102
13/39/75

MASTER

Executive Summary

**PRELIMINARY ASSESSMENT
OF A
HYPOTHETICAL NUCLEAR ENERGY CENTER
IN NEW JERSEY**

November 1975

**ENERGY POLICY ANALYSIS GROUP
DEPARTMENT OF APPLIED SCIENCE
BROOKHAVEN NATIONAL LABORATORY**

**Prepared for the
UNITED STATES NUCLEAR REGULATORY COMMISSION
and the
UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
under Contract No. E(30-1)-16**

DISTRIBUTION

UNLIMITED

E X E C U T I V E S U M M A R Y

PRELIMINARY ASSESSMENT OF A HYPOTHETICAL
NUCLEAR ENERGY CENTER IN NEW JERSEY

November 1975

Energy Policy Analysis Group
Brookhaven National Laboratory

Center for Environmental Studies
Princeton University

College of Engineering
Cornell University

Regional Science Department
University of Pennsylvania

J.E. Edinger Associates

Work supported by the Office of Special Studies of the Nuclear
Regulatory Commission and the Division of Biomedical and Envi-
ronmental Research of the United States Energy Research and
Development Administration in the context of the Brookhaven
National Laboratory Regional Energy Studies Program.

BROOKHAVEN NATIONAL LABORATORY

Associated Universities, Inc.

under Contract No. E(30-1)-16 with the

UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

NOTICE
This report was prepared as an account of work
sponsored by the United States Government. Neither
the United States nor the United States Energy
Research and Development Administration, nor any of
their employees, nor any of their contractors,
subcontractors, or their employees, make any
warranty, express or implied, or assume any legal
liability or responsibility for the accuracy, completeness
or usefulness of any information, apparatus, product or
process disclosed, or represents that its use would not
infringe privately owned rights.

DISTRICT IV

UNLIMITED

Rec

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Nuclear Regulatory Commission, nor the United States Energy Research Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
Price: Printed Copy \$6.50 (on foreign purchases, add \$2.50);
Microfiche \$2.25

November 1975

650 copies

PARTICIPANTS IN THE STUDY

ENERGY POLICY ANALYSIS GROUP, BROOKHAVEN NATIONAL LABORATORY:

Philip F. Palmedo
Peter M. Meier
Saifur Rahman
J. Steve Munson

CENTER FOR ENVIRONMENTAL STUDIES, PRINCETON UNIVERSITY:

David Morell
Frank Sinden
Robert Socolow

with Senior Research Assistants:

Patricia Fingerhood	Mark Hainline
Harlan Fuglesten	Gail Peek

and Research Assistants:

Lorrie Asch	Ed Sterling
Elizabeth English	Fred Wright
Judy McPherson	Michio Umegaki
Rita Ormasa	

COLLEGE OF ENGINEERING, CORNELL UNIVERSITY:

Franklin K. Moore
Simpson Linke

REGIONAL SCIENCE DEPARTMENT, UNIVERSITY OF PENNSYLVANIA:

Walter Isard
Thomas Reiner

with: Jose Allende
James Strathman
Roger Van Zele
Phyllis Kaniss

J. E. EDINGER ASSOCIATES, INC.

John Edinger

Acknowledgements

Many individuals and organizations generously contributed their time and insights to the development of this report. We are especially indebted to the following groups and individuals whose interest and expertise have added measurably to this study.

- Mr. John Casazza, Vice President -- Planning and Research, Public Service Electric and Gas Company, and his staff
- Mr. Stuart Pollack, Public Utilities Commissioner, State of New Jersey
- Dr. Glenn Paulson, Mr. Thomas O'Neill and others, Department of Environmental Protection, State of New Jersey
- Mr. William Cramer, Director of Utility Taxation, State of New Jersey
- Mr. Arthur Rosie, Bureau of Financial Regulation Assistance, State of New Jersey
- Mr. Robert Patrick, President, Salem County Chamber of Commerce
- Mr. Joseph Picardi, Atlantic County Planning Board
- The elected officials and staff of Ocean and Salem County
- Mr. Jack Lamping, Public Information Officer, Ocean County
- Ms. Joana Bumbera, Utility Taxation Division, State of New Jersey

EXECUTIVE SUMMARY

Background of the Study

The Energy Reorganization Act of 1974 which established the Nuclear Regulatory Commission (NRC) required the new agency to carry out a survey of possible sites for Nuclear Energy Centers (NEC's). In addition to the site survey, the Commission was to examine the feasibility and practicality of locating nuclear reactors and other fuel cycle facilities in clustered NEC's rather than in the traditional dispersed siting mode. Congressional interest in such centers derived from at least two basic considerations: the possibility of reducing the time required for siting and licensing nuclear power plants and, more importantly, the promise of reducing the risk of theft of materials from the nuclear fuel cycle, particularly materials such as plutonium, from which nuclear weapons can be made.

This study represents one of many inputs to the overall NRC effort. Its preliminary and exploratory nature -- it was carried out in only two months -- can not be emphasized too strongly. We have focused on one of the geographic regions identified in the initial NRC coarse site screening effort. That effort identified the general area around Delaware Bay and the southern New Jersey coastal region excluding the Atlantic City area, as possibly acceptable for an NEC site. The initial screening was based on a very crude geographical grid, and considered only the first-order criteria of seismicity, water availability, land use and population density. This is the only one of the six surrogate NEC sites selected for analysis lying in a coastal region, and therefore using ocean or brackish water for cooling. As such, this analysis of a hypothetical New Jersey site was to be representative of coastal locations in general.

To explore the issues involved in siting an NEC in the southern New Jersey region, we selected two representative counties -- Ocean County, to the north of Atlantic City and Salem County, on Delaware Bay (see Figure 1). Neither is necessarily a preferred region for an NEC site, but each is representative of generic problems in the region as a whole. In Ocean County we could address the problems of using ocean water for cooling and of locating an NEC in a fast-growing, summer resort area; in Salem County we could deal with the problems of estuary cooling and of siting an NEC in a static, relatively undeveloped region. It should be noted that this study deals largely with issues that are specific to the two surrogate site locations in New Jersey, and does not consider many of the generic questions of NEC feasibility and practicality which are being explored by others.

Basic Assumptions

In order to span the range of possibilities, we took as a reference case the largest NEC considered in the overall NRC study, one eventually comprising 40 plants totaling 48,000 Mwe by 2020. Initially the rate of installation of plants is assumed to be one per year, increasing to two per year by 2012. It was assumed that the center would occupy some 75 square miles. Although some consideration was given to employment in associated fuel cycle facilities, the primary focus of our attention was placed on the power generating facilities alone. The question of the feasibility of Nuclear Energy Centers will revolve around the differences between clustered and dispersed siting, of the power plants even though their advisability may be determined by safeguards and similar considerations.

Figure 1. New Jersey.

Energy Demand Projections

An analysis of future electricity demand was made for a region including the Pennsylvania - New Jersey - Maryland (PJM) Interconnection and the three utilities serving the New York City metropolitan area. The total new capacity required in this region by 2020 may be as much as several times the projected 48,000 Mwe capacity of the NEC. In fact, under one set of assumptions concerning future growth of electricity demand in New Jersey (an annual growth rate of 4.5% after 1985), and assuming that the nuclear portion of new capacity would be 60% from 1990 to 2000 and 80% thereafter, the requirements for nuclear capacity in New Jersey alone would exceed that provided by the NEC. As shown by Figure 2, even if demand in New Jersey grows significantly slower than postulated, an NEC of considerable size could be consistent with this state's future energy needs alone. Since it is unlikely that an NEC built in New Jersey to serve primarily energy needs in another state would be politically feasible, the conclusion of adequate load growth in the state is of considerable significance.

Transmission Analysis

A number of significant conclusions emerge from our analysis of transmission requirements. Imposing an NEC onto the existing PJM transmission grid will likely mean construction of a 765 kv network that would not necessarily be required in the dispersed siting mode. The alternative to the new 765 kv network would be excessively large right-of-way requirements for multiple parallel 500 kv lines. But even given the requirement of 765 kv, examination of the associated cost shows that construction of the approximately 1000 miles of 765 kv lines estimated as necessary by 2020 represents 1 to 2 percent of the total construction cost of the NEC itself.

Figure 2. New Jersey capacity requirements.

Moreover, when this order of magnitude of transmission cost is compared to the cooling cost (which runs to perhaps 10% of total NEC construction cost), it becomes apparent that as a locational determinant, transmission is much less important than access to water. Thus the incremental transmission penalty incurred, for example, by an NEC location in the southernmost tip of New Jersey (desirable from a water resource viewpoint) is negligible in comparison to the costs of pumping ocean water to an inland NEC location (say in Ocean County) that is nearer the load centers (and would thus require fewer miles of transmission).

Under the dispersed siting mode, long range transmission requirements would perhaps be no more than 10% of that necessary for an NEC. Thus, it may be that the significant additional transmission mileage required for the NEC requires placement of at least some lines underground. The comparative cost conclusions given above apply to overhead, AC transmission; the cost picture changes substantially if the transmission links must be put underground. In that case, proximity to load centers would be a much stronger locational determinant from an economic standpoint, since underground transmission costs could well run as high as 10% of the total capital costs of the NEC.

Organizational Issues

A number of alternatives exist for the financing, construction and ownership of an NEC, ranging from its being a completely Federal facility to a purely private operation. In fact, a combination of these elements would undoubtedly be involved. A review of organizational possibilities and problems has uncovered no insurmountable institutional obstacles to an NEC in New Jersey, although the difficulties of achieving consensus and cooperation on the project should not be minimized.

Private utilities in the region are already accustomed to joint ownership arrangements, and it appears that construction and operation of an NEC could be handled by a multi-utility consortium, provided that participating utilities could reach agreement on such questions as ownership interests and division of responsibility. While coordination problems are lessened if the NEC is considered to involve primarily the New Jersey utilities, construction of 48 Gwe NEC would be facilitated by inclusion of other utilities, such as those companies comprising the PJM Interconnection and those serving the New York City metropolitan area. These utilities could provide additional financing and expertise and share the risks of the venture.

The primary state role for a New Jersey NEC would likely be in land assembly and site planning, whereas Federal involvement would be primarily necessary for financing the significantly larger front-end costs, and in initial technical planning efforts. Radical restructuring of the private utility sector in New Jersey or creation of a state-owned public power authority are not, in our judgement, pre-conditions for successful implementation of an NEC in the state.

Siting Constraints

Three major siting constraints were considered in the study: seismicity, water availability, and population densities.

As indicated in the environmental reports for the Oyster Creek and Salem Nuclear Generating Stations, no known faults lie in either of the surrogate areas, the closest lying in the Appalachian highlands some 40 miles northwest of Ocean County. Epicenter analysis also indicates that seismicity would not be a significant siting constraint in the surrogate site region.

The choice of cooling technology lies at the heart of any environmental evaluation of an NEC site. In the areas under consideration we have been concerned primarily with four issues: meeting temperature limitations on discharged cooling water; maintenance of salinity levels in receiving estuaries (particularly for evaporative cooling); local effects (due to drift from salt water cooling towers, for example); and cost.

Water resource constraints prove to be quite restrictive. Once-through cooling can be eliminated at both locations: on the Atlantic shoreline, as typified by Ocean County, an NEC would need to be several miles inland, and communicate with the ocean, not with Barnegat Bay. The resulting cost for once-through proves to be in excess of dry cooling. On the Delaware River, even in Salem, thermal standards preclude once-through cooling. Make-up water for evaporative systems would have to be taken from the ocean or the bay, as adequate freshwater sources are not available. Cooling ponds, thus of necessity saline, can be rejected mainly for reasons of leakage into aquifers and supersaturation problems in winter, whereas spray cooling techniques are eliminated for reasons of salt drift. Mechanical draft towers, too, can be expected to result in substantial drift problems, and in addition suffer from high noise levels which may prove unacceptable. One cannot neglect, furthermore, the formidable visual impact that such an array of towers would entail.

Based on our preliminary analysis, the most promising alternative is the use of plume-control wet/dry towers, with make-up and blowdown communicating with the ocean (in the case of Ocean County), and with the lower Delaware estuary (in the case of Salem County). Indeed, this latter conclusion suggests that Salem County, and the artificial island site, is too far up the estuary for water resource reasons, and that a site further down the bay would be more appropriate. This, of course, raises some interesting trade-offs between the cost of pumping cooling water, transmission cost, and infra-structure investments, a topic which should be investigated more thoroughly in follow-on work.

Our preliminary cost analysis suggests that the cost of the recommended cooling alternative is between \$75 and \$80/kw, or about 10% of the total capital cost.

Population densities present a problem to NEC construction in Ocean County, in contrast to the situation in Salem. Ocean's population of over 300,000 is concentrated primarily on its two major islands and along the coast of the mainland. The site meets NRC coarse-screening criteria for distance from a town of 25,000 only because Ocean County's populace is strung out along the entire length of a seaward-side of the county rather than clustered together into any single sizeable cities. An NEC in Ocean County would have difficulty in meeting NRC population guidelines and might raise serious objections regarding nuclear safety as a result of the large summer resort population. The offshore beach islands have very few bridges connecting them to the mainland, and the difficulties of evacuating the hundreds of thousands of residents and beach-goers could preclude the definition of a satisfactory contingency plan in case of an accident on a summer day. This consideration of offshore resort islands, may well represent a minor restriction for hundreds of miles along the East Coast, from Ocean County, N. J. all the way down to Virginia Beach, or even to the Florida Keys.

In Salem County, NRC population guidelines could easily be met, since most of the county's modest total population is found on the banks of the Delaware River, sufficiently far away from where a center would be located. Even here, however, an NEC might have difficulty in meeting NRC guidelines if other states are considered. The far side of the Delaware is also highly populated, with both Wilmington and Philadelphia within 50 miles of any site in Salem County. Locating the NEC further down the Bay would, of course, ease that problem.

Land Use Issues

Decision-making on an NEC must take into account the socio-economic characteristics of proposed sites, since, obviously, these will affect its acceptability and dictate part of what must be done in planning for NEC construction. Ocean County is located in the middle of New Jersey's Atlantic coastline. As noted earlier, the county's population is concentrated in suburban-style developments on two long islands offshore and along its coastal section. A few miles inland begin the Pinelands, a delicate ecosystem above an important ground water aquifer. Already threatened by development, the Pinelands could be in grave danger of destruction if an NEC were built in Ocean County with no attention paid to their preservation. On the other hand, with proper planning and with an insignificant incremental investment, it would be possible to construct an NEC in such a way as to preserve most of the Pinelands from turnover development. The range of possible damage and worry is wide indeed.

The county's economy is based predominantly on shore-oriented recreation, with construction to satisfy a high demand for housing another important component. In the 1960's, Ocean was New Jersey's fastest growing county. Local officials, entrepreneurs, and land-owners all feel that location of an NEC could affect the tourist trade disastrously. Although these concerns for their area's economy are probably exaggerated, Federal, regional, and local

planners must take into account not only those existing attitudes but also the possibility that their predictions are correct and prepare means to compensate them for their losses.

Salem County presents a sharp contrast to its companion New Jersey surrogate site. Whereas Ocean has been the fastest growing county in the state, Salem has remained static. A rural area, Salem has an urbanized strip along the Delaware River opposite Wilmington and wetlands on the Bay along its southern coast. The economy remains predominantly agricultural, accounting for almost 10% of New Jersey's total crop production; there is little industry. If it were not for a high birth rate, Salem would have lost population to out-migration in the past 15 years. In the next 15 years, Salem should begin to grow more rapidly as development driven by Philadelphia reaches it, but at no time is the county likely to begin rocket-like growth similar to that of Ocean. As a result, as a possible NEC site it is superior to Ocean in terms of land availability and population proximity. Salem presents difficulties, on the other hand, in terms of its preparedness for rapid growth, and in terms of political acceptance of a large NEC. Although the citizens appear in favor of up to 10 reactors being built in their county, they might well resist 40 reactors. If this resistance were overcome, construction would require careful planning if its impacts are not to disrupt community life.

Analysis of the economic impact of NEC construction indicates that some \$360 million dollars per year could flow into the local economy. This assumes that 90% of the construction force and 30% of the operations and maintenance force would reside outside the county, commuting in to the NEC for work. Even if most workers settle outside of Salem County, however, the remaining increment to its income could still be substantial in relative terms and the new residents might well change the character of local towns. This would not be the case in Ocean County.

Other analyses have suggested that NEC's could be used as stimuli to sagging rural economies. One problem with this growth-inducement concept is the lack of any special attraction to industry for locating near an NEC. In addition, such suggestions ignore the reason why power parks must be located in remote areas in the first place - to reduce the population at risk to levels manageable in case evacuation is required due to an accident. If the philosophy of remote siting is correct, then nuclear centers should not be allowed to stimulate growth; development not directly required by the NEC itself should be excluded to keep these areas remote. This may require a special effort on the part of the Federal and state governments to keep population levels down within acceptable bounds, through use of buffer zones, transportation planning and so on. The current phenomenon of official disinterest after construction of a plant must not be allowed to continue if NRC population guidelines are to be meaningful. It should be noted that NEC's have an inherent advantage over dispersed sites in terms of ensuring their perpetual remoteness. At the least, purchase of additional land to serve as a buffer zone is possible at a small percentage increment of the NEC's total cost.

We recognize that the idea of an NEC licensee exercising development rights beyond the exclusion zone (i.e. in that zone currently defined as the low population zone, and possibly beyond), represents a significant departure from existing practice and regulatory policy. However, the sheer size of an NEC, and the likely development pressures resulting from its construction, clearly warrant, in our judgement, some modifications to current practice.

Environmental Issues

The brief amount of time available for this study permitted only superficial analysis of the overall environmental impact of a Nuclear Energy Center. Problem areas have been identified, but complete discussion must await further research.

As our discussion of siting constraints indicated, it is possible for an NEC to meet water temperature and salinity restrictions at a cost both of dollars and complexity. The environmental and social costs resulting from the use of cooling towers remain, however, highly uncertain. The question of possible climatological impacts of evaporative cooling at this scale could well be the most critical undertainty in the overall evaluation of NEC's. Marine biological and ecological impacts are also of clear importance but, because of time limitations, could not be addressed in this study.

Water and sewage service would have to be expanded to meet the increased demand caused by the influx of the construction and operational forces. Salem County might have great problems in providing water to enlarged communities, since it has few water systems and they have limited capacity for expansion. Ocean County should have fewer problems in this regard. Both counties would have to plan carefully to widen their sewage service areas if adequate treatment of wastes is to be ensured and pollution of local aquifers is to be avoided. State and Federal aid would be required to guarantee that sufficient planning is performed and communities will have enough funds to expand facilities beforehand to be ready for the newcomers.

One further problem of a NEC, of particular relevance in a resort area like Ocean County, is its visual impact. The NEC's 80-100 towers, 400-500 ft. high could be seen for 20 miles or more in New Jersey's flat land, and the condensation plumes from these

towers would be visible for up to 40 miles. It would be impossible to hide or disguise the presence of 20-40 nuclear reactors and their accompanying cooling towers throughout the entire region. This may well prove to be a significant difference between NEC's and dispersed plants.

Taxation

New Jersey allows almost all taxes paid by utility companies -- a sizeable sum statewide -- to remain in the local municipalities where the company's physical facilities actually are located. Since one vital precondition for a nuclear generating station is an area which is sparsely populated, enormous amounts of revenue thus go to mostly small and rural townships. This factor already applies to dispersed nuclear sites in the state. Lower Alloways Creek (Salem County) and Lacey Township (Ocean County) are two such municipalities; the Salem and Hope Creek plants are in the former, the Oyster Creek facility in the latter. These two townships have experienced an almost unbelievable increase in revenue. As a result of nuclear power plant construction, public spending in these tow municipalities already have reached the saturation point.

The tax implications of a large NEC for small municipalities are staggering. We estimate the facility's annual taxes at \$113 million. Moreover, an NEC of 75 square miles could easily swallow up one or even two townships; in this case, to whom would these taxes be paid locally? At a minimum, they seem to demand that New Jersey alter its present utility taxation statutes so that the entire county and state share in the revenue which would come from an NEC. Intrastate tax-sharing would seem a necessity, for if state laws were left unchanged, small municipalities would become

rich communities over night while other areas of the state would be left to fight hopelessly the continuing battles of municipal and school financing.

Institutional and Political Issues

Perhaps the central issue concerning the practicality of an NEC in New Jersey revolves around resolution of the inevitable political controversy surrounding the project. Implicit in the political debate would be a set of tensions between regional and local interests; between Federal, state and local authority; between majority interests and minority rights; and between pressures for development and demands for environmental preservation. Each of these issues is addressed in some detail in this report.

There is little doubt that a proposal for a large NEC would spark intense public reaction and stimulate emergence of a well-organized opposition. Local response could be expected to be almost entirely negative. This would be especially true in Ocean County and in other coastal areas heavily dependent on the resort and recreation industry; but it is also likely to be the case in almost any other area of New Jersey for which an NEC location might be considered. Members of the Ocean County Board of Freeholders, in discussing the possibility of an NEC, used words such as "maniacal", "suicidal", and "irresponsible"; the Board voted unanimously to express "violent protest" against any such facility. Even in the more static Salem County, where there is favorable reaction to the economic stimulus of power plant construction, it seems doubtful whether a facility of more than about ten reactors could be considered without awakening strong concern.

Although New Jersey remains a strong home-rule state, it appears that state and Federal authority is sufficient to circumvent local attempts to block NEC development. For example, the state's

Public Utilities Commission has the power to over-ride local zoning ordinances which might affect power plant siting. Nevertheless, local authorities could impede or delay NEC development through legal challenges, failure to grant minor permits and the like. More importantly, strong local opposition would undoubtedly have an impact on state and Federal politicians and policy-makers.

New Jersey has a complex set of administrative and regulatory organizations that would have to approve various aspects of an NEC. The state has been undergoing a wave of environmentalism affecting judicial interpretation of the public trust doctrine, resulting in extensive regulatory powers having been granted to the Department of Environmental Protection. Since 1970, in an effort to protect the natural endowment of the state against further encroachment, several acts have been enacted related to land use, including the Coastal Area Facilities Review Act, the Wetlands and the Flood Plains Act. It would be an error, however, to assume that the state government would address the NEC issue with a single voice. For example, while the Department of Environmental Protection might view an NEC as an environmental monstrosity, the Department of Labor and Industry might be favorably disposed to the project based on its positive employment impacts. It is certain that a proposal for a large NEC in New Jersey would become a major statewide political issue. How the issue would be resolved in the political arena would inevitably be determined by the public's perception of the need for further energy development, and of alternatives to the NEC for providing it.

Assuming the emergence of significant state and local opposition to an NEC proposal, the question of Federal pre-emption must be addressed. On the one hand, it appears the Federal Government could circumvent state and local opposition in a variety of ways

(e.g., Federal supremacy in the areas of nuclear energy, in use of navigable waterways, and in interstate commerce). On the other hand, state and local authorities could obstruct NEC development through permit delays and lengthy litigation, and in this way would tend to eliminate one of the potential advantages of an NEC, i.e., reducing the time required for siting and licensing of nuclear power plants. In the end, any Federal-state confrontation over a Nuclear Energy Center would be resolved in the political arena.

Recommendations for Follow-on Research

The major recommendation in regard to follow-on work concerns geographic focus. Time and resource constraints have narrowed the focus of the present study primarily to two counties in New Jersey, a perspective that has proven to be quite restrictive, and which would need to be extended to all of the coastal and Delaware Bay counties in a more comprehensive investigation. The estuarine Cape May and Cumberland County area already appear to be a more desirable location, from both a cooling water and a population point of view, than the two areas studied here. Moreover, many of the problems we have encountered would need to be investigated at the regional level before sufficiently hard conclusions can be reached--for example, the question of including fuel cycle facilities, which we have purposely excluded in the present analysis, would require consideration of nuclear facilities and NEC's throughout the Northeast.

Moreover, given that an NEC were to be located at the eastern periphery of the PJM Interconnection, one would also need to evaluate the opposite shore of the Delaware Estuary in Delaware as a potential surrogate site. Finally, one should also include the option of offshore location for the NEC. Our initial conclusions show that much of the Atlantic Coast south of New York, as typified by Ocean County, may be unsuited as an NEC location for reasons of recreation

and development pressures and unfavorable cooling water constraints. For a coastal state, therefore, the offshore option is worthy of some attention.

A further major extension of the present study would lie in more detailed comparisons of the NEC option with the conventional, dispersed siting option. Thus further investigation of the NEC concept would require comparative scenarios of dispersed siting modes, with more attention placed on evaluation of the differential environmental and economic impacts. Time and resource constraints have not allowed as close an analysis of the alternative dispersed scenarios as would be desirable.

In terms of the subject coverage of more detailed analysis, the major deficiency to be redressed concerns evaluation of the environmental and particularly biological impacts. Although it may be true that many of these are highly specific to the particular site chosen, much could be said in general terms regarding the relative sensitivity of the biota in different candidate areas.

Clearly, there are many specific areas of inquiry that will need more comprehensive analysis than has been possible in the present study. Thus, in the area of demand analysis, a more comprehensive analysis would call for a series of load growth scenarios to be evaluated for both the dispersed and NEC options, with an effort directed at varying key assumptions to understand their importance to projection of demands and to the final decision on the advisability of NEC's. The question of what constitute prudent decisions given large uncertainties in future demands should be addressed.

Much more technical detail will be required in the transmission analysis. Comprehensive transmission scenarios, including load-flow, fault and stability analyses, will need to be constructed for both

the dispersed and NEC cases. And as noted in Section 2.1.4, the possibilities of high voltage DC and cryogenic transmission also appear promising, and thus merit more detailed study.

Turning to land-use and socioeconomic issues, we have already noted that the analysis need be extended to cover uniformly all of the Atlantic Coast and estuarine counties. This is especially true of the economic issues, for which we have addressed only Salem County in any detail in the present study. Moreover, we have identified as one of the key land-use issues in the area the potential development encroachment of much of the Pinelands; and the relationship of an NEC to this issue needs more comprehensive analysis.

More analysis should be made regarding people's attitudes toward energy development in an attempt to understand why the "export of electrons" is perceived to be different from the export of any other goods to the rest of the country, or the world; and to assess more accurately the aesthetic impact of an NEC and its implications for political attitudes. If NEC's are determined to be, in an overall sense, socially beneficial strategies must be developed to overcome the resistance of various non-Federal actors in the process of NEC construction. For instance, utility companies may not undertake to build such large projects as NEC's, preferring to proceed on an incremental basis. If so, how can they be persuaded? Would NRC refusal to approve dispersed sites be effective? Would it be wise? Different state agencies, local governments, or even a state as a whole might resist NEC construction; are they to be persuaded, or coerced?

Although the major issues of organization of an NEC appear to be quite clear, several details should receive attention in follow-on work. Particularly in the area of financing a number of

questions remain in view of the unprecedented size of an NEC. Indeed, if one accepts the necessity and premise of Federal aid, a series of concerns emerge in regard to the desirability, as a matter of Federal policy, or Federal aid to private utilities.

Further consideration must be given to the political and financial costs involved in getting one NEC site approved and the facility built, as compared to the "hassle" involved in getting an equivalent number of dispersed reactors approved and built. Synergistic effects may come into play for an NEC, which would need congressional funding, would have to overcome possible resistance from the utility companies, and would have to secure state and local cooperation. These effects would not exist -- at least not to this degree -- if a comparable number of reactors were to be built in dispersed sites, because the size of the effort would not be so apparent as to excite as much resistance and opponents of nuclear power would not be as aware of their allies elsewhere. However, if an adequate number of acceptable dispersed sites seems impossible to obtain, the larger discrete battle for the NEC might -- on balance -- be smaller than for a series of contested dispersed sites.

Follow-on work will be able to draw on two major studies of generic NEC issues not available to this work. One is the overall NRC effort for which this study is an element. The other is a study recently completed by the General Electric Company for the National Science Foundation.

It is too early to determine the degree to which the generic studies of NEC impacts will form an adequate basis for site-specific analysis. We have assumed, for example, that analyses of optional construction schedules, relative security force requirements (dispersed vs. clustered) and vulnerability to attack will all be adequately covered in the generic work. Although that work will

also contribute some understanding to such questions as differential environmental and economic impacts, it is clear that an adequate understanding of such effects must be based on site-specific and regional analyses.

Thus, a final conclusion of this study is an affirmation of the importance of the issues being addressed and the necessity of approaching these issues through the sort of site-specific and regional analysis toward which our study has been a modest first step.