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State Policy Recommendations for Geopowering Texas An Example for States to Follow in Developing Their Geothermal Energy Resource on Non-Federal Acreage

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Keywords

Texas, state policy, geothermal resource, energy policy, co-produced, sedimentary basins, oil and gas wells, regulations

ABSTRACT

Unlike many western states, federal lands in Texas are nearly non-existent. Land is owned by private citizens or the state, and the state oversees energy and mineral production. Beginning a Texas geothermal industry requires well defined rules and regulations that contribute rather than hinder energy development. This paper presents recommendations that were submitted to the Texas State Energy Conservation Office as part of a state supported geothermal investigation.

Introduction

Development of geothermal energy in Texas will include geothermal HVAC, direct use, and electric generation (Figure 1). Most development will occur on land either privately or state owned. Although each geothermal application can grow independently, many of the rules and regulations that govern one form of geothermal development may impact the other two.

This paper discusses recommendations provided to the Texas State Energy Conservation Office for furthering Texas geothermal development. Some recommendations may be appropriate for other states. None of the recommendations are presently authorized but rather are suggestions based on discussions with energy professionals in Texas and review of historic Texas geothermal documents. The recommendations fall within four categories: technical assistance, industrial/economic development, advocacy, and policy/legal action. Where appropriate the discussion pinpoints the geothermal energy type that is the focus of each recommendation.

Technical Assistance

Geothermal energy can be used anywhere in Texas. But the type of geothermal development depends upon the resource temperature. Geothermal energy for electrical generation or direct use requires access to hot water through new or existing wells for hot water production. In Texas most hot water will come from deep rock strata that have been drilled for natural gas extraction.

Data regarding deep temperatures, amount of water available, thermal conduction, subsurface water movement, and

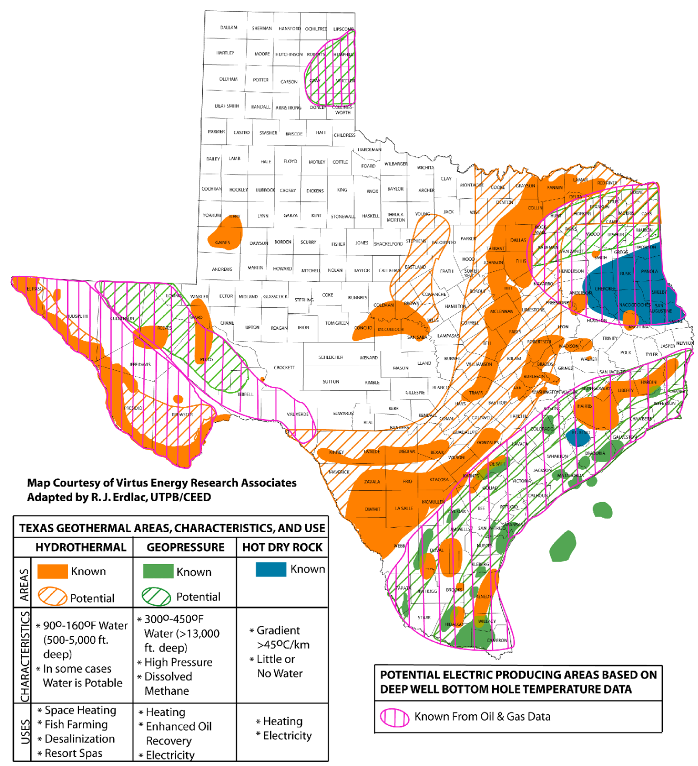


Figure 1. This is a generalized map of Texas showing areas with possible characteristics and use. Geoexchange system can be employed anywhere. Direct use and electrical production will be employed in areas where hotter water can be brought to the surface through wells. Virtus Energy Research Associates originally developed this map to show the approximate location and boundaries of geothermal areas in Texas (Valenza, 1995). This map has been updated and altered as a result of work conducted by Erdlac, 2007.

other factors affecting geothermal production are not readily available due to their lack of need by oil and gas companies. These issues can begin to be addressed by state agencies, which will further geothermal development.

The biggest technical issue facing geothermal development for electrical power and direct use activity in Texas is determining where and how deep the resource lies. Two large geothermal databases are presently known for Texas, the original 1976 regional data that has received extensive use by the SMU Geothermal Laboratory, and the database constructed at UTPB-CEED for the deep Delaware and Val Verde Basins. These databases need to be expanded in a manner that can foster this new industry.

Recommendation 1 – State Funding Program

A technical assistance program would establish a "Texas Geothermal Atlas" available to the public that would emphasize well data collection and analysis, map generation, rock property determination on target formations, economic models for geothermal acquisition, and technology transfer for energy production. Industry advocacy and educational outreach activities would also be conducted, with the program geared to jump-starting a Texas geothermal energy industry.

The state would fund the program for four years through the State Energy Conservation Office (SECO) as the overseeing agency. The cost estimate of $18 million (Figure 2) is based on geothermal work conducted at UTPB-CEED during the 2005-2006 period of DOE-SECO support. A collaborative discussion would fine tune the budget for this project.

Funding would support three universities that have conducted geothermal work in Texas or have an individual with past geothermal experience. Presently, these organizations include The University of Texas of the Permian Basin Center for Energy & Economic Diversification (UTPB-CEED), Southern Methodist University Geothermal Laboratory (SMUGL), and the University of Houston (U of H).

Each university would target specific geographical areas while maintaining a close working relation with each other. UTPB would focus on Permian and Val Verde Basins, and the Trans-Pecos region. This would expand the existing Delaware Basin work that was funded by the DOE and SECO from mid 2005 through 2006. An estimated $5.4 million would support the Permian Basin and Trans-Pecos Geothermal Atlases during the 4-year period. An additional $48,000 would provide education and technology transfer to businesses and venture capital groups interested in developing West Texas geothermal energy.

SMU would receive $4.8 million for Geothermal Atlas development within the Anadarko Basin of the Texas Panhandle, and for work in East Texas. Education and technology transfer efforts would receive $48,000. Additionally, SMU would receive $500,000 for conductivity studies of target geothermal formations throughout the state. They would coordinate experimental efforts for the entire program rather than each organization conducting independent studies.

The University of Houston would receive $7.2 million for Geothermal Atlas development and $48,000 for education and technology transfer. The larger amount of funding is due to the larger area covered in the Texas Gulf Coast when compared to the other regions covered by UTPB-CEED and SMU.

Finally, SECO would receive an additional $200,000 to assist in developing industry partnerships with the three universities to carry work beyond the four-year period of state funding. In this manner future university geothermal R&D funding would be supported by industry actively participating in developing geothermal energy applications within the state.

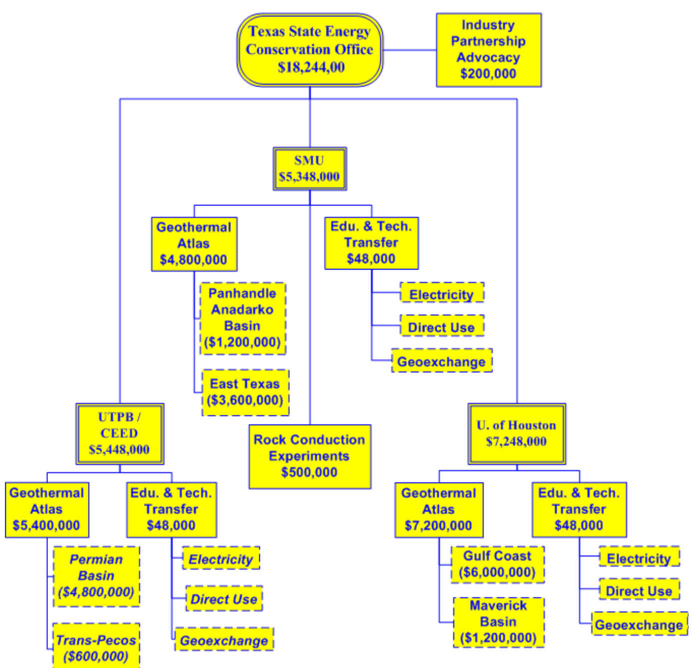


Figure 2. An organizational chart for defining the hierarchy and possible funding amounts and areas of the state covered for a targeted Texas geothermal program. The research and investigations by all participating agencies would result in a "Texas Geothermal Atlas" that would be available to public for enhancing a new geothermal energy industry in the state.

Industrial / Economic Development

While major efforts at industrial diversification have occurred, Texas is still an oil and gas energy capital. In West Texas, economic dependence on the oil and gas industry for high skill, high paying jobs has been the norm. Production, transport, and sale of oil and gas resources outstripped other industries in the region. For example, between January and March of 1997 D&B Market Place reported that the petroleum industry represented 1,795 businesses (15.3%) of a total 11,718 businesses within Midland and Ector Counties (Table 1). However these businesses represented over 34.7% of all business sales, or $2,573,600,000 during this period (Table 2), equating to an average of over $1,433,000 per company. By contrast all other businesses averaged only $477,970 per company. Thus economic dependence upon oil and gas production has been enormous.

The oil and gas industry has changed drastically over the last two decades. Major O&G companies pulled out of domestic basins looking for areas to develop worldwide. Others were bought out, probably in the attempt to maximize producing assets in a world of dwindling O&G production. This created a vacuum that has been partially filled by smaller, more aggres-

Table 1.

Jan-Mar 1997 Business Statistics For Midland & Ector Counties		
Business Type	**Number Businesses**	**Number People Employed**
Bus. Excluding Petroleum ^	9,923	78,345
Bus. Excluding Petroleum & Agriculture ^	9,784	77,851
Petroleum ^	1,795	
Exploration & Prod Co. *	228	

^ From D&B Market Place
* SW Bell Yellow Pages

Table 2.

Jan-Mar 1997 Business Statistics For Midland & Ector Counties	
Business Type	**Sales**
All Businesses ^	$7,408,100,000
Agriculture & Related ^	$91,600,000
Petroleum & Related ^	$2,573,600,000
Remaining Businesses ^	$4,742,900,000

^ From D&B Market Place

sive independent O&G companies. These companies benefited from higher world energy prices by drilling in older fields and smaller plays that are now economically feasible.

During the last decade wind energy has grown within Texas. Energy Efficiency and Renewable Energy (EERE) wind maps show Texas at 2,898 MW installed capacity, with California a close second at 2,320 MW. Randy Sowell (personal communication), a West Texas wind energy professional, indicates an average of 1 technician for every 10 MW of installed potential. Crews are composed of two individuals, one for electronics and computers and the second for the mechanics and operation of the tower. This equates to around 300 people employed in the field. Installation of 2 MW wind towers may alter this number to 1 technician to every 12 towers, but insufficient numbers of these larger towers are in place to determine the future employment rate.

The geothermal industry has a much higher employment ratio. A 20 MW plant might employ 12-14 people and a 50 MW plant 40-50 professionals (Ormat Technologies, Inc., oral presentation). These people comprise administrative and supervisory personnel, plant operators, and maintenance personnel. The rate of employment at a geothermal facility can vary from a minimum of 6 to 10 people for every 10 MW of produced electricity. If 2,898 MW of wind energy in Texas were produced by geothermal electric, employment might range from 1,738 to 2,898 personnel. The employment potential in geothermal is larger than that presently found in the wind industry, probably from the greater complexity of operation and the higher capacity factor for geothermal over wind. This employment rate does not include the geoscientists, (petroleum) engineers, drillers, and support staff found in the O&G industry, and who would play a vital part in developing and maintaining a Texas geothermal industry.

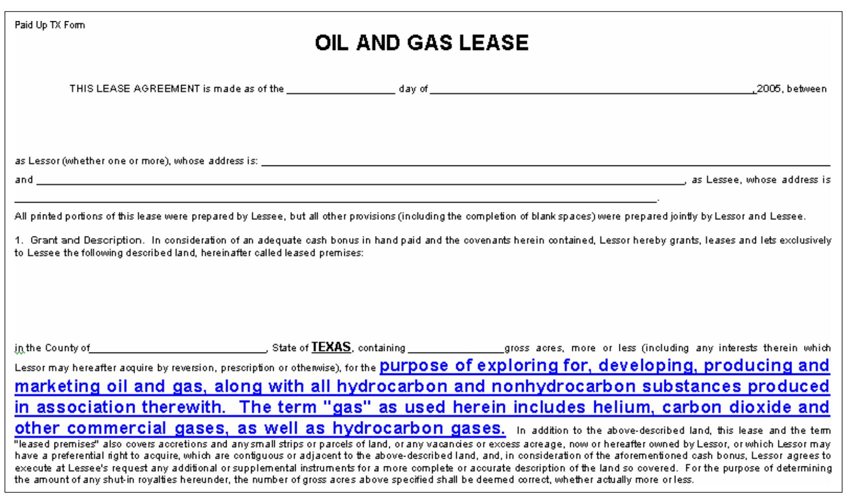
Recommendation 2 – Leasing Definition and Clarification

To facilitate "the rapid and orderly development of geothermal energy and associated resources" (Texas Geothermal Resources Act of 1975, §141.002(1)), and as "an integrated development of components of the resources, including recovery of the energy of the geopressured water without waste, is required for best conservation of these natural recourses" (§141.002(4)), and as the intent of the Texas Legislation was the "prevention of waste of natural resources, including geothermal energy and associated resources" (§141.012(b)(2)), a clarification is needed for co-production or multi-stage development of oil, gas, and geothermal resources in Texas.

Many oil and gas wells produce hot water at 180°F (82°C) and above along with oil and gas. The water may be stored in a tank for later injection and disposal, or it is immediately injected into a nearby water disposal well. In either instance the heat energy is lost. Can an existing lessee extract this heat and use it as an energy source as part of their existing lease, or must they have a geothermal lease separate from oil and gas?

Existing O&G leases (Figure 3) use phrases such as "oil, gas, and associated fluids" or "nonhydrocarbon substances produced in association" with the oil and gas. This allows hot water to be produced along with oil and gas. However does this wording allow purposeful extraction of heat energy from this same water for renewable energy application? Heat energy is nonhydrocarbon in nature and a lease that uses this phrase might be argued to cover production of geothermal energy in conjunction with or after the extraction of oil and gas.

This issue requires clarification. Heat energy is wasted in the same manner that natural gas was once flared by industry. Today, there is a market for this natural heat energy, one that was not present in the past. Developing Texas geothermal requires knowledge of sedimentary strata in basins where oil, gas, and water cohabitate. It also requires an energy triad development approach…oil, gas, and geothermal …that will undoubtedly find bypassed oil and gas reserves or reserves suf-


Paid Up TX Form

OIL AND GAS LEASE

THIS LEASE AGREEMENT is made as of the ________ day of ____________________, 2005, between

as Lessor (whether one or more), whose address is: ____________________

and ____________________, as Lessee, whose address is ____________________.

All printed portions of this lease were prepared by Lessee, but all other provisions (including the completion of blank spaces) were prepared jointly by Lessor and Lessee.

1. Grant and Description. In consideration of an adequate cash bonus in hand paid and the covenants herein contained, Lessor hereby grants, leases and lets exclusively to Lessee the following described land, hereinafter called leased premises:

in the County of ____________, State of **TEXAS**, containing ________ gross acres, more or less (including any interests therein which Lessor may hereafter acquire by reversion, prescription or otherwise), for the **purpose of exploring for, developing, producing and marketing oil and gas, along with all hydrocarbon and nonhydrocarbon substances produced in association therewith. The term "gas" as used herein includes helium, carbon dioxide and other commercial gases, as well as hydrocarbon gases.** In addition to the above-described land, this lease and the term "leased premises" also covers accretions and any small strips or parcels of land, or any vacancies or excess acreage, now or hereafter owned by Lessor, or which Lessor may have a preferential right to acquire, which are contiguous or adjacent to the above-described land, and, in consideration of the aforementioned cash bonus, Lessor agrees to execute at Lessee's request any additional or supplemental instruments for a more complete or accurate description of the land so covered. For the purpose of determining the amount of any shut-in royalties hereunder, the number of gross acres above specified shall be deemed correct, whether actually more or less.

Figure 3. An example of an oil and gas lease in Texas. In this lease the phrase "nonhydrocarbon substances produced in association therewith" is probably used to cover brine that might also be brought to the surface. Would such a phrase also cover geothermal energy found in the brine?

ficiently small that only by a triadic approach is it economically feasible for drilling to occur.

Recommendation 3 – Lease Expansion

Oil and gas is the byproduct of buried organic material entrapped within sediments deposited in a basin. When buried under proper pressure and temperature conditions, the organic material was converted into oil and gas. Thus oil and gas is a byproduct of the geothermal conditions that existed within the basin.

That oil and gas is severed from geothermal energy in a lease is of concern. It is conceivable that an unscrupulous company could enter an area where deep gas is produced, along with associated hot water, lease the geothermal rights separate from oil and gas, and then sue the oil and gas operator because they are wasting the heat contained in the hot water. The reverse situation could also occur, where geothermal rights have been leased by one company and a second company leases the oil and gas rights at the same location, causing difficulties to the first company. Reservoir integrity is important for both oil or gas and geothermal energy production.

Recommendation 3 allows oil and gas companies with exiting O&G leases on lands under state jurisdiction to grandfather into existing leases the right to develop geothermal energy along with the oil and gas that may already be in production. Development might occur in conjunction with oil and gas production, or it might be developed later when dwindling O&G production allows for the opening of bypassed hot water zones for heat extraction. This would ensure the intent of the Legislation for "prevention of waste of natural resources, including geothermal energy and associated resources".

Advocacy

Advocacy is the act of supporting, encouraging, backing, sponsoring, or promoting a particular business, concept, individual, or thing. Although geothermal energy is not new in Texas, its full development will require education and general support from industry, public, and political partners. Organizations such as the Texas State Energy Conservation Office (SECO) and the Texas Renewable Energy Industries Association (TREIA) have provided important advocacy actions for existing Texas renewable resources. This same advocacy is necessary to launch geothermal growth in Texas.

Recommendation 4 – Financial Forums

In business, understanding the market and its demand, identifying the experienced personnel, and securing funding are all important. In many instances the market has been researched, the expertise is available, but the funds are lacking. This recommendation would establish yearly renewable energy forums across the state that would bring investment organizations, venture capitalists, and angel investors to startup companies looking to secure funding for operations. This forum could be developed for each renewable energy resource, or the forums could be held concurrently for all renewable energy companies seeking funding. The second approach would allow the investor to talk with different renewable energy clients at a single location.

Recommendation 5 – Nesting

Each energy resource has various strengths and weaknesses. For example wind and solar energy are readily accessible. They are experienced by people each day due to the resource being a surface phenomenon. By contrast geothermal energy is under the ground, requiring drilling into the subsurface for its acquisition. On the other hand, sun light and wind are not available at the same location throughout the day. The sun does not shine at night and the wind may not be blowing. However the earth stores tremendous quantities of heat in the subsurface that can be tapped any time of the day or night.

Recommendation 5 advocates the concept of 'nesting', or the planned development of two or more renewable resources in concert with each other in the same geographic area. This approach offsets a weakness of one resource with the strength of another, and it ensures a steady, constant, and predetermined stream of energy availability. Although untested, nesting might be cheaper in overall capital outlay when measured against capacity factor from a sole source resource.

Policy / Legal Action

Numerous barriers have been sited to geothermal energy development. In considering this problem, I believe that there are few barriers but many constraints on geothermal (Erdlac, 2005). The term barrier implies an obstacle or a boundary through which further passage is impossible. But, a constraint suggests a state of being checked, a situation that may be temporary.

Constraints can be local or global. They may represent a fundamental impasse or they may be our own construct, forms of thought or action that if altered or viewed from a different perspective disappear as a boundary all together. Some constraints are unique to the area being investigated. Other constraints are common to all geothermal electric power development. These constraints fall into three broad categories: natural or geological/geographical; technical; and human (Table 3). This list is not complete, but the approach

Table 3.

CONSTRAINTS TO GEOTHERMAL DEVELOPMENT			
Natural (Geological/Geographical)		Technical	Human
Surface	Subsurface		
Landforms/Geography/ Geology	Heat Resource Available	Drilling (techniques- horizontal, radial patterns)	Economics (cost vs. profit) (drilling costs)
	Reservoir Characteristics	Heat Acquisition Methodologies	Perception
	Water as Transfer/Storage Agent	Environmental Concerns (toxic & nontoxic minerals)	Transmission
		Data acquisition	Information/Technology Transfer
			Politics (gov., people [advocacy groups])
			Ownership
			Resource Management
			Research

defines a framework to evaluate how to overcome a specific constraint. Understanding the impact and interaction of these categories helps develop the strategy for successful geothermal energy expansion.

Some constraints are not unique to any one category, but rather have influences from other categories. One way to visualize this is to use the categories to define a ternary constraint diagram (Figure 4). Each apex represents 100% influence of that category on any given constraint. Percentages of influence of each category on a constraint are represented by the position of the constraint in the field. A constraint influenced by one category will cluster around that category. If two categories are involved, the constraint will lie on or near the line connecting those two categories. A constraint that is affected by all three categories will occupy a position somewhere within the triangle.

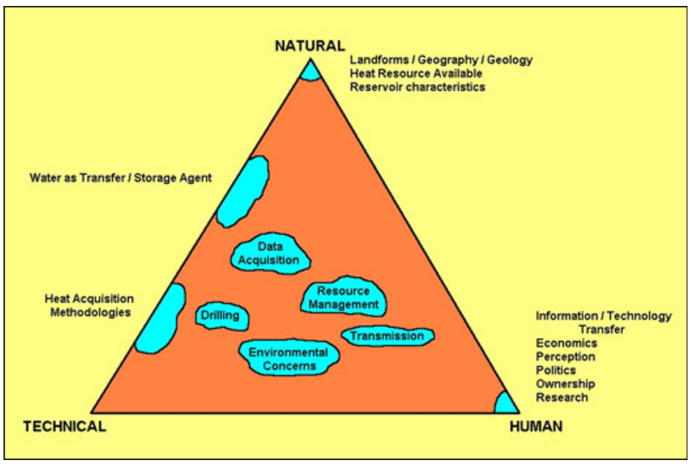


Figure 4. This ternary constraint diagram is defined by three categories: natural, technical, and human. Using these categories, a series of constraint fields were delineated to qualitatively describe the influence that each of these three categories might have on a given constraint.

Determining the location of these constraints is subjective, representing a qualitative rather than a quantitative approach. Landforms, geography, geology, heat resource availability, and reservoir characteristics are within the single category of nature. Constraints such as economics, politics, perception, information/technology transfer, ownership, and research fall within the influence of humans. I interpreted the fields of water as transfer/storage agent and heat acquisition methodologies as lying within a two category realm of nature and technology. The remaining constraints, data acquisition, drilling, resource management, environmental concerns, and transmission, are influenced by all three categories.

This analysis helps determine how geothermal energy is hindered from development due to human imposed constraints. This is where local, state, and federal policy and legislative action is of greatest assistance in furthering geothermal development. Constraints that are human made are also constraints that can be 'unmade'.

Recommendation 6 – Retrofit State Buildings

A way to demonstrate the importance of geothermal energy is for the State of Texas to take a leadership role in its development through policy implementation. Recommendation 6 suggests that the State embark on a plan that requires all state buildings and state supported facilities to retrofit these facilities with geoexchange HVAC systems.

Geoexchange systems decrease the heating and cooling cost to business and home owners. A part of this savings results from reducing the amount of electricity and non-renewable resources needed to operate the geoexchange system when compared to traditional HVAC. These systems, while more easily installed during new construction, can be retrofitted to existing buildings, reducing heating and cooling bills and the maintenance needs of the building.

The program would operate over a multiyear period. The State would see a savings in heating and cooling costs in each building. As the State has a fiscal responsibility to its citizens, this program would demonstrate that Texas is stepping out as a leader in working to cut its own costs through the use of geothermal renewable energy. Lubbock Christian University (LCU) is an example of a successful implementation of a large retrofit. LCU has retrofitted several buildings and is in the process of installing geoexchange HVAC for the entire campus. They have already experienced a 40 to 50% drop in heating and cooling costs. Their maintenance department is caught up with work and actually conducts preventative maintenance throughout the University. This helps lower long-term maintenance cost for the campus.

Recommendation 7 – Incentives

Texas has embarked on financial incentive programs for businesses and home owners to use renewable energy. Businesses that use, manufacture, or install solar energy receive franchise tax deductions and/or exemptions. A property tax exemption exists for solar, wind, biomass, and anaerobic digestion for business installation or construction of such systems. However these incentives presently exclude geothermal. As the recent Renewable Portfolio Standard includes geothermal for electrical power generation, existing incentives should be extended to include geothermal energy use and installation. Federal incentives include geothermal energy production within various credit programs. Texas should follow this example to allow its home-grown geothermal industry to develop. It is the responsibility of the State Legislature to ensure that a fair and even playing field is established for a broad development of its renewable energy potential, including geothermal energy. One approach might be that all new renewable energy projects should be entirely tax exempt until the initial investment cost has been paid for by the product developed by the renewable energy project.

Recommendation 8 – Capacity Factor

Availability of a continuous, uninterrupted source of electricity is essential to maintaining our technological civilization. Renewable energy resources were not of sufficient magnitude to launch the highly industrialized civilization that we have enjoyed for the last 150 years. Coal, oil, and natural gas were of extreme importance because of their higher energy density when compared to various renewable energy resources. Fossil resources are readily storable and are available on demand to fulfill our energy needs in a rapid fashion and at any location where that energy is needed. This on demand capability is comparable with capacity factor.

Availability measures the number of hours that a power plant is accessible to produce power divided by the total hours in a set time period, usually one year. Capacity factor (Figure 5) measures the amount of real time during which a facility is used. An analogy to these two terms is a car. If the car is not used, but is free of defects and is available for use, we would speak of the car's availability factor. If the car is being driven, we speak of the car's capacity factor. Geothermal plants often have availability factors around 95% and a capacity factor ranging from 89 to 97%, depending on the type of geothermal system in place.

A successful transition from fossil fuels to renewable energy must consider the resource capacity factor if a continuous electrical energy supply is to be maintained. In reviewing the wording of Texas SB 20, terms such as "generating capacity" and "cumulative installed renewable capacity" are used when discussing the requirement of 5,880 MW by January 1, 2015. These terms are not the same as capacity factor but rather reflect availability factor. The serious development of renewable energy for electrical production requires that the Texas Legislature define the renewable energy electrical portfolio in terms of capacity factor rather than installed generating capacity. It is the capacity factor that puts electrons on the wires for homes and businesses at anytime, day or night, not the potential for generation under the most favorable conditions. This approach is necessary to better determine long term electrical needs of the state and plan for a targeted transition from fossil to renewable energy over time.

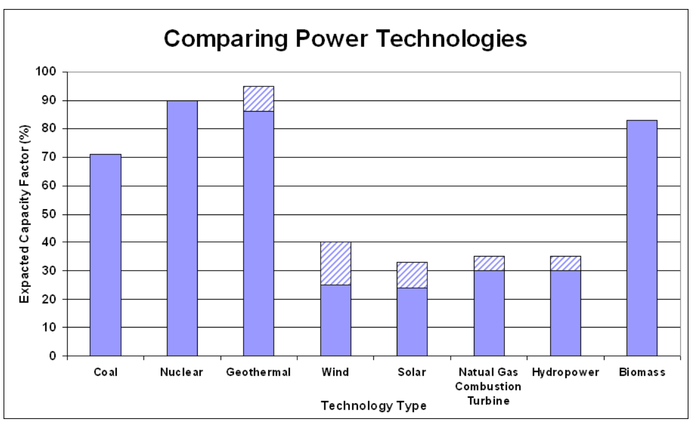


Figure 5. Capacity factor measures the amount of real time during which a facility is used. The difference in capacity factor of various energy resources is striking. The hachured areas for five of the technology types indicate the minimum to maximum range for capacity factor.

Recommendation 9 – Shallow Geothermal Use

Past Texas legislation defined geothermal as a mineral and energy resource, managed by the Texas Railroad Commission (Oberbeck, 1977). It also appears that geothermal is owned by the mineral owner. This is fine when dealing with the deeper production of geothermal energy for direct use or for electrical power generation. However geoexchange systems work in the upper 300 feet of the Earth's surface, usually considered to be part of the property owner's domain. Geoexchange systems use this portion of the Earth for storing heat from a building during the hot summer months and then extracting this heat during the colder winter months. While no legal problems have developed to date, the Legislature needs to revisit the definition of geothermal energy and the methods of its use to clearly define ownership of this resource based upon the depth from which it is extracted and how it will be used.

Conclusion

Texas geothermal energy development will impact the growing needs of an energy dependent society. Its versatility is a powerful vehicle for maintaining and creating energy jobs in urban and rural settings. The State of Texas must be more active in establishing this energy resource in the state. Industry is conservative and economically cautious of new ventures when future development is uncharted. Companies that are experts in one industry are slow to change when they lack the knowledge and experience in the newly proposed activity. Texas must take a leadership role because of the long-term benefit to its citizens, and provide the necessary incentives to entice industry to embrace a new direction of energy productivity. The recommendations listed above can be initiated with the goal of leading the existing Texas energy industry into a new energy future, the development of geothermal energy.

Acknowledgements

This work was conducted at The University of Texas of the Permian Basin Center for Energy and Economic Diversification through a grant provided by the Texas State Energy Conservation Office (CM540). I wish to thank Pam Groce and Dub Taylor of SECO for their support that made this investigation possible.

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