The Senate Interim Committee on Natural Resources

Interim Report to the 77th Legislature

Future of the Texas Oil and Natural Gas Production Industry

November 2000

TEXAS SENATE
NATURAL RESOURCES COMMITTEE

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November 1, 2000

The Honorable Rick Perry
Lieutenant Governor of Texas
Members of the Texas Senate
Texas State Capitol
Austin, Texas 78701

Dear Governor Perry and Fellow Members:

The Committee on Natural Resources of the Seventy-Sixth Legislature hereby submits its interim report including findings and recommendations for consideration by the Seventy-Seventh Legislature.

Respectfully submitted,

Senator J.E. "Buster" Brown, Chair

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BACKGROUND

The oil and gas industry and Texas continues to be inextricably linked. Due to the Clean Air Act Amendments of 1990, natural gas demand for electric generation and other uses will continue to be high for the foreseeable future. Crude oil, though much more subject to world wide influences, will continue to be in demand for the foreseeable future. Though the Texas economy has diversified over the last 15 years, the most current data shows the contribution of the oil and gas industry to the Texas Gross State Product is approximately three times the electronics industry and five times the agricultural industry. In 1999, Texas oil and gas producers paid approximately $3.4 billion in royalties alone.

Though oil and gas prices are currently high, both are commodities and subject to price fluctuations beyond the control of Texas oil and gas producers. Since oil can be transported by tanker to the United States at a reasonable cost, the price of oil and the volume of oil available is subject to world wide influences. Natural gas, however, is a North American product that is supplied from the Outer Continental Shelf (30%), Texas (26%) and Canada (30%). Less than 1% of the natural gas used in the United States is imported in the form of liquified natural gas. The National Petroleum Council, in a report this year to the Secretary of Energy, forecasts United States demand for natural gas to remain high through 2010.

Rate of return has become the driver for oil and gas investments. The price of the commodity can and does fluctuate. Regardless of price, producers will invest where they can make the greatest return on their investment. For publically traded companies their shareholders and Wall Street are demanding this approach. For privately held companies they must make the investment out of cash flow or demonstrate to their banks that they are maximizing rate of return.

A comparison of the Outer Continental Shelf and Texas illustrates the issues. An oil and gas investment in the Outer Continental Shelf, though higher in front end capital costs, should result in a higher rate of return due to greater reserves found per well, no severance tax, no property tax, no sales tax and lower royalty administrative costs due to a single royalty owner.

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Current natural gas production in Texas demonstrates that tax incentives work. Approximately 30% of current natural gas production in Texas is directly attributable to the High Cost Gas Tax Incentive that Texas enacted ten years ago. Texas and its citizens are currently benefitting from this additional supply of natural gas.

Volatility in the oil and gas industry has created certain issues that will remain difficult to address. Manpower is of a key concern. In times of low prices, the industry has downsized. Many of those that have been downsized have not and will not return to the industry. Downsizing has also created a disincentive for young people to study geology and petroleum engineering. The overall workforce is getting older. The oil industry calls this the "graying of the industry." On the positive side, many of the jobs being created are being secured by minorities. LULAC estimates that seven out of ten jobs being created in the industry are being filled by Hispanics.

Many of the drilling rigs that were available in the 80s have now been scrapped. A shortage of drilling rigs and other equipment has been an issue for many Texas producers over the last 12 to 18 months.

Industry consolidation continues to occur at all levels. Consolidation by the major oil companies has created a new class of companies called the "super majors." They are Exxon-Mobil, BP Amoco and the just announced merger of Chevron and Texaco. We have also seen it occur among the Large Independents. The merger of Anadarko and UPRC is an example. As reported, these mergers have occurred to lower overhead and to increase rate of return.

Declining oil production continues to be a concern. In 1990, Texas produced 642,442,112 barrels of crude oil. Crude oil production for 1999 was 406,815,325 barrels of crude oil. Offsetting or arresting this decline continues to be interest for any number of reasons, including the school property tax base these fields and wells represent.

With the emphasis on natural gas over the last decade, natural gas production has been held constant. 1990 production was 5,533,770,539 MCF versus 5,538,929,430 MCF in 1999. To meet demand, however, the National Petroleum Council forecasts natural gas production needs to grow by more than 2% per year for the next 10 years. The majority of natural gas reserves in the lower 48 states are located in the onshore and offshore Gulf

Coast region of Texas and Louisiana. Providing about 30 percent of the total United States' supply, Texas is the largest producer of natural gas among all states[1].

As to well plugging and remediation by the Texas Railroad Commission, much has been accomplished on these issues by the Commission during the year. The Commission, after discussion with the stakeholders, has issued new W-1X (plugging) regulations that address the problems that have been cited in these areas. Sunset Commission review of the Texas Railroad Commission will be before the Legislature in 2001.

COMMITTEE CHARGE: In response these important issues, Lieutenant Governor Perry charged the Senate Natural Resources Committee to "evaluate the future of the Texas oil and natural gas production industry. The Committee shall identify existing impediments to exploration and production, and examine whether incentives should be offered to help Texas producers capitalize on the expected increase in natural gas demand in coming years. The Committee shall also analyze the effectiveness of the well plugging and remediation program of the Texas Railroad Commission.

COMMITTEE HEARINGS: In response to the Lt. Governor's charge on oil and natural gas issues, as well as other charges assigned to the Committee, hearings were held throughout the interim in Austin, Amarillo, Brownsville, Corpus Christi, Dallas, El Paso, Galveston, Houston, Midland, San Antonio and Victoria, with a special emphasis on the oil and natural gas charge at the Houston, Midland, Corpus Christi, El Paso and Victoria hearings.

In addition to the Committee's hearings, Chairman Brown requested the Texas Energy Coordination Council (TECC) to assist the Committee with this charge. In response, the TECC held several hearings and heard extensive invited testimony on the various aspects of this charge and submitted a final report complete with findings and recommendations to the Committee on October 1, 2000.

The following, denoted by italic print, is taken directly from the TECC's report to the

[1] Railroad Commissioner Tony Garza's testimony before the Senate Natural Resources Committee, September 29, 1999

Committee. Following this excerpt is the report on the well plugging and remediation program at the RRC, along with the Committee's recommendations.

EXECUTIVE SUMMARY

Pursuant to Senator Brown's request, the Texas Energy Coordination Council (TECC) has investigated the current state of affairs of the Texas oil and gas industries and the challenges facing them, including issues related to the oil and gas severance tax, potential financial incentives, technology enhancements and existing impediments. In light of its findings, the TECC has identified and evaluated potential mechanisms for stimulating the economic growth of the Texas oil and gas industries in order to produce as much of the state's remaining crude oil resources as possible and to ensure that Texas gas is a part of the expanding natural gas market.

Texas is at an important crossroads in the state's history. Energy issues that will shape the state's future for many years to come are confronting Texas. As a result of the state's vibrant economy and growing population, energy consumption in Texas has been growing and projections suggest that this trend will continue. However, energy production in the state has been declining over the last quarter century, to the point that Texas has become a net energy importer for the first time in the state's history. With this gap between energy production and energy consumption projected to continue to widen, the state will have to make concerted efforts to increase production, reduce demand, and/or cope with the economic consequences of increasing energy imports.

Challenges facing the oil and gas industries in Texas require a balancing of supply, demand, environmental, and other considerations. Natural gas is the fuel of choice for a large number of new powerplants to be constructed by Texas' restructured electricity industry. The Texas natural gas industry is faced with the challenge of being able to produce and deliver enough natural gas to meet growing demands. Gasoline consumption for transportation continues to increase along with the percentage of that consumption that is supplied by foreign oil. The Texas oil industry is faced with the challenge of declining oil reserves that are more difficult to produce. Finally, as the combustion of fossil fuels continues to increase, growing environmental concerns make it even more difficult and expensive to meet governmental requirements concerning atmospheric emissions.

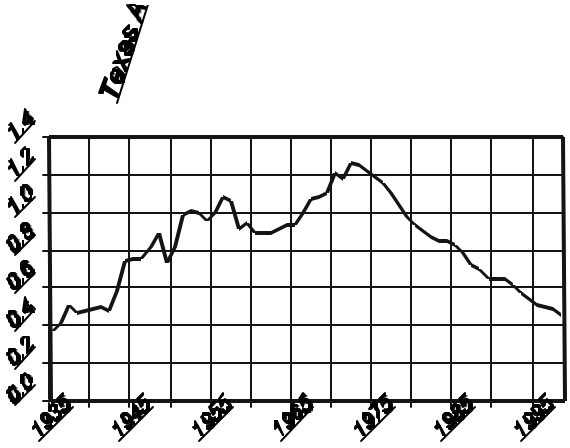
The economics of the industry have resulted in other challenges for Texas oil and gas. Due to the volatility of prices that have driven the industry in the last few decades, oil and gas companies are finding it difficult to attract investment. As budgets are squeezed companies are increasingly focusing on near-term profits. As a result, investments in Research and Development (R&D) that have traditionally been made by industry are being curtailed. In addition, the oil and gas industries are finding it difficult to attract and retain skilled industry personnel at all levels and experiencing a "graying" of their workforce. Likewise, the next generation of workers is choosing not to enter the industry. As a result of declines in crude oil prices in the 1980's, enrollments in petroleum engineering and geoscience programs, key disciplines that support the producing sector, have declined dramatically. Increased funding of university research, student scholarships, and industry internships would help alleviate the problems associated with the R&D crunch and the poor outlook for the industry's workforce. Experts from the academic community, as well as the industry itself, provided recommendations aimed at optimizing public and private investments in industry research and development and improving academic curricula.

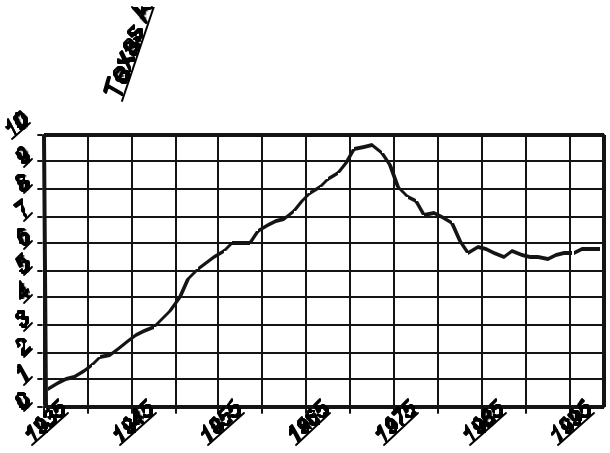
The large increases in natural gas consumption that are expected in the future will require an increase in natural gas deliverability. An additional challenge for the industry, beyond finding and producing the resources, will be to have enough safe and reliable pipeline capacity to deliver the gas. Ensuring adequate pipeline capacity would be encouraged by increasing the regulatory certainty associated with returns on investments and by facilitating the acquisition of rights-of-way. In addition, testimony before the TECC identified a number of complementary energy resources that could help the state make the most of its existing energy resources, including further utilization of Combined Heat and Power production and increased use of energy efficiency.

INTRODUCTION

State of the Texas Oil and Gas Industries

During much of the 20th century, the history and economy of Texas were inextricably linked with the state's oil and gas industries. Texas' energy consumption has been increasing and is expected to continue to increase.[2] A significant increase in demand for natural gas is projected due to the need for new electricity generation, the vast majority of which is expected to be fueled by natural gas.





Texas' demand for energy is expected to continue to grow; however, production of both oil and gas in Texas has declined from historical peaks. Oil and natural gas production has been steadily declining, to the point that Texas' oil production is currently equal to what it produced in 1935 and gas production is near the 1955 level. After reaching a peak of 1.257 billion barrels per year in 1973, Texas oil production is currently at a rate of approximately 400 million barrels per year. Likewise, production of natural gas reached its peak in 1972 with annual production of 9.6 billion Mcf. After falling to a recent low of 5.4 billion Mcf in 1992, natural gas production has risen during recent years to approximately 5.8 billion Mcf. This decline in the production of oil and gas was both foreseen

[2] Information concerning Texas' energy consumption is included as Appendix 1 of this report.

and inevitable. These declines can be attributed to falling prices, higher production costs, and maturation of the state's major oil and gas fields.[3]

By squeezing company profits, falling prices and higher production costs have reduced the industry's incentive to explore for and produce energy. Texas oil must compete with prices that are set in a global market. Continued production of Texas oil will depend on whether it can be produced profitably. On the other hand, while an increase in the price of natural gas would encourage production, economic research has shown that increasing the price of natural gas has a negative effect on the state economy as a whole. These limitations suggest that increased energy production may best be accomplished by focusing first on reducing production costs as much as possible.

The decline in oil and gas prices has affected the industry in various ways. It resulted in low drilling rates and shut-in production. As oil and gas prices have risen in recent months, the rig count has rebounded somewhat. From a peak of 376 running rigs in November of 1997, the number fell to 180 in April of 1999. By March 2000, however, the Texas rig count was up to 296, with about 80 percent searching for natural gas. Though the rig count and drilling permits have increased during 2000, completions have not. Consequently, natural gas supply has remained virtually unchanged. What's more, as with other energy producing states, Texas' oil and gas production infrastructure is severely strained due to a lack of equipment and experienced personnel.

The collapse of oil and gas prices, coupled with the decline in domestic energy production has also affected the composition of the industry's work force and, as a result, the industry's ability to meet the state's future energy demands. Texas has become accustomed to "cheap" energy and good jobs that were created to support the development of the energy industry. Many existing industry professionals are reaching retirement age and are not being replaced by new, younger professionals. In addition, funding of R&D activities is being curtailed or shifted, affecting both educational quality and industry's ability to find ways to continue lowering exploration and production costs. As the domestic oil and gas industries face tremendous production challenges to meet projected demand, it would be judicious to begin planning how the state will balance its energy supply and demand, optimize the utilization of its oil and gas

[3] A discussion of supply, demand, and price trends affecting the international and domestic oil and gas industries is included as Appendix 2 of this report.

resources, and maintain a healthy physical and economic environment.

Economic Implications of Rising Energy Prices

According to recent research at the University of North Texas' Center for Economic Development and Research (CEDR), higher gas prices bring both good news and bad news for Texas.[4] Though rising natural gas prices are a boon to gas drilling, production, and distribution industries and their employees, the resulting higher costs to Texas industries and households more than offset any gains to the Texas economy. Researchers found that each $1 per Mcf increase in the price of natural gas has the net effect of decreasing state economic activity by $3.4 billion per year, reducing salaries and wages by $911 million, and lowering total employment by more than 34,000 jobs. Among other detrimental effects, a $1 per Mcf increase in the cost of natural gas would lead to a $1.5 billion increase in the cost of natural gas for utilities and Non-Utility Generators that would be passed on to residential consumers.[5]

CHALLENGES FACING THE OIL AND GAS INDUSTRIES

As noted previously, Texas is inextricably linked with energy. The state's energy policies will determine our future as they have determined our past. Challenges facing the Texas oil and gas industries are primarily associated with maintaining our energy security, through balancing supply and demand, maintaining a healthy, productive oil and gas industry, and achieving these objectives in the most economically optimal manner. The ability to reduce our dependence on imported energy may well be a crucial characteristic that will influence the economy and environment of Texas for decades, if not centuries. However, while energy security is critical to both the nation and the state, as a major energy producer Texas is also faced with complex issues related to maintaining a viable energy production and delivery infrastructure. To put these issues into their proper context it may be useful to reflect briefly on recent observations concerning energy issues affecting Texas.

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[4] "The Impact of Higher Natural Gas Prices on the Texas Economy," Bernard L. Weinstein, Ph.D. and Terry L. Clower, Ph.D., University of North Texas, Center for Economic Development and Research, Denton, Texas, July 2000.

[5] The Center for Economic Development and Research Report found that because of rising demand, coupled with supply constraints, natural gas prices are likely to remain high for at least the next several years. Some marketers are predicting spot gas prices as high as $7 per Mcf by the winter of 2000-2001.

Texas Comptroller's "Fiscal Notes," July 1989:

"Texas' natural gas industry is beginning to recover from a major oversupply in the early 1980s that was caused by lower demand, federal regulation and stiff competition from other energy sources. Today, demand for Texas gas is up, prices are rising and excess gas supplies are steadily dwindling. . . But the industry has not recovered entirely. Current prices are only about half the $3 per MCF most industry experts consider necessary to spur significant new drilling and production. Without more drilling activity, Texas natural gas reserves and production will continue to decline."

Texas Comptroller's "Fiscal Notes," September 1994:

"For the first time ever, U.S. imports of crude oil and petroleum products in 1993 reached 50 percent of the nation's petroleum consumption. By comparison, in 1974, when the effects of the Arab oil embargo first dramatized America's dependence on foreign oil, U.S. imports amounted to 37 percent of consumption."

Finally, in a 1995 article in the Texas Comptroller's "Fiscal Notes," former Deputy Secretary of Energy Bill White stated:

…sometime in the next two decades, there will be another oil crisis, perhaps more severe than those of the 1970s. Conditions will be increasingly ripe for it early in the 21st century. Predictions of an oil crunch rest on objective analysis of supply and demand. First, the world is projected to need another 20 million barrels of oil per day by 2010, according to the U.S. Energy Information Administration (EIA). The International Energy Agency predicts even higher demand growth. Second, with two-thirds of the world's oil reserves, the Persian Gulf is projected to supply the vast majority of that increased demand--as much as 80 percent, according to EIA and OPEC itself. America's trade deficit in oil is projected to double to $100 billion a year by 2010, at which time the nation could depend on imports to meet more than 60 percent of its oil demand. . . . We are lowering our vulnerability to oil shocks by reducing oil consumption through energy efficiency, by increasing our investments in promising innovative technologies and alternative fuels, by expanding use of natural gas and renewable energy resources and by diversifying our international sources.

These strategies represent the best means to meet our current and future energy needs, lessen our reliance on oil imports and improve our economy. What have we accomplished if we select a path to balancing the budget that sets us up for another oil shock and a steadily rising trade deficit in oil, and costs us our competitive advantage in the huge and growing market for advanced energy technologies? Ensuring prosperity two decades from now requires balancing the budget without increasing the likelihood of other threats to our future well-being.[6]

The challenges facing the Texas oil and gas industries have many similarities but they also

[6] "The Coming Oil Crisis," Bill White, August 1995. As Deputy Secretary of Energy from July 1993 to August 1995, Bill White served as chief operating officer of the U.S. Department of Energy. He recently resigned to return to the private sector in Houston. He has taught antitrust and voting rights law at the University of Texas at Austin.

have many important differences. The Texas oil industry has been faced with competing with prices that are set in a global market during a time of relatively low worldwide energy prices. The Texas oil industry is concerned with maintaining the profitability of the older oil fields in Texas, producing an increasingly high cost product with a diminishing resource base of both oil and skilled personnel. On the other hand, the natural gas industry is confronted with having the infrastructure and personnel in place to produce an adequate supply of gas to satisfy large increases in demand that are expected in the future while avoiding large price increases.

Production and Reserves

Increased Natural Gas Consumption: Senate Bill 7

One of the most significant energy issues facing Texas is meeting the projected demand for natural gas for electricity generation. Environmental concerns about generating electricity with coal and lignite, coupled with an increasing demand for electricity, will require increasing Texas' production of natural gas in the near future. The Texas Legislature's passage of Senate Bill 7 (SB7), the electric industry restructuring legislation, will result in increased demand for natural gas. SB7 requires that 50 percent of all new (non-renewable) generating capacity use natural gas and that the preferred fuel will be gas produced in Texas.

Natural gas is the "cleanest" fossil fuel. It is considered by many to be the fuel of choice for the early part of the 21st century. Natural gas is expected to power our economy into the sustainable fuels of the later decades and beyond. The Texas Public Utility Commission reports that 35,400 megawatts of newnatural gas-fired generating capacity will come on line by 2003 in Texas, which, in turn, will require an additional 3.9 billion cubic feet (Bcf) of natural gas per day.[7] However, the service requirements and price sensitivity of this additional load present many challenges to suppliers and transporters of natural gas. Growth in gas demand will remain subject to changes in such key variables as growth in the economy, price of competing fuels, nuclear retirements, and the capacity utilization of coal-fired electricity generation plants.

In his testimony before the Texas House Ways and Means Committee, Railroad Commissioner Charles Matthews discussed the challenges of producing enough gas to meet

[7] The dramatic shift to natural gas as a fuel for generating electricity using gas turbines is driven by improved turbine efficiencies, lower capital costs, reduced construction time, more expeditious permitting of natural gas-burning facilities, and environmental compliance advantages.

the growing demand. Commissioner Matthews stated that demand for natural gas is expected to increase dramatically, primarily due to an increase in gas-fired electric generation. He suggested that supplying just the 6,800 MW of new gas-fired generating capacity projected by the Public Utility Commission to be on line in Texas by the summer of 2000, will require drilling approximately 500 new gas wells.[8] Commissioner Matthews stated that Texas has large natural gas resources in the ground; however, he added that we also have declining gas production and gas storage, as well as a shortage of qualified labor. As a result, Commissioner Matthews stated that his key concerns are how to stimulate production and ensure that the industry infrastructure is available to produce enough gas to meet the growing demand.

Dr. Michelle Foss, Director of The Energy Institute at the University of Houston testified that the cyclic nature of the oil and gas industries makes operating in the business very difficult and drives people to focus on cost. Therefore, one part of the "super major" strategy is cost-containment. The thinking in the industry is that if you focus on cost and become a more efficient explorer and producer, then you can better get through the cycles. However, the concern then becomes the upside of the cycle, the situation that now faces the industry, and the possibility of being too short on capacity to be able to satisfy demand.

Many of the issues currently facing the oil industry are mirrored in the gas industry. In introducing the National Petroleum Council's (NPC) report "Meeting the Challenges of the Nation's Growing Natural Gas Demand," Joe Foster, Chair of the NPC, stated that natural gas can make an important contribution to the nation's energy portfolio well into the twenty-first century. He noted that demand for natural gas will continue to increase as economic growth, environmental concerns, and the restructuring of the electricity markets encourage the use of natural gas. The estimated natural gas resource base is adequate to meet this increasing demand for many decades, and technological advances will continue to make more of those resources technically and economically viable. However, Foster stated that realizing the full potential for natural gas use will require focus and action on certain critical factors, including:

- *Continued technological advancements*
- *Financial requirements for developing new supply and infrastructure*

[8] Dr. Foss (University of Houston, Energy Institute) suggested the possibility that replacing the state's aging gas generators with modern, higher efficiency gas turbines could ultimately result in little increase in natural gas consumption.

- *Availability of skilled workers*
- *Expansion of the U.S. drilling fleet*
- *Access to resources and rights-of-way*
- *Lead times for development, and*
- *Changing customer needs*

Mr. Foster noted that each of these factors can be positively influenced, but government, industry, and other stakeholders must act quickly, cooperatively, and purposefully to ensure the availability of competitively priced natural gas.

Majors Focusing On International Resources

For a variety of reasons, the major oil companies are increasingly shifting their operations to international rather than domestic resources. The extent to which potential domestic resources have been explored has led the major oil companies to look outside of the United States due to the greater likelihood of finding large reserves. In addition, the disparity in production cost between domestic and international resources often causes international resources to be more economical.

Dr. William Fisher[9] testified that most of the potential for future oil in Texas is in carbonate rocks of the Permian Basin, suggesting that 25 billion barrels of oil may exist in Permian Basin carbonate reservoirs. Carbonate rocks are not resolved and imaged by existing seismic techniques as well as non-carbonate rocks. New advances or significant breakthroughs will be necessary if much of the remaining Texas oil potential is to be realized. Dr. Fisher stated that oil must compete in a global economy, and the mature fields of Texas, although containing large volumes of potentially recoverable oil, are not entirely competitive with lower-cost foreign sources.[10]

While significant reserves may still be found in Texas, they are dwarfed by potential resources elsewhere. Of the approximately one trillion barrels of crude oil reserves estimated to exist

[9] Dr. Fisher is the Leonidas T. Barrow Chair in Mineral Resources, Department of Geological Sciences at the University of Texas at Austin and was previously the Director of the Texas Bureau of Economic Geology.
[10] Testimony of William L. Fisher and Scott W. Tinker before the Texas Senate Natural Resources Committee, April 13, 2000.

worldwide, Middle East reserves are estimated to exceed 600 billion barrels while total U.S. reserves are estimated to be approximately 21 billion barrels.[11] *In his testimony before the TECC, Mr. Douglas Swift, Vice-Chairman and Director of Geological Research at the West Texas Earth Resources Institute (WTERI), estimated probable reserves of 3 to 5 billion barrels of crude oil remaining to be discovered in the Permian Basin. However, he added that a problem is one of scale, noting that while there are many places to search for 1 million or 10 million barrel fields, after almost one hundred years of exploration, there is no untested part of the Permian Basin in which to fit 1 billion barrels of oil.*

As a result of the flight of the majors, the development of domestic oil and gas resources is likely to be undertaken only by independent producers. In fact, Richard Erdlac, Director of the West Texas Earth Resources Institute, noted that for the first time in the history of the petroleum industry, domestic exploration and production activity is dominated by independent producers. Mr. Erdlac stated that in February 1999, the Department of Energy reported about 7,000 independents throughout the country are drilling 85 percent of all domestic wells, and producing 66 percent of all domestic natural gas and 40 percent of all domestic crude oil.

Independent producers are enthusiastic about the potential for continued production in Texas. Thomas Blank, Union Pacific Resources' (UPR) Vice-President of State, Regulatory and Public Affairs, testified that after UPR is merged with Anadarko the new company will be the biggest operator in the state. He stated that his company sees the possibility of continued profitable exploration and development in Texas, with important positive consequences for the state economy and government revenues, and that they would pursue it as long as the business climate is welcoming.

Texas' ability to increase its level of oil production is hampered by several economic factors. First, the cost of producing oil in Texas is much greater than many other parts of the world. Railroad Commission Chairman Michael L. Williams reported that the current "uplift" cost of a barrel of oil in Texas is $12-14 per barrel compared to $3-5 in the Middle East. This fact makes it difficult for Texas oil to compete with prices that are set in the global market. In addition to these direct costs, other factors exist that increase the cost of production and represent further impediments to the production of Texas oil. Many of the witnesses who testified before the TECC recommended various mechanisms for reducing the costs of oil and

[11] U.S. Department of Energy, Energy Information Administration, World Crude Oil Reserves, 1999.

gas production, including the phase-out of severance taxes, reductions in administrative costs, and increased exploitation of electronic information systems.

Industry Economics

Severance Taxes

Texas oil and gas are subject to a significant number of taxes that add production cost. This increases the difficulty of economically producing these Texas resources because they are competing against prices that are determined in a global market. Many businesses in Texas are subject to sales, franchise, and property taxes. However, in addition to paying "normal" property taxes, franchise taxes, and sales taxes, the oil and gas industry also has to pay severance taxes, regulatory taxes, a well servicing fee, a clean up fee for oil, a clean up fee for gas, a petroleum fee of $50 for every truck that delivers oil and gas wherever it goes, plus other smaller fees and taxes.

Railroad Commission Chairman Michael Williams advocated the permanent elimination of the state severance tax on oil and natural gas. In his testimony before the Texas House of Representatives Ways and Means Committee, Chairman Williams discussed the reasons that "[t]he original public policy rationales for the imposition of severance taxes no longer fit today's circumstances." Chairman Williams stated that Texas is a mature producing state with increasingly marginal production. He noted that all of the top 25 producing crude oil fields in the state were discovered more than 40 years ago, adding that each of these fields is undergoing some form of secondary recovery and that several are undergoing tertiary recovery.

Chairman Williams stated that Texas has become a net importer of crude oil and that developments in the electric industry are likely to result in increased demand for natural gas. Therefore, he stated that, in order to meet the state's energy needs, it will be necessary to keep every existing well on line and encourage new production. Chairman Williams compared the severance tax to wearing a backpack while climbing a steep slope. He concluded that eliminating the severance tax would: 1) reduce the negative policy impact that retards statewide oil and gas production, 2) encourage new activity, 3) position Texas to capitalize on an expected increase in natural gas demand, 4) maintain energy-related jobs, 5) and generate continued revenue for the State.

Chairman Williams recommended continuation of: 1) the High Cost Gas Incentive, 2) the Two and Three-Year Inactive Well Incentive, and 3) Enhanced Oil Recovery incentives. Chairman Williams testified that gas production under the High Cost Gas Incentive accounted for approximately 27 percent of the natural gas production in Texas and approximately $906 million in ad valorem tax contributions on cumulative production. In addition, he stated that production from the Two and Three-Year Inactive Well Incentive pumps $1.65 billion per year back into the Texas economy. Finally, Chairman Williams reported that over 100 million barrels of oil per year, more than 20 percent of the state's production, is generated through Enhanced Oil Recovery incentive projects and provides a $53 million contribution to ad valorem property taxes.

Douglas Swift (WTERI) agreed that the elimination of severance tax would substantially aid the independent producers of Texas. However, he added that it would be important to optimize the benefits associated with such tax relief. Mr. Swift cautioned that a primary danger to elimination of the severance tax lies in the probability that multinationals, who control much of Texas' production, would harvest the benefits and invest them in more fertile fields abroad. He recommended that every effort be made to see that any elimination of severance taxes result in reinvestment of comparable funds in Texas.

Mr. James LeBas, of the Office of the Comptroller of Public Accounts, testified before the TECC and discussed the implications of severance tax relief on the state's revenues. Mr. LeBas reported that the revenue from severance taxes represents a much lower percentage of State revenue than in the past,[12] but that the $1.9 billion per biennium is still material when compared to the budgets of various state agencies. Mr. LeBas addressed the existing crude oil and natural-gas tax relief programs, including high-cost gas, inactive wells, and enhanced oil recovery, noting that the combined relief from these programs totaled $151 million during fiscal year 1999. Mr. LeBas suggested that the impact of these tax cuts is hard to measure and that it would be important to analyze the state's competitive situation relative to other states and nations, as well as the significance of the tax relative to the risk and capital required. In conclusion, Mr. LeBas stated that attempts to "lighten the load" on capital intensive industries have historically been unsuccessful.

[12] Mr. LeBas stated that the severance tax is currently at an all time low as a percentage of total State revenues, amounting to approximately 2 percent in 1999, compared to a high of approximately 15 percent in 1984.

Mr. Obie O'Brien of Apache Corporation provided testimony to the TECC concerning economic issues facing the industry.[13] Mr. O'Brien identified two reasons that the oil and gas industry hasn't recovered as well as it had previously when the price has gone up. First, the industry took on a large amount of debt right before the last downturn and, as a result of that debt, the last downturn was a crushing blow to a number of companies. In addition, the industry is increasingly in a global competition for where it spends its capital. Mr. O'Brien reported that for most of the publicly traded, large independents in the United States, rates of returns are currently 4 percent or less, adding that this hardly compares to the high-tech industry which, in spite of its recent downturn, is still outperforming the oil and gas industry.

Mr. O'Brien discussed a severance tax reduction proposal that has been developed by the industry. This plan would link any tax benefits to Texas investment and would require the industry to "put its money on the table" prior to receiving any benefits from the State. Under this plan, severance tax rates would be reduced by making "qualified investments" in excess of 125 percent of the investments made during a baseline period. Qualified investments would be capital investments within the state that increase reserves or production, everything other than acquisition costs and day-to-day lease-operating expenses. Additional tax rate reductions would require additional investments in excess of 125 percent over historical amounts until reaching a point where severance taxes would be eliminated across the board.

In addition to the possibility of maintaining Texas' status as a net exporter of natural gas, the industry estimates the benefits of its severance tax reduction plan (assuming 100 percent participation) would include:

- *An increase in oil and gas investment in Texas from $5 billion per year to $6.3 billion per year*
- *Creation of 68,000 additional jobs over a five to six year period*
- *3,000 new producing oil wells and 140 million barrels of new oil production*
- *4,300 new producing natural gas wells and 21.5 trillion cubic (TCF) of new natural gas production*
- *5.5 TCF of new natural gas reserves, and 207 million barrels of new oil reserves*
- *An additional $480 million per year in additional property taxes to school districts and local*

[13] Mr. O'Brien testified on behalf of the large independents group, the Texas Independent Producers and Royalty Owners Association (TIPRO), and a few of the smaller regional associations.

governments

- *An increase in Gross State Product of $13 billion over the entire period, and*
- *A positive net impact on the state of $12 to $120 million per year, depending on the date that the industry first receives its benefits.*

Mr. O'Brien estimated that 50 to 75 percent of the Texas oil and gas industry would participate in this incentive program. Large independents, including Apache, EOGR, Anadarko, and Burlington would participate. Some of the majors, such as Texaco, seem to be intrigued with the proposal although some of the "mega-majors" may or may not participate. Companies want to invest money in Texas for a variety of reasons. Many of the companies are headquartered in Texas, the infrastructure is here, and there is a reduced concern about companies being nationalized or somebody blowing up a pipeline. The feeling in the industry is that it is easier to operate in Texas but in many cases the rates of return don't allow it. The elimination of the severance tax would increase industry returns to the point that Texas would have a "huge advantage" over Louisiana and a "big advantage" over Oklahoma. Furthermore, it would make Texas "very competitive" with Canada and the Gulf of Mexico, where Texas has most of its competition for oil and gas dollars.

Reduction in Administrative Costs

The administrative costs associated with regulation of the Texas oil and gas industries are a burden that adds cost to domestic oil production. Although improvements in this area have resulted from recent actions of the Texas Railroad Commission, further potential exists for administrative cost reductions that would lower the cost of domestic oil production.

In his testimony before the TECC, Chairman Williams discussed efforts he had sponsored that resulted in reducing regulatory costs by more than $5 million per year. In addition, Chairman Williams stated that the Railroad Commission had recently launched the first-round of its Environmental Compliance and Approval Process (ECAP). He estimated that this on-line permitting process will save the industry $200-400 per permit.

Exploitation of Electronic Information Systems

Mr. Thomas Blank of Union Pacific Resources testified that ECAP will bring "phenomenal" increases in employee productivity and decreases in costs and time, as will on-line access to hearing files, which the Railroad Commission staff is now developing. In addition, Mr. Blank reported that the Railroad Commission is planning to redesign its website to allow instant electronic access to Railroad Commission data that is now available only by traveling to

Austin and "combing through paper files during business hours." Mr. Blank suggested that the Railroad Commission's willingness to investigate creative ways to modernize regulatory processes, embrace new technology, devote the necessary resources, and work cooperatively with industry, shows the Commission's understanding of the importance of creating a rational and efficient regulatory environment for the oil and gas industry in Texas.

The Texas Railroad Commission currently provides some information on oil and gas through the Internet, such as the Texas Advanced Computational Technology Initiative (ACTI). ACTI is an oil & gas production database that was developed "to provide quick and easy access to Texas oil and gas information over the Internet." ACTI provides interactive reports on oil and gas production from 1993-2000 by county, district, field, lease, or operator. Railroad Commission Chairman Williams reported that ACTI receives approximately 200,000 "hits" per month. Other information currently provided by the Railroad Commission includes oil and gas drilling and production statistics and reports, including top Texas producers, monthly oil and gas production (1994-2000), oil and gas well counts by county, historical oil and gas production and well counts (1935-1998), gas storage statistics, and other industry-wide oil and gas statistics.

Workforce

Loss of Skilled Industry Professionals, Valuable Information, and Data

Many of the witnesses that provided testimony before the TECC addressed the effect of oil and gas prices on the oil and gas industries' workforce. The industry suffered extensive "downsizing" as a result of falling oil prices. Witnesses also reported a "graying" of the industry, suggesting that there is an approaching "talent gap" which will emerge as oil companies seek to fill the roles of experienced personnel that will be brought about by retirements. The "next generation" of workers is choosing not to enter the oil and gas industry. Without immediate action, impending shortages of qualified personnel are expected to hinder the ability of the supply sector to find and develop the required oil and gas supplies.

Changes in the oil and gas industries have had a profound effect on the composition of their workforce. To survive in a highly volatile marketplace oil companies took aggressive measures to reduce costs. The extreme volatility of oil and natural gas prices over two decades taught a valuable lesson to operators: rely more on operational efficiencies, and less on commodity prices to boost profits. Those efficiencies included eliminating obsolete jobs and identifying overlapping responsibilities that lead to duplication of effort. The increased use of technology cut staffing needs everywhere from technical to managerial to administrative. The popularity of outsourcing to increase efficiency and cut overhead has been manifest in the need for fewer "staff" oil industry jobs. Finally, synergies and scale

economies attained through mergers and acquisitions have allowed many companies to achieve more with fewer net employees.

Three major shocks to employment prospects in the producing sector occurred in the last 20 years (1982, 1986, and 1998). These were caused by drastic declines in the world market price of crude oil and resulted in significant reductions in expenditures and jobs. Approximately 500,000 jobs have been eliminated from the U.S. gas industry since the early 1980's, with over 40,000 job cuts occurring in the producing sector alone in the past year. The Texas Workforce Commission estimates that 150,000 jobs have been lost in the Texas oil and gas industry since 1982. The Texas Railroad Commission estimates that the Texas oil and gas extraction industry has lost 18,000 jobs and $885 million in payroll in the 18 months following the beginning of 1999, despite the recent rebound in prices.

An additional consequence of this loss of jobs has been the loss of a great deal of knowledge and experience that is not being replaced. Testimony before the TECC suggested that knowledge acquired through a lifetime of experience in the industry has tremendous value and that, once this knowledge base is lost, much of it is irreplaceable. Reductions in industry hiring rates during the last 20 years have resulted in a disproportionate percentage of the workforce reaching retirement age in the next decade, an average of 40 percent in a sampling of major producers.[14] As a result, the producing sector now suffers from a very slim pool of mid-career workers between the ages of 30 and 40 and is facing a large wave of retirements.

The next generation of workers is choosing not to enter the industry. In addition to jobs lost as a result of "downsizing," industry professionals are aging and are not being replaced by new professionals. A large influx of new professionals at the end of the 1970's and beginning of the 1980's was driven by an expectation of extremely high world prices. These individuals were trained by older, experienced professionals. When world oil prices collapsed, so too did the influx of new professionals. In the aftermath of precipitous declines in crude oil prices in 1981, enrollments in key disciplines that support the producing sector began to decline drastically and gained momentum with the equally devastating oil price drop in 1986. Enrollments in undergraduate petroleum engineering and geoscience programs have declined by 77 percent and 60 percent, respectively, between 1985 and 1998.[15]

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[14] "Meeting the Challenges of the Nation's Growing Natural Gas Demand," National Petroleum Council, Committee on Natural Gas, December 1999

[15] Data from (1) Petroleum Engineering and Technology Schools 1997-1998, Society of Petroleum Engineers http://www.pe.ttu.edu/spe_schools_book/html/school.html, (2) State of Oil and Natural Gas Industry, Independent Petroleum Association of America, August 4, 1999.

The U.S. Bureau of Labor Statistics' (BLS) biennial "Occupational Outlook Handbook" (2000-2001) states that extraordinarily few of the 339,000 people classified as oil and gas extraction workers are in their teens or twenties. More than 65 percent are ages 35 to 54. In addition to the "graying" of the oil and gas industry, the job market for future oil and gas workers does not look promising. The BLS suggests that the oil and gas industry has the worst employment prospects in the entire U.S. economy over the next decade. There are only 528 petroleum engineering students nationwide and the BLS forecasts that the need for geologists and geophysicists in the oil industry will fall 47 percent in the decade ahead. Not surprisingly, the number of geoscience students has plunged 32 percent over the past ten years.[16]

Twenty years ago, skilled workers who were laid off from an industry had few options for changing careers. They tended to be available for rehire when the employment cycle turned around. But times have changed. With the economy creating new jobs at a rate of 14 percent per year, competition for workers is intense. Energy companies have come to realize that eliminating a job increasingly means permanently removing the jobholder's skills from the available industry employment pool. As a result, the oil and gas industry will have an increasingly difficult time replacing retirees over the next fifteen years.

The oilfield service/supply sector faces similar challenges in meeting engineering and operations requirements. Price volatility has led to fluctuating labor demands in the drilling industry that have caused many tool pushers and other key supervisory personnel to leave the industry in search of more stable careers. Industry contractors will be challenged to find and train adequate numbers of skilled laborers, such as machinists, electricians, pipefitters, and welders. Higher wage scales are likely to be required to attract workers back into the industry. Aggressive proactive workforce planning will be necessary for producers and contractors to achieve staffing levels that are necessary to meet the challenge of the projected demand increase.

Dr. Foss suggested that, in addition to more personnel, the industry may also need different skills. While everyone is concerned about whether there are enough people to drill the wells

[16] Employment in the oil and natural gas sector is expected to decline 6 percent, a rate 36 percent more severe than apparel manufacturing, the second worst sector. For upstream oil and gas extraction, which makes up the largest segment of BLS's mining occupational group, total employment is expected to drop a whopping 16 percent between 1998 and 2008. Petroleum refinery occupations are projected to experience a modest 2.5 percent decline, while oil and gas field services are projected to witness growth, albeit a tiny 0.5 percent, over the next ten years. Furthermore, the BLS estimates openings for petroleum engineers will drop 21 percent over the next ten years. This follows a slump in enrollment in petroleum engineering programs nationwide of 28 percent in the last decade.

that need to get drilled, especially on the natural gas side, the shrinking resource base may require a restructuring in higher education. The traditional boundaries between disciplines are no longer relevant. For example, the Geoscience's program at the University of Houston is considering a new concept, a Master's degree that integrates business concepts. Under this program, a student pursuing a Master's degree in geology or geophysics would also be taught economic concepts and decision-making analysis before having to learn that in the business. Companies are trying to put people together in teams and need to be able to take graduates, put them into teams and go to work right away. The current cycle time is so short that no one has time to retrain people.

In addition to changes in university curricula, Dr. Foss suggested that the oil and gas industry could address the difficulty of replacing skilled personnel by making the industry a more attractive workplace and by improving the industry's image. The industry could come to be seen as a more attractive workplace due to the surge in technology businesses and the attractiveness of technology businesses to the workforce. The industry has an opportunity to offer a workplace of meaningful jobs, including the opportunity to innovate. In addition, there are opportunities for creating the workplace diversity that is needed to be able to understand what customers want. Dr. Foss suggested that the industry work on corporate responsibility, adding that too often companies say that they are interested in sustainable development or environmental programs, but need to do more than give lip service to these concepts. In addition to how shareholders view companies, the ability to recruit employees is also a "market test."

Research and Development

The U.S. Department of Energy has concluded that investment in R&D, both public and private, is America's investment in its future[17]. Research and Development is a major driver of economic growth and job creation, and one of the most important foundations for America's future economic competitiveness and international leadership. However, DOE also found that the "R&D headlights" are being lowered in the private sector, where "long term" is now considered to be five years or less. Widespread cutbacks, restructuring, and foreshortening of time horizons threaten U.S. energy R&D at a time when science and technology are of growing importance for meeting global challenges. The report noted that federal energy R&D has been cut by 75 percent since the late 1970's and that the Japanese government currently spends more than twice as much on energy R&D as the U.S.

[17] U.S. Department of Energy, Secretary of Energy Advisory Board, Report of the Task Force on Strategic Energy R&D (1995).

Technology advancement has played a major role in the increase of the North American oil and gas resource base by: improving the efficiency of drilling, equipment, operating, and other costs; increasing recovery factors of discovered oil and gas in place; improving success rates (reducing the number of dry holes); and by revealing new areas and types of resources for exploitation through innovative geologic and engineering concepts. These improvements have occurred mainly through advances in 3D seismic capabilities, directional drilling, and improved completion techniques. Information and communications technology have also had a widespread impact on all facets of the producing sector. The continuing improvement of computing power at continuously decreasing cost has placed increasingly powerful information technology tools in the hands of even the smallest producers, improving efficiency and reducing costs.

Dr. Fisher characterized the Texas oil and gas industries' situation as a paradox. At a time when production from mature fields (such as those in Texas) is increasingly dependent on technology and the pace of technology advance, industry has strongly curtailed its R&D efforts and public entities have not enlarged their traditionally modest efforts. Dr. Fisher suggested that, although industry has historically been able to "piggyback" technologies that have been developed outside the industry, this trend is probably not sustainable. He suggested that other areas of research and technological development are needed in oil and gas exploration and discovery beyond digital technology, adding that the basic research that will support the technology and technological development a decade or so hence is not being broadly conducted privately.

The United States' historical dominance in developing and using oil and gas technologies is being lost as industry reduces its funding for long-term research and development activities. While the independents are the most likely to develop domestic resources, they are unable to pursue some of the important R&D functions previously undertaken by the majors. The major oil companies have traditionally undertaken the majority of the oil and gas industry's R&D. However, as a result of mergers and downsizing, the curtailment of long-term research, and a decline in federal government R&D funding, funds available for R&D have been drastically reduced. In his testimony before the TECC, Mr. Erdlac (WTERI) reported that in the last three years alone, major oil and gas companies have reduced overall R&D spending by 22 percent.

Dr. Kurt Marfurt of the Allied Geophysical Laboratories at the University of Houston also addressed the reduction in research and development that is affecting the oil and gas industry. Dr. Marfurt stated that consortia, sponsored through oil or service company research or technology centers, had been the mainstay of exploration geophysics research at universities

for over 25 years. Through these consortia students were financially supported, trained, informally evaluated, and recruited over a 2 to 4 year period. With the disappearance of more than half of the potential oil industry sponsors through mergers in the past two decades, and with financial investments being dictated by oil company business units with other financial goals, the university consortium model is currently broken. The foundering of university consortia is having a major impact on the training of the next generation of geophysicists. Most major oil companies no longer have research or technology centers and those that remain are half their former size. Most independents, many of whom are multi-billion dollar enterprises, have never had research or technology centers.

Furthermore, the majors have historically employed and trained new industry professionals because independents were unable to invest the time and financial resources necessary to do so. The reorientation of the major oil companies has diverted their attention from basic R&D to near-term product development and technical services, thus eliminating the traditional training ground for new industry professionals.

Although many of the witnesses testified to significant reductions in R&D funding, Dr. Foss offered a somewhat different perspective. She reported that industry spending on oil and gas production research and development has actually remained fairly stable. A recent survey found R&D spending by industry to be down by only $100 million during the past nine years. However, it was noted that a shifting in the allocation of investment from research to development had occurred. Industry has reallocated its funding to make sure that investments in R&D are going toward things that companies really need. Dr. Foss recommended that, to the extent that the State takes over some of the responsibility for funding R&D, it is important to avoid investing in non-productive R&D by determining what it is that companies are really doing or wanting to do, and whether traditional areas of R&D investment are still relevant.

Natural Gas Transportation

Changes in energy markets have resulted in renewed emphasis on the use of natural gas. However, the infrastructure required to deliver gas to market will need to be optimized and expanded to accommodate the expected increase in demand as well as the changing logistics of getting new supply to new customers. The anticipated growth in demand for natural gas for electricity generation will require the delivery system to be re-optimized to meet larger off-peak swing loads as well as increasing peak-day requirements. Furthermore, meeting requirements of electricity generators on a larger scale will entail changes that must be accomplished without degrading the historically reliable service to the residential, commercial, and industrial markets.

In his comments before the Texas Senate Natural Resources Committee, Patrick J. Nugent, Executive Director of the Association of Texas Intrastate Natural Gas Pipelines, discussed a number of challenges currently being faced by the pipeline industry. He stated that, despite the natural gas pipeline industry's excellent safety record and longstanding support of efforts to enhance the safety of pipeline systems, the industry is increasingly confronted with a general resistance to new pipeline projects characterized by "not in my backyard." Mr. Nugent testified that if Texas is to capture its share of new market growth, that legislators, regulators, the natural gas industry, and landowners must develop mechanisms that will promote the timely and economic construction of new pipelines in a safe and environmentally responsible manner.

Mr. Nugent also suggested that, if the natural gas pipeline industry is to respond to the numerous proposals for new facilities, there must be an opportunity to earn reasonable returns on these investments. He stated that since many pipeline projects serve more than one purpose, there must be reasonable regulation for the appropriate recovery of costs from the different customers using and benefiting from such projects, adding that new projects are typically dependent on existing infrastructure that can only be maintained if adequate compensation is provided to the pipeline.

The transmission and distribution sectors of the industry face challenges in attracting investments to future projects. Expanding the infrastructure of the delivery system to accommodate increased demand and changing requirements of newcustomers will involve changes in financial risks. Uncertainty exists with future rate structures and obligations to serve, as electricity and gas restructuring continues. Industry participants and regulators must work together to find an appropriate balance for these risks so that the needed infrastructure expansions can be accomplished.

Developing Complementary Energy Resources

Several of the witnesses who testified before the TECC identified energy resource opportunities that were either related to the oil and gas industries or were complementary to it. These included the exploitation of potential geothermal resources in the Permian Basin, increased utilization of combined heat and power (cogeneration), and the expanded implementation of energy efficiency and energy conservation. Because some geothermal prospects are closely allied with or dependent on existing wells (as in the Permian Basin), and because much of the science and skill sets, subsurface technology and infrastructure are common to oil, gas, or geothermal exploration and production, we are including a more extensive discussion of that resource than other equally viable and important renewable energy resources such as wind or solar.

Exploitation of Existing Geothermal Resources[18]

Testimony by Mr. Douglas Swift before the TECC suggested that existing well bores in depleted deep gas fields in West Texas offer the potential for exploiting significant geothermal energy resources. The development of this geothermal potential is related to the future of the oil and gas industry because of some overlap between the two in technology and expertise. Mr. Swift testified that the essential components for developing geothermal power exist in the Permian Basin, including existing wells with sufficient temperature; well-documented geological information on these wells; necessary personnel; and markets for electricity produced within reasonable transmission distances. Mr. Swift suggested that access to existing wells would offer an opportunity to take advantage of this resource at a reduced cost but that the window of opportunity was rapidly closing.

Mr. Alan Jelacic of the U.S. Department of Energy's Geothermal Power Program agreed that there is a lot of heat that is possible to extract from the Permian Basin and other basins but that the utilization of these resources may not be cost-effective. However, he added that, due to the rise in natural gas prices and a decrease in the cost of new geothermal technology, these applications are becoming increasingly cost-effective. Mr. Jelacic agreed that the availability of existing wells provides an important economic advantage but suggested that further research would be necessary to determine if the utilization of the Permian Basin's geothermal potential would be viable and cost-effective.

The use of existing geothermal resources in Texas would provide an opportunity for certain portions of the oil and gas industry that are threatened to transition to a related industry and, as such, provide a "soft landing" for some industry personnel. The oil and gas industries in the Midland/Odessa area have been hard hit by the recent volatility of oil prices. The remaining industry workers in this area may possess many of the skills that would be necessary to develop and exploit a potential geothermal resource in this area. The viability of this potential has not yet been determined but could be an important energy and economic development resource for this area.

The window of opportunity for evaluating and developing the Permian Basin geothermal resources is small and rapidly closing. Many of these wells are scheduled for plugging within the next few years and after that time the economic advantage of exploiting this potential

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[18] Further background on potential West Texas geothermal resources and technical information concerning geothermal energy in general can be found in Appendix 3 to this report.

resource will be lost. The Railroad Commission has jurisdiction over geothermal resources in the state but there are no procedures in place for conversion of hydrocarbon wells to geothermal extraction. Reservoir integrity of these wells needs to be maintained to allow geothermal development.

Combined Heat and Power

Mr. Paul Cicio of Dow Chemical recommended increased usage of Combined Heat and Power (CHP), or cogeneration, through the development of CHP industrial parks. He stated that natural gas has been proposed as an abundant, low cost, clean fuel source that can, among other things, replace coal and nuclear energy in the electricity industry. The possibility of fulfilling these promises, however, is based upon the assumption of increased production of natural gas and relatively low gas prices. Mr. Cicio suggested that the recent history of natural gas production and prices suggests that natural gas may be unable to fulfill all of our hopes and that we should not become overly reliant on natural gas. Instead, he recommended that Texas' goal be a sustainable energy policy that includes the use of all energy sources, encourages energy efficiency, and encourages competition between energy sources.

Mr. Cicio stated that CHP, which uses "waste heat" to generate electricity, is the most energy efficient method for producing economical power and steam and also emits less air emissions per megawatt-hour than other fossil fuel alternatives. Texas has numerous existing "heat sinks" that represent a significant energy resource that could be utilized for CHP. Unlike oil and gas reserves, which continue to be available if they are not produced, waste heat is dissipated in the environment and is wasted and unrecoverable in the future if we don't utilize it. There are currently approximately 10,000 Megawatts (MW) of CHP generation in operation in Texas. Mr. Cicio reported that an additional 20,000 MW of generating capacity could be obtained by developing CHP industrial parks, consisting of hospitals, universities, office buildings, and/or housing complexes. A CHP industrial park would combine the power and steam demands of multiple users and allow the construction of a single CHP unit that might not be cost-effective for individual entities, thereby reducing overall energy consumption and air emissions. Mr. Cicio recommended that the State eliminate barriers to building CHP industrial parks by using "output based standards" as the basis of NO_x regulation for all power plants, and reducing disincentives to CHP by reducing stranded cost and environmental cost payments for customers that disconnect from their local utility.

Energy Efficiency and Conservation

Energy efficiency is one of the most expeditious, cost-effective, and environmentally benign of all of Texas' energy resources. However, for a variety of reasons, much of this important energy resource goes untapped. Studies performed on behalf of the Texas Sustainable

Energy Development Council developed estimates of conservation potential for Texas' industrial sector of 8,293 GWh, or almost ten percent of annual industrial energy consumption. The industrial sector is the most energy intensive sector in the state, representing over 50% of total energy consumed. Another study by the University of Texas' Center for Energy Studies suggests that comprehensive cost effective energy conservation measures in the residential and commercial sectors could reduce peak electrical demand by 27%. Current initiatives targeted by the Public Utility Commission call for efficiency and conservation to contribute a modest 10% reduction to annual demand growth.

Increased investment in energy efficiency becomes more attractive and more critical in light of the state's dwindling oil and gas resources and increasing environmental constraints. Unless supply and demand can be brought into balance, future energy costs in Texas are likely to increase, with corresponding negative implications for the Texas economy.

FINDINGS

Texas is at an important crossroads in the state's history. Energy issues that will shape the state's future for many years to come are confronting Texas. To a large extent, issues facing the oil and gas industries in Texas reflect fundamental changes that are occurring throughout the world, such as globalization of the economy, mounting environmental concerns, rising energy prices, and expansive growth of industry and high technology. However, some of these changes are unique to Texas. Each of these changes will have such profound effects on Texas, due to the state's historical dependence on energy and energy industries, that the state will likely have a completely different economy within the next 20 to 40 years. Industry experts testifying before the Texas Energy Coordination Council identified several areas that could be addressed by policy makers to improve the outlook for Texas' oil and gas companies and increase the production of Texas energy.

One of the most fundamental challenges to the Texas oil and gas industries is continuing and/or expanding production from a diminishing pool of reserves in mature fields. While further production will always be possible, doing so cost-effectively will be a continuing challenge to the industry and the state. Texas' ability to participate in the oil and gas markets of the future will be determined largely by the profitability of the Texas oil and gas industries. In addition to price levels, over which the industry and the state have little control, profitability is influenced by production costs. Decreasing the cost of finding and producing oil and gas can be achieved in various ways, including by encouraging continued Research and

Development and increasing the availability of electronic information. In addition, reducing production taxes has a significant effect on the profitability of the industry by directly increasing the industry's return on investment.

Phase-Out of Severance Tax

The TECC supports phase-out of the oil and gas severance tax conditioned on requiring companies to increase their capital investments above historical levels.

The proposed phase out of taxes in exchange for increased capital investment addresses many of the issues related to increasing the incentives for production of Texas oil and natural gas that were identified by the various witnesses. It would encourage new exploration and production by reducing cost and, therefore, increasing the industry's return on investment. It would eliminate disincentives to exploration and production and allow Texas to capitalize on an expected increase in natural gas demand. In addition, the plan would maintain jobs and increase Texas' competitiveness relative to other areas outside Texas. Finally, this plan would generate continued revenue for the State without risking State funds and would optimize benefits by requiring reinvestment in Texas.

Improve Deliverability of Natural Gas

To ensure adequate deliverability of natural gas to meet future needs it will be necessary to expand a safe and reliable pipeline infrastructure. Both gas and electricity facilities need to be developed to accommodate and to encourage new economic growth in Texas. Incentives may be required to insure the development of gas pipeline facilities and to assure customer access to gas and electricity. Any incentives for developing gas facilities should recognize customer use and benefit and the recovery of costs through negotiated or cost-based recourse rates.

Expanding the pipeline infrastructure would be encouraged by decreasing regulatory uncertainty concerning companies' return on investment, and by developing uniform safety standards and clear and predictable permitting processes. Patrick Nugent called for "legislators, regulators, the natural gas industry, and landowners [to] develop mechanisms that will promote the timely and economic construction of new pipelines in a safe and environmentally responsible manner."

Stop the Erosion of the Knowledge Base

It has been said that the most important discovery for the oil and gas industry was the

computer chip. The increased utilization of computer technology has had enormous benefits for the industry. Computers have decreased exploration costs and also led to more efficient production. As the industry continues to focus on cost reduction, the benefits of continued Research and Development, including increased utilization of computer technology, cannot be overemphasized. Benefits accrue from the utilization of these technologies to study production histories, locate reserves through 3D seismic imaging, and enhance recovery techniques through complex reservoir modeling. However, as research labs of the majors move offshore, and federally supported research centers such as the Gas Research Institute expire, and traditional funding sources evaporate, the knowledge base continues to erode and potentially cost-effective resources remain undiscovered.

Independent oil producers have traditionally 'inherited' or licensed technology developed by the majors, but that resource has essentially vanished. Without continuing improvement in exploration and production technology, independents lose efficiencies, become less competitive, and leave valuable oil and gas resources unproduced. The Governor's Science and Technology Council made recommendations in the 76th session to increase funding to the Advanced Technology and Advanced Research Programs administered by The Higher Education Coordinating Board. The legislature chose not to increase ATP/ARP funding, but state support of R&D targeted to support oil and gas exploration and production would yield significant returns to the state's oil and gas economy.

Dr. Kurt Marfurt of the University of Houston, Allied Geophysical Laboratories provided several recommendations for increasing the funding of university Research and Development to support the oil and gas industry. His recommendations included developing government programs to: 1) match industry provided R&D funds, 2) fund an initiative to develop and apply newtechnologies to Texas oil and gas, and 3) fund graduate student loan programs, including loan forgiveness for certain jobs. Dr. Marfurt also recommended industry-based initiatives to increase university research and development, including: 1) industry reimbursement of student loans, 2) replacing current internships with a "Cooperative" program, including a two year commitment, 3) and maintaining the current level of "in kind" R&D support.

Increase Availability of Electronic Information

The development of Texas remaining oil and gas resources would be encouraged by providing easy access to technical information. Although some of this information may be considered confidential, and some may be available through public libraries in the Midland/Odessa area, much of the valuable information that could be made available is not currently readily available to interested parties. The availability of production histories and

electronic logs through the Internet or other electronic media would facilitate exploration and development of these resources.

Mr. Swift commended the Railroad Commission for establishing the digital filing of forms through ECAP and data archiving on the Internet through ACTI but emphasized that these activities need to continue and expand. In particular, he recommended that updated digital maps of Texas, including county land maps and field discovery maps, be made available over the Internet. He urged avoiding the tendency to centralize the data in Austin unless there is a strong commitment to making that data available via the Internet. Mr. Swift testified that data is crucial to the exploration for oil and gas and that the ACTI program is an excellent start. He stated that the more readily available the data is, the easier it is to generate the exploration prospects and develop projects of the future.

Promote Energy Efficiency

Texas has energy resources related to the oil and gas industry that can be utilized to complement those of the oil and gas industry while benefitting the state in various ways. The expanded use of Combined Heat and Power can increase the efficiency of electricity generation while reducing atmospheric emissions. Likewise increasing investments in energy efficiency can help balance the energy supply and demand equation in a quick and cost-effective way, while reducing air pollution and the consumption of valuable non-renewable resources.

Energy efficiency offers an attractive means of balancing between energy supply and demand. Global supplies of oil and gas are being consumed at an increasing rate and are not being replenished. An increasing disparity between supply and demand is projected for oil and gas in Texas. We should expect to see energy prices continue to rise over the long-term unless supply and demand can be brought into balance. The importance of balancing supply and demand should be considered in light of the findings of the University of North Texas' Center for Economic Development and Research, which found that increasing energy prices have a negative impact on the overall state economy.

Furthermore, due to environmental concerns associated with the implications of the combustion of fossil fuels, demand side reductions should not be overlooked as an important mechanism for keeping the energy supply and demand equation in balance while simultaneously addressing environmental issues. Demand side options include curtailing energy use as well as strategic load modification strategies that flatten electricity demand by shifting load from peak to off-peak periods. Demand side reductions can reduce the

consumption of non-renewable energy resources and optimize the use of the electricity system.

Increase Utilization of Combined Heat and Power

For the average central station power plant, over two thirds of the energy content of the input fuel is converted to heat and wasted. As an alternative, an end-user with significant thermal and electric needs can generate both its thermal and electrical energy in a single combined heat and power system located at or near its facility. Combined heat and power, also called cogeneration, can significantly increase the efficiency of energy utilization, oftentimes reducing emissions of criteria pollutants and CO_2, and lowering -users operating costs.

WELL PLUGGING AND REMEDIATION PROGRAM

The State's interest in oil and gas production, however, does not end when these valuable resources are extracted from the land. The growing number of marginal wells coming out of production, many of which were last operated by thinly capitalized operators, leaves the state to deal with more abandoned wells that need to be plugged and sites to be cleaned. The RRC's Oil Field Cleanup Fund (Fund) faces increasing demands, yet does so at a time of tightening fund balances.[19]

When times were tough for the oil and gas industry in the 1980's and the industry faced a dramatic and sustained downturn, many producers were forced to shut down production on certain wells. To ease the burden, the RRC - through an extension program called "W-1X" - allowed some wells to remain unplugged until they could be returned to production in more profitable times. But what may have started as a benign attempt to allow marginal wells to remain unplugged during tough economic times has led to the loosening of RRC plugging requirements and, in turn, the eventual abandonment of thousands of wells.[20]

Extending the period of time to plug a well was never envisioned as a trade-off for environmental protection or as a means to avoid plugging liability. In fact, operators seeking plugging extensions have long been required to demonstrate that an unplugged well would not cause pollution and either present a viable plan to use the well within a reasonable time or post financial

[19] Railroad Commissioner Tony Garza's testimony to the Senate Natural Resources Committee, September 29, 1999

[20] A Call to Action: Putting a Cap on Well Plugging Extensions, Railroad Commissioner Tony Garza

security to cover the well's plugging costs. Yet in 1986 and 1992, RRC rules were changed to extend the period of time to plug from 90 days to one year and allowed unlimited extensions with a payment of $100 and RRC approval. As a result, inactive wells were no longer kept unplugged simply during a cyclical downturn in price, but rather remained unplugged for many years and without sufficient financial assurance to cover plugging costs. The net effect of these changes is that more and more wells fall to the State for plugging through the Oil Field Cleanup Fund.[21]

Understandably, the State and the energy industry during periods of low prices had an interest in allowing operators to temporarily shut-in otherwise productive wells in flowing fields. As prices rebounded, it was expected that these wells would roll back into production. However, a recent review reveals that there are over 25,000 non-compliant oil and gas wells throughout the state and an additional 61,000 compliant shut-in wells. There are approximately 163,000 active oil wells in the state and the average production from these wells is less than seven barrels a day. Of these producing wells, there are approximately 77,000 oil wells that have an average production of just over one barrel a day (1.06). Based on an analysis by the RRC's Oil and Gas Division staff, a reasonable cost estimate to plug the currently abandoned wells, those that will become abandoned over the next ten years, and the cost to remediate abandoned sites may exceed $500 million.[22] Needless to say, this projected amount far exceeds the projected balance of the Oil Field Cleanup Fund.

The Legislature created the Oil Field Cleanup Fund in 1991 to give the RRC, on behalf of the State, the financial ability to plug abandoned oil and gas wells and to remediate abandoned oil field sites throughout the state. The RRC has since developed and implemented an effective and efficient program, with a proven track record of over 15,000 plugged wells and more than 1,300 completed cleanup activities at abandoned oil field sites.

Revenue for the Fund comes from the oil and gas industry in the form of fees for permits, oil and gas production, financial assurance, sales of salvageable equipment, reimbursement for plugging and remediation costs, administrative penalties, and civil penalties. Most of these categories of revenue sources are dependent on the health of the industry. During periods of low prices and rig counts, revenue from permit fees and production drops. Yet, at the same time, demands on the Fund increase as the state must deal with more abandoned wills and neglected sites. As a result, a downturn in revenue coupled with increased expenditure demand on the Fund leads to declining fund balance, thereby restricting the ability of the RRC to undertake more projects.

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[21] id.

[22] Railroad Commission of Texas, Legislative Proposals, 77th Legislative Session

The balance in the Fund peaked in FY 95 at $6,519,860 and reached a low of $4,293,216 in FY 98. Based upon current statistics, the Fund could reach a projected balance nearing zero in FY 2001.[23]

Toward the end of 1999, the RRC evaluated the Fund, revealing for the first time that an excess number of FTEs had been included within the Fund's overhead, but were not performing tasks directly related to the Fund's plugging and remediation activities. Concerned that this administrative funding structure was drawing money away from direct cleanup efforts, the RRC approved an FY 2000 budget for the Fund that encompasses 93.5 positions, a decrease of 20.38 positions from the FY 1999 budgeted level. This 18% decrease in FTEs will allow the RRC to redirect $636,000 of additional funds for the plugging of wells and site remediation work.[24]

In addition, the RRC began looking for additional sources of funds, beyond those provided for by the Legislature, to help pay for plugging and remediation efforts. To date, the RRC has secured funds through unique ventures with the Texas Natural Resource Conservation Commission (TNRCC) and the General Land Office (GLO).[25]

On August 12, 1999, Railroad Commission Tony Garza and TNRCC Commissioner John Baker announced an innovative partnership to fund additional oil and gas well plugging by the State of Texas. Under this collaborative effort, the TNRCC will provide $1.6 million in funding with the RRC contributing $1 million in resources to plug oil wells along a portion of the Upper Colorado River Basin. The program, part of a federal-state partnership among the RRC, the TNRCC and the U.S. Environmental Protection Agency (EPA), seeks to address the quality of Texas waterways. Through the program, the RRC will undertake well plugging in the Upper Colorado River Basin, a portion of the river known to have increased salinity levels. The RRC will plug approximately 171 wells and earmarks money for determining the source of saline seeps in the basin, as well as assessment and possible remediation of an abandoned reclamation plant and saltwater disposal facility.[26]

On September 14, 1999, Commissioner Garza announced an innovative effort to plug non-compliant coastal oil and gas wells on state leases. The agreement between the GLO and the RRC is a first for the two agencies and merges RRC technical expertise with support and funding

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[23] Railroad Commissioner Tony Garza's testimony to the Senate Natural Resources Committee, September 29, 1999

[24] id.

[25] id.

[26] id.

from the GLO. The two agencies are in the process of preparing an inventory of all known non-compliant oil and gas wells and prioritizing each well based upon its potential threat of pollution, threat to navigation in State waters and other related factors.[27]

Additionally, Commissioner Garza has proposed that authorization be obtained from the Legislature to allow the RRC to receive proceeds of loans or other indebtedness in the Oil Field Cleanup Fund. This authority would avail the RRC the opportunity of exploring additional financing sources for the Fund, including participating in the Clean Water State Revolving Fund (CWSRF) administered by the Texas Water Development Board (TWDB).

On August 10, 1999, the RRC passed the final version of the well plugging measure[28] that gives oil and gas operators until November 1, 2000 to plug, produce or secure financial assurance for wells that have not produced in three or more years. This measure is aimed at ensuring that the state's Oil Field Cleanup Fund is no longer forced to take responsibility for abandoned oil and gas wells that no longer produce. Under this measure:

- the current 12-month period to restore a well to production or plug a well is retained;
- W-1X plugging extensions granted prior to November 1, 2000 will remain in effect for their full stated one-year term. Upon expiration, the well will have to be restored to active operation, plugged, or an extension of plugging obtained under the terms of the new rule;
- For wells that have been inactive for more than 36 months, for which the operator desires a W-1X plugging extension, the operator must, in addition to the usual requirements for a plugging extension, file proof of an acceptable fluid level test or mechanical integrity test demonstrating that the well does not pose a pollution threat and obtain a well plugging bond or letter of credit for the well;
- The well plugging bond or letter of credit is required to be in the face amount of the estimated cost of plugging the well, which is presumed to be $3 per foot of depth for land wells, $60,000 for bay and inland waterway wells, and $250,000 for offshore wells.

CONCLUSIONS

In the past three decades, the petroleum business has transformed itself into a high-technology industry. Dramatic advances in technology for exploration, drilling and completion, production, and site restoration have enabled the industry to keep up with the ever-increasing demand for reliable supplies of oil and natural gas at reasonable prices. The productivity

[27] id.

[28] TAC Title 16, Part 1, §§3.14 and 3.78

gains and cost reductions attributable to these advances have been widely described and broadly recognized. Looking forward, the domestic oil and gas industry will be challenged to continue extending the frontiers of technology. On-going advances in exploration and production productivity are essential if producers are to keep pace with the steadily growing demand for oil and gas, both in the United States and worldwide. Continuing innovation will also be needed to sustain the industry's leadership in the intensely competitive international arena, and to retain high paying oil and gas industry jobs.[29]

In summarizing his testimony, Dr. Fisher stated that the oil and gas reserves in Texas, although not what they once were, are still an important part of the state and federal economy. He stated that the intelligent application of technology could serve to retard the natural decline, providing greater resources for longer periods. Development and understanding of technology are currently in the hands of a few mid-size companies, large service companies, and public agencies and universities. The application of technology is left to the small to mid-size independent operator. Dr. Fisher suggested that alliances and partnerships between universities, state agencies, service companies, and independent operators will play a large role in the future of the Texas oil and gas industry.

Although the oil and gas industries have reduced their costs and increased their cost-effectiveness, they are still challenged by economic factors that are outside of their control. Reductions in taxes and regulatory costs and the increased availability of electronic information would increase the industries' rates of return and make investments in Texas oil and gas more competitive with other regions. Increasing the economic incentives for development of the industry within the state would help stimulate the economic growth of the Texas oil and gas industries and encourage the industry to produce as much of the state's remaining crude oil resources as possible and ensure that Texas gas is a part of the expanding natural gas market.

RECOMMENDATIONS

All too often the well plugging program has not been used to ride out the vagaries of world price swings, but rather as a tool to delay and ultimately shift to the State the burden of plugging these

[29] U.S. Department of Energy, Office of Fossil Energy, Environmental Benefits of Advanced Oil and Gas Exploration and Production Technology, October 1999.

wells. Relying on the new W-1X rules, utilizing innovative partnerships with other state agencies, and shifting more dollars toward the well plugging program will not only clean up abandoned sites, but will go a long way in curbing the increasing tide of abandoned oil and gas wells.

- Proportionately reduce the oil and gas severance with the increase of capital investments above historic levels.

- Expand a safe and reliable pipeline infrastructure.

- Increase research and development targeted to support oil and gas exploration and production.

- Increase the availability of electronic information from the Railroad Commission.

- Allow the Railroad Commission to utilize the Texas Water Development Board's Clean Water State Revolving Fund (loan funds) to plug oil and gas wells that pose a threat to both surface water and groundwater.

- Strengthen the Railroad Commission's Oilfield Cleanup Program by providing additional funding, enhanced enforcement capabilities, and monitoring of non-producing wells.

APPENDIX 1: TEXAS ENERGY CONSUMPTION

Texas leads the nation in output of crude oil and natural gas, and is the 5th largest producer of coal. However, Texas is also a very large energy consumer, ranking 1st in total energy consumption, as well as a first in the consumption of petroleum, natural gas, coal, and electricity. Texas has the largest industrial sector use of energy and is second in the nation (after California) in the amount of energy consumed in the residential and transportation sectors.

Texas' Share of U.S. Energy Use (1997)

	Share of U.S. Total	Rank
All Energy Consumption	12.1%	1
Coal Consumption	7.2%	1
Natural Gas Consumption	17.9%	1
Petroleum Consumption	14.4%	1
Electricity Consumption	9.1%	1
Residential Sector Use	7.2%	2
Commercial Sector Use	7.6%	3
Industrial Sector Use	18.3%	1
Transportation Sector Use	9.6%	2

Texas' high level of energy consumption results in one of the highest energy expenditures in the nation. However, lower energy prices than in some other states results in Texas' total energy expenditure being the second highest in the country.

Not only does the Texas climate result in the utilization of large amounts of electricity for air-conditioning but many of Texas' industries are also very energy intensive.

APPENDIX 2: TRENDS IN OIL AND GAS PRICES, DEMAND AND PRODUCTION

International

World oil prices fell sharply throughout most of 1997 and 1998, in part due to the economic recession in East Asia. Economic recovery in Asia and actions by the Organization of Petroleum Exporting Countries (OPEC) to limit oil production have resulted in higher world oil prices. Price projections over the next several years are expected to be much higher as a result of the Asian economic recovery and the March 1999 agreement by OPEC and four non-OPEC countries to reduce oil production. This agreement is believed to represent a new level of cohesion and cooperation between OPEC members. The DOE Energy Information Administration projects average world crude oil prices to be $22.04 a barrel in 2020 in 1998 dollars.[30] However, sources within the industry suggest that OPEC's goal is to control production so that the price of West Texas Intermediate at Cushing, Oklahoma stays between $25 and $30 per barrel. On August 18, 2000, the spot price of West Texas Intermediate crude oil was $31.97 per barrel.

Worldwide demand for oil is expected to increase 50 percent, from 75.0 million barrels per day in 1998 to 112.4 million barrels per day in 2020. Although the demand for oil grows rapidly, the potential for production increases in both OPEC and non-OPEC nations is expected to lead to relatively low growth of prices through 2020. OPEC oil production is expected to reach 55.5 million barrels per day in 2020, nearly double the 31.7 million barrels per day in 1998. Non-OPEC oil production is expected to increase from 44.3 million barrels per day in 1998 to 56.6 million barrels per day in 2020.

United States: Oil

Consumption: Despite rising prices, U.S. petroleum consumption is expected to continue to rise. U.S. petroleum consumption is projected to increase by 6.2 million barrels per day between 1998 and 2020, with estimates of total petroleum product supplied in 2020 ranging from 23.0 to 27.3 million barrels per day, compared with 18.9 million barrels per day in 1998. Petroleum demand is projected to grow at an average rate of 1.3 percent a year through 2020. Most of the increase in petroleum consumption occurs in the transportation sector, which accounted for two-thirds of U.S. petroleum use in 1998. Increases in transportation miles are expected to more than offset gains from increased fuel efficiency. In the industrial sector, which accounts for more than a quarter of U.S. petroleum use, consumption in 2020 is higher than the 1998 level by 1.2 million barrels per day. Petroleum

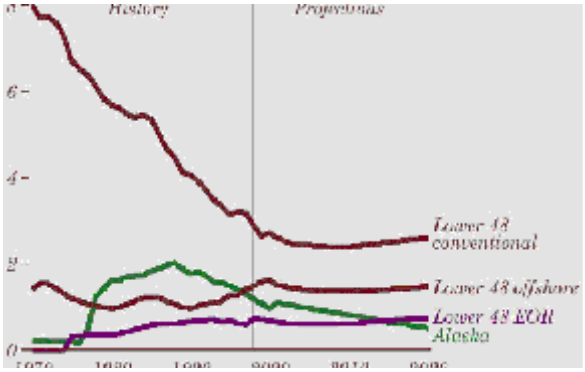
[30] U.S. Department of Energy, Energy Information Administration, "International Energy Outlook 2000."

use is expected to decline in the residential, commercial, and electricity generator sectors, where natural gas becomes the fuel of choice.

Prices:
Domestic prices for crude oil are determined largely by the international market. After 2000, prices are initially expected to decline, then increase through 2020. Prices are expected to remain above the present level, with wellhead prices projected to increase from 0.9 to 4.0 percent per year through 2020.

Production:
While demand for oil increases steadily, U.S. crude oil production is expected to decline, at an average rate of 0.8 percent a year between 1998 and 2020, to a projected level of 5.3 million barrels per day, 1 million barrels per day less than the 1998 level. Projected domestic crude oil production continues its historic decline through 2005. After 2005, however, technological improvements[31] and rising prices are projected to arrest the decline, leading to relatively stable lower 48 production in the remainder of the forecast. However, advances in oil exploration and production technologies are anticipated to be insufficient to offset declining resources.

Crude Oil Production By Source, 1970-2020
(Million Barrels per Day)



Imports
Additional petroleum imports will be needed to fill the widening gap between supply and consumption. Projections for net petroleum imports in 2020 range from a high of 18.1 million

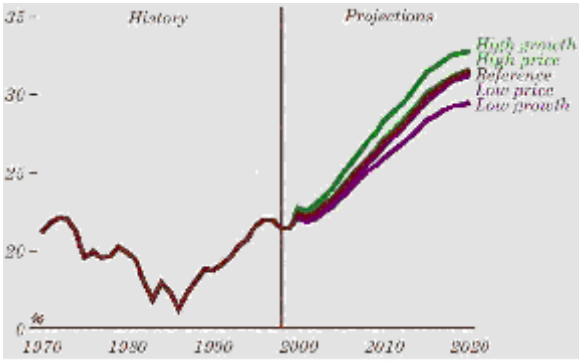
[31] Greater technological advances can markedly increase the quantity of economically recoverable resources by driving down costs, increasing success rates, and increasing recovery from producing wells. Expected production rate declines could be slowed or even reversed within the forecast period if faster implementation of advanced technologies is realized.

barrels per day to a low of 14.2 million barrels per day, compared with the 1998 level of 9.8 million barrels per day. The value of petroleum imports in 2020 ranges from $108.3 billion to $161.3 billion. Total annual U.S. expenditures for petroleum imports, which reached a historical peak of $133.7 billion (in 1998 dollars) in 1980, were $46.6 billion in 1998.[32] In 1998, net imports of petroleum climbed to a record 52 percent of domestic petroleum consumption. Continued dependence on petroleum imports is projected to reach 64 percent in 2020.

United States: Natural Gas

Consumption:

Natural gas consumption is projected to increase by an average of 1.8 percent per year through the year 2020. Domestic consumption projections range from 29.5 to 32.7 trillion cubic feet per year, compared with 21.4 trillion cubic feet in 1998. Increases in consumption are expected in all end-use sectors, but more than half of the increase results from rising demand for electricity generation. Natural gas consumption in the electricity generation sector rises from 3.7 to 9.3 trillion cubic feet between 1998 and 2020, as demand for electricity increases and retiring nuclear and older oil and gas steam plants are replaced by turbines and combined-cycle facilities.



Domestic Natural Gas Consumption (1970-2020)
(trillion cubic feet)

Price:

Growing demand is expected to lead to a rise in the price of natural gas. The average U.S. wellhead price of natural gas is projected to increase from $1.96 per Mcf in 1998 to $2.81 (in 1998 dollars) per Mcf in 2020, an average increase of 1.7 percent per year. The increases reflect rising demand for natural gas and its impact on the natural progression of

[32] Energy Information Administration, Annual Energy Review 1998, DOE/EIA-0384(98) (Washington, DC, July 1999), Table 3.7.

the discovery process from larger and more profitable fields to smaller, less economical ones. Despite the changes in sources of production, technically recoverable resources are anticipated to be more than adequate overall to meet the necessary production increases. Although consumption, and thus production and price levels, for natural gas are projected to increase, the price increases attributable to rising demand are expected to be tempered by the beneficial impacts of technological progress on both the discovery process and production operations.

Production:

Problems on the supply side have exacerbated the natural gas price spike. Drilling for gas plummeted in 1998 and early 1999 in the face of low prices. Between January 1998 and April 1999, the number of rotary rigs drilling for natural gas in the U.S. fell from 609 to 371. The U.S. natural gas rig count on August 4, 2000 was at a recent high of 772 rigs. Exploration and production budgets for many natural gas producers are expected to increase sharply in 2000, spurred by higher prices and greatly improved current and expected revenues from producing assets. Gas-directed drilling in the United States has exceeded 600 rigs since October 1999 compared to the low point of 362 reached in April 1999.[33]

In Texas, the natural gas rig count dropped from 376 to 180 between January 1998 and April 1999. Reserve additions in 1998 replaced only 83 percent of that year's production and discoveries of new gas fields decreased 60 percent from a year earlier. All told, the amount of new gas discovered in 1998 was equal to just 61 percent of that year's production.[34]

Eventually, higher gas prices will bring forth new supply. But this will not occur quickly. Though the rig count has rebounded to 1998 levels, extraction is up only six percent from a year ago. Natural gas exploration is being hampered by a severe shortage of drilling rigs as well as a dearth of trained personnel. Considerable expertise, particularly in exploration and development, was lost as workers looked for greener pastures after the energy bust of the late 1980's and late 1990s; and very few young people today are choosing energy as a career. Shortages of rigs and expertise are compounded by the fact that discoveries of large gas fields in the continental U.S. are increasingly rare. Thus more rigs and workers are needed to explore the smaller fields that remain.

The continuing increase in domestic natural gas production in the forecasts are expected to

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[33] U.S. Department of Energy, Energy Information Administration, "Short-Term Energy Outlook," August 2000.
[34] "The Impact of Higher Natural Gas Prices on the Texas Economy," Bernard L. Weinstein, Ph.D. and Terry L. Clower, Ph.D., University of North Texas, Center for Economic Development and Research, Denton, Texas, July 2000.

come from new finds. Unconventional sources also increase in share, and gas from offshore wells in the Gulf of Mexico contributes significantly to production. The innovative use of cost-saving technology and the expected mid-term continuation of recent huge finds, particularly in the deep waters of the Gulf of Mexico, support this projection. Production from conventional sources is projected to grow rapidly through 2010 in response to increasing demand. After 2010, slower growth of consumption and higher production from increasingly economical offshore and unconventional sources cause production from conventional sources to level off.

Imports:
Net natural gas imports are expected to grow from 14.6 percent of total gas consumption in 1998 to 16.3 percent in 2020. Most of the increase is attributable to imports from Canada, which are projected to grow substantially. Mexico has a considerable natural gas resource base, but its indigenous production is unlikely to increase sufficiently to satisfy rising demand. Since 1984, U.S. natural gas trade with Mexico has consisted primarily of exports. That trend is expected to continue through 2020, especially in light of the recent elimination of the 4-percent import tariff and an increase in cross-border pipeline capacity. U.S. exports to Mexico are projected to grow from 50 billion cubic feet in 1998 to 240 billion cubic feet in 2020.

Texas Oil and Gas Trends

Production of both oil and gas in Texas have declined from their historical peaks. After reaching a peak of 1.257 billion barrels per year in 1973, Texas oil production is currently at a rate of approximately 400 million barrels per year. Likewise, production of natural gas reached its peak in 1972 with annual production of 9.6 billion Mcf. After falling to a recent low of 5.4 billion Mcf in 1992, natural gas production has risen somewhat during recent years to approximately 5.8 billion Mcf.

Dr. William Fisher projects future crude oil production in Texas to amount to about 16 billion barrels over the next 60 years, based on existing technology and without any specific breakthroughs in reservoir characterization. With advances in technology and sustained efforts at characterizing the complex reservoirs of the Permian Basin, Dr. Fisher projects future production of Texas crude oil amounting to 24 billion barrels during the next 60 years, with relatively stable production of 400 million barrels per year for the next 40 years.

As oil and gas prices have risen recently, the rig count has rebounded somewhat. From a peak of 376 running rigs in November of 1997, the number fell to 180 in April of 1999. By March 2000, however, the Texas rig count was up to 296, with about 80 percent searching for natural gas. Though rig count and drilling permits have increased during 2000, completions have not. Consequently, natural gas supply has remained virtually unchanged.

What's more, as with other energy producing states, Texas' oil and gas production infrastructure is severely strained due to a lack of equipment and experienced personnel. This decline has had a significant impact on employment in the oil industry and also on state revenues and, as such, has caused both the oil industry and the State to make major adjustments to compensate for this change. In 1984 severance taxes accounted for approximately 15 percent of total State revenues but by 1999 had dropped to less than 2 percent of State revenues, approximately $1 billion per year or an amount equal to the General Revenue Fund allocation to the Texas Department of Criminal Justice.[35]

[35] Testimony of James LeBas, Office of the Texas Comptroller of Public Accounts, before the Texas Energy Coordination Council, May 2000.

APPENDIX 3: GEOTHERMAL ENERGY OVERVIEW

Testimony by Mr. Douglas Swift[36] of the West Texas Earth Resources Institute before the Texas Energy Coordination Council suggested that existing well bores in depleted deep gas fields in West Texas offer the potential for exploiting significant geothermal energy resources. Mr. Swift testified that the essential components exist, including existing wells with sufficient temperature for operating binary power plants; well-documented geological information on these wells; necessary personnel, including geologists, geophysicists, and engineers; and markets for electricity produced within reasonable transmission distances. It has been estimated that drilling and completion of wells for exploration, production, and injection account for 20 to 40 percent of the cost of generating electricity from geothermal resources. Mr. Swift suggested that access to existing wells would, therefore, offer an opportunity to take advantage of this resource at a reduced cost.

The viability of this concept was discussed with Mr. Alan Jelacic of the U.S. Department of Energy's geothermal power program. Mr. Jelacic stated that there is no doubt that there is a lot of heat that is possible to extract from the Perlman Basin and other basins. However, he added that the utilization of this resources may not be cost-effective. Mr. Jelacic stated that Texas has large geothermal resources along the Gulf Coast, as well as in the Permian Basin, and added that he was involved in a geothermal demonstration project near Houston, in Brazoria County, involving the simultaneous production of natural gas and 1 MW of electricity. At that time, the demonstration project was not considered to be economical. However, Mr. Jelacic added that, due to the rise in natural gas prices and a decrease in the cost of new geothermal technology, these applications are becoming increasingly cost-effective. He stated that, as a result, the DOE Geothermal laboratory has been considering re-examining the geothermal resources in Texas.

Mr. Jelacic agreed that the availability of existing wells provides an important economic advantage. However, he suggested that further research would be necessary to determine if the utilization of the Permian Basin's geothermal potential would be viable and cost-effective. Mr. Jelacic suggested the importance of structures conducive to production, noting that most geothermal resources are dominated by "fracture permeability" and that, while the Ellenberger formation is relatively porous, it may not have sufficient flow volume. Mr. Jelacic suggested that the economics would be influenced by the specific technology being considered and whether fluids to be injected into the wells are readily available. In

[36] Testimony of Douglas Swift before the Texas Senate Natural Resources Committee, May, 25, 2000. Mr. Swift is Vice Chairman and Director Of Geological Research at the West Texas Earth Resources Institute.

addition, Mr. Jelacic stated that it would be important to consider the integrity of these older wells, adding that they would need to be in decent shape for the next 10 to 15 years. Finally, he suggested the need to examine the potential for "scale" that may result in carbonate formations, such as the Permian Basin. He added, however, that scale inhibitors can be used effectively and only result in a small increase in cost.

As discussed in the testimony of Mr. Swift, the window of opportunity for evaluating and developing the Permian Basin geothermal resources is small and rapidly closing. The Railroad Commission has jurisdiction over geothermal resources in the state but there are no procedures in place for conversion of hydrocarbon wells to geothermal extraction. In addition, Mr. Swift stated that reservoir integrity needs to be maintained for geothermal development and suggested that legislation would need to be developed to protect the reservoir integrity of these geothermal resources. He noted that many of these wells are scheduled for plugging within the next few years and that, after that time, the economic advantage of exploiting this potentially important resource will be lost.

Technology Overview

Geothermal technology exploits the heat of the earth, which increases with depth. Geothermal energy technologies consist of: 1) geothermal power used to generate electricity and 2) direct use applications in which lower temperatures are utilized for heating or to operate heat pumps for space conditioning, etc. Large geothermal plants use hot fluids for industrial process heat, or to drive electricity-producing turbine-generators, or both. Electric-powered geothermal heat pumps use the differential between the temperature of the earth and that of the ambient air to provide residential and commercial buildings with hot water, heat in the winter and cooling in the summer.

Several attributes of geothermal resources make it a good source of energy. Energy can be extracted from the resource without burning a fossil fuel such as coal, gas, or oil. Therefore, carbon dioxide and other gases formed during combustion of fossil fuels are not emitted into the atmosphere when geothermal resources are used. Geothermal fields produce only about one-sixth of the carbon dioxide that a natural gas fueled electrical generating power plant produces and none of the nitrous oxide or sulfur-bearing gases. Use of geothermal resources is also beneficial, because it can enable states to diversify their energy portfolios with domestically available resources.

Electricity produced from geothermal energy in the United States displaces emissions to the atmosphere of 22 million tons of carbon dioxide, 200 thousand tons of sulfur dioxide, 80 thousand tons of nitrogen oxides, and 110 thousand tons of particulate matter every year, compared with production of the same amount of electricity from an average U.S. coal-fired plant. Geothermal power can be generated from modular units ranging in size from a few

hundred kilowatts to more than 100 MW. The U.S. government receives about $41 million annually in royalty and lease payments from geothermal energy production on federal lands. The cost of generating power from geothermal resources has decreased about 25 percent over the past two decades.

The long-term sustainability of geothermal production has been demonstrated by continuous electrical power generation at the Larderello field in Italy since 1913, at the Wairakei field in New Zealand since 1958, and at The Geysers field in California since 1960. In fact, no geothermal field has been abandoned because of resource decline. However, pressure and production decline have been experienced, and research at The Geysers has focused on mitigating these effects through injecting water to maintain reservoir pressure.

Geothermal energy is natural heat from the Earth's interior where temperatures reach greater than 7000EF. The heat is brought to the surface as steam or hot water—created when water flows through heated, permeable rock—and used directly for space heating in homes and buildings or converted to electricity. The most rapidly growing use for geothermal energy is geothermal heat pumps, which use earth or low-temperature groundwater as a heat source in the winter and a heat sink in the summer.

Because of the variety of applications for geothermal energy, the technologies for extracting the resource differs widely. The focus here is on power generation, direct use, and geothermal heat pumps.

Current Status

The current production of geothermal energy from all uses places third among renewables, following hydroelectricity and biomass, and ahead of solar and wind. Yet this production has barely scratched the surface of the enormous potential of geothermal energy. U.S. geothermal resources alone are estimated at 70,000,000 quads, equivalent to a 750,000-year supply of energy for the entire nation at current rates of consumption. The geothermal energy potential in the uppermost 6 miles of the Earth's crust amounts to 50,000 times the energy of all oil and gas resources in the world.

At the end of 1997, worldwide geothermal electrical generating capacity was just short of 8,000 MW, with major capacity in Costa Rica, El Salvador, Italy, Mexico, the Philippines, the U.S. and elsewhere. U.S. geothermal companies have installed geothermal power plants overseas that generate more than 1,500 MW of electricity and represent an investment of more than $3 billion. The Geothermal Energy Association estimates that U.S. firms have participated in the development of 60% of world geothermal electric capacity.

Geothermal energy is the United States' second largest grid-connected renewable

electricity source, after hydropower. In 1997, U.S. geothermal electric capacity stood at 2,850 MW, with one-fourth of that at The Geysers in Northern California. The Geysers geothermal field in northern California has been generating electric power for more than 35 years. Geothermal power generated in California, Hawaii, Nevada, and Utah amounts to 14 to 17 billion kilowatt-hours per year of electricity worth and $1 billion in annual utility sales.

Countries making large direct use of geothermal heat include China, France, Hungary, Iceland, Japan, the U.S. and others. Geothermal energy facilities consisting of 11,300 thermal MW are being used in more than 27 countries for direct-use applications such as aquaculture and greenhouse operations, and industrial processing. The geothermal heat pump industry has installed 300,000 units worldwide; 3.5 million units may be in place nationally by 2010, with total direct employment of 350,000 person-years. Installation American manufacturers shipped almost 58,000 units in 1997, up 13% from the previous year. The Geothermal Heat Pump Consortium website lists 24 domestic manufacturers, as well as many dozens of related manufacturers and trade allies. Total industry revenue from manufacturing is probably around $420 million.

The cost of generating power from geothermal resources has decreased about 25% over the past two decades. A power plant built today would probably require about 5 cents to 8 cents per kilowatt-hour (kWh). Some geothermal power plants receive much more per kWh during some time periods, because of various incentives related to reliability of generation and power provided during peak demand. The goal of the geothermal industry and the U.S. Department of Energy is to achieve a geothermal energy life-cycle cost of electricity of $0.03 per kWh. It is anticipated that costs in this range will result in about 10,000 MW of new capacity installed by U.S. firms within the next decade.

Geothermal heat pumps are already boasting low operating and maintenance costs, and usually, low life-cycle costs. (Life-cycle cost is the total cost of the equipment, as well as operating and maintenance costs, spread over the useful life of the equipment.) Consumption of electricity is reduced 30% to 60% compared to traditional heating and cooling systems, allowing a payback of system installation in 2 to 10 years.

Market Potential

A strong market for geothermal electrical generation is anticipated as a result of the Clean Air Act of 1990 and because of the growing concern about global warming. Geothermal development will benefit from the growing need for energy sources with low atmospheric emissions and proven environmental safety. However, it will not be easy for the U.S. geothermal industry to continue a high growth rate because most of the traditional geothermal resources have already been discovered and many have been developed. In order to locate new geothermal resources, new approaches to exploration and exploitation

are needed. The high economic risk of drilling in frontier areas has limited geothermal exploration in recent years.

The demand for electric power has finally caught up with the supply in Texas and continues to increase. Large amounts of new capacity will be required and are expected to be on-line within the next few years. Over 8,000 MW of additional capacity are under construction in Texas, and almost 19,000 MW more have been announced.[37] In addition, Texas has adopted a renewable energy mandate that requires the installation of 2,000 MW of additional renewable generation by 2009. Experts estimate that demand for new capacity will continue to grow during the next decade, but the current low prices for natural gas make it difficult for geothermal power to compete with gas-fired generation on a cost-only basis. Further action may be required to enhance the competitive position of geothermal energy projects.

Significant growth in geothermal generating capacity during the next decade will require the discovery and production of new geothermal fields. In the absence of significant changes in demand, incentives, or the regulatory process, new geothermal generating capacity in the U.S. is not expected to exceed 500 MW during the next 5 years. Growth in the longer term is difficult to predict, however, and the possibility of large untapped resources in Texas and an excellent reputation for rapid, reliable, and cost-effective development, the geothermal industry has the potential to contribute significant economic growth in an economically deprived region of the state.

Geothermal energy offers an environmentally benign source of electricity that is reliable and cost effective. Today's hydrothermal power plants with modern emissions controls have minimal impact on the environment. The plants release little or no carbon dioxide, a greenhouse gas suspected of contributing to global warming. Geothermal power plants are very reliable when compared to conventional power plants. Taken as a group, geothermal power plants are able to generate power 95% or more of the time; they are seldom off-line for maintenance or repair. Not only are they reliable, but their capacity factor—the ratio of the amount of electricity a plant produces to how much energy it is capable of producing—is highest among all types of power plants. Finally, because they are abundant in the United States, geothermal resources offer a large source of secure energy to the nation's energy portfolio. Geothermal electricity production can help reduce the need for oil imports, reducing the trade deficit and adding jobs to the U.S. economy.

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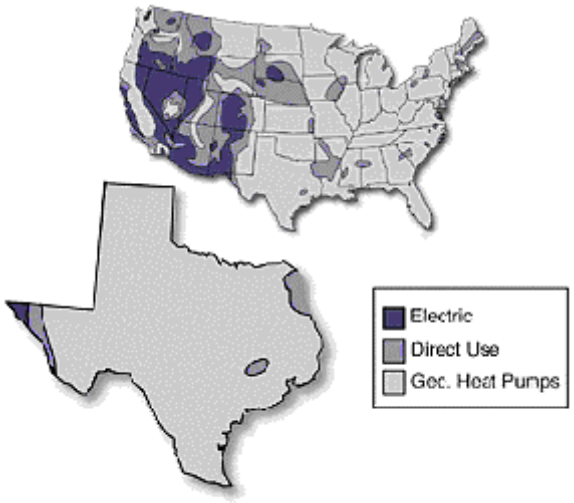
[37] The Public Utility Commission expects annual demand growth in demand for electricity in Texas to be slightly over 3 percent in the next few years. Over 5,500 MW of generation in Texas are expected to come into commercial operation prior to the expected summer peak in August 2000. Installed capacity in Texas for 2000 is estimated to be 73,871 MW after the additions.

All these attributes make geothermal energy attractive for international as well as domestic markets. In the developing countries, demand for electric power is burgeoning—and nearly half of these countries have geothermal resources. These markets represent promising export options for geothermal technologies and expertise. By one estimate, more than 80,000 MW-electric of potential for geothermal electrical power projects currently exist in developing countries using hydrothermal resources alone.

Texas Geothermal Resources

As indicated on the map, Texas has high-temperature resources that are suitable for electricity generation. Every geothermal site has a unique set of characteristics and operating conditions. For example, the fluid produced from a geothermal well can be steam, brine, or a mixture of the two; and the temperature and pressure of the resource can vary considerably from site to site. Therefore, a plant design must be carefully matched to the type and temperature of a particular resource.



Texas geothermal resource

The Future of Geothermal Power

Before geothermal electricity is considered a key element of the U.S. energy infrastructure, it must become cost competitive with traditional forms of energy. Toward that end, the geothermal industry, with assistance from the Department of Energy, is working to achieve a geothermal-energy life-cycle cost of electricity of $0.03/kWh. It is anticipated that costs in this range will result in about 15,000 MW of new capacity installed by U.S. firms within the ensuing decade.

Are there sufficient geothermal resources to support this much capacity? Reserves of hydrothermal energy in the United States are difficult to quantify because much exploration remains to be done. However, the U.S. Geological Survey (USGS) estimates that geothermal energy from identified U.S. hydrothermal resources could supply thousands of megawatts more power than current production. In addition, USGS estimates that five times

that amount may be available from undiscovered hydrothermal resources in the United States.