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Maintaining a Competitive Geothermal Industry

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Good Morning. I am pleased to be here this morning to participate in this 14th review of geothermal programs.

I come to this geothermal business with over 30 years of experience in the power generation industry. I have earned my spurs (so to speak) in the electric utility, nuclear power, coal and the gas-fired cogeneration power businesses. I have been employed by Oxbow Power for the past seven years and for the past 18 months I have been based in Reno and responsible for the operation, maintenance and management of Oxbow's domestic power projects which include three geothermal and two gas-fired facilities.

The Oxbow Power Group (consisting principally of Oxbow Power Corporation, Oxbow Geothermal Corporation, Oxbow Power of Beowawe, Oxbow Power International and Oxbow Power Services, Inc.) is based in West Palm Beach, Florida, and has regional offices in Reno, Hong Kong and Manila to support on-line geothermal projects in Nevada, other domestic power projects and a geothermal plant under construction in the Philippines. Oxbow Power employs approximately 30 professionals in the development and management of power projects and over 100 supervisors and technicians in the operation and maintenance of power facilities. Current ownership in independent power projects total 340 MW in the United States and 47 MW under construction in the Philippines. Oxbow is currently negotiating additional projects in several Asian and Central American countries.

The power group's corporate mission is to develop, own and operate profitable and

efficient power plants worldwide, using geothermal, and other technologies in an environmentally acceptable manner.

Commitment and Challenges

Oxbow's commitment to the development of new geothermal capacity is based on a firm belief in the many benefits of geothermal power generation which include:

- the local economic benefits and sustainability of the projects,
- the use of indigenous resources to displace imports of fuel,
- the wisdom and security of energy diversification,
- and the obvious environmental advantages of renewable over traditional energy sources.

These benefits are not restricted to domestic power planning but, are considered to have worldwide applicability as fundamental energy policy.

We are all well aware of the changes occurring or about to occur in the U.S. and worldwide electric power industries. These changes challenge us to be as efficient and as competitive as we can be. With those challenges in mind I'd like to focus my remarks this morning on Oxbow's perspective on creating a forward-looking, cooperative government-industry R&D program that will make U.S. geothermal technology competitive on the world market.

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DOE's Role in Support of the Industry

Generally, Oxbow has looked to the federal government for leadership in establishing policy and lead efforts to level the competitive playing field in the electric power industry. We see the principal role of the federal government as establishing policy and the legal and regulatory environment conducive to the development of a U.S. energy industry which is secure, sustainable, environmentally responsible, safe and efficient.

However, there is a legitimate role for government in the support of technology development when such undertakings are beyond the capabilities of private enterprise or when the benefits of such undertakings achieve stated government objectives (such as national security). In the case of development of renewable energy technology the benefit is multi-faceted and widespread (in the form of national security, environmental protection and economic development). Further, the development of technology which can assure U.S. leadership and export sales abroad is a form of playing field leveling on an international scale.

The funding of R&D to secure these objectives has been a part of federal energy policy for my lifetime. It has taken the form of substantial direct investment in fuel and technology development in the coal, nuclear and petroleum industries, as well as the geothermal, solar, wind, and biomass fields. Given the manifold and broad-based benefits of renewable energy it is especially appropriate that our federal government play a significant role in support of R&D for renewable energy technology development.

It should go without saying, that in an atmosphere of budget deficits and competing uses for government funds it is urgent that dollars spent for geothermal R&D:

- focus on projects with the maximum leverage;
- lead to near term commercialization; and
- be efficiently spent.

Projects which aim to reduce drilling costs, increase the certainty of identifying commercial resource, improve the management of resource, improve power plant efficiency, and improve power project economics are projects with leverage.

Projects which focus on fundamental improvements of existing technologies have near term applicability.

Projects which are cost-shared and jointly managed have the maximum potential of applying dollars efficiently.

Oxbow-DOE Cost Shared Projects

Oxbow has a significant history of active support of DOE geothermal programs. This has taken the form of active participation in DOE workshops and Annual DOE Program Reviews over the years. This level of participation has included planning and critique of ongoing industry-DOE activities. We believe that this participation has helped formulate the direction of DOE funded research and development programs.

Over the years, Oxbow cost-shared programs are intended to demonstrate cost effective innovation in resource management and power production and to make these techniques available to the industry for world-wide application. Some examples of the benefits to industry from Oxbow participation in the DOE program include:

- The development of multiple tracers for reservoir analysis which was

demonstrated with the Beowawe and Dixie Valley studies and have become routine in industry and research with newer tracers with detection at part per billion concentrations will soon be tested for refined reservoir analysis.

- The use of slim-holes as a cost effective evaluation tool to test heat flow in moderate depth volcanic environments was demonstrated within the thick volcanic sequence in the Santiam Pass.
- Current programs of reservoir fracture analysis and reservoir augmentation studies offer the promise of more efficient exploration and production.

These studies have met meaningful R&D objectives and provided mutual benefit both to Oxbow and to DOE funded research groups; Oxbow benefited from exposure to new technology and ideas which could or would not be pursued with internally generated funds. The DOE-funded research groups benefited through access to geologic environments which would be cost prohibitive for most R&D budgets and through access to the production and process problems associated with viable commercial energy projects.

This sharing of benefits is key to defining successful projects. From Oxbow's perspective, the gain from these programs has been real and the publication of the knowledge gained has presented an acceptable sharing of normally proprietary information for the benefit of the industry at large.

We are currently conducting work preliminary to two negotiated programs and are seriously considering two additional programs that have been proposed to us by credible research institutions.

Future Direction for DOE Funded R&D

Competition both with fossil fuels, and with foreign-based companies on the international scene can only be accomplished by true efficiency in all aspects of our business. Goals should include:

1. **Development of effective exploration and drilling strategies and tools to either salvage dry holes or working models to improve the odds for success on subsequent wells.** While slim-hole programs have been effective in delineating areas of high heat flow, the problem of predicting permeable fracture systems at depth remains. Dry hole costs for wells which reach geologic targets only to find sub-commercial permeabilities or even a total lack of production capability in a known structural zone continues to be a major cost factor for many projects.
2. **Improvements in drilling hardware and techniques to bring drilling costs for geothermal wells into a more predictable and cost effective range.** The basic problems of effective penetration rates in the harsh geothermal environment and coping with lost circulation zones or sub-commercial water flows in this same environment remain as major contributors to drilling inefficiencies. We still have not bridged the gap between R&D efforts and commercialization in these areas. These uncertainties place large risk factors in our economic models for resource development and increase the difficulties of competing with lower cost traditional alternative energy sources.
3. **Energy conversion improvements.** While improvements in generation efficiencies at The Geysers over the past

three decades are notable, fully integrated efficient conversion of produced geothermal fluids to beneficial energy is missed in most geothermal projects and results in large project inefficiencies.

Topping and bottoming cycles need to be routinely integrated into the concept of geothermal development to prevent produced energy from being wasted by low efficiency conversion or re-injected back into the ground. Investigation of ultra-low flash technology is a step in this direction. Efficiency will be critical to being competitive in our industry. We simply cannot afford to put produced energy back into the ground.

Other efficiencies in plant design and operation can be achieved through a careful inventory of the design and operation of power plants over the life of a project. For example, traditional heat rejection systems are often designed and operated without consideration for lost BTU's in the energy conversion, without regard to lowering parasitic load and without regard to conservation of water which eventually becomes critical to maintaining reservoir performance. More efficient designs for new plants and retrofit of old plants need to better address such inefficiencies.

4. **The development of by-product and co-resident projects which enhance economic value for geothermal energy.** The concept of compatible uses associated with geothermal development deserves more consideration. Waste heat and solids contained in brine streams offer the opportunity for development which can add value to geothermal power development. Existing by-product recovery systems are often little more than environmentally

acceptable waste disposal alternatives. The development of commercial products as a mitigation of silica scaling problems has been discussed but, never brought beyond pilot testing (which suggests that geothermal silica is a superior commercial product in comparison to traditional silica resources). The coupling of indigenous industry ranging from mineral extraction or agricultural to power generation facilities has become a rare reality despite the proximal location of these three industries.

The U.S. energy companies have maintained a market edge in the world over the past decades by innovative approaches to the problems of efficient production of electric power from fossil and nuclear fuels and in the design and operation of end use energy distribution systems for electrical power and liquid fuels. This edge was established and maintained by cooperation between industry and DOE its predecessor agency. Early geothermal development followed this same pattern; however, this innovative edge is rapidly being lost to smaller countries which recognize that strongly funded and innovative R&D programs directed to geothermal power generation is the key to not only efficient use of their own indigenous geothermal resources but, is also a major export edge in doing business in emerging energy markets throughout the world. Quality R&D programs focused on the efficient use and development of geothermal systems is moving countries such as Japan, Italy and New Zealand into leadership positions in development of geothermal resources within the Asian and Central American-South American markets.

The domestic geothermal industry was successful in past decades largely due to industry-government R&D cooperative efforts through ERDA and DOE. The

evolved domestic industry has lost participation in the very programs which contributed to the success of the U.S. geothermal industry throughout the world. Arguments over the reasons for this decline in opportunity for co-operation are not particularly beneficial, formulating a forward looking formula for joint industry-DOE development and export of geothermal technology is an obligation of both industry and the federal DOE program.

Thank you for your attention.

