeneration, Miniturbines, Stirling Engines, Hybrid Vehicles, Batteries, Storage, Thermoelectric Energy, Solar Pool Heating, Anaerobic Digestion, Renewable Fuels, Microturbines	Commercial, Industrial	Payroll tax credit for businesses engaged in renewable energy research, development or manufacturing located in the NextEnergy Zone equal to their qualified payroll amount multiplied by their income tax rate for that year
Michigan (3)	Photovoltaics	Industrial	Tax credit of 25% against the Michigan Business Tax of the capital costs for building a qualifying PV manufacturing facility up to generally $15 million, but one certificate may be for up to $25 million. Total credits issued for all years may not exceed $75 million.
Michigan (4)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Solar Pool Heating, Anaerobic Digestion, Renewable Fuels	Commercial, Industrial, Local Government	Facilities within a state-designated Renewable Energy Renaissance Zones do not pay the Michigan Business Tax, state education tax, personal and real property taxes, or local income taxes (where applicable)
Montana	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Small Hydroelectric, Fuel Cells using Renewable Fuels	Commercial, Industrial	35% tax credit against individual or corporate income tax
Montana (2)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Municipal Solid Waste, CHP/Cogeneration, Hydrogen, Solar Pool Heating, Anaerobic Digestion, Fuel Cells using Renewable Fuels	Commercial, Industrial, Manufacturers	50% property tax abatement
New Jersey	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Balance of System Components, Anaerobic Digestion, Tidal Energy, Wave Energy, Fuel Cells using Renewable Fuels	Commercial, Industrial	Total (grants and loans): $3.3 million; grants: $300,000; loans: $3 million; 50% cost share required; loans at 0% interest for up to 10 years with three year deferral of principal repayment
New Mexico	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Fuel Cells, Municipal Solid Waste, Batteries, Hybrid Electric Vehicles, Electric Vehicles, Anaerobic Digestion, Fuel Cells using Renewable Fuels	Commercial, Industrial	Manufacturers' tax credit of up to 5% of taxpayer's qualified expenditures
New York	Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Fuel Cells, All Types of Renewable Electricity Generation, Energy Storage, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Commercial, Industrial	Grants up to $200,000; 50% cost share; funded by System Benefits Charge
New York (2)	Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Fuel Cells, Electric Storage Products for Grid-Connected Applications, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal	Commercial, Industrial	Grants vary up to: Facility and Site Characterization: lesser of 5% of project or $75,000 (50% cost share); Pre-production Development: lesser of 20% of project or $300,000 (50% cost share); Production Incentive Payment: up to $1,125,000, paid based on 25% of New York content of product sales over 5 years (75% cost share); Total: $1.5 million per project; funded by New York System Benefits Charge
Ohio	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, CHP/Cogeneration, Advanced Solid Waste, Electricity Storage, Advanced Nuclear, Anaerobic Digestion	Commercial, Industrial, Nonprofit, Local Government, State Government, Tribal Government, Fed. Government, Institutional	Grants of $50,000 to $2 million for advanced energy technology targeted to commercialization and production; funded by bonds
Oklahoma	Wind	Industrial	Income tax credit based on square footage of rotor swept area: $25.00/ft^2 for 2005 through 2012
Oregon	Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Geothermal Heat Pumps, Solar Pool Heating, Small Hydroelectric, Tidal Energy, Wave Energy	Commercial, Industrial	50% of eligible construction costs for a facility that will manufacture renewable energy systems, and includes the costs of the building, excavation, machinery and equipment costs (10% per year for 5 years) up to $20 million

TABLE A-6: STATE AND FEDERAL RECRUITMENT INCENTIVES FOR CLEAN ENERGY DEVELOPMENT--CONT'D.			
Pennsylvania	Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, MSW Must be Waste-to-Energy, Anaerobic Digestion, Small Hydroelectric, Renewable Fuels, Geothermal Direct-Use	Commercial, Industrial, Nonprofit, Schools, Local Government	Varies by project, but program generally requires matching funds at least equivalent to funding; Manufacturer Loans: $35,000 per job created within 3 years; Manufacturer grants: $10,000 per job created within 3 years; Loans for distribution projects: $5 million; Grants for distribution projects: $2 million; Grants for Energy Savings Contracts (ESCO): $500,000; Loan guarantee grants: Up to 75% of deficient funds up to $5 million
Pennsylvania (2)	Solar Water Heat, Solar Thermal Process Heat, Photovoltaics	Commercial, Industrial, Nonprofit, Schools, Local Government	Varies by project, but program generally requires matching funds at least equivalent to funding; Manufacturer loans: $35,000 per job created within 3 years; Manufacturer grants: $5,000 per job created within 3 years; Loans for distribution projects: Lesser of $5 million or $2.25/watt; Loans for solar thermal projects or R&D facilities: $5 million; Grants for distribution projects: Lesser of $1 million or $2.25/watt; Grants for solar thermal projects or R&D facilities: $1 million
			Grants for feasibility studies: 50% of cost up to $175,000; Loan guarantee grants: Up to 75% of deficient funds up to $30 million; Loans at a fixed interest rate -- 5% as of August 2009 -- up to 10 years (equipment) or 15 years (real estate); Loan guarantee grants have a maximum term of 5 years
Pennsylvania (3)	Wind, Geothermal Electric, Geothermal Heat Pumps	Commercial, Industrial, Nonprofit, Schools, Local Government	Varies by project, but program generally requires matching funds at least equivalent to funding; Manufacturer Loans: $35,000 per job created within 3 years; Manufacturer Grants: $5,000 per job created within 3 years; Loans for distribution projects: $5 million; Grants for distribution projects: $1 million; Grants for feasibility studies: 50% of cost up to $175,000; Loan guarantee grants: Up to 75% of deficient funds up to $5 million; Loans at a fixed interest rate (5% as of August 2009) up to 10 years (equipment) or 15 years (real estate); Loan guarantee grants have a maximum term of 5 years
Tennessee	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Hydrogen, "Clean Energy Technology", Solar Pool Heating, Anaerobic Digestion, Small Hydroelectric, Other Distributed Generation Technologies	Commercial, Industrial	99.5% sales and use tax credit; Taxpayer must make $100 million investment (minimum) and create 50 full-time jobs at 150% rate of Tennessee's average occupational wage
Texas	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind	Commercial, Industrial	100% exemption from franchise tax of all revenues of companies in Texas engaged solely in manufacturing, selling or installing solar energy devices (franchise tax is equivalent to corporate income tax)
Utah	Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Other Non-Renewable Alternative Energy Resources (see summary for list), Small Hydroelectric	Commercial, Industrial	Post-performance refundable tax credit up to 100% of new state tax revenues (including, state, corporate, sales and withholding taxes) over the life of the project (typically 5-10 years); evaluation includes several criteria including number and salaries of jobs created; long-term capital investment; amount of new tax revenue
Virginia	Solar Water Heat, Solar Space Heat, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Heat Pumps, Solar Pool Heating, Fuel Cells using Renewable Fuels, Geothermal Direct-Use	Commercial, Industrial	Green jobs tax credit of $500 per each job created with salary of $50,000 or more up to $175,000 total credit
Virginia (2)	Photovoltaics	Commercial, Industrial	Annual incentive grants of $0.75 per watt of panels sold with a maximum of 6 MW; funded for $4.5 million
Washington	Photovoltaics	Industrial	43% reduction of state's business and occupation (B&O) tax for manufacturers and wholesale marketers
Wisconsin	Solar Water Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Hydrogen, Energy Storage, Anaerobic Digestion, Renewable Fuels, Other Distributed Generation Technologies	Commercial, Industrial	Low-interest loans for manufacturers locating or expanding in the state; State contribution limited to 25% of project costs; Loans at 2% interest rate for 5-10 years (equipment) or 5-7 years (working capital); deferral of up to one year
Wisconsin (2)	Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Hydrogen, Renewable Substitutes for Petroleum-based Chemicals, Anaerobic Digestion, Renewable Fuels	Commercial, Industrial, Institutional	Grants and loans to businesses and researchers for development and commercialization of clean energy; grants require a 50% cost share; loans are offered at interest rates of 4% for up to 15 years and a maximum of 25% of project cost

Note: Some additional requirements and limits may apply. Does not include local or private sector incentives. Many of these incentives also apply to energy efficiency.

Source: U.S. Department of Energy, North Carolina Solar Center and Interstate Renewable Energy Council, Database of State Incentives for Renewables & Efficiency, "Financial Incentives for Renewable Energy."