G101560

GEOTHERMAL GUIDEBOOK

Prepared for the Washington Legislature

1980 Geothermal Policy Review

JUNE 1980

ENERGY PROGRAM - GEOTHERMAL PROJECT
NATIONAL CONFERENCE OF STATE LEGISLATURES
1125 SEVENTEENTH STREET, SUITE 1500
DENVER, COLORADO 80202
303/623-6600

Introduction

The National Conference of State Legislatures (NCSL) Geothermal Project has been invited by the Washington Legislature to assist the House and Senate Energy and Utilities Committees in a review of geothermal policy issues. The Geothermal Project and the Washington State Energy Office are co-sponsoring the Washington Geothermal Symposium on June 2, 1980.

This Geothermal Guidebook is a basic research document of the Project. It describes what geothermal resources are and how they may be developed. The appendices contain additional detailed background material including a glossary and bibliography. Specific sections on Washington's geothermal potential, statutes and regulations, were prepared for the initial meeting of the Committees. The bulk of the Guidebook is a discussion of generic policy concerns relating to geothermal energy. This section provides the background analysis necessary to understand the particular issues of concern in Washington. These issues will be identified at the next meeting of the Committees. Subsequent workshops will examine policy options and recommendations to be considered for legislative introduction in the 1981 session.

This report was prepared under a grant from the U.S. Department of Energy (DE-FG03-78SF01795). The material and opinions contained herein are those of the NCSL Geothermal Project and not necessarily those of the Department of Energy.

TABLE OF CONTENTS

PART I—OVERVIEW

Why Geothermal Energy?

Energy supply is one of the most important issues facing state legislatures today. The question of how each state can ensure the reliability and sufficiency of its future energy supplies in a manner which is economically viable, environmentally compatible and politically feasible is receiving a great deal of attention in the nation's statehouses.

The United States currently imports almost half of its oil needs--nearly one-quarter of the total energy demand. The concerns raised by this heavy reliance on an increasingly expensive resource in an unstable and politically explosive world market come at a time of dwindling reserves of natural gas, environmental problems with coal and new difficulties with nuclear power.

Renewable energy resources are being given increasing attention and support in all parts of the country. Solar, wind, small-scale hydropower and geothermal energy all rely on indigenous resources, often well-suited to local needs. They are cleaner and safer than conventional energy sources and are not dependent on a finite and limited resource base--such as petroleum. And, perhaps most importantly, once a facility has been constructed, the fuel cost is minimal.

Geothermal energy--the heat of the earth--can be used either directly (as steam or hot water), or indirectly (to generate electricity). Currently the United States uses both forms: over 600 megawatts of electricity (MWe) are generated at The Geysers powerplant in California; and many locations heat homes, buildings, greenhouses and industrial process water with geothermal energy. Yet, the potential is far greater. The U.S. Geological Survey (USGS) estimates that identified geothermal resources can generate 23,000 MWe over a thirty-year period, plus yield approximately forty-two quads of direct heat.* The USGS also estimates that undiscovered geothermal resources represent over five times the energy of the identified resources. These figures do not look at the costs of developing this energy; however, numerous studies indicate that this energy source holds great cost-competitive future promise.

The Role of State Legislatures

As with other sources of energy, geothermal development largely depends on public and private investments in this relatively untried resource. State policies, however, play a prominent role, both in the regulation of geothermal development and in promoting its use. Legislative concerns fall into four main categories:

---

*One quad is the energy equivalent of 175 million barrels of oil; forty-two quads represents 54 percent of total U.S. energy use.

A. Characterization and Ownership

1) What are geothermal resources and how do they relate to other resource categories, especially water?

2) What party controls geothermal property rights?

B. Access and Allocation

1) How may geothermal development rights on public lands be obtained?

2) How shall competing producers share a common supply?

C. Regulatory Procedures

1) Are there adequate controls on geothermal development?

2) Is the regulatory system simple and efficient?

D. Finance and Marketing

1) How may investment in geothermal development be encouraged?

2) How may geothermal markets be expanded?

Many geothermal policy areas were developed with regard to other resources, or before the need for geothermal energy was realized. Legislatures may find worthwhile a comprehensive review of all state policies which affect the production, costs and use of geothermal energy.

The Role of NCSL

The Geothermal Project of the National Conference of State Legislatures (NCSL) will be working with the Washington Legislature in a review of geothermal issues. The goals of this project are to identify problem areas, propose various options for consideration by state legislators and administrators, and help implement those options most applicable to Washington. The NCSL Geothermal Project offers its services and experience with other legislatures to supplement the efforts of the Washington legislators and staff in seeking solutions to our current energy problems.

PART II—THE GEOTHERMAL RESOURCE

A. The Physical Resource

Every point of the globe rests on an ocean of molten rock at 1000°C (about 1800°F). This tremendous source of heat surfaces most dramatically as geysers, hot springs and volcanoes. The resource, however is more prevalent than just in these displays: broad belts of accessible geothermal energy encircle the earth. This energy frequently heats large sub-surface rock formations (thus labeled hot dry rocks), or creates underground reservoirs of steam and hot water (known as hydrothermal convection systems).

Different types of hydrothermal convection systems exist. Vapor-dominated systems such as The Geysers powerplant in California consist solely of dry steam; they are above 240°C (464°F). Liquid-dominated systems contain a mixture of steam and very hot water; they have a broad temperature range and generally are divided into high, medium and low temperature categories. Geopressurized thermal resources are also found--they have a medium-temperature but very high pressure and large amounts of dissolved natural gas increase their energy content. Most plentiful are low-temperature hydrothermal convection systems--under 90°C (194°F), offering a great potential for small-scale uses.

In the United States the thirteen westernmost states (including Alaska and Hawaii) contain the highest temperature, most promising resources. The U.S. Geological Survey has identified 3 vapor-dominated systems (greater than 240°C), 52 high temperature liquid-dominated systems (between 150°C and 240°C), and 163 medium temperature liquid-dominated systems (between 90°C and 150°C)--all of which are in the West. However, the bulk of geopressurized systems lie in the Gulf states, and low-temperature systems (below 90°C) are found in the West, the Gulf states and the Appalachian Mountain states (from Georgia to Massachusetts).

The USGS has classified more than 3 million acres in one hundred and eight locations, as Known Geothermal Resource Areas--these are the most promising. An additional 100 million acres have received classification as Prospective Geothermal Resource Areas.

At least twenty-eight states have some form of prospectively available hydrothermal convection system. Furthermore, all fifty states can efficiently use the heat energy contained in normal groundwater. In short, the natural energy of the earth represents a resource which can be used in all regions of the country.

B. The Resource Base in Washington

Washington possesses extensive reserves of geothermal energy. Liquid-dominated hydrothermal systems abound, offering vast areas of the state the potential for geothermal development. Most of these reservoirs are medium-temperature which are well suited for direct use applications, although electric power generation may prove feasible.

The USGS has identified three high- and medium-temperature systems. Based upon the USGS' determination of the available heat from these areas (in USGS Circular 790) the following estimates can be made:

Number of sites	Wellhead Thermal Energy	Beneficial Heat	Barrels of Oil Equivalent*	Cost of Oil Equivalent**
3	5.8×10^{14} Btu	1.2×10^{14} Btu	32,000,000	$960 million

*Based on 5,700,000 Btu/barrel and a 65 percent efficiency in generating beneficial heat from petroleum.

**Assuming current import prices of $30 per barrel.

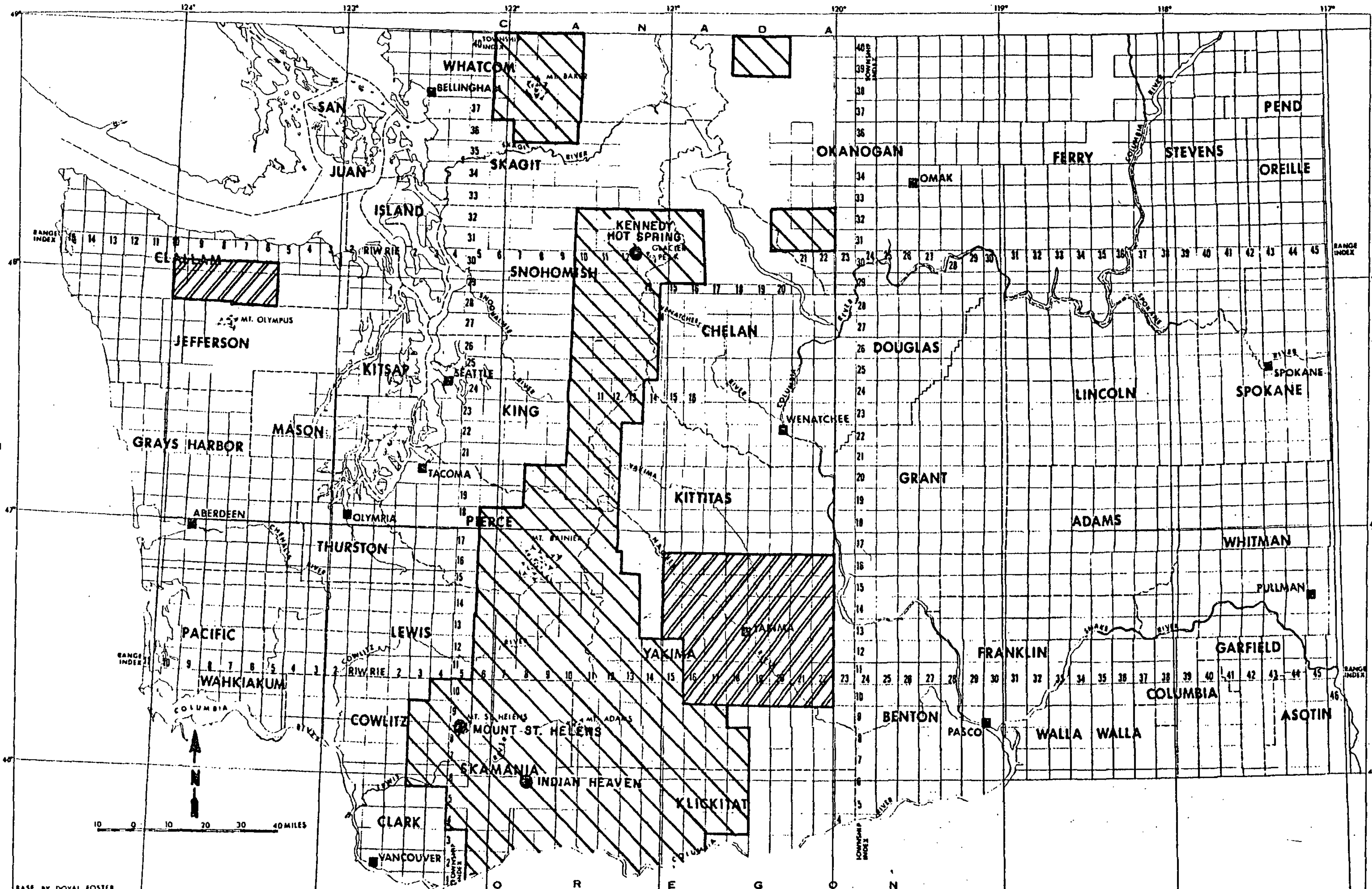
These savings cannot be immediately realized; rather, they indicate the potential for energy savings during the useful lifetime of the reservoirs.

The Oregon Institute of Technology evaluates four sites--Mount St. Helens, Mount Rainier, Mount Baker and Yakima--as the most likely targets for commercial geothermal development.

Washington's geothermal resource areas are mapped in Figure 1.

FROM: Geothermal Energy in Washington: Site Data Base and Development Status by R. Gordon Bloomquist, Ph.D.

FIG. 1 - GEOTHERMAL LAND CLASSIFICATION MAP OF WASHINGTON STATE



● KNOWN GEOTHERMAL RESOURCES AREA

LANDS VALUABLE PROSPECTIVELY FOR GEOTHERMAL RESOURCES

AREA OF KNOWN WARM WATER USE

The most likely commercialization targets are: Mount St. Helens, Mount Rainier, Mount Baker and Yakima.

C. Existing Uses

Geothermal energy has a long history of direct use in the United States and around the world. Hot springs were used by American Indians for bathing and for scalding wild fowl; pioneers used them for drinking, bathing and watering stock; the therapeutic use of hot springs in spas (balneology) is well known. Modern uses of geothermal heat in the U.S. are widespread and include:

* residential and commercial space heating;
* food dehydration and processing;
* warm-water irrigation and greenhouse heating;
* "pre-heated" industrial process waters; and
* aquaculture, snow melting, car washing, explosives manufacture, dry ice production, and other specific applications.

At present only The Geysers relies on geothermal energy for electricity production, with a current capacity of 663 megawatts--the electrical need of approximately one-half million people. It is scheduled to increase incrementally; eventually generating more than 1,000 megawatts of geoelectricity. Powerplants in Utah and the Imperial Valley, California, are currently under development.

Geothermal energy is not currently utilized in Washington for electrical generation. The National Park Service runs a resort at Sol Duc Hot Springs which heats cabins, an inn and mineral baths using naturally-heated waters. In the City of Yakima, geothermal waters are used in warm-water irrigation wells and a car wash.

D. Potential Uses

All of the above ongoing uses of geothermal resources demonstrate their viability as an energy source. Many areas which already utilize the resource can expand to other uses. Areas which do not yet tap geothermal resources may find the economics encouraging.

In addition to the proven uses already mentioned there are many other prospective applications, such as residential cooling, crop and timber drying, in pulp and paper mills, and ethanol distillation for use in gasohol. Furthermore, the energy and economic efficiency of geothermal utilization can be increased by "cascading"--using industrially discharged water in spaceheating, for example. Figure 2 charts the temperature ranges needed by various industrial processes. These temperatures are typical for low-to-medium temperature geothermal waters.

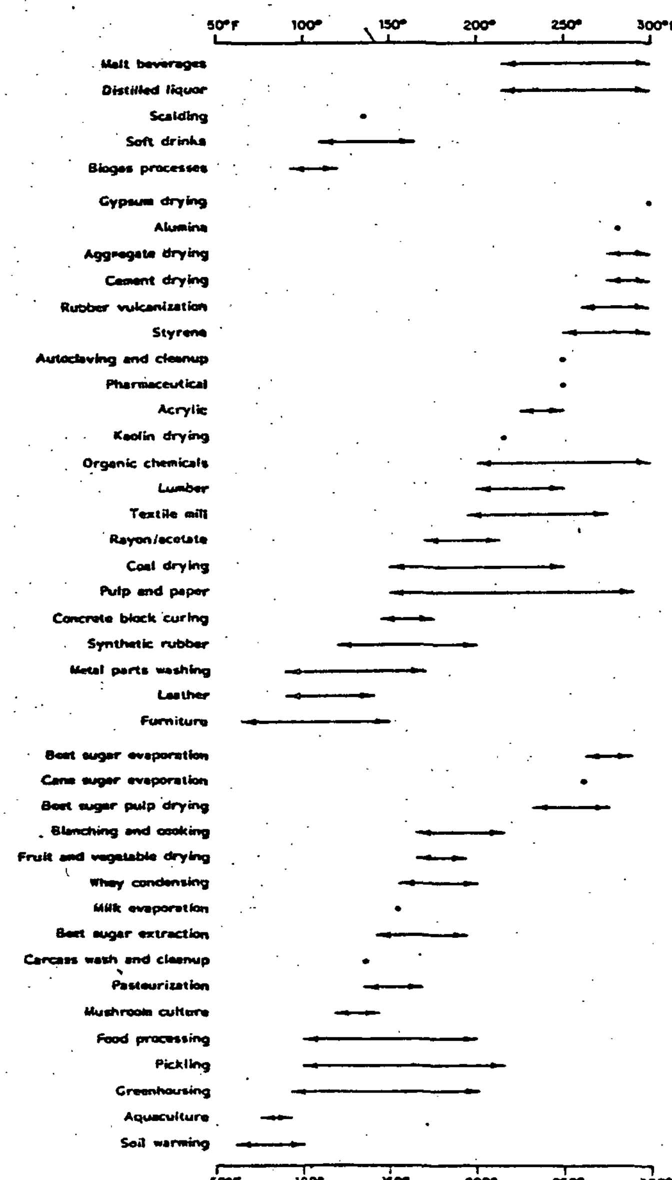


Figure 2

Direct thermal application of geothermal energy.

1/ Reprinted from WSEO newsletter, Oct. 1979, v. 2, no. 4. Courtesy of Gordon Bloomquist.

Current technologies require geothermal waters of at least 170°C (338°F) for electrical generation. Geothermal powerplants are in the planning stages in Idaho, New Mexico and Nevada. Hot dry rocks are a potential source of electricity; however, that development must await technical advances.

Heat pumps also make use of natural energy supplies; they are reversible devices which move heat from one point to another, thereby heating one location and cooling the other. The advantage of heat pumps which utilize groundwater, rather than the more common air-to-air system, is that groundwater stays at a fairly constant temperature--warmer than cold winter air and cooler than hot summer air. Recent experience has demonstrated that groundwater-referenced heat pumps are cost-competitive with traditional sources of heat.*

E. Energy and Economic Value

Direct heat applications at less than 250°C (482°F) account for 40 percent of the nation's total energy consumption--the aggressive development of geothermal resources can displace the consumption of costly fossil resources for many of these purposes. Geothermal energy is relatively benign environmentally, and is not subject to the spiraling costs of fossil fuels or their supply uncertainty. These fossil reserves may prove more valuable in the long term as chemical feedstocks rather than as heat sources.

Geothermal energy is most efficiently used near its production site. This factor, along with the diversity of end-uses it can meet, makes it particularly amenable to small-scale, locally determined energy needs. Geothermal utilization will not only promote a more diversified energy future for Washington, but will permit greater local participation in solving energy problems.

---

*For more information please see the Geothermal Project's "Guide to Groundwater Heat Pumps," available from NCSL.

PART III—STATUTES AND REGULATIONS

A. Federal Law

Various federal laws and policies affect geothermal development by establishing procedures for the use of federally-owned geothermal resources, levying taxes and providing incentives. Particularly important are the Geothermal Steam Act of 1970 (30 USC 23 §§ 1001-1025), the Geothermal Loan Guaranty Act (P.L. 93-410), and the comprehensive National Energy Act (P.L. 95-617 through 95-621). The key provisions of these acts and their corresponding regulations follow.

1. Geothermal Steam Act of 1970 (see also CFR 270-271 and 43 CFR 3000 et. seq.)

a. The Secretary of the Interior may issue leases for the development of geothermal resources for all federally-owned lands including mineral reservation lands,

b. Lands within KGRAs must be competitively leased; non-KGRA lands are non-competitively leased,

c. The Bureau of Land Management (BLM) conducts lease sales, contingent on the completion of Environmental Impact Statements (EISs) by the surface management agency,

d. National park, recreation and wilderness lands cannot be leased; tribal lands are under the jurisdiction of the Indian nations,

e. Lease size and terms, maximum holdings and environmental requirements are specified.

The Federal Land Policy and Management Act of 1976 required that 50 percent of revenues received from federal geothermal leases would accrue directly to the state in which the leased lands are located.

2. Geothermal Loan Guaranty Act

The Geothermal Loan Guaranty Program (GLGP) was established in 1974. Its aim is to provide a federal guaranty--through the U.S. Department of Energy--of repayment of a commercially-obtained loan in order to reduce the risks associated with geothermal development. To date the GLGP has guaranteed parts of four loans with several applications pending.

3. National Energy Act

Two of the five acts within the National Energy Act are particularly important to geothermal energy.

a. "Energy Tax Act of 1978" (P.L. 95-618)

i. Authorizes the deduction of intangible drilling costs on the same basis as for oil and gas wells,

ii. A declining depletion allowance is granted for geothermal resources,

iii. Allows a residential energy tax credit for the use of geothermal energy,

iv. Establishes a supplemental business investment credit for equipment used to produce or use geothermal energy (although not available to utilities).

b. "Public Utilities Policies Act of 1978" (P.L. 95-617)

i. "Qualifying small power producers" (one which generates not more than 80 megawatts of electricity from renewable resources, which is presumed to include geothermal energy) can be interconnected to existing transmission facilities by order of the Federal Energy Regulatory Commission (FERC),

ii. FERC can require utilities to sell to or purchase electricity from small power producers,

iii. Power producers not more than 30 megawatts may be exempted by FERC from the regulatory control of the Federal Power Act and state public utility commissions.

B. Public Land Ownership

The federal government is a major land holder in many states--particularly in the West. Federal land ownership in the West ranges from 9.7 percent of Hawaii's area to 95.3 percent of Alaska's. In these states federal decisions on the development of geothermal resources (and the restrictions placed by the Geothermal Steam Act of 1970) are of particular importance. In the non-western states, the federal government controls no more than 9 percent of a given state's land, and generally much less. State land ownership in the West also varies greatly--from Hawaii's 36.4 percent to Nevada's 0.2 percent.

The status of federally-owned lands is critical to Washington's geothermal development. Over 90 percent of the Mount St. Helens KGRA lies in the Gifford Pinchot National Forest; 85 percent of the Mount Rainier PGRA is in the Mount Rainier National Park, or in National Forests; more than 97 percent of the Mount Baker PGRA belongs to the Mount Baker-Snoqualmie National Forest; and, although only 21 percent of the land of the Yakima area is federal, an additional 20 percent is in the Yakima Indian Reservation. For the state as a whole, 29.4 percent is federally owned; 7.6 percent is state owned.

C. State Statutes

Washington has enacted two geothermal statutes: The "Geothermal Resources Act" of 1974 (RCW 97.76) and the "Geothermal Resources Rights" of 1979 (S.B. 2191).

1. The "Geothermal Resources Act" details requirements in developing certain geothermal resources on state and private land. Important provisions include:

a. The Act defines geothermal resources as those from which it is "technologically practical to produce electricity commercially),"

b. The geothermal resources, as defined above, are characterized as sui generis--neither a mineral nor a water resource,

c. The Department of Natural Resources (DNR) is given the authority to regulate the drilling, operation, environmental protection, safety, bonding and restoration of geothermal projects,

d. Any non-electricity producing wells are regulated under the Department of Ecology's water-well rules,

e. DNR is allowed to promulgate well-spacing requirements, implement unitization programs and establish proportionate costs.

2. The "Geothermal Resources Rights" Act assigns the ownership of high-temperature geothermal resources to the surface estate owner (as opposed to the public domain or mineral estate owner).

D. State Regulations

In response to the "Geothermal Resources Act" and the responsibility of managing state-owned lands (including 20,736 acres in the Mount Rainier PGRA and more than 160,000 acres in the Yakima area), DNR has adopted drilling regulations and drafted leasing regulations.

1. DNR's draft leasing regulations affect both electricity-generating and direct-use wells. Its main features are:

a. Method--all lands are competitively leased by cash bonus bidding, at either an oral auction or by sealed bids,

b. Primary term--five years,

c. Renewal--for length of commercial productivity, up to 20 years, with preferential right to second 20 year lease,

d. Renegotiation--(no provisions),

e. Annual rental--$3/acre,

f. Royalties--after DNR determines that paying quantities have been produced: $10/acre annual royalty; additionally: 10 percent of gross revenues of energy production, 4 percent of net revenues of byproducts,

g. Acreage limits--minimum: 40 acres; maximum 640 acres,

h. Bonding--$5,000 per lease.

2. DNR's drilling regulations, "Geothermal Drilling Rules and Regulations" (WAC 332-17), are applicable to all lands within the jurisdiction of the state. Distinctions are made between exploratory core-holes and productions wells. The important features are:

a. Permit--required for all geothermal wells,

b. Bonds--$15,000 per well, $50,000 blanket bond for more than one; $5,000 per core-hole, $25,000 blanket core-hole bond,

c. Well spacing--site specific well-spacing approved by DNR, taking into consideration topography, economic efficiency, multiple use of lands and the protection of correlative rights,

d. Equipment--casing and cementing, blowout prevention and electric logging (the two former on a site-specific basis),

e. Abandonment--approval by DNR required, plugging required,

f. Unitization--(no explicit provisions),

g. Environment--protection of esthetic values, public health and physical and biological environment.

PART IV—LEGISLATIVE POLICY CONCERNS

Geothermal activity in the United States is in initial stages. Thus, the states may establish a comprehensive legal framework to guide the course of future development. For geothermal energy to supply its full potential, policies must be adopted which identify the subject resource and provide for prompt access and secure rights to the resource, efficient regulatory procedures, equitable financial treatment and a substantial market. Geothermal developers favor such legislative action as it reduces uncertainty regarding title to the resource, methods of development, and obligations to competitors and the public interest.

A clear understanding of the nature of geothermal development is a prerequisite for effective legislation. Geothermal resources have distinctive characteristics which should be recognized in state laws and regulations. Regulatory experience with other resources is an important reference, but may not be transferable to geothermal development. Indeed, current state and federal geothermal policies are often criticized for excessive reliance on mineral or water law precedents. In addition, policies applied to deep, hot geothermal resources may be inappropriate forshallow, warm thermal fluids.

A. Characterization and Ownership

The basic task is defining the subject resource and determining its relationship to existing resource categories. This is a complex task due to the unique nature of geothermal resources which resemble in some respects water, minerals and gas. In addition, geothermal resources occur in a variety of geologic settings ranging from deep, hydrothermal reservoirs and hot dry rock strata to shallow aquifers in areas with a normal thermal gradient.

Determination of the legal status of geothermal resources, including ownership and relationship to existing resource categories, has often been left to the judiciary. However, a legislative assignment has several advantages. Unlike courts, legislatures are not precedent-bound, nor are they limited to a particular factual dispute. Rather, they may examine a wide range of issues and make decisions on the basis of public policy.

Definition

The basic element of value of a geothermal resource is heat (enthalpy); however, some transfer medium, usually water, is a necessary component. In addition, valuable minerals and gases may be entrained or dissolved in the transfer medium. A complete definition would include all these physical constituents and help to avoid conflicting claims to separate components.

Further, deep, hot geothermal resources differ from shallow, warm groundwater in numerous ways. These differences include exploration and production methods, capital requirements, end uses, environmental impacts and effects on standard water supplies. Definitions which utilize a temperature and/or depth threshold, or focus on end use attempt to recognize these differences. In general, deep, hot systems suitable for electrical generation or industrial process heat may properly be defined as unique or mineral resources, while shallow, warm systems suitable for residential, commercial and agricultural applications may properly be defined as groundwater.

Ownership

Defining a geothermal resource to be mineral or water may determine ownership as well. Mineral ownership derives from an estate in land, which may be "severed" from property rights to the overlying surface. Groundwater is generally held in the public domain in the western states, while being an aspect of surface ownership in the eastern states.

The federal government claims geothermal ownership wherever it holds the mineral estate, either jointly with the surface estate or as a mineral reservation (severance). This claim was upheld in the Union Oil* case. Whether federal ownership extends to groundwater useful for thermal purposes is unclear. Absent an implied or explicit reservation of water pursuant to the establishment of a federal enclave, the states have primary control over water resources.

Two states (Oregon, Washington) have declared geothermal resources to be the property of the surface owner. The others, either by statute or practice, appear to recognize mineral ownership; although, in three states (Nevada, Utah, Wyoming), it may be argued that geothermal resources are in the public domain due to their classification as water.

The possible conflicts inherent in this legal tangle are apparent. Surface owners, holders of the mineral estate and water rights applicants all may claim ownership of the same geothermal resources. This uncertainty and the likelihood of litigation are a severe hindrance to development. Legislative clarification of the geothermal property regime is a priority. Again, distinguishing geothermal resources "proper" from hot groundwater is a useful device.

Relationship to Water

Geothermal development may affect standard water supplies in both production and disposal stages. Disposal impacts will be dealt with in a later section. Production effects involve interference with established water uses. Such interference is more likely to occur with the development of shallow systems for direct applications than with the development of deep systems for electrical/industrial purposes. Thus, in this area also, geothermal resources proper may be treated in a different fashion than hot groundwater.

---

*see glossary for citation

Blanket application of water law--whether the appropriation (western) or riparian (eastern) doctrine--to geothermal resources has several disadvantages. Initially, it may allow conflicting ownership claims arising from mineral versus water rights. At the development stage, water law doctrines (priority, reasonable use) are not the most efficient method of allocating production (discussed below). And, especially in the water-short West, the requirement to appropriate may be impossible or prohibitively expensive.

Water law has three basic purposes: to convey property rights to a particular user, to protect established users and to insure the public interest. With regard to geothermal resources--as distinguished from hot groundwater--only the purposes of protection are relevant. This can be achieved without the wholesale application of water law and its attendant implications regarding ownership. Several states (Alaska, Arizona, California, Idaho, Oregon, Washington) provide a mechanism for geothermal development to proceed absent interference with prior water rights. Such mechanisms may require the geothermal developer to demonstrate non-interference or may create a rebuttable presumption in his favor.

Other approaches are possible as well. For example, geothermal developers may be required to obtain water rights only for the amount of "consumptive" fluid use--allowing a credit for reinjection. The legal principle of "developed water" may also be applied to geothermal development. That is, a geothermal developer would obtain water rights to his total fluid production, even in critical groundwater basins, if he tapped a new source of water unavailable but for the geothermal project. Hydrologic sophistication and tailored legal treatment are the key in this area.

It should be noted that classification of geothermal resources may affect access methods and financial liabilities, as well as ownership and allocation. Generally, mineral resources are leased and are subject to royalties and/or severance taxes. Geothermal electrical/industrial projects can usually support such financial liabilities and are developed by exploration companies familiar with mineral/oil and gas leasing practices.

On the other hand, water resources are generally available for the taking rather than leased. Surface access may be obtained through ownership or (in the West) through eminent domain. And water use usually does not incur royalty or severance tax liability. These features would be attractive to small-scale direct users. Thus, a division of geothermal resources and groundwater has effects which extend into virtually all areas of project operation.

A final note in this area relates to "byproduct water." Some states provide authority for an agency to compel the production of demineralized byproduct water from geothermal projects and subject it to appropriation for beneficial use. Such authority must be exercised with care, taking into account project economics and reservoir maintenance (reinjection) programs. Additionally, the original producer should have a preferential right to appropriate project effluent. Other appropriators should have their water right conditioned on non-interference with required reinjection and subject to project shut-downs and termination. The simplest course is probably to eschew a separate property regime for geothermal project effluent, allowing the producer to market such byproduct water by contract to subsequent users where feasible.

B. Access and Allocation

Some system of leasing, selling, franchising or licensing development rights to geothermal resources must be established. Such a system should not constitute a time-consuming burden on development and must allow developers to secure their investment. In addition, a method of allocating production among competing developers of a common supply is needed. Such a method should ensure adequate returns on investment while preventing waste of the resource.

Access

Two models are familiar options for resource distribution on public lands: patents (hard rock minerals) and leases (oil and gas, coal, common minerals). Patents commit surface and resource ownership to developers; leasing provides for surface occupation and production rights while retaining surface and resource ownership in public hands. The federal government, and most states (excepting geothermal "appropriation" states) have adopted leasing as the preferred method of providing access to geothermal resources.

A "two-tiered" leasing approach is commonly used. In areas of strong geologic indications or competitive interest, bidding on leases is competitive. In other, less promising or unexplored areas, leases may be obtained by application. Some states provide for exploration permits prior to lease applications. In order to provide security for discovery expenses, such permits may be exclusive and convertible to a lease.

The first task for a state legislature in this area is to establish or review its method of providing access, whether through permits, leases or both. For competitive leasing, various bid factors are possible, including cash bonuses, royalties or profit shares, rentals and work commitments. Cash bonus bidding tends to favor large, well-capitalized companies, while profit-share bidding allows for greater participation by smaller entrepreneurs. On the other hand, cash bonuses provide a return certain to state treasuries which may be refunded to localities to mitigate front-end impacts.

The second task involves establishing lease terms governing project operation. Such terms should balance public and private interests in the resource. Public interests include fair return of resource value, efficient production and protection of surface lands. Private interests include security of tenure, flexibility in development and profitability. Relevant terms address lease duration, renewal, rentals, bonding, stipulations (work commitments, environmental conditions, covenants for surface restoration), royalties or profit shares and renegotiation. (See Appendix D.)

Finally, the access regime should address the problems of fragmentation and monopolization of the resource. Many states have adopted acreage limitations. Minimum acreages are set for individual parcels, while maximum acreages are applied to both individual and total holdings. Maximum number of parcels or number of townships occupied are other options for limiting total holdings. Leases actually in commercial production may be exempted from the limitation on total holdings. Acreage limits should correspond to the needs of geothermal development. Minimum acreages that are too high may inhibit small-scale projects, while maximum acreages that are too low may impede exploration and prevent developers from securing their investments in a reservoir.

For small-scale users of hot groundwater, the leasing system should be less cumbersome than for major geothermal projects. For instance, a simple surface use/commercial lease with minimal rentals would be appropriate in many cases. The lessee would obtain a water right to the thermal resource, which should probably revert to the state upon termination of the lease.

Allocation

While the earth's internal thermal energy may be virtually inexhaustible, it takes time for that heat to build up locally into a useful concentration. In addition, the geothermal fluids containing and transmitting that enthalpy are limited and usually slow to recharge. Therefore, the geothermal resource often is a "wasting" resource, with limited useful life. Further, reservoir dynamics may produce drawdowns in some areas as production occurs in others. Thus, the geothermal resource is a "fugitive" resource.

Resources of this type--oil and gas for instance--are generally allocated by one of two methods: the rule of capture or correlative rights. The rule of capture implies that whatever is reduced to possession becomes the property of the producer. However, it is difficult to reduce enthalpy to possession; it can be neither stored nor transported for a long distance. In addition, the rule of capture may lead to a wasteful "race to capture" the resource, with overdrilling and possible reservoir damage. Efficient production of geothermal resources requires more coordinated development than occurs under a rule of capture.

The trend in geothermal resource allocation has been to a system of correlative rights. That is, each producer obtains a *pro rata* share (based on acreage, productivity, etc.), and the reservoir as a whole is managed for optimal utilization. Correlative shares in a geothermal reservoir may be assigned by a state agency or implemented through cooperative development--unitization. Unitization usually requires a specified percentage of operators to agree to the unit operation.

The application of the appropriation doctrine to geothermal reservoirs would preclude either of these two methods. Appropriative water rights create "quantified priorities" incompatible with correlative rights and its inherent flexibility and equitable apportionment. Appropriation probably is the relevant doctrine for users of hot groundwater, however, since they are likely to affect standard water users with established priorities.

The other prevailing doctrine for allocating groundwater--reasonable use--presents difficulties to thermal utilization of this resource. Transportation of groundwater off a particular surface parcel is precluded under reasonable use if damage results to other users of the common supply. There is no recourse to priority. This limitation could operate as a severe impediment to small-scale projects involving production on one parcel and use on another.

C. Regulatory Procedures

The states have a valid interest in ensuring that geothermal development takes place in a manner which protects public health and welfare, the environment and other resources, and is fiscally responsible. Drilling controls, reinjection, environmental pollution, and land use issues need to be examined. Protection of scarce water resources represents a special concern. It also is vital that the regulatory burden on geothermal development not be excessive.

Drilling Controls

The primary purpose of drilling controls is to ensure the use of proper techniques and equipment in constructing geothermal wells. This will protect freshwater aquifers from infiltration of geothermal brines and protect geothermal reservoirs from damage due to well blow-outs. Such controls generally cover drill pad siting, casing, cementing, logging, blow-out prevention, disposal of drilling muds and well cuttings, well venting and abandonment. Often bonds are required on an individual well or blanket basis to ensure compliance with the regulations.

Drilling controls may also encompass well-spacing and pooling orders or production limits. Well-spacing orders commonly prevent drilling adjacent to parcel boundaries, roads and buildings, and may impose a well-location grid on entire geothermal systems, thereby limiting the number of holes drilled into the reservoir. Geothermal lessees on small, scattered parcels may be precluded from drilling by a well-spacing grid. Ifso, their lease will be "pooled" with adjacent producing leases. Production limits are usually applied as a modification of the rule of capture.

Reinjection often receives special attention with regard to protection of intervening freshwater aquifers and premature cooling of geothermal reservoirs. Reinjection is generally the preferred method of geothermal effluent disposal and may assist in maintenance of reservoir pressures and fluid recharge. Recent federal regulations promulgated under the Safe Drinking Water Act (40 CFR 141) apparently require up to three monitoring wells around each reinjection well.

Environmental Controls

Air, water and noise pollution, as well as subsidence/seismicity are the environmental concerns associated with geothermal development. Air pollution primarily involves hydrogen sulfide (H_2S) and would be regulated via the State Implementation Plans required by the federal Clean Air Act. Specific standards for ambient levels of H_2S are under development in California and New Mexico. Promising technological advances have been made in controlling H_2S emissions from geothermal facilities.

Water pollution (other than drilling-related--see above) problems include siltation of surface waters due to geothermal project construction activities, surface disposal of geothermal effluent and percolation of geothermal fluids from evaporation ponds into freshwater aquifers (leachate). Siltation problems are probably covered by the Army Corps of Engineers "dredge and fill" program (Section 404 of the Federal Water Pollution Control Act). Surface disposal of geothermal effluent would require an NPDES permit (§ 402 FWPCA), usually administered by a state agency. Problems relating to geothermal leachate are more difficult to assess and control, but would probably fall under state area-wide water pollution control plans (§ 201 FWPCA).

Noise associated with geothermal projects arises from construction and drilling activities, and especially from well venting to clear obstructions from the drill-hole. Most states do not have applicable noise control statutes. Recent advances in well muffling technology have reduced the scope of this problem.

Subsidence due to geothermal fluid production may be a significant potential problem in some areas. For example, the irrigation system in the Imperial Valley of California is very sensitive to subsidence. Mandatory reinjection appears to be the answer in such areas. A related issue is whether reinjection of geothermal effluents may induce seismic events. A deep waste injection well in Colorado did in fact cause increased seismicity. Indications are that reinjection-induced seismic events are minor in intensity and may in fact provide a "relief valve" for crustal tensions.

Land Use Controls

Compatibility of geothermal development with multiple land uses is, of course, a significant environmental concern. Both federal and state programs are implicated. Protection of hot springs and geysers (e.g., Yellowstone) is of particular importance. Preservation of archaeological and historic sites is another goal.

Geothermal facility siting, especially of powerplants, will usually be subject to Public Service Commission jurisdiction. Generally, compatibility with local land use plans is also required. It should be remembered, however, that geothermal utilization must occur near the production site. Geothermal energy cannot be transported by barrel or pipeline for significant distances. Thus, normal site selection criteria, particularly alternative site requirements, may need to be waived for or tailored to geothermal development.

Impact Assessment

Federal (NEPA) and state (SEPA) environmental impact assessments may be triggered by the decision to issue a geothermal lease or exploration permit. These assessments can act as major stumbling blocks to rapid geothermal development. Coordination of federal-state reviews should be sought. In addition, full-blown environmental assessments of total development impacts should await a commercial discovery, with only an analysis of exploration impacts required prior to that time.

Regulatory Streamlining

As discussed above, coordination of state-federal environmental programs should be pursued. And a distinction should be made between exploration and development phases of a project. In addition, states may adopt numerous streamlining measures to simplify their licensing procedures. The goal of all these actions is to minimize overlapping agency jurisdictions, eliminate redundant reviews and shorten the lead times for obtaining environmental permits. Pre-application meetings between developers, regulators and public interest groups can often head off future problems. Imposing deadlines on agency decisions, such as California's eighteen-month NOI/AFC (Notice of Intent/Application for Certification) process is another option.

Three different approaches to reorganization of agencies have been suggested as methods of promoting the above goals. These approaches can be described as follows: a clearinghouse agency, a lead agency, and a single-stop agency.

Under a clearinghouse approach, one agency is granted authority to coordinate the entire application process between the applicant and all participating agencies. The clearinghouse agency does not have authority to overrule any permitting agency. Its role is to provide a single office with which the applicant can interact. From this office all applications are sent to permitting agencies and decisions are received from those agencies and forwarded to the developer. The clearinghouse agency may also be given authority to enforce a licensing timetable.

A lead agency has all of the elements of a clearinghouse situation. Additionally, a lead agency is granted appellate authority over other agencies in the decisionmaking process. Thus, if a developer and a subordinate agency cannot agree regarding a necessary license or permit, the lead agency will act as the arbiter.

Under a one-stop agency, all decisions are handled by a single agency. Within this agency, expertise for all matters are located. Rather than shepherding an applicant through a series of different agencies, all decisions are made within the single agency. A state may wish to give consideration to a reorganization along one of the preceding models.

D. Finance and Marketing

Geothermal development is a high-risk, capital-intensive industry with front-end financial burdens and significant delays until commercial returns are realized. As such, it is vital that the financial climate regarding the industry be, at a minimum, equitable. In fact, incentives and subsidies may be desirable. Financial options relate to both geothermal producers and consumers.

Geothermal marketing is also subject to state initiative, particularly with regard to utility regulation. State legislatures should review the impact of Public Utility Commission regulation of geothermal power generation and, especially, of geothermal direct applications. Other state actions, such as publicly-funded demonstration projects may also contribute to an expansion of the geothermal market.

Tax Incentives

Geothermal tax incentives may be considered for both producers and consumers. Federal incentives in this area have been outlined earlier. State incentives are described in Appendix E. Generally, for producers, incentives relate to the state income tax and the local property (ad valorem) tax. States may parallel the federal tax benefits--additional investment credit, accelerated depreciation, deductions for intangible expenses, depletion allowance--in their income tax codes.

The ad valorem property tax is a particularly significant burden since it will be applied to front-end investment in geothermal equipment and facilities long before commercial returns are realized. Options to reduce this burden include exempting non-producing leases from property taxation or deferring payment until such time as commercial returns are received. Alternatively, a wellhead (percentage of gross receipts) tax in lieu of ad valorem taxation may be levied.

All of these benefits, however, would delay tax payments to localities impacted by geothermal development. This problem may be alleviated in at least two ways. One approach would be to earmark a portion of state and federal geothermal lease revenues for return to impacted counties. Another would be to require geothermal developers to reach a contractual agreement with impacted localities to pay for services rendered before qualifying for the suggested tax benefits.

For consumers, income tax credits/deductions are a common incentive regarding expenditures for geothermal equipment. An additional incentive would be to exempt the added value due to a geothermal installation from property tax liability. Sales tax exemptions are another possibility.

Other state taxes--severance tax, corporate franchise fee, sales tax, public utility tax--should also be reviewed for their impact on geothermal development.

Loan Programs

The federal Geothermal Loan Guaranty Program has been described earlier. States also may institute loan programs for renewable energy. For instance, Oregon provides low-interest loans to veterans who purchase renewable energy equipment for their homes. Such loan programs may be funded by one-time or annual appropriations, or may be set up as a revolving fund which receives repayment of principal and interest from outstanding loans. The states may decide to authorize loans for residential, commercial and industrial applicants, as well as using the fund to assist public financing.

Public Finance

Various political subdivisions may wish to develop or use geothermal resources, either for power generation, heating districts or industrial parks. Examples of such entities include municipalities, special districts, cooperatives and industrial development authorities. Various legal parameters need to be reviewed in this regard: method of utility/heating district formation, service areas, purposes and powers, especially financial (see Appendix F).

The public finance options for such activity are basically general obligation and revenue bonding. General obligation bonds are supported by the faith and credit (taxing power) of the issuer and usually require a referendum. They also generally obtain lower debt service than revenue bonds and are subject to constitutional/statutory debt limitations (except in the case of special districts).

Revenue bonds are supported by project revenues (service charges, special assessments) rather than full faith and credit. As such they usually do not require a referendum and are not subject to debt limits. Debt service is usually higher on such bonds, however. The most important factor in floating a revenue bond issue is the power marketing contract obtained on the project.

A major problem with both these options is that they are inappropriate vehicles for funding feasibility studies, exploration and reservoir confirmation drilling due to the inherent risk at those project stages. Innovative approaches such as a state development fund or joint ventures with private companies are needed in this regard. Additionally, states may wish to consider guaranteeing local bond issues (especially revenue bonds) in hopes of obtaining lower debt service.

Other public finance options are available as well, including direct appropriations for project purposes, revolving loan funds, subordinated loans and leveraged leases. State securities commissions may be directed to rate geothermal revenue bonds as legal investments for institutional investors. Public finance is a complex area requiring the use of qualified bond counsel and tax consultants.

Utility Markets

Investor-owned utilities are traditionally conservative entities which may be reluctant to enter the geothermal field. Publicly-owned utilities may be unable or unwilling to assume the risks inherent in this emerging technology. For these reasons, the usual development scenario includes a geothermal exploration/production company which markets its output to a utility for conversion to electricity. These companies will not engage in such activities if subjected to Public Utility Commission (PUC) jurisdiction over rates, accounts and organization.

In addition, some geothermal developers may wish to actually generate electrical power for retail sale to selected customers (as in an industrial park) or for wholesale to an existing utility. Again, PUC jurisdiction will operate as a disincentive to such activity. PURPA (discussed earlier) provides for exemptions from PUC jurisdiction in certain situations like these; however, implementation is up to the states. PURPA also provides for mandatory purchase by existing utilities of the output from "qualifying small power producers"--again, implementation is a state matter.

PURPA does not apply to "wheeling" of the output of a qualifying small power producer across existing utility grids for retail sale. This is an area for state initiative; the availability of such wheeling may determine the feasibility of some projects (i.e., a geothermal producer wishes to wheel his output across utility lines to customers in an industrial park). One approach is to designate transmission lines as "common carriers" available for a reasonable fee. Reliability of the grid and the impact on a utility holding an exclusive franchise for a particular service area must be considered.

Existing utilities can be encouraged to participate in geothermal development in a number of ways. They may, for instance, be required to consider renewable fuel sources for new capacity before turning to fossil or nuclear supplies. Inclusion of construction work in progress costs in the rate base will act as an incentive. Utilities might also be allowed a higher rate of return on equity invested in renewable facilities. Finally, utilities may be authorized to recover investment in geothermal projects which terminate due to reservoir or facility failure. This last option is likely to be controversial.

The direct use utility market can also be strengthened by examining PUC jurisdiction and regulation. PURPA type exemptions might be extended to geothermal heating districts. In addition, such heating districts should be granted easements along or across public by-ways and existing transmission corridors to place their distribution network. Eminent domain power may be necessary to complete the network.

Market Expansion

The states may foster the expansion of geothermal markets in a number of ways. Public education and technical assistance programs, administered by a geothermal ombudsman or the state energy office, can influence consumer acceptance of geothermal energy. Political subdivisions also could benefit from planning and impact assistance. In particular, geothermal elements should be prepared for local zoning elements, bearing in mind that geothermal resources must be developed where found or not at all.

Building codes should also be examined for compatibility with geothermal equipment. Life-cycle costing of new or renovated public buildings should be performed, including a feasibility analysis of geothermal energy systems. State-funded demonstration projects can encourage geothermal acceptance. More radically, all new construction may be required to use geothermal energy where feasible (analogous to the San Diego County requirement of solar hot water heaters). Overall, the state can play a significant role in establishing adequate markets for geothermal energy.

E. Conclusion

Geothermal reserves are a major new energy resource, representing a secure domestic supply with relatively minor environmental dangers. Innovative state legislation can provide a substantial impetus to geothermal development. While comprehensive policymaking would focus on all the outlined areas, a step-by-step approach would still be valuable. In any case new policies should be monitored and revised as necessary to insure effectiveness in operation.

APPENDIX A

Glossary

Binary (heat exchange) system - electrical-generating system in which geothermal energy heats a working fluid (with a low boiling point) to power turbines.

Byproducts - dissolved or entrained minerals and gases in geothermal fluids and extracted during production (statutory definitions generally exclude hydrocarbons).

Cascading - the successive use of progressively cooler geothermal fluids for various direct applications.

Correlative rights - a legal principle which allocates a common supply among competing producers on the basis of equitable apportionment.

Developed water - a new source of water made available only due to a particular project development.

Direct use - the use of geothermal heat without conversion into electrical energy.

Enthalpy - heat content of a body or a system available as thermal energy.

Flash system - electrical-generating system in which high temperature geothermal fluids under pressure rapidly vaporize at atmospheric pressure to power turbines.

Geothermal - literally "earth heat."

Groundwater-referenced heat pump - a device which uses groundwater as a heat source in the winter and as a heat sink in the summer.

Hot dry rock - geothermally-heated rock which lacks a natural fluid for heat transfer.

Hydrothermal reservoir - subsurface systems containing geothermally heated fluids. If dry steam is produced (e.g., The Geysers, California), the reservoir is characterized as vapor-dominated; if steam and hot water are produced, it is characterized as liquid-dominated.

Industrial process water - water used for its chemical or heat value in industrial processes (e.g., hot water for food processing).

KGRA (Known Geothermal Resource Area) - lands classified by the USGS on the basis of geological and geophysical data, resource discoveries or overlapping lease applications.

Material medium - substance used to transfer geothermal energy to the surface; it can either be naturally-occurring (e.g., brine, steam) or artifically injected (water, freon, etc.).

Mineral reservation - the severance of real property rights into separate surface and mineral (sub-surface) estates. The federal government claims ownership of geothermal resources where it has reserved the mineral rights, and was upheld in the decision of Union Oil v. U.S., 369 FS 1289 (1973) rev'd. 549 F. 2d 1271 (1977) cert. den. 434 U.S. 930 (1978), reh. den. 435 U.S. 911 (1978).

Retrofitting - adapting existing facilities to utilize geothermal or other new energy sources.

Space conditioning - heating or cooling residential or commercial buildings for human comfort, including the production of domestic hot water.

Sui generis - constituting a class alone; with unique properties.

Thermal Gradient - rate of increase (or decrease) in temperature with distance below the surface; one indication of geothermal potential.

Unitization - cooperative development of a geothermal reservoir as agreed to by the producers or required by the state.

$^{o}C = 5/9\ (^{o}F - 32)$
$^{o}F = 9/5\ ^{o}C + 32$

APPENDIX B
SELECTED READINGS

Leading Articles

Elmer and Rogers, "Legal Issues in the Development of Geopressured--Geothermal Resources of Texas and Louisiana Gulf Coast;" PROCEEDINGS--SECOND GEOPRESSURED GEOTHERMAL ENERGY CONFERENCE, Vol. 5, 1 (1976).

Olpin and Tarlock, "Water That Is Not Water;" 13 LAND AND WATER L.R. (2) 391 (1978).

Olpin, Tarlock and Austin, "Geothermal Development and Western Water Law," UTAH LAW REVIEW (4) 773 (1979).

Sato and Crocker, "Property Rights to Geothermal Resources (1,11);" 6 ECOLOGY L.Q. 250, 481 (1977).

U.S. Geological Survey, L.J.P. Muffler, Editor, CIRCULAR 790, (1978).

Vranesh and Musick, "Water and Other Conflicts Encountered by the Developer;" 13 LAND AND WATER L.R. (1) 109 (1977).

Additional References

Aidlin, "United States Law as it Affects Geothermal Development;" PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON GEOTHERMAL RESOURCES, Vol. 3, p. 2353 (1975).

Allen, "Legal and Policy Aspects of Geothermal Resource Development;" 8 WATER RESOURCES BULLETIN 250 (1973).

Beeland, et al., Geothermal Development on Federal Lands--Impediments and Potential Solutions," WAPORA, INC (January 1978).

Bible, "The Geothermal Steam Act of 1970;" 8 IDAHO L.R. 86 (1972).

Bloomster, et al., "Geothermal Energy Potential for District and Process Heating Applications in the U.S.--An Economic Analysis," BATELLE PACIFIC N.W. LAB (August 1977).

Bloomster, et al., "The Economics of Geothermal Electricity Generation from Hydrothermal Resources," BATTELLE.

Bjorge, "Development of Geothermal Resources and the 1970 Geothermal Steam Act--Law in Search of a Definition;" 46 U. COLO. L.R. 1 (1974).

Davis, "Geothermal Resources for the Small Developer;" 3 J. CONTEMPORARY LAW 241 (1977).

Elmer, FIRST ANNUAL REPORT OF THE GEOTHERMAL COMMITTEE OF THE ABA'S NATURAL RESOURCES SECTION.

Franzen, "Property Systems in Geothermal Resources: A Critique and Recommendations;" PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON GEOTHERMAL RESOURCES, Vol. 3, p. 2373 (1975).

Geothermal Resources Development Institute, THE ROCKY MOUNTAIN MINERAL LAW FOUNDATION (January 1977).

Geothermal Resource Development Institute, 13 LAND AND WATER LAW REVIEW (1) UNIVERSITY OF WYOMING (1977).

Kitchen, "Geothermal: The Resource, the Law and the Landman;" 22 ROCKY MOUNTAIN MINERAL LAW INSTITUTE 821 (1976).

Nakamura, Nakahara and Iga, "Geothermal Rights and Problems of Legislation in Japan;" PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON GEOTHERMAL RESOURCES, Vol. 3, p. 2421 (1975).

Schlauch and Worcester, "Geothermal Resources: A Primer for the Practitioner;" 9 LAND AND WATER L.R. 327 (1974).

Torfason, "The Law of Iceland as it Affects Geothermal Development;" PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON GEOTHERMAL RESOURCES, Vol. 3, p. 2435 (1975).

Wagner, "State Taxation of Geothermal Resources Compared with State Taxation of Other Energy Minerals (November 1977).

Weinstein, Gordon and Maslan, "Legal Aspects of Geothermal Energy Development;" PROCEEDINGS--SECOND UNITED NATIONS SYMPOSIUM ON GEOTHERMAL RESOURCES, Vol. 3, p. 2447 (1975.

State Laws and Regulations Regarding Geothermal Resources

ALASKA

Statutes: Geothermal Resources Act (1971) AK. Stat. 38.05.181

Leasing: Div. of Lands - Regulations & Statutes Pertaining to Coal and Other Leasable Minerals (1974) 11 A.A.C. 84.700...

Drilling: Div. of Oil & Gas - 11 A.A.C. 94.730... (1974)

ARIZONA

Statutes: Geothermal Resources (1972); amend. HB 2257 (1979) A.R.S. 27-651...

Leasing: Land Dept. - Geothermal Resources (1972) T.12C.5.A.22 (under revision)

Drilling: Oil & Gas Conservation Comm. - General Rules & Regulations Governing the Conservation of Geothermal Resources (1972) T.27C.4.A.4

CALIFORNIA

Statutes: leasing - Geothermal Resources Act (1967) Pub. Res. Code 6902...
production - Laws for the Conservation of Geothermal Resources (1967, as amend.) Pub. Res. Code 3700...
siting - Energy Resources Development; Conservation Act (1974) Pub. Res. Code 25000...

Leasing: State Lands Comm. - Leases & Prospecting Permits for Geothermal Resources (1970) C.A.C. 2250...

Drilling: Div. of Oil & Gas - Statewide Geothermal Regulations (1976) C.A.C. 1900...

Siting: Energy Comm. - Provisions Applicable to Geothermal Notices & Applications (1978)

COLORADO

Statutes: Geothermal Resources Act (1974) C.R.S. 34-70-101...

Leasing: Board of Land Commissioner - Special Rules & Regulations Relating to Geothermal Resources Leases (1972) SLB #248-1

Drilling: Oil & Gas Conservation Comm. - Rules & Regulations for the Development & Production of Geothermal Resources (1976) G101...

HAWAII

Statutes: Government Mineral Rights (1974); amend. HB 3033 (1978) H.R.S. 182-1...

Leasing: Dept. of Land & Natural Resources - Regulations on Leasing & Drilling Geothermal Resources (1978) Reg. No. 8

Drilling: Reg. No. 8

IDAHO

Statutes: leasing - Geothermal Resources Leasing Act (1975) ID Code 47-1601...
production - Geothermal Resources Act (1974, as amend.) ID Code 42-4001...

Leasing: Board of Land Commissioner - Rules & Regulations Governing the Issuance of Geothermal Resources leases (1974) (under revision)

Drilling: Water Resource Board - Drilling for Geothermal Resources (1978)

LOUISIANA

Statutes: Geothermal Energy Resources (1976) L.R.S. 30:800...; Geothermal & Geopressure Energy Research & Development Act (1975) L.R.S. 30:681

Leasing: Mineral Board - none (oil & gas model likely)

Drilling: Office of Conservation - statewide order 29-P (1978)

MARYLAND

Statutes: Geothermal Resources Act (1978) A.C.M. 8-8A-01

MONTANA
Statutes: leasing - Lease of Geothermal Resources (1974) R.C.M. 81-2601...
siting - Major Facilities Siting Act (1975, as amend) R.C.M. 70-801...
filing bottom-hole temperatures - Act to Facilitate the Discovery of Geothermal Energy Sources (1975) R.C.M. 60-127, 144,148
Leasing: Dept. of State Lands - Geothermal Rules & Regulations (1975) M.A.C. 26-2.6(2
Drilling: Geological Survey -Conservation Division - Geothermal Investigation Reports (1975) M.A.C 36-2.8(14)

NEVADA
Statutes: leasing - An Act Relating to State Lands (1975) N.R.S. 322.030...
production - An Act Relating to Geothermal Resources (1975) N.R.S. 534A.010
Leasing: Div. of Lands - pending
Drilling: Div. of Water Resources - Regulations Pertaining to Exploration Drilling (1978)

NEW MEXICO
Statutes: Geothermal Resources Act (1967) N.M.S.A. 7-15-1...
Geothermal Resources Conservation Act (1975) (Chap. 272)
Leasing: State Land Office - Rules & Regulations Relating to Geothermal Resources Leases (1971)
Drilling: Oil Conservation Div. - Rules & Regulations for Geothermal Resources (1974)

OREGON
Statutes: Geothermal Resources (1975) O.R.S. 522.005...
Geothermal Heating Districts (1975) O.R.S. 523.010...
Leasing: Div. of State Lands - Geothermal Lease Regulations (1975) 75-010...
Drilling: Dept. of Geology & Mineral Industries - Rules, Regulations & Laws Relating to Exploration & Development of Geothermal Resources (1977) 632-20-005...

TEXAS
Statutes: Geothermal REsources Act (1975) V.A.C.S. Art. 5421s
Leasing: Railroad Comm./Div. of Oil & Gas - none (oil & gas model likely)
Drilling: Railroad Comm./Div. of Oil & Gas - Rules Having General Application to Oil, Gas, & Geothermal Resource Operations (1976) 051.02.02.000
School Land Board - Rules & Regulations Governing Drilling & Producing on Permanent Free School Lands (1974) (general)

UTAH
Statutes: Water & Irrigation Laws (1973) U.C.A. 73-1-120
Leasing: Div. of Lands - Rules & Regulations Governing Issuance of Mineral Leases (1973); Geothermal Steam Lease Agreement (1973)
Drilling: Div. of Water Rights - Rules & Regulations for Wells Used for the Discovery & Production of Geothermal Energy (1978)

WASHINGTON
Statutes: Geothermal Resources Act (1974) T.79 R.C.W.
Leasing: Dept. of Natural Resources - Geothermal Leasing Policy (1978) DRAFT
Drilling: Dept. of Natural Resources - none

WYOMING
Statutes: Underground Water (1973) WY Stat. 41-121
Leasing: Board of Land Commissioner - Rules & Regulations Governing the Issuance of Geothermal Resource Permits & Leases (1975)
Drilling: State Engineer's Office--Rules & Regulations

	Newly Offered	Subsequent Leasing	Bidding Factor	Designation Criteria
Alaska	---	---	(A)	(A)
Arizona	Competitive	Competitive	Cash Bonus	All lands awarded competitively
California	---	---	Cash Bonus or other	Producing Well
Colorado	(A)	(A)	(A)	(A)
Hawaii	Competitive (B)	Competitive (B)	(A)	All lands awarded competitively (B)
Idaho	Public Drawing (30-day filing)	By Application	(A)	Producing Well
Louisiana	(C)	(C)	(C)	(C)
Montana	Competitive	Competitive	Cash Bonus	All lands awarded competitively
Nevada	(C)	(C)	(C)	(C)
New Mexico	Competitive (3- day filing)	By Application	Cash Bonus	Determined by Commissioner of Lands
Oregon	Public Drawing (30-day filing)	By Application	Cash Bonus (D)	Geology and/or producing well
Texas	(C)	(C)	(C)	(C)
Utah	Cash Bonus (E) (15-day filing)	By Application	(E)	(E)
Washington	Competitive	Competitive	Cash Bonus (F)	All lands awarded competitively
Wyoming	---	---	(A)	(A)

(A) Specified by state land commissioners

(B) Mineral reserve lands may be leased non-competitively to occupier (or assignee) with two-thirds vote by Board of Land and Natural Resources.

(C) Regulations not finalized

(D) If no bids received, Division of State Lands may reclassify for non-competitive leasing

(E) Lands are offered non-competitively by order of application, except when they are newly offered. Newly offered lands are leased by cash bonus bidding.

(F) Unlike Montana, if a tract receives no bid, it is withdrawn.

APPENDIX D--STATE GEOTHERMAL LEASE TERMS

State	Primary Term	Renewal	Renegotiation of Rentals and Royalties
Alaska	10 years	one 5-year term if drilling; for duration of commercial production, up to 40 years	20-year intervals beginning 35 years after commercial production; and at end of first 40-year lease period
Arizona	10 years	2 years if drilling; for duration of commercial production	....
California	20 years	so long as geothermal resources are produced or capable of being produced in commercial quantities, up to 99 years	10-year intervals, beginning 20 years after lease date
Colorado	10 years	for duration of commercial production; lacking production, at discretion of state land board	minimum royalty: 5-year intervals
Hawaii	10 years	so long as geothermal resources or byproducts are produced in commercial quantities, up to 65 years; 5 years with diligent drilling without production, or with shut-in wells without market	15 year intervals, beginning 35 years after the lease date
Idaho	10 years	for duration of commercial production or drilling operations to at least 1000 feet, up to 40 years beyond primary term	....
Louisiana	at most 10 years	for duration of commercial production or development operations	....
Montana	10 years	for duration of commercial production or drilling	10-year intervals, beginning 20 years after lease date
Nevada	....	....	....
New Mexico	5 years*	so long as geothermal resources are produced or capable of being produced in commercial quantities; *secondary 5-year term at increased rental even without production. If production is lost subsequently, the commission may extend lease in one-year increments up to three years.	10-year intervals, beginning 20 years after lease date
Oregon	10 years	10 years, if royalties in any year of preceding term equalled or exceeded annual rental due under lease; 5 years, if no production but discovery has been made or is deemed imminent; maximum of 50 years from lease date	....
Texas	(no lease terms established)		
Utah	10 years	for duration of commercial production; or 1-year terms, in absence of production, upon payment of $5/acre advance royalty	3-year intervals
Washington	5 years	so long as drilling with diligence; or upon commercial discovery, up to 20 years	....
Wyoming	10 years	so long as geothermal resources produced or capable of being produced in commercial quantities	10-year intervals

State Geothermal Lease Provision

Annual Rental	Royalties	Acreage Limits
variable; $1/acre minimum	primary: 10-15% byproduct: 2-10% minimum: $2/acre/year	minimum lease: 640 acres maximum lease: 2,560 acres (5,750 for submerged lands) maximum state holdings: 25,600 acres
not less than $1/acre	primary: at least 12.5% byproduct: at least 12.5% shut-in: 4 times annual rental per year	maximum lease: 2,560 acres (4 sections) confined to 6 miles square
$1/acre	primary: 10% byproduct: between 2% and 10% minimum: $2/acre/year	minimum lease: 640 acres maximum lease: 2,560 acres maximum state holdings: 25,600 acres (includes acreage under exploration permit)
$1/acre	primary: 10% byproduct: 5%	....
state: as bid or set in lease surface occupant: as agreed or set by Board of Land and Natural Resources	primary: 10-20% byproduct: 5-10%	minimum lease: 100 acres maximum lease: 5,000 acres, or 2,560 if length of tract is more than six times the width maximum state holding: 80,000 undeveloped acres
first 5 years: $1/acre second 5 years: $2/acre thereafter: $3/acre	primary: 10% byproduct: 5%	minimum lease: all state lands within a section must be leased maximum lease: 640 acres maximum state holdings: interest in 50 township-and-ranges
at least $1/acre or ½ cash bonus, whichever is greater	primary: at least 10% byproduct: at least 5%	maximum lease: 5000 acres
at least $1/acre	primary: at least 10% byproduct: between 2% and 5% shut-in: set in lease minimum: $2/acre/year	maximum lease: 640 acres
$1/acre	primary: 12.5% byproduct: 5.0%	....
$1/acre $5/acre for leases extended for second 5-year term without production	primary: 10%-15% (KGRA) byproduct: between 2% and 10% recreation or therapeutic: between 2% and 10% powerplant: 8% (net revenue) minimum: $2/acre/year	minimum lease: 640 acres maximum lease: 2,560 acres maximum state holdings: 51,200 acres
years 1-3: $1/acre year 4: $3/acre years 5-10: $5/acre years renewed: $5/acre	primary: 10% byproduct: 1%, demineralized water; 5%, other (rentals paid each year deducted from royalties due)	minimum lease: 40 acres
(no lease terms established)		
$1/acre	primary: 10% byproduct: 10% (net proceeds)	minimum lease: 40 acres maximum lease: 640 to 2,560 acres, at discretion of director of state lands
at least $1/acre; at least $5/acre upon commercial production	primary: 10% byproduct: at least 4% (net proceeds) minimum: $5/acre/year	minimum lease: 40 acres maximum lease: 640 acres
$2/acre	primary: 10% byproduct: 5%	minimum lease: 640 acres maximum lease: 2,560 acres

ENACTED INCENTIVES FOR GEOTHERMAL DEVELOPMENT

INCOME TAX

Colorado	H.B. 1019 (1978)	Commercial or residential investments for solar, wind and geothermal energy systems deductible for state income tax.
	S.B. 321 (1979)	Include geothermal system in alternative energy devices for income tax deduction.
Idaho	H.B. 468 (1976)	Income tax deduction for investments in residential geothermal energy facilities.
Montana	H.B. 292 (1977)	Tax deduction for residential nonfossil energy generating systems (may apply to geothermal).
	S.B. 167 (1977)	Tax credit for nonfossil energy systems (may apply to geothermal).
Oregon	S.B. 399 (1977)	Income tax credit up to $1,000 for residential geothermal space heating.

PROPERTY TAX

Colorado	S.B. 316 (1979)	Exclude alternative energy devices from valuation of property for property tax assessment.
Hawaii	S.B. 2467 (1976)	Property tax exemption for building improvements to use geothermal energy.
Nevada	A.B. 144 (1979)	Exempt nonproducing geothermal leases from property tax.
	A.B. 277 (1977)	Property tax credit up to $2,000 for residential geothermal facilities for heating and cooling.
South Dakota	H.B. 1354 (1978)	Residential and commercial property tax credit for geothermal and other renewable energy systems.

SALES TAX

Hawaii	H.B. 3033	(1978)	Determines the applicability of excise taxes on geothermal gross proceeds. Provides for royalties in lieu of a severance tax. Clarifies utility access.

LOANS

Alaska	H.B. 266 Ch. 29	(1978)	Establishes an alternative power resources revolving loan fund within the state Department of Commerce and Economic Development.
Oregon	S.B. 477	(1977)	Loan program for veterans--up to $3,000 for residential geothermal energy facilities.
Virginia	H.B. 100 Ch. 631	(1978)	Directs the Virginia Housing Development Authority to establish a loan program for financing the purchase and installation of insulation, storm windows and doors, and solar and other alternative energy sources that will reduce reliance on present sources of energy in residential, public and nonprofit buildings.

LEASING POLICY

California	S.B. 1027	(1978)	Modifies leasing procedures giving State Lands Commission discretion in issuing exploration and development leases; revises rentals, royalties and renegotiation procedures; gives the commission discretion in issuing and setting the terms of direct use leases.
New Mexico	H.B. 446	(1979)	Extend the acreage limitation on state geothermal leases from 25,000 to 51,200 acres and provide for a second 5-year lease term without production upon payment of increased rental.

DEVELOPMENT REGULATIONS

California	A.B. 2644 (1978)	Streamlines geothermal exploration and field development regulation and facility siting; authorizes the state energy commission to prohibit curtailment of geothermal power production or transmission.
Oregon	H.B. 2159 (1977)	Authorizes waiver of state bonding requirements for well drilling if operation has bond with federal government.
	H.B. 2134 (1979)	Establish procedures for reinjecting geothermal fluids and permit DOGAMI to adopt regulations on reinjection and require DEO water pollution control facilities permit for reinjecting contaminated fluid.

UTILITY REGULATIONS

California	S.B. 77 (1976)	Empowers PUC to order public utilities to transmit electricity generated by private producers from non-conventional sources.
	A.B. 2644 (1978)	Streamlines geothermal exploration and field development regulation and facility siting; authorizes the state energy commission to prohibit curtailment of geothermal power production or transmission.
	A.B. 4032 (1976)	Higher rate of return allowed for utility investments in renewable energy facilities.
Hawaii	S.B. 995 (1977)	Exempts nonfossil power generation and transmission facilities from PUC regulation when energy used by producer or sold directly to public utility. Authorizes PUC to require public utilities to purchase surplus power from such facilities.

Utility Regulations cont.

Hawaii	H.B. 2165	(1978)	Makes rates paid by public utilities to geothermal developers for geothermal steam, or electricity from geothermal steam, subject to PUC regulation.
	H.B. 3033	(1978)	Determines the applicability of excise taxes on geothermal gross proceeds. Provides for royalties in lieu of a severance tax. Clarifies utility access.
Kansas	H.B. 2842	(1978)	Allows utilities to receive a 1/2% to 2% higher rate of return on investments in systems which derive energy from solar, geothermal and other renewable energy sources.

DEVELOPMENT AUTHORIZATIONS

Hawaii	S.B. 1773 Act 36	(1978)	Authorizes counties individually or together with utilities and end users to develop geothermal and other alternative energy resources.
Oregon	S.B. 572	(1977)	Energy Conservation and Production Fund financed by state bond issues established to assist utility companies and individuals in development of non-nuclear energy resources. Emphasis on geothermal and other resources not currently in widespread use. Oregon Department of Energy authorized to develop alternate energy projects, fix rates and sell energy.
	SJR 32	(1977)	Authorizes issuance of bonds for Energy Conservation and Production Fund (rejected by voters).
	H.B. 3185	(1975)	Authorizes geothermal heating districts with contracting and bonding authority and power of eminent domain.

Development Authorizations cont.

Oregon	S.B. 502	(1979)	Permit joint participation in geothermal activities of cities and people's utility districts in Oregon with cities, utility districts, electric cooperatives and privately owned electric utility companies in Nevada and California.

LIFE-CYCLE COSTING/BUILDING CODES

Maryland	H.B. 413	(1978)	Requires consideration of life-cycle costing and energy consumption analysis during the preliminary design of new buildings financed by the state or with state assistance.
Mississippi	S.B. 2379	(1978)	Establishes life-cycle costing in the design of state buildings.
Nevada	S.B. 326	(1977)	State energy conservation standards for buildings must allow design and construction latitude to the extent that solar, geothermal, or other nondepletable energy sources are used.
New Jersey	A.B. 562	(1978)	Requires life-cycle cost analysis in the design phase of any construction or renovation of major facilities. The analysis must compare alternative energy systems.
New Mexico	H.B. 395	(1975)	Life-cycle cost analysis of nonfossil energy systems required for new state buildings or major renovations.
Ohio	H.B. 419	(1978)	Requires life-cycle cost analysis in state-owned, assisted or leased facilities.
Texas	HSR 24	(1977)	Requests all state agencies and universities to encourage feasibility studies and demonstration projects for alternate energy use in state buildings.

OMBUDSMAN/TECHNICAL ASSISTANCE

Oregon	S.B. 572	(1977)	Energy Conservation and Production Fund financed by state bond issues established to assist utility companies and individuals in development of non-nuclear energy resources. Emphasis on geothermal and other resources not currently in widespread use. Oregon Department of Energy authorized to develop alternate energy projects, fix rates and sell energy.

RESEARCH AND DEVELOPMENT/DEMONSTRATIONS

Arizona	H.B. 2078	(1979)	Expands activities of Arizona Solar Energy Research Commission to include other renewable energy sources, includin geothermal.
Hawaii	S.B. 1581 H.B. 3039	(1978)	Major funding provided for geothermal resource assessment; research and development of non-electric uses; and the rift zone laboratory.
	H.B. 1680	(1979)	Establish the Energy Laboratory of Hawaii and make appropriations.
Montana	S.B. 86	(1975)	Applies state coal tax fund to renewable energy projects.
New Mexico	S.B. 185	(1975)	Created permanent fund for energy research and development and appropriated funds.
	H.B. 199	(1978)	$2 million appropriation for energy research and development.
	H.B. 2	(1978)	$200,000 appropriation for establishing geothermal space heating demonstration projects. 100% matching funds required.

OWNERSHIP

Washington	S.B. 2191	(1979)	Place ownership of geothermal resources with the surface owner (private).

APPENDIX F

Geothermal Resources Council, TRANSACTIONS, Vol. 3 September 1979

DISTRICT HEATING: LEGAL & INSTITUTIONAL PARAMETERS

Kenneth A. Wonstolen

National Conference of State Legislatures - Denver, Colorado
Geothermal Policy Project

ABSTRACT

District heating is a proven vehicle for the direct application of geothermal energy. Successful systems currently exist in Iceland, France and the U.S., with numerous others in planning or construction stages. As geothermal resources come on-line, district heating is likely to be a widespread method of utilization. Such systems will provide centralized space-conditioning, as well as "cascaded" uses where feasible. Legal and institutional factors should be examined to ensure an adequate foundation for implementing geothermal district heating.

INTRODUCTION

District heating basically means the centralized distribution of heat to multiple end-users within a particular service area. Cascaded utilization would involve the successive use of progressively cooler fluid (e.g. industrial process heat, space-conditioning, greenhousing, aquaculture). The heat source may be geothermal, solar or fossil fuel. The use of cogenerated or waste heat would be especially appropriate. If alternate energy sources are used, supplemental fossil fuel capacity may be necessary to meet peak demands or emergencies. Various entities, both private and public, may constitute vehicles to develop and operate a heating district. Such a heating district will be presumed to be a utility.

INVESTOR-OWNED UTILITIES

The private sector may organize a heating district by incorporating an investor-owned utility. Some existing utilities may already have a steam distribution system in place. In other states, specific legislative authorization for utilities to provide district heating services may be required. Such authorization should allow the production and transmission of various heat mediums, including geothermal, for public and private use.

In order to incorporate a new investor-owned utility, or expand the scope of an existing one, certification from the Public Service Commission (PSC) will ordinarily be necessary. Such a "certificate of public convenience and necessity" may be difficult to obtain where the heating district would impinge on an existing heating utility (gas/electric) service area. State legislatures should consider exempting heating districts using alternate fuel sources or waste heat from the certification requirement. Alternatively, they may direct the PSC to grant certification where the public interest would be served, despite competition with an existing utility.

Investor-owned utilities are under the rate-making jurisdiction of Public Service Commissions, although this may not be clear where heating/cooling services are newly authorized. PSC control of utility rates normally is justified due to the monopoly status accorded a utility in a particular service area. State legislatures may consider, as an incentive to investment, exempting heating districts using alternate or waste heat sources from PSC rate-making jurisdiction.

Thus, legislatures should review at least three aspects of district heating via investor-owned utilities: the authorization to provide district heating services; the requirement of PSC cerification; and, the applicability of PSC rate-making jurisdiction.

PUBLICLY-OWNED UTILITIES

Counties, municipalities, special districts and other political subdivisions also are possible vehicles for implementing district heating. However, most political subdivisions possess no inherent powers. Thus, specific enabling legislation often will be necessary to authorize a political subdivision to organize a heating district. In some cases, municipal utility codes or authorizations to provide "water" may be liberally construed to cover district heating services. "Home rule" entities also may be able to implement district heating on their own initiative.

Where new enabling legislation is required, at least two approaches are possible. One is to enact a comprehensive, specific statute such as Oregon's Geothermal Heating Districts Act (ORS Chap. 523, 1977). Such an approach has the advantage of authorizing entities with a specific, single mandate. Alternatively, an existing political subdivision charter may be amended to include district heating, as Idaho has done with its municipal code (S. 1062, 1979). While the district heating mandate to such entities may be diluted by existing functions, this approach has the advantage of utilizing personnel and infrastructure in place. In addition, where existing bonding and other powers are already adequate, the legislative drafting job is simplified.

Special districts, a species of local government, offer several advantages as district heating vehicles. They may usually cross other political subdivision boundaries and may sometimes include non-contiguous areas, important factors in matching resource and service load centers. Special districts may be able to impose differential taxing coincident with service areas. Their bond issues normally are exempt from constitutional debt limitations applied to cities and counties. And, they are organized and operated to perform a narrow range of similar functions.

Whatever political subdivision is chosen as a district heating vehicle, certain basic parameters need to be established. These relate to the method of heating district formation, the nature of its boundaries, its purposes and its powers, especially financial.

Formation of a heating district will normally involve resolutions of the governing bodies of participating political subdivisions or, perhaps, a local citizen initiative. A referendum on the matter may be required, especially where the district would have property taxation (ad valorem/special assessment) power. State legislative and/or Public Service Commission approval also may be necessary, although this is less common.

A heating district should have flexibility with regard to its boundaries. The crossing of municipal and county lines, and the inclusion of non-contiguous areas, may be necessary to match the heat source with load centers. Annexation capability would be a useful adjunct. The district also may require extra-territorial jurisdiction over sources of supply and facilities.

The purposes of a heating district will generally be to produce, distribute, utilize, sell and dispose of geothermal resources and other heat mediums for domestic, commercial and industrial use. The authority should be broad enough to include geothermal and cogenerated or waste heat sources, as well as the use of fossil fuels for peaking or emergencies such as well shut-downs. While centralized space-conditioning may often be the primary function, integrated development of cascaded uses should be within the purview of the district.

Since political subdivisions are inherently not risk-taking entities, the exploration function may require an innovative approach. Exploration may be an appropriate function for the district where the geothermal resource is demonstrated or where outside (state/federal) capital is available. Otherwise, joint enterprise ability - joint power authorities (with other political subdivisions) and joint ventures (with private industry) - may be necessary to obtain financing. Alternatively, franchises may be granted to private companies to explore for and produce the resource under a contract of sale. Exemption of such production from PSC rate-making jurisdiction would be an appropriate incentive to attract private risk capital. Publicly-owned utilities already are exempt from PSC jurisdiction in most states.

A geothermal heating utility will require the range of powers of a body corporate and politic: legal status to sue and be sued; ability to contract for services and employ personnel; ability to acquire and dispose of property (within and without the district); ability to fix rates for service; ability to apportion user charges and enforce collection (usually via liens); and, the ability to generate capital.

The most likely avenue for capital financing of a geothermal heating district will be revenue bond issues. Service charges would be designed, and may be statutorily required, to retire revenue bond principal and interest, as well as covering operating expenses. However, the ability to levy special assessments may be a necessary concomitant in order to cover revenue shortfalls. Revenue bond issues are not subject to constitutional debt limits and usually need not be approved in an election.

Where the district has ad valorem taxation power, it may be authorized to issue general obligation bonds. Such bonds also may be retired by project revenues but are supported by the full faith and credit (taxes) of the issuing district. General obligation bonds will usually be subject to debt limits if the issuing authority is a municipality or county. Debt limits for special districts are less common, and if applicable, special district debts are generally not cumulative with other local political subdivision debt. General obligation bond issues may need to be approved in an election.

Whatever the bond option chosen, marketability is subject to legislative initiative. State legislatures should consider declaring heating district bonds a legal investment for all banks, trust funds, school funds and other institutional investors. Such accreditation would expand the capital market for the bonds.

A final consideration regarding the powers of heating districts is the grant of easements and eminent domain. Easements along, across and under public byways and existing transmission corridors would assist the district in forming its distribution network. The power to condemn easements on certain private property also may be necessary to complete the system. Consideration may be given to extending the eminent domain power to existing geothermal wells and sources of supply, although such a proposal is likely to be controversial.

The problem of condemning existing wells or their forced incorporation into a heating district may be unavoidable where single or multifamily wells are already in use. Geothermal production for a heating district may result in reservoir drawdowns, rendering such wells useless. District monetary liability for such events, as opposed to the issuance of an injunction restraining operations, would result, as a practical matter, in condemnation. A possible method to minimize such liability would be the designation of system-wide economic drilling levels, above which no liability would accrue to the district.

Thus, the legislative agenda for public district heating is manifest. The charters of existing political subdivisions should be examined to identify suitable candidates and amended as necessary. Alternatively, a comprehensive, new district heating statute may be enacted. Formation, boundaries, purposes and powers are the parameters which need to be established for public heating districts.

CONCLUSION

While this paper has focused on the specific legal and institutional parameters of geothermal district heating, there are additional factors subject to legislative initiative which will generally affect the pace of implementing such systems. These include: public funding for demonstration projects; geoheating public buildings; innovative and compatible building codes and zoning ordinances; public education and technical assistance; loan programs and tax incentives for alternate energy systems; royalties and taxes on resource production; streamlined regulatory and leasing procedures; and, resolution of ownership and water rights issues. While beyond the scope of this paper, the NCSL geothermal project is prepared to assist states to deal with these policy areas.