Geothermal Energy in a Changing Policy Environment'

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1. INTRODUCTION

The role that geothermal energy will play in helping meet future energy requirements will certainly depend on the caprice of technological breakthroughs, hut also on how well the industry associated with its exploitation adapts to the changing policy environment. Government? can influence the rate of deployment of technologies. But the role of governments in the energy sector. while still significant, is considerably reduced from what it was during the seventies and eighties. And it continues to evolve; while generally declining, it is becoming more neutral with respect to technology choice, avoiding "picking winners". Nowhere is this perhaps more dramatic than in the Electricity Supply Industry (ESI). A set of pressures is altering the structure, regulation and management of the ESI: these include. technology development (aeroderivative gas turbines. microprocessors); changing attitudes of government and international lending institutions towards public utilities and their ownership; changing perceptions of fuel availability [especially natural gas); shifts in public attitudes towards plant location and power sector development; and new and evolving environmental concerns and associated renewed emphasis on energy efficiency. The realization that generating electricity is not a natural monopoly has prompted the introduction of competition to the industry. One of the consequences of this reform. at least for the short-term, is that electricity prices tend to decline in real terms. Finally. how governments respond to their commitments under the United Nations Framework Convention on Climate Change could alter governments' policies affecting electricity production and use. It is within this context — institutional, technological. political and economic — that geothermal energy's future must be made.

Geothermal cnergy can he used directly and in this form is already making a significant contribution. This note focusses primarily on that part of the resource which might be used to generate electricity, and specifically the implications for geothermal of the changing policy context.

2. A CHANGING POLICY FRAMEWORK: ECONOMIC/ENERGY/ELECTRICITY

Reform of the Electricity Supply Industry has to be placed in the broader context of economic or structural reform that has taken place over the past decade or so. In instituting structural reform, governments have, among other things. sought to increase the role of private players operating in open markets, especially in those segments of the economy where public entities used to dominate. Besides privatization. economic policy reform has aimed to increase competition, deregulate markets, remove or reduce subsidies and reduce barriers to trade and investment while liberalizing financial markets. This structural change is unlikely to be reversed in the foreseeable future. Therefore, industries and segments of society that have benefitted from previous distortions and interventions will need to innovate and adapt if they are to grow and flourish.

Poor economic performance, exacerbating government deficits in most OECD countries has helped prompt this reform. Governments sought means of reducing their expenditures. They also realized that many of the interventionist energy policies of the seventies simply did not work or turned out to be extremely costly. Energy is a highly capital intensive sector of the economy and the argument far a strong role for government in its planning, management and control has not been sustained by the experience in most countries. Many government sponsored energy schemes, predicated on picking what were thought by government officials to be potential winners, ended up as financial losers (e.g., synthetic fuels in US and New Zealand; heavy oil upgraders in Canada). Not surprisingly. when budgets tightened these activities were the first to go: being energy projects, they were generally very high cost for the social and strategic benefits that had been hoped from them. Reform in the energy sector has not k e n an end in itself it has only been one part of an overall process of reform aimed at improving economic efficiency which aims to increase a nation's productivity.

2.1 Electricity Sector Reform

The International Energy Agency recently assessed the status of and issues associated with reform of the Electricity Supply Industry in OECD countries (IEA, 1994a). In particular, the report examined how reform might affect the pursuit of traditional policy goals associated with the ESI. The report acknowledges that reform differs between countries and that in many cases it is still too early to judge the full implications, in particular for fuel diversity and its effects on security of supply. Regarding fuel or technology selection, it concluder that *"In competitive electricity markets, investors prefer less capital intensive, shorter-term investments. Governments* will *still he able to influence fuel choice, though the tools for doing so will change"* (p.23). On the other hand, *"increasing the number of investors also opens a niche for consideration of less traditional and hence financially riskier technologies"* (p.78).

In this context. what applies to geothermal. equally applies to other technologies. Nuclear, for example. faces an even more difficult set of conditions (Skinner. 1993) notwithstanding its

The views expressed in this paper are those of the author. They do not necessarily reflect the official position or the International Energy Agency or of the governments of IEA Member countries.

significant contributions over thr past two decades in displacing oil in power generation, and its obvious potential benefits as an energy source with low associated greenhouse gas emissions.

Reform of the ESI is not restricted to OECD countries. International lending institutions are placing greater emphasis on institutional reform in the power sector (World Bank. 1993a). The general themes of this reform include: reducing the direct role of government in power sector management: instilling sound commercial principles *and* practicer; introducing competition where appropriate; snd attracting foreign private participation in the sector including in financing, construction. operation, ownership and so forth. Developing countries are being encouraged. therefore. to create a transparent framework of governance and an investment environment that will attract private investors leading to greater competition of ideas and technologies in order to yield the most economically efficient outcome. This includes considering demand side options — improving energy efficiency — on an equal basis with adding supply.

This process of reform is at an early stage. Moreover, it is debated whether same reforms commenced in industrialized countries and prescribed by multi-lateral funding bodies far developing countries. are succeeding in the former. let alone liable to work in thr latter. There is by no means universal agreement that free and open markets are appropriate for the power sector (World Bank, 1993b and Stoffaës, 1994). But what is clear is that countries wishing to undertake reform, need to do so in a manner that takes into account their own technical. cultural and development situations. While there is no one approach that suits all, the above general themes should apply.

It is also clear that in order to meet their enormous power sector requirements (estimated at around $100 billion per year). developing countries will have to compete for foreign capital. To the extent that project and market risks. along with political risk, can be reduced, investment will be attracted. Utilities with seriously distorted tariffs, which do not collect bills, that do not develop and sustain skills to support and maintain facilities and are subject to political interference in the day-to-day management. are unlikely to be viewed as attractive business partners. There is no shortage of potential power projects because there is a virtually insatiable demand for the services that electricity can provide. Customers want heat, convenience. cooling. refrigeration, motive power. etc: most do not usually care which fuel provider them. Private capital, meanwhile, will seek the least risky technology and projects.

2.2 Prospects for Geothermal

Does this new institutional environment improve the prospects for geothermal rnergy! Geothermal energy projects received the lion's share of Official Development Assistance from OECD countries for (non large-scale hydro) renewable cnergy technologics between 1979 and 1991 (Kozloff and Shobowale, 1994.). De-politicizing utility management and making the economic and technical basis for fuel choice more transparent would trnd to move utilities away from the "favored fuel" syndrome (which might even in some cases already be favoring geothermal!). Increasing tariffs (thought to be 4 to 5 US cents per kwh below the average in industrialized countries; World Bank, 1993b) to better reflect costs, as would happen in a competitive. commercially-oriented power sector, would improve the relative economics of geothermal. (This likely rise in electricity prices contrasts with the general trend in industrialized countries where the introduction of competition tends to lead to a drop in prices in the short-term at least.) It would also generate much needed local capital. Given the high ricks and associated costs of delineating geothermal prospects. not usually covered by multilateral lending agencies. financially strengthened utilities with geothermal potential would be better placed to seek private partners to develop commercially sound geothermal projects. Proper electricity pricing reflecting input costs would tend to focus utility planners and governments on indigenous sources of energy over imports of fossil fuels which command world prices and are subject to exchange rate fluctuations which. in countries with high rates of inflation. could exacerbate balance of payments and deficit problems. Proper pricing. an ths other hand. should normally encourage the application of principles of integrated resource planning. In such an approach the costs and benefits, including environmental, of both supply and demand-side options are assessed. Thus. a harder assessment of the prospects for improving the efficiency of existing electricity end-use would result. Implementation of effective demand-ride measures could put off the day when new supply is needed.

This changing institutional and policy environment leads to the following conclusion claiming special status or depending on specific supports or hoping for a favorable fiscal treatment relative to other sources of energy would not appear to be a sensible strategy for any industry or promoter of any particular technology to adopt. Each technology has to make its own case on its own merits.

3. WORLD ENERGY OUTLOOK — SCOPE FOR GEOTHERMAL ENERGY-BASEL) POWER SYSTEMS

The International Energy Agency's most recent World Energy Outlook (IEA, 1994b), like many other projections of energy demand, points to the following developments:

World demand for primary energy could nearly double over the next 15 to 20 years;

Most growth in demand will take place outside the industrialized countries, principally in Asia-Pacific and China:

Fossil fuels will provide most of the supply:

- Electricity will continue to be the fastest growing form of energy demand (at 2.8% per annum): and of fuels for electricity generation, natural gas will make the largest contribution. but geothermal and other nan-hydro based systems will grow the fastest (8.5% per annum):

Most such projections are based on a set of contestable assumptions about future oil prices: the rate of technology diffusion; whether future elasticities will mirror those of the past: whether rates of income growth (GDPI and present demographic trends (population growth) are sustainable; and above all, in the case of the IEA's outlook. that there will be no change in energy policy. The reality is that changes in policy are occurring all the time. in particular as part of OECD countries' responses to the Climate Change treaty (see below). Nonetheless. having been clear on this '*no policy*' assumption, the outcome from such model-based projections offers a starting point far policy discussions. But it must be stressed that such projections are not. in and of themselves, as is so often asserted. a *basis* for policy.

What is of interest abaut there projections, as far as geothermal energy is *concerned,* is the striking geographic coincidence of where high rates of energy demand growth are projected, and the distribution of geothermal resources. Well over 90% of the world's installed geothermal electricity capacity is in countries along or near the 'Pacific King of Fire' (Dickson and Fanelli, 1993). Geotectonically hot, this King can also be seen as 'hot' in terms of potential economic growth and attendant increases in energy demand. especially for electricity. In North America from Alaska through British Columbia, Washington State, Oregon to California, growth in electricity demand is expected to be above national averages (US Department of Energy/EIA, 1994 and NEB, 1994). Even higher growth rates are projected

for Mexico and South America, as well as on the western edge of the Pacific Ring of Fire. Electricity demand in the OECD Pacific Region (Japan, Australia and New Zealand) is expected to grow at 2.8% per annum out to 2010: this compares with 2.1% for the OECD as a whole.

The IEA's World Energy Outlook implies that nearly 25% of the world's expected growth of electricity output between 1990 and 2010 will occur in the region of Asia Pacific and China. The Outlook does not provide a breakdown of projected contributions by geothermal. wind, wave and solar generated electricity. However, notwithstanding the highest rates of growth far these technologies (8.8% in the OECD and 7.7% in the Rest of the World. excluding the Former Soviet Union and Central and Eastern Europe), resulting in an overall increase from 41 Twh to 191 Twh, this will still amount to less than 1% of total electricity generation by 2010. Work in progress an an update of the Outlook indicates that far the OECD region (including Mexico) geothermal could more than double in capacity to 11.2 GW by 2010, when it would make up over a third of non-hydro and non-biomass renewable bared electricity generation capacity.

Whether new, geothermal based power projects will be built will depend on how well the technology competes with other fuels. There may well be certain charactenstics of the state of economic development along parts of the Pacific *'ring of economic fire'* that suit the choice of geothermal energy. Certainly the variable size of geothermal power systems and their modularization make them suitable for small and developing electricity markets, and for rural electrification and off-grid settings. including the direct use of heat as in combined heat and power settings. Also, the introduction of more competition in many countries' power sectors at least opens the door for Independent Power Producers (IPP's) based on geothermal. In California. the introduction of wholesale and retail competition in the ESI, which accounts for nearly 40% of the world's current geothermal capacity, might pave the way for more geothermal if environmental and other concerns can be resolved and if the costs can be reduced to compete with natural gas based systems — not insignificant challenges. But most of the geothermal power resource has already been exploited and is declining, raising concerns among investors and therefore doubts that California will see past rates of growth in geothermal duplicated. In general worldwide. the highly site-specific nature of geothermal power and the associated project risks will have to be reconciled with the requirements imposed by private sources of capital for most of their financing in the future

4. ENVIRONMENTAL POLICY — RENEWED EMPHASIS

In addition to structural change generally and power sector reform in particular, there are challenges and opportunities for geothermal presented by the response to the concern about climate change. The United Nations Framework Convention on Climate Change can be seen as a de facto international energy treaty. It represents an unprecedented collective decision by the governments of the biggest energy consuming nations of the world to change how energy is produced and used in their economies. Of the emissions tabulated and of the actions and measures identified for their reduction. in national climate action plans submitted to the Climate Convention secretariat. more than 95% relate to fossil fuels

How governments will reconcile their collective commitments for actions with their recent policy reforms which place less emphasis an direct government intervention remains to be seen. While there is much discussion about the desirability, efficacy, efficiency and practicability of economic instruments, such as carbon taxes. there would appear to be little prospect of their implementation at the international or OECD-wide basis (Skinner, 1994). Instead. governments are increasingly turning to partnerships and voluntary approaches with industry to achieve their climate policy objectives (IEA, 1994c and 1994d). In any event, a policy environment that generally favors non-fossil fuels should he encouraging to the geothermal industry. even though many existing geothermal projects do emit carbon dioxide (Armannsson and Knstmannsdottir. 1992). But a greenhouse gar emissions constrained power sector also encourages other new energy technologics such as solar, wind and small scale hydro. Moreover, many policies contained in climate action plans are designed to improve the efficiency of current energy use rather than to change the fuels of supplying that energy.

The Climate Convention. in the first instance, is unlikely to he a major factor in determining fuel choice in most developing countries. However. it might influence development assistance financing over the medium- and longer-term in the following way. An industrialized country could finance the incremental costs of, say geothermal. over a fossil-fuel based plant in a developing country, and claim emissions reduction credits under the concept of joint implementation. This, of course. requires that an appropriate regime for doing so he developed and agreed to under the Framework Convention on Climate Change.

Much of the literature on new and renewable technologies, including geothermal, contains references to the need for policies designed to correct for what are viewed by some to be policy failures at present (see for example World Energy Council, 1994). Same urge the use of international carbon taxes and other fiscal measures in order to internalize environmental and social costs. currently external to the price of energy. While this may have some academic basis and appeal, it would require unprecedented coordination of fiscal reform and taxation approaches among OECD countries. This would appear to fly in the face of recent trends, not only in fiscality. but in international economic policy cooperation (Skinner, 1994).

Many governments have largely lost their resolve tu return to interventionist measures of the past that restrict choice of consumers or producers or increase their costs. Instead, as noted above, they are pursuing innovative cooperative approaches with industry to jump-step the rate of technology deployment. The result. commonly referred to as *'market transformation'*, can achieve public policy goals while relying on baric market forces. This does not mean however that governments will not continue with structural reform to increase economic efficiency. Meanwhile. OECD governments show signs of reorienting their energy research and development activities to reflect this overall shift in economic, energy and environmental priorities (IEA, 1994d).

5. THE TECHNOLOGY PATH

In a recent assessment of technology options and strategies for addressing climate change. the International Energy Agency identified a number of key features that new and renewable technologies will need to be based on if they are to make more significant contributions to electricity generation (IEA/OECD, 1994). These are:

- Large and well distributed resource base available globally:
- Safe and simple to operate:
- Provide power on a continuous basis:
- Environmentally benign with minimum emissions:
- Optimal scale of individual plant to 10-100 MW(e);
- Technology easily transferred to developing countries:
- Potential to be cost competitive with fossil fuel plant.

Geothermal, when examined against these criteria, with the exception of the first, would appear to score fairly well. If the definition of geothermal includes the various heat pump applications as well as direct uses of geothermal heat, then it is

ideally suited to make a major contribution in a world where burning fossil fuels faces environmental policy constraints.

Technology development should also address secondary or enabling and supporting technologies. There are natural synergies between the petroleum and geothermal industries. The same sets of skills, technologies and knowledge characterize bath. The ail and gas industry. faced with lower prices, has developed new technologies to not only reduce the costs of finding new reserves but to expand production from existing fields. The techniques of three dimensional seismic, horizontal drilling, deep drilling in over-pressured sedimentary basins may be directionally transferrable to geothermal exploration and development. Moreover. the dramatic downsizing that has taken place in the upstream part of the petroleum industry would imply that the necessary intellectual resources and skills are available for transfer to geothermal resource delineation. This could help reduce the highly site specific costs of the geological assessments of geothermal. Materials research in general could lead to the development of high temperature metals and the enabling technological breakthroughs needed to accelerate the demonstration and deployment of saline. corrosive. deep, difficult-to-drill hydrothermal systems and eventually Hot Dry Rack or Magma-based systems.

The paint of this discussion is that while governments are reforming their approach to the power sector, the re-examination of priorities in government Research and Development could be appropriate and might lead to breakthroughs in techniques and technologies to improve the competitiveness of geothermal energy systems. As for geothermal, governments traditionally carry out baseline research such as detailed topographic and geologic mapping and gravity surveys. When publicly owned and directed. the power sector's R&D tended to serve social (and. indeed, political) goals. Once privatized, its shareholders may no longer consider the financing of the pursuit of these societal goals as their responsibility. Thus. public policy reform including of the power sector may call for a review of research and development priorities. This is not to suggest that new technologies will not be introduced in a privately owned and competitive power industry. Indeed, the evidence would suggest the contrary, at least in the United States, where new breakthroughs in turbine technology and electricity end-use technologies are being deployed.

International collaboration in energy technology research, development and deployment has been a fundamental activity of the IEA far nearly 20 years. The IEA's collaborative energy technology projects and programmes are established under special legal mechanisms, called "Implementing Agreements". These set out the commitments of the Contracting Parties and establish a management structure for ongoing activities. All resources are supplied by the Contracting Parties which nominate one of their number to be the Operating Agent. While most participants are government organizations or semi-public entities, the Implementing Agreements are open to any public or private organizations that arc formally designated by their national governments. Associate participation is open to organizations froin countries which are not Members of the IEA. Over the last few years we have sought to involve various non-IEA countries in these collaborative activities on an "equal partner" basis.

Nearly 60 Implementing Agreements have been established and currently there are over 40 in operation. of which six are directly related to renewable energy technologies. Although Implementing Agreements relating to geothermal equipment and Hat Dry Rock technologies have been terminated after successfully completing their tasks, an IEA group of experts is exploring the feasibility of establishing a new IEA Implementing Agreement on geothermal energy systems. Possible missions for such a new Agreement include resource sustainability: deep drilling and production technologies; hot dry rock technologies: environmental impacts; and new power generation cycles. But the IEA seeks a consolidated view from the geothermal community as to where limited R&D resources might be best deployed.

6. CONCLUSION

In conclusion, the changing policy environment, characterized by economic and structural reform and pressures arising from the concern of climate change. pose both opportunities and challenges for geothermal energy-based systems. Energy technologies and fuels will have to compete on the basis of delivering reliable, economic and environmentally acceptable energy. While policy changes that would improve the relative economic merits of geothermal can never be ruled out, they should not be counted on as a basis for future expansion of geothermally based energy systems. Where energy will be most needed in the future happens to be where geothermal resources are the most plentiful: around or near the Pacific Ring of Fire. Geothermal projects can be sized to meet local electricity requirements. Changing regulation, ownership and institutions in the power sector world wide, call for review of government research and development priorities in electricity generation. in order that the promise of near-commercial technologies can be trrted. International technology research and development collaboration can help foster accelerated deployment of geothermal based energy systems worldwide.

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