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Mr. Chairman, I am pleased to appear before this Subcommittee to discuss the federal government's energy research and development (R&D) policy. Many elements of today's energy R&D policy were shaped by prospective assessments of oil markets that no longer prevail. Thus, a reexamination of federal support for energy R&D is appropriate.

In my testimony today, I will focus on three questions:

- What is the long-term prospect for oil prices?
- What potential problems does this assessment of the oil market pose?
- What are the resulting implications for energy R&D policy?

THE PROSPECTS FOR OIL PRICES

Oil prices lie at the heart of energy policy because of their influence on energy prices in general and in particular, on the rate at which oil is displaced as the world's primary energy source. In the Congressional Budget Office's view, oil prices are likely to remain roughly constant (in real terms) through the rest of this decade at least. Assuming that the economic recovery now taking shape is maintained--even at slower growth rates than those indicated by past business cycles--and that the Organization of Petroleum Exporting Countries (OPEC) retains its basic unity, the prospect that real oil prices will continue to drift downward appears slight. What seems likelier is a continuation of the pattern in which oil prices rise in ratchets and subsequently diminish in real terms, and occasionally in nominal terms. Such a price path will not eliminate the United States' need for an inevitable transition from oil, but it may postpone that need.

On the demand side of the oil market, the two principal uncertainties are the growth of the world economy and the pace of increased displacement by means of conservation and substitution--both factors crucial in the recent decline in oil demand. Between 1979 and 1983, oil consumption in the free world has dropped significantly--from about 51 million barrels per day to about 45 million barrels. At least half of this decline can be ascribed to increased conservation worldwide. The rest is probably attributable to slow economic growth; this part of the reduction may be reversed as world economic growth resumes. Sustained recovery worldwide would lead to the greater energy demands associated with higher income levels and increased industrial output--especially in nations developing an industrial base.

Continued energy conservation and substitution of other fuels for oil will offset some of the higher energy demands associated with greater economic activity. These forces were set in motion by the wave of oil price increases that followed the Iranian revolution in 1979. Within the United States, for example, oil prices rose from about $12.50 per barrel in 1978 to about $30 today, and oil imports have, in turn, dropped from more than 8 million barrels per day to about half that amount. Yet, though conservation has played a major role in trimming oil demand, the U.S. economy's energy efficiency may not continue to improve at the rate of the past several years. Further improvement can be foreseen in some cases, such as the automotive and aviation fleets, in which older, less energy-efficient vehicles will be retired. But many of the last few years' conservation gains involved one-time-only shifts in energy use--such as turning down thermostats--and may be hard to repeat. With oil prices at their current levels, other conservation and substitution activities may not be economic. For example, substituting coal for oil in electric utility boilers generally appears economic when the price of oil reaches $35 per barrel. With oil prices at $30 per barrel, many such conversions are not cost-effective. Conservation and substitution with nonpetroleum fuels may also have been slowed by lower expectations of future oil prices. Certainly, the potential for greater energy efficiency and substitution of other fuels for oil is still great. But the CBO does not expect these gains to outweigh the increases in oil demand anticipated to come with economic growth and higher income levels.

With these factors in mind, the CBO foresees free world oil demand of about 52 million barrels per day in 1990. This is considerably lower than the demand levels the CBO envisioned before the oil market's reaction to the price increases set off by the Iranian revolution.

This smaller demand raises two major uncertainties on the supply side of the oil market. The first of these concerns OPEC unity. The cartel has thus far withstood severely depressed oil markets and bitter conflicts among its members. If oil prices are to be maintained, OPEC's cooperation will have to continue. If indeed free world oil demand reaches 52 million barrels per day by 1990, then the daily demand for OPEC oil will probably be about 25 million barrels. Though this is lower than most estimates of OPEC's capacity, it is probably enough to allow OPEC to allocate it among its members. Thus, the CBO expects OPEC to remain a powerful force in the oil market. A related uncertainty concerns non-OPEC sources of oil--notably Mexico and China, the two non-OPEC producers with the greatest apparent resource potential for growth. Yet both nations are constrained by problems related to politics and scarce capital and foreign exchange. These difficulties may cause non-OPEC oil supplies to be smaller than their resource potential suggests.

Even more than other areas of forecasting, long-term judgments regarding oil prices are necessarily somewhat speculative. When the various uncertainties within and around the oil market are balanced, though, they do suggest a pattern of constant real prices into the 1990s. Though this is a more moderate price path than the one envisioned in the late 1970s, when much of current energy policy was made, it does not mean that the energy problem is solved. Ultimately, the United States still faces an inevitable transition away from oil, since world reserves are finite. But a more moderate price path may afford extra time to make the transition.

RETHINKING THE ENERGY POLICY PROBLEM

Although the need to replace oil as the United States' primary energy source is clearly the central long-run U.S. energy problem, policy also must address possible short-term interruptions in the supply of imported oil. Indeed, while lower expected oil prices defer the Unites States' need to make a speedy transition away from petroleum use, they may, by simulataneously encouraging petroleum consumption and discouraging domestic production, increase our short-term vulnerability to supply disruptions.

Policy tools other than research and development, however, seem most appropriate to confronting the possibility of short-term supply interruptions. Rapid filling of the Strategic Petroleum Reserve, particularly during the current soft oil market, offers good insurance against the economic effects of supply disruptions. In addition, if the concentration of U.S. oil imports from Persian Gulf suppliers is the cause of U.S. vulnerability, then a policy of diversifying sources of supply might offer additional protection.

Any policy that encourages conservation of oil contributes both to the longer-run transition away from oil use and to reduced dependence on oil imports in the event of a disruption. An oil import fee would encourage both conservation and additional domestic oil exploration. Other policy options are available to correct market imperfections that impede an orderly transition to other energy forms. A good example is appliance and automobile labeling to guide purchasing decisions toward energy-efficient products.

Energy research and development should be seen as one of a variety of policies available to promote a transition away from imported oil and ultimately, toward renewable energy sources. Energy R&D activities can be seen as a means to accelerate the development of specific energy technologies or as a way to diversify the base from which market forces will select technologies for commercialization.

THE CURRENT ENERGY R&D PROGRAM

During most of the 1970s, the Department of Energy's (DOE) R&D programs promoted specific energy technologies for commercialization in pursuit of energy independence for the United States. Toward the end of the decade, DOE had become the third largest federal source of R&D

funding, with budget authority for R&D amounting to $4.8 billion in fiscal year 1980 (see Table 1). Of that sum, $3.7 billion went for civilian applications. Government funding was provided to projects with adequate market incentives, on grounds that there was an overriding national interest in accelerating the rapid replacement of oil in the economy. As a result, the R&D programs initiated by the DOE in the late 1970s were heavily oriented toward development instead of basic and applied research. Of the total 1980 DOE budget for civilian R&D, 70 percent was devoted to development, a commitment that involved the government in questions of technological choice. Funding went for an array of energy development ranging in sophistication from nuclear to passive solar technologies.

By 1983, DOE's R&D budget had fallen slightly, to $4.6 billion in current dollars. Within that total, the allocation of spending has shifted. Two factors have been the strongest determinants of a recent redirection of the total federal R&D budget--increased defense spending and reduced public intervention in the private market. Defense-related spending by DOE in the 1984 budget request is 68 percent greater than the 1980 level (a real increase of 32 percent), so that the defense-related share of DOE R&D spending has grown from less than one quarter to more than two-fifths of the total. In terms of energy R&D per se, funding for basic research in advanced physics and energy-related sciences has doubled in current-dollar terms. Funding for development, on the other hand, has been reduced from

TABLE 1. **DEPARMENT OF ENERGY BUDGET AUTHORITY FOR RESEARCH AND DEVELOPMENT, FISCAL YEARS 1980, 1983 and 1984** (In millions of current dollars)

	1980			1983			1984 a/		
	Basic Research	Applied Research	Development	Basic Research	Applied Research	Development	Basic Research	Applied Research	Development
MILITARY									
Atomic Energy for Defense	0	178.2	955.0	0.5	219.7	1,506.6	0.5	209.2	1,695.2
CIVILIAN									
General Science and Basic Energy Sciences	518.2	17.6	0	818.3	0	0	993.2	0	0
Nuclear Fission b/	2.0	22.6	976.3	2.6	30.0	804.0	1.9	18.4	873.7
Nuclear Fusion	0	174.0	61.1	0	361.6	0	0	392.7	0
Fossil Fuels	0.6	76.2	652.1	0	213.4	93.6	0	46.2	41.3
Solar and Geothermal	0	46.8	500.0	0	93.0	120.3	0	74.9	25.3
Conservation	0	14.5	347.6	0	88.2	45.4	0	51.6	13.8
Biological and Environmental	0	154.1	0	21.6	146.6	0	18.5	143.0	0
Total Civilian	522.5	572.2	2,549.6	842.5	938.8	1,066.1	1,019.6	732.3	957.0
GRAND TOTAL	522.5	750.4	3,504.6	843.0	1,158.5	2,572.7	1,020.1	941.5	2,652.2

SOURCE: Congressional Budget Office from U.S. Department of Energy, Budget Office data (February 17, 1983).

NOTE: Excludes capital equipment and construction costs, except in "General Science and Basic Energy Sciences" category.

a. Data refer to the Administration's January budget proposal, prior to amendment by the Congress.

b. Includes uranium enrichment.

more than $2.5 billion in 1980 to less than $1 billion in 1984. On the basis of the Administration's forecasts of inflation rates, this represents a real decline of more than 70 percent. Development accounts for only 35 percent of the DOE civilian R&D budget proposed by the Administration for 1984.

Nuclear energy R&D has been least affected by these cuts. In current dollars, total nuclear R&D (for both fission and fusion power) is higher in the 1984 proposal ($1.29 billion) than in either fiscal year 1983 or 1980. In addition, $270 million is requested for R&D related to the construction and operation of the Clinch River Breeder Reactor. In general, though, nuclear R&D spending has been slightly reoriented, away from development and toward research. Corrected for inflation, nuclear development funding proposed for 1984 is significantly higher than for 1983, but it is well below the 1980 level. But compared to development expenditures for other energy forms, nuclear development spending has increased. In the proposed budget for 1984, nondefense nuclear development expenditures account for 91 percent of total energy development expenditures, in contrast to 41 percent in 1980. It should also be noted that about 10 percent of the roughly $1.3 billion spent for nuclear R&D goes to the uranium enrichment and radioactive waste disposal programs, for which user fees are collected to defray costs.

The bulk of the reductions in DOE R&D funding have fallen on non-nuclear energy technologies--conservation, fossil fuels, solar energy, and geothermal energy--with most cuts coming from development. The budget request for development spending in these technologies is only 5 percent of the 1980 level. The proposed fiscal year 1984 DOE budget also calls for a slight real-dollar decline in the research funding for these areas. Thus, the recent pattern of DOE R&D funding has eliminated development funding for non-nuclear civilian energy technologies in order to boost funding for defense activities and basic research, leaving nuclear funding more or less unchanged.

POLICY IMPLICATIONS

These spending patterns raise several issues for Congressional consideration. First, a large body of evidence suggests that the government's record of successfully bringing technologies to commercial use is not good. This implies that, as a general rule, funding for development projects should be limited, leaving commercialization to the private sector and concentrating government efforts on research. If recent trends in energy markets suggest that the need to displace petroleum is less urgent than previously thought, then the federal commitment to the development of specific technologies could be reevaluated. Research in alternative technologies is a suitable response to the long-term problem of displacing oil use, but other policy tools--for example, tax incentives or pricing initiatives--might be more effective in inducing the commercialization of new energy technologies.

In aggregate terms, the DOE R&D budget has already made significant steps toward this reorientation away from commercialization and toward research. Yet the government is still funding very expensive development projects, such as the breeder reactor and synfuels. Loan and price guarantees authorized by the Synfuels Corporation, for instance, dwarf most of the on-budget allocations for energy R&D; the total funding that will be available to the Synfuels Corporation for such guarantees is $17.4 billion. To limit further government involvement in commercialization, two conditions might be applied: first, that there is a strong private interest, backed by financial commitments; and second, that the private enterprise would encounter significant barriers--for example, a likelihood that the technology would be copied by competitors. Even under these conditions, however, other policies, such as antitrust approval for joint research, might be more appropriate than direct federal funding.

Another point concerns the distribution funding of among different fields of energy research. If federal energy R&D policy goal is to provide a diverse technological base from which market forces can select projects for commercialization, then the existing program may be too narrowly focused on nuclear power and synthetic fuels development. The shift from development to research has been applied far more extensively to conservation, to renewable energy sources, and to conventional fossil fuels than to these types of energy. This pattern risks undermining the market-based selection of alternatives to imported oil by subsidizing some technologies and not others. The payoff to private investments in conservation, for instance, appears to have been higher than to investments in nuclear power; yet this is not reflected in the proposed DOE budget. For 1984, government spending for conservation is cut by 82 percent from the 1980 level, while nuclear R&D is funded at a higher level.

Further, the energy R&D program cannot be completely understood by looking only at DOE research. R&D with a bearing on energy policy is also conducted in other areas--such as metallurgy, environmental science, and mining technology--and with the support of other federal departments and agencies (for instance, the Department of Defense, the National Science Foundation, and the Synfuels Corporation). The CBO is now preparing a report assessing the federal R&D effort and presenting a unified federal research and development budget.

Finally, it should be noted that the bulk of the nation's R&D effort--both within the energy field and in other areas--occurs in the private sector. Thus, stimulating private research initiatives is an important avenue of energy R&D policy. The Economic Recovery Tax Act of 1981 provided new tax incentives for private R&D, and tax credits now exist for innovations that conserve energy or substitute renewable energy forms in industry. Consideration might be given to allowing greater cooperation among firms and industries in R&D activities that could lead to improved energy efficiency--for example, allowing or encouraging greater industry-wide cooperation to improve automotive fuel economy. The federal government might relax antitrust restrictions or it could provide seed money for such cooperative efforts and ensure that federally funded applied research programs are better structured to support private-sector efforts. Yet private R&D efforts in the energy area are probably best encouraged by an energy policy that allows for the correct pricing of fuels and brings realistic market signals to energy users and producers.