The Texas House Select Committee on Electric Generation Capacity and Environmental Effects

Report to the 81st Texas Legislature

Representative Dennis Bonnen
Chairman

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Committee Clerk

Select Committee on Electric Generation Capacity and Environmental Effects

January 12, 2009

Chairman Dennis Bonnen

P.O. Box 2910
Austin, Texas 78768-2910

The Honorable Tom Craddick
Speaker, Texas House of Representatives
Members of the Texas House of Representatives
Texas State Capitol, Rm. 2W.13
Austin, Texas 78701

Dear Mr. Speaker and Fellow Members:

The Select Committee on Electric Generation Capacity and Environmental Effects of the Eightieth Legislature hereby submits its interim report including recommendations and drafted legislation for consideration by the Eighty-first Legislature.

Respectfully submitted,

Dennis Bonnen

Charles "Doc" Anderson

Kevin Bailey

Norma Chavez

Rick Hardcastle

Phil King

Burt Solomons

Joe Straus

Sylvester Turner

The Select Committee on Electric Generation Capacity & Environmental Effects

Dear Members of the 81st Texas Legislature:

We live during a time of great uncertainty about the future of the electric grid and electric generation. But we also live when investors and inventors alike believe innovations will soon revolutionize the ways that businesses and individuals receive and use power.

The pace and uncertainty of these developments coupled with the ability of new technologies to disrupt existing markets pose serious challenges for policymakers and leaders from every state, and the structure of Texas's legislative system adds more complications. Legislators often hesitate to act because of concerns about creating problems that they will not be able to fix for two years.

In addition, lawmakers must also begin to change the ways that they think about the delivery of electricity because the methods and techniques used for generation and distribution must change. Historically, Texas has relied on natural gas for much of its energy generation, and it has provided reliably clean and efficient power. However, the price stability provided by natural gas prior to 1999 has gone away and most analysts believe that it will not return. This is due in large part to the fact that the amount of natural gas available even using unconventional drilling methods is shrinking. In the past, U.S. energy forecasters believed that liquefied natural gas would fill that gap, but more recent developments in domestic and international policies have made that less likely. Also, the centralized generation model that has served the state so well needs revisions in light of new proven technologies and economic realities. The practice of siting transmission and distribution infrastructure must be changed to accommodate new renewable resources and to give consumers more control over their electric consumption.

Aware of these challenges, the Select Committee has tried to keep in mind three principles. First, policymakers should establish goals for the state's deregulated generation markets and then stand by those goals without prescribing specific technologies or generation methods. Doing so will send clear market signals to investors without privileging one source over another. In the state's transmission and distribution industry, lawmakers should provide clear instructions to the state's regulators and provide them with the authority to carry out their tasks.

Second, legislators and regulators must resist the temptation to get caught up in the excitement around new technologies. Emerging technologies portrayed as "the next big thing" often loom large in future electricity projections. Studies and reports showing theoretical outcomes are often accepted at face value instead of seeing them in their proper context. Hyperbole and exaggeration can sometimes drive debate more than facts and logic. Long-used existing technologies often provide the best value for the generators who bear the financial responsibility for building them and the ratepayers who use their energy. For instance, combined heat and power significantly reduce the costs of electricity to businesses and community resources while providing reliable energy during times of crisis, yet they receive little attention when compared with new technologies.

Third, the debate over electric generation should be primarily pragmatic, not idealistic. Without reliable, inexpensive streams of electricity, industries fail and people's quality of life declines. We only need to look at life in the wake of Hurricane Ike for an example of how much we all rely on electricity everyday. State leaders must carefully consider the perspectives of all stakeholders when crafting energy policy, and they should understand that major changes take time. The electric grid is an evolving work in progress and because of its characteristics, such as high capital costs and the need to maintain existing infrastructure, small changes leading towards established goals are the best way to make sure that the lights stay on.

In any discussion of sources for future electricity generation, keep in mind that all sources of electricity have positive and negative features. Productive and relevant energy plans must address the negatives associated with a power source, but must also balance those concerns against the relative ease of offsetting those effects and their relative costs compared with their benefits. As examples, wind and coal have arguably been the most contested forms of electric generation in Texas over the last decade. Wind advocates point out the zero fuel cost and total lack of emissions, while critics note that wind requires huge investments in transmission and distribution, the intermittent and unreliable nature of wind power, and the unknown negative effects on the environment. Proponents of coal fired generation argue that coal provides low-cost, reliable electricity and that technologies associated with emissions reductions have greatly improved. Opponents say that coal emits more carbon dioxide than any other generation source and will inevitably mean higher costs of power when the federal government places constraints on greenhouse gases. In order to make a rational assessment of a new electric generation source, lawmakers should keep in mind that all sources have drawbacks and consider those against the realities of the marketplace and the need for electricity in the state.

The Select Committee believes that this report is the beginning of creating a long-term plan for the state's energy future, not the end of the process. The options available require thoughtful and ongoing consideration. The complexity of these issues goes beyond the abilities of any one person or committee to completely address, and the entire state must continue to work alongside industry and consumers to ensure that Texas remains a world energy leader.

Sincerely,

Dennis Bonnen, Chair

Members of the Select Committee on Electric Generation Capacity and Environmental Effects

Rep. Dennis Bonnen, Chair

Rep. Charles "Doc" Anderson

Rep. Kevin Bailey

Rep. Norma Chavez

Rep. Rick Hardcastle

Rep. Phil King

Rep. Burt Solomons

Rep. Joe Straus

Rep. Sylvester Turner

Part I: Introduction & Background Information

Overview and Goals of the Committee

Background & Methods

On December 6, 2007, Speaker Tom Craddick exercised his authority to create the Select Committee on Electric Generation Capacity and Environmental Effects. The duties of the Select Committee mirror those of the Special Committee proposed under HB 2713 by Representative Bonnen from the 80th Regular Legislative Session[1] and include:

- Studying the state's demand for electric generation capacity for the next 50 years and the infrastructure and technology available for meeting that demand;
- Studying the environmental effects of existing electric generating facilities, including the effects on global warming or climate change;
- Preparing a long-term electric energy and environmental impact plan for the 81st Legislature.

In order to fulfill those duties, the Select Committee held hearings in Austin and the Houston area to take testimony from experts in the related fields. In addition, committee members and staff met with relevant agencies and stakeholders throughout the interim in order to gather the best available data on these topics. These meetings were supplemented by consulting written works and publications on a variety of topics.

Crucial Energy Concepts

Electricity policy has a reputation for strange terminology paired with complicated engineering and financial concepts, but because electricity fundamentally structures the success or failure of a modern economy, all policymakers must understand the major concepts behind it. Therefore, this report begins with a brief discussion of those concepts and how they operate in Texas.

[1] Vetoed by Governor Rick Perry on June 15, 2007. See House Journal for the 80th Session, page 7407.

Energy and Capacity

In the electricity market, it is important to recognize the difference between a resource's generation and capacity.

- **Generation** refers to the electricity that power plants actually create over a given time.
- **Capacity** refers to the amount of electricity that a facility could potentially generate if it ran at full strength under ideal conditions.

The difference becomes crucial when discussing new generation sources. While a wind farm might have a capacity of 1000 MW, wind generally only produces power 30% of the time, so its actual generation would fall somewhere in the area of 300 MW.

In order to determine how much energy planners can expect from a generation resource, they use what is known as a **capacity factor.** In order to determine the capacity factor of a generation source, take the amount of power actually generated during a year and divide it by the amount of power it could provide operating at full capacity.

$$\textbf{Capacity factor} = \frac{\textbf{Amount of power actually produced over time}}{\textbf{Power that could be produced at 100\% full production}}$$

Looking at the electric generation totals from 2006, we can get an idea of what the capacity factors are across the United States for different generation sources. The Energy Information Administration reports that nuclear operates at a capacity factor of 89% and coal at 72% because these two resources operate more efficiently when they run at steady rates. Because of its high cost of fuel and the fact that it is generally used to meet demand during peak times, combined cycle natural gas operates at 38%.[2]

[2] Energy Information Administration, Form EIA-860, "Annual Electric Generator Report;" Form EIA-906, "Power Plant Report;" and Form EIA-920 "Combined Heat and Power Plant Report."

Baseload and Peak Generation

Baseload generation sources produce energy at a constant rate, usually at a low cost relative to other resources in the system. However, these resources work best when they run at a steady rate, so they do not respond economically or mechanically to spikes in power. Also, baseload generation plants tend to be the most expensive to build because of the high capital costs and long lead time required.

Demand for electricity varies throughout the day and the year based on many factors such as weather and the daily activities of the population. Baseload generation is not efficient when it is turned up and down to meet this demand, so **peak generation plants** must be available to meet those high points.

Remember, the entire electric delivery system is designed around the ability to meet peak demand. Because of the material and technological makeup of the grid, when demand far exceeds supply, the state faces blackouts and long periods of time to get the system back up. For the purposes of planning for electric generation needs, all that matters is peak moment. Therefore, most of the peak generation resources sit idle except for several hundred hours each year when they are needed.

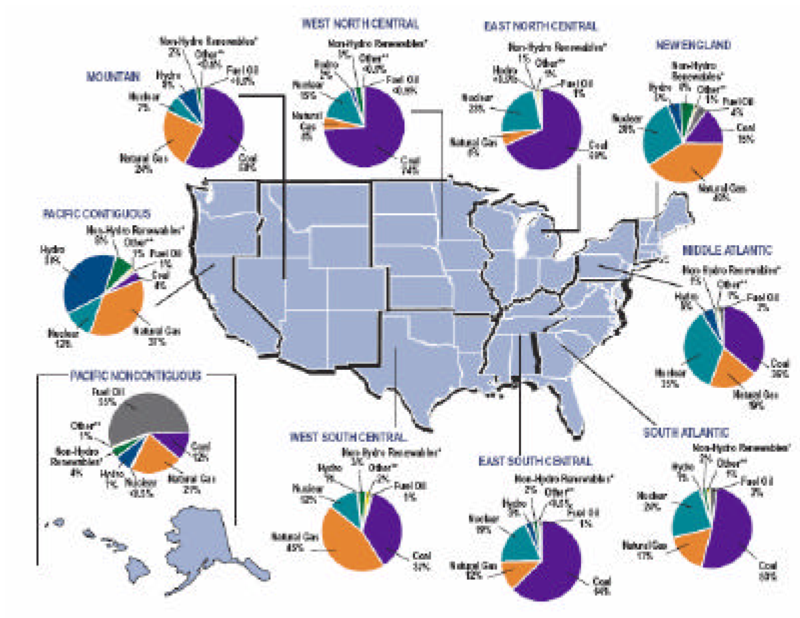
Peak Demand

Because consumers tend to use electricity at the same times during a 24-hour cycle, planners develop **demand curves** to show when the need for electricity will peak. This graph shows the amount of electricity needed on June 30, 2008 within the ERCOT region. The lowest demand comes between 3:00 and 4:00 AM when most people are asleep and businesses are closed so little electric demand exists. Throughout the day, demand for electricity increases until it peaks sometime in the evening.

1 ERCOT historical load data for June 30, 2008. Accessed October 1, 2008.

Fuel Diversity

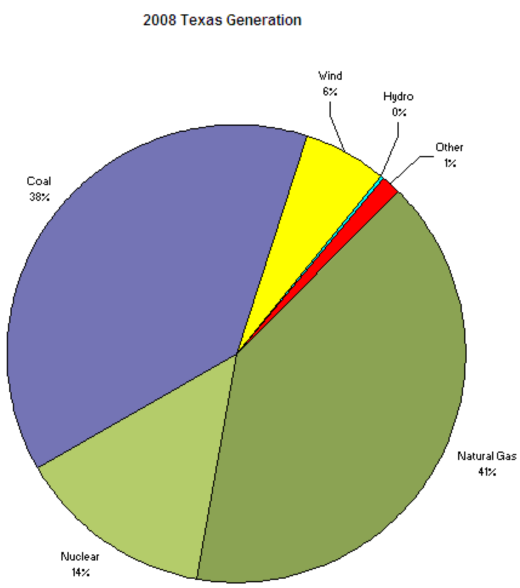
U.S. electric generation comes from a variety of fuel mixtures that differ by region. Geography, natural resources, and historical regulation dictate what fuels generators tend to use.

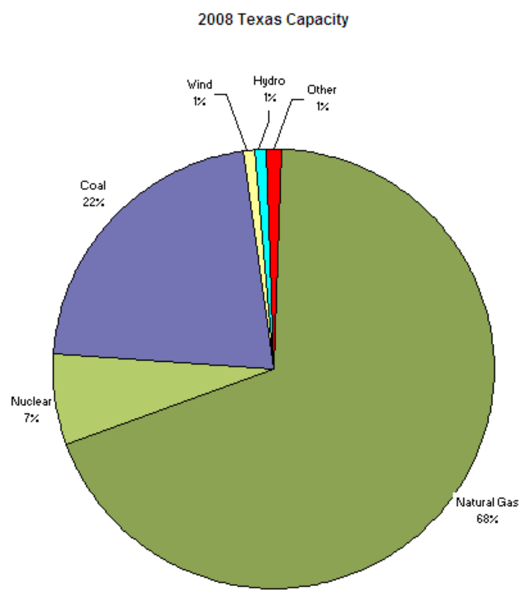


2 From the U.S. Department of Energy, Energy Information Administration, Power Plant Report (EIA-920) and Combined Heat and Power Plant Report (EIA-920) and compiled by the Edison Electric Institute. Published April 2008.

For instance, the Middle Atlantic and New England regions generate much of their energy from a fleet of nuclear plants that have been in place for decades. It would not be feasible for Texas to expect this much power from nuclear in the short run because of the high capital costs and long permitting period for a source like this. By the same token, those regions could not expect to use natural gas in the amounts that Texas and Louisiana do. Any attempt to do so would simply leave a massive amount of infrastructure designed for the nuclear fleet to sit unused.

While Texas is not alone in relying heavily on natural gas, it does lead the nation in the amount of gas it uses for electrical generation. Much of this fuel comes from the state's own rigs, but it is the most volatile fuel in terms of price.



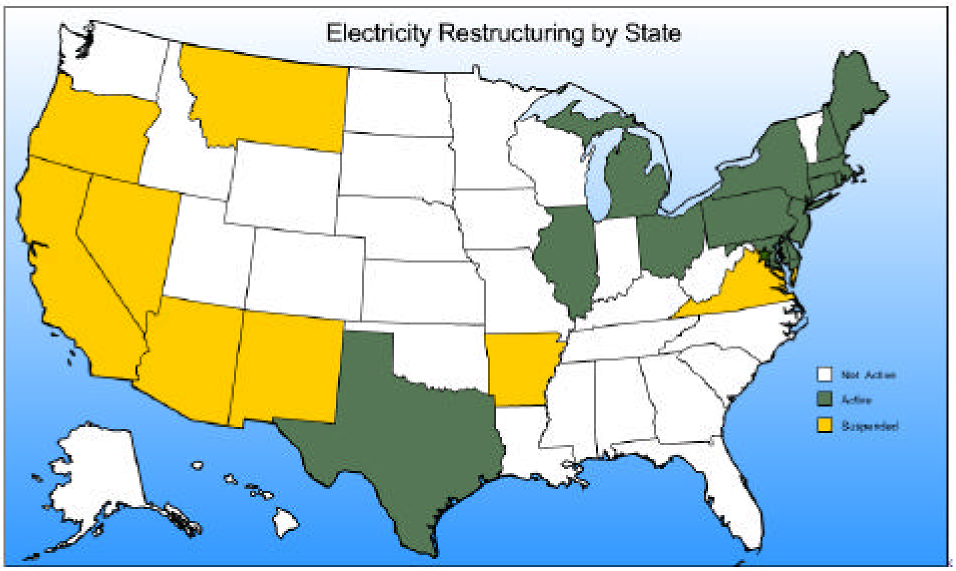


Regulated and Unregulated Markets

The Texas electric market is largely deregulated or restructured, two terms can be used interchangeably and often are. Put simply, in a restructured market for electricity, generators sell electricity on the wholesale market to retail electric providers who then sell it to industrial, commercial, and residential customers. Fourteen other states have adopted this method of providing electricity.[3]

[3] For a more detailed study of the regulated and restructured states, see www.eia.doe.gov/cneaf/electricity/page/restructuring/restructure_elect.html.

From a generator's viewpoint, there are risks and rewards for building new sources in restructured and regulated markets. A restructured market increases the uncertainty surrounding revenue and operating costs because there is no regulatory framework that provides a standard rate of return. But while the risk for losses is lessened in regulated states the possibilities for profits are, too, which could dissuade companies from building new generation.



3 Regulated and restructured states

The benefit to ratepayers in deregulated states is that the risks of new investment remain with the shareholders of the generation company instead of the public. In regulated states such as Florida, which shares many of the same characteristics as the Texas market[4], ratepayers shoulder the burden of risk instead of the shareholders.

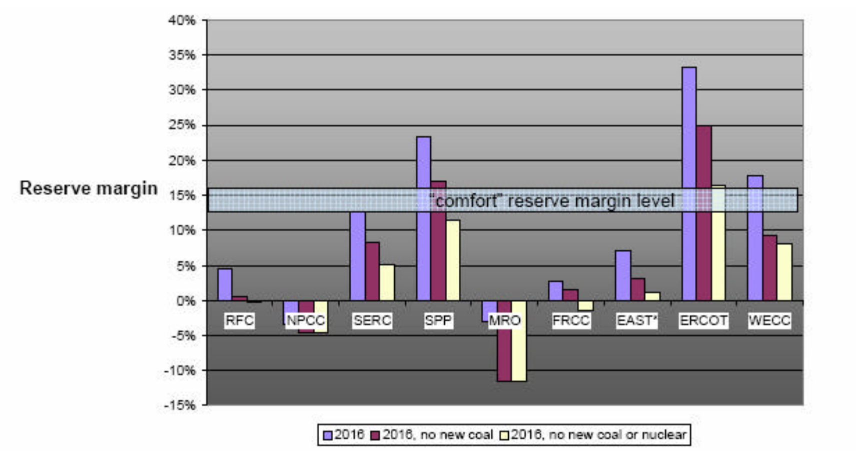
[4] Because of its geographic characteristics, Florida also has limited interconnections with the rest of the nation, even though it falls under NERC's authority; the heavy load and generation centers of Florida are exposed to hurricane damage in the same way as Houston and the manufacturing centers along the Texas coast; Florida's commercial and residential economies also rely on reliable, wide-spread air conditioning to maintain quality of life. Florida, however, does not share the disparities in weather that Texas has, nor does it have to deal with the distances between generation and load that Texas does.

Reserve Margins

In order to maintain the reliability of the Texas electric grid, ERCOT maintains a goal to have an excess of electricity at 12.5% of the projected demand load. This extra generation allows a reliable stream of energy in the event of a major generation outage or congestion on the transmission lines. The reserve margin can also be used by wholesale generators to make predictions about the need to build more generation resources. A lower reserve margin means a greater opportunity to sell power profitably.

In some restructured states, generators are required to maintain a certain level of capacity in order to ensure that the reserve margin is stable. The states do this by contracting with generators for a prescribed level of reserve capacity above their peak load during certain time frames. ERCOT does not impose this on the generators in Texas making it an "energy only market."

Compared with other regions in North America, ERCOT's projected reserve margins match up well in the short-term. For example, NERC estimates that the Arizona and New Mexico regions will need many more resources by 2010.[5] Projections of energy growth in demand and capacity indicates that ERCOT is well prepared for the future as far out as 2017 as the graph below shows:



4 Projected reserve margins in 2016 by region, from Natural Gas and Electricity Costs and Impacts on Industry, DOE/NETL-2008/1320 (April 2008) page 8.

[5] *2008 Long-Term Reliability Assessment: 2008-2017,* North American Electric Reliability Corporation (October, 2008), page 8.

Unlike other areas of North America, ERCOT and SPP both enjoy a comfortable reserve margin through 2016 as long as generation investment continues. As noted in a DOE study on reserve margins, if coal and nuclear, which provide baseload power for many regions are, "not available before 2016, the entire Lower-48, save ERCOT, will be at high risk of power shortages, a present-day South African-like, electricity supply situation."[6] Although Texas is sometimes criticized on the national stage, this data seems to indicate that the market is performing well and incentivizing adequate generation capacity relative to other states and regions.

Ancillary Services

Ancillary services are basically different ways for ERCOT to make sure that the electric grid remain reliable. They include electric reserves beyond the reserve margin and various procedures that go into effect in the event of a power emergency.

The costs of ancillary services are spread across all of the ratepayers in Texas. Therefore, if one generation resource fails to perform as expected, it is the ratepayers who foot the bill.

Transmission and Distribution

A generation source is only as good as the transmission system that connects it to the customers. In Texas, the Electric Reliability Council of Texas (ERCOT) oversees and has jurisdiction over transmission lines within its jurisdiction. Non-ERCOT areas fall under the Public Utilities Commission and the Federal Electric Reliability Council (FERC), which means that non-ERCOT utilities must gain approval from both of those agencies before taking actions. Unlike every other power region in the U.S., the ERCOT transmission system has few connections to neighboring states and grids meaning that ERCOT is almost solely responsible for its own generation and energy future.

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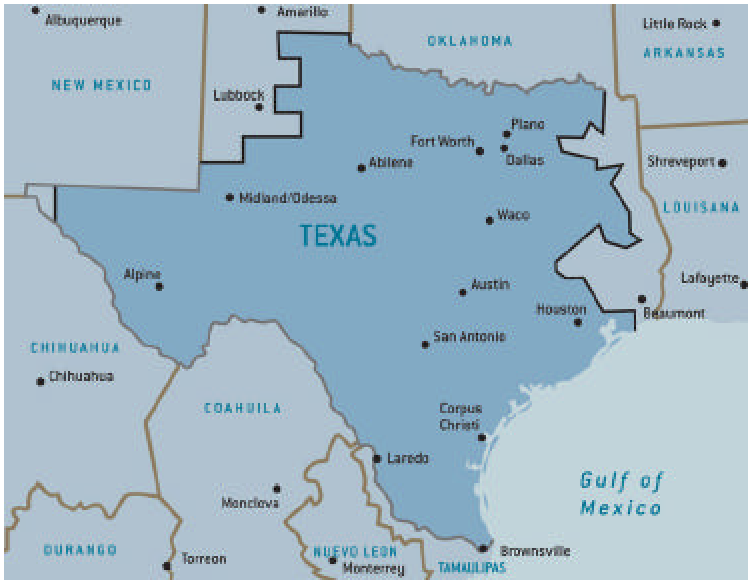
[6] Projected reserve margins in 2016 by region, from *Natural Gas and Electricity Costs and Impacts on Industry*, DOE/NETL-2008/1320 (April 2008) page 8**.**



5 The ERCOT region of Texas

When Texas restructured its electric market, policymakers decided that the transmission lines should provide unrestricted access for generators in order to prevent established generation companies from keeping new companies out of the system. Therefore, these utilities remain regulated. This state-level oversight provides a major benefit to customers and generators since costs associated with the building of new lines in regions controlled by FERC often cause serious regulatory problems and act as a barrier to generators wishing to enter a new market. Texas and ERCOT's ability to control their own transmission planning within the state provides benefits that other states and markets do not enjoy.[7]

[7] For a thorough list of studies on transmission cost allocation, see the Harvard Electricity Policy Group's website on the topic at www.hks.harvard.edu/hepg/.

Part II: Meeting Texas's Demand for Electricity, 2008 to 2060

Current State of Texas Electric Generation

Many different factors affect a state or region's need for electricity, such as population and economic growth or weather and atmospheric activity, just to name two. Fluidity makes up the one common trait that these different factors share and depending on the context, different factors have more influence than the others. Therefore, the information in this section and in later sections about the future should be seen as a snapshot of the state's generation situation and likely future trends in the closing months of 2008. By the time this report is printed and distributed to the members of the 81st Legislature, the horizon will have likely changed in many minor and potentially some major ways.

That fact might lead some to wonder what the value of any study on this topic would be. Although neither this nor any other printed report can provide an up-to-the-minute view of the situation, such reports can give perspective to anyone interested in past forecasts and how past economic and regulatory factors have influenced the markets. These can provide a basis for projecting future growth needs, although we must keep in mind that current economic conditions tend to have a disproportionate weight on how we see the future. Regulators and businesses must continually revise their views of the energy system and its likely directions on an ongoing basis.

This section provides details about the current assets in the state for electric generation, a very brief history of capacity additions in Texas, the current technologies available for generation, and some factors causing pressure or growth in the field.

Current Generation Capacity

Just as each day's demand cycle has a peak, the state experiences a peak usage day each year when demand exceeds all others. And as might be expected, that day always comes during the summer months when air conditioning for homes and businesses must overcome the losses experienced through inefficiencies. According to ERCOT, as of the summer of 2008, the state currently has 72,503 MW of resources available. The chart below gives the totals of generation resource sources by category.

Generation Resources Available, Summer 2008	
Installed Capacity, MW	61,552
Capacity from Private Networks, MW	6,247
Effective Load-Carrying Capability (ELCC) of Wind Generation, MW	480
RMR Units under Contract, MW	133
Operational Generation, MW	**68,411**
50% of Non-Synchronous Ties, MW	553
Switchable Units, MW	2,848
Available Mothballed Generation , MW	143
Planned Units (not wind) with Signed IA and Air Permit, MW	851
ELCC of Planned Wind Units with Signed IA, MW	13
Total Resources, MW	**72,820**
less Switchable Units Unavailable to ERCOT, MW	317
less Retiring Units, MW	0
Resources Available to ERCOT, MW	**72,503**

This list of resources includes 143 MW of mothballed generation and 851 MW of planned non-wind units that have completed the air permitting process and have signed an interconnection agreement with ERCOT.[8] Mothballed plants are resources that have become uneconomic to run, but ERCOT requires generators to keep them available as possible sources of power in case of an emergency.[9]

For the winter months of 2009, ERCOT projects electricity demand of 46,068 MW with 75,504 MW of generation available. That gives the state a reserve margin during that time of 63.9%.

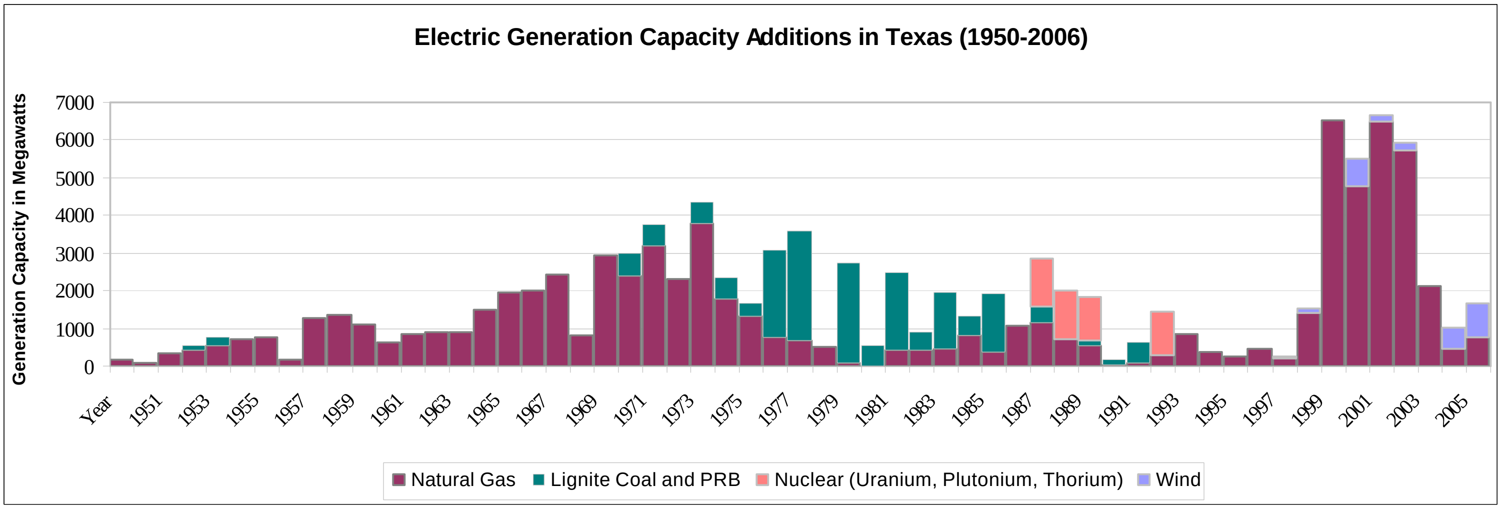
How We Got Here (Texas Generation Capacity Since 1950)

For the last fifty years, the vast majority of generation capacity additions in Texas have come from natural gas. Since 1950, EIA reports that natural gas has made up 75,488

[8] ERCOT defines an interconnection agreement in its protocols as, "An agreement that sets forth requirements for physical connection between an eligible transmission service customer and a transmission or distribution service provider."

[9] The mothballed designation only applies to generation resources for which ERCOT has declined to execute an Reliability Must-Run Agreement. Generators must also keep ERCOT up to date on the estimated lead time required for a mothballed resource to return to service (Protocols 6.5.9.3, October 1, 2008).

MW of the state's capacity additions. Coal-fired plants came in second, adding 18,856 MW of generation capacity during that same period. Beginning in 1988, nuclear energy added 4,860 MW of generation capacity and starting in 1993 wind has added 2,744 MW.



As depicted above, after the Second World War, natural gas was almost exclusively responsible for new generation until in 1978 when Congress enacted the Power Plant and Industrial Fuel Use Act, which imposed harsh limits on new construction of natural gas-fired electric plants. The Act came about as a result of concerns over national energy security in the wake of the 1973 oil crisis. This led to a substantial drop off in natural gas capacity installation and an increasing interest in coal-fired generation.

At the time, experts believed that only coal and nuclear power could meet the country's long-term demand for electricity. During the same period, it was widely believed that domestic supplies of natural gas would soon run out. Because petrochemical companies and other manufacturers use natural gas as a feedstock for their products, they successfully argued that electric generation demand could be met through other means and that natural gas was far too valuable to the nation's other economic sectors.

As a heavy natural gas dependent state which also is home to many petrochemical companies, Texas was one of the early movers in this area. In 1975, the Railroad

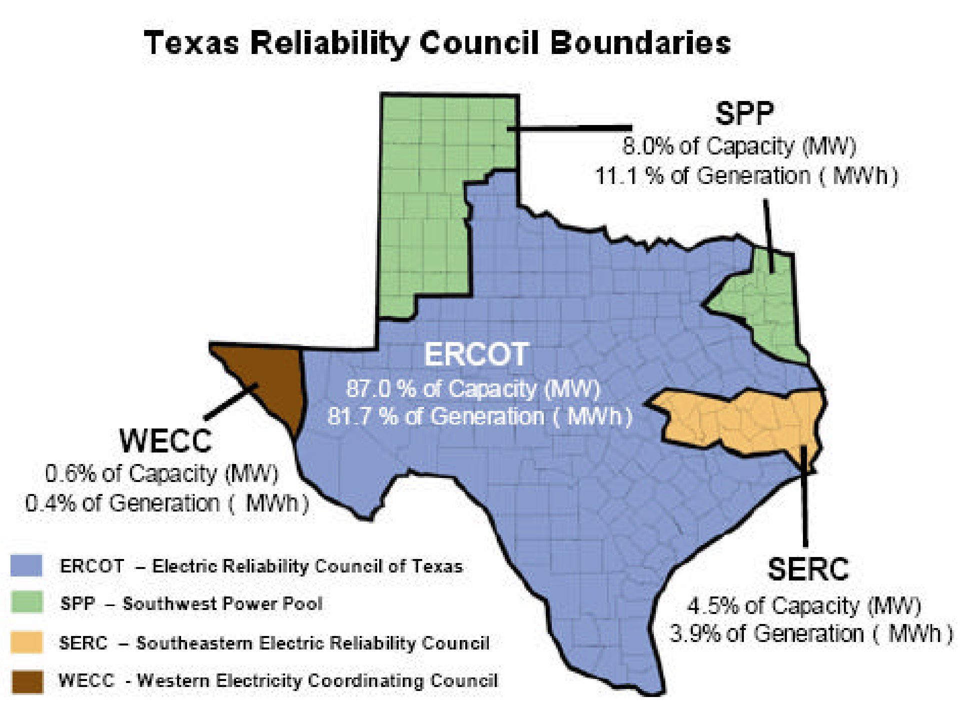
Commission adopted an order prohibiting the use of natural gas in all newly constructed electric plants and requiring a 25% reduction in natural gas generation for existing plants by 1985. In 1987, Congress repealed the sections of code restricting the use of natural gas for electricity generation as it became clear that new gas drilling techniques and unconventional sources meant that natural gas would be more abundant than previously thought. Combined with breakthroughs in gas-turbine efficiency and the possibility of comprehensive electricity deregulation, gas-fired generation boomed through the mid to late 1990s.

Regulatory Policy in Texas

A Brief History of the Texas Grid

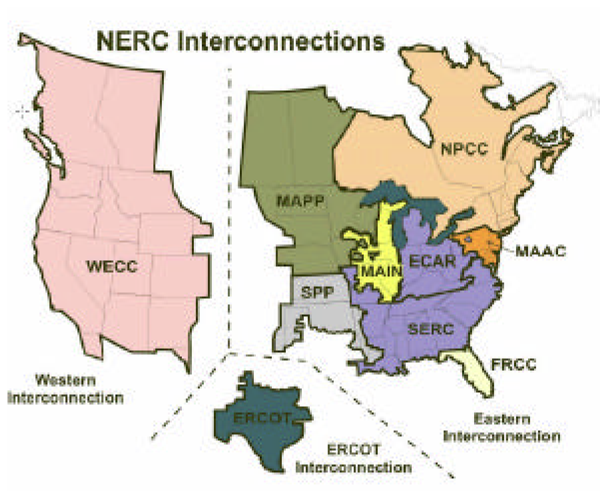
The Electric Reliability Council of Texas

The Electric Reliability Council of Texas (ERCOT) is one of three Interconnection Regions in the United States. It covers 75% of the Texas land area and carries the majority of the state's electric load.



6 From "Final Report: A Clean Energy Plan for Texas," prepared for TCEQ by Dr. Michael E. Webber, et al. Submitted August 31, 2008.

The non-ERCOT areas of the state fall under the surrounding NERC regions such as the Southwest Power Pool (SPP), Southeastern Electric Reliability Council (SERC), and Western Electricity Coordinating Council (WECC). Although ERCOT does not manage the entire Texas electric grid, using growth rates for ERCOT alone provides a reasonable assessment of how the entire state will change over time.[10]



7 NERC Interconnection Regions throughout the United States and Canada

ERCOT is the only state that does not fall under the jurisdiction of the National Electric Reliability Corporation (NERC). As mentioned in the opening sections of this report, transmission providers in ERCOT only need the approval of the state's regulators instead of state and federal regulators when determining appropriate costs for service. Therefore, utilities in Texas spend less time and money on administrative and legal processes and can deploy their projects faster than utilities outside of ERCOT. More importantly, unlike other states who currently have a restructured electric market, ERCOT does not have the multi-jurisdictional issues associated with interconnections across state lines, such as issues related to siting of infrastructure and coordinating public policy between jurisdictions.[11]

[10] Including more renewable generation sources from non-ERCOT regions could change this statement, however, the PUC's actions in approving the CREZ tends to indicate that ERCOT's future will still act as a reasonable indicator of the state's energy future.
[11] As of October, 2008, the states pursuing or operating a restructured electric market are Connecticut, Delaware, Illinois, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, and Rhode Island. States grouped by region or those that share interconnections with

The transmission system and authority within Texas has evolved in response to external demands as well as internal pressures. In 1941, several electric utilities in Texas formed a group to support the war effort and sent the group's excess power generation to industrial manufacturing companies on the Gulf Coast. The combined utilities, known as the Texas Interconnected System (TIS), found that interconnection provided them reliability advantages that they did not have as stand-alone generators, so the members continued to use and develop the interconnected grid. TIS eventually became the Electric Reliability Council of Texas, which operates a single grid contained only within the state of Texas. Since 1970, ERCOT has ensured the reliability of the electric system within a majority of the state.

Although the industry has changed dramatically since the time of TIS, the essential idea--that electric utilities can and should band together to prop one another up--remains the same. As the blackouts on the east coast in 2004 demonstrated, electric utilities depend on one another for stability. During that incident, one utility collapsed which caused all the interconnected utilities around them to breakdown leading to a kind of domino effect regarding blackouts.

From Vertically Integrated Utilities to Competitive Markets

Up until the 1970s, electric regulation was grounded in the idea that an electric utility was a natural monopoly since the investments required to create, operate, and maintain a generation and distribution system were so large. Beginning in 1975, the Public Utilities Commission of Texas (PUC), began regulating the investor-owned utilities who generated electricity, transmitted it over distance at high voltage, distributed power to consumer, and then billed them for the service. The PUC governed the price of power through rate proceedings with the aim of allowing utilities to gain a fair return on their investments while keeping costs reasonable for consumers. Municipally-owned utilities and co-ops performed the same functions as investor-owned utilities but they did not

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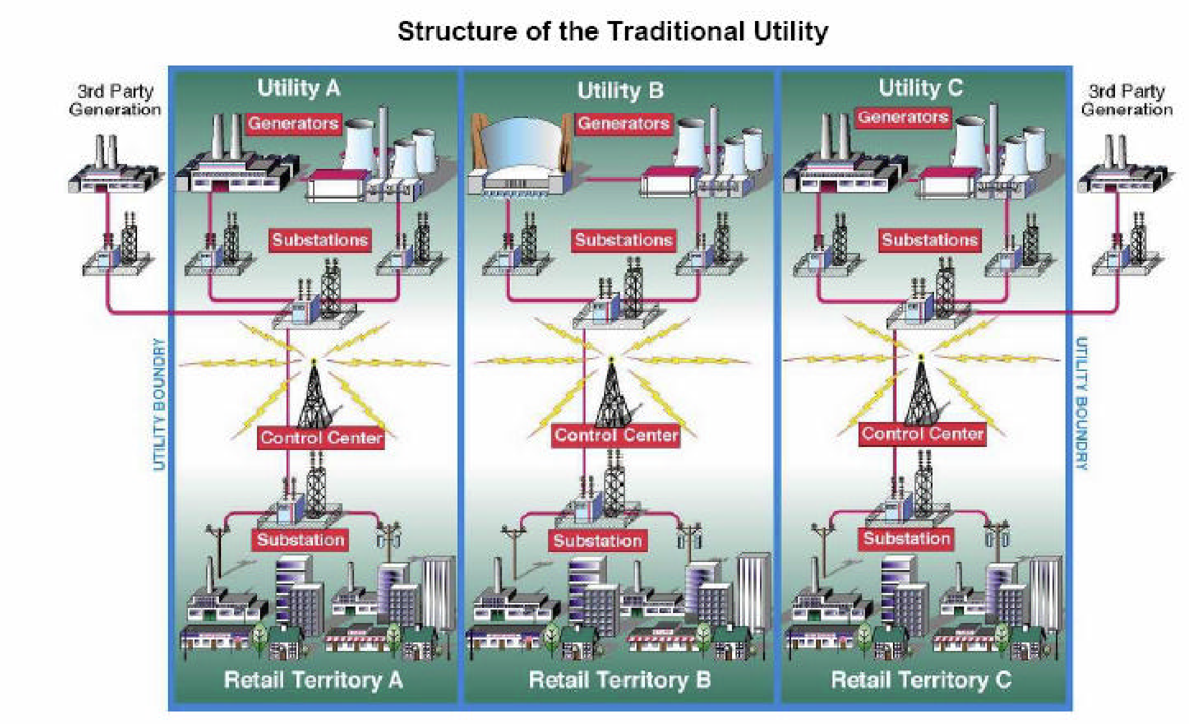
other regulated states often find that competing interests and political purposes work against each other to slow and add costs to regulatory discussions.

have the purpose of generating profit for investors. These utilities were known a "vertically integrated" because they handled electricity from start to finish and even though different parts performed very different functions, they effectively operated as one unit from start to finish.

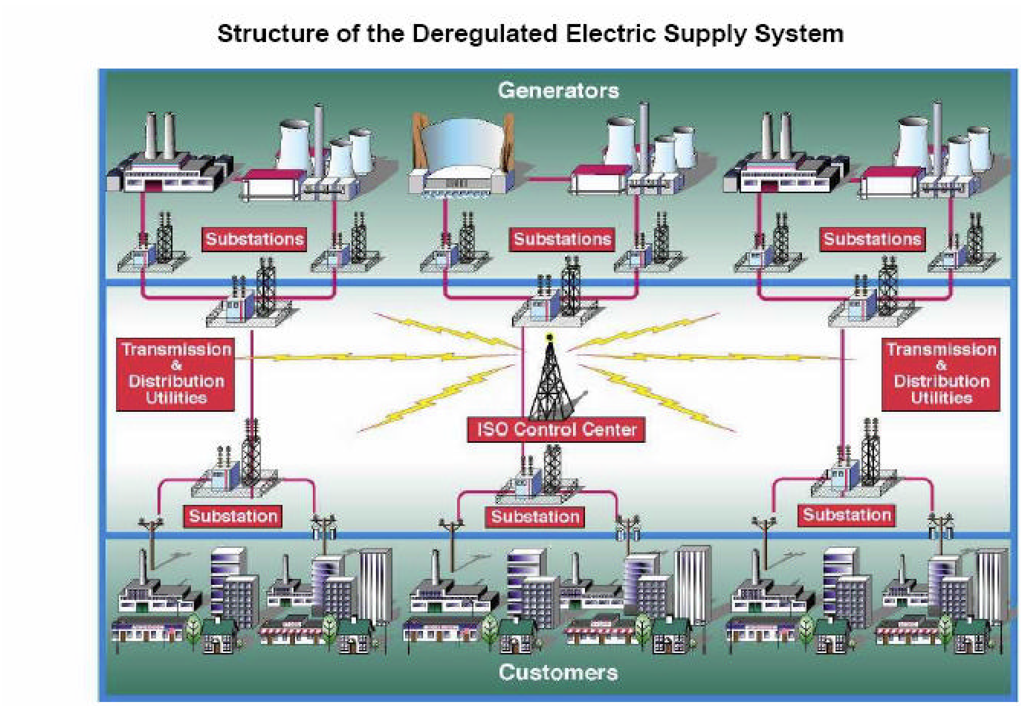
The interest in restructuring the Texas electric market came about at the same time as other deregulation efforts in other states and at the federal level. Technological improvements in electricity generation and a greater diversity of fuels made competition viable for the first time in the industry's history. Proponents argued that competition would encourage utilities to create more efficient and cleaner methods of generation which would in turn lower prices for customers.

The increasingly complex developments in electric delivery also helped to create the need for a competitive electric market. The rise of energy marketers and traders who did not own generation assets along with highly technical needs such as ancillary services began to wear away at the vertically integrated model of electric delivery.

In 1995, the Legislature allowed competition in the Texas electric wholesale market. The law gave exempt wholesale generators and independent power marketers to sell electricity into the grid for regulated industries to purchase. It also stipulated that utilities had to provide open access to transmission networks for these new wholesale players. This move paved the way for retail competition. Texas now had precedent and a system in place for wholesalers to transmit electricity over utility-owned wires for a reasonable fee.



8 Traditional vertically integrated utility model



9 The different levels that make up the structure of a deregulated market

In 1999, SB 7 by Sibley created customer choice for Texas's retail electricity market. Vertically integrated utilities were required to "unbundle" or rather separate their business activities into different companies. Other customer protections were put into place along with provisions to help protect the state's air and water quality and a pilot program for competition was created.

While the deregulated wholesale and retails markets provide significant advantages for Texas, it also means that legislators and regulators concerned about the state's energy future have a limited impact on planning that future. For instance, although the state's leaders have an ongoing interest in the availability of water, neither the PUC nor the Legislature have the ability to affect the siting of power plants based on water availability. Instead, a deregulated market relies on the business decisions made by electric generation companies and trust that they would not make a multi-million dollar investment in an area that does not have the natural resources to support the functioning of that investment.

One way that regulators can still impact the decisions about whether or not new generation assets will be built is through planning the transmission and distribution system for Texas. But as several observers have noted, recent decisions about electric transmission in Texas seem to conflict with one another. For instance, for years, the PUC and ERCOT have spent millions of dollars to establish a nodal transmission system to replace the zonal transmission system now in place. In other deregulated markets, nodal transmission systems have created clear pictures of where the least expensive electricity is generated and the best way to move that power to consumers, which allows generators to make responsible decisions about where to build new resources. As PUC Chairman Barry Smitherman wrote in a 2005 memo to his fellow commissioners while the nodal system was being debated, "Efficient economic dispatch, one of the hallmarks of nodal design, must be a high priority for this Commission."[12] However, the PUC acting on the Legislature's direction has recently decided to pursue massive power corridors to bring

[12] From page 5 of Commissioner Barry T. Smitherman's memo to Commissioners Julie Parsley and Paul Hudson dated July 28, 2005 re: Project No. 28500-*Activities Related to the Implementation of a Nodal Market for the Electric Reliability Council of Texas.*

wind energy from far West Texas to larger cities, using what amounts to a command and control strategy for new transmission siting and forcing the market to respond. Legislators must keep in mind how important projects such as the CREZ lines could run at counter-purposes to established state policy, and send unreliable signals to the market. And as stated in the opening sections of this report, lawmakers must remember that big changes or policy decisions can have sometimes disastrous long-term consequences such as in the Fuel Use Act.

Power generation companies require wholesale revenue predictability in order to build new generation facilities. Therefore, any changes to Texas law regarding generators should take into consideration their need for clear and consistent market signals. In states that have attempted to create a mixed market or that have rapidly changed their market structures, investors have shied away from new investment in capital-heavy projects. For example, in Michigan, where lawmakers tried to create a hybrid electric market that combined elements of regulated and deregulated systems, independent power producers and utilities delayed investment in new generation resources due to uncertainty regarding multiyear revenue streams.

Energy Demand for the Next Fifty Years

Worldwide Competition for Resources and Markets

Texas has always taken pride in its political and economic independence. However, the last fifty years have demonstrated that large manufacturing and energy consuming states like Texas no longer compete solely with other U.S. states. Texans need to think about competition from other states and other developing nations who seek new energy sources to drive their own economies.

As an example, consider the fact that in 1978, the major international oil companies controlled production from 70% of oil and gas reserves worldwide. Today, they control production from about 20%. National and state-dominated energy companies now make up about 75% of the world's conventional resources. During this shift from centralized, internationally stable energy production, producers have moved to lock up markets in order to maintain demand. Consumers, on the other hand, have tried to reduce demand growth, increase efficiency, and find resources closer to home.

The largest consumers of energy, the U.S., the E.U., China, India, Japan, and Brazil have led these attempts at reducing demand and finding new domestic energy resources. Analysts expect that by 2010, China will become the largest energy consumer in the world. In order to understand how truly incredible these gains are, consider that in 2005, the U.S. used 35% more energy than China, but the modernization of the country's economy and its need for domestically produced, reliable electricity has driven its growth in generation capacity.

The major producer nations, Russia, the Caspian nations, and Saudi Arabia, on the other hand, find their economies and political influence waning in light of these new developments. In response, we have seen moves by producers to centralize their authority and regain some measure of control. For instance, recently the members of the Gas Exporting Countries Forum such as Russia, Venezuela, Iran, Qatar, and the United Arab Emirates created a more formal arrangement to consolidate their influence over the natural gas markets. As if to put an exclamation point on the importance of this development, Russian Prime Minister Vladimir Putin said at the conclusion of the meeting, "The expenses necessary for developing fields are rising sharply. This means that despite the current problems in finances the era of cheap energy resources, of cheap gas, is of course coming to an end."[13]

In prior energy forecasts, analysts have anticipated that new imports of liquefied natural gas (LNG) would make up for tightening supplies and rising demands on the natural gas market. However, the political outlook for the next half century seems to indicate that will not be the case.

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[13] "Putin Hails End of 'Cheap Gas' Era," *Business Week*, December 23, 2008, available at http://www.businessweek.com/globalbiz/content/dec2008/gb20081223_503103.htm?chan=globalbiz_europe+index+page_top+stories.

Additionally, the economic crash of the last year has led the public to call for greater oversight in many areas of government, one of which is the environment. With the change of political parties in power, most observers expect that so-called greenhouse gas emissions will come under increasing scrutiny and likely become part of the manufacturing and transportation industries' bottom line costs. These changes will of course have a major impact on the way that businesses build and use resources for electric generation. In the absence of emission charges and EPAct incentives, conventional fossil-fuel technologies continue to dominate sources such as nuclear and renewable energy. Without EPAct incentives, a carbon dioxide charge of $45 per metric ton would make nuclear the most attractive option for new generation capacity. A carbon dioxide cost between $20 and $45 per metric ton makes nuclear an option but does not raise it above natural gas or coal.[14] But this dynamic is fluid and it will see changes as time goes on. Utilities have already incurred the costs of new capital-intensive projects such as coal plants, so in the short-term, electricity generated by existing plants would cost less than the investments required for new plants. Even if carbon-constraints did drive up the price of generation from coal and natural gas units, the initial investments might make them less costly than the money needed to expand or break ground on a new plant.

Economics and Energy

<u>The Cost of Electricity and the Importance of Efficiency</u>

Regardless of the types of generation built, analysts tend to agree that in the next twelve to fifteen years, the retail rate of electricity for end-use consumers will double.[15] Put simply, the cost of power will go up, and policymakers as well as industrial, commercial, and residential consumers must understand that if they expect to use the same amount of electricity, they must allow for higher costs in their budgets. As an alternative, regulators and legislators have also begun setting goals for energy efficiency and demand reduction. Texas has led in the area through such legislation as HB 3693 passed in 2007 by Rep. Joe

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[14] A detailed analysis can be found in "Nuclear Power's Role in Generating Electricity," A CBO Study by the Congressional Budget Office. Published May, 2008.

[15] In *Moody's Corporate Finance Special Comment*, "New Nuclear Generating Capacity: Potential Credit Implications for U.S. Investor Owned Utilities." Published May 2008 by Moody's Investor's Services.

Straus. Laws like this take the perspective that government should lead by example through reducing its own energy usage before asking businesses to do likewise, but the evidence that now is available helps to make a convincing case for the importance of efficiency.

Efficiency arguments or proposals are often met with skepticism by critics who ask why generation companies who make profits off of consumption would encourage or support lowering the amount of electricity needed. For generators, reductions in the need for future electric generation does not pose as great of an economic threat as the risks associated with building new generation facilities. In addition, running plants at full capacity longer than usual can lead to unexpected downtimes from equipment breakdowns and losses of income from those outages. Therefore, energy efficiency presents one of the strongest possible options for helping to meet the state's future energy needs. But even if all utilities and consumers operated under the best available efficiency practices, the state would still need new investment for generation.

Energy Investment and the Credit Crisis

In the late summer and fall of 2008, the world's financial sectors entered a major economic downturn. In response, the federal government began proceedings to bolster the economy through various programs and packages while increasing the regulatory oversight of the country's investment industries. This has created a fairly chaotic regulatory environment where businesses and lawmakers alike are racing to try and find the best information and take steps to not repeat the mistakes of the past. In practice, the regulatory and financial landscape is changing at a bewildering pace.

Observers note that when the Congress reconvenes under the Obama administration, tightening of regulation is likely to continue at all levels, and this uncertainty causes investors to avoid riskier markets and towards more established sectors. For the energy industry, this means capital will flow towards power plants, transmission lines, and rate-regulated utility markets reversing previous expectations. Power and gas companies had previously increased their budgets for capital expenditures, a move designed to prepare for the widely anticipated "Big Build" to update transmission and distribution lines as well as pipelines.[16] However, initial and incomplete data from the end of 2008 seems to show that lowered electricity usage by Americans may be more than just a response to the economic crisis. It may be a more permanent condition, lowering growth to as little as 0.9% per year by some estimates. If so, utilities will likely continue to consolidate in order to eliminate redundant expenses and they will lower investment in new generation and transmission.[17]

Like all industries, utilities have had difficulty getting access to ready capital during the general economic recession. Oddly enough, however, the Enron crisis that at the time brought a fair amount of shame and suspicion on the industry might have been a good thing for the prospects of a credit recovery now. The small collapse resulting from that company's failure forced energy companies to get rid of their bad debt, which puts them in a stronger position as the post-Lehman period begins. Until the regulatory situation has settled at the federal and state levels, however, businesses will likely refrain from investing in new resources.

Renewable Energy and the Economy

As emerging technologies, renewable generation resources will feel the brunt of any downturn in investment more than many established industries. Observers have also wondered if history will repeat itself in the U.S.'s energy policy. During the oil embargos of the 1970s, American interest in renewable resources for energy skyrocketed along with funding for applied research. But once the price for energy began to go down, so did interest in developing renewables. Industry analysts have begun examining whether or not high costs for oil and natural gas that have crashed during the economic turbulence of 2008 will create a similar boom and bust period for companies that produce renewable electricity generation technologies.

[16] For a more complete discussion of this, see Michael T. Burr's "The Path Forward," in *Public Utilities Fortnightly*, Oct. 2008, page 39.
[17] The continuing discussion between Exelon Energy and NRG Texas is one barometer of how deep these consolidations will go.

As the nation's economy has continued to drag through the second half of 2008, signs of weakness began to emerge in Texas's economy, although the state continued to outpace the rest of the nation. As the Federal Reserve Bank of Dallas noted last summer, as of June 2008, Texas lost manufacturing jobs at a 1.4% rate, which is much slower than the 3.4% decline nationally.[18]

Across Texas, the downturn has led to the cancellation of some wind projects that had filed interconnection agreements with ERCOT. However, wind is the least economically susceptible renewable energy source because of its relatively long experience in the markets. Energy technologies in the earliest stage of development are unlikely to survive this downturn since they rely most heavily on investors. Even early-stage products that show promise will most likely fail in what venture capitalists call "The Valley of Death" between the laboratory and the marketplace.[19] Analysts in this area identify enhanced geothermal, advanced solar thermal, and new grid management technologies as the most vulnerable.

In the third quarter of 2008, venture capitalists invested $87,107,100 in Texas's Industrial and Energy Sector and closed four deals, which is a number within historic norms. However, that total is significantly lower than the $122,711,000 invested during the second quarter of 2008 and the $139,237,100 from the first quarter of that year.[20] More tellingly, all of the venture capital that came into the state's energy sector during Q3 went to companies engaged in the production of or exploration for oil and gas, and it made up 31.6% of all the venture capital investment during that time. By comparison, GridPoint, a start-up, which develops technology to improve the efficiency of the electric grid, raised $120 million in September alone. Silver Spring Networks, another smart grid company, raised $75 million just in October.[21] Generally, as long as the economic

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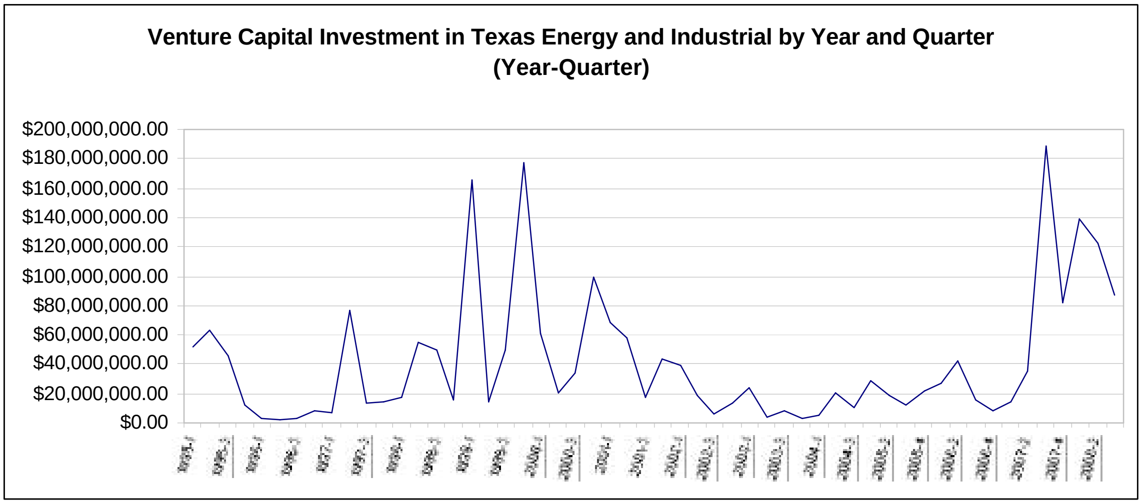
[18] Lalia Assanie and Raghav Virmani, "Texas Economy Feels National Pinch," *Southwest Economy*, published by the Federal Reserve Bank of Dallas, July/August 2008, page 10.
[19] Jonathan Pershing, "Will the Economic Crisis Stall Energy Projects?" World Resources Institute. October 21, 2008.
[20] Data from PricewaterhouseCoopers and National Venture Capital Association's *MoneyTree Report*, which can be accessed at www.pwcmoneytree.com.
[21] "Gathering Clouds," *The Economist*, November 8, 2008, pages 79-80.

downturn persists, technology that will earn a quicker return such as efficiency equipment will prove best able to survive.



The currently low price of natural gas will also likely affect the near and long-term strategies energy companies adopt. For instance, as natural gas fell into the $6 to $7/MMBtu range, wind developers in West Texas began to shift their focus away from building new turbines. But as stated earlier in this report and elsewhere, natural gas prices as exceptionally volatile and international developments will likely drive them up. As gas prices rise along with the expected pricing of greenhouse gas emissions, interest and investment will once again turn towards renewables. In order to continue to lead in this field, Texas should continue investing and developing these new technologies through the economic crisis and come out on the other side at the top of the market.

Advocating that Texas continue to support new energy technologies does not necessarily mean subsidies or prescribing particular types of generation technologies. One researcher with first-hand experience investigating the results of high-budget federal government research notes that the track record of federal financing towards breakthrough technologies has a spotty record. He notes that in 2001, the Energy Department spent $42 billion and only three programs made a "truly significant contribution." And in each case, the programs did not lead to sweeping new technologies. Rather, they produced basic innovations in industries with established track records, such as a new type of drill for natural gas.[22]

Considerations on Future Electricity Development

Even with all of the resources available to them, energy experts have difficulty forecasting trends in the industry. As one put it, "Forecasters of all types—from government, to Wall Street, to the gas and power industries—exhibited the classic bias of placing excessive weight on recent history."[23] In order to try and mitigate this problem as much as possible, the Select Committee sought to find the most important drivers of future events and then to develop scenarios based on those drivers. Based on the committee's research and hearings, four drivers were selected for their central role in future generation development: federal mandates on carbon dioxide emissions; construction costs; financial and regulatory uncertainty; and fuel prices. The next section examines how each of these drivers could affect new generation development.

Carbon Constraints

Although no legislation exists at the time of this publication, most analysts agree that Congress will enact some form of cost for emissions of carbon dioxide in the short-term horizon.

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[22] Robert Fri, quoted in "Experts say government research has done little to push climate change solutions, despite decades of warnings." *ClimateWire: The Politics and Business of Climate Change.* Thursday, Oct. 30, 2008. Accessed 10/30/2008. http://www.eenews.net/climatewire/2008/10/30/4/

[23] James Henderickson and Dan Gabaldon, "The New Gas Wisdom," in *Public Utilities Fortnightly*, December 2008, p. 65.

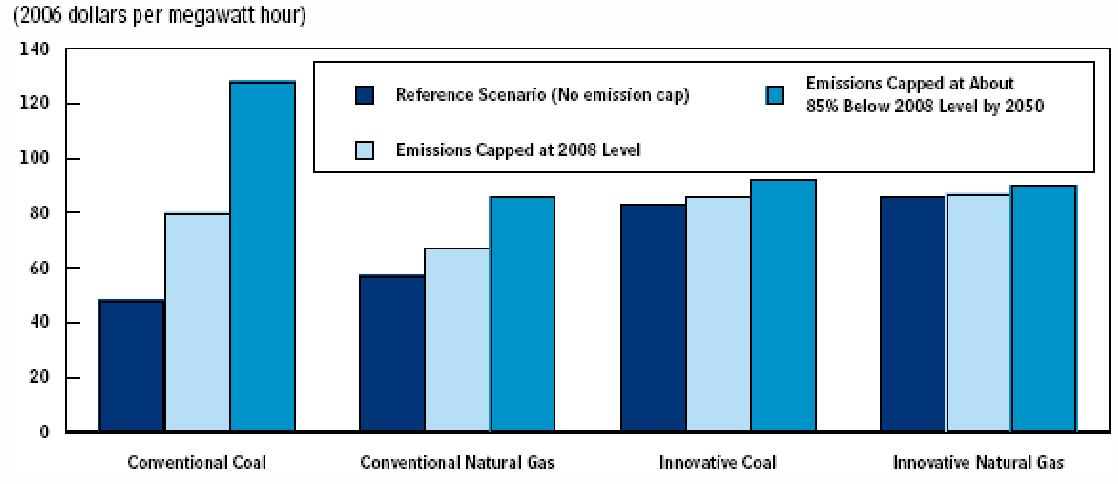

Figure 10 Sensitivity to carbon constraints, data based on CBO's analysis of the relative impacts

The graph above shows the relative sensitivity of different electric generation technologies to carbon dioxide costs. In the reference scenario (dark blue column), carbon dioxide emissions are not constrained at all so there is no price associated with emissions. In the second case (light blue middle column), the number of allowances issued each year for carbon dioxide emissions corresponds to a cap roughly at 2008 levels of emissions. In the third case, the number of such allowances corresponds to a cap of 85% below the 2008 level by 2050. Conventional coal plants in this scenario use pulverized coal technology and conventional natural gas are assumed to use combined-cycle turbines. Both innovative coal and innovative natural gas technologies are assumed to capture and store carbon dioxide emissions. Nuclear and renewable sources do not have any associated carbon dioxide emissions during the actual generation process, so they are not included.

Construction Costs

In this scenario, the CBO calculated the reference scenario using estimates of overnight construction costs from the Energy Information Administration. In the "Lower Construction Costs" model, CBO halved the estimates and recalculated levelized costs. In the "Higher Construction Costs" model, they doubled the estimates.

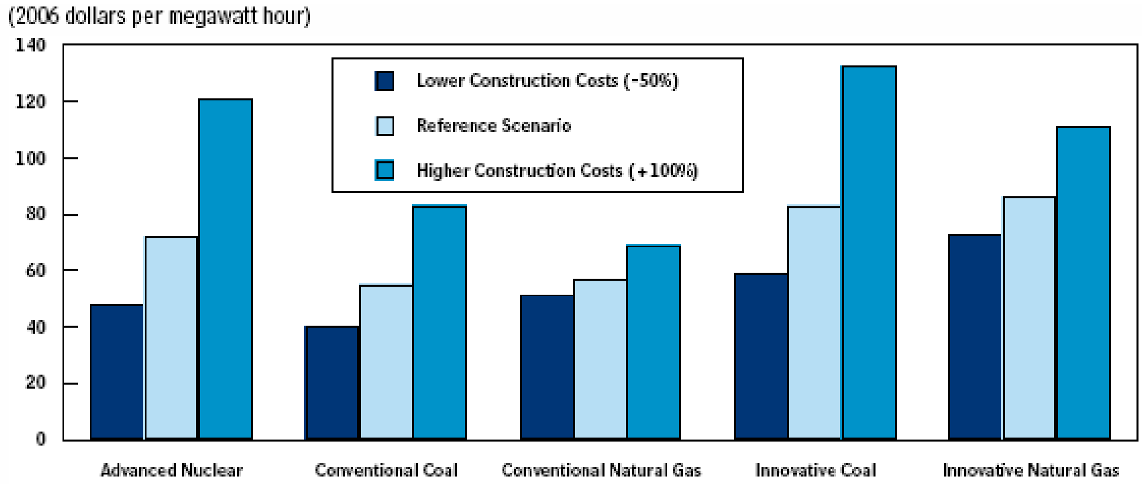

Figure 11 Sensitivity of new generation sources to rising construction costs

One of the most interesting points on this graph is that under the scenario that envisions rising construction prices, advanced nuclear is still more economical than innovative coal. This fact comes from the problems with developing innovative coal projects and a lack of a market-viable demonstration project.

The market for construction materials plays a significant role in new electric generation because of the specialized and resource intensive development required for them. In the last year, commodities used in the construction of new generation plants have all increased. Steel has seen the largest increase, followed by copper, generating equipment, and concrete.[24]

As the average cost of construction materials went down in the United States following its peak in the mid 1970s, the cost of electric utility construction also dropped.
In 2000 and 2001, construction costs began to rise across the country and the capital required to build large-scale coal and nuclear facilities was too great to recover the costs created by the upturns. Comparing this data to the addition of electric generation capacity in Texas, one can see that utilities tended to add the less capital intensive natural gas generation facilities, which also have a shorter lead time to build.

[24] U.S. Bureau of Labor Statistics; http://www.bls.gov.news.release/ppi.t02.htm and http://www.bls.gov/ppi/ppitable05.pdf.

Rising construction costs have also led to upward pressure on generators and electric utility rates. As noted in several major reports on this subject, some of the construction cost trends are straightforward, such as rising costs for construction materials. Dramatically increased prices for raw materials, such as cement and steel, require utilities to add in significantly higher costs. Recently, the world has seen higher prices after a decade of relatively stable or even declining real construction costs. From January 2004 to January 2007, the costs of steam-generation plants, transmission projects, and distribution equipment rose by 25 to 35%. In 2006 alone, the cost of gas turbines increased by 17%.[25] As a result, the levelized capital cost component of baseload coal and nuclear, two capital-heavy generation sources, has risen by $20/MWh.[26] To demonstrate the fluid dynamics of this market, however, construction commodities have begun to go back down in the last few weeks of 2008 and the beginning of 2009.

Increased construction materials cost also impact alternative sources of electric generation, including renewable generation.[27] One 2006 study developed for a group of states noted that commodities used in the manufacture and installation of wind turbines and the associated ancillary equipment, including cement, copper, steel, and resin for the blades have all increased in recent years. Therefore, the study's authors note that the cost of new wind projects rose sharply over just a two-year period perhaps offsetting any economic benefits gained by the lowered fuel consumption.[28]

Financial Uncertainty

As the past year has shown, we live in a time when investors are faced with a great deal of uncertainty about future returns and costs. Both innovative and conventional natural gas are largely unaffected by financial uncertainty, while other capital-intensive projects such as advanced nuclear and innovative coal have significant differences in how much investors might expect.

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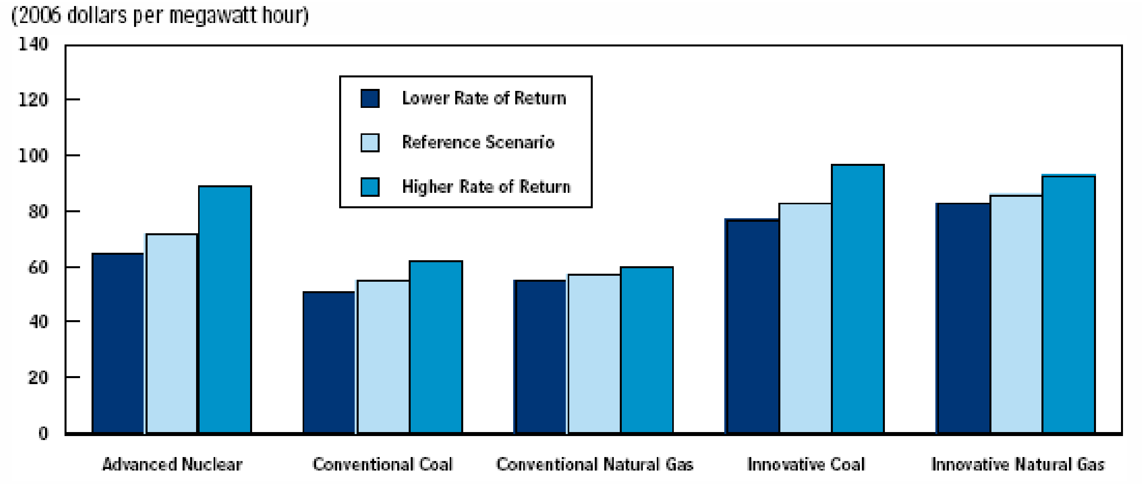
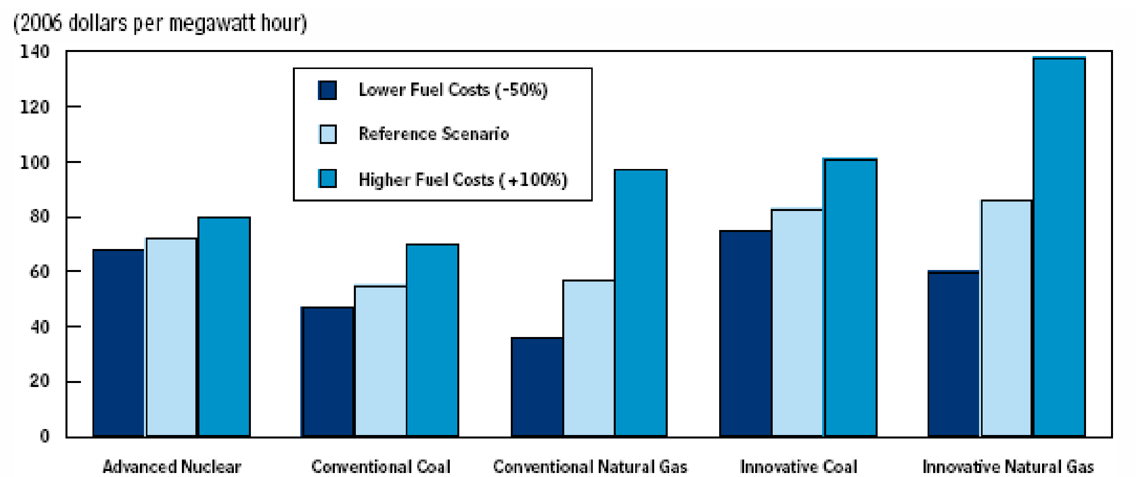
[25] For more information, see Marc W. Chupka and Gregory Basheda's *Rising Utility Construction Costs: Sources and Impacts*, prepared by The Brattle Group for The Edison Foundation, Sept. 2007.
[26] Chupka and Basheda, page 2.
[27] Costs related to construction are explored in-depth in the next section.
[28] See the Northwest Power & Conservation Council's "Biennial Review of the Cost of Wind Power," July 13, 2006. Available at http://www.bpa.gov/Energy/N/projects/post2006conservation/doc/Windpower_Cost_Review.doc.



<u>Fuel Costs</u>

As discussed in this report and elsewhere, natural gas is most susceptible to changes in fuel prices, although all generation sources suffer when fuel costs go up. Because of its relatively inexpensive fuel source, nuclear is least susceptible, while coal tends to have an acceptable difference in sensitivity to fuel.



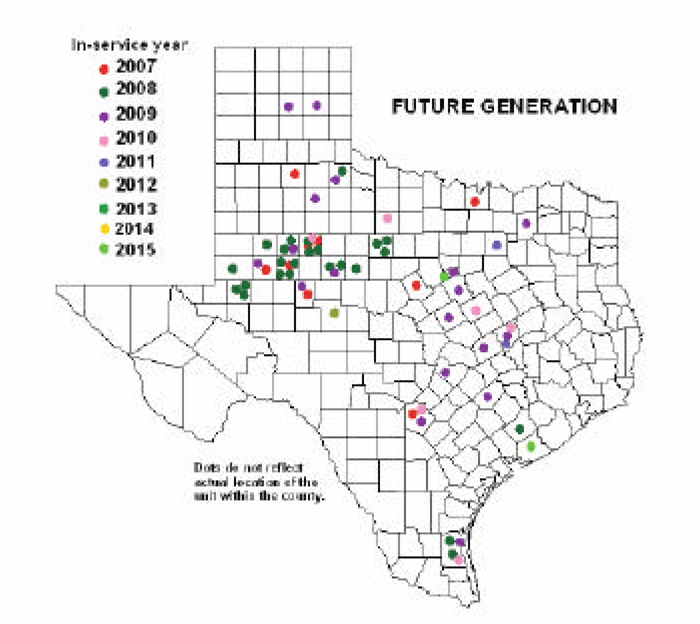
Forecasting Electric Demand

After considering the relative sensitivity to each of the most important drivers, the Select Committee examined short and long-term possibilities for generation demand. Short-term is much easier in that ERCOT requires an interconnection request for new generation sources. Long-term forecasts pose other demands that will be discussed in the coming sections.

Short-Term Texas Forecast

In November 2008, the System Planning Division of ERCOT reported the ISO was tracking 244 active generation interconnection requests, totaling more than 102,000 MW.[29] Of those requests, approximately 48,000 MW came from wind generation companies, while approximately 28,000 MW were made by natural gas generators. Nuclear requested 12,386 MW and coal reported 9,506 MW. During 2007, however, wind generation produced the most megawatts of signed interconnection agreements with 17 accounting for 3,064 MW of the total 3,900 MW of signed agreements. As noted in the report, however, there is still a great deal of uncertainty associated with many of the proposed plants, and some of the requests are for alternative sites. Therefore much of the capacity will not be built. There is also the question of whether or not interconnections with new technologies will take place. In the November 2008 report, ERCOT reported tracking 863 MW of solar generation, but the details of the filing were not public at the time this report went to press.

[29] System Planning Division, "Monthly Status Report to Reliability and Operations Subcommittee for November 2008," ERCOT, November 2008.



Long-Term Generation Forecasts

<u>Planning for Uncertainty</u>

Because technologies, societal structures, and social networks constantly change, no single methodology or model can consistently forecast future demand with any accuracy. Failing to acknowledge the problems inherent in any energy projection means that policymakers and planners will make critical mistakes about future needs.

For the purposes of this report, a survey of the existing research identifies the following nine drivers as fundamentally important in the future of electricity:

1. Development in the primary fuel markets;
2. Public views and responses to externalities such as the idea of climate change;
3. Growth and structure of the world's economy;
4. Changes in political values among regulators;
5. Changes in social networks and social values;
6. Business models for the electric industry;
7. Natural events related to, or perceived to be related to, climate change;
8. Changes in the price of electricity and customer responses to them;

9. Changes in the infrastructure of the power industry.[30]

Of these, two were identified as central to all others: developments in the primary fuel markets, especially natural gas, and changes in the public's views and responses to externalities, such as carbon dioxide emissions.

Complicating the issue is the question of energy efficiency. As indicated earlier in the report, Texas has already taken the lead in efficiency through the enactment of HB 3693 from the 80th Regular Session, but in order to allow for a range of possibilities, this report operates with the possibility that due to economic or technological deficiencies, the policy could be abandoned over the next half century.

Therefore, the four scenarios showing the interaction of the key drivers were placed within the framework of two larger meta-scenarios. Business as Usual operates under the assumption that efficiency policies do not gain a foothold and growth in the need for generation continues as it has in the past. The High Efficiency meta-scenario assumes that the maximum possible efficiencies are achieved by generators and consumers, so overall demand shifts downward.

As stated above, scenarios are not rigid, fixed plans. Rather they provide insights into how we should respond to changing conditions and areas of high uncertainty. Therefore, it is useful to think of the drivers on a continuum that presents the four possible developments.

Depending on how the primary change drivers interact in the future, the likelihood of different scenarios changes. As time goes on, these assumptions and their relative importance will change. However, the pace of that change is likely to be slow and gradual as opposed to suddenly disruptive.

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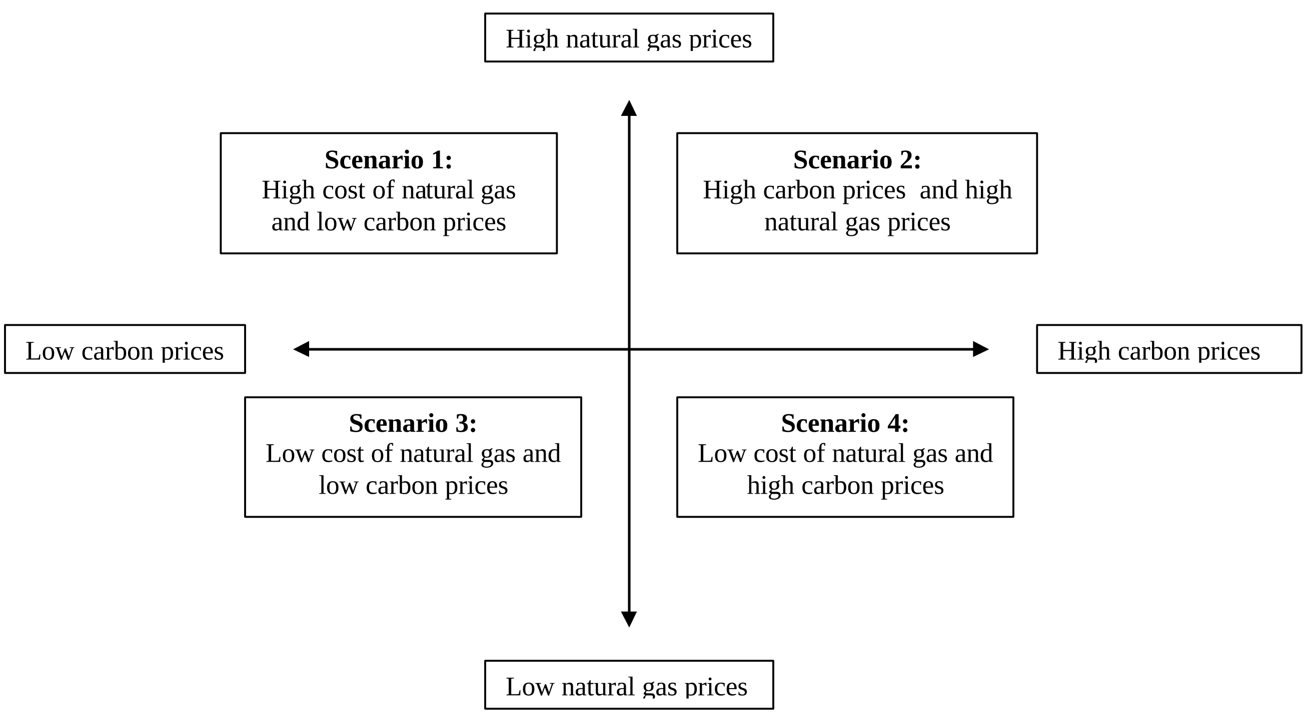
[30] Program on Technology Innovation: Electric Power Research Institute--Electric Power Industry Technology Scenarios: Preliminary Results. Dec. 2005. S. Gehl, Project Manager.

Key Drivers for Future Generation: Natural Gas and Carbon Prices

The two major factors unknowns in either the Business As Usual or the High Efficiency cases related to the future of electric generation in Texas are the future costs of natural gas and what the economics of future federal mandates on carbon dioxide will be. Therefore, under both generation scenarios, there are four possible situations: high natural gas prices with no carbon price; high natural gas prices with a carbon price; low natural gas prices with no carbon price; low natural gas prices with a carbon price. On a continuum, the four scenarios would look like this:



In the development of this report, natural gas prices are defined as high if they prevent natural gas combined cycle plants from acting as baseload facilities. Low natural gas price, conversely, allow gas to act as baseload as they did in the Fall of 2008 when they made up approximately 40% of electricity sales outside of industrial generation.[31]

[31] This methodology and the standards used to bound the carbon dioxide constraints come from the Bureau of Economic Geology's report, "Water Demand Projections for Electric Generation in Texas." The Select Committee is very grateful for the assistance of that paper's authors, Ian Duncan, Carey King, and Michael Webber.

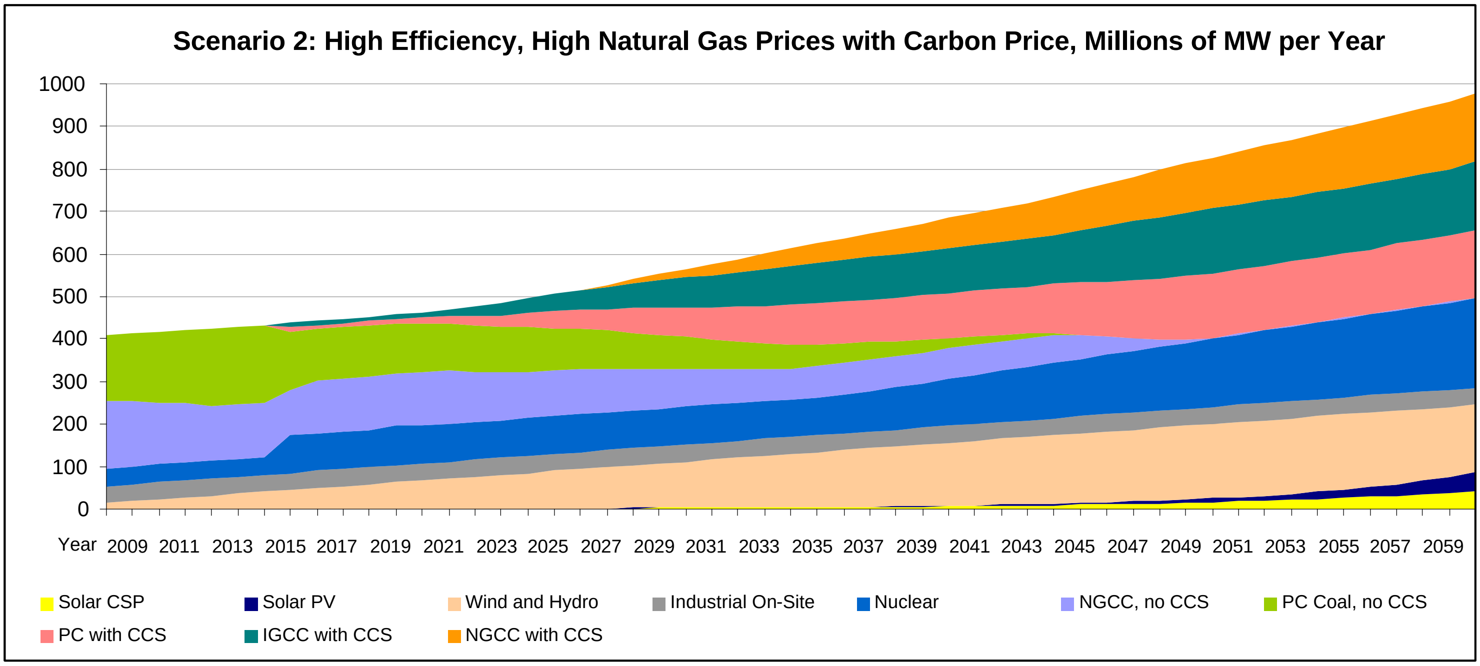
Regardless of whether the federal government embarks on a course under "cap and trade" programs" or a straight carbon tax, the program will establish a price for carbon dioxide, also known as a "carbon price." As the carbon price goes up, so does the likelihood of generators putting carbon capture and storage technologies into place. Because of the extra electricity needed to operate facilities with carbon capture and storage, the overall amount of power generated also rises with the carbon price.

For the scenarios that include a carbon price, this report uses the emissions levels laid out in the Lieberman-Warner Climate Security Act of 2007. Although this legislation did not meet with a warm welcome in Congress when it was first introduced and recent actions by the Congress indicate that it is moving in a less restrictive direction than Lieberman-Warner, this bill represents a worst-case scenario for emissions reductions and provides a good estimate for the highest levels of required emissions reductions. The target is to lower approximately 97% of 2005 U.S. emissions by 2012 to 29% of 2005 U.S. emissions in 2050. The Energy Information Administration reports that Texas emitted 150,589,000 metric tons of carbon dioxide from coal-fired generation and 104,094,000 metric tons of carbon dioxide from natural gas generation in 2006. Therefore, to reduce emissions by 71% in 2050, Texas must reach annual electric carbon dioxide emissions of about 74,000,000 metric tons of carbon dioxide.

Scenario 2: High Efficiency, High Natural Gas Prices with Carbon Price

Based on existing Texas laws, the current economic situation, and regulatory changes at the federal level, the Select Committee determined that the most likely scenario of the four is that consumers and generators will continue to make gains in energy efficiency, carbon dioxide emissions will be priced, and natural gas prices will continue to rise. As stated in the opening discussion of this section, heavy energy consumers continue to look for ways to save energy through more efficient means, while generators, faced with higher capital costs and growing environmental concerns, are looking for ways to do more with the levels of energy they currently produce.

Despite the price-volatility associated with natural gas, it will still be a leading choice in the near-term as Texas moves towards greater nuclear capacity and more renewable energy sources. That demand coupled with a worldwide crunch on natural gas will cause prices to rise, but in order to meet demand and stabilize the electric grid, gas must continue to meet the demand of consumers in Texas.



Based on this forecast, pulverized coal without carbon capture and storage begins to contribute less and less energy to the state until 2045 when it exits the market completely. Combined cycle natural gas without carbon capture and storage also sees a decline even though its emissions are relatively small. However, the need for electricity that can be readily ramped up will mean some smaller gas fired plants without capture technologies will still exist. By 2026 they will make up less than 20% of the Texas market and by 2042, they will dip below 10%.

Although high capital costs and long permitting and construction times prohibit any major short-term additions of nuclear generation, by 2015, nuclear will make up 20%. Renewable electric generation technologies as well as IGCC and carbon capture methods pose more of a problem for forecasts. As noted earlier in this report, in order for renewable generation sources to play a larger role in the state's energy mix, changes in the transmission and distribution system will be needed to handle and move the electricity from remote sources, as in the case of wind and large-scale solar, and also for delivery to nearby loads, such as we required with household and commercial solar or small wind turbines. Further, if these intermittent sources are to become a major part of Texas's electric makeup, then new breakthroughs in energy storage, weather forecasting, and backup sources will be necessary.

The futures of IGCC and carbon capture are even less clear. DOE studies have demonstrated the viability of an IGCC generation plant, however, the costs of those plants makes them uneconomic. Moreover, IGCC does not reduce emissions from existing plants, which need to be retrofitted with unproven carbon capture technologies. Therefore, the forecasts for wind, solar photovoltaic, commercial scale solar, IGCC with carbon-capture and storage, and natural gas combined cycle with carbon-capture and sequestration are based on well crafted studies, but they represent possibilities, not actualities. The novelty of these technologies means that they do not have any historical information such as we have with other sources.

Based on these studies, the projections indicate that by 2060, all solar generation will account for 8.8% of Texas generation, although as the graph above shows, those numbers will continue to grow after that point. Pulverized coal with carbon-capture and storage accounts for approximately the same generation totals as IGCC with carbon-capture and storage, totaling 32.6%. Nuclear will account for 21.4% mainly due to the inability to place nuclear facilities across the state in any great number because of the problems associated with licensing and siting. Combined-cycle natural gas with carbon-capture and storage will makeup 16.3%, which will likely compliment wind generation as the turbines bring in 16.2%.[32]

The specific numbers that created this projection appear as Appendix A of this report. In developing this forecast, the Select Committee assumed ERCOT's annual demand growth of 1.8% with a loss from transmission and distribution of 6.3%. The High Efficiency

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[32] The remaining small percentage comes from industrial on-site generation from natural gas and other small-scale generation, such as biomass.

meta-scenario uses the assumptions developed in the American Council for an Energy-Efficient Economy's 2007 report on the possibility of demand reduction strategies through energy efficiency in Texas.[33] That report states that by 2023, 101 million MWh of electric demand could be realized through efficiency programs, renewable sources, and combined heat and power facilities. Therefore, the High Efficiency meta-scenario subtracts this amount beginning in 2023 and maintaining the ratio established at that point. It represents a reduction of 10.5% from the Business as Usual meta-scenario.

Moving Forward

In discussions about the state's energy future, everyone agrees that we must develop more of everything. However, few people go beyond that to describe how exactly we do that. As stated earlier, legislators have little input into the development of new technologies and even if the laws were changed to allow them more say in the matter, policymakers are notoriously bad forecasters. But legislators and regulators can create an environment that promotes these innovations without unduly influencing any one.

The first problem to deal with is the electric grid's infrastructure. As we have seen in West Texas, a rush to build new wind turbines without adequate transmission throws the economic conditions out of line and floods the market for that area. In order for Texas to develop an electric grid capable of handling multiple generation sources and adapting to changes in the market, advanced metering technologies should be deployed. In some of the hearings, legislators voiced their concerns about socializing the costs of advanced meters and wondered if they would be worth the investment that the Legislature is asking the taxpayers to make.

In order to answer this question, it might be useful to compare advanced meter technologies with another major transmission and distribution project in Texas, the CREZ project. Some observers have wondered whether this is the best plan to work on the electric grid since these CREZ lines will cost a significant amount and the cost will be

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[33] From "Potential for Energy Efficiency, Demand Response, and Onsite Renewable Energy to Meet Texas's Growing Electricity Needs," Report Number E073, American Council for an Energy-Efficient Economy.

socialized throughout ERCOT even though it is not clear that doing so will reduce the cost of power. To get some idea of the CREZ project's size, in 2007, Texas had 8,792 miles of transmission lines over 200 kV. When all planned transmission work is completed in 2017 there will be 9,684 miles.

However, the CREZ project proposes to build more than 2,300 miles of bulk transmission lines, more than 25% of the total existing bulk transmission currently installed in the state. While these new lines will certainly make it easier to move the intermittent power generated by wind to the load centers, they will also require most of the available labor in the state as well as pushing ratepayers' bills even higher, decreasing their tolerance for additional charges.

Advanced meters, on the other hand, give consumers the ability to better control their consumption and thereby lower the total amount of electricity needed in ERCOT. They also allow homeowners and small businesses to generate and sell their own electricity through small-scale renewable resources. At a relatively small cost each month, advanced meters are a way that customers can not only participate in the electric market but also lower their bills. Therefore, it appears that advanced meters are at least as useful as the widely accepted CREZ lines and are just as important for the development of new resources.

Therefore, the states should consider as one of its top priorities the need to build and implement the nation's most advanced transmission system. ERCOT's unique standing outside of FERC control and without any inter-state jurisdictional issues makes it singularly able to move quickly in this area. This new grid would include advanced metering and communications infrastructure to enable end-use efficiency, demand response, and distributed generation. As a recent report by the RAND Institute noted, "Governments are neither building new capacity to match the growth in demand nor maintaining existing infrastructure sufficiently to reverse deterioration…But rebuilding and repairing critical infrastructure systems is only part of the challenge. We need to reinvent the systems themselves."[34]

Methods and Benefits of Grid Improvement

Advanced Metering Infrastructure (AMI)

Although it is not a generation technology, advanced metering technologies, also known as "smart meters," will play a major role in Texas's energy future plans. The major benefits of smart meters are that they allow utilities to better utilize existing resources while allowing consumers to better manage their energy usage.

Deployment of advanced metering systems includes installation of the meter, which provides 2-way communications between the consumer and the utility. Meters detect and report customer outages as well as provide dynamic pricing, commonly called time-of-day pricing. As discussed in the first section of this report, the price of electricity does not remain constant throughout the day and is most expensive at peak demand times. Advanced meters give customers the opportunity to understand these costs throughout the day and the vary their usage accordingly.

AMI deployment allows retail electric providers to offer competitive programs and distinguish themselves from other market players. In public testimony before the Select Committee, Reliant Energy indicated that in 2008, they expected to bring three new programs to customers including a time-of-use, 1-year rate plan that would bring customer prices down by 7%.

It also adds a major missing part of a competitive energy market: transparency from the consumer end. Under the current competitive environment, unless consumers are on a fixed plan, they only learn the price of electricity after they have used it, meaning that they have very little if any control over the process.

[34] Martin Wachs, "Innovative Infrastructure," in *Issues Over the Horizon*, Summer 2008 *Rand Review*, 19.

In 2005, the Texas Legislature passed House Bill 2129 in order to encourage the implementation of advanced metering across the state. The bill increased the reliability of the regional electric network, enabled dynamic pricing and demand response, improved the deployment and operation of generation, transmission, and distribution assets, and authorizes utilities to assess a non-bypassable surcharge to recover the costs incurred through the deployment of advanced meters.

Demand-Side Management

Demand-side management means any activity taken to reduce electricity demand in response to price, incentives, or utility orders in order to maintain reliable service during periods of high demand. This could mean anything as simple as providing incentives to customers who reduce their consumption through weatherization of their homes to having certain heavy loads such as manufacturing plants ready to go off the grid in times of electric emergency.

A system operator such as ERCOT could require a single, large demand source to go offline, or with the proper technology in place, reduce demand from a group of smaller sources in order to achieve the same results.[35] Following a series of rolling blackouts in April of 2006, ERCOT asked the PUC for an expedited review of its programs designed to allow load-shedding.

Utilities around the U.S. have implemented demand response, time-based rates, and advanced metering.[36] The attraction of these technologies is that customers can vary their usage in response to price signals. Because of their two-way communications capabilities, advanced meters also allow utilities to diagnose and fix line problems without having to physically assess the damage.

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[35] Studies performed by the Lawrence Berkeley National Laboratory have found that ISOs have much lower levels of confidence in economic demand response programs, but they do see them as ways to make markets more efficient and economic.

[36] For an in-depth look at these programs, see FERC's 2007 staff report *Assessment of Demand Response and Advanced Metering.* Published September 2007.

Outlook for Major Generation Sources

Background

During the last two decades, Texas and the rest of the U.S. have seen major changes in the portfolio mix of their electric generation capacity. Driven in part by environmental requirements and also by rising resource costs, the price of building a new plant has more than doubled in the last 10 years alone. In response to these market factors, many generators across the country have shifted their focus from higher cost, longer term, lower return investments to shorter term, low cost, higher return structures. By way of an example, the cost of a combined-cycle natural gas plant, which is the most commonly build new generation, usually costs around $700,000 per MW and are typically 200 to 400 MW in size. Total costs for this type of facility run between $200 to $400 million. On the other hand, a new clean coal plant with carbon sequestration usually runs about 3.5 times as much, roughly $1.4 billion.[37] In times of uncertainty about the regulatory and financial environment, investors in both regulated and unregulated markets tend to favor short term, lower cost investments, which poses a major challenge to U.S. generators who need reliable and affordable baseload generation.

Natural Gas Generation

The Current State of Natural Gas

Most of Texas's electric generation capacity and actual generation comes from natural gas plants. Across the state, seventy-seven new natural gas plants have come online since 1995 with another twenty-four projected to come online between 2009 and 2012.[38]

In 2001, optimism about the future of natural gas was running high. The Energy Information Administration projected that 29 trillion cubic feet of gas would be available by 2010 and 35 trillion cubic feet by 2020.[39] Those projections were based on assumptions about high growth rates of natural gas use in electric generation and continued growth in domestic production and Canadian imports.

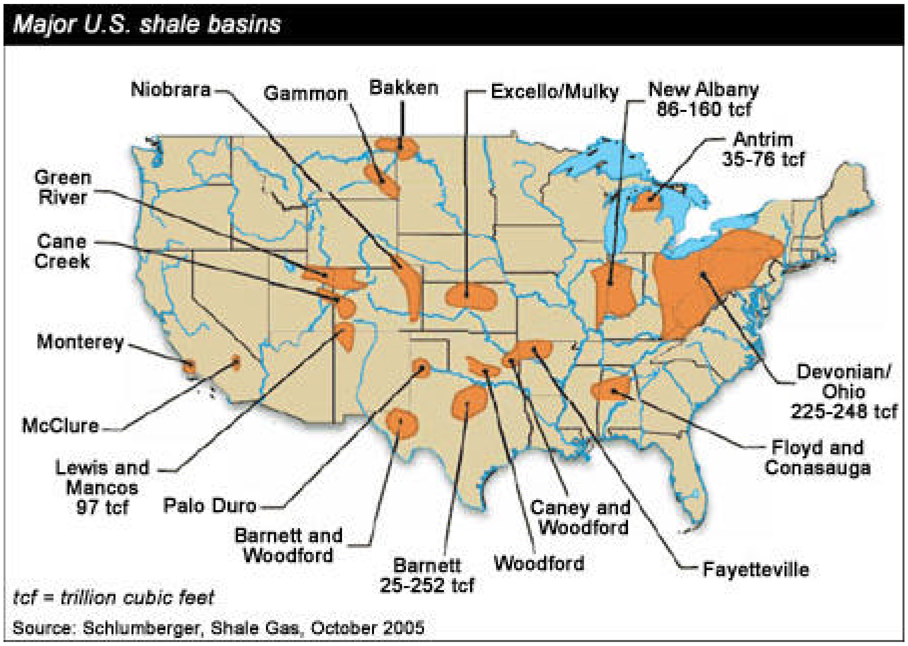
[37] From Chapter 2 of DOE's draft report, *Lighting Our New World Energy Future.*
[38] Twenty-three natural gas generators have been cancelled, mostly due to the expiration of the plant's air quality permit.
[39] EIA's 2001 Outlook for energy.

The difference between the long term projections for natural gas in 2001 and 2008 is about 13 trillion cubic feet. The discrepancy between the two is caused by the increase in the price of natural gas and the ready availability of substitute fuels for electric generation, such as coal. Prices have risen because supply has decreased and will continue to do so while demand from natural gas-fired capacity has shot up. Domestic production is expected to decline steadily falling below 20 trillion cubic feet by 2030. The installation of natural gas and combined cycle units has driven that demand as electric generators anticipate federal restrictions on carbon dioxide emissions.

Natural gas production across the lower 48 states has increased during the last part of 2007 and the first quarter of 2008, but more than half of that increase came from Texas where supplies grew by a very high 15%. EIA attributes this growth to improved technologies that allow drilling in unconventional resources. One indicator of the transition to unconventional production is the increase in horizontal wells. In the 1990s, 40 rigs were drilling horizontally while in May 2008, 519 rigs had this capacity.[40]

At the forefront of this drilling technique, Texas accounts for one-third of the total U.S. natural gas production. Horizontal drilling in the Barnett Shale has buoyed these efforts. The Barnett Shale contains huge reserves of natural gas, but the rock is too dense for rigs to remove gas at high rates without extensive additional efforts. Moreover, most the Barnett Shale lies under the city of Ft. Worth and its suburbs. Natural gas companies have still been able to produce gas in this urban environment, including the placement of rigs at the Dallas/Ft. Worth airport and other densely urban areas.

[40] EIA, "Is U.S. Natural Gas Production Increasing?" Articles in Brief, June 11, 2008. Accessed Oct. 30, 2008. http://tonto.eia.doe.gov/energy_in_brief/natural_gas_production.cfm



12 Major shale basins throughout the United States

When natural gas serves as the fuel for electric generation, one of two kinds of turbines can be used:

- Combined-cycle turbines generate electricity in two processes:
    - First using the energy produced by burning natural gas
    - Second by harnessing residual steam heat;
- Single-cycle turbines only use the energy from burning the natural gas.

Single-cycle turbines are not as efficient for the production of baseload energy because they produce less energy from the same amount of fuel as combined-cycle plants, however they do operate well as peaking plants because they are the easiest to ramp up and down in response to demand. This makes single-cycle generation the leading complimentary generation technology for renewables such as wind.

Since 1994, natural gas capacity has expanded more than the capacity of coal or nuclear, confirming the projections of EIA at that time. However, that agency and others believe that the prices for natural gas will not return to the rates seen in the 1990s and that rising demand will always outstrip supply.

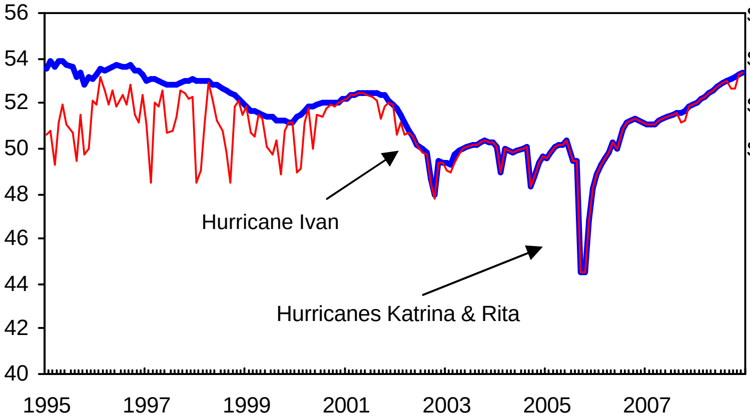
The CBO estimates the price per megawatt hour of electricity generated by conventional natural gas to be $40 (in 2006 dollars), although the authors of that study note that the long-term price for natural gas has been notoriously difficult to predict.

As has been cited in this and many other publications, the high volatility of the price of natural gas has led to pricing uncertainty in the Texas electric market. Natural gas is particularly sensitive to short-term supply and demand shifts in recent years because of market inelasticity. In the short-term, consumers cannot rapidly switch fuel sources and the current infrastructure across the U.S. is already operating near full capacity. Natural gas is also highly subject to weather-related events, such as hurricanes. In the summer of 2005, hurricanes along the Gulf Coast caused more than 800 billion cubic feet of natural gas production to be shut in from August 2005 to June 2006. That amount represents approximately 22% of annual production in the Gulf.

Market conditions for other electric generation fuels also have an effect on the price of natural gas. Because baseload power comes generally from coal and nuclear power, natural gas tends to cover incremental power requirements during peak demand. But if one of those other fuels experiences a disruption or sudden increase in price, it could set off an increase in the demand for and price of natural gas.

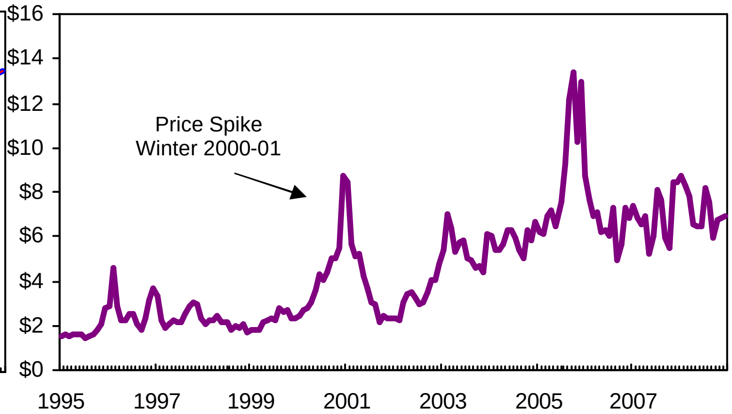
Finally, economic conditions across the country influence gas markets. Because the markets lack real-time supply and demand data such as production, capacity, or consumption volumes, market players tend to use price as a barometer of market conditions. As the economy improves, increasing demand for goods and services from industrial sectors creates an increase in demand for natural gas.

Lower-48 Dry Gas Production Vs. Dry Gas Capacity (BCFD)



Source: Energy and Environmental Analysis, Inc.

Historical Gas Price at Henry Hub ($ per MMBtu)



Source: Platts Gas Daily & Energy and Environmental Analysis, Inc.

As seen in the graphs above, the 1990s saw a time of relative price stability as gas supply and demand did not significantly diverge. The blue line in the graph on the left represents production capacity of natural gas and the red line represents actual gas production. Beginning in the winter of 2000 and 2001, supply and demand began to grow further apart leading to a tight balance between the two. Additionally, the powerful storms that have hit the Gulf Coast have led to lowered available supplies of gas.

Analysts believe that this trend will continue leading to higher gas prices and increased price volatility.[41] Using 2008 as an example, the state saw summer prices for natural gas as high as they have been in recent memory and we have also seen temporary price drops during the fall and winter of 2008. Researchers believe that the price of natural gas will continue to see greater variability making it harder to predict future trends.

Coal Generation

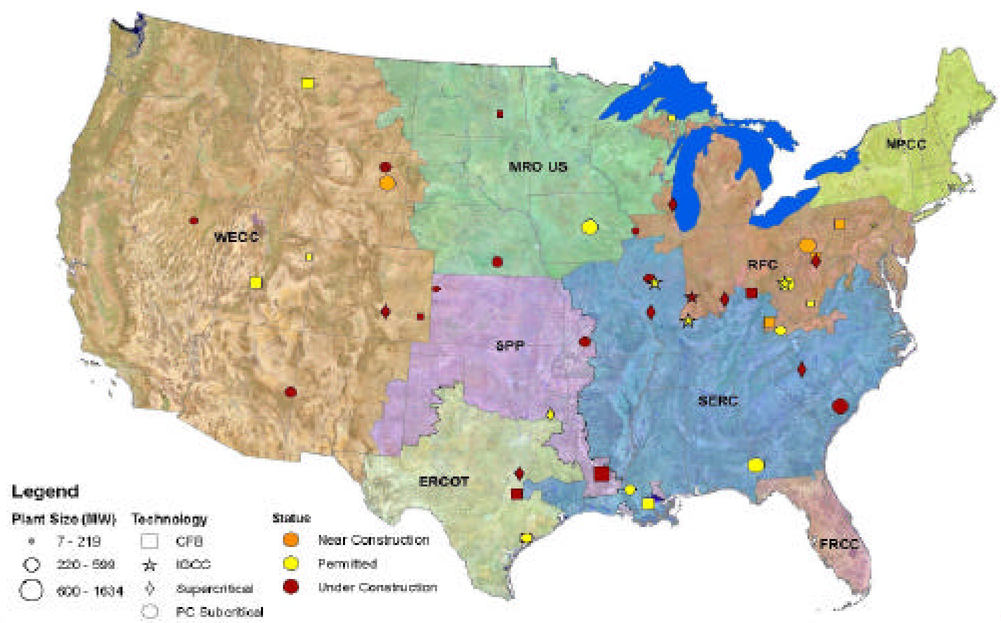
Current State of Coal Generation

In 2006, 36.5% of Texas electricity came from coal-fired plants, below the national average of 51% of all electric generation. Of the 25 Texas plants that have been announced since 1995, four have been built and four more are currently under

[41] Kevin R. Petak, Vice-President, Gas Market Modeling, Energy and Environmental Analysis, Inc. an ICF International Company. Presentation "Gas Supply and Demand in an Uncertain Environment" at the 2007 EIA NEMS Conference, panel on Varying View on the Future of the Natural Gas Market, in Washington, D.C., March 28, 2007.

construction. These plants that are currently being built will provide a major infusion of capacity into the Texas electric market if they are brought to completion. Combined, they are projected to account for 3041 megawatts of capacity.[42] Across the United States, there are about 600 coal-fired plants with 110 in various stages of development.

However, there are serious concerns within the coal-fired generation industry, even outside of concerns about emissions. Prices for coal have doubled in the past two years and as the price of natural gas has gone down, utilities have increasingly depended on the less capital intensive generation capacity of gas. According to a report by the National Energy Technology Labs, delays and cancelations of coal plants have come about because of regulatory uncertainty regarding emissions reductions decisions and strained project economics that have arisen out of the rising industry costs.



13 Geographical Map by NERC Regions: Coal-Fired Plants, Permitted, Near Construction, and Under Construction. From NETL's "Tracking New Coal-Fired Power Plants" by Erik Shuster, June 30, 2008

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[42] From the Public Utilities Commission's data on electric capacity additions in Texas since 1995 available at http://www.puc.state.tx.us/electric/maps/gen_tables.xls.

Recent changes at the federal level and decisions by the U.S. Supreme Court and the EPA signal a trend that does not favor emissions-intensive generation sources such as coal. In April 2007, the Supreme Court ruled that the EPA does have the right to regulate carbon dioxide and other greenhouse gases under the Clean Air Act.[43] More recently, in November 2008 the EPA's own Environmental Appeals Board blocked a permit for a proposed coal plant near Vernal, Utah. Although the particular circumstances of both these decisions do not apply directly to Texas, they send the clearest signals that high-emitting generation sources will likely face greater federal scrutiny in the near future and utilities seem to be reflecting this in their construction planning. NETL reports that since the end of 2007, 3,853 MW of new coal-fired generation have been proposed and 4,133 MW have been removed.[44] In Texas, eleven announced coal plants have been removed in the last few years.

Stricter caps on the amount of carbon generation sources are allowed to produce will mean that coal-fired generators will need to put more capital into retrofitting their older plants and developing new forms of carbon capture and sequestration. If regulations designed to lower greenhouse gas emissions make the price of coal prohibitively expensive, then generators might be willing to rely more heavily on natural gas as a bridge fuel until new technologies and demand reduction programs go into effect.

Costs and Availability of Coal Generation

The CBO estimates the fuel costs for conventional coal plants at $40 per megawatt hour of electricity.[45] When considering the current state of coal, we also need to take into consideration the costs of transporting raw coal from mines to generation facilities. While trucks make up a small part of the mine to market routing of coal, the majority travels by train. Industry participants have expressed their concerns about rail disruptions affecting the entire energy sector. For instance, in 2005 weather and accumulated coal dust on track beds caused two derailments out of the Powder River Basin, which supplies

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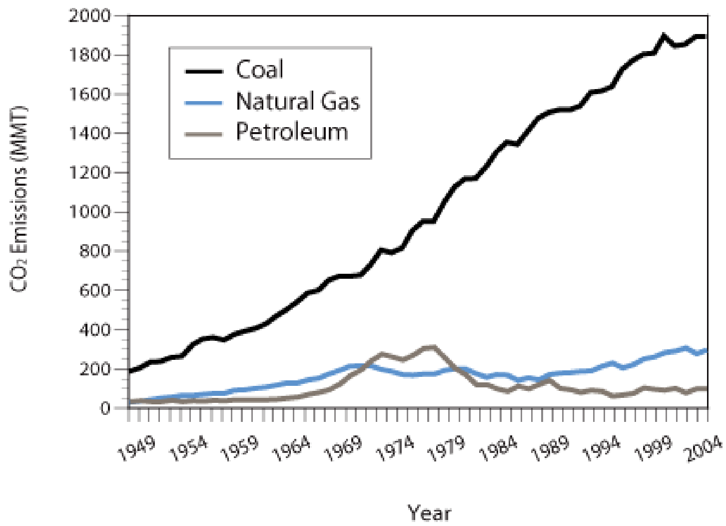
[43] See Massachusetts et al. v. Environmental Protection Agency et al., No. 05-1120, Argued November 29, 2006 and decided April 2, 2007.

[44] See page 19 of Erik Shuster's "Tracking New Coal-Fired Power Plants," published by the National Energy Technology Laboratory, Office of Systems Analyses and Planning, June 30, 2008.

[45] See "Nuclear Power's Role in Generating Electricity," (May 2008), page 18.

most of the coal used in Texas. Further, rail companies have said that further consolidation savings are no longer available and that they will need higher rates in order to continue developing the rail lines to meet demand.[46]

Although coal provides reliable and inexpensive electricity due to its relatively low costs and widespread availability, the environmental impact is high. Generation from coal releases significant amounts of local pollutants such as mercury and particulate matter and also global pollutants such as carbon dioxide.



Source: Report # DOE/EIA-0573(2004)

1949-1959: Calculated from energy data in the Annual Energy Review.
1960-1989: Calculated from energy data in the State Energy Data Report.
1990-2004: Estimates documented in Greenhouse Gases in the United States 2004.

As the above image from the Energy Information Administration shows, coal produces far more carbon dioxide than either natural gas or petroleum, but as noted earlier, we must also keep in mind that coal provides inexpensive, reliable electricity.

Clean Coal Technologies/ Carbon Capture and Storage (CCS)

According to a study performed by EPRI and the Edison Electric Institute, clean coal technologies will likely not become commercially available until 2015. IGCC and

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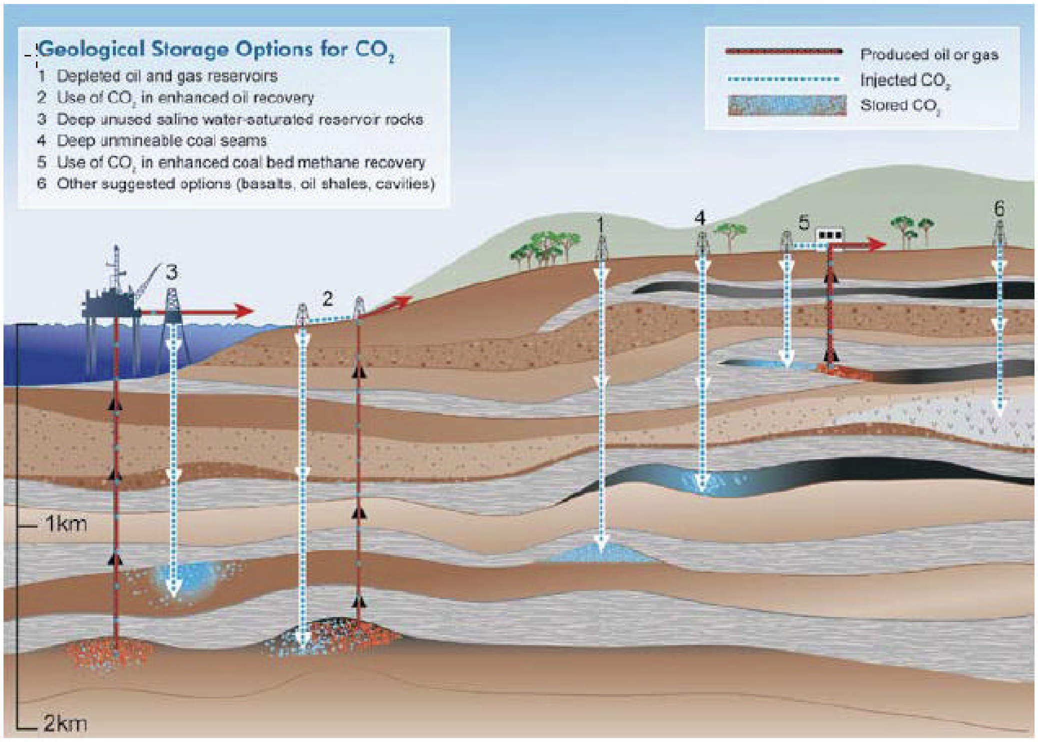
[46] For a complete study of this area, see EIA's website on the issue at http://www.eia.doe.gov/oiaf/aeo/otheranalysis/cti.html.

advanced combustion systems will make such reductions in greenhouse gases through new plant efficiencies, but the cost differential with conventional systems will keep widespread deployment down.[47]



Due to a lack of funding for new research and few pilot projects, EPRI estimates that CCS would become commercially viable near 2020. Without an increase in the pace of research, that estimate stretches to 2025.[48] CCS would make coal-fired generation zero or near-zero GHG emissions.

The Congressional Budget Office estimates that construction of an innovative coal plant would be $2.4 million per megawatt of capacity. CBO assumes that these plants would be built over the next decade, but it does not take into account first-of-a-kind costs covered by federal research and development programs.[49] Additionally, GAO reports that the Department of Energy has focused its resources on Integrated Gasification Combined Cycle technologies, which has proven promising for new generation sources,

[47] Included in Eric Holdsworth's presentation "Power Sector Views on Climate Change Legislation" at the EIA's Energy Outlook and Modeling Conference in Washington D.C., March 28, 2007.
[48] Holdsworth, "Power Sector Views on Climate Change Legislation."
[49] See "Nuclear Power's Role in Generating Electricity," by the Congressional Budget Office, published in May 2008.

but unreliable when applied to existing coal power plants.[50] This fact is especially important to keep in mind when considering the new costs of carbon dioxide emissions. If post combustion capture has to be retrofitted to existing coal fired plants, the efficiencies of such plants could decrease by up to 35%.[51] In addition, fuel costs for innovative fossil fuel generation plants will be 10 to 30% higher than conventional sources because additional energy is needed to capture carbon dioxide. While coal does not have the associated costs of spent-fuel disposal like nuclear power does, analysts note that the costs of carbon dioxide capture and disposal could rival or even surpass the costs of uranium storage.

But despite these challenges, cleaner coal and CCS present the most promising and achievable solution to emissions from coal-fired electricity generation. And since more than half of the nation runs on coal-generated electricity, it cannot be replaced as a power source in the near term. In order to address the question of emissions, policymakers must deal with coal. As a leading researcher from the World Research Institute recently put it, "We don't have the luxury to rule out the one technology that applies to coal."[52]

Even if carbon dioxide costs were to go well beyond the point at which another baseload generation source such as nuclear became economic, it would take decades for enough nuclear capacity to come online to replace the existing coal plants. Therefore, the state's regulators should seek ways to make coal more acceptable in the current environment.

One of the most important areas to address in dealing with coal is the problems that developers will have finding new capital. According to one report by Moody's Investor Services, the prospect of future carbon constraints could negatively affect the credit rating of utilities and raise the cost of capital for investment in conventional coal-fired

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[50] "Climate Change: Federal Actions Will Greatly Affect the Viability of Carbon Capture and Storage as a Key Mitigation Option." United State Government Accountability Office, Report to the Chairman of the Select Committee on Energy Independence and Global Warming, House of Representatives, September 2008.

[51] On page 6 of Carey King, Ian Duncan, Michael Webber, "Water Demand Projections for Power Generation in Texas," prepared for the Texas Water Development Board, published August 31, 2008.

[52] Sarah Forbes, panel discussion on "Carbon Sequestration: Silver Bullet or Black Hole?" Society of Environmental Journalists Conference, October 21, 2008.

generation.[53] One U.S. Department of Energy Study notes that environmental requirements and rising resource prices have doubled the cost of a new coal plant over the last ten years.[54] The same report estimates that a new IGCC plant with carbon sequestration would cost nearly $1.4 billion.

Nuclear Generation

The Current State of Nuclear Generation

The projected increases in the demand for electricity along with concerns about legislative constraints on greenhouse gas emissions has led many to reassess the role that nuclear power might play in the future. Nuclear power's use of an abundant resource to produce energy and its relatively lower emissions make it likely that more plants will be planned and financed at a greater rate than anytime in the nation's history outside of the 1970s. A number of state and federal leaders have also expressed their preference for nuclear power.[55]

Costs and Availability of Nuclear Generation

As of 2008, utilities had filed construction and operating licenses for thirty nuclear plants,[56] three of which would operate in Texas. According to official estimates, completing the revised design and licensing process with the Department of Energy cost approximately $100 million dollars, which sounds like an impressive sum. However, it only represents about 5% of the anticipated costs of building one reactor. Filing a construction and operation license by the end of 2008 was a requirement for a utility to potentially receive a share of the $7.5 billion production tax credits.

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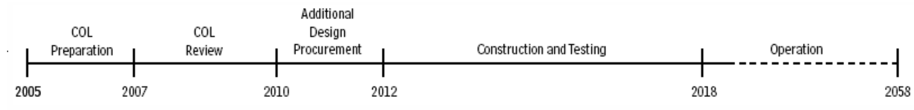
[53] See "Coal Utilities Say They Do Not Fear Risk to Credit, Despite Moody's Warning on Carbon Burdens," *Platts Electric Utility Week* (March 3, 2008), page 1.

[54] Draft report of the Electricity Advisory Committee at the Department of Energy, released October 31, 2008 entitled *Lighting Our New World Energy Future.*

[55] In the Oct. 31, 2008 edition of *The San Antonio Business Journal* Gov. Perry said, "All of these [energy] efforts are the bridge to get us to nuclear." Also see speeches and policy statements from the Obama and McCain campaigns on the long-term benefits of nuclear.

[56] For the purposes of this section, a nuclear power plant is defined as having one reactor. For example, if a utility had plant with two reactors, it would be considered as two power plants.



Clear federal regulations will determine whether or not these companies decide to go forward with their plans and take the risks associated with construction, and one of the primary considerations for them will be what the cost of carbon dioxide emissions will be. According to a report by the Congressional Budget Office, if the cost per metric ton for carbon dioxide goes above $45, then nuclear generation becomes competitive with conventional fossil-fuel technologies. Below that, conventional gas technologies would provide a more economical supply of electricity.[57]

The same report notes that uncertainties about construction costs and natural gas prices could also affect a utility's confidence in the future of nuclear energy. If the building costs rose to similar levels seen in the 1970s and 1980s or if natural gas prices fell to their 1990 levels, the nuclear would not be competitive with conventional technologies regardless of incentives. The costs of carbon-dioxide would have to rise close to $80 per metric ton to make nuclear competitive under this scenario.

The CBO estimates that fuel costs for nuclear power to be $8 per megawatt hour of electricity (in 2006 dollars). In addition, the agency adds $1 per megawatt hour onto the cost of fuel for nuclear in order to cover the costs of uranium disposal, which is unique to nuclear generation.

In the past, construction costs for nuclear facilities have been about twice as much as originally estimated. However, the Nuclear Regulatory Commission's revised licensing process, which was adopted in 1989, could reduce mid-construction modifications which were the source of many past cost overruns. A recent example shows how this could take place. One of the proposed reactors in Texas was based on a new design known as the Economic Simplified Boiling Water Reactor, or ESBWR for short. The company

[57] Found on page of 2 of "Nuclear Power's Role in Generating Electricity," A CBO Study by the Congressional Budget Office. Published May, 2008.

developing this new reactor technology had been warned by the Nuclear Regulatory Commission that it was not providing quality information about the new design, which led to delays in the review of ESBWR. The generation company working with ESBWR in Texas eventually dropped the proposed design in October 2008 because, "we had no chance of getting federal loan guarantees."[58] As proposed projects face increased scrutiny prior to receiving taxpayer dollars, they will likely waste less money during the construction process.

In addition, advanced nuclear reactors might also cost less than first and second-generation plants because they use fewer parts. In considering future costs, both the EIA and CBO project that a 25% reduction in cost overruns from historical numbers. This figure takes into consideration construction of advanced reactors in Japan, but it does not take into account the significant differences between the American and Japanese regulatory or construction process. Costs for advanced reactors should also take into consideration the longer operating life of these new designs, which is typically reported at 60 years.[59]

CBO estimates in its base-case assumption that overnight costs of building a new nuclear plant to be $2.4 million per megawatt of capacity, which is the same price estimated for innovative coal projects. Other estimates such as the one conducted by IEA and the Massachusetts Institute of Technology place these costs about 10% lower than CBO and EIA's figures.[60] However, the MIT study was conducted before construction costs spiked, demonstrating the uncertainty inherent in any long-term energy construction project.

This uncertainty is only stoked by the history of building new plants in the United States. Between 1966 and 1986, 75 nuclear power plants were built in the U.S. and the average

[58] Rebecca Smith, "Nuclear Project Hits Obstacle As Exelon Balks," *Wall Street Journal,* Business Section, November 27, 2008. Article available at http://online.wsj.com/article/SB122783386119963145.html?mod=googlenews_wsj.
[59] From the World Nuclear Association's information paper on "Advanced Nuclear Power Reactors," available at http://www.world-nuclear.org/info/inf08.html.
[60] See *The Future of Nuclear Power: An Interdisciplinary MIT Study* published in July 2003 and *World Energy Outlook* published by the International Energy Agency in 2006.

construction costs exceeded estimates by more than 200%. No new reactors were proposed after the incident at Three Mile Island in 1979, but more than 40 projects were already underway. For those plants, construction costs averaged 250% over initial estimates.[61]

Based on data from the EIA's *An Analysis of Nuclear Power Plant Construction Costs,* Technical Report DOE/EIA-0485, January 1, 1986

Construction Starts			Average Overnight Costs		
Year Began	Number of Plants		Initial Projection (Thousands of dollars per MW)	Actual Costs (Thousands of dollars per MW)	Overrun (Percent)
1966-1967	11		612	1279	109
1968-1969	26		741	2180	194
1970-1971	12		829	2889	248
1972-1973	7		1220	3882	218
1974-1975	14		1263	4817	281
1976-1977	5		1630	4377	169

One interesting observation about these numbers is that they do not show a typical learning curve when it comes to the costs associated with construction. The economics of technologically-based construction expect that as an industry gains more experience and expertise among its workforce, the costs overruns should go down. However, the industries unpredicted expenses actually went up even as the industry gained more experience.

Two later projects also provide some insights into the expected cost overruns. the Japanese utility, the Tokyo Electric Power Company, constructed advanced nuclear reactors at costs and schedules close to original estimates.[62] But a Finnish utility building a reactor based on a different advanced reactor design has gone well above both the time and costs originally projected. As of 2007, that project has gone at least 18 months

[61] These numbers are based on data from the Energy Information Administration's *An Analysis of Nuclear Power Plant Construction Costs*, DOE/EIA-0485 (1986).
[62] Duetch et al., *The Future of Nuclear Power*, page 142.

behind schedule and caused costs to increase by €700 million over the initial €3 billion projection.[63]

As stated earlier, however, these situations must take regulatory structure and energy policy into consideration. In June 2002, the Japanese government created a new Energy Policy Law, which established the basic principles of energy security and stable supply. It also have the government greater authority when setting up energy infrastructure, as well as providing tools for government to promote efficiency in consumption. All of these policy decisions moved the country away from dependence on fossil fuels but also away from market liberalization. Later that same year, Japan announced a new tax on coal in order to provide incentives for nuclear development and more recently, the ruling party has announced that they want fast-breeder reactors to become the nation's technology hallmark. Clearly, Texas and the U.S. have relied more on the market to decide the best technologies, which also means greater uncertainty for investors. However, Japan faces a vastly different energy reality than Texas. As an island-nation without the resources of the U.S., Japan depends on energy imports for 96% of its primary supply. Even with nuclear energy included in its domestic energy, dependency still remains very high at 81%.[64] This example also shows the difficulty of drawing any easy conclusions from comparisons between electric generation in Texas and other states or countries.

The most important challenge for the industry will be the shortage of parts needed for nuclear plants including the steel forgings necessary to contain the reactor's core.[65] As one indicator of how the industry has changed since the U.S. began shying away from nuclear projects nearly thirty years ago, nearly 1,350 American companies were members of the American Nuclear Society in 1977. Today, there are only 700 and many of them

[63] From David Gauthier-Villars, "Trials of Nuclear Rebuilding: Problems at Finland Reactor Highlight Global Expertise Shortage," *Wall Street Journal*, March 3, 2007, p. A6.
[64] For more information, see "Japan's Vulnerable Energy Supply Situation," which can be found on the Federation of Electric Power Companies of Japan's website, http://www.fepc.or.jp/english/energy_electricity/supply_situation/index.html.
[65] For more information see Chupka and Basheda, *Rising Utility Construction Costs: Sources and Impacts*, report submitted to The Edison Electric Foundation by the Brattle Group, September 2007.

are owned by foreign companies.[66] Aside from the problems this presents from a supply chain point of view, it also creates uncertainties about the reliability of the products themselves. In April 2008, the U.S. Nuclear Regulatory Commission concluded to cases of counterfeit parts at nuclear plants. The agency noted that these cases did not lead to any major shutdowns or incidents, but that the parts came from companies with little to no experience in the nuclear market.

However, nuclear plant developers can mitigate future risk by holding on to the option of abandoning a project if it appears that the costs to complete construction are too high, as would be the case in uncertain regulatory or market scenarios. Delay in plant construction has what is known as an "option value," in that the developers can get additional information as time goes on and can narrow the range of uncertainty, especially the uncertainty associated with new technologies and to a lesser extent, new regulatory mandates.[67]

As noted above, the nuclear power industry has significant hurdles to overcome in order to take a leading role in the development of power in Texas. Memories of past problems including the accidents at Three-Mile Island in 1979 and Chernobyl in 1986 still loom large in the public's mind even if those concerns are unfounded. As one expert in the field put it, "there is a very powerful feedback loop from real and perceived nuclear performance into public opinion and public policy. The favorable feedback is very gradual; the negative feedback can be devastatingly quick."[68]

Investors also may be shy about putting money into nuclear projects. As the examples above show, cost runs can still happen and many veteran financiers remember that ninety-six nuclear projects were cancelled between 1974 and 1994 because of concerns

[66] Rebecca Smith, "Utilities Fret as Reactor-Part Supplies Shrink," in *The Wall Street Journal,* April 11, 2008, Page B1.
[67] The term "option value" comes from the books *Investment Under Uncertainty Investment Under Uncertainty* by Avinash K. Dixit and Robert Pindyck. See also Lynne Holt et al. article "(When) to Build or Not to Build?: The Role of Uncertainty in Nuclear Power Expansion," in *Texas Journal of Oil, Gas, and Energy Law* vol. 3, 2007-08, Number 2.
[68] Bruce Lacy, President of Lacy Consulting, LLC, from his presentation at the World Nuclear Association Annual Meeting in 2006. His presentation can be found at www.world-nuclear.org/sym/2006/pdf/lacy.pdf.

over costs and safety. Even in places that generally stand as symbols of nuclear success stories, there are problems. As recently as 2007, an earthquake in Japan showed that the Tokyo Electric Power reactor at Kashiwazaki could not survive a powerful earthquake and the plant was shut down.[69]

One of the leading arguments in favor of nuclear development is fuel. Uranium is located in regions of the world that are politically friendly to the United States. However, some experts in the field disagree about the demand for uranium in the future. According to one estimate, to meet the fuel demand for existing nuclear power, uranium mining and enrichment capacity would need to double in the next five years.[70]

Fuel costs have historically accounted for a small part of nuclear capacity's costs. Even with EIA projections of a 40% increase in the price of uranium over the next 10 years, the overall cost of nuclear technology would only increase by 3%. The CBO estimates that fuel costs for nuclear power to be $8 per megawatt hour of electricity (in 2006 dollars). In addition, the agency adds $1 per megawatt hour onto the cost of fuel for nuclear in order to cover the costs of uranium disposal, which is unique to nuclear generation.

In addition, nuclear plants require security and monitoring systems in order to protect against potential threats. On the basis of EIA's analysis, we can assume that the combination of such costs run about five times those of a natural gas plant and about twice those of a conventional coal plant.

In the past, construction costs for nuclear facilities have been about twice as much as originally estimated. However, the Nuclear Regulatory Commission's revised licensing process should reduce mid-construction modifications which were the source of many past cost overruns.

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[69] Gabriella Coppola, "Fault Lines Increase Japanese Worries, *Wall Street Journal Online*, July 18, 2007, http://blogs.wsj.com/energy/2007/07/18/fault-lines-increase-japanese-worries.
[70] Jim Harding, "Economics of Nuclear Power and Proliferation Risks in a Carbon-Constrained World," 20 *The Electricity Journal* 70 (Dec. 2007).

Advanced nuclear reactors might also cost less than first and second-generation plants because they use fewer parts. In considering future costs, both the EIA and CBO project that a 25% reduction in cost overruns from historical numbers. This figure takes into consideration construction of advanced reactors in Japan.

Renewable Energy Sources

Current State of Renewable Electric Generation

As concerns about federal caps on greenhouse gas emissions continue to grow as well as the need for a greater diversity of sources in the state's generation mix, the issue of renewable energy comes up more frequently. The generally accepted definition of "renewable energy" comes from the Energy Information Administration, which defines those sources as, "Energy sources that are naturally replenishing but flow limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time."[71]

In other words, renewable sources are intermittent in that they do not provide power all of the time. However, they do not rely on any exhaustible fuels, so they avoid the environmental and economic concerns associated with fuel. It is important to note that many observers also include technologies that use certain exhaustible fuel streams in a definition of renewable generation. These include generation from municipal waste and bio-solids.[72]

Based on state and federal programs and incentives created in the last decade, there appears to be a growing consensus that renewable energy sources should play a role in future energy goals. Despite policy decisions designed to encourage renewable generation, these sources still make up a very small part of the state and nation's portfolio. Much of the discussion surrounding renewable generation has focused on cost and issues related to where to place these new sources. However, the topic of that

[71] From the EIA's website dedicated to renewable energy, which can be found at http://www.eia.doe.gov/fuelrenewable.html. Last accessed Nov. 11, 2008.

[72] Some energy analysts also make the argument that when uranium can be reprocessed, nuclear energy is a renewable source, but since this represents a developing viewpoint outside the scope of mainstream research, for the purposes of this report, nuclear is considered a non-renewable resource.

discussion is now turning towards the challenges posed by transmission and distribution of renewable energy. As NERC's Planning Commission noted in a recent report, operators must learn to accommodate, "new variable resources (such as wind and solar) into the grid as well as respond to a broad array of system emergencies."[73] The challenges come from the difficulty of predicting the availability of renewable energy and the difficulties posed by bringing electricity from remote regions to population centers.

States such as Texas have indicated their support for renewables through the implementation of RPS or Renewable Portfolio Standards programs. Studies performed by public and private groups in Texas and across the country highlight the success of the RPS as a policy-development tool. Basically an RPS is a requirement on retail electric suppliers to supply a minimum percentage or amount of their retail load with eligible and pre-defined sources of renewable energy.[74]

State regulators and policymakers tend to favor RPS programs because ideally they establish goals without prescribing the types of energy that must be used to meet those goals. Doing so gives electric providers broad latitude to comply with the standards as they see fit. In other parts of the country, regulators have ongoing arguments about what an RPS is because the standards vary so widely from state to state. Since Texas does not need to worry about overlapping jurisdictional problems, it is easier for regulators to implement and monitor an RPS.

Most states allow wind, solar, landfill-gas, and geothermal energy to satisfy the RPS requirements, but eligibility for biomass, municipal solid wastes, and hydropower vary from state to state.[75] Some states even allow for energy efficiency and fuel cells to count. The Texas RPS establishes a target of 5,880 MW of renewable energy by 2015 with credit multipliers provided for non-wind resources. The program exempts municipal

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[73] "Special Report: Electric Industry Concerns on the Reliability Impacts of Climate Change Initiatives," published by the Planning Commission of NERC, Nov. 2008, page 11.
[74] This definition is borrow from the Environmental Energy Technologies Division of the Energy Analysis Department of Berkeley Energy Labs.
[75] Even though hydropower is generally considered a renewable resource, RPS programs incent new technologies and hydropower is a well established industry.

electric utilities and co-ops, but even without the standards applying to them, these utilities generally have a higher level of renewable electricity usage than other providers.

The operational experience among all the states with RPS has been very limited. The longest program in operation is Iowa, which first completed a compliance period in 1999. Therefore it is difficult to draw any definite conclusions from the data collected from these programs.

Wind Generation

Beginning in 1993, Texas began adding wind generation to its electric mix. During that year, 6.6 MW of capacity were brought onto the grid and 33.6 MW came online next in 1995. It wasn't until 1999 when wind began to develop in earnest with the passage of the renewable portfolio standard for the state, and 112 MW were added that year. From 2001 to the present, Texas has seen the largest additions of wind capacity as a combination of production tax credits, investment tax credits, assurances about future transmission availability, and questions about future regulatory policies have come together. In the fall of 2008, ERCOT had 6,234 MW of installed wind capacity, and a total of 8,066 MW of capacity is expected by the end of the year.[76]

However, as noted above, wind has a smaller capacity factor than some other generation sources due to its intermittent nature. Remember that in creating a capacity factor, analysts use historic generation numbers to predict what future performance is likely to be. In addition to this data, ERCOT also creates models through simulations to determine the amount that generation resources can reliably produce. Most recently, the Generation Adequacy Task Force used a new methodology to calculate the effective load-carrying capacity of wind generation. After analyzing the data, the Task Force determined that 6,300 MW of wind has the same load carrying capacity of 550 MW of thermal generation giving wind an 8.7% effective load-carrying capacity.

[76] Presentation by Chairman Barry Smitherman to the Senate Business and Commerce Committee, November 18, 2008.

Because wind is the most economic among renewable power options, it has become by far the most widely used renewable generation technology. Over 80% of the current U.S. renewable power construction and development pipeline is made up of new wind projects. Solar technologies come in a distant second with a combined 7% of the pipeline.[77] Other states are using renewable resources, but other than solar and wind, few have gained a very large foothold in the energy generation industries. Between 1990 and 2007, geothermal energy, which provides baseload generation with few if any emissions, actually declined by about 372 megawatts.[78]

Because of its zero cost for fuel, wind has often been touted as more cost-effective than conventional generation. However, the capital costs and intermittency costs for wind mean that it ultimately has a higher total cost of generation. In terms of capital expenditures, wind costs between $1,900 to $2,000 for every kW generated. Combined cycle gas generation, by contrast, has capital costs of $800 to $1,000 per kW.

Also, adding wind generation resources increases the amount of "variability and unpredictability that must be addressed in system operations."[79] Another way to say this is that regulators must take into consideration more variables when considering how much wind to expect. On-shore wind generation in Texas tends to be "anti-correlated" with the daily peak load curve, which means that when demand is highest across the state, wind generally produces the least amount of energy. Therefore, ERCOT and other regional operators must prepare for possible drops in wind energy during peak times by securing alternate sources of generation known as ancillary services. ERCOT must procure a certain amount of ancillary services for all types of generation sources due to the possibility of an outage on any of these. But the services are only needed during identified times of "high risk" when periods of hot, cold, or uncertain weather exist. These extra costs for reserve generation have typically passed through to ratepayers across the state, and this continues to be the case with wind.

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[77] Report by CERA on renewable portfolio standards.

[78] Energy Information Administration, Table 8-11c, http://www.eia.doe.gov/emue/aer/elect.html.

[79] From "Analysis of Wind Generation on ERCOT Ancillary Services Requirements," prepared by GE Energy for ERCOT, March 28, 2008. GE has extensive expertise in this area since the company is one of the largest suppliers of wind turbine technology in the world.

Advocates of wind, however, are quick to point out that GE's study of ancillary services shows that increased wind energy production lowers the amount of combined-cycle gas turbine generation. The authors of that study write, "For every 1000 MWh of wind generation, combined-cycle plant energy output drops approximately 800 MWh."[80] Advocates also point out that since natural gas tends to run during times when utilities purchase power at high costs on the spot market, reductions of natural gas would mean lower bills overall. The authors do not indicate or address what time of day these amounts were lowered or whether they happened during times of high demand, which would correspond to high rates for consumers. If most of these reductions take place at night when wind generation is highest, then the results could be less significant than they appear. Coal and nuclear plants cannot ramp up or down fast enough to act as a backup for wind, so ERCOT must rely on more expensive natural gas generators. Some believe that new natural gas plants will need to come online in order to support greater wind development, which will ultimately cost more for wind energy.

Wind does work well providing energy during the fall and spring and especially at night. Analysts note that once industry-scale energy storage becomes viable or if demand increases for needs such as plug-in/hybrid vehicles which would mostly charge at night then wind can significantly meet demand.

Biomass

Biomass generation uses wood, dried switch grass, and other agricultural products to create energy. Since these materials have a much lower heat value than other combustibles, it takes a much larger amount of them to create the same amount of electricity. On the other end of the spectrum, landfill gas has roughly double the heat content of coal, which makes it the renewable fuel of choice where it is available.

Because biomass presents problems when it comes to handling and transportation, it is principally thought of as a small-scale enterprise. Therefore, biomass projects have

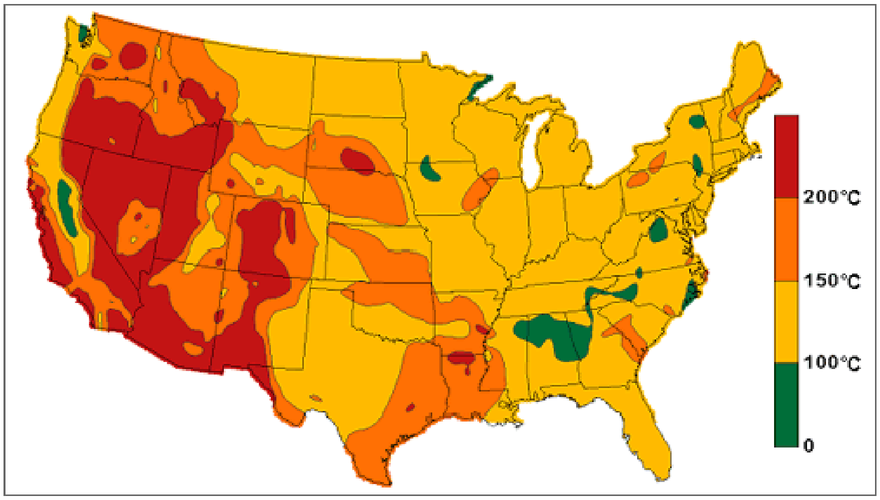
[80] Ancillary Services Report, Executive Summary, page 7.

suffered from a lack of investment due to higher investment costs and lower expectations for returns. Biomass projects tend to succeed in places where public policies have been designed to offer major project incentives.

Geothermal

Geothermal power holds a unique place within the renewable industry in that it provides dispatchable baseload power that can be produced at much lower costs than other renewable sources. Currently available geothermal has some major drawbacks. It is only economically possible near geologic faults and vents. Emerging technologies have been shown to allow geothermal generation from cooler sites than the 200 to 300 degrees Fahrenheit required by today's methods.

The map below shows the estimated underground temperatures at a depth of 6 kilometers. A small portion of Texas near El Paso has the natural setting to establish geothermal, but in many other parts of the state, lower temperature technologies would need to become market viable before they could be used.



14 From DOE's Energy Efficiency and Renewable Energy Geothermal Technologies Program

In Texas, 8,000 oil wells capable of producing energy using hot water at 190 degrees could be utilized to generate electricity from hybrid technologies being developed. However, the electricity produced would largely go towards powering the well's equipment and since the amount of energy produced would be relatively low, it would not be possible to transmit it very far.

On a commercial or industrial scale, the major barriers for geothermal to thrive in the Texas market is finding locations for economical energy production with minimal interconnection costs as well as high capital costs for construction. Access to available heat sources in the earth require access to very difficult and remote terrain. Once a site is identified, concerns arise regarding water tables, sustainability of heat flows, protected wilderness issues, and of course, transmission issues. Other barriers include dealing with environmental concerns due to the requirements of handling a corrosive fuel containing some heavy metals.

Solar

Texas currently does not have any industrial scale solar projects, however, several utilities around the state have publicly discussed their interest in pursuing them. The largest solar energy generating facility in the world is the Solar Energy Generating System (SEGS), which consists of nine solar power plants in the Mojave Desert of California. SEGS has 354 MW of installed capacity and it has a capacity factor of approximately 21%.

Photovoltaic installations can cost between 20 to 50 cents per kilowatt-hour prior to incentives while concentrated thermal installation costs between 15 to 17 cents per kilowatt-hour.[81] While solar prices are continuing down, the costs remain substantial. Industrial-scale solar also faces similar barriers as wind and geothermal in that transmission to these sites can be very difficult and expensive. However, it has the advantage that it can be used as an on-site generation resource, which could give it an edge against future renewable energy sources.

Solar resources also play a complimentary role to the most widely deployed renewable resource, wind. When wind energy is at its lowest generation level at peak demand

[81] See http://www.solarbuzz.com/statsCosts.htm for more information.

times, solar tends to be at its highest. This also gives solar the advantage of being able to shave some of the peak load away from expensive natural gas peaking plants.

Part III: Texas Emissions and the Climate Change Debate

Background

Few members of the general public and no one in the energy industry doubts that the question of emissions restrictions will play a major role in future electric generation policy. Recently, the chairman of the U.S. House Energy and Air Quality Subcommittee said, "The debate about whether we're going to have federally imposed control of carbon dioxide emissions is now over. As a practical matter the U.S. Supreme Court settled that debate last year. So regulation is coming, either by EPA or Congress."[82] With that in mind, the Select Committee tried to strike a balance between the state's historical perspective of resisting restrictions on emissions and the growing realities of federal mandates.

The Climate Change Debate

A large, well-established and well-worn catalog of publications exists from every side of the climate change debate. Because the methods and materials needed for this kind of research go well beyond the Select Committee's technical expertise and budget, this report will not try to verify or disprove the findings of any particular scientific point of view. Even scientists working in the field show great differences in what they believe, as seen in the attached bibliography. As the state's climatologist, John W. Nielsen-Gammon puts it in a letter to the Select Committee, "I have found widely varying degrees of skepticism with regard to anthropogenic [man-made] climate change. It seems that the wide range of opinions is caused in part by the politicization of the issue of climate change." In order to try and move beyond the political arguments in this area, this report will in a later section lay out the known facts in the area and briefly discuss what these mean in the context of electric generation.

This report also includes the assumption that sometime in the very near future, federal mandates will require industries to curtail their emissions of greenhouse gases. While Texas can and should continue to represent the state's interests to the policymakers who will create federal mandates about emissions policies, industries, businesses, consumers,

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[82] Quoted in Michael T. Burr's editorial "Good News for Coal," in the December 2008 edition of *Public Utilities Fortnightly*, page 6.

regulators, and legislators must account for a wide range of possibilities in order to adapt to changing policy conditions. The scientific and ideological debate must go on. As Scott W. Tinker the Director of the Bureau of Economic Geology eloquently wrote:

> As scientists we must protect the right of scientific challenge and debate. It is what pushes us to defend our ideas and to discover in the process. That is research. That is science. It demands debate. The debate is never over in science. It is precisely this debate that causes science to advance. Debate is as important to science as the first amendment is to a democracy.[83]

But unfortunately, mandates do not wait for scientific consensus. It appears more and more likely that greenhouse gas will be scrutinized, regulated, and eventually priced. It is worth repeating that Texans can disagree about the impacts or realities of climate change, but the state and its industries must continue to take action now in order to lessen the long-term economic effects of emissions restrictions.[84]

Texas is known as a state that encourages innovation and entrepreneurship, and it should continue to do so. But many business leaders now agree firms that make moves now to refocus their operations in order to take advantage of the coming emissions control legislation will be the ones that succeed. The state's future depends on its industries' successes. Therefore, it must encourage investment in emissions reductions technologies by sending clear policy and market signals that Texas has the talent and the ability to adapt to changing market conditions. One approach to this that might be useful for policymakers and businesses would be to change the way they think about greenhouse gas emissions. Instead of seeing them as a necessary byproduct of industry, Texas could

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[83] Scott W. Tinker, "Thoughts on Science and Climate," presented at the Rocky Mountain Natural Gas Strategy Conference and Investment Forum, Presented by the Colorado Oil and Gas Association, at the panel, "A Meaningful Discussion about Climate Change," held in August 2007.

[84] The timeline for implementation of a new emissions-reductions mandate may be shorter than most people imagine. On November 11, 2008, the head of Barack Obama's transition team John Podesta said, "I anticipate [President-Elect Obama] moving very aggressively and very rapidly on the whole question of transforming the American platform in the United States from one that's based on high-carbon energy to one that's based on low-carbon energy." From Darren Samuelsohn, "Obama to move swiftly on energy, climate--Podesta," in E&E News PM, November 11, 2008. http://www.eenews.net/eenewspm/2008/11/11/1

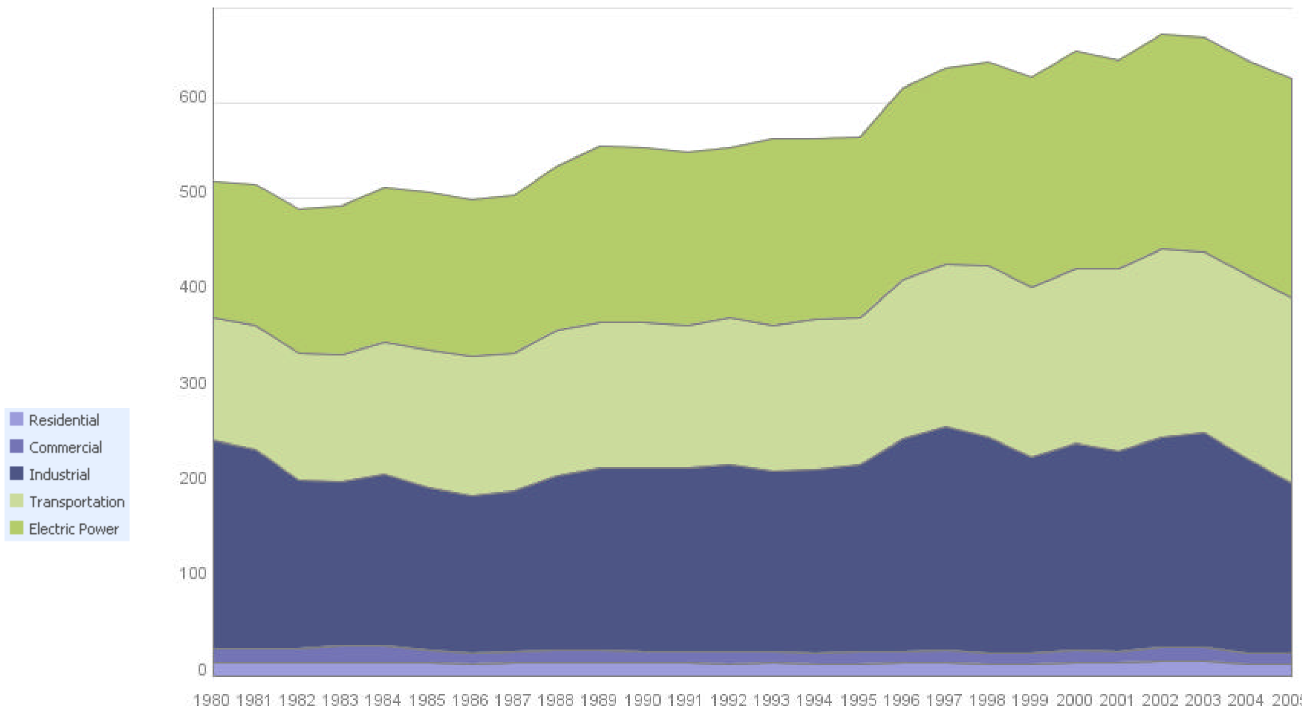
begin to think of them as an operational inefficiency that wastes resources and incurs excessive expenses.[85]

Consideration of new energy goals and emissions reductions does not necessarily translate directly into subsidies for new energy companies. Businesses that depend on subsidies are generally not healthy or sustainable. There are a wide variety of methods available for Texas to take the lead on this issue, one of which could be to seek a transparent system of emissions inventories that treats them like any other part of a business's outcomes. The crucial factor in any new goals is to let Texas businesses do what they do best: compete.

Texas Greenhouse Gas Emissions

As discussed previously, Texas legislative policy has generally resisted statewide emissions caps. However, because of recent moves by the federal government that seem to signal a turn towards carbon dioxide and greenhouse gas emission caps, the state's businesses and industries have begun focusing on the possible implications to Texas. The state is the largest emitter of carbon dioxide and other greenhouse gases in the U.S., which mostly comes from Texas's heavy manufacturing industry and refining capabilities that create products consumed or used in Texas and many other states. As the chart below shows, from 1980 to 2005, emissions of CO2 went up in almost all sectors that produce the gas, although the numbers began to decline after 2003.

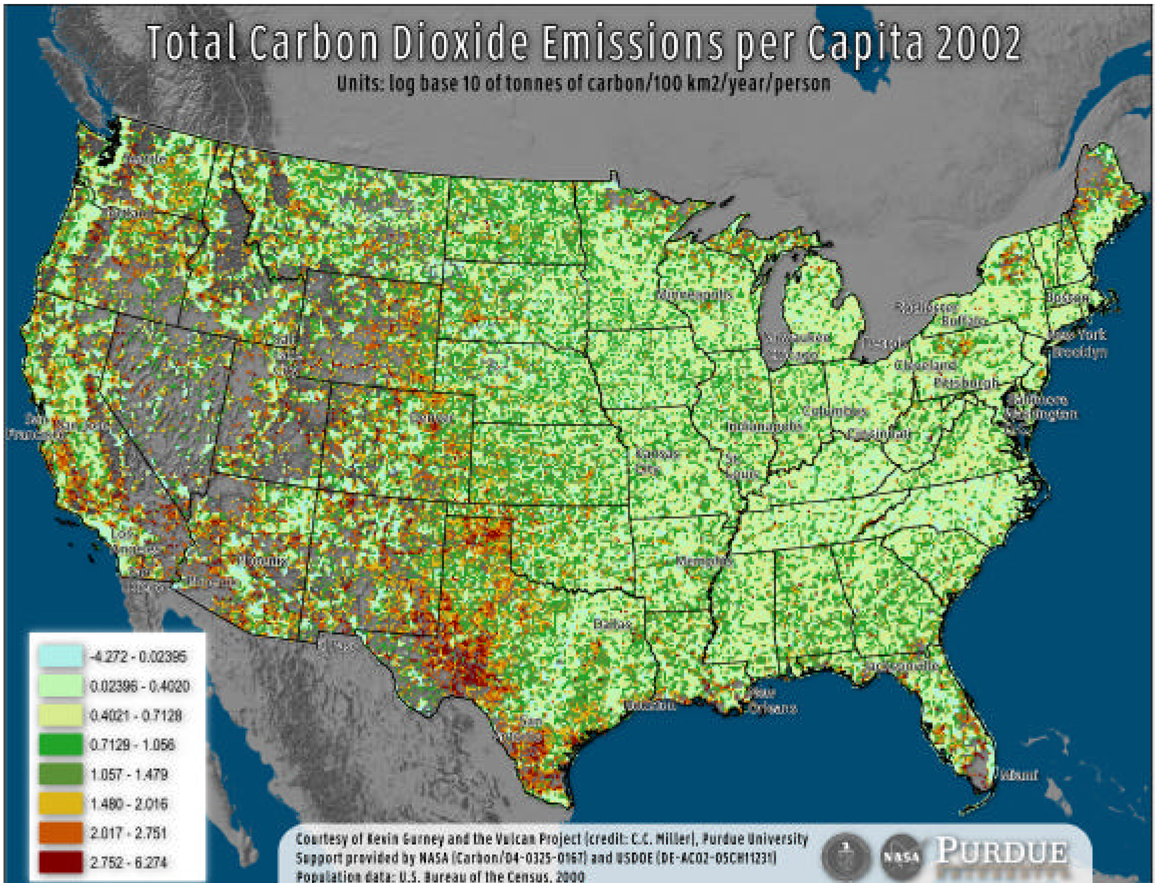
[85] For a more in-depth treatment of ways that businesses might approach this idea, see Michael E. Porter and Forest L. Reinhardt's "Grist: A Strategic Approach to Climate" in the October 2007 issue of *The Harvard Business Review.*



15 Total Texas emissions by sector

As this graph also shows, the majority of greenhouse gas emissions come from the transportation, industrial, and electric generation sectors. The amount of these gases from the residential and commercial industries still contribute, but as a percentage represent very little. Practically, what this means for Texas is that caps on greenhouse gases would hit the electric power generation and industrial producers hardest. Further, these problems would happen during a time when the state is losing about 1.5% of its manufacturing jobs every year.

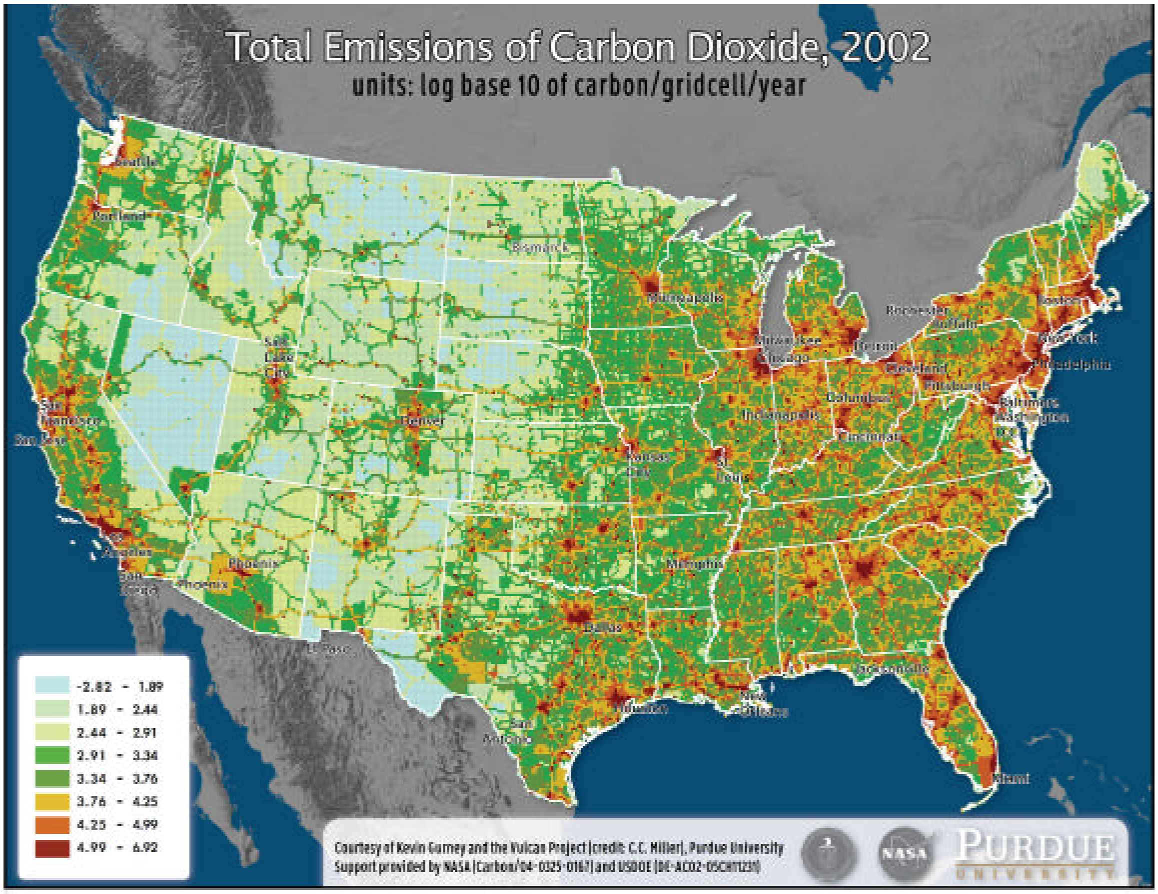
From a policy point of view, this means that Texas leaders must push for consideration of its unique position during the debate on emissions reductions. Generally, analysts in this area recommend that Texas ask for emissions credits at no cost for a transition period in order to establish a reliable method of buying and selling credits or by developing new technologies. Other possibilities include asking for the carbon price to be paid by the consumers or purchasers of carbon-intensive products instead of manufacturers.



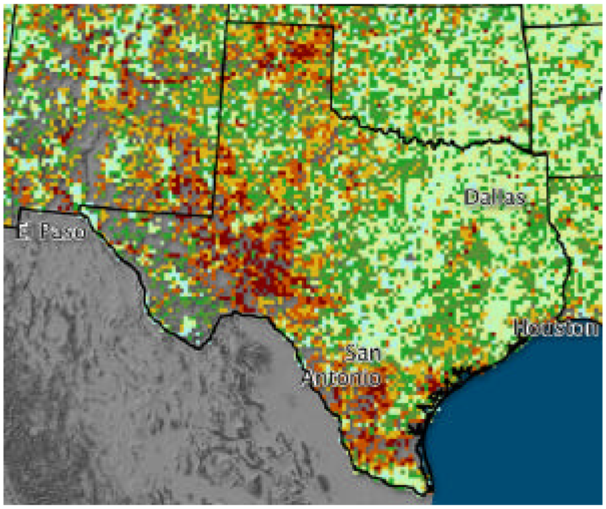
NOTE: This map is a "quick" recalculation of the Vulcan 2002 fossil fuel CO2 emissions inventory in order to achieve a per capita quantity. Please note the methods employed to produce this map and the intrinsic caveats. We are currently developing a more accurate assessment of per capita emissions for the Vulcan inventory. However, this map gives a reasonable approximation of per capita emissions and should serve to adequately inform discussions on that basis.

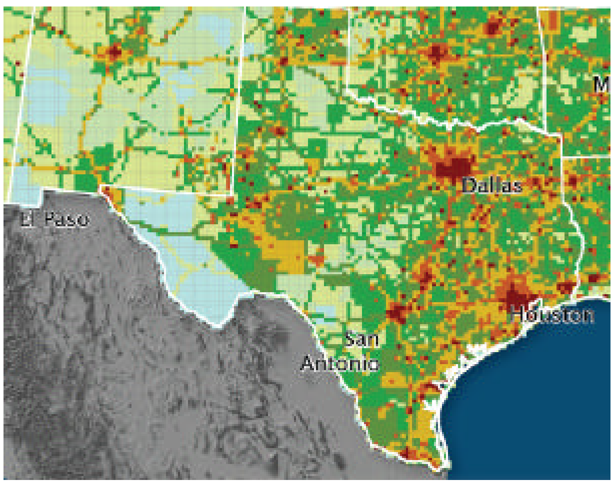
METHOD: Vulcan emissions in each 10 km x 10 km grid cell were divided by the total population of all U.S. Census Blocks (Decennial Census 2000) found within the cells' boundaries. For simplicity, only the centroids of Census blocks (not their polygons) were used to determine which blocks' populations were summed into any given grid cell. In the likely scenario in which many blocks lie within a single grid cell, the blocks' populations were summed into the cell before the per capita value was calculated. In the fewer cases where a Census block overlaps several grid cells, only the grid cell containing the block's centroid is given that block's population. Vulcan grid cells with no emissions or which overlaid areas with no population were omitted.

The map above shows the amount of carbon dioxides emissions in the U.S. per-capita. It represents the amount of carbon dioxide produced in 100 square kilometer regions of the country divided by the number of residents who live in that same square. Compared with other maps of carbon dioxide emissions such as the one below, this map indicates one of the rarely mentioned realities of the greenhouse gas debate: in lower population density areas of the nation, infrastructure serving only a few people generates high per-capita emissions; in population-dense regions, the same infrastructure is capable of serving much higher numbers of people providing a better per-capita result.



As noted above, total emissions of carbon dioxide tend to follow population numbers. Comparing a breakout of Texas from both maps can show the differences considering the relative impact of carbon emissions based on population.





As can be seen in these two maps of Texas's carbon dioxide emissions, policymakers need to take into account more factors than just raw totals.

In the top map, emissions of carbon dioxide in 2002 are broken down into 100 square kilometer regions and then divided by the number of residents in those regions. In the less populated area of the state, the same infrastructure exists to serve fewer people, while highly populated areas use their infrastructure to its greatest capacity.

Depending on how federal mandates come down on Texas, regulators and lawmakers should keep these considerations in mind since the wording of any laws could have very different impacts on different regions of the state depending on these per-capita figures.

Possible Effects of Greenhouse Gas Emissions

As stated in the introduction to this report, the scientific debate behind climate change continues to go on and it is beyond the scope of the Select Committee's resources and expertise to prove or disprove the scientific accuracy of either side. However, in a letter to the Select Committee the state's climatologist succinctly lays out the three scientifically supportable points about the debate on climate change:

> "First, climate is always changing, on scales of years, decade, centuries, and longer. Second, the magnitude of the radiative changes to the climate system caused collectively by anthropogenic greenhouse gases, aerosols, and land use changes is similar to the magnitude of variations of external forcing agents (such as the Sun and volcanoes) that have caused major climate changes in the past.

> Third, the best available estimates of temperature changes caused by man's influence, assuming steps are not taken to reduce emissions, are a global average of about 2° C to 4.5° C [3.6° F to 8.1° F], with both higher and lower values possible."

Put another way, the amount of man-made activity is similar at this point in time to past natural events that have changed the world's climate.

Many available different climate change models show many different outcomes. Most agree that if climate change were to take place, its effects would be unevenly distributed across the United States and Texas. The effects of climate change do not necessarily correspond to rising temperatures or lowered precipitation, but rather to higher levels of climate variability. One developing trend among the different climate models shows that variability patterns would affect the southwestern United States hardest. According to one fifteen-model combined projection, the strongest U.S. effects are felt by a region reaching from southern California to west Texas and most intensely over northern Mexico.[86]

Local climate change projections are even more difficult to create. Texas weather is very susceptible to sea-surface temperature changes such as those associated with El Niño, and these events may themselves change in response to changing global climate. However, the state's weather data shows some identifiable trends. Over the last 100 years, global temperatures have risen, but Texas temperatures show no significant century-long trend, either upward or downward. Over the past 30 years, Texas has seen a strong upward temperature trend, that is according to the state's climatologist, "larger than any conceivable errors introduced by instrumentation or urban heat islands, and all model projections indicate that this trend is likely to continue."

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[86] Richard A. Kerr, "Climate Change Hot Spots Mapped Across the United States," *Science*, Vol. 321, August 15, 2008, 909.

In a report describing the possible effects of climate change on electric generation and the availability of water in Texas, the Bureau of Economic Geology echoes the difficulty of making confident projections of climate impacts on the local level, however, the authors also say, "Possible effects from climate change in Texas may include lower summer flows in Texas rivers, longer and more severe droughts, rises in sea level, and deterioration of wetlands."[87]

Reducing Greenhouse Gas Emissions in Texas

Although Texas had made major reductions in emissions, the state still leads the U.S. in so-called greenhouse gases. However, Texas has made gains in reducing the state's overall emissions rate, which recent studies have shown will be more effective in lowering near-term climate change.

The Advantages of Acting Early

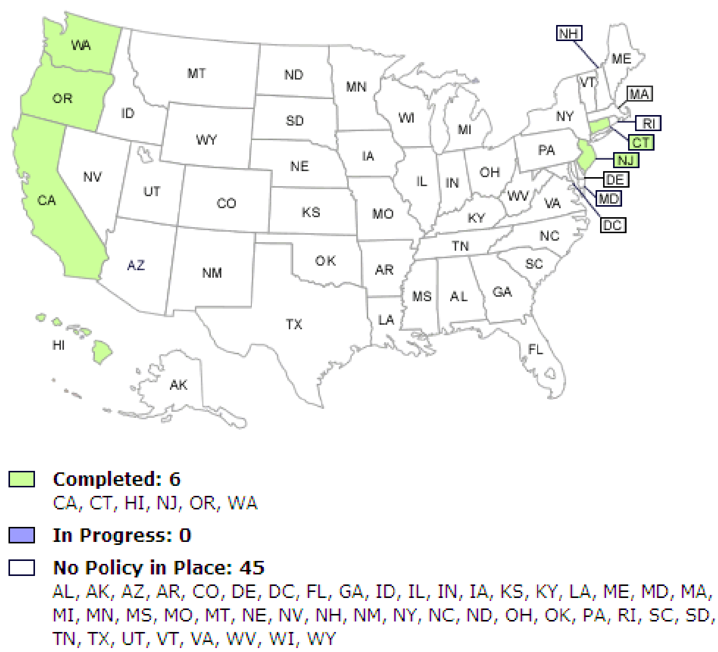
As it becomes increasingly likely that some form of emissions pricing program will come down from the federal government, economies that delay taking action face higher long-term costs as global investment goes towards early movers. Furthering the problem, these economies lock-in emission-intensive infrastructure saddling future generations with rising costs for their industries. The combination of these two factors has the ability to cripple the state's economy. Early action allows individuals and companies to adjust business plans and acquire the skills and capital needed to adapt to the new market environment.

For Texas, the emphasis should be on securing free permits for emission-intensive trade sectors such as manufacturing and electric generation. These would shield the businesses during the transition years and although it would spread the costs of emissions to the ratepayers and customers, it would save them money in that these companies would not be forced to raise their prices due to pollution constraints.

[87] Carey King, Ian Duncan, and Michael Webber, *Water Demand Projections for Power Generation in Texas*, prepared for the Texas Water Development Board, published August 31, 2008, page 4.

However, these free permits will not last forever. As major companies shift their business models towards lower emission processes and create infrastructure to support these moves, national and state policies will remain in place since less pressure will come from the nation's economic leaders. States making early strides in renewable technologies and emissions reductions will develop the knowledge base and worker experience needed to lead the field. Additionally, states that attract new generation manufacturing jobs will likely take prominent roles in an economy centered around new technologies.

Many observers have argued that moving early on emissions reductions technologies will simply drive emissions-heavy industries to other areas and maintain the same regional air quality problems. This process is also known as "carbon leakage," since the affected business, in a sense, leak their emissions back to the areas that they fled from. However, economic studies of nations that have implemented these programs do not show any major relocations of their businesses and it is not expected to have a significant effect on the U.S. or Texas economies.



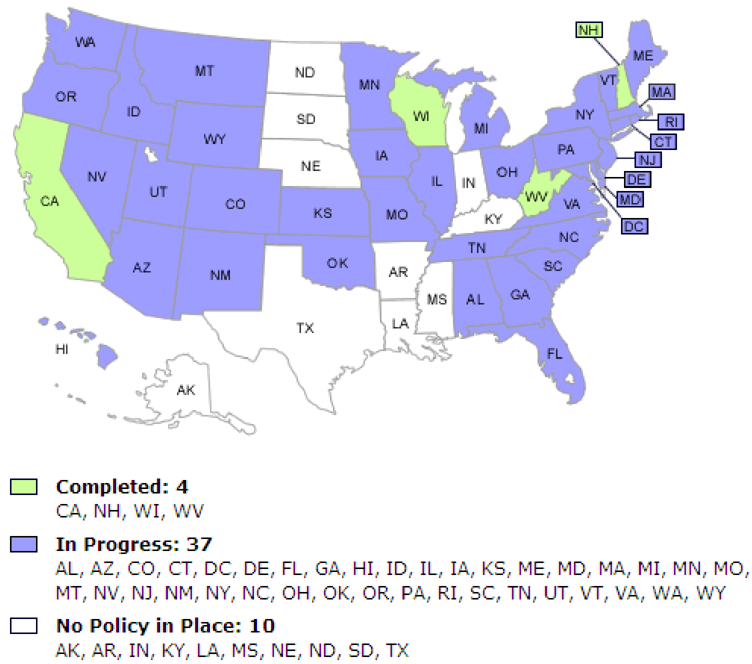
16 States with greenhouse gas caps in place as of August 2008

Need for a National Policy

Nevertheless, it should not be up to the states or regions to create emissions reductions programs. Piecemeal policy actions that do not take advantage of economies of scale created through national credit trading programs pose a major challenge to the future success of emissions reductions. Policies enacted across the U.S. have generally reflected this point of view and as of August 2008, only six states had put greenhouse gas caps in place.

Additionally, a statewide program would ignore the realities of Texas's role as an exporter of carbon-intensive products to other parts of the U.S. If emissions reductions mandates are going to be put in place, in order to mitigate the potential economic impacts of a greenhouse gas reductions program on Texas, the federal government should enact a nationwide standard that sends clear market signals to all participants while recognizing the unique status that Texas has as the first and crucial link in the nation's economy.

Texas policymakers should consider a step that many other states have taken in anticipation of a federal mandate. Currently, 41 states have some form of greenhouse gas registry in place in order to create adequate methods of measuring greenhouse gases, as well as to have data to counter federal estimations of those emissions.



17 States with a greenhouse gas registry in place

Regardless of the path that Texas leaders choose for dealing with future federal mandates on emissions restrictions, the state must continue to take a seat at the table and try to lead the discussion or else risk becoming a victim of it.

Appendix A: Generation Numbers by Source for Scenario 2

Year	PC, no CCS	IGCC Coal, no CCS	NGCC no CCS	NG Industrial On-site	Wind	Nuclear	Solar CSP	Solar PV	PC Coal, w/CCS	IGCC Coal, w/CCS	NGCC w/CCS	Other	Total MWh
2008	154,917,375	0	157,968,269	40,000,000	13,987,000	41,270,000	0	13,000	0	0	0	4,957,356	413,113,000
2009	158,000,000	0	153,786,185	40,000,000	18,424,323	41,270,000	0	15,192	0	0	0	5,000,000	416,495,701
2010	165,000,000	0	145,120,259	40,000,000	22,861,277	42,000,000	0	17,753	0	0	0	5,000,000	419,999,290
2011	170,000,000	0	139,307,398	40,000,000	27,297,800	42,000,000	0	20,746	0	0	0	5,000,000	423,625,944
2012	180,000,000	0	128,619,816	40,000,000	31,383,417	42,000,000	350,400	24,244	0	0	0	5,000,000	427,377,877
2013	180,000,000	0	128,059,769	40,000,000	35,781,948	42,000,000	387,297	28,332	0	0	0	5,000,000	431,257,346
2014	180,000,000	0	127,629,553	40,000,000	40,175,904	42,000,000	428,080	33,108	0	0	0	5,000,000	435,266,645
2015	140,000,000	0	104,431,504	40,000,000	44,564,760	89,000,000	473,156	38,691	10,000,000	10,000,000	0	5,000,000	443,508,111
2016	120,000,000	0	124,268,001	40,000,000	48,947,929	89,000,000	522,980	45,214	10,000,000	10,000,000	0	5,000,000	447,784,124
2017	120,000,000	0	124,241,467	40,000,000	53,324,751	89,000,000	578,049	52,837	10,000,000	10,000,000	0	5,000,000	452,197,105
2018	120,000,000	0	124,354,366	40,000,000	57,694,490	89,000,000	638,918	61,745	10,000,000	10,000,000	0	5,000,000	456,749,519
2019	117,500,000	0	119,121,709	40,000,000	62,056,317	95,000,000	706,196	72,155	11,250,000	11,250,000	0	5,000,000	461,956,377
2020	115,000,000	0	126,033,550	40,000,000	66,409,304	89,000,000	780,559	84,321	12,500,000	12,500,000	0	5,000,000	467,307,734
2021	112,500,000	0	123,514,991	40,000,000	70,752,410	89,000,000	862,751	98,537	16,000,000	16,000,000	0	5,000,000	473,728,690
2022	110,000,000	0	117,171,179	40,000,000	75,084,465	89,000,000	953,599	115,150	22,000,000	22,000,000	0	5,000,000	481,324,393
2023	107,500,000	0	110,979,809	40,000,000	79,404,152	89,000,000	1,054,013	134,565	28,000,000	28,000,000	0	5,000,000	489,072,538
2024	105,000,000	0	108,276,959	40,000,000	83,709,992	89,000,000	1,165,001	157,252	34,000,000	34,000,000	0	5,000,000	500,309,204
2025	100,000,000	0	107,313,245	40,000,000	88,000,320	89,000,000	1,287,675	183,765	40,000,000	40,000,000	0	5,000,000	510,785,005
2026	95,000,000	0	106,590,011	40,000,000	92,273,260	89,000,000	1,423,267	214,748	46,000,000	46,000,000	0	5,000,000	521,501,286
2027	90,000,000	0	101,755,319	40,000,000	96,526,699	89,000,000	1,573,137	250,955	52,000,000	52,000,000	5,000,000	5,000,000	533,106,109
2028	85,000,000	0	97,072,788	40,000,000	100,758,252	89,000,000	1,738,789	293,266	58,000,000	58,000,000	10,000,000	5,000,000	544,863,094
2029	80,000,000	0	92,543,992	40,000,000	104,965,228	89,000,000	1,921,883	342,710	64,000,000	64,000,000	15,000,000	5,000,000	556,773,814
2030	75,000,000	0	88,171,821	40,000,000	109,144,588	89,000,000	2,124,257	400,491	70,000,000	70,000,000	20,000,000	5,000,000	568,841,158
2031	70,000,000	0	83,959,081	40,000,000	113,292,896	89,000,000	2,347,942	468,014	76,000,000	76,000,000	25,000,000	5,000,000	581,067,933
2032	65,000,000	0	79,908,643	40,000,000	117,406,266	89,000,000	2,595,180	546,921	82,000,000	82,000,000	30,000,000	5,000,000	593,457,010
2033	60,000,000	0	76,023,429	40,000,000	121,480,298	89,000,000	2,868,453	639,132	88,000,000	88,000,000	35,000,000	5,000,000	606,011,311
2034	55,000,000	0	72,306,411	40,000,000	125,510,008	89,000,000	3,170,501	746,889	94,000,000	94,000,000	40,000,000	5,000,000	618,733,809
2035	50,000,000	0	75,120,619	40,000,000	129,489,744	89,000,000	3,504,354	872,815	96,000,000	96,000,000	45,000,000	5,000,000	629,987,532

2036	45,000,000	0	78,109,134	40,000,000	133,413,094	89,000,000	3,873,363	1,019,972	98,000,000	98,000,000	50,000,000	5,000,000	641,415,562
2037	40,000,000	0	75,275,093	40,000,000	137,272,777	95,000,000	4,281,228	1,191,939	100,000,000	100,000,000	55,000,000	5,000,000	653,021,037
2038	35,000,000	0	73,621,691	40,000,000	141,060,518	100,000,000	4,732,041	1,392,900	102,000,000	102,000,000	60,000,000	5,000,000	664,807,150
2039	30,000,000	0	72,152,179	40,000,000	144,766,906	105,000,000	5,230,325	1,627,742	104,000,000	104,000,000	65,000,000	5,000,000	676,777,153
2040	25,000,000	0	70,869,867	40,000,000	148,381,231	110,000,000	5,781,078	1,902,180	106,000,000	106,000,000	70,000,000	5,000,000	688,934,356
2041	20,000,000	0	69,778,124	40,000,000	151,891,291	115,000,000	6,389,826	2,222,887	108,000,000	108,000,000	75,000,000	5,000,000	701,282,129
2042	15,000,000	0	68,880,382	40,000,000	155,283,179	120,000,000	7,062,675	2,597,666	110,000,000	110,000,000	80,000,000	5,000,000	713,823,902
2043	10,000,000	0	68,180,131	40,000,000	158,541,028	125,000,000	7,806,374	3,035,633	112,000,000	112,000,000	85,000,000	5,000,000	726,563,167
2044	5,000,000	0	64,500,928	40,000,000	161,646,725	130,000,000	8,628,385	3,547,440	116,000,000	116,000,000	90,000,000	5,000,000	740,323,478
2045	0	0	56,256,389	40,000,000	164,579,573	135,000,000	9,536,954	4,145,539	123,000,000	123,000,000	95,000,000	5,000,000	755,518,455
2046	0	0	43,220,201	40,000,000	167,315,909	140,000,000	10,541,196	4,844,477	130,000,000	130,000,000	100,000,000	5,000,000	770,921,782
2047	0	0	30,396,112	40,000,000	169,828,657	145,000,000	11,651,184	5,661,255	137,000,000	137,000,000	105,000,000	5,000,000	786,537,208
2048	0	0	17,787,941	40,000,000	172,086,815	150,000,000	12,878,053	6,615,743	144,000,000	144,000,000	110,000,000	5,000,000	802,368,553
2049	0	0	5,399,574	40,000,000	174,054,857	155,000,000	14,234,112	7,731,157	151,000,000	151,000,000	115,000,000	5,000,000	818,419,701
2050	0	0	1,184,968	40,000,000	175,692,047	160,000,000	15,732,964	9,034,630	153,000,000	153,000,000	120,000,000	5,000,000	832,644,610
2051	0	0	1,228,150	40,000,000	176,951,643	165,000,000	17,389,645	10,557,869	153,000,000	153,000,000	124,000,000	5,000,000	846,127,308
2052	0	0	1,503,221	40,000,000	177,779,972	170,000,000	19,220,775	12,337,926	153,000,000	153,000,000	128,000,000	5,000,000	859,841,894
2053	0	0	1,164,354	40,000,000	178,115,365	175,000,000	21,244,723	14,418,100	153,000,000	153,000,000	133,000,000	5,000,000	873,942,542
2054	0	0	1,065,799	40,000,000	177,886,919	180,000,000	23,481,792	16,848,992	153,000,000	153,000,000	138,000,000	5,000,000	888,283,502
2055	0	0	1,211,881	40,000,000	177,013,062	185,000,000	25,954,425	19,689,732	153,000,000	153,000,000	143,000,000	5,000,000	902,869,100
2056	0	0	1,607,004	40,000,000	175,399,887	190,000,000	28,687,426	23,009,421	153,000,000	153,000,000	148,000,000	5,000,000	917,703,738
2057	0	0	1,625,651	40,000,000	172,939,228	195,000,000	31,708,212	26,888,809	155,000,000	155,000,000	150,000,000	5,000,000	933,161,900
2058	0	0	832,384	40,000,000	169,506,416	200,000,000	35,047,086	31,422,262	155,000,000	155,000,000	157,000,000	5,000,000	948,808,149
2059	0	0	3,701,850	40,000,000	164,957,679	205,000,000	38,737,545	36,720,056	155,000,000	155,000,000	160,000,000	5,000,000	964,117,130
2060	0	0	1,438,777	40,000,000	159,127,130	210,000,000	42,816,608	42,911,057	160,000,000	160,000,000	160,000,000	5,000,000	981,293,573