Chapter 1

INTRODUCTION

Much has changed since the state of Texas completed its first comprehensive renewable energy resource assessment in 1995.[1] The cost of energy resources has risen, with the world price of crude oil reaching new heights in mid-2008. Concerns over the contribution of fossil fuel use to global climate change are reported in the press on a daily basis. By some measures, Texas has become a net importer of energy resources.

In response to concerns over the cost, availability, and environmental impacts of some traditional energy resources, Texas has taken a number of steps to tap into its vast renewable energy resource base. Goals for renewable energy were established as part of the legislation which restructured portions of the state's electric utility industry in 1999. Texas has emerged as the leading state in the production of electricity from wind farms. Aggressive goals for solar energy development have been established by the city of Austin. In addition, energy efficiency efforts—including utility programs and building codes—are increasingly being relied upon to help reduce the state's growing power requirements.

The Demand for Energy in Texas

A number of factors contribute to Texas' leadership in energy use. The hot and humid climate that dominates much of the state is responsible for a high demand for summer air conditioning. Until the recent increases in natural gas prices, the price of electricity in Texas tended to remain below national averages. Relatively low energy prices, the availability of crude oil and natural gas reserves within the state, and an expanding economy made Texas an ideal site for the development of energy-intensive industries, such as petroleum refining and chemicals production, steel mills, aluminum smelting, and electronics.

Texas consumes almost 12 percent of all energy used in the United States, as can be seen in **Exhibit 1-1**.[2] In 2005, Texas' energy consumption of over 11,500 trillion BTUs exceeded that of California (8,400 trillion BTUs), the US's second largest energy consumer, by 38 percent.[3]

Exhibit 1-1 Energy Consumption, Texas versus U.S.

Total Energy Consumption by Sector (Trillion BTU), 2005	Texas	U.S.	Texas Percent of Total U.S. Consumption
Residential	1,618	21,652	7.5%
Commercial	1,399	17,971	7.8%
Industrial	5,812	32,733	17.8%
Transportation	2,730	28,331	9.6%
Total	11,558	100,687	11.5%

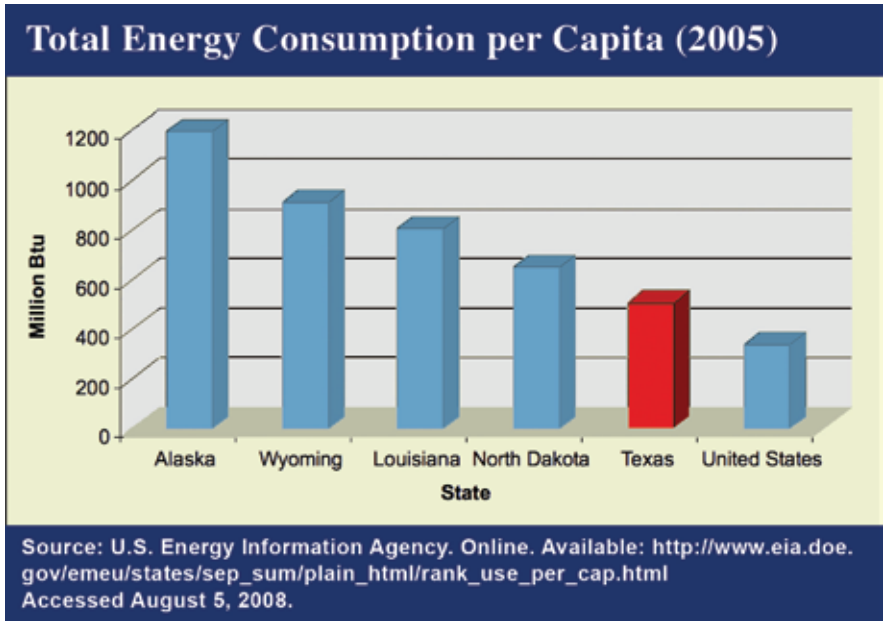
Source: Energy Information Administration.

Texas ranks fifth in the nation in terms of total energy consumption per capita, at 506 million BTU in 2005 (**Exhibit 1-2**).[4] Although total energy consumption has increased by 2.2 percent annually since 1960, per capita usage has declined. In 2005, energy consumption per capita dropped to 1965 levels.[5]

Energy consumption is often broken down into four end-use sectors: industrial, transportation, residential, and commercial. Texas's industrial sector accounts for 50 percent of the state's energy consumption and nearly one-fifth of all U.S. industrial consumption.[6] The demand for transportation has increased steadily over the past four decades at an average of 2.7 percent annually.[7] As of 2005, Texas ranked second behind California in energy consumption for this sector. Residential and commercial consumption has also increased over this time span. In 2005, Texas ranked first and second in the nation, respectively.[8] **Exhibit 1-3** shows the annual consumption in Texas by sector between 1960 and 2005.

The demand for electricity, encompassing all sectors, is growing faster than any other type of energy consumption. Between 1995 and 2006, electricity generation increased by 21 percent in the US.[9] Accounting for over 30 percent of Texas' energy use in 2005, demand for electricity is expected to continue growing.[10] A fast growing population is expected to further increase energy demand across all sectors.

EXHIBIT 1-2 Total Energy Consumption per Capita (2005)



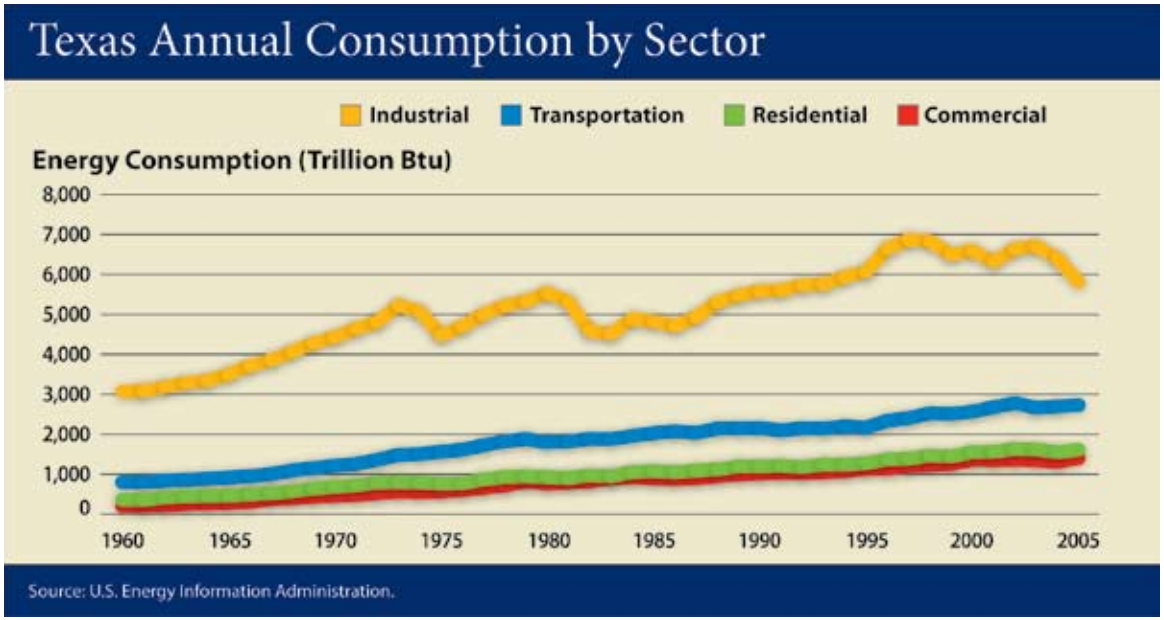
Source: U.S. Energy Information Agency. Online. Available: http://www.eia.doe.gov/emeu/states/sep_sum/plain_html/rank_use_per_cap.html Accessed August 5, 2008.

Texas at an Energy Crossroads

Historically, Texas has been a national leader in the production of petroleum products, crude oil and natural gas, and in the generation of electricity. This trend persists today as Texas continues to produce the most oil and gas of any state in the country; however, production of these precious resources has been in a downfall since their heyday in the 1970s.[11] At the same time, energy consumption in Texas and the nation have continued to steadily climb as the population expands and everyday energy demands increase (**Exhibit 1-4**).

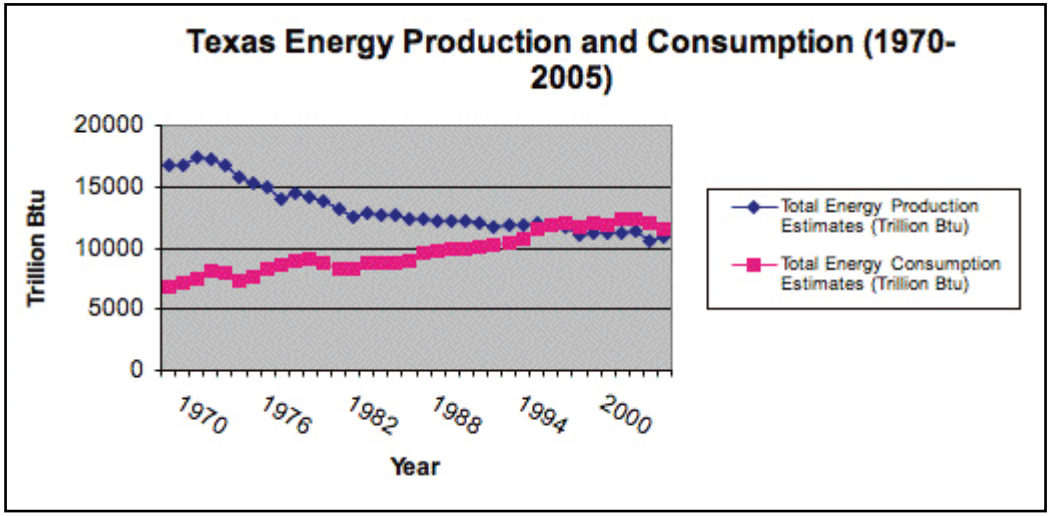
The steady decline in production levels combined with the growth in consumption has led to an energy crossroads never before seen in the state of Texas. During the early 1990s, consumption overtook production, effectively establishing Texas as a net importer of energy resources, forcing the state to increasingly rely on outside sources of energy to meet demand (**Exhibit 1-5**). This gap will continue to widen over time based on historical trends, thereby illustrating the fact that traditional energy sources will not be enough to satisfy the nation's growing thirst for energy. Texas' large, yet underutilized supply of renewable energy resources will make up a larger percentage of our total energy supplies in the future.[12]

EXHIBIT 1-3 Energy Consumption Estimates in Texas by Sector, 1960 to 2005



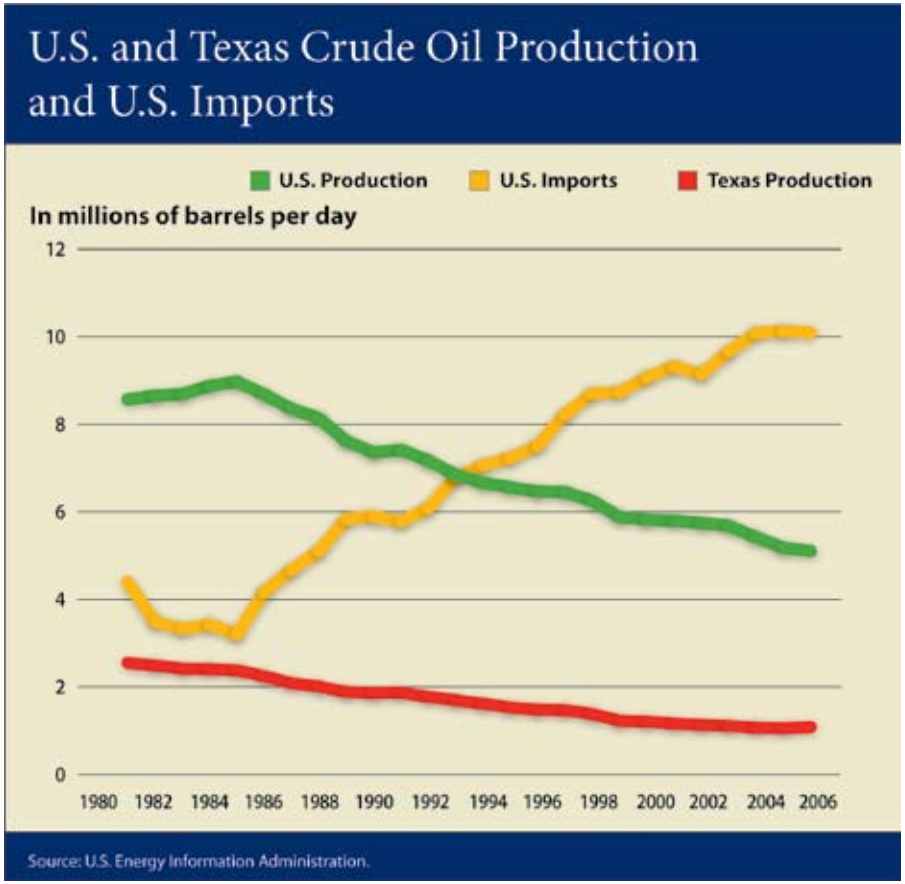
Source: Texas Comptroller of Public Accounts, The Energy Report 2008 (Austin, Texas, May 2008), p. 5, http://www.window.state.tx.us/specialrpt/energy/ (Last visited May 30, 2008.)

EXHIBIT 1-4 Texas Energy Production and Consumption (1970-2005)



Source: Energy Prod Estimates: http://www.eia.doe.gov/emeu/states/sep_prod/P7/PDF/P7_tx.pdf
Consumption Estimates: http://www.eia.doe.gov/emeu/states/sep_use/total/use_tot_tx.html

EXHIBIT 1-5 Production and Imports



Source: Texas Comptroller of Public Accounts,
The Energy Report 2008 (Austin, Texas, May 2008), p. 15,
http://www.window.state.tx.us/specialrpt/energy/ (Last visited May 30, 2008.)

Fueling Texas

Due to rising energy costs, volatility in the prices of some energy resources, variation in the suitability of different types of energy resources in different applications, national security issues, and environmental concerns, Texas must rely on a diversity of energy sources to fulfill its ever-growing energy needs. The mix of energy resources produced in Texas has not changed drastically since 1995. Natural gas, petroleum products, and coal continue to make up the vast majority of Texas' energy portfolio; however, 2005 production levels for each source were slightly below 1995 levels. Nuclear electric power provides a relatively small percentage of total production. Renewable energy resources, including wind, solar, biomass, and hydroelectric power contribute a small but increasing percentage of total energy production.[13] **Exhibit 1-6** lists the major energy sources in Texas, denoting the primary uses for each.

Non-renewable resources are the dominant energy source in Texas and the nation as a whole. Coal, natural gas, crude oil and natural gas plant liquids accounted for 78 percent of domestic energy produced in 2006, equal to 56 quadrillion BTU (quads) of energy.[14] Texas is the top producer and consumer of non-renewable fuels in the nation with 95 percent of the state's total energy produced from fossil fuels in 2005.[15]

Exhibit 1-7 and **Exhibit 1-8** show the 2005 breakdown of energy production by source for the US and Texas, respectively.

Used primarily for transportation as a direct use energy source (including heating and manufacturing), petroleum products have played a major role in the state's energy make-up and economy for decades. Texas is home to approximately one-fourth of the nation's oil reserves and leads the nation in the production of oil and gas (excluding federal offshore areas).[16] However, crude oil production has been declining since its peak in 1972 (**Exhibit 1-9**),[17] contributing to the state's and the nation's increased dependence on foreign oil. The price of crude oil has increased from approximately $17 per barrel (bbl) in July 1995 to over $141 bbl in July 2008 (West Texas Intermediate spot prices).[18]

Natural gas from Texas accounts for approximately 30 percent of the nation's total energy supply[19] and accounts for over 60 percent of energy production within the state.[20] Production of natural gas has remained fairly steady since 1995; however, the substantial jump in oil prices has resulted in an increase in production over 2005 output.[21] The electricity and industrial sectors account for the majority of natural gas demand, consuming approximately four-fifths of the state's total usage.[22] The average price of natural gas delivered to US residential customers has doubled since 1995.[23]

EXHIBIT 1-6 Primary Uses of Energy

Energy Source	Direct Use	Electricity	Transportation
Petroleum	X		X
Natural Gas	X	X	
Coal		X	
Uranium		X	
Solar	X	X	
Wind		X	
Biomass	X	X	X
Water		X	
Geothermal		X	

Source: Virtus Energy Research Associates, Texas Renewable Energy Resource Assessment, Report for the Texas Sustainable Energy Development Council, July 1995.

EXHIBIT 1-7 Total US Energy Production Estimates by Source (2005)

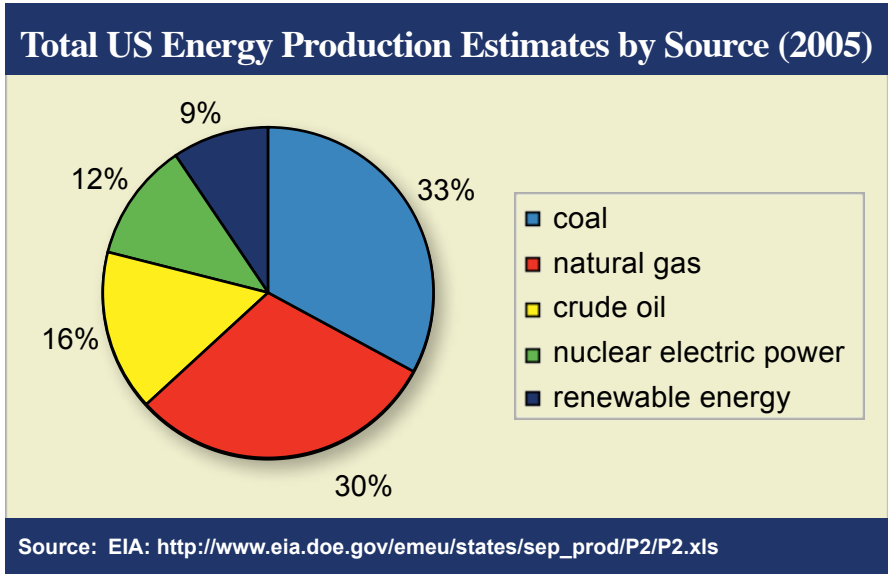
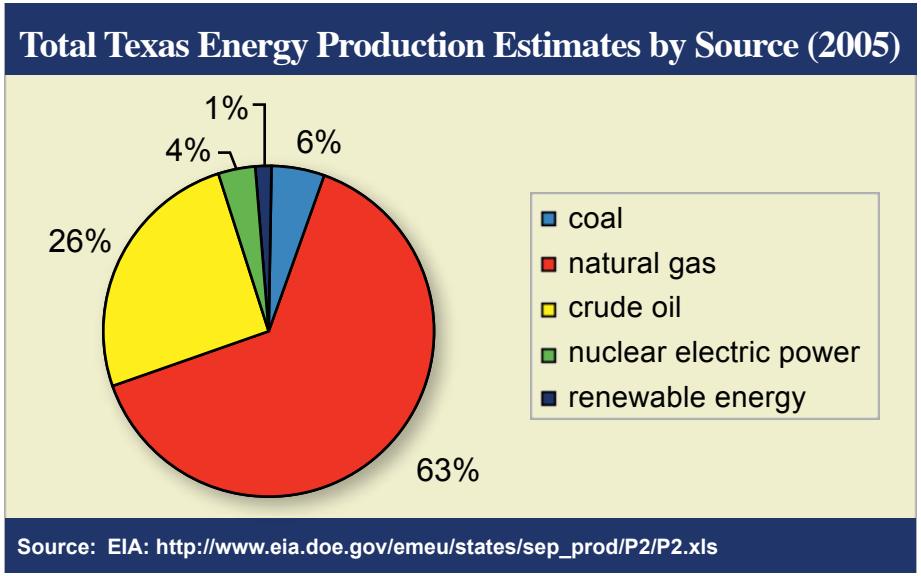


EXHIBIT 1-8 Total Texas Energy Production Estimates by Source (2005)



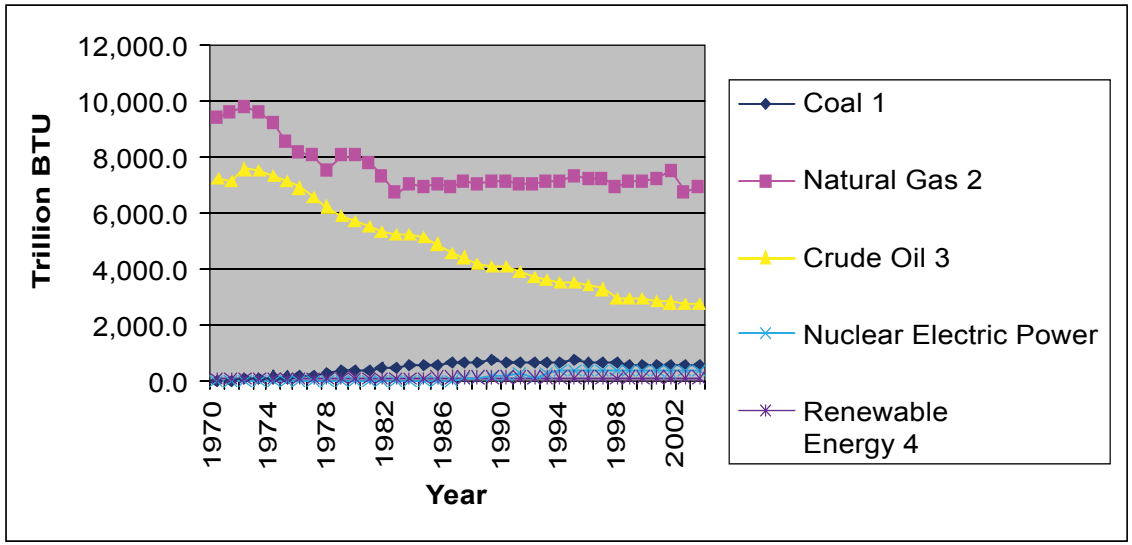
Coal, in the form of lignite, is yet another non-renewable resource found within the state. Despite the fact that Texas has some of the largest coal mines in the country, the majority of the state's coal supply is imported from Wyoming.[24] This resource accounted for approximately 595 trillion BTU (6%) of total energy produced in the state, compared to 33 percent for the US. Coal consumption in 1995 totaled 1,365 trillion BTU; in 2005 this number had increased to 1,628 trillion BTU.[25] As the price of petroleum products and natural gas continue to increase, domestic coal resources may be used in increasing amounts to offset the price of electricity production. Unfortunately, this may lead to an increase in emissions, affecting air quality throughout the state. As the biggest coal consumer in the nation, Texas is also one of the largest emitters of carbon dioxide and sulfur dioxide in the nation.[26]

Nuclear power accounted for 398 trillion BTU (4%) of Texas' total energy production in 2005.[27] This number has not changed significantly since 1995; however applications for new nuclear development could potentially turn Texas into a nuclear power leader within the nation. As of 2005, the state "ranked 7th among the 31 states with nuclear capacity"[28] and, with two plants located in Texas (South Texas Project and Comanche Peak), the state is considered a "major nuclear power generating state."[29] South Texas' application to the US Nuclear Regulatory Commission (NRC) for two new reactors was still under review as of June 30, 2008. Comanche Peak is also expected to apply for an additional two units in 2008. If these four new units are approved and built, they would have a combined generating capacity of over 6,000 megawatts (MW).[30]

Renewable Energy

Interest in renewable energy in the US and Texas has experienced a rebirth in recent years due to an increase in environmental awareness, skyrocketing oil and gas prices, and national security concerns. In 1995, renewable energy accounted for approximately 7.6 percent (6.8 quadrillion Btu) of total energy consumed in the US.[31] After a decrease in consumption during the early 2000s, renewable energy usage is on the rise with US consumption increasing 7 percent (up to 6.9 quadrillion Btu) between 2005 and 2006.[32] Preliminary data for 2007 shows a slight decline in total consumption over 2006 levels; however the breakdown by source is almost identical (**Exhibit 1-10**).

EXHIBIT 1-9 Energy Production Estimates by Source in Texas, 1960-2005



Source: EIA: http://www.eia.doe.gov/emeu/states/sep_prod/P7/PDF/P7_tx.pdf

EXHIBIT 1-10 US Renewable Energy Consumption as Share of Total Energy (2007)

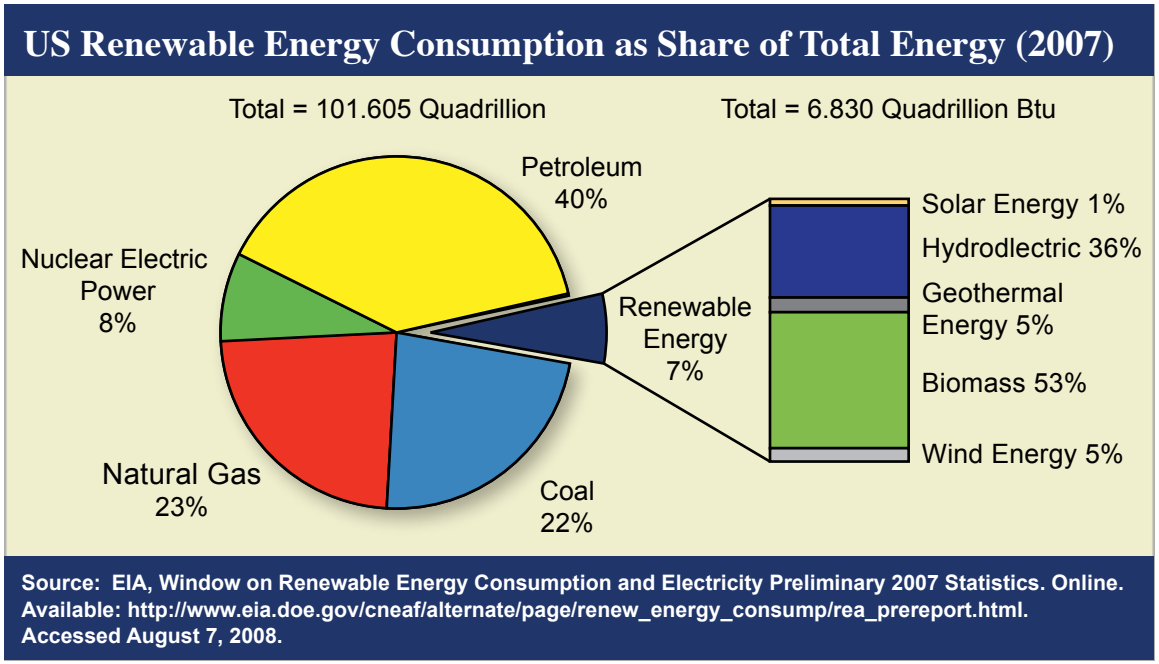
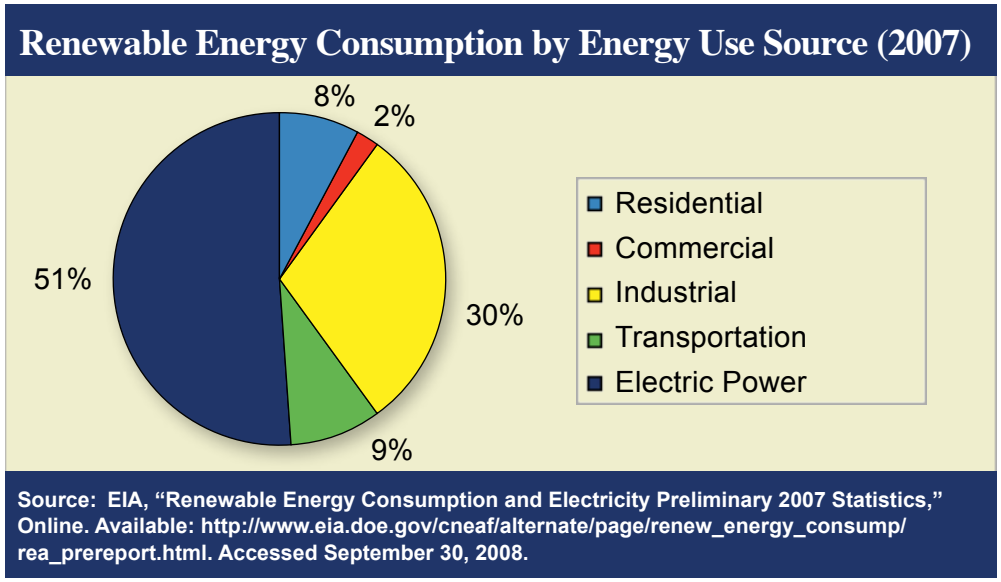


EXHIBIT 1-11 Renewable Energy Consumption by Energy Use Sector (2007)



Note: The electric power sector comprises electricity-only and combined-heat-power (CHP) plants within North American Classification System (NAICS) 22 category whose primary business is to sell electricity, or electricity and heat, to the public.

Source: EIA, "Renewable Energy Consumption and Electricity Preliminary 2007 Statistics," Online. Available: http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/rea_prereport.html. Accessed September 30, 2008.

Fundamentals of Renewable Energy

Renewable energy is obtained through a variety of sources; hydropower, geothermal, biomass, wind and solar resources are all utilized in some manner to produce energy. The majority of renewable energy produced is consumed by the electric power sector. (**Exhibit 1-11**).[33] This percentage has dropped over the past few years (down from 60 percent in 2004[34]) as other sectors are utilizing renewable energy in increasing amounts.

Renewable resources are fundamentally limited in terms of how they can be used and their availability in certain areas or at particular times. **Exhibit 1-12** lists the characteristics of each of the major renewable resources, denoting its energy type (how the energy is generated), intermittence (if the resource is continuous or not) and spatial variability (relative location/availability of the resource). For example, the opportunity to harness solar power is not always available due to rain or thick clouds; however, at the same time the majority of the earth is exposed to sunlight on a daily basis. Therefore, it is coded as an intermittent resource with low spatial variability.

Renewable Energy Sources in Texas

Hydropower and biomass (including wood, waste, and biofuels) resources have historically led the way in terms of energy production and consumption in the state. Geothermal energy has been steadily increasing over the past few decades as a reliable resource in the US; however Texas does not currently use it to generate electricity.[35] Solar and wind power have experienced huge leaps in production and consumption over the past ten plus years.[36]

Wind is currently the dominant source of renewable energy in the state. According to ERCOT data, between 2002 and 2007 wind energy production increased by 280%, while total renewable production increased by 79%.[37] This increase in wind production resulted in Texas providing 2 percent of the total renewable energy generated in the US for 2006, ranking it eighth in the nation.[38]

Potential for Renewable Energy in Texas

The potential for increased production of renewable energy in Texas is large, barring a few key issues. As of June 2008, Texas ranked first in the nation for installed wind capacity with a generating capacity more than twice that of second place California. The state also leads the nation in biodiesel production as a transportation fuel and is starting to capitalize on solar power as a viable energy resource. Ernst & Young ranked Texas number one in its "All Renewables Index" for the first quarter of 2008. Looking at the state's long-term potential for wind, solar, biomass, and geothermal energy production, the index analyzes a state's capacity for renewable production in terms of renewable energy infrastructure, political climate, technology factors, and transmission issues. In terms of individual resources, the state topped the wind index and ranked third in the long-term solar index, behind California and Arizona.[39]

Transmission-related obstacles are the major barriers to new renewable electricity generation in the state. More often than not, areas where renewable resources are abundant, e.g. wind in west Texas, are areas of low energy demand. Inadequate transmission to more populous areas of the state, where additional energy resources

Exhibit 1-12 Fundamental Characteristics of Renewable Energy Resources

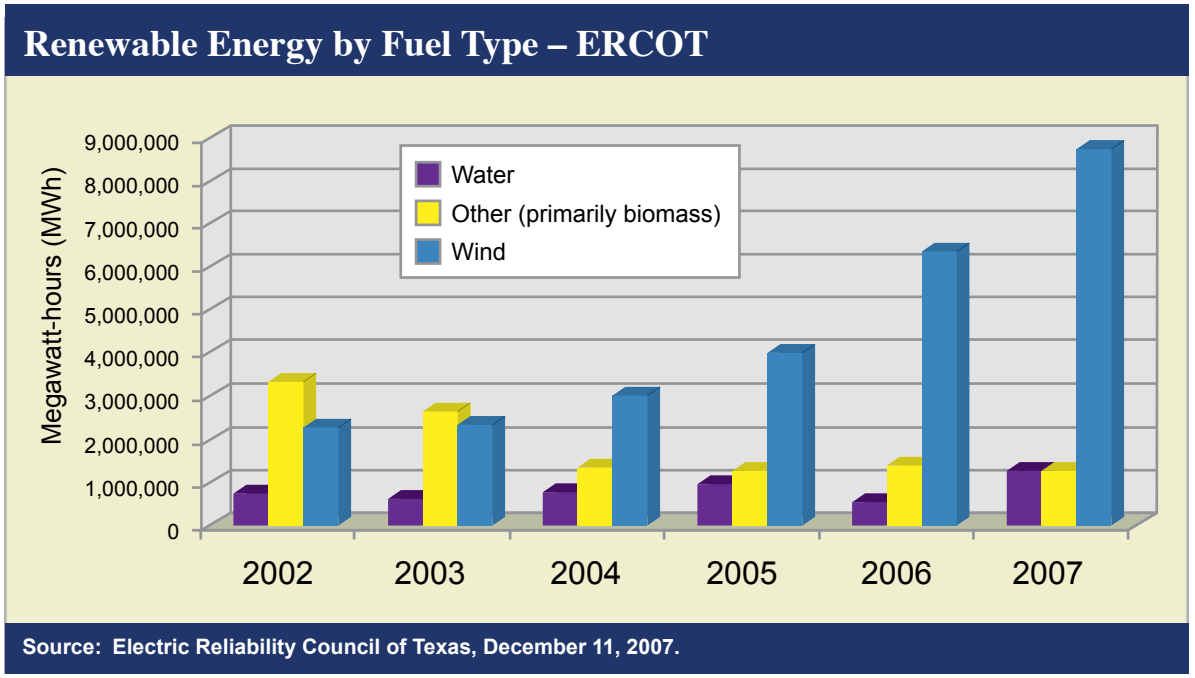
Resource	Energy Type	Intermittence	Spatial Variability
Solar	Radiative/Thermal	Yes	Low
Wind	Kinetic	Yes	High
Biomass	Chemical	No	Very High
Water	Kinetic/Thermal	Some	Extreme
Geothermal	Thermal	No	High

Source: Virtus Energy Research Associates, Texas Renewable Energy Resource Assessment, Report for the Texas Sustainable Energy Development Council, July 1995.

are needed, has hampered the overall growth of alternative energy. Overcoming this issue is seen by some as critical to the future of renewable energy production in Texas.

In July 2008, the Public Utility Commission of Texas (PUCT) took the first step in addressing the transmission problem by granting preliminary approval of a $4.93 billion plan to build new transmission lines from the windy west to the more populous urban areas of the state. If completed, transmission capacity would increase by 18,456 MW.[40] The additional wind power would displace energy production from more traditional power plants (i.e. lignite and coal plants), substantially reducing emissions and improving air quality throughout the state. Moreover, the plan has been deemed economically viable and beneficial to both producers and consumers of energy.[41]

EXHIBIT 1-13 ERCOT Renewable Generation by Fuel Type (2002-2007)



Source: Electric Reliability Council of Texas, December 11, 2007.

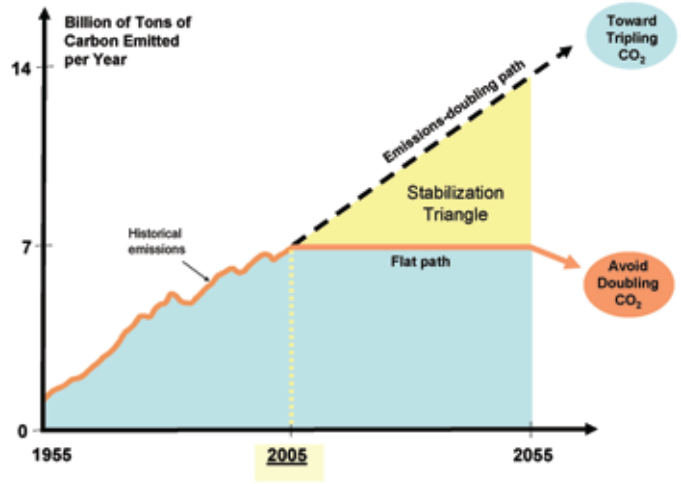
Socolow Wedge Theory

Since the creation of this report in 1995, the phrase "climate change" has become part of the average vocabulary. Burning fossil fuels to produce energy releases carbon dioxide. As a greenhouse gas, these carbon emissions blanket the earth, trapping greater amounts of heat within the atmosphere. This results in the Earth warming above the temperatures that would otherwise occur, causing changes in long-term weather patterns across the globe. Scientists believe that if greenhouse gas concentrations in the atmosphere continue to rise, weather patterns could change dramatically, resulting in potentially dire consequences for the Earth's inhabitants.

A number of studies have explored the potential role of renewable energy and energy efficiency in mitigating climate change. For example, Robert H. Socolow and Stephen W. Pacala formulated a "wedge theory" in 2004 that proposed a multifaceted approach to mitigating carbon emissions. The scientists envisioned two 50-year futures. In one, emissions are frozen at the current rate over the next 50 years through various measures. Over the following 50 years, emissions are then reduced by half. The second future takes a different direction in which the "emissions rate continues to grow at the pace of the past 30 years for the next 50 years". The first scenario would prevent the drastic increase in CO_2 levels anticipated to occur if action is not taken, thus maintaining the greenhouse gas at a less volatile level. The second scenario would result in atmospheric levels of CO_2 three times that of the pre-Industrial atmosphere; a level thought to cause potentially irreversible climate change.[42]

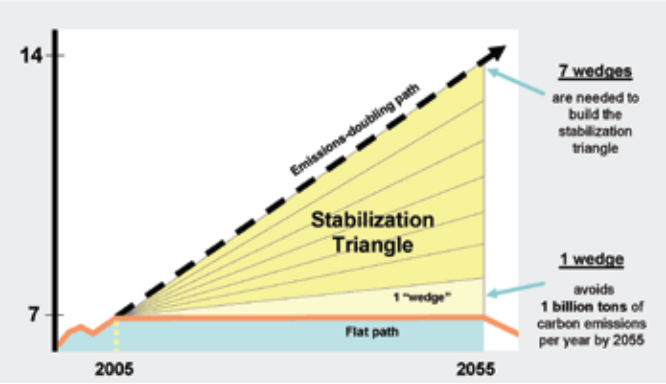
The difference between the carbon emissions released by the two futures creates a "stabilization triangle [that] can be divided into [eight[43]] 'wedges,' each representing a reduction of 25 billion tons of carbon emissions over 50 years"[44] (**Exhibit 14** and **Exhibit 15**). The reduction wedges proposed by Socolow can be accomplished through a variety of means. Two of the major wedge categories involve efficiency/conservation and alternative energy sources, specifically renewable energy. For example, cutting electricity use in homes and offices through basic efficiency measures could reduce CO_2 emissions by one wedge. In addition, increasing wind power 40-fold and doubling current nuclear capacity to avoid the use of coal could each provide a reduction of 25 billion tons of emissions over 50 years.[45]

EXHIBIT 1-14 Stabilization Triangle



Source: Princeton University. Carbon Mitigation Initiative. Window on Stabilization Wedges. Online. Available: http://www.princeton.edu/wedges/presentation_resources/. Accessed May 24, 2007.

EXHIBIT 1-15 Stabilization Wedge



Source: Princeton University. Carbon Mitigation Initiative. Window on Stabilization Wedges. Online. Available: http://www.princeton.edu/wedges/presentation_resources/. Accessed May 24, 2007.

The ultimate goal of Socolow's wedge theory is to provide a way of looking at reducing carbon emissions through the use of clean energy resources, energy efficiency standards, and other realistic measures without unduly hampering economic growth. As carbon emissions continue to grow and concerns surrounding climate change mount, renewable energy resources could become a major player in the development of a cleaner, less carbon intense energy policy for Texas and the nation.

Summary

The potential for renewable energy in Texas is bright. Today, the state has the natural resources, cost-effective technologies and manpower to turn Texas into *the* dominant leader in the renewable energy industry. At this juncture, forward-thinking policies are critical to the establishment of a robust and sustainable renewable energy market. An increased focus on the renewable market would ultimately result in environmental benefits and substantial economic rewards to the state in terms of new business, more jobs, and overall growth in the Texas economy.[46] In addition, integrating renewable technologies and efficiency measures into the state's current energy plan will help ensure a more stable energy future and reverse the trends toward an increase in imported energy sources through the development of the state's renewable potential.

Objectives of this Study

The update to the Texas Renewable Energy Resource Assessment is sponsored by the State Energy Conservation Office (SECO) through the Office of the Comptroller, as required by Rider 15, Comptroller Fiscal Programs, House Bill 1, 80th Legislature, Regular Session, 2007.

The study's objective is to provide an update to the Texas Renewable Energy Resource Assessment, originally produced by Virtus Energy Research Associates in July 1995. Partnering with the state's leading experts on renewable energy resources, opportunities and impediments to the development of Texas' renewable energy resource base have been identified and assessed in terms of its potential as part of the state's future energy plans. New research and updated statistics have been included and were used to evaluate Texas' total renewable energy resource base.

Overview of this Report

The next chapter gives an overview of the Texas climate and is followed by six sections highlighting each of the major renewable energy resources. Each resource is described in terms of its current and potential use and how it is being incorporated into the overall energy make-up of the state. Characterizing the energy base in Texas, technologies necessary to convert renewable resources into useable forms is discussed. The final chapter provides a discussion of the issues and opportunities concerning renewable energy resources, compares the economics of each resource, and delineates a variety of energy policy options for consideration.

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11. Texas Comptroller of Public Accounts, The Energy Report 2008 (Austin, Texas, May 2008), p. 14, http://www.window.state.tx.us/specialrpt/energy/ (Last visited May 30, 2008.)

12. Production/consumption estimates based on heating content by BTU values. If production and consumption levels are based on the economic value of energy resources, Texas continues to be a net exporter.

13. EIA, "Table P7. Energy Production Estimates in Trillion Btu by Source, Texas, 1960-2005," http://www.eia.doe.gov/emeu/states/sep_prod/P7/PDF/P7_tx.pdf (Last visited August 7, 2008).

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