Overview and Findings

During the 1970s, the environment within which utilities made investment decisions changed from a relatively predictable continuation of past trends to a highly uncertain and complicated maze of interrelated financial, regulatory, and technology considerations. As electric utilities face the 199os, the experiences of the 197os have made them much more wary of the financial risk of guessing wrong and overcommitting to large central station coal and nuclear plants. At the same time, the possibility of being unable to meet electricity demand exists, causing growing concern among utilities as the next decade approaches.

As a result, utilities are now taking steps to enhance their flexibility in accommodating future uncertainties. [n addition to continued and primary reliance on conventional technologies, supplemented by coal combustion technology enhancements to reduce pollution emissions and increase efficiency, utilities are considering a variety of less traditional options. These include life extension and rehabilitation of existing generating facilities, increased purchases from and shared construction programs with other utilities, diversification to nontraditional lines of business, increased reliance on less capital-expensive options such as load management and conservation, and smaller scale power production from a variety of conventional and alternative energy sources. Such options offer utilities the prospects of more rapid response to demand fluctuations than traditional, central station powerplants.

The Role of New Technologies

This report focuses on a number of alternative generating technologies, as well as on energy storage and load management technologies that are new or have not traditionally been used by utilities or other power producers. It examines their technical readiness and the conditions under which they could contribute to meeting electricity demand in the 1990s. The study does not examine in detail the more traditional technologies of central station coal or nuclear, nor does it analyze advanced nuclear or combined-cycle systems and enhancements to pulverized coal plants such as supercritical boilers, limestone injection, or advanced scrubber systems. In addition, we do not discuss more mature renewable technologies such as low-head hydropower or refuse- or wood-fired steam plants. Many of these options are discussed in other OTA reports. It is important to note, however, that these traditional options and their variations are likely to remain the principal choice of electric utilities i n the 1990s.

It is convenient to divide the technologies considered i n this assessment into two basic groups in order to discuss appropriate policy options:

1. The first consists of technologies envisioned primarily for direct electric utility applications and includes integrated gasification combined-cycle (IGCC); large (>100 MW) atmospheric fluidized-bed combustors (AFBC); large (>100 MW) compressed air energy storage (CAES) facilities; large (>50 MW) geothermal plants; utility-owned, fuel cell powerplants, and solar thermal central receivers.
2. The second group consists of technologies that are characterized as suitable either for utility or nonutility applications, and includes small (<100 MW) AFBCs in nonutility cogeneration applications; small (<100 MW) CAES; fuel cells; small (< 50 MW) geothermal plants; batteries; wind; and direct solar power generating technologies such as photovoltaics and parabolic dish solar thermal.

Virtually all of these technologies offer the potential for sizable deployment in electric power applications beyond the turn of the century. The potential is high because these technologies offer one or more advantages over most conventional generating alternatives. In general, they would constitute a diverse array of equipment capable of flexibly meeting future demand growth and increasing the clean and efficient utilization of abundant domestic energy resources. Some are **smaller scale technologies with modular designs that permit capacity additions to be made in small increments with less concentration of financial assets and short lead-times between commitment and coming ''on-line.''** Utilities

may be able to realize notable financial benefits from smaller scale capacity additions, even when the capital cost per kilowatt of smaller units is as much as 10 percent more than that of large-scale capacity additions. other attractive features of these technologies include **reduced environmental impacts, the potential for fewer siting and regulatory barriers, and improved efficiency and fuel flexibility.**

Despite these long-term advantages, however, **at the current rate of development very few of these technologies are likely to be deployed extensively enough in the 1990s to make a significant contribution to U.S. electricity supply.** In both groups of technologies, the ultimate goal of research, development, and demonstration is to reduce costs and increase performance so that these new technologies can compete with more traditional technologies.

For the first group, the likelihood of long preconstruction and construction lead-times—up to 10 years—is the primary constraint. Although these technologies have the potential for much shorter lead-times—5 to 6 years—problems associated with any new, complex technology may require construction of a number of plants before that potential is met. If the longer lead-times are needed, deployment in the 1990s will be limited because of the short time remaining to develop the technologies to a level utilities would find acceptable for commercial readiness.

Technologies in the second group are likely to have shorter lead-times and are often smaller in generating capacity. **For most of them to make a significant contribution in the 1990s, however, their development will have to be stepped-up in order to reduce cost to levels acceptable to utility decisionmakers and nonutility investors, and to resolve cost and performance uncertainties.**

In addition to new generating and storage technologies, **load management** is being pursued actively by some utilities. **Widespread deployment among utilities in the 1990s, however, will depend on: continued experimentation by utilities to resolve remaining operational uncertainties; further refinement of load management equipment including adequate demonstration of communications and load control systems; development of incentive rate structures; and a better understanding of customer response to different load controls and rate incentives.**

For load management as well as certain generating technologies—specifically fuel cells, photovoltaics, solar thermal technologies, and batteries—economies of scale in manufacturing could reduce cost substantially. Of course, these reduced costs will not be realized without substantial demand from utilities or other markets.

Finally, the relative advantages of both groups of new generating technologies and load management varies by region. Factors such as demand growth rates, age and type of existing generating facilities, natural resource availability, and regulatory climate all influence technology choice by utility and nonutility power producers.

Steps for Accelerated Development and Deployment

If electricity demand growth should accelerate by the early 1990s, the first choice of utilities is likely to be conventional central station generation capacity. Because of many well-documented problems, however, there may be severe difficulties in relying on this choice alone and utilities could face serious problems in meeting demand. As a consequence, it may be prudent to accelerate the availability of the technologies discussed in this study. Although not all the technologies would be needed under such conditions, if they were available, the market would be able to offer a more versatile array of choices to electricity producers.

The steps necessary to make these technologies available vary. **With the first group of technologies, it is necessary first to resolve cost and performance uncertainties within the next 5 to 6 years, and then to assure the 5- to 6-year lead-time potential is met for early commercial units.**

In the wake the experiences of the last decade, utility decisionmakers, in particular, are now very cautious about new technology, and they impose rigorous performance tests on technology investment alternatives. **This conservatism makes advanced commercial demonstration projects even**

more important. For the **basic** designs of the AFBC, IGCC, and utility-scale geothermal plants, **the current development and demonstration schedule appears adequate to allow these technologies to be ready by the 1990s.** The cooperative industry-government demonstration efforts, managed by the utilities, have a good track record. **The transition from demonstration to early commercial units, however, will have to be accelerated if the technologies are to produce a significant amount of electricity in the 1990s.** Moreover, variations in basic designs or more advanced designs to enhance performance characteristics further will require additional research and development.

Lead-times being experienced by some early commercial projects in both groups of technologies have been longer than anticipated, partially due to the time required for regulatory review. **Working closely with regulators and taking steps to assure quality construction for the early commercial plants could greatly assist the achievement of shorter lead-times. Emphasis on smaller unit size—200 to 300 MW—wou!d facilitate these actions.**

For the technologies in the second group defined earlier, where cost and performance are of greatest concern, one approach to accelerating development would be to increase or concentrate Federal research and development efforts on these technologies. This could be particularly effective for photovoltaics, solar thermal parabolic dishes, and advanced small geothermal designs.

There are other approaches, though, in which Federal efforts can assist technology development. The reemergence of non utility power production as a growing industry in the United States is providing, and can continue to provide, an important test bed for some of these new generating technologies. **For nonutility power producers, the Renewable Energy Tax Credit (RTC) and the recovery of full utility avoided costs under the Public Utility Regulatory Policies Act of 1978 (PURPA) have been crucial in the initial commercial development and deployment of wind and solar power generating technologies.** In particular, with declining direct Federal support for renewable technology development, **the RTC has supported both development of advanced designs as well as commercial application of mature designs,**

Without some continuation of favorable tax treatment, based either on capacity or production, development of much of the domestic renewable power technology industry may be significantly delayed. Some technologies such as geothermal and wind have advanced to the point, however, where industry probably would continue development, although at a much slower pace, even if the RTC were withdrawn.

Cooperative agreements among utilities, public utility commissions, and the Federal Government can provide another mechanism for supporting advanced commercial demonstration projects of technologies from both groups. A portion of such projects could be financed with an equity contribution from the utility and the remainder through a "ratepayer loan" granted by the public utility commission, possibly guaranteed by the Federal Government,

Other Actions

The rate of deployment of new generating technologies also will be affected by the extent to which utilities and nonutility power producers can resolve such issues as interconnection stanciards, coordination with utility resource plans, and procedures for gaining access to transmission for interconnection and wheeling of power to customers or other utilities.

The contribution of new generating technologies is likely to be enhanced if utilities are allowed to enjoy the full benefits afforded to qualifying facilities under PURPA and if the restrictions on the use of natural gas in power generation are removed. The latter would allow the use of natural gas as an interim fuel during the development of "clean coal" technologies, and give utilities and nonutility power producers added flexibility.

The new generating technologies that appear to show the most promise for significant deployment in the 1990s are those that can serve ad-

ditional markets beyond the domestic utility grid. Such markets are particularly important while the need for new electric generating capacity is low, and while the cost and performance of these technologies are uncertain in grid-connected applications. Indeed, **if priorities must be set in supporting developing technologies, it is important to note that broad market appeal is as important as commercial readiness to their timely development.** In this respect, Federal efforts to help industry exploit foreign markets could be especially important.

The rate of new generating technology deployment also is tied closely to future trends in avoided cost and other provisions established by PURPA, **Long-term energy credit and capacity payment agreements between utilities and nonutility power producers could accelerate deployment. So could mandatory minimum rates or fixed price schedules for utility payments to nonutility power producers or for use as a basis for cost recovery by utilities themselves.**

Finally, to increase the number of **nonutility power projects** employing new electric generating technologies, steps to streamline the mechanisms for wheeling of power through utility service territories might open up new markets for the electricity they produce and thereby stimulate their development.