

Chapter 8. Greenhouse Gas Emissions

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As outlined in Chapter 1, the warming of the Earth is directly related to the atmospheric concentration of greenhouse gases, notably carbon dioxide (CO₂). Since pre-industrial times GHG emissions have grown significantly, with an increase of 70 percent between 1970 and 2004. Emissions of the various gases have increased at different rates, with CO₂ emissions growing about 80 percent between 1970 and 2004 and representing 77 percent of total GHG emissions in 2004. This has resulted in an increase in atmospheric CO₂ from a pre-industrial value of about 280 parts per million (ppm) to 379 ppm in 2005. This exceeds by far the natural range over the last 650,000 years (180 to 300 ppm), as determined from ice cores. Over the same period, methane emissions have increased by 148 percent (IPCC 2007a).

The largest growth in global GHG emissions between 1970 and 2004 has come from the energy supply sector (an increase of 145 percent). The growth in direct emissions in this period from transportation was 120 percent, industry 65 percent and land use, land use change and forestry 40 percent. The most important factors in these increases are global income growth (77 percent) and global population growth (69 percent). These increases have more than offset a decrease in global energy intensity of 33 percent between 1970 and 2004, although the long-term trend of a declining carbon intensity of energy supply reversed after 2000 (IPCC 2007b).

Per capita emissions of CO₂ vary enormously, with 20 percent of the world population producing 57 percent of world Gross Domestic Product and accounting for 46 percent of global GHG emissions. As the rest of the world strives to attain a higher standard of living, emissions are expected to increase dramatically, with an increase in warming of about 0.2°C (0.36°F) per decade projected for a range of emission scenarios. CO₂ emissions from energy use between 2000 and 2030 are projected to grow 40 to 110 percent. Two thirds to three quarters of this increase is expected to come from developing regions (IPCC 2007b).

An increase in global average surface temperature following a doubling of CO₂ concentrations is likely to be in the range of 2-4.5°C (3.6-8°F), with a best estimate of about 3°C (5.4°F); values substantially higher than 4.5°C cannot be excluded (IPCC 2007a). A change in global temperatures of this magnitude could result in "abrupt and irreversible" impacts that could include the fast melting of glaciers and species extinctions. As many as 20-30 percent of species assessed so far are likely to be at risk, if increases in global average temperatures exceed 1.5-2.5 °C (relative to the 1980-1999 average) (IPCC 2007c). Even if levels of CO₂ in the atmosphere stayed where they are now, it is likely that temperatures will continue to increase about 0.1°C per decade because of the slow response of the oceans. Without extra measures, CO₂ emissions will continue to rise; they are already growing faster than a decade ago, partly because of increasing use of coal. The IPCC's economic analyses indicate that the trend can be reversed at reasonable cost. Indeed, it says, there is "much evidence that mitigation actions can result in near-term co-benefits (e.g. improved health due to reduced air

pollution)" that may offset some costs (IPCC 2007b). This reversal needs to come within a decade or so, if the worst effects of global warming are to be avoided.

It is generally agreed that the richest countries need to reduce their GHG emissions 60-80 percent. Such a reduction in emissions could totally change our current lifestyles. The developed world has a very energy-intensive way of life, and this is particularly true of the United States, which uses approximately twice the amount of energy per unit of gross domestic product as do Japan and Europe. However, this discrepancy alone illustrates that significant opportunities exist for reducing the amount of energy consumed, without a significant deterioration in living standards. In response to the 1973 oil embargo, some attempts to reduce energy consumption were initiated by the U.S. government, but the return of low energy prices in the 1980's reduced a lot of the motivation. An unwillingness to address energy consumption and global warming has been particularly evident since the election of President Bush in 2000. He initially said that he would address the issue, but then backed down under pressure from the energy industry.

Overall, the federal government has made little effort to address the issue of global warming and, in general, policies that would reduce emissions are primarily aimed at reducing energy use and our dependence on imported oil. With the election of a Democratic Congress in 2006, there has been some movement on the issue. An energy bill enacted in December 2007 increases the fuel efficiency standard of cars to 35 mpg by 2020 among other provisions. However, important provisions, including those to increase renewable energy production, were omitted. With the election of Barack Obama, there is a promise of real change at the federal level. He has committed to implementing an economy-wide cap-and-trade program to reduce greenhouse gas emissions 80 percent by 2050 and investing \$150 billion to catalyze private efforts to build a clean energy future (Obama 2008).

So far most of the implementation and development of new initiatives has taken place at the state level. In this chapter we examine the potential problems and opportunities for Texas as we move toward an era of increasing pressures, both economic and regulatory, to improve energy-use efficiency and limit greenhouse gas emissions. Some states have already adopted programs aimed at increased energy-use efficiency, and an analysis of some of these programs is included.

THE CONTRIBUTION OF GHG EMISSIONS IN TEXAS TO GLOBAL WARMING

The Nature of Greenhouse Gases

The Earth's atmosphere is 99 percent oxygen and nitrogen; the other one percent is made up of a number of "trace" or "greenhouse" gases. These gases include carbon dioxide, carbon monoxide, methane, nitrous oxide, ozone and, for the last 50 years, chlorofluorocarbons. The majority of shortwave solar radiation passes through the atmosphere and is absorbed by the Earth's surface. The longwave radiation emitted by the Earth's surface interacts with the gases in the atmosphere, resulting in the absorption of some and the reemission of the balance. As trace gases increase in relative amount, the quantity of heat retained by the atmosphere increases.

The most prominent of the greenhouse gases is CO₂. In nature CO₂ is part of an integrated carbon cycle, in which plants absorb CO₂ from the atmosphere, storing the carbon and releasing oxygen. In turn, CO₂ is released back into the atmosphere as a result of respiration, organic decay, combustion and chemical diffusion. A steady state results, if these processes are in equilibrium. However, human activity has caused an acceleration of many of these processes, resulting in a disproportionate increase in the production of CO₂. One of the more significant causes is the rapid release of CO₂ from fossil fuels that have acted as a carbon sink over a very long period of time. A second major contributor is the destruction of forests, which not only release their existing carbon, but no longer have the capacity to contribute to the carbon cycle by removing CO₂ from the atmosphere.

Methane is a naturally occurring gas that makes up approximately 18 percent of the current greenhouse gas contribution for human activity. It is generated naturally by bacteria that break down organic matter in the absence of oxygen. Methane may be produced by natural wetlands, flooded rice fields, ruminant livestock, landfills, coal mining, biomass burning and deforestation. The melting of Arctic permafrost as a result of higher temperatures also releases methane. The concentration of methane has more than doubled since the industrial revolution (Graedel and Crutzen 1989).

Recognizing that stratospheric ozone was being destroyed by CFCs, an international agreement, the 1987 Montreal Protocol, was signed by representatives of more than 40 industrialized countries. It aimed to phase out CFC production.

By 2004 the emissions of these gases were about 20 percent of their 1990 level (IPCC 2007b). In contrast, the concentration of ozone in the lower atmosphere is increasing. Here it acts as an infrared absorber, contributing to global warming. It is produced mainly as a result of emissions from fossil fuel combustion and is the main component of photochemical smog.

Whereas industrialized countries were able to come to an agreement to phase out CFCs, efforts to control greenhouse gases have been far less successful. Countries such as the United States, Canada and Australia, in particular, have resisted any efforts that they perceive will impede their economic growth. After two and a half years of intense negotiations, the Kyoto Protocol was adopted at the third Conference of the Parties to the Framework Convention on Climate Change (UNFCCC) in Kyoto, Japan, in December 1997. Most of the world's countries eventually agreed to the Protocol, but some nations, including the United States, chose not to ratify it. Following ratification by Russia, the Kyoto Protocol entered into force in February 2005. It requires each developed countries to reduce its GHG emissions below a specified level by 2012. This will result in a total cut in GHG emissions of at least 5 percent against the baseline of 1990 (Finn 2004). The Protocol places a heavier burden on developed nations under the principle of "common but differentiated responsibilities." Developed countries can more easily pay the cost of cutting emissions and have historically contributed more to the problem by emitting larger amounts of GHGs per person.

With the period covered by the Kyoto Protocol nearing conclusion, a follow-up agreement was deemed necessary. As more and more countries have come to understand the urgency of the situation, a more concerted effort to address the issue of climate change that would include participation by developing countries has been initiated. In December 2007 the UN climate change convention concluded in the Indonesian island of

Bali with an agreement to launch a two-year negotiating process, the "Bali roadmap," that aims to secure a binding deal at the 2009 UN summit in Denmark. The agreement acknowledges that evidence for the planet warming is "unequivocal", and that delays in reducing emissions increase the risks of "severe climate change impacts". But attempts by the EU, China and many developing countries to get the richest countries to agree to cut their emissions by 25-40 percent were vigorously rejected by the U.S. (Vidal 2007).

Greenhouse Gas Emissions in Texas

According to data compiled by the California Energy Commission from a variety of sources, only 12 states had more GHG emissions per unit of gross state product (GSP) than Texas in 2001. While Texas had approximately 900 metric tons per million dollars of GSP, the three highest emitters exceeded 1500 tons. All three states are coal-mining states, with Wyoming, the highest, emitting more than 3000 tons. The four lowest states, including California, emitted approximately 300 tons, as compared with a U.S. average of 600 tons. Internationally, California had comparable levels to Japan, Italy and France. Texas was closest in emissions to Australia. Some of the highest levels were emitted by India (2200 tons), China (3000 tons) and Russia (5000 tons). However, when these data are expressed as metric tons per capita, the U.S. has the greatest level of emissions, eight times that of China and 20 times that of India (California Energy Commission 2006).

Due to its large population and an energy-intensive economy, Texas leads the Nation in energy consumption, accounting for more than one-tenth of total U.S. energy use. Energy-intensive industries in Texas include aluminum, chemicals, forest products, glass and petroleum refining. Texas' petroleum refineries can process more than 4.6 million barrels of crude oil per day, and they account for more than a quarter of total U.S. refining capacity. Most of the State's refineries are clustered near major ports along the Gulf Coast, including Houston, Port Arthur, and Corpus Christi. These coastal refineries have access to local Texas production, foreign imports, and oil produced offshore in the Gulf of Mexico, as well as the U.S. government's Strategic Petroleum Reserve.

Texas crude oil reserves represent almost a quarter of total U.S. oil reserves, and Texas natural gas reserves account for almost 30 percent of U.S. total reserves. Texas is the Nation's leading natural gas producer, accounting for more than a quarter of total U.S. gas production. Texas has 10 natural gas marketing centers, more than any other state, and its natural gas storage capacity is among the highest in the Nation. Most of these active storage facilities are depleted oil and gas fields that allow Texas to store its natural gas production during the summer, when national demand is typically lower, and to ramp up delivery quickly during the winter months when markets across the country require greater volumes of natural gas to meet home heating needs (Energy Information Administration 2008a).

Table 8.1 shows CO₂ emissions in Texas for 2005 by use and fuel. With the exception of cement manufacturing, all of these emissions are a result of combustion of coal, natural gas or petroleum products (32, 30 and 37 percent of total emissions, respectively). Energy consumption data by source and year were obtained from the Energy Information Agency (2008b and 2008c) and these values were used to determine quantities of CO₂ using conversion factors provided by the Environmental Protection Agency (EPA 2007a). Emissions for each fuel were then assigned to use category, using

data from the Energy Information Agency (2008d-h). Electricity generation produces the most GHG emissions at 43 percent of total, followed by transportation (30 percent) and industrial uses (23 percent).

Table 8.1. CO₂ Emissions in Texas for 2005 by Sector (million short tons)

	Total	Industrial		Residential		% of US total	
	Transportation	Electricity	Commercial				
Coal	221.91	9.56	212.35				9.35
Natural gas	212.21	4.98	98.22	88.26	11.14	9.62	16.02
Distillate	60.06	49.26	9.41	0.12		1.27	8.51
Jet fuel	35.61	35.61					13.11
LPG	34.88	0.04	33.94		0.76	0.13	55.80
Motor gas	113.46	111.07	2.35			0.07	8.33
Residual fuel	14.21	12.24	0.23	1.75			7.75
Other petroleum products	2.11		2.11				
Cement manufacturing*	5.16		5.16				
Total	699.62	213.19	160.98	302.47	11.90	11.10	10.99

*Based on TNRCC 2002 report, assuming cement manufacturing increased by 2 percent per year since 1999

Other data based on Energy Information 2008b-h

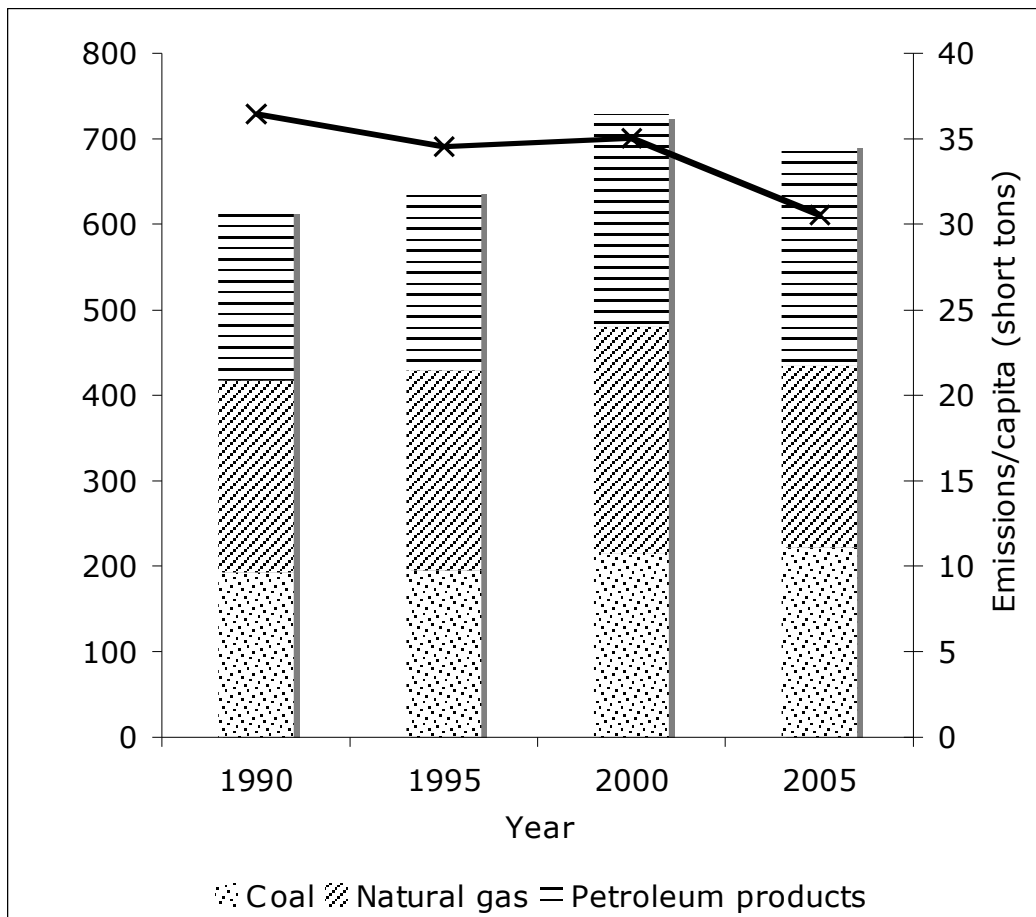
Natural gas-fired power plants typically account for about one-half of the electricity produced in Texas and coal-fired plants account for much of the remaining generation. Texas consumes more coal than any other State and its emissions of carbon dioxide and sulfur dioxide are among the highest in the Nation. Almost all of the emissions produced from coal are a result of electricity generation and account for 70 percent of these emissions. Natural gas accounts for 29 percent, but, because it produces more than twice the energy for the same amount of CO₂ produced, this is not a true reflection of the importance of natural gas for electricity production. Natural gas is also an important input for manufacturing and total natural gas use in Texas accounts for 16 percent of US usage.

Texas per capita residential use of electricity is significantly higher than the national average, because of high demand for electric air-conditioning during hot summer months. Texas's total petroleum consumption is the highest in the Nation, and the State leads the country in consumption of asphalt and road oil, distillate fuel oil, jet fuel, liquefied petroleum gases (LPG) and lubricants. Texas LPG use is greater than the LPG consumption of all other States combined, due primarily to the State's active petrochemical industry, which is the largest in the United States (Energy Information

Agency 2008a). Almost half of the emissions from petroleum products result from gasoline consumption in motor vehicles.

Figure 8.1 shows the change in CO₂ emissions between 1990 and 2005. Overall the state has increased its emissions by 13 percent, although total emissions have decreased by 4.6 percent since 2000. When adjusted for population growth, per capita emissions remained almost constant during the 1990s and then declined by 13 percent between 2000 and 2005. As discussed in Chapter 9, this is a result of the increasing importance of the service sector to the economy. Natural gas use increased 18.6 percent during the 1990s and then declined to slightly below 1990 levels between 2000 and 2005, probably as a result of price increases that reflect a reduction in domestic supply and the difficulties associated with importing natural gas.

Figure 8.1. CO₂ Emissions in Texas. Based on Energy Information Administration 2008b.



Emissions from petroleum products have increased 30 percent since 1990. For motor gasoline this figure was 36 percent, somewhat higher than the increase in population. Statewide per capita vehicle-miles traveled (VMT) increased 10 percent between 1990 and 2000, but was 8 percent for the 1990-2005 period. In the major urban areas per capita VMT increased throughout the 1990s, and was greatest between 1992

and 1995, particularly in Austin (up 25 percent) and Dallas-Fort Worth (up 20 percent). Since 2000 per capita VMT has remained relatively constant or has declined. For the period 1992 to 2005, per capita VMT increased 19 percent for San Antonio, 16 percent for Austin, 14 percent for Dallas-Fort Worth and 6 percent for Houston (Federal Highway Administration 1990-2005). Over the last 20 years these cities have had very high rates of growth, much of it in the suburbs. In recent years both Houston and Dallas have developed light rail systems and encouraged higher density development in the central city, and this, together with higher gasoline prices and high-occupancy vehicle lanes, may have slowed the rate of increase in VMT.

Methane emissions are hard to quantify. However, although small, they are an important component of GHG emissions because a ton of methane is equivalent to almost two and a half tons of CO₂. According to the Texas Natural Resource Conservation Commission report published in 2002, methane accounted for 7.4 percent of carbon-equivalent greenhouse gas emissions in 1999, slightly less than the 8.3 percent in 1995 and 1990. The largest contributors are landfills, enteric fermentation and natural gas extraction and transmission. During this period, there was a significant decline in emissions from natural gas production and a slight decrease as a result of programs to capture methane at landfills.

Nitrous oxide is another small, but significant contributor to global warming. However, it declined from 4.5 percent of total carbon-equivalent emissions in 1990 to 2.7 percent in 1999 (TNRCC 2002). This is largely as a result of efforts to improve air quality.

POLICY OPTIONS FOR REDUCING GHG EMISSIONS

Reducing Energy Consumption and Air Pollution

Reducing GHG emissions typically involves reducing energy consumption, often by making equipment and vehicles more fuel-efficient or by improving building standards. Many such programs were initiated in the 1970s following the 1973 Arab oil embargo. In 1975 Congress passed the Energy Policy and Conservation Act, which included the creation of a national infrastructure of state energy offices and set broad national goals. Some funding was provided, but implementation was left to the states, which were required to document energy savings (NASEO 1991). President Carter was also a proponent of energy conservation, seeing our dependence on foreign oil as a national security issue. With lower oil prices in the 1980s, many of these programs declined in importance.

At the time many of these programs were initiated, global warming was not considered to be an issue. The 1990 amendments to the Clean Air Act were primarily aimed at reducing pollution, particularly that causing acid rain. New stationary sources, such as power plants, came under strict new regulations and vehicle emission standards were tightened. In addition, states were required to improve air quality and lost highway funding, if cities did not meet certain air quality standards. This resulted in efforts to increase carpooling and encourage the use of public transportation. A recent decision by the U.S. Supreme court has, however, provided the EPA with the authority necessary to regulate GHGs under the Clean Air Act.

Individual states have the authority to promote energy efficiency through utility regulation, building codes, mass transit, urban planning and state taxes/rebates. States also have the ability to regulate vehicle emissions, encourage sequestration of carbon dioxide and promote fuel switching. Through statewide education programs, states can inform the public about the threat of global warming and the part that the individual can play in dealing with the problem. In addition, individual state governments can set an example through their own buying policies, e.g. by buying recycled and recyclable materials and ensuring that state car fleets use the most fuel-efficient vehicles. In 1989 the EPA awarded a grant to the National Association of State Energy Officials to evaluate some of these programs. The most successful programs were found to be cost-effective, frequently with a pay-back considerably less than the life of the project. Under these conditions, the programs can be justified on economic terms alone, and the savings of CO₂ emissions are realized at no cost (NASEO 1991).

Motor vehicles produce a variety of greenhouse gases. The major component is CO₂, but several other components of vehicular emissions are produced in significant quantities. The most important of these, for the purposes of current discussion, are nitrogen oxides and volatile organics, which combine to form ozone. Ozone is a major component of smog and also contributes to global warming by acting as an infrared absorber. Another component, carbon monoxide, prolongs the life of methane in the atmosphere and is eventually converted to carbon dioxide.

Currently, manufacturers of new passenger cars sold in the United States are subject to CAFÉ standards, which require that the vehicles meet an average fuel economy standard of 27.5 mpg. At the time of the first edition of this book (1995) we mentioned a proposal in Congress to increase this level to 40 mpg by the year 2001. Now, 13 years later, Congress has finally acted to raise the standard to 35 mpg by 2020. Economic analyses have shown that there are less expensive ways to achieve energy conservation and reduce GHG emissions than CAFÉ standards. We quoted a study that estimated that a gasoline tax of 27.5 cents imposed over five years would achieve the same petroleum and CO₂ savings through 2003 at less than one-quarter the cost (Charles River Associates Inc. 1991, p. 7). It is likely that, when higher oil prices return, especially if they exceed \$100 per barrel, gasoline price increases will have a more dramatic effect than increasing CAFÉ standards to 35 mpg, making fuel efficiency a significant factor in consumers' choice of vehicles.

Alternative fuels such as ethanol were initially blended with gasoline in small amounts to reduce air pollution. More recently they are being seen as a means of reducing GHGs from transportation. However, these fuels vary in their effectiveness in reducing such gases and this is highly dependent on how they are produced. Fuels that reduce emissions include natural gas, electric vehicles recharged from natural gas plants or renewable energy, and fuels produced from biomass – methanol or ethanol. Use of solar energy and fuel cells can also produce net reductions in GHG emissions, but their use is dependent upon continued technological improvements. Alcohol fuels (methanol and ethanol) range from a small improvement to increased GHG emissions, depending upon how they are produced. Methanol is generally produced from natural gas and results in a slight reduction in greenhouse related emissions. Ethanol produced from biomass greatly reduces emissions, but ethanol produced from corn or grain, as is the general practice, may actually result in an increase. Even though it is often claimed that GHG emissions

are reduced by 20 percent, a recent study shows that emissions could increase by as much as two-fold when all of the environmental consequences of ethanol production (including deforestation to increase the acreage available for crops) are considered (Searchinger 2008).

Programs in Texas

In 2005 Texas consumed 278 million barrels of motor gasoline, 8.3 percent of the total U.S. consumption. As a result, Texas emitted 113 million short tons of CO₂ (16.2 percent of Texas CO₂ emissions) (Table 8.1). Several mechanisms are available for reducing GHG emissions from vehicles, including reducing the amount of fuel consumed and controlling gaseous emissions. The former includes increasing the fuel efficiency of vehicles, encouraging multiple-occupancy of vehicles and considering a wider range of criteria in transportation planning. While Texas was one of the first states to develop a ride-share program, it has given it little attention since the mid 1980s, when low oil prices resulted in a reduction in public demand. Other incentives include higher parking fees and high-occupancy-vehicle lanes.

The State Energy Conservation Office is a small agency with a mission to reduce energy consumption. Most of its focus is on education, but there are limited funds for energy conservation projects. Over the past several years, the SECO has funded solar, wind and biomass demonstration projects throughout Texas, and has cosponsored conferences, workshops and other educational efforts, yielding a positive impact on Texans' familiarity with renewable energy. Free training was provided to Public Housing Authorities in Houston, Dallas and San Antonio so that they could learn how energy performance contracting could benefit their complexes. It is hoped that as a result of these workshops, 20 or more PHA's will invest 80-100 million dollars over the next three years for energy-related capital improvement.

SECO has also partnered with the Texas Department of Housing and Community Affairs' Housing Trust Fund Program to increase the energy efficiency of new and rehabilitated multi and single-family housing for low to moderate-income families. The Housing Trust Fund Program is the only state-authorized project dedicated to the development of affordable housing, providing loans to finance, acquire, rehabilitate and develop affordable housing for low and very low-income families. SECO provided funds to ensure that energy-efficient design and appliances were incorporated into new housing construction, requiring it to exceed the Model Energy Code of 1992 and 1995.

The LoneSTAR revolving loan program has saved taxpayers more than \$200 million through energy-efficiency projects for state agencies, institutions of higher education, school districts, county hospitals and local governments. Borrowers repay loans through cost savings generated by the projects. LoanSTAR-funded projects have prevented the release of 7,130 tons of nitrogen oxides, 2.1 million tons of CO₂ and 4,832 tons of sulfur dioxide.

The agency also administers a program that sets minimum requirements for energy efficiency standards for new state buildings or those undergoing major renovation. The standard is based on the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standards 90. The goal is to construct, operate and maintain buildings in such a way as to reduce energy consumption without compromising

the function, productivity or comfort of the occupants. SECO also provides energy code training throughout the state as part of a larger program to improve the energy efficiency of new buildings, including single-family homes. Legislation passed by the Texas legislature in 2001 adopts the energy-efficiency chapter of the International Code Council's International Residential Code as the standard municipal residential building code for the state. Municipalities may adopt local amendments, but these may not result in less-stringent energy-efficiency requirements for any areas designated as nonattainment for air quality standards as designated by EPA. Local amendments must be reviewed by the Energy Systems Laboratory of the Texas A&M University System, designated by the Legislature as the agency responsible for energy code implementation. In the first year, the Texas Building Energy Performance Standards were projected to save nearly 1.75 trillion Btus from residential buildings alone, with approximately \$1.1 billion in annual energy cost savings by 2008. Greater energy efficiency will reduce emissions from coal- and natural gas-fired power plants. Public Citizen estimates that by 2008, the annual reduction in nitrogen oxide (NOX) emissions is expected to exceed 21,000 tons, which will help Texas nonattainment areas meet Clean Air Act requirements (Office of Energy Efficiency and Renewable Energy 2002).

Because the chemical sector relies extensively on natural gas as both feedstock and fuel, energy costs account for a large percentage of manufacturing costs, putting this sector at a disadvantage in a global market. Texas Industries of the Future is a partnership strategy in which the U. S. Department of Energy's Industrial Technologies Program and the Texas State Energy Conservation Office provides outreach, technical assistance and training for Texas industrial energy consumers. It conducts conferences, workshops and forums, providing training and outreach to engineers and consultants in process industries on a variety of industrial energy-efficiency topics. The goal of this program is to work with the chemical and refining sector to achieve an overall reduction in energy intensity of 15 percent between 2002 and 2010. (State Energy Conservation Office)

Initiatives to Reduce GHG Emissions at the State Level

Many states, notably California, have taken the lead in developing strategies to tackle global warming. The Pew Center on Global Climate Change gives details on its website of policies adopted at the state level. Actions by individual states include one or more of the following:

Monitoring Greenhouse Gas Emissions

On May 8, 2007, more than 30 states plus two Canadian Provinces signed on as charter members of The Climate Registry, a collaboration aimed at developing a common system for entities to report greenhouse gas emissions. The Registry will serve as a tool to measure, track, verify and publicly report greenhouse gas emissions consistently and transparently between states. Voluntary, market-based and regulatory greenhouse gas emissions reporting programs are all supported under the Registry. As of August 2008, there are 39 states, nine Canadian Provinces and six states in Mexico included in the Registry. Texas is not a participant.

Establishing Emissions Reduction Targets

Each state that is aiming to reduce its greenhouse gas emissions has set its own set of guidelines. Some examples are shown in Table 8.2. In addition, states have formed regional compacts in order to initiate a coordinated effort to address emissions reductions.

Table 8.2. Emissions Reduction Targets Enacted by States

State	Base Year	Emissions Reduction
Arizona	2000	2000 levels by 2020; 50% below by 2040
California	1990	1990 levels by 2020; 80% below by 2050
Colorado	2005	20% by 2020; 80% by 2050
Connecticut*	1990 2001	1990 levels by 2010; 10% below by 2020 75-85% long term
Florida	1990	1990 levels by 2025; 80% below by 2050
Hawaii	1990	1990 levels by 2020
Illinois	1990	1990 levels by 2020; 60% below by 2050
Maine	1990 2003	1990 levels by 2010; 10% below by 2020 75-80% long term
Minnesota	2005	15% by 2015; 30% by 2025; 80% by 2050
New Jersey	1990 2006	1990 levels by 2020 80% by 2050
New Mexico	2000	2000 levels by 2012; 10% below by 2020; 75% below by 2050
New York	1990	5% below by 2010; 10% below by 2020
Oregon	1990	10% by 2020; 75% by 2050
Rhode Island	1990	1990 levels by 2010; 10% below by 2020
Utah	2005	2005 levels by 2020
Virginia	2007	30% by 2025
Washington	1990	1990 levels by 2020; 25% below by 2035; 50% below by 2050

*Massachusetts, New Hampshire and Vermont have the same requirements

Source: Pew 2008

The Memorandum of Understanding for the Northeast Regional Greenhouse Gas Initiative (RGGI) was the first multi-state greenhouse gas emissions cap-and-trade program in the U.S. As members of RGGI, states agree to a regional cap-and-trade program covering power plant carbon dioxide emissions. RGGI aims to cap these emissions at approximately current levels between 2009 and 2015, and then reduce this level 10 percent by 2019. Currently there are ten member states. Originally formed in February 2007 by five western states, including California, the Western Climate Initiative now consists of seven states and four Canadian provinces. It has set a regional goal of reducing heat-trapping pollution to 15 percent below 2005 levels by 2020. An additional 13 jurisdictions, including six Mexican border states, participate as observers.

In November 2007 six states and one Canadian province established the Midwestern Regional Greenhouse Gas Reduction Accord. Under the Accord, members agree to establish regional greenhouse gas reduction targets, including a long-term target of 60 to 80 percent below current emissions levels, and develop a multi-sector cap-and-trade system to help meet the targets. Participants will also establish a greenhouse gas emissions reductions tracking system and implement other policies, such as low-carbon fuel standards, to aid in reducing emissions. The Accord represents the first Midwestern regional agreement among U.S. states to collectively reduce greenhouse gas emissions, and will be fully implemented within 30 months. Under the agreement, by 2008 the member states and provinces will establish a cap-and-trade system to aid in meeting their regional greenhouse gas emissions target of 15 percent below 2005 levels by 2020.

Montana, which also joined the Accord, has also adopted an emissions standard for new electricity plants, prohibiting the state Public Utility Commission from approving new electric generating units primarily fueled by coal, unless a minimum of 50 percent of the CO₂ produced by the facility is captured and sequestered. Several other states also have specific requirements for power plants. California caps emissions from electricity retailers, and Washington and Oregon require new plants to offset 20 and 17 percent respectively of anticipated CO₂ emissions.

Establishing Renewable Energy Targets

More than half of the states have developed such standards, requiring a certain percentage of electrical generating capacity to come from renewable sources. Some examples are shown in Table 8.3. In addition, the Western Governors' Association (representing 19 western states including Texas) unanimously resolved to examine the feasibility and actions required to reach a goal of 30,000 megawatts of clean energy by 2015 and a 20 percent improvement in energy efficiency by 2020.

The first Renewable Portfolio Standard (RPS) enacted in Texas as part of the state's electricity industry restructuring legislation in 1999 required electricity providers (competitive retailers, municipal electric utilities, and electric cooperatives) to collectively generate 2,000 megawatts (MW) of additional renewable energy by 2009. Each provider was required to obtain new renewable energy capacity based on their market share of energy sales times the renewable capacity goal. For example, a competitive retailer with 10 percent of the Texas retail electricity sales in 2009 would be required to obtain 200 megawatts of renewable energy capacity.

Table 8.3. Some Examples of Renewable Energy Targets Enacted by States

State	Renewable Energy Targets
California	20 percent by 2010
Delaware	20 percent by 2019
Illinois	25 percent by 2025
Minnesota	25 percent by 2025
Missouri	15 percent by 2021
Montana	15 percent by 2015
New York	25 percent by 2013
North Carolina	12.5 percent by 2021
Ohio	25 percent by 2025
Oregon	25 percent by 2025
Vermont	25 percent by 2025
Washington	15 percent by 2020

Source: Pew 2008

The Texas RPS was so successful that its 10-year goal was met in just over six years. Wind power development in Texas has more than quadrupled since the RPS was established. As a result of competitive pricing, available federal tax incentives and the state's immense wind resources, wind power is expected to remain competitive with coal- and gas-fired plants. In 2006 Texas brought online the second and third phases of the mammoth Horse Hollow Wind Energy Center, bringing total project capacity up to 736 megawatts, and making it the largest wind farm in the world. That same year Texas surpassed California as the country's largest wind energy producer (Energy Information Agency 2008a), and in 2007 it increased its wind-power capacity by 59 percent, more than any other state. Texas wind farms now represent 26 percent of the nation's total capacity (American Wind Energy Association).

In 2005 the Texas Legislature passed a major extension and expansion of the RPS legislation. The state's RPS goal was increased to 5,880 MW by 2015, of which, 500 MW must come from non-wind resources. This provision indirectly promotes solar power and biomass in Texas and provides farmers and ranchers with new revenue sources from the use of crops and animal waste to produce energy. The legislation also set a goal of 10,000 MW in renewable energy capacity by 2025. The bill also included a provision to increase transmission capacity to get clean energy (especially wind) from remote areas to the cities (Pew 2008).

Developing Energy Efficiency Standards and Providing Financial Incentives to Install New Systems

California has been a leader in the fight to reduce greenhouse gas emissions in the face of federal inaction on this issue. Among other measures, it provides financial incentives for the installation of solar panels for both power generation and hot water production, and

requires existing and new state buildings and parking facilities to install solar energy systems, where feasible. The California Energy Commission is required to adopt energy efficiency standards for general-purpose lights, with the expectation that the use of incandescent light bulbs in the state will be phased out. A recent \$2 increase in vehicle registration fees will fund the new Alternative and Renewable Fuel and Vehicle Technology Program, which will provide financial assistance to develop and deploy low carbon fuels and vehicles.

In 1999, Texas required electric utilities to offset 10 percent of load growth through end-use energy efficiency. In 2007, the legislature doubled the standard to 20 percent of load growth. Higher targets of 30 percent and 50 percent are being investigated as potential options for the future.

Develop Higher Emission Standards for Vehicles

California is uniquely qualified to develop improved vehicle emission standards as a result of a provision in the 1971 Federal Clean Air Act. At the time the act was passed, California already had more stringent requirements for improving air quality and has special authority under the Act to set its own vehicle emissions standards that go beyond federal standards, though it must first obtain a waiver from the U.S. EPA. Other states may chose to comply with either the federal or California standard.

On November 8, 2007, the state of California sued the U.S. Environmental Protection Agency (EPA) for its failure to act on the state's vehicle emissions standards waiver request, which was originally made by the California Air Resources Board in December 2005. California's proposed GHG emissions standards for motor vehicles would be gradually phased in starting in 2009, and by 2016 would require reductions of tailpipe GHG emissions from new motor vehicles of approximately 30 percent. On December 19, 2007, EPA Administrator Stephen Johnson denied California's request for a waiver, arguing that recently enacted federal energy legislation establishes national vehicle efficiency standards of 35 miles per gallon by 2020, and that this unified standard is preferable to a state-by-state approach. On January 2, 2008, California filed a lawsuit challenging the EPA's decision. Fifteen other states intend to adopt the California standard and are parties to the lawsuit (Roosevelt 2008).

U.S. Mayors Climate Protection Agreement

Recognizing that climate change is an urgent threat to communities across the world and that the U.S. was not likely to address the problem at the national level, Seattle Mayor Greg Nichols launched the U.S. Mayors Climate Protection Agreement. Seattle was well placed to lead this effort. It already had policies in place that would help to reduce the amount of greenhouse gas emissions, including a goal of achieving net-zero emissions at the city-owned utility through a combination of renewable energy sources and carbon offsets. It has invested heavily in mass transit and has educational programs in place to encourage energy conservation in heating and lighting, as well as encouraging people to cycle and walk. In addition, the Seattle Climate Partnership was developed to encourage the private sector to reduce its emissions.

The U.S. Mayors Climate Protection Agreement, which was announced the day the Kyoto Protocol became law in 141 countries, has since been signed by more than 700 mayors, representing more than a quarter of the U.S. population. More than 20 Texas mayors have signed the agreement, including Dallas, Fort Worth, San Antonio and Austin. Under the Agreement, participating cities commit to take the following three actions:

- Strive to meet or beat the Kyoto Protocol targets in their own communities, through actions ranging from anti-sprawl land-use policies to urban forest restoration projects to public information campaigns;
- Urge their state governments, and the federal government, to enact policies and programs to meet or beat the greenhouse gas emission reduction target suggested for the United States in the Kyoto Protocol -- 7 percent reduction from 1990 levels by 2012; and
- Urge the U.S. Congress to pass the bipartisan greenhouse gas reduction legislation, which would establish a national emission trading system.

On November 1-2, 2007, 100 mayors attended the 2007 Mayors Climate Protection Summit in Seattle, Washington. At the Summit, the United States Conference of Mayors (USCM) and the Clinton Foundation's Clinton Climate Initiative (CCI) announced a new partnership. All 1,100 cities in the USCM will have the opportunity to purchase energy-efficient and clean-energy products and technologies through CCI's existing purchasing consortium. Mayors at the conference also urged Congress to complete energy efficiency legislation by the end of the year. The City of Houston is also participating in the Energy Efficiency Building Retrofit program, a partnership between the CCI, four multinational energy service companies, five global banks, and 16 major cities around the world to significantly reduce energy use in municipal buildings. Under the program, participating cities will retrofit their municipal buildings with more efficient heating, cooling and lighting systems, reflective roofs, and other efficiency measures and products. These upgrades are expected to reduce these buildings' energy use by between 20 and 50 percent. The five participating banks – ABN AMRO, Citi, Deutsche Bank, JPMorgan Chase, and UBS – have agreed to contribute \$1 billion each to help finance the project, and cities will repay the bank loans with their energy cost savings (Pew 2008).

The City of Austin prides itself on being a leader in reducing fossil fuel consumption and has long had a green building program that has been a model for the nation. The program seeks to educate both builders and the public on energy conservation and sustainable building techniques, as well as rate new homes according to a point system that results in the assignment of up to five stars. Its GreenChoice program for electricity generation from renewable sources has also received national recognition. In February 2007 Mayor Will Wynn unveiled an aggressive plan that will increase the community's commitment to reductions in greenhouse gas emissions. It has five components:

Municipal Operations

This initiative strives to make the City of Austin – all of its internal municipal functions – 100 percent carbon-neutral by 2020. All city-owned and -operated buildings and other facilities will be exclusively powered by 100 percent renewable energy by 2012. Only wind, solar and biomass power will be used. All City of Austin vehicles will be carbon-neutral by 2020. The intent is to have the entire fleet powered by electricity or nonpetroleum fuels, if technically possible – even heavy equipment. Within every individual department, the city will achieve maximum possible reductions of greenhouse-gas emissions and energy consumption. The city will educate, motivate and support its more than 10,000 employees to help them reduce their personal carbon footprints.

The Utility Plan

Austin Energy has set a goal of becoming the top utility in the nation for greenhouse-gas reductions. The city-owned electric utility is already a national leader in environmental initiatives, including its Green Building Program, GreenChoice Renewable Energy Program, and Plug-In Partners, a national initiative promoting advanced hybrid vehicles to automakers and fleet purchasers. Through new improvements in efficiency and conservation, Austin Energy will reduce energy use from current levels by a total of 700 megawatts (the equivalent of a whole power plant) by 2020. In addition, Austin Energy has committed to meet 30 percent of all energy needs through renewable energy by 2020.

Homes and Buildings

Responsible for 70 percent of emissions, new buildings will be required to meet strong energy-efficiency measures amended into (and enforced through) the city's building code. These measures expand on the energy-efficiency components of the city's successful Green Building Program but take them much further. Four specific initiatives include a goal to make all new single-family homes zero net-energy capable by 2015. That means requiring that home builders incrementally increase energy efficiency by 65 percent. This ambitious goal would be roughly equivalent to achieving the highest possible energy score for a top five-star rating within the existing Green Building Program. For all other new construction, the goal is to increase energy efficiency by 75 percent by 2015. In addition, when a house or other building is resold, it will be required to have an energy-efficiency inspection and meet minimal standards. The buyer will be responsible for adding basic improvements, if necessary, and these can be financed through Austin Energy's zero-interest-loan program or rolled into a 30-year mortgage.

Community Plan

Although less well-defined, the goal is to involve the whole community through a broad public-information campaign that will lead to innovative methods for inspiring behavioral change. Two major areas of concern are transportation and land-use planning. The former includes a two-pronged approach to get people out of their cars through investments in mass transit, while also putting drivers into lower-emission vehicles – the goal of Austin Energy's Plug-In Partners program. The latter includes encouraging urban infill to

promote density rather than suburban sprawl, which in turn supports greater use of public transit and reduced car-trip miles.

Going Carbon Neutral

The city will also develop and implement a program to motivate and help everyone in Austin – individuals, businesses large and small, organizations, even visitors – voluntarily take their net greenhouse-gas emissions down to zero. Those who aspire to a carbon-neutral lifestyle generally improve everything they can by buying energy efficient appliances and cars and then purchasing compensating "offset credits" to zero-out their remaining greenhouse-gas emissions. An online tool will help households and small businesses calculate their total greenhouse-gas emissions, based on Austin data (City of Austin 2007).

POLICY OPTIONS FOR TEXAS

State action, however crucial, is not a substitute for federal action. As the report Reducing the Rate of Global Warming: The States' Role concludes: "States can initiate models of effective programs, but a strong federal presence is required to ensure that all states implement effective policies" (Machado and Piltz 1988). In addition, there are certain policy options that states cannot take unilaterally and remain economically competitive; these policies are best pursued by the federal government. For example, a charge based on the carbon content of specific fossil fuels would most likely be passed on to the consumer in the cost of finished products and would place an unfair burden on any one state instituting such a carbon tax on its own. (Indeed, such a charge may have to be part of an international system.) Similarly, standards regarding fuel efficiency of vehicles or the energy efficiency of household appliances would be most easily applied at the point of manufacture by the federal government.

However, as the previous section demonstrates, there is a whole range of energy-saving measures that are cost-effective, even if the only benefit considered is the avoided energy cost. In many cases the projects pay for themselves long before the effective life of the program or equipment expires, and the additional benefit of reducing CO₂ emissions is literally without cost. Often all that is needed to implement such programs is a pool of money for capital expenditures or low-interest loans. Texas has a number of state-financed revolving funds, and these could be used as a model for similar energy-conservation programs.

So far, Texas has done very little to address the problem of global warming. In fact, the official policy appears to be to wait and see what the federal government comes up with. However, several cities, particularly Austin, have taken a leading role, and will provide models once action is mandated either by the state or federal government. Given that more than half of U.S. states have taken some action, it would be preferable for Texas to take the initiative and not wait for regulations to be imposed on it. With oil

prices exceeding \$100 per barrel likely to return in the near future, most of the following solutions would be cost-effective within a very short time frame:

- **Monitor Greenhouse Gas Emissions:** Join more than 30 states plus four Canadian Provinces as members of The Climate Registry, a collaboration aimed at developing a common system for entities to report greenhouse gas emissions.
- **Establish Emissions Reduction Targets:** Such targets could be developed specifically for Texas, or Texas could join the Western Climate Initiative, which has set a regional goal of reducing heat-trapping pollution to 15 percent below 2005 levels by 2020. By joining such an alliance now, Texas would be able to participate in the development of regional solutions such as a cap-and-trade program.
- **Increase Renewable Energy Targets:** Because of the great potential for wind power, Texas was one of the first states to set goals for renewable energy generation. However, the current target of 5880 MW by 2015 represents only about 5-7 percent of total generating capacity and is close to being realized. Increasing the target to 20 percent would be an entirely achievable goal. New and existing state buildings could be required to install solar energy systems.
- **Develop Energy Efficiency Standards:** Texas recently passed legislation requiring utility companies to meet 20 percent of new demand from energy efficiency by January 2010, and calls on the Public Utility Commission to study a goal of 50 percent of new energy demand within ten years. More could be done. For instance California is developing standards for general-purpose lights.
- **Provide Financial Incentives:** The state could provide financial incentives for the installation of energy efficient equipment, such as air conditioners. This could be used to encourage customers to buy units of greater efficiency or to replace existing units. Financial assistance for the purchase of solar panels for the generation of power or hot water would also encourage their installation.
- **Improve Building Codes:** Increase the energy efficiency requirements in the standard municipal residential building code.
- **Adopt Higher Emission Standards for Vehicles:** Join 15 other states in adopting California's proposed greenhouse gas emissions standards for motor vehicles.
- **Replace Roads with Rail:** Instead of promoting roadway construction for the transportation of NAFTA traffic, develop a more extensive rail system, which would move freight with less than half of the fuel used by trucks.
- **Develop Standards for State Agency Purchases:** Require state agencies to purchase equipment that meets certain minimum efficiency standards and cars that meet certain fuel efficiency standards, including a certain percentage of hybrid and plug-in hybrid (when available) vehicles.

With increasing energy costs and fewer resources, at both the personal and government level, saving energy is not only wise environmental policy, but also good economics. Reducing input costs for the agricultural and industrial sectors of the state will improve the competitiveness of Texas' products in the market place. Our competitors in Japan and Europe use less than half the energy we use for manufacturing processes. One of the factors contributing to the high energy-intensity of this society is the

considerable subsidies associated with energy use. The many examples of this include government expenditures for defense to protect oil imports, infrastructure maintenance associated with transportation, direct subsidies to oil companies, and the failure to account for the health and environmental costs of air pollution.

As the pressure to improve energy efficiency and reduce GHG emissions increases, Texas has an opportunity to evaluate the role that it can play in the debate. By taking an active part, Texas can help to shape policy options with its own interests in mind. The Texas economy is heavily dependent on the energy sector. As a major exporter of natural gas, Texas would be the beneficiary of policies aimed at substituting natural gas for other fuels such as coal, which produces twice as much CO₂ for the same amount of energy generated. In the longer term, Texas could position itself to take advantage of opportunities to develop and manufacture new, energy-efficient technologies. The potential for wind and solar power in Texas is almost unlimited. The development of these technologies would create well-paying jobs in an industry with great export potential, and encouraging the use of renewable energy for electricity generation would, in the long run, make Texas' products more competitive.

The United States, which produces more than 20 percent of worldwide anthropogenic CO₂ emissions, has an obligation to develop policies to limit its reliance on fossil fuels. Reducing CO₂ emissions through energy conservation is a realistic goal. Many states have demonstrated the economic feasibility of such measures, and Texas could take a more aggressive approach to the problem. Until such time as national and international policies are implemented, however, emphasis should be placed on cost-effectiveness and overall economic benefits.

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