4. National Energy Policy/Overview

The Energy R&D Infrastructure of Selected OECD Countries

Private Sector Energy R&D. Describing changes in the private sector's support of energy R&D can be difficult due to the proprietary nature of data concerning industry's R&D support. That said, this section presents a composite sketch drawn from available information, suggesting that private sector support for energy R&D is undergoing significant changes and downsizing. Moreover, in addition to the fact that private sector energy R&D is in rapid decline, R&D investments are being redirected from longer-term projects that might be viewed as having a higher value from a public goods perspective. Instead, investments are directed to a greater extent to meet the near-term proprietary needs of private sector energy R&D companies operating in competitive markets. This reorientation has major implications from the standpoint of public policy; for example, a widening energy R&D gap is likely to heighten the technological challenges and economic costs associated with the long-term stabilization of atmospheric concentrations of CO_2.

Utility restructuring is having an overall negative impact on private sector investments in energy R&D. For example, while U.S. industries generally invests about 3.1% of annual sales revenues on R&D, U.S. utilities, on average, devoted 0.3% of sales to R&D in 1994; estimates indicate that this percentage has continued to decline since then.[1] Similar trends are evident elsewhere in the OECD. Utilities in the UK have reduced their R&D investments steadily over the past decade, to a level that currently stands between 0.1%-0.3% of sales.[2] Dutch utilities are reducing their R&D investments from 0.7% to 0.6% of sales, with further decreases expected, while Norwegian utilities currently invest approximately 0.3% of sales in energy R&D.[3]

In terms of society's ability to stabilize atmospheric concentrations of CO_2, it is important to note that certain forms of energy R&D are experiencing a much larger share of the reductions. A recent utility industry journal article noted that utilities with plans to sell off generation assets will "naturally pull their funding for R&D previously targeted to power production."[4] This shift away from advanced power generation R&D can be seen in actions taken by utilities in many countries.

For example, utilities in Italy and the Netherlands are no longer sponsoring new, large-scale technology demonstration programs and have terminated ongoing demonstration projects for advanced power system technologies, such as grid-connected photovoltaic systems, which can not be justified strictly on economic grounds.[5] In the United States, Electric Power Research Institute's (EPRI) advanced power generation program (focusing on technologies such as fuel cells, coal gasification, advanced gas turbines, and

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[1] General Accounting Office (GAO) (1996). Changes in Electricity-Related R&D Funding. GAO-RCED-96-203, General Accounting Office, Washington, DC.

[2] International Energy Agency, Energy Technology Policy Office (1996). Submission to the International Energy Agency's Committee on Energy Research and Technology's Round Table on Greater Utility Competition and Its Impact on Industry and Government Technology R&D Budgets and Priorities. Paris, France. 13 November.

[3] KEMA (The Netherlands) (1996). Summary of Corech/Eurelectric Discussion of R&D in a Deregulated Market October 11, 1996. Paper presented to the International Energy Agency's Committee on Energy Research and Technology's Round Table on Greater Utility Competition and Its Impact on Industry and Government Technology R&D Budgets and Priorities. Paris, France. 13 November.

[4] Jones, Cate. "R&D continues to brace for a difficult future." Power. November/December 1998.

[5] Italian submission (1996). Paper and presentation to the International Energy Agency's Committee on Energy Research and Technology's Round Table on Greater Utility Competition and Its Impact on Industry and Government Technology R&D Budgets and Priorities. Paris, France. 13 November.
The Netherlands' Economic Ministry. Greater Utility Competition in the Netherlands. Paper and presentation to the International Energy Agency's Committee on Energy Research and Technology's Round Table on Greater Utility Competition and Its Impact on Industry and Government Technology R&D Budgets and Priorities. Paris, France. 13 November.

renewable energy technologies) declined 66% over a 3 year period.[6] EPRI's renewable energy program, a subset of the advanced power generation program, saw its budget cut 45% in just two years.[7]

There is also mounting evidence that R&D time frames and perceptions of acceptable risk levels for energy R&D sponsored by utilities are contracting due to heightened competition. For example, the time-horizon for British utilities' long-term R&D projects has contracted from five- to seven-years a decade ago, to less than three years now. It is estimated that in a fully competitive market R&D timeframes could be cut to one year for R&D sponsored by UK utilities.[8] Under such circumstances, as one US utility research executive noted, the initiation of advanced power generation R&D programs (e.g., fuel cells) would not be feasible.[9]

In this regard, Sweden's Vattenfall, the sixth largest utility in Europe, has completely reversed the composition of its R&D portfolio from 70% "corporate R&D" (e.g., advanced power production) and 30% in the firm's "business units." Seventy percent of R&D resources are now invested in the near-term R&D needs at the "business unit" level.[10] Vattenfall is doing away with its central "longer-term corporate R&D" in much the same way as countless energy firms eliminated their corporate R&D laboratories in the late 1980s and early 1990s in an attempt to adjust to the demands of international economic liberalization. Energy R&D investments are moving "downstream," closer to the consumer.

Utilities in deregulated markets are also directing more of their resources (including R&D resources) to areas only tangentially related to energy. Utility companies are entering new businesses and reorienting R&D resources as well in areas such as telecommunications, home security, and integrated home energy management systems in an effort to offer new services that will allow them to maintain a strong customer base in an increasingly competitive environment.[11] Similarly, firms that are planning to acquire new assets in a liberalized energy market setting often reduce their R&D expenditures to build cash reserves needed to finance such purchases.[12]

The reductions in the support for energy R&D that are underway in the utility sector are also present in the oil and gas industry. The largest oil and gas companies in the U.S. (most of which are large multinationals) have reduced their investments in R&D, by 43% on average, throughout the 1990s.[13] Several factors have contributed to this trend, including consolidation in the oil and gas industries; the opening of several major upstream areas around the world, and the more extensive deployment of existing advanced exploration and production technologies.[14] These overlapping drivers have had a dampening effect on energy R&D in this industry. Since oil and gas prices are expected to remain stagnant or in decline in real terms for the foreseeable future, given slack demand and abundant supplies, firms have little incentive to expand their R&D efforts.

Public Sector Energy R&D. Currently, just nine OECD countries perform more than 95% of the world's public sector energy R&D and, consequently, nearly all of the world's long-term energy

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[6] GAO, 1996.
[7] Electric Power Research Institute (EPRI). 1996. *The Impact of Utility Industry Restructuring on Research for the Public Good*. BR-107160. Electric Power Research Institute, Palo Alto, CA.
[8] Walker, J.A. and Riley, F.D. (1996). Utility Competition's Impact on Energy R&D in the United Kingdom. Paper and presentation to the International Energy Agency's Committee on Energy Research and Technology's Round Table on Greater Utility Competition and Its Impact on Industry and Government Technology R&D Budgets and Priorities. Paris, France. 13 November.
[9] Jones 1998.
[10] KEMA 1996.
[11] See Jones 1998 and Dooley 1998.
[12] Jones, 1998.
[13] US Department of Energy, Energy Information Administration. *Performance Profiles of Major Energy Producers, 1997*. Washington, D.C. January 21, 1999.
[14] US Department of Energy, Energy Information Administration. *Petrolium 1996: Issues and Trends.* September 1997. Washington, D.C. DOE/EIA-0615.

R&D.[15] Given the high concentration of energy R&D capabilities in such a small number of industrialized nations, it is not an exaggeration to say that this small country set is defining the world's future energy choices through its energy R&D investment decisions. It is also important to note that between 1985-1995, these nine energy R&D intensive OECD countries each reduced their budgets for energy R&D on average by more than 20% in real terms. In extreme cases, such as those of Germany, Italy, and the United Kingdom, budgets were slashed by 70% or more over the same period.[16]

The scale of these reductions in energy R&D funding and the commonality of the funding cuts across countries make it worthwhile to examine the evolution of key countries' energy R&D portfolios and to seek to explain the overall downward trend. In this section, we present preliminary findings from a major research effort underway at the Pacific Northwest National Laboratory to better understand the composition of the energy R&D programs of these countries.[17] This ongoing research effort seeks to assess the adequacy of the industrialized world's energy R&D programs, particularly in the light of the significant energy technology challenges that global climate change could soon pose. As of the end of 1998, in depth case studies of the United States, Japan, the European Union, Germany, and the Netherlands are near completion. In 1999, case studies for of Canada, France, Italy, Switzerland, and the United Kingdom will be completed thereby completing the survey of the major energy R&D intensive nations.

Overall public sector investment levels in energy R&D have declined over the past decade as the following data show[18]:

- The US federal energy R&D program has fallen by 26% over the period 1990-1997, a decline of more than $1.2 billion in real terms from the level in 1990.
- The Japanese government's energy R&D program declined 8.6% over the past three years (1996-1998), a real decrease of $226 million. As a percentage of total public sector R&D effort, energy R&D has fallen from 19.9% in 1990 to 13.7% in 1998.
- The German energy R&D program has declined by 71% since 1990, a funding reduction of $1.04 billion.
- EU-sponsored energy R&D has declined by 13% since 1984; as a fraction of the EU Framework Programme budget, energy R&D's share has declined from 47% to 18% over the same period.
- The Netherlands' public energy R&D support declined by 28% in real terms from 1985 to 1995. Support for energy R&D has recovered somewhat between 1996-1997.

The trends in overall public budgets for energy R&D tell an incomplete story, however. Figure 3 shows the energy R&D portfolios of the five countries mentioned above by program area. The composition of these

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[15] The countries are the United States, Japan, Germany, the Netherlands, United Kingdom, France, Italy, Canada, and Switzerland. The European Union, which is a major energy R&D sponsor, is also regarded as an individual "country" in this paper, although its energy R&D investments are not included among those of the nine countries listed here. Source: International Energy Agency, *IEA Energy Technology R&D Statistics: 1974-1995* (Paris: International Energy Agency, 1997).

[16] International Energy Agency, *IEA Energy Technology R&D Statistics: 1974-1995* (Paris: International Energy Agency, 1997).

[17] This analysis was prepared using data obtained directly from country sources and avoiding data from third party sources such as the Paris-based International Energy Agency (IEA). The use of official country source data facilitated more accurate and more detailed analysis of energy R&D trends. The use of country source data also enabled the conversion of all currencies into constant 1995 purchasing power parity (PPP) US dollars.

[18] These data are from JJ Dooley, PJ Runci, and EEM Luiten, "Energy R&D in the Industrialized World: Retrenchment and Refocusing," Pacific Northwest National Laboratory Technical Report No. PNNL-12061 (December 1998). This report summarizes the progress of this research program in 1998.

portfolios is, in many respects, as important as the overall funding levels in determining the range of future technological options.[19]

Figure 3 shows that national governments have sharply different priorities with regard to energy R&D technology investment areas. For example, Japan devotes 66% of all public sector energy R&D expenditures to nuclear fission programs, while the United States and the Netherlands devote a continually declining share—currently less than 8%--of their energy R&D resources to fission.[20] Furthermore, although all of these nations have energy policies that place a very high priority on developing and deploying renewable energy and energy efficient technologies as a way of increasing their energy security and protecting the environment, only the Dutch government invests the majority of its energy R&D resources in these technology areas.

An important observation that arises from this side-by-side analysis of public energy R&D expenditures is the large variance in the scale of government programs, from the United States' and Japan's expenditures of more than $2 billion each, to the Netherlands' $137 million expenditure. In fact, Japan's fission energy R&D budget alone is larger than the sum of the Netherlands, EU, and German total energy R&D budgets.

[19] The residual "Other" category in Figure 3 deserves explanation. For the US, this category amounts to nearly half of the US total energy R&D effort and largely comprises the "basic energy sciences" research programs supported by the US Department of Energy's Office of Science (formerly the Office of Energy Research). These US programs explore fundamental aspects of the science that underpin energy technologies. In the other countries this "Other Energy R&D" category accounts for programs focusing on systems and policy analysis, as well as some basic research, electric power transmission, distribution, and storage R&D programs. Other nations do not seem to fund these "basic energy sciences" on a scale comparable to that of the United States.

[20] At this point in this research effort, these comparisons are rough estimates. This research project is still collecting and standardizing the data from country sources. For example, the US "fission energy R&D" program might not include US funds for research covered in the other nation's fission R&D programs such as those used for the geologic disposition of radioactive waste.