New Jersey's Energy Infrastructure:
Investing in our Future

March 2006

CENTER FOR ENERGY,
ECONOMIC & ENVIRONMENTAL POLICY

Edward J. Bloustein School of Planning and Public Policy

THE STATE UNIVERSITY OF NEW JERSEY
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New Jersey's Energy Infrastructure

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Acknowledgements

This report is the product of discussions and participation of the Strategic Issues Forum of the Center for Energy, Economic and Environmental Policy at the Bloustein School of Rutgers, The State University of New Jersey. Contributors include Frank A. Felder, Daniel R. Benson, and Scott A. Weiner. A special note of thanks is given to the members of the Advisory Board and the Strategic Issues forum for their participation in the discussions that led to this report and for their edits and comments on initial drafts. Also, the additional stakeholders noted above were very helpful in providing additional input on key energy issues facing other inter-related policy areas.

Preface

This report was written to raise the key issues facing New Jersey's energy stakeholders and policymakers as they relate to energy infrastructure. In doing so, the report highlights the importance of understanding the complexity and interrelatedness of other state infrastructures, such as transportation and telecommunications, and their impacts on energy infrastructure decisions. The goal for this report is to create the initial discussions leading to thoughtful policy solutions that encourage appropriate investment in New Jersey's energy infrastructure. It focuses on these issues through the lens of investor-owned utilities, but examines the broader non-regulated energy industry as it interacts to provide infrastructure investment and policy decisions.

The questions this reports sought to address were as follows:

- Deciding How to Decide: What are the criteria for policymaking regarding New Jersey's energy infrastructure?
- What is the state of New Jersey's energy infrastructure and what are its important linkages?
- Are there policy barriers that prevent the appropriate level of investment in New Jersey's energy infrastructure?
- What role does New Jersey's energy infrastructure play in New Jersey's economic development?
- Should policy changes be considered to ensure appropriate levels of investment in New Jersey's energy infrastructure?

The discussion and findings in the report were the product of a year long set of meetings, whitepapers, and further discussion with key energy stakeholders in New Jersey. The meetings were hosted by the Center for Energy, Economic and Environmental Policy (CEEEP) through its Strategic Issues Forum, made up of CEEEP's Advisory Board members and other invited participants from the organizations represented by Advisory Board members. The mission of the Forum is to provide a place for discussion of important near-term and long-term issues facing the State in a setting separate from the regulatory and ratemaking processes. It is also an opportunity to provide specific, concrete, and practical suggestions that may form the basis of future study like this report. In the words of one participant: "A free hand to look at things dispassionately; good ideas backed by strong analytics."

Each meeting of the Strategic Issues Forum addressed one of the questions related to energy infrastructure. Between Forums, CEEEP worked to tie-up loose ends and researched additional issues. White papers were circulated prior to each Forum to structure subsequent discussions. In addition, the Center developed and issued in tandem with the Forum meetings the appropriate draft chapters of this final report for comment from its members. CEEEP also initiated conversations with other stakeholders interested in New Jersey's energy infrastructure to obtain their views and feedback and to broaden input. These activities were accomplished in hopes of building a robust dialogue that informed and guided the research and writing of this report.

CEEEP intends to convene additional Strategic Issues Forums in the future to address other issues facing New Jersey's energy future. These forums will involve current particpants as well as additional state energy stakeholders. Through these discussions CEEEP hopes to contribute towards a strong forward-thinking policy environment where innovative solutions can be examined and encouraged.

Introduction

The quality of life of the residents of New Jersey depends, in large part, on its energy infrastructure. The ability to access, process, and deliver oil, natural gas, electricity, and other forms of energy is critical to the State's economy and the well-being of its residents. Residents of New Jersey must have access to affordable and reliable energy sources while having their health and environment protected.

Numerous challenges and uncertainties are confronting the State's aging energy infrastructure. They include the growing demand for energy, rising oil and natural gas prices, increasing security threats, calls for uniform reliability standards and modernization across New Jersey's and PJM's electric power grid, and difficulties in siting energy projects.

Compounding these challenges is the fact that energy infrastructure policymaking is difficult. First, infrastructure investments have large-scale costs, economic and environmental impacts, and geographic reach.

Second, infrastructure investments are long-lived, capital intensive and involve sunk costs. Once expenditures are made, they are irreversible and cannot be put to an alternative use. As a result, uncertainty and risk over the need, performance, and implications of an infrastructure investment are critical issues. The design of rate policy that is flexible to address the needs for investment, while addressing sunk costs is important, leading to inherent tradeoffs among these issues.

Third, most infrastructure decisions depend on regulatory approval and ultimately public acceptance and must consider important social, political, and economic aspects. They cross Federal/state/local jurisdictions and boundaries of regulatory agencies, and require the input of many stakeholders with different values and objectives. These decisions produce winners and losers, some that can be identified with pinpoint accuracy and therefore have a strong interest in the outcome while the consequences to other stakeholders are diffused and therefore they have less incentive to be engaged in the decision-making process.

Fourth, they involve complex systems, whose behavior is difficult to predict even if subsystems are readily understood. Important linkages and feedback exist among infrastructure investments. Energy infrastructure investments in one area can affect the cost and performance of other energy and non-energy infrastructure investments. Cost and benefits of infrastructure investments may not be readily quantifiable and may be external to those that pay for and obtain the benefits of the investment. These systems are also technically complex and technology changes over time, creating a risk of future stranded investments. Policymakers must weigh issues, such as length of depreciation time for investments, to encourage investment in new technology and recoup investments while more fully understanding their benefits.

Given these challenges and uncertainties with energy infrastructure investment and its importance to the well-being of residents of New Jersey, this energy infrastructure study was undertaken at the request of the members of the Center of Energy, Economic, and Environmental Policy (CEEEP) Advisory Board and participants of the Strategic Issues Forum. The Forum was initiated by CEEEP in September 2003 to bring together leaders from New Jersey regulated utility companies with government decision makers and members of the Edward J. Bloustein School of Planning and Public Policy faculty. Additional forums to continue the dialogue initiated by this group, including other stakeholder groups are planned for the future. A listing of the Advisory Board and Strategic Issues Forum members is provided at the beginning of this document.

Given the energy infrastructure policymaking challenges discussed above, it is critical that policymakers and stakeholders have a framework and process that promotes long-term thinking, involves strategic planning, and provides the state with meaningful and diverse options to choose from in order to address future needs. The goal of this report is to raise some of the critical issues that policymakers should confront, underscore the complexity and interrelatedness of policymaking in this area, and provide a common starting point for future discussions about policy solutions.

This study was part of a yearlong process that included a series of structured discussions with the Forum. Five discussions were held with the Forum. The first topic was on "deciding how to decide." It involved identifying and defining the criteria that policymakers should use regarding making decisions pertaining to New Jersey's energy infrastructure. The second discussion was on the state of New Jersey's energy infrastructure with particular emphasis on understanding the linkages within segments of the energy infrastructure and among the energy infrastructure and other critical infrastructures. The third discussion was on describing the policy influences that affect the level of investment in New Jersey's Energy Infrastructure. Given the importance of the state's energy infrastructure to its economic vitality, the fourth Forum was on the topic of what role does New Jersey's energy infrastructure play in its economic development. Finally, the fifth Forum raised the topic of what policy changes, if any, should be considered to ensure appropriate levels of investment in the state's energy infrastructure.

During the discussions with the Forum, in order to make the work more manageable, it was decided to focus this study on investor-owned energy utilities, i.e., electricity and natural gas utilities. This is not at the exclusion of other parts of the energy infrastructure or its interrelationships with other critical infrastructures, such as oil and transportation. Changes in the regulator and legislative roles of the investor-owned utility in infrastructure investment decisions has limited and fragmented infrastructure investment decision-making. Other actors such as wholesale energy suppliers, generation owners, and distributed energy suppliers as well as entities such as PJM all have important roles in coordinating infrastructure investment decisions beyond just investor-owned utilities and are also included in the discussion of the report.

Other discussions were held with stakeholders that were not part of the Forum. They included informal discussions and symposia in which the Center presented its work and obtained feedback. A listing of these stakeholders is also provided at the end of this report. This report is a product of substantial interaction between the Forum, the Center, and various stakeholders. Although the report's findings and recommendations are informed by these discussions, the report is the work of the Center and may not necessarily represent those of Forum participants and other stakeholders. For brevity, when this report mentions stakeholder discussions, it does not always distinguish between those that occurred with Forum participants or with others as part of the stakeholder symposia or discussions with individual stakeholders.

This report makes the following findings:

- Deciding how to decide is a fundamental topic that policymakers and stakeholders must grapple with but too often do not prior to specific decisions and crafting policies.
- The fundamental goal of energy infrastructure policymaking is improving the quality of life for New Jersey residents and the three major values to do so are economic strength, human health and safety, and protection of natural resources.
- There are important linkages between existing portions of the State's energy infrastructure and other non-energy infrastructures that must be understood and considered when formulating energy infrastructure policies.

- There are no comprehensive reports or studies evaluating New Jersey's energy infrastructure, and data regarding the existing major components or future additions are not available in one centralized database.

- Substantial policy barriers – uncertain cost recovery, regulatory and market incentives, jurisdictional conflicts, and difficulties in quantifying benefits especially compared to costs – exist that limit effective energy infrastructure policies.

This report recommends for the consideration by policymakers and stakeholders three policy initiatives:

- The institutionalization by the New Jersey Board of Public Utilities of pilot programs for new technologies by investor-owned utilities. Pilots have been recognized as an effective mechanism to demonstrate new technologies, new regulatory programs, and other innovative ideas. Encouraging pilots and institutionalizing the process of their approval, data collection, subsequent evaluation, and finally the decision to expand or end the pilot program would greatly enhanced the innovation and adoption process.

- The assignment of an infrastructure planning component to the Energy Master Plan committee to examine proposed energy utility infrastructure investments and to attempt to quantify their costs and benefits and a full discussion of investment options. This would reduce barriers created by multiple, fragmented jurisdictional reviews across different levels of authority and government that are able to investigate fully these issues. Most importantly, such a responsibility within the Committee would address the need to look at energy utility infrastructure in a comprehensive, integrated fashion given the interdependencies among critical infrastructures in New Jersey.

- The study by the state of the impacts of changes in rate regulation through decoupling. Decoupling breaks the link between a utility's sales and revenues. The existing link, according to some, provides utilities with a strong incentive to increase sales instead of providing cost-effective and environmentally sound energy services. The recommended study would consider possible policy options and potential effects of decoupling on energy infrastructure and investment in New Jersey. It would investigate how decoupling would be designed to align utilities' financial incentives with the state's energy goals.

This report is organized as follows. The topic of the first chapter is discussing possible criteria upon which policymakers can use to evaluate infrastructure policy and decisions and describing New Jersey's energy infrastructure and its linkages. The energy infrastructure description serves to raise some important issues that should be considered. Chapter 2 discusses the status of New Jersey's energy infrastructure, and evaluates its economic impact and role in the state's economic development. Chapter 3 describes how policy barriers impact upon energy infrastructure investment, and discusses policy initiatives to encourage energy infrastructure investment planning and policy. The appendix catalogues the various elements of the energy infrastructure located in New Jersey.

Chapter 1: Description of New Jersey's Energy Infrastructure and Its Linkages

I. Introduction to Chapter 1

The starting point for the description of New Jersey's energy infrastructure and its linkages, both among components of that infrastructure and among it and other critical infrastructures, are the values, objectives, and criteria for making energy infrastructure decisions. In other words, how should policymakers decide how to decide when making policy in this arena? This topic is the first major section of Chapter 1.

In the discussions with stakeholders on deciding how to decide, this report concludes that this is a fundamental topic that policymakers and stakeholders must grapple with and do so prior to making specific decisions and policies. In addition, by laying out the values, objectives, and criteria prior to policy formulation, policymakers can help in expanding the range of alternatives that might be available to them when making their decisions. Without some sense of what is really important to policymakers, those that invest, operate, and maintain energy infrastructure investments will not be as able to meet the desired objectives.

In presenting the findings and conclusions in this section of the report, some of the stakeholders' comments and discussion is reported in order to provide insight into their thinking. The intent is not to provide a verbatim transcript or a comprehensive summary of the discussions.

The second major section of Chapter 1 is a detailed description of New Jersey's energy infrastructure system. Besides providing the context for the rest of this report, this description also raises some important policy consideration. Supplementing the description in this chapter is an appendix that provides additional details.

Chapter 1 is organized into six sections. After this Introduction, Section II discusses possible policy criteria. Section III is an overview of New Jersey's energy infrastructure, and elaborates on the linkages among the state's energy infrastructure and other infrastructures, including "soft" systems. Section IV provides a more detailed description of the key issues regarding the state's investor-owned energy utilities and infrastructure. Section V concludes this chapter.

To provide some guidance to policymakers, this report contains several Policy Highlights that summarize key findings and conclusions on specific issues that the report raises. The two Policy Highlights for Chapter 1 are on the topics of deciding how to decide and the linkages between the energy infrastructure and non-energy infrastructures.

II. Deciding How to Decide

To avoid a process that produces a mere wish list of projects, proposals, and policies, a conceptual framework is needed that structures collaboration, effectively communicates information, and identifies the causes of opposing views with the possibility of reducing differences. This framework should also contribute to the state's efforts to arrive at consistent, informed, and transparent policy insights and accommodate the difficulties noted above regarding infrastructure policymaking.

Policy Highlight #1 - Deciding How to Decide

Energy infrastructure decisions are challenging because they involve complex systems over long periods of time in which many key factors that influence the outcome are uncertain. They require regulatory approval in many cases that span different regulatory bodies and jurisdictions and at the end of the day depend on public acceptance.

In addition, these decisions must tradeoff between multiple objectives such as cost, economic impact, environmental consequences, and performance. Stakeholders may tend to focus on one or two of the objectives at the exclusion of the complete range of objectives that policymakers may want to accomplish. In some cases energy infrastructure decisions produce clear winners and losers and therefore these parties make their concerns heard in the decision-making process, whereas the consequences to other stakeholders are diffused and therefore they have less incentive to be engaged.

In the conducting interviews with stakeholders, it became readily apparent that there is not an agreed upon set of consistently defined objectives that stakeholders believe that policymakers should use in their deliberations. Several broad areas of agreement exist in the areas of economic strength, human health and safety, and protection of natural resources, although different stakeholders characterized these areas differently and place different emphasizes on the relative importance of these objectives.

In some cases, there are substantial definitional differences in key terms and concepts that need to be resolved before trying to determine whether stakeholders agree upon a common set of objectives. Some terms, for example the word “proper” in the context of the Board of Public Utilities’ (BPU) mandate for “safe, adequate, and proper” service, are inherently vague. Others words, such as “security” mean very different things in different contexts. Security, particularly after the events of 9/11 means physical safety from attack. In the context of the reliability of electric power systems, however, security means the ability of the power system to function upon the loss of a system component.

It is, of course, impossible to obtain agreement among all stakeholders regarding the objectives and their relative importance in energy infrastructure and policymaking. At the end of the day, the political and regulatory process will have to make the final determination of which objectives are of primary concern. There is a choice, however, regarding how this selection and prioritization of objectives is performed. Either policymakers can make decisions, and from these decisions objectives would be implicitly determined, or they can explicitly identify, define, and rank the importance of the objectives that they will use in their deliberations.

Furthermore, by laying out the values and criteria prior to policy formulation, policymakers can help in expanding the range of alternatives that might be available to them when making their decisions. Knowing the objectives beforehand should enable planners to fashion realistic and meaningful alternatives, giving policymakers a real choice. Otherwise, policymakers may be confronted with the false choice of accepting the unacceptable status quo or adopting a solution that was fashioned in crisis. Moreover, without some sense of what is really important to policymakers, those that invest, operate, and maintain energy infrastructure investments will not be as able as they should to meet the desired objectives by thinking creatively about different strategies to do so.

It is also important for policymakers to distinguish between fundamental goals and the means used to achieve those goals. This distinction enables the resolution of some differences among stakeholders when these differences stem from how to accomplish the fundamental goal and not with the fundamental goals themselves. It also narrows the discussion to the efficacy of the means, which may be resolvable with technical analysis.

This report concludes that deciding how to decide is a fundamental topic that policymakers and stakeholders must grapple with and do so prior to making specific decisions and crafting policies. Although this point seems so basic and should be done, it is almost always not. If policymakers and stakeholders spend some time on deciding how to decide, this effort will be rewarded. It will serve to solidify areas of agreement, narrow and focus topics of disagreement, enable planners and industry to anticipate problems and formulate meaningful alternatives before crises develop, and make the policymaking process more accountable and transparent. To paraphrase the old adage, "If you do not know where you are going, any policy will get you there."

A. Multi-Criteria Decision-making (MCDM)

One effective framework that has been applied to many similar efforts is multi-criteria decision-making (MCDM)[1]. This framework enables the consideration of many conflicting objectives that policymakers might have on a given issue. In the case of energy infrastructure policymaking, there are numerous competing criteria such as costs, environmental impacts, safety, and security, among others. MCDM aids policymakers in their efforts in identifying the values, objectives, and criteria that they are using to make their decisions, structure these values, etc. in a hierarchical relationship so that their relative importance is made explicit, and to make trade-offs among them. It is a formal process that attempts to make decisions more rigorous, transparent, and rational.

Multi-criteria decision-making is conducive for collaboration for several reasons. First, it explicitly incorporates and distinguishes different values and their emphasis among stakeholders, different and possible competing objectives and associated tradeoffs, and uncertainty in decision-making. The process of implementing multi-criteria decision-making enhances systematic and productive discussions. In some situations, it may identify policy options that satisfy several different stakeholders that have different values and policy criteria. In other cases, it may discover policies that satisfy some criteria with little negative impact on others. Finally, in situations where basic tradeoffs between criteria are pronounced, multi-criteria decision-making disentangles values from analysis, which may narrow the scope of disagreement among stakeholders.

As employed in this report, MCDM is a vehicle to bring to the forefront key goals, issues, and tradeoffs related to New Jersey's energy infrastructure and associated policymaking. The purpose is not to use MCDM as a formal and rigid tool, nor is its use meant to suggest that it is the only way to approach these issues. Moreover, to apply effectively MCDM to energy infrastructure decision-making, it is critical to understand the linkages within the energy infrastructure and among it and non-energy infrastructure, which the second half of this chapter addresses.

During initial discussions with Forum participants, one challenge to the practicality and usefulness of this approach pointed out that while this may be a useful academic exercise, when a real problem develops, it is a matter of looking at the available options, negotiating with interested parties, and selecting the best option. The example cited to support this viewpoint was the recent siting of a major transmission line in the Pinelands by Conectiv, which took an extended period of time and only occurred when it became a crisis Although the issue was resolved, decision-making by crisis limits the choices available to policymakers.

This view that a MCDM approach may be too academic and not useful in real decision-making is a valid and legitimate concern. The response to this statement is that without some prior planning, anticipation of issues, and consensus on which values and goals to pursue, the list of available options is

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[1] See, for example, B. F. Hobbs and P. Meier, Energy Decisions and the Environment: A Guide to the Use of Multicriteria Methods, Kluwer Academic Publishers, Boston, 2000.

considerably smaller than would be available to policymakers otherwise. If, for example, the reliability problem necessitating the need for additional transmission was anticipated because there was a planning process in place that contained the elements of MCDM, then perhaps other possible options could have been evaluated and perhaps pursued. Of course, MCDM even with sufficient planning does not guarantee the timely development of meaningful alternatives unless there is also sufficient political and industrial leadership to drive the development.

Of course, detailed evaluations of key infrastructure issues requiring a particular analytical approach are also required, and their results can easily be incorporated within this framework. It also does not preclude collapsing multiple objectives into a single metric, such as dollars, which is done in a cost-benefit approach.

The general steps in this process are the following:

1. Identify the values, objectives, and their measurable criteria that we should use;
2. Consider the alternatives that are available given the policymaking context;
3. Assess the uncertainties that affect our alternatives; and
4. Evaluate the consequences of each alternative given our criteria and the uncertainties.

As part of the preparation for this report, the Center went through these steps with various stakeholders. This chapter reports on the discussions pertaining to the first step in this process.

B. What are the Criteria for Policymaking Regarding New Jersey's Energy Infrastructure?

There is a long list of possible criteria to consider in energy infrastructure policymaking: costs, environmental impact, reliability, economic development, security, public acceptability, fuel diversity, price volatility, etc. In thinking through the responses to this question, this report organized the criteria discussion, as well as asked stakeholders to do so as well, around the following:

1. Criteria should serve values, things that ultimately matter to the stakeholder and the reasons for making the decision in the first place. Whereas values are general, the criteria are to be used as the foundation for energy infrastructure policy analysis.

   Stakeholders should think through their values and identify criteria that serve those values. For instance, improving the quality of life for New Jersey residents is a value. Increasing the reliability of a distribution system by 10% in five years may be a criterion that supports this value.

2. Within the category of criteria, it is important to distinguish between fundamental goals and means. For instance, reduction of sulfur dioxide emissions could be thought of as a means serving two fundamental goals of improving public health and reducing property damage.

   Another example: is the objective of New Jersey having a world-class energy infrastructure a fundamental goal or a means? If the latter, what are the fundamental goals of a world-class energy infrastructure?

   This distinction between fundamental goals and means is important. It enables the resolution of some differences among stakeholders when those differences stem from how to accomplish the fundamental goals and not the fundamental goals themselves. It also narrows the discussion to the efficacy of the means, which may be resolvable with technical analysis.

3. Where possible, criteria should be quantifiable with performance measures. In some cases, there may be multiple ways to quantify a criterion whereas in others, different ways to quantify a criterion may suggest that there are actually two distinct criteria. For instance, two possible measures of a low-cost energy infrastructure are actual costs and the change of costs over time.

But these two measures could also be thought of as two distinct criteria, one regarding the level of costs and another regarding the rate of increase.

Not all performance measures are equal, however. Some may be more direct measures of a particular criterion than others. In addition, performance measures are only as important as the criterion that they are measuring and not all criteria are equally important.

C. Hierarchy of Values, Fundamental Goals, and Means

CEEEP proposes the following hierarchy of values, fundamental goals, and means for consideration based on its discussions with stakeholders. Clearly, participants in the process and other stakeholders could have their own hierarchy. Others may agree with the structure of the proposed hierarchy but place different weights reflecting the relative importance of different values.

Stakeholder discussions revealed that key terms that describe fundamental goals and means are not used consistently. Some terms, for example the word "proper" in the context of the Board of Public Utilities' (BPU) mandate for "safe, adequate, and proper" service, are inherently vague. Others words, such as "security" mean very different things in different contexts. Security, particularly after the events of 9/11, means physical safety from attack. In the context of the reliability of electric power systems, however, security means the ability of the power system to function upon the loss of a system component. One objective of the proposed hierarchy presented below is to provide consistent and precise definitions of terms so that discussions among stakeholders can engage the issues and avoid definitional debates.

In addition to the definitional differences, stakeholders had divergent views on characterizing the top-level value that energy infrastructure policy should pursue. These differences occurred even within the energy utility group of stakeholders. Some saw the primary value as "reliability" with three major goals of "safe, adequate, and proper service." Supporters of this view noted that this was consistent with the New Jersey Board of Public Utilities statutory mandate. Others thought that the fundamental value that should be pursued was broader than reliability, although reliability is a critical goal, and that this fundamental value should include quality of life issues. One company representative used this discussion to highlight his belief that his company is a supplier of "life-line" services. Others saw the access to universal service as a key value in New Jersey's energy policy.

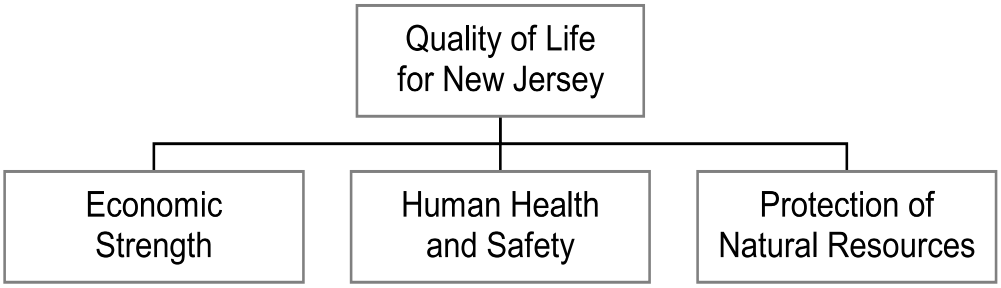

Figure 1: Top-two Tiers of Hierarchy of Values and Fundamental Goals

Of course, it is up to policymakers to define and articulate fundamental value and goals that energy utilities are required to fulfill as part of their obligations. Clearly, the types of policies and associated infrastructure investments and responses by utilities depends heavily on whether the fundamental goal that energy policymakers are pursuing is relatively narrow, as in the case of reliability, or relatively broad, as in the case of improving the quality of life of New Jersey residents.

Figure 1 presents the top-two tiers of the proposed hierarchy. The fundamental value is the maintenance and improvement of the quality of life of New Jersey residents. Having an affordable, safe, and well performing energy infrastructure is not an end in and of itself, but a means to accomplishing this overarching value.

Clearly, there are other infrastructures that are also required to achieve this fundamental goal of quality of life for New Jersey residents, such as the health care system and the educational infrastructure.[2] In addition, there are many important linkages among the energy infrastructure and other critical infrastructures. For example, New Jersey's telecommunication infrastructure and security/emergency response infrastructure depends on the state's energy infrastructure. Within the energy infrastructure, there are also important linkages among various components, for instance between natural gas transmission and electricity generation. These linkages are discussed more extensively in Sections III and IV of this chapter. In addition, the impacts of decisions made by investor-owned utilities for energy infrastructure extends well beyond just New Jersey and have a large impact on society in general. While this is the case, the focus of the report is on the values and fundamental goals for New Jersey's infrastructure, but it recognizes that the decisions made regarding these values and goals have a broad impact.

At the same level within the hierarchy, the order of the boxes does not denote relative importance, for example, the order of the three fundamental values in the second row of Figure 1. In fact, it is easy to imagine that different stakeholders, for instance the business community in contrast to the environmental community, may place different weights on some of these goals, such as economic strength versus protection of natural resources.

The hierarchy at this level captures the stakeholder discussions in the sense that all of the values that were discussed can be categorized under one of these three headings, as is shown below. In addition, a review of value documents published by two different groups, New Jersey Future and the New Jersey Business & Industry Association (NJBIA), also contain similar values pertaining to energy infrastructure that are presented in Figure 1.[3] Some of New Jersey Future's goals included economic vitality, healthy people, natural and ecological integrity, and protected natural resources. The first value lines up with economic developmentstrength, the second with human health and safety, and the third and fourth with protection of natural resources. NJBIA's principles include a strong focus on economic development, reliable and affordable energy supply, and sensible environmental laws and regulation that protect the public's health. These values of NJBIA align with the first two values that the Center proposed (economic strength and human health and safety).

Each of the three fundamental goals, economic strength, human health and safety, and protection of the natural environment, is further discussed in turn.

i. Economic Strength

Forum participants generally agreed that economic activity requires a reliable energy infrastructure. Much of the discussion centered on what is meant by reliability. For some, it is technical definition of "how many 9's" should the system be. (A system with three 9's is 99.9% reliable.) For others, reliability is an economic concept: a reliable energy infrastructure means that it makes the business users of the infrastructure more competitive. Under this economic definition, issues of whether and how different users could purchase different levels of reliability, and who pays, become important.

Figure 2 presents the next level of analysis developed by CEEEP for the fundamental goal related to economic strength.

The hierarchy contains three fundamental goals for economic strength: energy infrastructure costs and

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[2] For a somewhat similar approach but in a broader context, see New Jersey Future, Living with the Future in Mind, December 2000 (hereafter New Jersey Future) and New Jersey Sustainable State Institute, Living with the Future in Mind III: Goals and Indicators for New Jersey's Quality of Live, December 14, 2004.

[3] See footnote 2 for the New Jersey Future report citation; see also the New Jersey Business & Industry Association, Public Policy Principles & Priorities, 2004-2005.

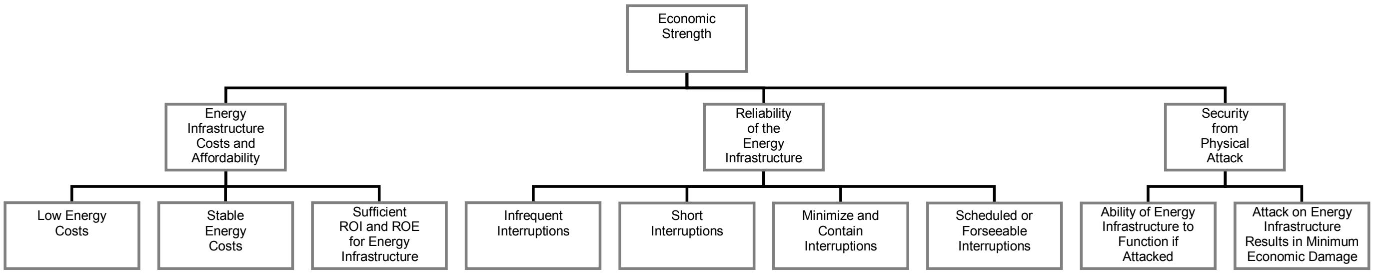

Figure 2: Further Details Regarding Economic Strength

affordability, reliability of the energy infrastructure, and security from physical attack. Affordability has three goals: low energy costs, predictable energy costs, and sufficient return on investment (ROI) for investors in the energy infrastructure. Separating energy infrastructure costs into two categories, low costs and predictable costs, captures the fact that some energy infrastructure policies may result in higher energy prices on average, but in less volatile ones. The access to low-cost and affordable energy that many stakeholders are proponents of would fall in this area. Universal Service is a policy aimed at addressing low energy costs and the fundamental goal of energy infrastructure costs and affordability. In turn, New Jersey's comprehensive low-income assistance program, seeks to improve the fundamental value of the state's quality of life for its residents. In addition, some consumers and industries may, if exposed to predictable energy prices, be able to respond to reduce their total energy costs compared to situations in which energy prices are unpredictable. Sufficient ROI is important in order to capture both a return on debt and equity (ROE), not just for investors, but also for the banks that provide financing for long term debt. Sufficiency is also key, because without sufficient ROI and ROE for investors in the energy infrastructure, investments will not occur, which over the long-term will increase the cost of maintaining the existing infrastructure. This will adversely affect New Jersey's investor-owned energy utilities and their competitiveness in the marketplace. Their ability to earn a reasonable ROI and ROE will be dependent on access to financial markets on reasonable terms.

The reliability goal, consistent with reliability theory, is divided into four categories: frequency, duration, size, and predictability. For example, all else equal, a smaller frequency of reliability events is preferable to a greater frequency. Different consumers and industries, however, may have different preferences among these goals, for example frequency versus duration, or scope versus size.

The final goal under economic strength is security from physical attack. Under economic strength, this goal focuses on minimizing the economic consequences of a physical attack. The goal of human health and safety, discussed below, also contains a security goal, but it relates to the human safety aspects of a physical attack. This economic strength security goal is divided into two parts. The first is the ability of the energy infrastructure to function if attacked; the second is the ability of the infrastructure to minimize the economic consequences of an attack on the infrastructure. An attack on the energy infrastructure may damage or destabilize part of it, but that may or may not result in substantial economic damages. For instance, damage to the transmission system could have substantial economic damages if the energy infrastructure contains very little distributed generation compared to an infrastructure with significant distributed generation. In addition, it must be determined what level of functionality the infrastructure should have if attacked. Having an energy infrastructure that functions enough after an attack to provide power to critical public safety infrastructure is very different from having the infrastructure able to function for all users after an attack. The investments needed for the former may be less costly, while the economic impact of such a policy may be greater in the event of an attack.

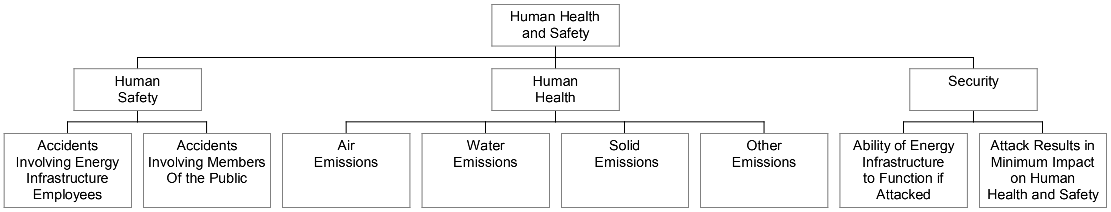

Figure 3: Further Details Regarding Human Health and Safety

Each of the goals in the bottom row of Figure 2 can be evaluated with one or more performance measures. In some cases, performance measures can be empirically based when sufficient data exists. In other cases, performance measures may have to be determined by models, calculations, or expert judgment. For instance, performance measures regarding the cost of energy can be empirical due to the readily availability of energy price data. Some performance measures of the reliability of the electric power system or the ability of the energy infrastructure to withstand an attack may not to be empirically based given their infrequent occurrence. Finally, some "performance measures" may be better described as indicators. For instance, levels of emissions of nitrogen oxide may indicate the amount of ozone but is not a direct measure of ozone itself. The Center does not propose a set of performance measures in this report. These measures may vary based on the particular decision or policy that is under consideration.

ii. Human Health and Safety

Human health and safety required little discussion because the Forum agreed upon its importance. The discussion quickly centered on the relationship and overlap between human health and safety and environmental concerns. Some Forum participants made it clear that there are environmental issues that are not covered by human health and safety.

Figure 3 presents the next level of detail developed by CEEEP regarding the fundamental criterion of human health and safety.

As Figure 3 indicates, three goals are proposed under the fundamental goal of human health and safety. The first is human safety and refers to the safety of workers while working on the energy infrastructure and residents of New Jersey, whether at work or not. Human safety includes mortality and morbidity related to energy infrastructure accidents. The second goal is human health. This includes the health impacts to all New Jersey residents from various emissions – air, water, solid, or other – from the energy infrastructure. The final goal, security, is similar to the security goal under economic strength, but now refers to security that impacts human health and safety.

iii. Protection of Natural Resources

Figure 4 presents the proposed hierarchy for the value of protection of natural resources. It consists of two major branches, open space and ecological systems.[4] Open space includes farmland, parks, beaches and other recreational areas. Ecological systems include material inputs into economic activity, life-support services, environmental amenities used for recreation, and processing of waste products discharged into the environment.[5]

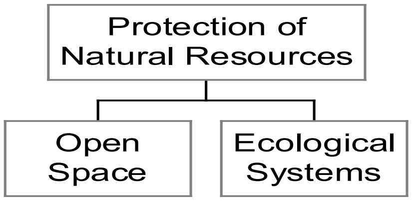

Figure 4: Proposed Hierarchy for the Protection of Natural Resources

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[4] Related to protection of natural resources, New Jersey Future uses the following indicators: freshwater wet land impacts, nesting bird populations, river health/dissolved oxygen, marine water quality, farmland, and preserved and developed land.

[5] See Freeman, A. Myrick, III, "On Valuing the Services and Functions of Ecosystems," Ecosystem Function and Human Activities: Reconciling Economics and Ecology, eds. David R. Simpson and Norman L. Christensen, Jr., New York: Chapman and Hall, 1997.

Table 1: Possible Performance Measures for Open Spaces and Ecological Systems

Goal	**Possible Performance Measures**
Open Space	• Total acres of New Jersey farmland • Total acres of preserved land • Total acres of developed land • Sprawl index[6] o Residential density o Neighborhood mix of homes, jobs, and services o Strength of activity centers and downtowns o Accessibility of the street network
Ecological Systems[7]	• Total acres of wetlands • Dissolved oxygen in rivers • Measures of biodiversity • Forest aesthetics • Amount of recreational fishing

Table 1 lists performance measures for open spaces and ecological systems. The purpose of Table 1 is to suggest some possible performance measures in order to illustrate how performance measures should be developed in order to measure the level of attainment of specific goals. Ideally, the development of performance measures for all of the goals in Figures 2 through 4 would occur as the first step in analyzing a particular energy infrastructure policy or decision. Different alternatives could be compared based on these performance measures. The development of performance measures is beyond the scope of this study, and it is left for future consideration. Furthermore, the New Jersey Sustainable State Institute is developing long-term energy performance measures as part of its ongoing work.

This chapter now turns to describing the energy infrastructure in New Jersey and its linkages within the energy infrastructure and among other non-energy infrastructures. Understanding these linkages is important in order to inform policymakers of the possible consequences and interactions of individual policies and decisions but also among different policies.

III. New Jersey's Energy Infrastructure

A. Energy Infrastructure Framework

The previous sections established the framework of values and criteria for making energy infrastructure decisions. This section creates a framework for examining the many diverse aspects of New Jersey's energy infrastructure. While the framework simplifies many of the complex trade-offs that occur at different stages of energy infrastructure as well as across them, its purpose is to help separate out these issues by each stage and to highlight the need to consider them in a global or holistic manner.

Within the category of energy infrastructure, many interdependencies occur. Natural resource extraction (oil, natural gas, and coal) requires large investments of energy. In addition, energy must be expended to transport, process, and distribute these resources from source to use. For example, coal shipments for coal-fired power plants rely on electrified rail lines in the Northeast. Natural gas is also used to generate electricity at power plants that rely on steady supplies. Nuclear power plants and other power suppliers are dependent on auxiliary power

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[6] See Reid Ewing, Rolf Pendall, and Don Chen, Measuring Sprawl and Its Impact, Smart Growth America, undated, available at www.smartgrowthamerica.org

[7] See Center for Energy, Economic & Environmental Policy, Economic Impact analysis of New Jersey's Proposed 20% Renewable Portfolio Standard, December 8, 2004.

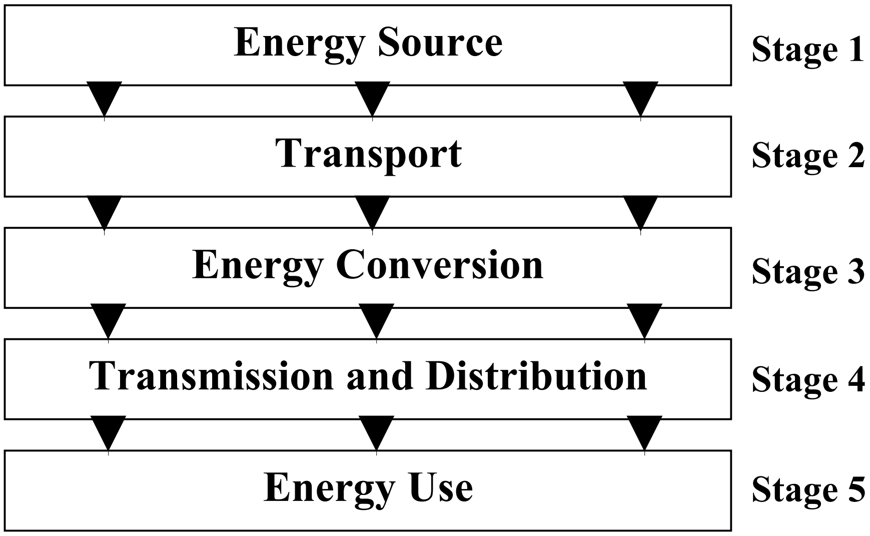

Figure 5: Fives Stages of Energy Infrastructure

for safety systems and to restart after an extended blackout. Backup power in the form of generators and batteries is used throughout to maintain levels of reliability. Alternative fuels such as hydrogen require either electricity from the grid or renewables for their generation through electrolysis. Fossil fuel sources, such as natural gas are also used to provide hydrogen for fuel cells. Policy decisions, while aimed at one aspect of the energy infrastructure, affect many other aspects of the overall energy system. These interdependencies and their impact on investor-owned utilities can be examined by separating the different aspects of the energy infrastructure into five stages: Energy Source, Transport, Energy Conversion, Transmission and Distribution, and Energy Use. Figure 5 below provides a graphical representation of these stages.

Stage 1 includes the energy source and the infrastructure related to its recovery. Stage 2 involves transporting the energy source to an intermediate point, where it is converted into different types of fuel or into electricity. If no conversion is needed then it is transported directly to its transmission or distribution network. Stage 3 contains the infrastructure for converting the energy source into a medium that is suitable for end use. This stage includes refineries, power plants, reformers and other processes that convert energy sources into energy products. Stage 4 involves the infrastructure used to transport the energy product to the location of end use. Finally, Stage 5 includes the levels and categories of consumption of energy by various end users.

The activities of New Jersey's energy investor-owned utilities are centered on Stage 4: Transmission and Distribution. Delivering energy in the form of electricity or natural gas, these companies must take into account infrastructure decisions within this stage, while also being cognizant of how changes in the other stages impact their operations. For example, location of electricity generation facilities will have important consequences for the deployment of transmission and distribution lines needed to deliver the electricity from supply to end use. Land use and economic growth will change patterns of energy use and impact Stage 4 infrastructure decisions. Finally, within Stage 4, the development and use of alternative technologies like fuel cells and solar photovoltaic panels may change long-term infrastructure decisions. Section IV below discusses further the issues raised in each stage in the context of investor-owned utilities. The next section examines the importance of New Jersey's energy infrastructure as it related to the state's other critical

Policy Highlight #2 - Linkages with Non-Energy Infrastructure

The August 2003 blackout, which affected Canada and the United States, brought to the forefront the importance of energy supplies and infrastructure for the smooth operation of many of the other critical infrastructure systems in society. As the power went out, the effects of the outage rippled through transportation, telecommunications, financial, security and water systems across the two countries. In the post-blackout world, understanding the interdependence of these systems with the electricity and energy infrastructure, not only in an emergency but also in daily operations, can help energy policymakers and other decisionmakers understand the added impact of their initiatives beyond energy infrastructure. Although we limit our discussion here to transportation and telecommunications, the interdependence of natural gas and electric energy and other critical infrastructures on one another is quite obvious. Two areas are highlighted here: transportation and telecommunications.

The Transportation Infrastructure depends on reliable electricity to power its traffic lights and signals, trains and subways. In addition, when trains or subways are inoperable due to loss of electric power, the amount of surface traffic volume in the transportation system increases significantly. This is compounded during extended area-wide blackouts as people leave workplaces and other buildings to return home or reach family members. In return, much of the backup energy generation is dependent on the roads and smooth operation of traffic signaling in the transportation infrastructure to deliver fuel supplies during longer service interruptions. This may pose a unique opportunity for certain distributed generation facilities to provide an added benefit during power interruptions. Distributed generation facilities, such as solar photovoltaic panels or hydrogen fuel cells, can be configured to continue to work during an outage, in addition to reducing the demand on the grid and provide energy savings to the installed building. This configuration is more costly than the current method that has these facilities trip off during an outage. This backup power, however, can also be tied to a self- contained micro-grid that may supply power to nearby critical infrastructure, thereby providing an additional benefit to the entire system.

Just as energy infrastructure is ubiquitous in providing power to keep the various other infrastructures operating, telecommunications infrastructure is also ubiquitous in keeping necessary information flowing for these systems. Today's reliance on cordless telephones means that many residents will be unable to access telephone service due to their power requirements when the grid is down. Similarly for businesses, remote telecommunications equipment, like PBXs, fail after the duration of the power outage exceeds the life of the battery backup. Central offices of local phone companies and tandem offices of long distance companies provide power during interruptions in grid electricity supply through battery backup and then through diesel generators. Cellular towers also fail after a time if the duration of the power outage exceeds the life of their battery backup, since most do not maintain generator backups. The failure of a few cellular tower sites can lead to a larger failure in the overall cellular system. In addition, even telephone and cellular networks that have power are often overloaded immediately after a power outage due to the increase in call volume after such incidents.

Changes in policy or technology in one can have profound effects over the others. A recent example of such a change can be seen in the emergence of fiber optics and wireless technologies in telecommunications. Both trends have pushed more network electronic devices out towards the customer and away from the central office. While wireline telecommunications policy has strict regulations regarding power and reliability, these rules do not apply to wireless communications or to many of the customer premise equipment such as cordless phones and PBXs. These effects can be compounded by a subsequent loss of communication, leading to further gridlock in transportation and prohibiting much needed backup power supplies from reaching critical facilities.

Policymakers can address these interdependencies by asking a few basic questions when considering a new initiative. First, one must identify what infrastructures are affected. Then the following should be examined:

- What affect does the policy have beyond its targeted infrastructure?
- Does the policy take into account these additional impacts?
- Is the policy's success dependent on the current state of other infrastructures?
- Keeping in mind each infrastructure's dependence on the other, if one system fails or changes significantly, does the policy still function successfully?
- How are trends in the targeted and interdependent infrastructures likely to affect the future success of the policy? (e.g. are regulations in one infrastructure gradually being reduced or are technological trends changing consumer usage patterns and choices?)

More specifically, there are a number of steps that policymakers can take to resolve these questions and help to ensure that policies take into account these issues.

- Coordination among oversight and policymaking agencies;
- Identification of alternative, redundant and/or backup systems needed for continued operation of the dependent infrastructures;
- Testing of these systems routinely to ensure they will operate when needed;
- Periodic reassessment of the state of interdependent infrastructures to determine whether shifts in technology or policy have changed their relationship; and,
- Inclusion of the cost/benefit impact on other infrastructures in the overall analysis of new or existing policies.

This policy highlight examined energy infrastructure's interdependence with other infrastructures with the examples of transportation and telecommunications. The full report in Chapter 1 explores further these linkages as well as examines linkages with more infrastructure systems like economic development, security, and water and waste infrastructures. Understanding these linkages will help to ensure that policymaking in one infrastructure area does not have unintended consequences in another area.

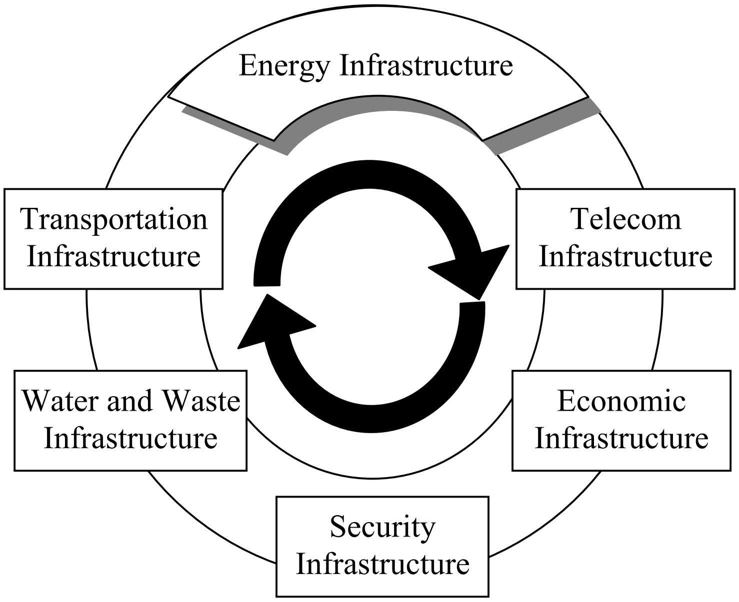

Figure 6: Linkages Among Critical Infrastructures

infrastructures.

B. Linkages with Non-Energy Infrastructure

A thorough examination of energy infrastructure decisions is essential in its own right, but is even more so given their linkages with other critical infrastructures upon which society depends. Figure 6 below depicts some of the major infrastructure systems that are affected by the energy infrastructure. In the sections that follow, the different components of New Jersey's energy infrastructure that affect each of these critical infrastructure systems are examined. The focus of these sections is to identify current or future policy issues that impact on New Jersey's energy and other critical infrastructures.

i. Transportation Infrastructure

The energy infrastructure and the transportation infrastructures are mutually dependent on each other for their smooth operation. Supplies of coal for power generation travel using the railroad infrastructure, some of which operates over electrified rail lines. As the most densely populated state in the nation, New Jersey is also highly dependent on its roads and highways for travel. Passenger rail transportation service in the Northeast is also over electrified rail lines. The traffic signaling and telecommunications networks are heavily dependent on the electricity grid to maintain smooth operations. Each of these systems is capable of handling localized or short-term outages due to natural or man made disasters or accidents. However, the region-wide blackout of August 2003 caused not just the loss of power to many homes and businesses across the northeast, but the failure of many transportation systems as well. Traffic lights and routing, mass transit, air traffic were all impacted during the blackout. It also should be also noted that the materials that go into building and maintaining the transportation infrastructure—roads, bridges, airports—also require large amounts of energy, and the industries that supply these materials are large consumers of energy. Compressed natural gas has already been implemented on a limited basis as an alternative vehicle fuel. Fuel cells and advanced electric batteries may also become a part of vehicle technology. This would have profound impacts on both transportation and energy infrastructure; however, such changes are unlikely in the next several decades. In the short term, there is an effort to reduce emissions at truck stops by reducing the need to keep trucks running to maintain refrigeration. The possible solution is to look to alternative powering such as cleaner sources of plug-in electric power at these sites, either from distributed generation or from grid power.

ii. Telecommunications Infrastructure

The telecommunications industry has changed dramatically as a result of competition, technology advances and market demand. Options for telecommunications services exist from a variety of different providers using the traditional wireline network, mobile and fixed wireless networks, and cable television company networks. Technology now exists to deliver state-of-the-art telecommunications services over power line networks. These advancements are changing customers' perceptions of telecommunication services and powering requirements. Legacy or traditional wireline infrastructure relies on grid electricity during normal operation and provides enough current on its copper loop infrastructure to power telephone operation. In the event of interruptions in the supply of electricity, switching centers provide back up power through diesel generators and then with battery backup. This back up power allows end users to still be able to use their phones as long as the phone lines to the home are not damaged as well.

Regulatory rules by the Federal Communications Commission and the state Public Utility Commissions require reliability levels and performance standards when it comes to maintaining service. These regulations continue to evolve to keep pace with the changing marketplace to foster equitable treatment across all networks and all service providers. With the advent of the cellular phone and the installation of fiber optic cable in the telecommunications plant, the need to meet these power requirements has led to pushing the energy infrastructure out from the central offices to cell towers and remote terminals closer to the end user. The latest telecommunications services and technologies, such as fiber-to-the-premises (FTTP), Voice of Internet Protocol (VoIP) and cable modems, rely on the customer's power supply to operate. FTTP includes battery backup at the customer's location so that service can continue even when the home's or business' electricity goes down. Moreover, the bandwidth capability of these advanced services, particularly FTTP, creates opportunities for new applications to better manage energy supply and consumption. Finally, telecommunications infrastructure often shares rights of way and easements with cable television, electric and natural gas infrastructure as well. New telecommunications and information technology infrastructure changes may be needed to manage growing interconnection and regionalization of the energy infrastructure, as well as a growing portfolio of renewable and distributed generation.

iii. Economic Infrastructure

In many industry sectors, many businesses' critical systems depend on reliable power from the electricity grid or in the event of an outage, from backup power systems. Even when the energy infrastructure is operating well, the changes in price for power can cause ripple effects throughout the state's economic infrastructure. Manufacturing consumes energy in production and exchange of goods and relies on energy throughout the transportation infrastructure discussed earlier. Both the manufacturing industry's reliance on just-in-time systems and the service industry's reliance on electronic information exchange mean that reliable electricity combined with powerful telecommunications infrastructure is also important. Modernization of legacy energy infrastructure investments may result in improvements for the economic infrastructure. However, the issue will be whether modernization will provide the increased reliability at a cost that is willing to be borne by customers. Energy process improvements like smart meter technology may not only provide operational savings to the energy company but may also lead to economic benefits to the end user when tied to energy efficiency and demand response programs.

iv. Security Infrastructure

Infrastructure for security – police, fire, rescue, and military – requires reliable energy to power their critical telecommunications operations as well as to power the facilities that they operate. Backup power during interruptions to the grid is essential, and special procedures are in place during blackouts. Since these special classes of consumers have special power needs, how should energy policies regarding distributed generation and reliability take into account their needs? Currently, despite incentives for renewable and energy efficiency investment, the installation of distributed generation is being managed through the marketplace. Those willing to take on the risk and capital investments decide whether a business, school or town will purchase either renewable or other distributed energy technologies to meet their needs. Should public policy flag certain critical infrastructures or other energy users (such as hospitals and emergency centers) as primary targets of incentives and investments in new technology, based on the security benefits such policies would have to these infrastructures? Emergency power is already mandatory for many critical infrastructure facilities. In the post-9/11 world, these requirements are being re-examined for sufficiency and whether greater levels of reliability and back-up power are necessary.

v. Water and Waste Infrastructure

Water and waste removal infrastructures are intensive users of energy to meet their processing needs. Water filtration plants require significant amounts of energy to treat the water supply and to operate filters, pumps, and other hydraulic systems. Waste removal infrastructure also requires significant energy to remove sewage and pump it to treatment facilities where several processes are used to dispose of the waste. Sewage facilities often use waste gases to power burners and turbines and are considered a source of biomass energy. When primary power fails, these infrastructures rely on back-up power to maintain operations. Policies that reduce water demand equally reduce demand in energy; the same is true for policies that reduce waste streams. Relying on gravity systems rather than pumping stations also leads to savings in energy use. Conversely, greater land-use will mean greater demand for water and waste infrastructure and therefore a greater energy demand.

C. Influences on Infrastructure Decisions

Having examined the interdependencies within energy infrastructure and among New Jersey's non-energy infrastructure, the following section identifies the direct influences and discusses examples of overarching policies that affect energy infrastructure decisions in the state. Chapter 3 of this report will examine in more depth how policy barriers impact energy infrastructure investment.

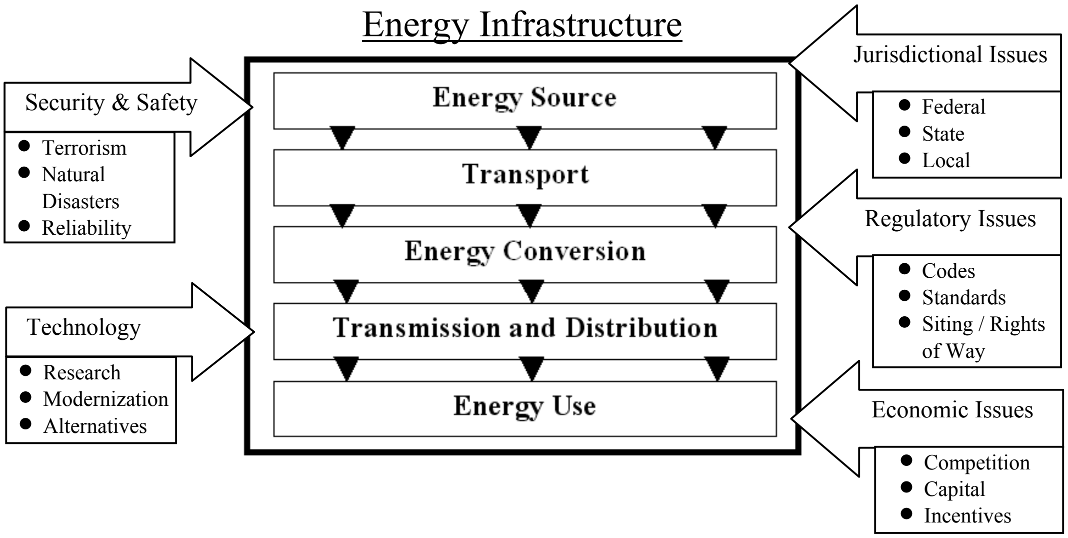

Figure 7: Influences on the Energy Infrastructure

i. Direct Influences on Energy Infrastructure

This section explores the influences that shape New Jersey's energy infrastructure and discusses the trade-offs inherent in energy infrastructure decisions. Figure 7 below shows an overlay of examples of the "soft" systems that influence the entire energy infrastructure system. The influences identified include jurisdictional, regulatory, and economic issues, security and safety, and technology.

In the area of technology, there is an inherent tension between legacy and new energy infrastructure investments. This is due to transition issues such as sunk costs, the obligation to serve, new government requirements and economic incentives. Competition and deregulation encourage short-term decision-making because there is greater uncertainty about future infrastructure investments. Competition from new distributed energy technologies also raises questions about who should pay for or share in the role of universal service and should changes be made to policies regarding obligation to serve. Security threats from terrorism have also generated new concerns that were unanticipated when past infrastructure decisions were made and are now impacting new decisions. Different jurisdictional requirements and regionalization of energy policy requires a greater

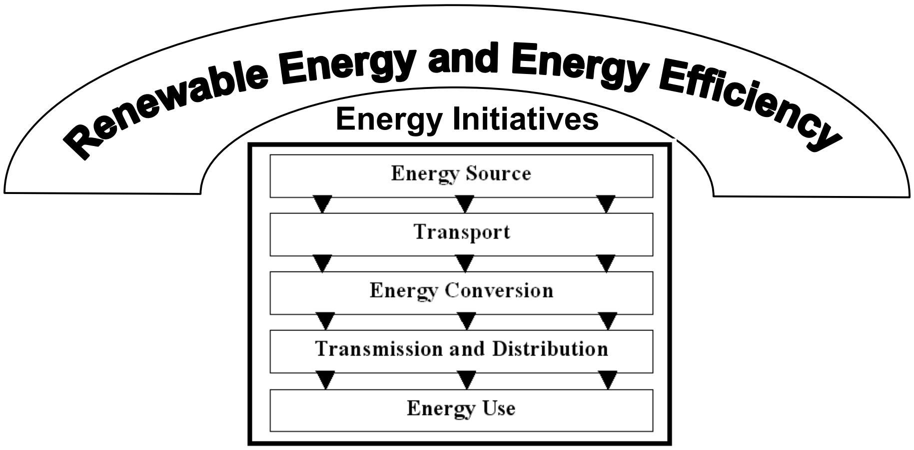

Figure 8: Initiatives Impacting Infrastructure

coordination and coherence in policymaking that is proactive, measures outcomes and is aligned with local, state and federal goals.

ii. Overarching Policy Examples

There are overarching policy initiatives that can influence the energy infrastructure system. This section examines a few examples of energy policies that affect investor-owned utility infrastructure decisions. Energy policy initiatives include policies promoting renewable energy and energy efficiency. Figure 8 below represents the impact these initiatives have on the energy infrastructure.

Other energy policy goals that influence infrastructure investments include reliability, new technology, economic development and affordability. Non-energy policies can also influence infrastructure investments, such as policies regarding land use (e.g. smart growth). Shifts in public opinion and political trends also add additional uncertainty to the policy process. Larger international trends such as global climate change and world energy prices also impact local or regional decision-making. Renewable energy and energy efficiency are examples of areas in which legislative and regulatory energy initiatives have impacted energy infrastructure decision-making in New Jersey. These initiatives are described in more detail below.

iii. Regulatory and Legislative Actions on Renewable Energy and Energy Efficiency

In 1999, as part of the comprehensive electric utility restructuring law, New Jersey adopted a Renewable Portfolio Standard (RPS) that requires electricity suppliers to acquire a minimum percentage of their power from renewable sources. The law included provisions for net metering, the creation of a "clean energy fund", and disclosure of energy sources to customers. In addition, a "societal benefits charge" or SBC is added to the cost of each kilowatt-hour of electricity sold in the state. The SBC yields approximately $125 million annually to support renewable and energy efficiency programs; 25 percent is earmarked for renewable energy technologies.

In April 2003, the Governor's Taskforce on Renewable Energy made three major recommendations:

- Double the RPS in 2008 from 2% to 4%;
- Establish a goal of photovoltaics providing 120,000 MWh of electricity generation by 2008; and
- Establish an RPS of 20% by 2020.

In April 2004, the NJ BPU adopted the first two recommendations and is reviewing the third. In June 2004, the NJ BPU commenced the statutorily required update to the "comprehensive resource analysis" (CRA) to determine the market demand and appropriate level of funding for energy efficiency and renewable energy programs to be supported by the SBC for 2004 through 2008.

The New Jersey Clean Energy Program offers a series of financial and technical assistance programs to help the public and private sectors adopt alternative energy technologies. Together these programs have impacted energy infrastructure in a number of ways. The following are just a sample of potential impacts. First, by subsidizing the cost of installing renewable energy facilities, especially in the area of solar energy, an entire industry has been stimulated in New Jersey that otherwise would have developed much slower, if at all. In addition, the savings in energy use by the energy efficiency programs have reduced the need for new facilities and deferred decisions on where and how to site new transmission lines that would have been needed to supply the otherwise greater power needs. As the percentage of distributed energy grows, new load-balancing infrastructure may be needed to handle distributed energy flows. In addition, as more customers use renewable power to reduce their energy bills, the cost of maintaining the existing energy infrastructure is being spread across a smaller base. This raises questions about obligation to serve and who pays for both maintaining existing infrastructure and needed improvements.

IV. Key Issues for Investor-Owned Utilities

This section highlights the different stages of New Jersey's energy infrastructure in greater detail

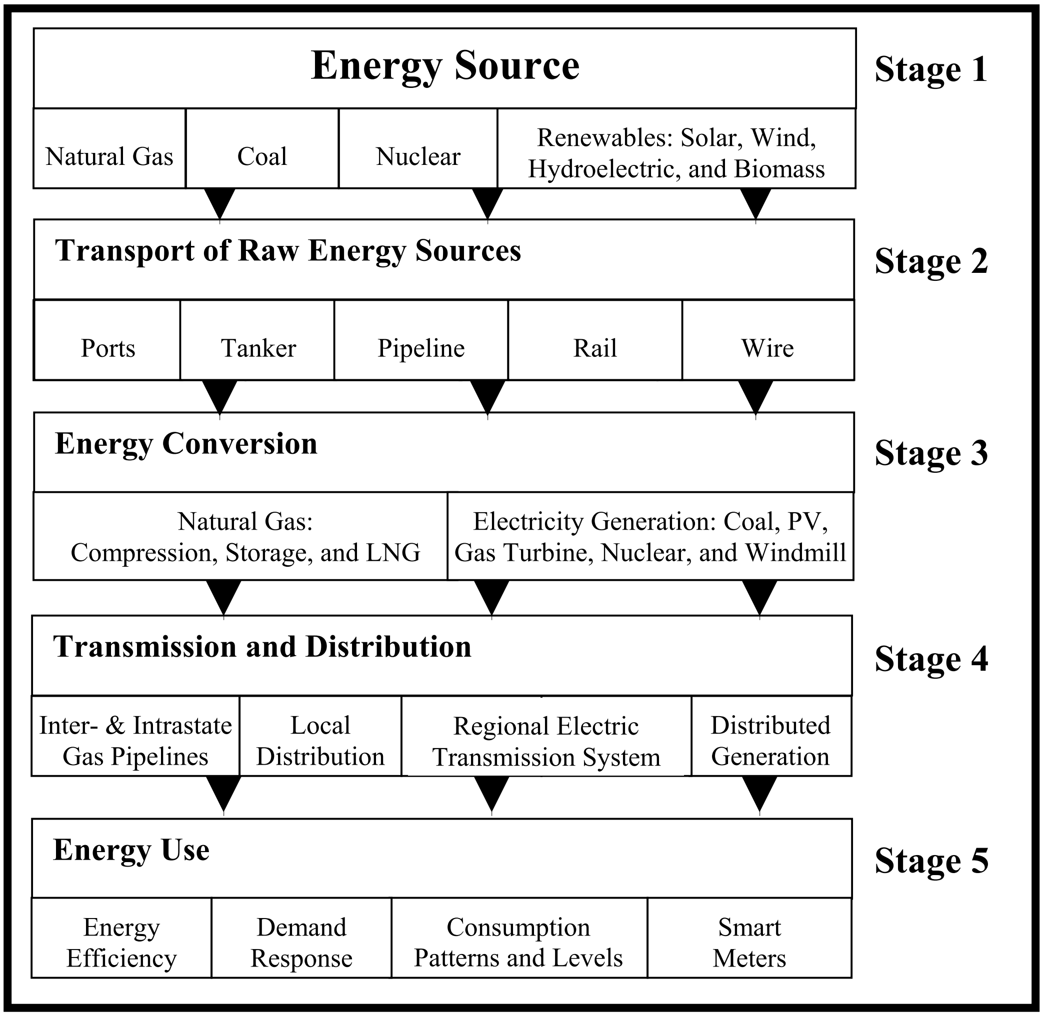

Figure 9: Detailed Breakdown of Five Stages of Energy Infrastructure

and discusses key issues raised within each stage. Figure 9 below shows the components of energy infrastructure broken down further from the point of view of Stage 4: Transmission and Distribution and displays the relationship of the other stages and key infrastructure components. Chapter 3 will look in greater detail at how policies addressing these trade-offs impact infrastructure investment decisions. In addition, a detailed inventory of New Jersey's energy infrastructure components from all five stages is provided in Appendix A (following Chapter 2).

Future needs of electric and gas consumers will require continued expansion of energy supply, storage, transmission and distribution. The investor-owned utility energy infrastructure can provide a platform for technical innovation and continued economic growth. Whether this expansion includes alternatives to the current components of the energy infrastructure will depend on near term decisions about investment. The different choices will have trade-offs in how they affect the capacity of existing infrastructure, the development of new supply and generation facilities, and the expansion of new distribution networks. Not all infrastructure technologies or configurations will be substitutable or available as potential solutions in every case. Decisions about infrastructure will also have to take into account conflicts between supply and demand and whether policies should support greater flexibility in fuel diversity and choice.

The discussion here is limited to identifying those issues among investor-owned utilities that raise important trade-offs. Each stage involves its own complex trade-offs among various issues. The importance is to examine these issues globally across all the stages in order to analyze trade-offs across the full life-cycle of an option or policy. Different stakeholders applying the values and criteria may come different conclusions about which infrastructure solutions are most optimal. This will depend on the different weights that a particular stakeholder may assign to each of the values and criteria and their own strategic points of view. For example, one stakeholder may view solar photovoltaic panels to be an inappropriate energy option for NJ's future infrastructure needs due to cost, power delivery and lack of energy storage for backup to critical infrastructure. While others may view the value of its reduced emissions and distributed nature outweigh perceived disadvantages with the technology.

A. Stages 1-3: Energy Sources, Transport and Conversion

New Jersey's energy sources can be examined in two ways: by percentage of overall consumption and by their in-state potential for exploitation. The first method is useful for exploring reliance on fossil fuel and nuclear energy sources, since no in-state sources exist. The second method is useful for exploring renewable energy sources, since their potential far exceeds current levels of use.

i. Fossil Fuels

New Jersey, similar to the nation as a whole, is heavily dependent on out-of-state fossil fuel sources for its energy needs. As shown in Table 2 below, New Jersey satisfies 74% of its energy needs through fossil fuels. In addition, 14% of its energy needs are identified as net inflows of electricity into the state.[8] This further increases the amount of energy consumed through fossil fuels since a portion of out-of-state electricity is generated using fossil fuel sources. The United States meets 85% of its energy needs through fossil fuels. Through nuclear energy sources, New Jersey fulfills an additional 11% of its energy needs compared to 8% for the nation.[9]

Again, the net inflows of electricity into New Jersey would increase the percentage of energy consumption by nuclear power, since some amount of out-of-state electricity is generated using nuclear power. Renewable energy sources such as wind, solar and biomass are the sole energy sources that are available in-state. The advantages of having in-state energy supplies are that they may provide economic development potential and may increase energy reliability and security. Fundamental goals such as energy security and economic development will affect what levels of investment the state decides to make in renewable domestic sources or in existing out-of-state sources like natural gas. In addition, state decision-makers may feel that they have a level of authority over the operations of in-state energy providers that the state would not have over out-of-state providers. With natural gas, as supplies of energy regionalize, there are questions about interchangeability and the effects of different levels of impurities across the system. In addition, if liquified natural gas (LNG) is also a significant component of the supply and transport of natural gas, there are issues about the impact of high ethane levels, which LNG contains, on pipeline infrastructure.

Table 2: Comparison of NJ to US Energy Consumption, 2000[10]

	Fossil Fuels	Nuclear Energy	Other*	Net Inflows
New Jersey	74%	11%	1%	14%
United States	85%	8%	7%	NA

**Other includes hydroelectric, wood and waste, and renewable energy sources.*

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[8] See EIA, "Table S1. Energy Consumption Estimates by Source and End-User Sector, 2000," State Energy Data 2000, Washington: GPO, 2002. *Net inflows are based on the net amount of electricity that came into the State during the year.

[9] Ibid.

[10] Ibid.

ii. Renewable Energy

There are potential trade-offs in initial cost versus increased security in policies favoring a move toward more diverse, cleaner energy supplies. In addition there are questions about the availability and the technical potential for renewable energy's use that will be key to long-term decisions about investments in technology and infrastructure in this area. Different stakeholders may reasonably apply fundamental criteria differently leading to different conclusions for policies. Some stakeholders may conclude that investments in certain renewable energy choices may be too costly or are not proven enough to meet the state's energy fundamental goals. Determining the performance measures is beneficial for deciding among different policy or investment options by adding the next step in the hierarchy of the decisionmaking process of whether such policies or investments are beneficial to improving the state's goals.

Wind energy sources in New Jersey can be divided into on-shore and off-shore wind potential. The state's on-shore wind potential is not sufficient for large-scale applications.[11] However, New Jersey has significant potential for off-shore power, where wind resources have been measured at levels as high as Class 5-6 on a scale of 1 (the lowest) to 7 (the highest).[12] According to the Navigant Report, a study performed for this Center, New Jersey has a technical potential of 2500 MW of off-shore wind resources.[13] This assumes only a 10% utilization of the overall theoretical potential during the 2005 to 2020 time period. Complicating the use of wind resources is that they are inextricably tied with other natural resources of New Jersey. Intertwined with off-shore wind is the aesthetic resources of the coastal views that provide tourism revenue and enjoyment to residents in the area. In addition, there are coastal fishing resources that are located in and nearby potential locations of wind energy installations. Because of perceived conflicts between these different resources and off-shore wind energy use, Acting Governor Richard Codey has issued a moratorium on approvals for these installations.

Solar energy potential in New Jersey lies in the middle of the pack when compared across the United States.[14] However, there are other resources in New Jersey that can contribute to the potential of solar energy within the state. In this case, the resource is the amount of flat roof space across land use patterns within New Jersey. This resource provides added potential by using these spaces to install flat panel solar designs for solar energy capture and conversion to electricity. When combined with the plentiful flat roof space, New Jersey's marginal solar energy resource turns into a significant potential source of energy for the state. The Navigant Report identifies that the technical potential for New Jersey's solar energy resources could be as high as 14,375 MW for residential and commercial buildings combined.[15]

Finally, in the area of biomass, New Jersey has the potential to obtain energy from the state's Class I sources (tree, forestry, and agricultural residues, yard trimmings, lumber and mill waste, and bioenergy crops) and non-Class I sources (landfill gas and biogas from wastewater facilitates). The Navigant report estimates half of the Class I biomass resources are from tree residues. The amount of energy that may be gained from these sources depends on advances in biomass technology. The Navigant report estimates the current technical potential for these sources is 114 MW, growing to 240 MW by 2020 if assumptions on technology advancement are met.[16] The report also estimates that an additional 64 MW could be gained from landfill gas and another 19 MW from biogas from wastewater facilities.[17] The existing landfill and biogas infrastructure makes these sources potentially

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[11] See Appendix A - Section A, Wind.

[12] See U.S. Department of Energy, Energy Efficiency and Renewable Energy (US DOE, EERE), "New Jersey Wind Resources," State Energy Information – New Jersey. State Energy Alternatives Website, updated July 21, 2004. (http://www.eere.energy.gov/state_energy/tech_wind.cfm?state=NJ)

[13] See Navigant Consulting, Inc. for Center for Energy, Economic and Environmental Policy (CEEEP), New Jersey Renewable Energy Market Assessment, August 2, 2004. (http://policy.rutgers.edu/ceeep/images/NJ_REMA_Final_8-04.pdf)

[14] See US DOE, EERE, "New Jersey Solar Resources," State Energy Information – New Jersey. State Energy Alternatives Website, updated July 21, 2004. (http://www.eere.energy.gov/state_energy/tech_solar.cfm?state=NJ)

[15] See Navigant Consulting, Inc. 2004.

[16] Ibid.

[17] Ibid.

viable if technological advances make them cleaner and more efficient than they currently are.

Since renewable sources within the state are generally consumed or converted to electricity on site, the transport and storage of energy sources in New Jersey deals primarily with natural gas in the interstate transmission system and with transporting coal and natural gas to electric generation plants.

iii. Natural Gas

New Jersey is home to a liquified natural gas (LNG) terminal in Carlstadt that acts as a reserve during peak demand times to supply additional natural gas to the distribution system. In addition, companies like BP are examining the possibility of adding an LNG port in New Jersey to allow for additional shipments of natural gas in the state and region.[18] Concerns have been voiced about the creation of another world market that will be captive to fluctuations in worldwide supply and external events similar to oil. Additionally, these facilities create trade-offs between increased economic development and energy supply reliability versus the environmental, safety, quality, and security concerns raised by these facilities. Increasing demand spurred by growth and patterns of land use also create additional trade-offs between location of pipelines within the state and examination of regional alternatives such as LNG ports. Without investments in LNG ports or alternatives, there will also be a need for additional pipeline capacity for the long-haul transport of natural

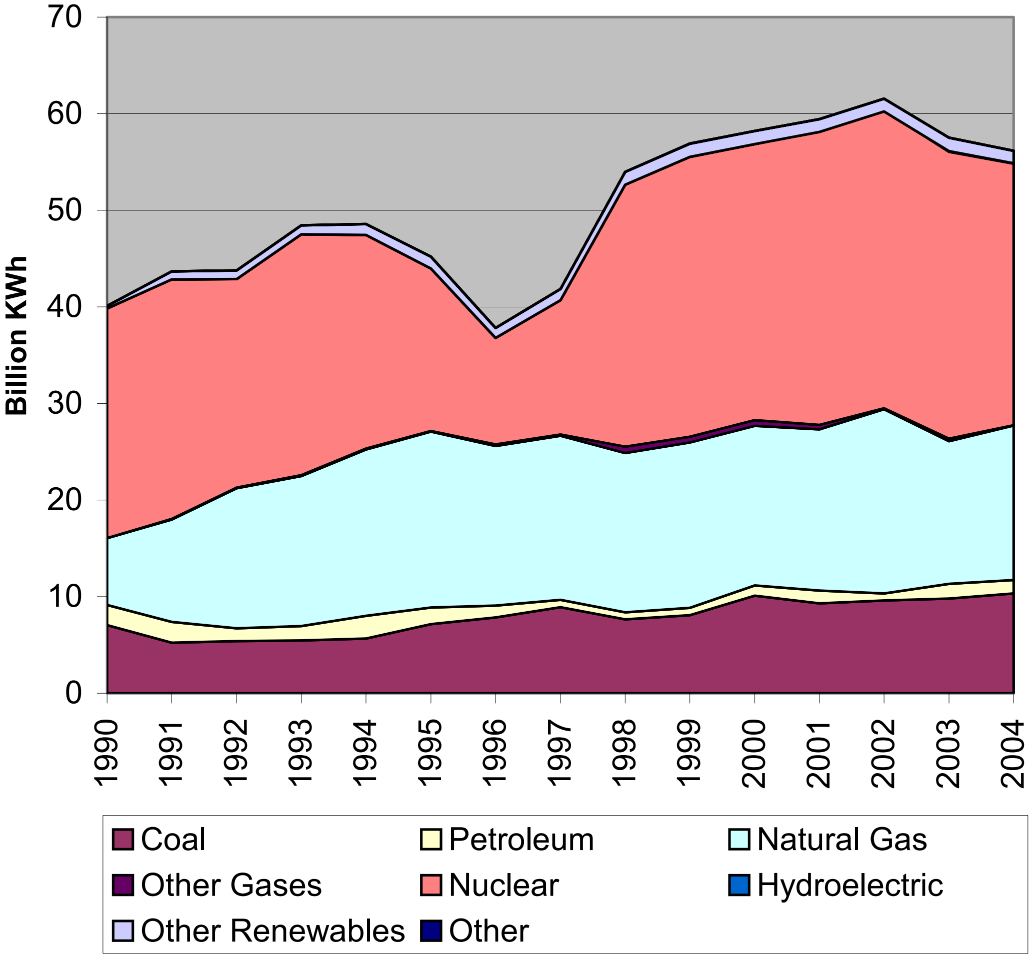

Figure 10: Generation of Electricity by Primary Energy Source in New Jersey, 1990-2004[19]

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[18] See BP Website, Crown Landing: Natural Gas for the Northeast, accessed December 15, 2004. (http://www.bplng.com/products/services_crown-landing.asp)

[19] See Energy Information Administration, U.S. Department of Energy (EIA), Electric Power Annual 2004, November 2005.

gas from traditional supply regions such as the Gulf Coast or Canada. Even with additional capacity, this can also lead to price volatility, as local supplies will be tighter and dependent on supplies from other regions.

The ability to effectively store and retrieve large quantities of natural gas has been a key factor in the growth and development of the natural gas industry. The basic function is to smooth out supply and demand functions to be efficiently matched. A second major function is the operational patterns associated with pipeline operations. A third function is the rapid turnover of gas storage inventory to take advantage of periods of high price volatility. LNG storage accounts for a very small portion of the overall natural gas storage capability in the US. However, LNG storage facilities have relatively high deliverability rates that allow operators to deliver amounts that greatly exceed underground storage systems. LNG storage can be grouped in two categories: peak-shaving storage and marine terminals. The former allows the system to rapidly respond to peaks in demand while the latter helps to provide for additional supplies to reach regional markets through importation.

iv. Electricity Generation

New Jersey is home to a number of electricity generation facilities that use primarily coal, natural gas and nuclear energy sources to supply power throughout the state. New Jersey is part of the larger PJM system that manages market transactions and supply and demand through an independent entity. The amount of electricity generated in a given year within the state depends on a larger system of electricity supply and transmission. Market transactions are managed through an independent entity, a regional transmission organization—PJM Interconnection. PJM coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia. PJM monitors the high-voltage transmission grid 24 hours a day, seven days a week to keep the electricity supply and demand in balance by telling power producers how much energy should be generated and by adjusting import and export transactions.[20] Figure 10 shows the electricity generated in New Jersey to supply the system and the breakdown among the various sources of electricity generation. For most of the last decade nuclear has been the largest single source of electricity generation. Natural gas is growing as a fuel to meet increasing demand for electricity.

The amount of electricity by each power plant in New Jersey varies from year to year depending on the cost of different fuel sources for the power plant, demand and other market factors. Generating capability in New Jersey has grown from 1990 to 2002 from 15,837 MW to 18,384 MW.[21] The growth in generation capacity in the last decade has been largely in the area of natural gas and dual-fired power plants. How much electricity is generated in New Jersey's near future will depend on decisions regarding the license renewal of the Oyster Creek nuclear facility, which expires in 2009, and the decision of PSE&G to retire some of its electric generation facilities.[22]

With regional electricity markets, is it important for New Jersey to maintain a certain level of in-state generation or can it depend on out-of-state supplies? In-state facilities provide jobs and revenue to the state and local governments, and New Jersey has more influence on them than regional suppliers. Also, new transmission facilities may be needed if the supplies of electricity move further away from customers. However, in-state facilities, such as nuclear power plants, may have negative environmental and land-use implications. Growth in renewable energy electricity generation provides an opportunity to offset changes in domestic supply of electricity by providing distributed generation at the site of use or, in the case of off-shore wind, for the region. New Jersey has provided a regulatory infrastructure for increasing renewable and distributed generation through the renewable portfolio standard and net-metering provisions of state statutes. There is also a burgeoning economic infrastructure

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[20] See PJM Interconnection website, About PJM – Overview, accessed January 10, 2005. (http://www.epjmtraining.com/about/overview.html)

[21] See EIA, State Electricity Profiles 1999 and 2002, January 2004.

[22] See EIA, U.S. Nuclear Reactors - State Nuclear Industry, New Jersey, August 4, 2004.

to support the growth of solar electricity generation. Unlike large electricity power plants, solar generation is a small scale, residential or commercial installation. This raises the issue of whether current rates of growth in renewable energy will provide a meaningful counterweight to potential closures of larger facilities. In addition, does New Jersey have the appropriate rate structure to accommodate distributed generation, such as fuel cells and solar power?

The importance of the electricity sector to the growth of natural gas infrastructure is rising. Gas-fired power generation capacity has been increasing in recent years. This capacity consists of combined cycle gas turbines (CCGT) installations, which are used for intermediate dispatch and gas turbines (GT), which are used for meeting electric peak demand. This generation capacity potentially could require a significant amount of daily gas transmission capacity to supply these plants. As the utilization rate for these generation plants increases and surplus pipeline capacity decreases, gas accessibility using interruptible pipeline capacity emerges as an issue.

B. Stage 4: Transmission and Distribution

New usage patterns across legacy infrastructure created by regional and competitive markets require a greater coordination of infrastructure investment among stakeholders. This is especially true in light of the changes in long-term planning that such markets can create. For example, PJM has now taken a much greater role in long-term planning, that traditionally the utility and state regulator had played in the past. These changing competitive markets have created tensions on long-term decisionmaking that policy may need to address. In addition, the expansion of PJM and mergers in the energy industry has created cross-state tensions over planning and investment decisions. Finally, changes in the vertical integration of the utility industry in states like New Jersey, has created the need for greater integration between generation and transmission and distribution planning. Today's electricity and gas transmission and distribution systems may be subject to increasing stress as they are used in ways for which they were not originally designed. The vision of the future of the national infrastructure is fragmented among stakeholders, the industry's commitment to long-term planning and development will be tested, and blackouts and other reliability concerns, including increasing reliance on competitive forces to meet consumer demand, have influenced public concern about energy reliability. Market reforms have been enacted with differing rules between states. The evolution of effective wholesale markets is impacted by the ability of the power delivery infrastructure to physically meet the pace and rigor of competitive markets.

In response to many of these issues, PJM has increased its long term planning and its investment in transmission within its 13-state region, including in New Jersey. PJM is responsible for the development of the Regional Transmission Expansion Plan (RTEP). The purpose of the plan is to maintain grid reliability, relieve congestion, and ensure grid robustness supports economic power sales around the region. Recently, the planning period for the RTEP process was expanded to 15 years from 5 years to provide a longer-term view of infrastructure planning. The purpose of this expansion is to allow for better planning for both reliability and economic projects. In December of 2005, PJM authorized an additional $464 million in transmission upgrades in its region.

A number of issues must be addressed in the effort to attract investment leading to efficient, reliable infrastructure supply in the region:

- Developing a plan for designing the future of the transmission system to distinguish between a "local" transmission system designed to serve local needs and a larger, "backbone" system designed to increase interregional trading;
- Sustaining the advance of competitive markets created through utility restructuring, while maintaining neutrality for unregulated, competitive entrants (both demand-side and supply-side generation)
- Reconciling this new longer planning approach with the anticipation that new market entrants may enter during the planning period;
- Providing for broad public input in the planning process that still ensures that a streamlined

process exists to avoid undue delays for project site approvals; and

- Creating the regulatory structures that allow for appropriate cost recovery and assignment of costs among states, the utilities, and their customers within the PJM region.

If access to financial markets on reasonable terms were to be affected and reduce the level of capital investments, this will create tensions at a time when the economy is increasingly dependent on reliable, high quality electricity and natural gas. Research, development, demonstration and venture capital expenditures on new technologies are competing with attempts to maintain the lowest possible short-term cost structure. Given divestiture, deregulation, and industry restructuring, any major strategy decision could prove costly by changes in regulatory or political trends. Infrastructure developments generally have been financed by contracts with terms of ten to twenty years. Strong integrated planning is necessary to increase or maintain the state and nation's energy infrastructure. Proper balancing of construction expenditures versus depreciation charges will be key to managing an appropriate level of maintenance and upgrades.

The progressive aging of the energy infrastructure will result in a further increase in the amount of transmission and distribution components that are replaced per year. Despite the use of cost-saving techniques, transmission and distribution upgrades or replacements can be more costly than the construction of new facilities. Frequently, replacements occur in congested public rights-of-way where numerous other underground facilities are located or they occur where pavement restoration and landscaping or lawn restoration is required. Utilities must make decisions on a case-by-case basis whether these situations reduce the ability to deploy new facilities in a locality to meet regional transmission growth, creating price volatility between the location of supply and markets that are increasingly further away from the source. Smart growth policies are also affecting utility decisions about location of facility deployment and changing the dynamics of least-cost or most economic routing of infrastructure.

If capital for new infrastructure decreases, especially in later years, then capital for maintaining and replacing existing infrastructure will become an increasing percentage of total capital requirements. This creates an issue with capital availability for new technologies or innovations. This is often mitigated by including new technology as part of regular maintenance through a scheduled replacement strategy. In the case of the natural gas infrastructure, this is exacerbated by investments for compliance with the Pipeline Safety Improvement Act and the fact that increasing investments are required for an aging infrastructure to ensure its safe and reliable operations. Maintaining the historical levels of reliability and flexibility of natural gas services as gas demand grows and load patterns change may require developing new mechanisms to foster research and development and financing deployment of these facilities. Unbundling of transportation and storage requires each supplier and consumer to inherit some of the responsibility to arrange for the purchase or sale of energy on their own behalf. Considerable uncertainty exists regarding the parties that will contract for unutilized capacity or who will sign long-term capacity contracts for future infrastructure projects. The unbundling and regionalization of components of the energy infrastructure also requires new mechanisms to coordinate siting issues among the parties affected as well as state and local governmental entities wherever multiple governmental entities have an impact.

Increasing productivity and reducing labor costs can be achieved through the implementation of new technologies. These technologies are the result of careful research and development. Many investor-owned utilities participate in and fund R&D, however, regulatory and market frameworks may discourage research and development.

New technology can also lead to new products and services. A self-monitoring and self-correcting, energy delivery system can help achieve a greater use of productivity-enhancing digital technology by all sectors of the economy, through digitally controlling the delivery network by replacing today's electro-mechanical switching with real-time, electronic controls. Digital controls can also help address the reliability, capacity, security, and market-service issues in today's energy infrastructure. Continuing to develop and integrate communications to create a dynamic, interactive energy system for real-time information and energy exchange is also important. Increased ability to deliver varying levels of reliable, digital-grade power or differing levels of quality of service and reliability can become a new service to industries with specific needs in these areas.

For investor-owned utilities, where applicable, regulatory bodies must ensure that providers of last resort or other entities providing service to residential customers – whether gas or electricity – are allowed to make capacity commitments necessary for long-term service reliability. Clear definition of these provider/supplier of last resort responsibilities and appropriate commitments from policymakers are needed to allow critical expansions and ensure reliable service to customers. The limited time periods or "construction windows" that are frequently required by various state and federal agencies can increase costs and the need for cooperation. Environmental agencies can also require pipeline companies to limit the width of construction in rights-of-way to reduce tree clearing or other earth disturbances. Environmental agencies can also require offsite "mitigation" in wetlands construction. The purchase of property for offsite mitigation can add substantial delays and cost to the project. All of these costs result in trade-offs over other options for which the funding could be used, such as infrastructure or technology investments.

C. Stage 5: Energy Use

Energy use is at the core of most energy policy issues. Types and levels of energy consumption drive the demand for different sources of energy, the location of infrastructure, and the systems and technology to manage energy efficiently, reliably and cost effectively. In each case, there are economic, environmental, safety and security impacts. As shown in Table 2, New Jersey ranks high in natural gas and petroleum consumption, which is expected given the state's high ranking in transportation and commercial sectors. The state's ranking in both residential and industrial sectors is also high relative to the rest of the nation.

Table 3: New Jersey's Ranking in the Nation in Energy Consumption 2000[23]

CATEGORY	RANK	CATEGORY	RANK
Per Capita Consumption		*Sector Consumption*	
Coal	36th	**Residential**	11th
Natural Gas	9th	**Commercial**	9th
Petroleum	9th	**Industrial**	15th
Electricity	20th	**Transportation**	8th
Total	32nd	**Total**	12th

While New Jersey ranks high in energy consumption by sector, its overall per capita consumption ranks us 32nd in the nation. , However, the issue is not New Jersey's energy consumption alone, but its impact on the environment and in the long-term security and continued availability of fossil fuels. Due to these concerns the state is pursuing renewable energy, distributed energy technology, and energy efficiency programs as well as stricter environmental policies. Renewable energy provides a source of clean energy that addresses environmental issues, but raises new questions about impacts on land use, aesthetics, power management and cost. When coupled with distributed technology, renewable energy generation may improve reliability, but requires new power management schemes and raises questions about cost efficiency versus large-scale centralized generation.

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[23] See EIA, "Table R2. Energy Consumption by Source and Total Consumption per Capital, Ranked by State, 2000," State Energy Data 2000, Washington, DC: GPO, 2002.

Energy efficiency programs may also be effective ways to manage energy use, reduce environmental impacts, and save money. New technology such as digital controls and consumer-based technologies may pave the way for better demand response by end users. Stricter environmental programs may also achieve the same results but at different costs. Important trade-offs exist between choosing among these different options of renewable energy, distributed generation, energy efficiency, and environmental requirements. These trade-offs do not mean that choosing one option eliminates the others, but that there is a continuum of different levels of support for each policy that state decision-makers must balance.

Energy patterns are also important to consider. Transmission and distribution systems have constantly varying conditions with large numbers of receipt and delivery points. The capacity of a system varies with the amounts of gas and electricity entering and exiting the system, the impacts at each inlet and exit point, and the locations of these supply and demand points. Seasonal variation of demand from winter to summer affects consumptions, also demand variation within a season or a month, and changes in hourly consumption during a daily cycle also occur. The seasonal variation exists largely due to consumption within the residential and commercial demand segments.

The growing utilization of natural gas fired turbines in the electric generation market is also raising concerns about the effect on summer pipeline and storage capacity usage. The market demand during the course of the day can vary considerably due to residential, industrial and electric generation consumption. The use of gas-fired facilities for electricity peaking can cause dramatic changes in natural gas consumption. The electric market has a profile driven by its electricity consumers and requires an instantaneous response while a pipeline operates best on a steady, ratable 24-hour flow. A more flexible infrastructure would allow for a more effective and efficient response; however, additional capital investment and changes in tariffs would be required to accommodate such an upgrade.

In the area of backup facilities, customers with fuel oil backup, such as industrial customers or electric generators, can interrupt their gas usage by switching to alternate fuels, and allow the LDC to use its system efficiently and reduce costs to customers. The greatest demands on a distribution system can arise when an electric generating unit uses natural gas at the same time the residential and commercial customers experience peak usage. Meeting these demands may require the LDC to expand its facilities, exacerbating its seasonal variance in capacity utilization and potentially increasing the total overall cost to serve customers. Fuel cell technology may exacerbate this phenomenon if widely deployed for primary power using natural gas as the source of hydrogen. This would cause the demand for natural gas to peak at the same time that electricity demand peaks.

All of the key issues presented in this section have various policy initiatives that are being implemented or considered to address them in one fashion or another. Given the framework presented in this and previous sections, are there alternative policies that may allow for a more appropriate investment in New Jersey's energy infrastructure? Understanding the impacts of current or alternative policies also will help to better define the role of the investor-owned utility in addressing these key issues facing the state.

V. Conclusion

The topic of this chapter was the development of possible criteria, such as economic strength, human health and safety, and protection of natural resources, which policymakers can use to evaluate infrastructure policy and decisions, and to describe New Jersey's energy infrastructure and its linkages with a focus on the role of investor-owned utilities. Chapter 2 discusses the status of New Jersey's energy infrastructure, and evaluates its economic impact. Chapter 3 describes how policy barriers impact energy infrastructure investment, and discusses policy initiatives to overcome these barriers.

Chapter 2: Assessing New Jersey's Energy Infrastructure

I. Introduction

Being able to assess the status of New Jersey's energy infrastructure and its linkages with other key infrastructures is a critical first step in formulating policies. This chapter reviews publicly available information regarding the status of New Jersey's energy infrastructure. Unfortunately, there are no comprehensive reports or studies evaluating New Jersey's energy infrastructure. Moreover, raw data regarding the existing major components or future additions is not available in one centralized database. Instead, this information is dispersed in differing formats and levels of detail among the companies that own these facilities, the NJ BPU, the NJ DEP, PJM, FERC, and other regulatory agencies.

With these limitations in mind, several themes emerge from a review of the material that is available regarding NJ's energy infrastructure. First, the state's energy infrastructure is vital to the well being of its residents. Events such as the large-scale blackout that occurred on August 14, 2003 illustrate this obvious fact. What is not known, however, is the amount of investment in NJ's energy infrastructure that is needed, how these investments should be allocated among different types of infrastructure projects, and how different investments interact among themselves and the rest of the state's economy. These unknowns point to the need for a systematic collection of energy infrastructure information, preferably in an electronic database that can be fed into a geographical information system (GIS). Of course, appropriate security concerns must be implemented regarding this data. Once more data is available in a useful format, the groundwork is prepared for detailed analyses along the lines just discussed.

Second, there are several large infrastructure decisions that the state must confront. One regards the potential relicensing of the Oyster Creek nuclear power station, whose current operating license expires in the year 2008. Another is how to address transmission constraints, i.e., a load pocket at the wholesale electricity level, that exist in parts New Jersey or that may arise in the future. This situation is affected by whether several generation units retire, including Oyster Creek, among other developments, and an aging fleet of electric transformers located in the PJM region.[24] The introduction of substantial amounts of renewable electricity generation facilities into NJ is also an energy infrastructure decision. Finally, the state must also evaluate the prospective location of a liquefied natural gas facility within its borders.

These decisions are interdependent to varying degrees, and these interdependencies need to be considered, as well as currently unconsidered alternatives, as part of the decisionmaking process. These interdependencies, along with the individual complexity of each of these decisions, point to the need for additional planning and policy coordination within the state. The discussion of these four decisions is not meant to imply that there are not other important energy infrastructure decisions or that the only important ones involve primarily the electric power system.

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[24] PJM presentation, Transmission Expansion Advisory Committee Meeting, May 10, 2005.

Third, the interaction between regulated and unregulated energy infrastructure will continue. Within the electricity and natural gas sectors, the market sets the prices for the commodity component but delivery charges are regulated. In addition, load management and conservation measures are market-based but are connected at the opposite end of the energy infrastructure from electric power plants or natural gas wells. Policies, therefore, not only affect the regulated portion of the industry, but the non-regulatory portions and potentially other energy sectors. This theme is discussed further as a policy barrier in Chapter 3.

The organization of this chapter follows the first two of these themes. Section II addresses the importance of energy infrastructure to NJ residents and the limitations in publicly available data regarding its status. Section III identifies several large energy infrastructure decisions before the state to illustrate their complexity and interrelationships. Section IV concludes this Chapter.

II. The Importance of New Jersey's Energy Infrastructure and Associated Data Limitations

A. The Importance of New Jersey's Energy Infrastructure

New Jersey is a growing state that values, as discussed in Chapter 1, its resident's health and safety, economic strength and environmental stewardship. The demands and growth patterns of its energy infrastructure can either follow the state's growth patterns or help shape them. Due to the state's limited geography, the importance of setting aside environmentally protected areas, and its population density, meeting its energy infrastructure needs is a challenge. NJ does not have the option of constructing large energy infrastructure projects away from major population centers and transporting the energy to consumers.

According to one reference, NJ's population will increase by 900,000 people from 2000 to 2020 to a total of over 9 million residents. Employment will grow by 800,000 jobs and the number of households will increase by 460,000, using roughly 200,000 to 350,000 acres of developable land. Half of this growth will likely take place within the central region of the state.[25] The obvious implication is that the existing energy infrastructure will be further stressed and that any additional infrastructure investments are likely to be limited to certain parts of the state. Balancing the objectives discussed in Chapter 1 will be even more challenging in the future than they are today.

In the discussions among Forum participants and other stakeholders, the need to better understand the relationship between the State's energy infrastructure and the values discussed in Chapter 1, particularly economic strength, was raised consistently. Some stakeholders believe that the information regarding the status of the infrastructure in a problem area is made available only once a problem develops and when available alternatives no longer exist. Other stakeholders felt that delays in approvals often created an atmosphere where difficult decisions are not made until a crisis develops. It would be preferable to have economic models that enable policymakers to calculate the costs of poor energy infrastructure performance and reliability to help formulate cost-effective policies. Others raised the issue of what are the performance measures to be used to evaluate the energy infrastructure and whether these measures are universal or do they vary among utilities or regions of the state. Some emphasized the importance of knowing what level of basic service is being provided.

Another concern identified is whether the existing infrastructure can meet future business needs to attract high paying jobs and how to engage the users of the infrastructure to help align investments and policies with state goals. In order to utilize the existing infrastructure, some suggested that the preferred location of these high-paying jobs, for instance from state-of-the-art, high-tech industries, is in urban areas

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[25] The Costs and Benefits of Alternative Growth Patterns: The Impact Assessment of the New Jersey State Plan, Center for Urban Policy Research, Edward J. Bloustein School of Planning and Public Policy, Rutgers, The State University of New Jersey, September 2000.

and older suburban areas. Knowing the level and type of reliability and performance businesses and customers need is important information that is not readily available. Finally, some stakeholders pointed out that the connections between energy infrastructure and telecommunications makes the need for a reliable energy infrastructure more important than in the past.

As described in Chapter 1, the state has vast networks of energy infrastructure that depend on and support other infrastructures. Due to these linkages, any disruption in one part of the energy infrastructure can ripple through to other parts or other infrastructures. Widespread blackouts shut down the economy, overload communication systems, and raise public health and safety concerns. Dramatic events, such as the August 14, 2003 blackout, illustrate this point. This can occur even when operating errors rather than infrastructure failures are the cause as in the 2003 blackout. According to one source, businesses incurred approximately $6 billion in costs due to this blackout.[26] New Jersey was able to protect much of itself from the cascading power outage and fortunately experienced far less economic fallout. Prior to the August 2003 blackout, other studies have identified the substantial cost to the U.S. economy due to power outages.[27] Electricity reliability problems can also be localized and occur within a state, such as the blackouts that occurred on the New Jersey shore during the summer of 2004.

Less publicized than widespread energy infrastructure failures are the costs associated with having an inadequate energy infrastructure. One reference notes the large and growing investment in off-grid premium power supply technologies such as backup generators, universal power supplies (UPS), and batteries among other technologies to supplement power purchased from the grid.[28] Without data and further study, it is hard to assess whether this is occurring because of efficient market forces or because of failures in grid investment to meet customer demand for levels of reliability. Customers may incur the costs to provide themselves with reliability above and beyond what the current grid provides and may make that economic decision based on their own specific cost-benefit analysis. Moreover, if New Jersey were to make additional investments in improving the reliability of its energy infrastructure, it is not known how much additional economic development, if any, would occur to offset the additional costs.

Table 4: Top Ten New Jersey Manufacturing Sectors and Total Hourly Production in 2003[29]

	Employees	Production lost Per Hour
Pharmaceuticals and Medicine	40,000	$ 11,422,800
Other Chemical Mfg.	34,200	$ 9,766,494
Computer and Electronic Products	32,300	$ 3,198,346
Food Products	31,700	$ 3,437,865
Fabricated Metals	28,500	$ 2,822,070
Printing and Related Support	25,000	$ 2,475,500
Plastics and Rubber Products	22,400	$ 2,218,048
Machinery	19,200	$ 1,901,184
Paper Products	16,600	$ 1,643,732
Nonmetallic Mineral Products	14,400	$ 1,425,888
Total for All NJ Manufacturing Industries	**450,100**	**$ 44,568,902**

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[26] Peter Fox-Penner, “Rethinking the Grid: Avoiding More Blackouts and Modernizing the Power Grid Will Be Harder than You Think,” The Electricity Journal, March 2005, pp. 28-42.

[27] EPRI, Scoping Study on Trends in the Economic Value of Electricity Reliability to the U.S. Economy, June 2001.

[28] Digital Power Group, Critical Power, August 2003.

[29] NJ Department of Labor. (2003). (http://www.wnjpin.net/OneStopCareerCenter/LaborMarketInformation/lmi06/stateann.xls)

The natural gas and electric power infrastructures are becoming more and more coupled as natural gas is being used increasingly as a fuel for the production of electricity. During January 14-16, 2004, New England experienced unusually cold weather accompanied by high electricity demand. This combined with a tight natural gas market highlighted some vulnerabilities of the New England bulk power system. In particular, it revealed capacity limitations of the natural gas system.[30] A major disruption in natural gas supply could have important negative implications on the PJM wholesale market and grid. If as expected new regional natural gas-powered facilities are built and older coal and nuclear facilities are retired, this interdependency will increase.

As an example of the impacts of an electric power outage or natural gas supply disruption, consider the NJ manufacturing sector. There are approximately 450,000 production workers in NJ, which is almost 12% of the state's private sector workforce. NJ manufacturing is responsible for about 14% of the state's gross state product.[31] Table 4 lists the ten largest manufacturing sectors in NJ along with the production lost per hour if each sector was completely shutdown. Clearly, even a short-duration shutdown of just the manufacturing sector before accounting for any ripple effects is costly. In addition, there are costs associated with electric power quality issues, such as very short interruptions or the provision of power outside of required specifications. In most cases, these losses are not permanent as production comes back on line and spoiled supplies are replaced.

Complicating the task of estimating the impacts of power outages is that these costs can vary substantially by industry and by the type of outage that occurs. Industries that require refrigeration can sustain short, temporary outages, but long-term outages could potentially destroy their inventory. Other industries cannot tolerate even the slightest interruption in electricity, although these interruptions do not threaten their product if it is already made. Still other industries could respond at little or no cost to a power outage, if they had sufficient advanced notice. Due to the fact that different conditions affect industries differently, also complicates the task of determining what infrastructure investments should be made. For instance, avoiding widespread blackouts generally requires different types of investments than improving power quality. New Jersey's manufacturing base obviously does not depend solely on electricity or natural gas. Other energy sources and non-energy utilities are also critical to this sector's performance.

Of course, expanding energy infrastructure is costly. Infrastructure investments are expensive, both in direct cost, but also due to potential health and environmental impacts. Direct costs are relatively easier to estimate than indirect costs, although particularly for large-scale projects, calculating direct costs can be challenging. When investors and not ratepayers incur the investment risk, then from a public policy perspective, errors in estimating direct costs are not critical. This is not the case for the regulated portion of the industry, such as transmission, distribution, and natural gas pipelines.

The indirect costs, which are just as real and important as direct costs, are more difficult to measure. For example, a recent extensive review of the health and environmental costs of electricity generation and associated air emissions documented the difficulties and ranges of various estimates.[32] These inherent uncertainties in estimating indirect costs, especially health and environmental ones, should not discount their reality, importance, or magnitude. Instead, efforts must be made to quantify these costs along with their uncertainties and factor them into the decisionmaking process. Chapter 3 discusses this issue in the context of policy barriers and presents some initiatives to overcome this specific barrier.

We now turn to a discussion on the data limitations associated with assessing New Jersey's energy infrastructure.

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[30] ISO New England Market Monitoring Department, "Final Report on Electricity Supply Conditions in New England During the Januray 14-16, 2004 "Cold Snap," October 12, 2004.

[31] New Jersey Business and Industry Association, (http://www.njbia.org/manufacturing/njpresearch.htm).

[32] Economic Impact Analysis of New Jersey's Proposed 20% Renewable Portfolio Standard, Center for Energy, Economic & Environmental Policy, Edward J. Bloustein School of Planning and Public Policy, Rutgers, The State University of New Jersey, December 2004.

B. Data Limitations Regarding New Jersey's Energy Infrastructure

As part of the research for this report, considerable amount of effort was made to try to compile a list of major energy infrastructure projects proposed in New Jersey. Some information was available on the web, such as PJM's transmission expansion plan or announcements for a proposed LNG facility. Other information is publicly available but less accessible. For instance, the NJ BPU and NJ DEP compile various filing that contain specific applications for new energy infrastructure, reports regarding the performance of some part of the state's infrastructure, and other related documents. The relevant information, however, is primarily in paper form and diffused in multiple documents, making it time consuming to compile into a database. Furthermore, some of the information may be out of date, for example if the information is only provided as part of a rate filing, which do not occur that frequently. Post 9/11 security concerns have also created a reduced ability for independent analysis and information sharing as such data at the state and federal level has greater restrictions on its use.

Directing energy infrastructure investments that serves the state's needs requires a portfolio of public policies that span regulated and unregulated industries, land use and smart growth issues, and health and environmental regulation. The foundation for any such coordinated policy approach is having solid information regarding the existing energy infrastructure, the future needs, and the costs and benefits of various infrastructure options. This information should be in a centralized database linked with global information system (GIS) capabilities that is updated, securely maintained, and available to the necessary governmental agencies to conduct long-term energy planning and infrastructure analyses. GIS capability is critical to help understand land-use implications, realize important interconnections between existing and the proposed infrastructure, examine various options, and assess the benefits and costs of any proposal.

Assessing the current informational capabilities on New Jersey's energy utility infrastructure would help to create a baseline for any future portfolio development of the state's overall infrastructure and analysis of interdependencies. Once the baseline is assessed, an action plan should be created to arrive at an agreed level of informational collection and integrity necessary to meet the needs of assessing infrastructure plans. New collection methods or requirements may be needed. Chapter 3 discusses some policy initiatives to raise the level of energy infrastructure planning in New Jersey, all of which require better data collection and access. The New Jersey BPU is in the process of funding a New Jersey State Energy Data Collection effort that would compile, organize, and make publicly available a lot of the information that would be used in a detailed assessment of the State's energy infrastructure.

III. Interrelationship of Several Large Infrastructure Decisions Confronting New Jersey

There are many infrastructure investment decisions that will be made explicitly or implicitly as NJ continues to grow. Large-scale decisions are likely to require explicit policies and decisions. There are four relatively near-term, large decisions related to NJ's energy infrastructure: the relicensing of Oyster Creek nuclear power station, reducing or mitigating transmission constraints into eastern portions of NJ, substantially increasing the amount of renewable generation, and the construction of an LNG facility. These decisions are raised, not to discuss their individual merits, but to point out how related they are to one another and that each of these decisions should not be made in isolation from the others. Moreover, we do not mean to suggest that these are the only four major energy infrastructure decisions confronting New Jersey.

The critical point is that the policies affecting the outcomes of these decisions should not be made in isolation. Instead, it is the combination of policies that apply to these four issues, and others, that will impact the goals and objectives that are discussed in Chapter 1. The construction of an LNG facility has important implications on the availability of natural gas to produce

Policy Highlight #3 - The Benefits of Having a Centralized Energy Infrastructure Database

Energy infrastructure decisions are challenging because they involve complex systems over long periods of time in which many key factors that influence the outcome are uncertain. They require regulatory approval in many cases that span different regulatory bodies and jurisdictions and politically depend on public acceptance. Information is critical if the impacts, linkages, and implications of major infrastructure decisions are to be understood and effectively communicated to the public.

New Jersey should consider constituting a centralized database of its existing energy infrastructure and proposed additions. This information should be in a centralized database linked with global information system (GIS) capabilities that is updated, securely maintained, and available to the necessary governmental agencies to conduct long-term energy planning and infrastructure analyses.

Centralization would enable policymakers of different agencies to have up to date information in order to conduct the appropriate analyses and evaluations of existing and proposed energy facilities. Such a database would also enable policymakers to anticipate problems and expand the universe of possible solutions so that decisions do not have to be made in a crunch between doing nothing and selecting an undesirable alternative. The public would have confidence that the information upon which decisions are made is complete, accurate, and current.

Assessing the current informational capabilities on New Jersey's energy utility infrastructure will help to create a baseline for any future portfolio development of the state's overall infrastructure and analysis of interdependencies. Once the baseline is assessed, an action plan should be created to arrive at an agreed level of informational collection and integrity necessary to meet the needs assessing infrastructure plans.

New collection methods or requirements may be needed. Procedures and protocols would be needed to maintain the security and integrity of this database, as much of the data will have Critical Energy Infrastructure Information (CEII) protected status. This will also be true for any system-specific date and customer-specific data that does not fall under CEII protection. Since much of the information that would be housed in this centralized database is already provided to various state departments and agencies, the additional cost imposed upon business to submit this data to a central location should be minimal.

The NJ Board of Public Utilities is starting a project that would help to establish an Energy Information Center (EIC) at the Center for Energy, Economic & Environmental Policy (CEEEP) at Rutgers University. The EIC will collect data related to Energy consumption, generation and other key NJ-specific energy time series data. The purpose is to improve data gathering for updating the state's Energy Master Plan every three years. This project would be a strong starting point to launch the policy proposed here to include the gathering and analysis of infrastructure data.

electricity, pipeline construction and maintenance, and the state's fuel mix. The role of renewable energy sources along with conservation depends critically on what other generation, transmission, and distribution resources that the state uses to meet its electricity needs. The more conservation and renewable energy resources that the state pursues, the less need there will be for natural gas and other fuels and perhaps the avoidance of additional transmission and distribution investments. How the state achieves its carbon dioxide emission polices is significantly affected by whether Oyster Creek is retired or not. The construction and retirement of power plants both within the state and in the region affects the need for new transmission facilities. Furthermore, the location and timing of new renewable resources depends in part on policies related to reducing transmission congestion.

These four decisions also point to the need to coordinate state energy, environmental, and economic development policies. For example, polices that promote renewable energy should be coordinated with cap-and-trade emission markets such as sulfur dioxide, nitrogen dioxide, and possibly mercury and carbon dioxide. A key issue regarding renewable energy policies is to what extent policymakers want these investments to occur within the state, which would benefit the local economy, versus developing regional renewable markets that may result in lower costs.

IV. Conclusion

The need to examine energy infrastructure decisions in a comprehensive fashion and to understand their connections and interactions with each other and other infrastructures reiterates the importance of having accurate and up-to-date information available to policymakers. First, New Jersey needs to have a comprehensive evaluation of its existing energy infrastructure. Second, future energy infrastructure needs should be identified along with possible solutions. These studies should culminate in creating a centralized but secure database available to policymakers that enable them to evaluate proposed energy infrastructure policies and investments. The linkages between different energy and non-energy infrastructures need to be investigated and catalogued. Finally, individual infrastructure decisions and their interaction with other pending decisions should be evaluated against the desired values and objectives, such as those presented in Chapter 1.

Although such information and analysis is necessary, we, along with many of the stakeholders engaged in our study, believe that additional policies are needed. We turn to these proposals in Chapter 3.

Appendix A: New Jersey's Energy Infrastructure Portfolio

The sections below look at the different stages of energy infrastructure and provide a detailed portfolio of New Jersey resources and infrastructure elements, and examine trends in energy production and use.

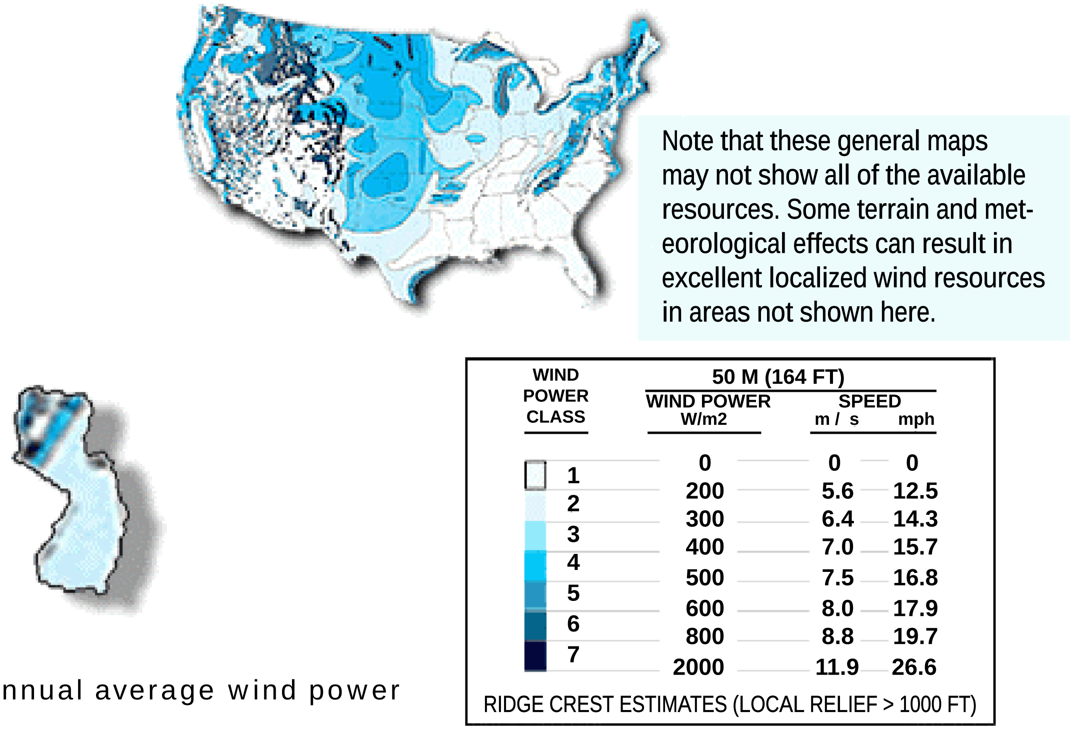
A.I. Energy Sources

A.A. Oil, Natural Gas, Coal and Nuclear

New Jersey does not have natural sources of oil, natural gas, or coal. The state's role in these resources involves transporting them to their point of conversion to other energy products or as a major regional storage site and is discussed further in Section B below. New Jersey also imports nuclear fuel for electricity generation and stores the material at its nuclear power generators located in the state.

A.B. Wind

There are both large wind turbines for utility applications and with small wind turbines for on-site generation. Wind is classified according to wind power classes, which are based on typical wind speeds, ranging from class 1 (the lowest) to class 7 (the highest). In general, wind power class 4 or higher can be used to generate wind power with large (utility-scale) turbines, and small turbines can be used at any wind speed. Class 4 and above are considered good resources. Figure A-1 shows general wind power classes for the U.S. and New Jersey and indicates that



Note that these general maps may not show all of the available resources. Some terrain and meteorological effects can result in excellent localized wind resources in areas not shown here.

Figure A-1: New Jersey Annual Average Wind Power[33]

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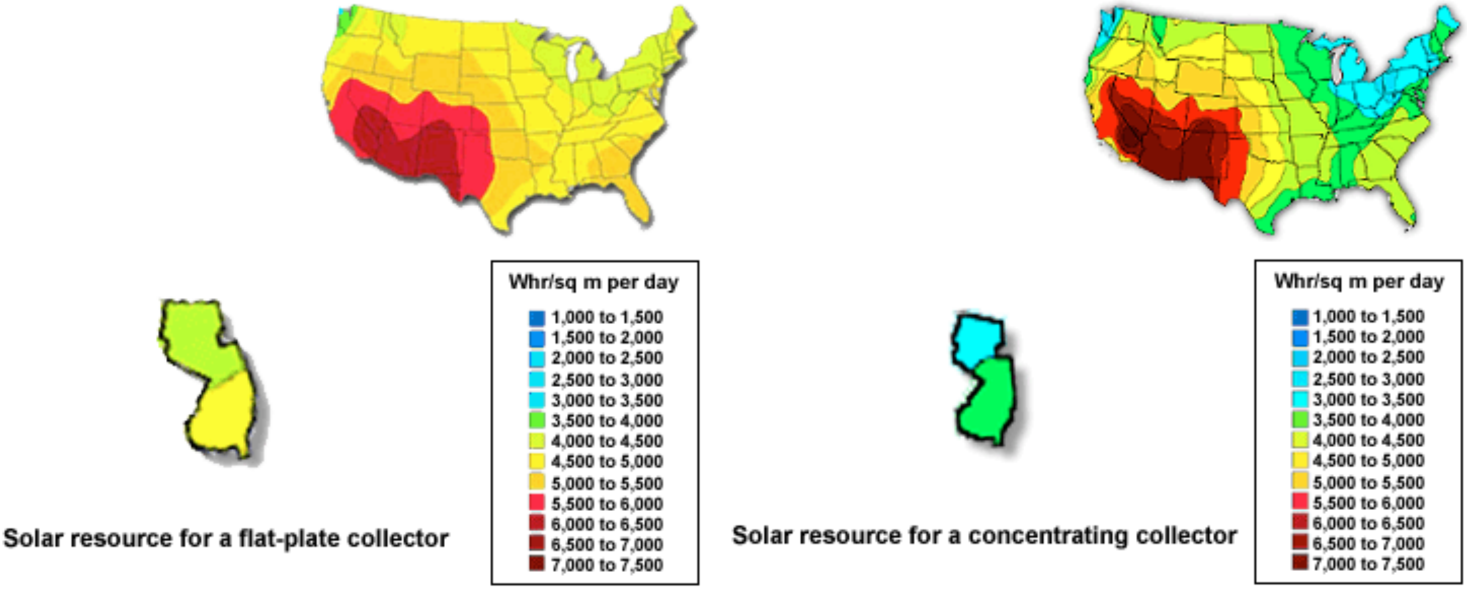
[33] See U.S. Department of Energy, Energy Efficiency and Renewable Energy (US DOE, EERE), "New Jersey Wind Resources," State Energy Information – New Jersey. State Energy Alternatives Website, updated July 21, 2004. (http://www.eere.energy.gov/state_energy/tech_wind.cfm?state=NJ)

the state has good wind resources in portions of the state, mostly in the coastal region.

Wind power estimates apply to areas free of local obstructions to the wind and to terrain features that are well exposed to the wind, such as open plains, tablelands, and hilltops. Within the mountainous areas identified, wind resource estimates apply to exposed ridge crests and mountain summits. In New Jersey, there are a couple of "ridgelines" at the north end of the state that provide the only non-coastal wind resources above Class 3. Local terrain features can cause the mean wind energy to vary considerably over short distances, especially in areas of coastal, hilly, and mountainous terrain. Although the wind resource maps identify many areas estimated to have high wind resource, the map does not depict variability caused by local terrain features. According to a report by Navigant Consulting commission by CEEEP (Navigant Report), the technical potential for on-shore wind power, after excluding land not suitable, is estimated to be 127 MW.[34]

According to the Navigant Report, off-shore wind resources in New Jersey are much more significant than on-shore with potential Class 6 wind resources available. The maximum theoretical potential is 24,500 MW. To determine what the technical potential could be for New Jersey, the report assumed that only 10% could be developed in the 2005-2020 time period, which is a technical potential of nearly 2,500 MW of off-shore wind resources.[35] However, New Jersey's Acting-Governor Richard Codey has issued an executive order imposing a moratorium on new wind installation and has established a Wind Commission to study the implications of off-shore wind in New Jersey.[36] The moratorium will last for one to two years and would bar state funding and permits while the state reviews whether regulations on such projects are strict enough. According to an article in The Star Ledger newspaper, most projects for off-shore wind in NJ are more than a year off in planning and may not be impacted by the moratorium.[37] Winergy LLC of Shirley, N.Y. has a proposal to build 98 windmills



Solar resource for a flat-plate collector

Solar resource for a concentrating collector

Figure A-2: Solar Resources in New Jersey[38]

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[34] See Navigant Consulting, Inc. for Center for Energy, Economic and Environmental Policy (CEEEP), New Jersey Renewable Energy Market Assessment, August 2, 2004. (http://policy.rutgers.edu/ceeep/images/NJ_REMA_Final_8-04.pdf)

[35] Ibid.

[36] See Lane, Alexander, "Codey to block energy windmills in ocean for a year," The Star Ledger, December 9, 2004.

[37] Ibid.

[38] See US DOE, EERE, "New Jersey Solar Resources," State Energy Information – New Jersey. State Energy Alternatives Website, updated July 21, 2004. (http://www.eere.energy.gov/state_energy/tech_solar.cfm?state=NJ)

3 1/2 miles off Monmouth County between Long Branch and Manasquan, and nearly 1,000 more off Cape May County.[39] It is unclear how and whether the moratorium will impact these plans because the proposed sites are located in federal waters, 3.5 miles off the New Jersey coast.

A.C. Solar

The sun is a direct source of energy. Using renewable energy technologies can convert solar energy into electricity, heating, and even cooling. Solar resources are expressed in watt-hours per square meter per day (Wh/m2/day). Solar energy, however, varies by location and time of year. Solar resources are greatest in the middle of the day — the same time that electricity customers have the highest demand, especially during summer months. According to the Navigant Report, the technical potential for solar resources in New Jersey, after adjusting for shading, orientation and other losses, could be as high as 8,560 MW for residential buildings and 6,815 MW for commercial buildings.[40]

Flat-plate solar systems are flat panels that collect sunlight and convert it to electricity or heat. These technologies include photovoltaic (PV) arrays and solar water heaters. Figure A-2 shows how much solar radiation reaches a flat-plate collector that is installed in a tilted position, for example, on a roof. For flat-plate collectors, New Jersey has sufficient solar resources to generate electricity for homes and commercial buildings, with southern New Jersey having the best resource. Because of their simplicity, flat-plate collectors are often used for residential and commercial building applications, but can also be used in large arrays for utility applications.

Solar concentrators are typically mounted on tracking systems in order to always face the sun to capture the maximum amount of direct solar rays. The solar resource for concentrators varies much more across the United States than the flat-plate solar resource. Figure A-2 shows that, for concentrating collectors, New Jersey has a limited resource. Because these systems require tracking mechanisms, solar concentrators are generally used for large-scale applications such as utility or industrial use, but they can also be used in small-scale applications, including remote power applications. New Jersey has a committed effort to develop solar power as part of its Clean Energy Program and Renewable Portfolio Standard.

A.D. Hydroelectric

Large volumes of water that travel through a significant change in elevation are needed to generate useable hydropower resources. New Jersey has a low amount of developed hydropower resource as a percentage of the state's electricity generation. The U.S. Department of Energy estimates that New Jersey could produce an estimated 300 MW of annual mean hydropower.[41]

A.E. Biomass

All plant or plant-derived material—biomass—from trees and grasses, agricultural crops, agricultural or forestry residues, and waste materials from plant products can be used to produce bioenergy. For heating applications or electricity generation, biomass can be burned in its solid form, or first converted into liquid or gaseous fuels for energy sources. Biomass power technologies convert renewable biomass fuels into heat and electricity using modern boilers, gasifiers, turbines, generators, fuel cells, and other methods.

For transportation use, liquid fuels made from biomass (biofuels) are used. The two most common biofuels used in the United States today are ethanol and biodiesel. Biomass materials that are byproducts

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[39] Ibid.

[40] See Navigant Consulting, Inc, 2004.

[41] See US DOE, EERE – Wind and Hydropower Technologies, Water Energy Resources of the United States with Emphasis on Low Head/Low Power Resources, April 2004, Appendix B, pp. B-123.

from activities such as wood products manufacturing, construction, agriculture, and forest harvesting or management are referred to as residues. Recent studies indicate that New Jersey has a fair biomass resource potential. An estimated 1.4 billion kWh of electricity could be generated using renewable biomass fuels in New Jersey.[42] This is enough electricity to fully supply the annual needs of 142,000 average homes, or 7 percent of the residential electricity use in New Jersey.[43] These biomass resource supply figures are based on estimates for five general categories of biomass: urban residues, mill residues, forest residues, agricultural residues, and energy crops.

Wood is the most commonly used biomass fuel for heat and power. The most economic sources of wood fuels are usually urban and mill residues. Urban residues used for power generation consist mainly of chips and grindings of clean, non-hazardous wood from construction activities, woody yard and right-of-way trimmings, and discarded wood products such as waste pallets and crates. Mill residues, such as sawdust, bark, and wood scraps from paper, lumber, and furniture manufacturing operations are typically very clean and can be used as fuel by a wide range of biomass energy systems. The estimated supplies of urban and mill residues available for energy uses in New Jersey are 648,000 and 21,000 dry tons per year, respectively.[44] Forest residues include underutilized logging residues, imperfect commercial trees, dead wood, and other non-commercial trees that need to be thinned from crowded, unhealthy, fire-prone forests. The estimated supply of forest residues for New Jersey is 131,000 dry tons per year.[45]

Agricultural residues are the biomass materials remaining after harvesting agricultural crops. These residues include wheat straw, corn stover (leaves, stalks, and cobs), orchard trimmings, rice straw and husks, and bagasse (sugar cane residue). An estimated 33,000 dry tons per year is available from corn stover and wheat straw in New Jersey.[46] Energy crops are crops developed and grown specifically for fuel. These crops are carefully selected to be fast-growing, drought and pest resistant, and readily harvested alternative crops. Energy crops include fast-growing trees, shrubs, and grasses such as hybrid poplars, hybrid willows, and switchgrass, respectively. For New Jersey, the production potential for energy crops is estimated at 143,000 dry tons per year.[47]

In New Jersey, Class I biomass resources are tree residues, yard trimmings, forestry residues, agricultural residues, lumber and mill waste and bioenergy crops. The Navigant Report estimates that the technical potential is approximately 14-15 trillion Btu of Class I biomass, half of which are tree residues.[48] For solid biomass fuel, the technical potential is estimated in the report to be about 114 MW, growing to 240 MW by 2020 assuming technological advances. In addition, the report estimates that landfill gas could add an additional 64 MW of additional capacity to the technical potential of biomass. There currently is about 90 MW of landfill gas capacity operating in New Jersey. Similar to landfill gas, biogas from wastewater treatment plants could add another approximately 19 MW to the technical potential of biomass.

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[42] See US DOE, EERE, "New Jersey Bioenergy Resources," State Energy Information – New Jersey. State Energy Alternatives Website, updated July 21, 2004. (http://www.eere.energy.gov/state_energy/tech_biomass.cfm?state=NJ)

[43] Ibid.

[44] See Marie E. Walsh, et. al., Biomass Feedstock Availability in the United States: 1999 State-Level Analysis, Oak Ridge, TN: Oak Ridge National Laboratory, April 30, 1999, updated January, 2000.

[45] Ibid.

[46] Ibid.

[47] Ibid.

[48] See Navigant Consulting, Inc. for Center for Energy, Economic and Environmental Policy (CEEEP), New Jersey Renewable Energy Market Assessment, August 2, 2004.

Table A-1. Foreign and Domestic[49] Waterborne Shipments to New Jersey with Selected Energy Commodities: 2000[50]

Commodity	Short tons	Percent of total
Crude petroleum	18,885,568	28.1
Petroleum products	18,289,552	27.2
Coal, lignite, and coal coke	37,498	<0.1
Total Selected Energy Commodities	*37,212,618*	*55.4*
Total (All Shipments)	***67,157,552***	***100.0***

There is currently only 900 kW of biogas capacity operating in New Jersey.[51]

A.F. Geothermal

Direct heat resources can be used to provide heat in a variety of applications. Geothermal heat pumps are similar to conventional air conditioners and refrigerators. Whereas air conditioners and refrigerators discharge waste heat to the air, geothermal heat pumps discharge waste heat to the ground during cooling season and extract useful heat from the ground during heating season. Direct-use applications require moderate temperatures; geothermal heat pumps can operate with low-temperature resources. New Jersey has low- to-moderate- temperature resources that can be tapped for direct heat or for geothermal heat pumps; however, electricity generation is not possible with these resources.[52]

A.II. Transport, Conversion, Transmission and Distribution of Energy

A.A. Oil Tankers and Ports

The Port of New York & New Jersey provides the infrastructure necessary to supply commodities like petroleum and petroleum products. Moreover, it is a source of economic activity and growth for the entire region. The port is the third largest seaport in the U.S. and the largest on the east coast. In the distribution of petroleum, the Port of New York & New Jersey is the largest petroleum distribution point in the U.S.[53] Other ports in NJ include Jersey City, Sayreville, Sewaren, Perth Amboy, Linden, Carteret, Woodbridge, Elizabeth, Bayonne, Newark, Deepwater, Crab Point, Paulsboro, Gloucester, Camden, Pennsauken, Burlington, and Duck Island. As Table A-1 below shows, waterborne shipments of petroleum, petroleum products and forms of coal make up over 55 percent of the total shipments to New Jersey.

A.B. Oil Pipeline & Refineries

New Jersey is home to one of the four Northeast Heating Oil Reserve sites established by Congress in 2000 to help cushion the risks presented by home heating oil shortages. The reserve capacity of the Woodbridge site totals one million barrels.[54] The state

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[49] "Domestic" includes intrastate shipments.

[50] U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center, State to State and Region to Region Commodity Tonnages, Public Domain database, available at http://www.iwr.usace.army.mil/ as of Oct. 30, 2001.

[51] See Navigant Consulting, Inc. for Center for Energy, Economic and Environmental Policy (CEEEP), New Jersey Renewable Energy Market Assessment, August 2, 2004.

[52] See US DOE, EERE, "New Jersey Geothermal Resources," State Energy Information – New Jersey. State Energy Alternatives Website, updated July 21, 2004. (http://www.eere.energy.gov/state_energy/tech_geothermal.cfm?state=NJ)

[53] See NJ SEED, 2004-2005 State Issues Briefing Book, 2004. (http://www.njseed.org/2004BB.pdf)

[54] On August 20, DOE announced that the regional reserve would be situated at three sites: [1] Equiva Trading would provide 500,000 barrels of storage at a terminal in New Haven, Connecticut; [2] Morgan Stanley Capital Group, Inc., would provide an additional 500,000 barrels of storage at its own site in New Haven; and [3] 1 million barrels would be stored in a Woodbridge, New Jersey, terminal (considered part of the New York Harbor) operated by Amerada Hess. The terminals in New Haven can distribute product by tanker, barge, tank truck or connection to the Buckeye Pipeline. The New Jersey site, near Perth Amboy, distributes heating oil by barge.

Table A-2: Capacity of New Jersey Refineries by Type of Process (2003)[55]
(Barrels per Stream Day)

Refinery/ Location	Atmospheric Distillation	Vacuum Distillation	Thermal Cracking	Catalytic Cracking	Catalytic Reforming	Catalytic Hydro-treating	Fuels Solvents Deasphalting
Amerada Hess Port Reading	0[a]	0[c]	0	62,500	0	0	0
Chevron Products Perth Amboy	83,000[b]	47,000	0	0	0	0	0
Citgo Asphalt Refining Paulsboro	30,500[b]	40,000	0	0	0	0	0
Coastal Eagle Point Oil Westville	146,000	49,000	0	55,000	30,000	59,000	0
ConocoPhillips Linden	263,000	65,000	0	145,000	29,000	160,000	21,000
Valero Refining Paulsboro	172,600	87,000	24,500	54,000	24,000	90,500	0

[a] The Amerada Hess refinery was converted from a crude oil refinery and reopened in 1984 processing only refined intermediates.
[b] Distillation units were completely idle but not permanently shutdown.
[c] A "0" capacity indicates that the petroleum refinery does not use this particular process.

is also traversed by a major product pipeline[56] and has six petroleum refineries.The refiners in New Jersey are farther north on the East Coast than any other ones, are major players in the national and worldwide petroleum industry, and are a gateway to the rest of the United States.[57] Several refineries are clustered on the Delaware River east of Philadelphia, Pennsylvania whereas the other refineries are located in the northern part of the state just south of New York City. Table A-2 below lists the refineries located in New Jersey and provides information on their capacity by process into petroleum products. Once the petroleum is refined into products such as gasoline, they are then transported through their appropriate distribution network. Gasoline for example is distributed by truck to the approximately 3,400 gasoline station outlets in New Jersey.[58]

A.C. Natural Gas Pipelines, Compressors and Hubs

New Jersey's heating and electricity needs are also served by natural gas. The state crisscrossed by a number of natural gas pipelines. There are compressors and hubs to maintain the pressure in the pipelines to keep the gas flowing and to allow for transfers between systems.

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[55] See Mid-Atlantic Regional Air Management Association, Evaluating Petroleum Industry VOC Emissions in Delaware, New Jersey and Southeastern Pennsylvania – Final Report, October 2003.

[56] There are no current major pipelines for crude oil or liquefied petroleum gas. The product pipeline carriers the following products: Colonial, Buckeye, and Sun. See Bamberger, Robert, CRS Report IB87050: Strategic Petroleum Reserve, Washington, DC: Congressional Research Service - Resources, Science, and Industry Division, August 2, 2001.

[57] "A Crucial Link in the Pipeline: Refineries. Tankers. Ports. Only Texas Hnadles More Gas Than New Jersy." The New York Times, Oct. 9, 2005.

[58] Ibid.

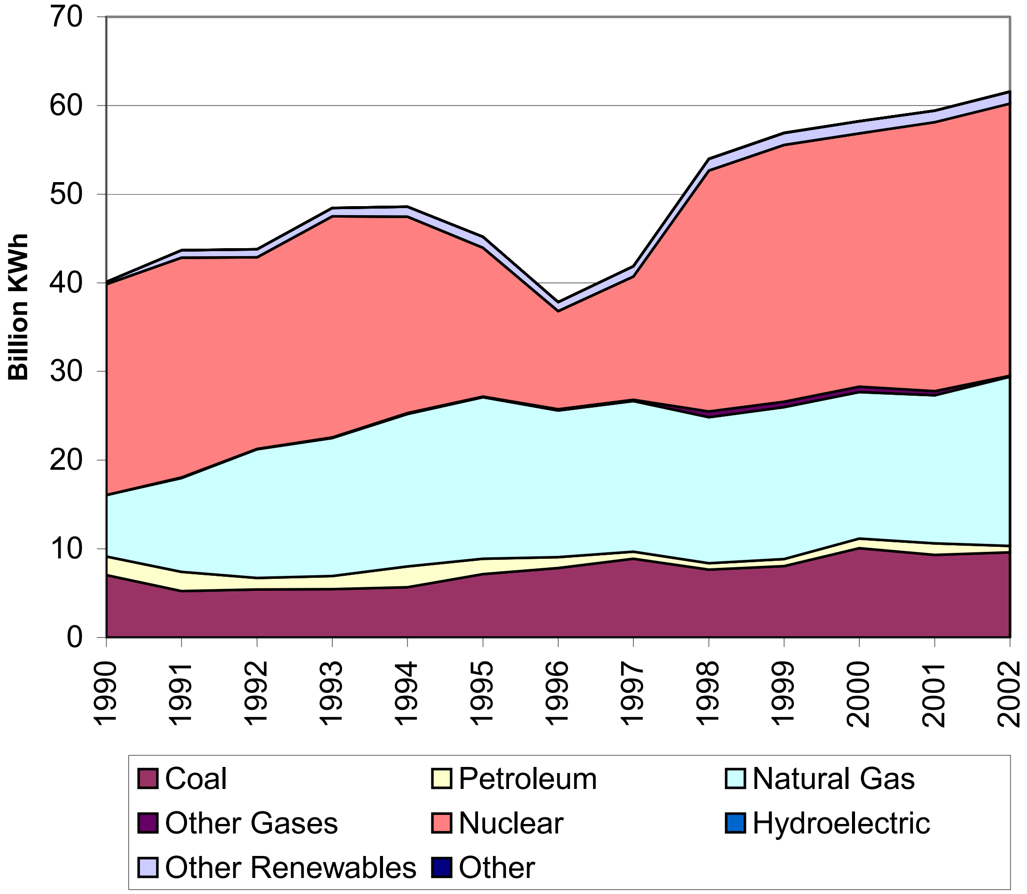

Figure A-3: Generation of Electricity by Primary Energy Source in New Jersey, 1990-2002[59]

A.D. Liquefied Natural Gas (LNG)

Natural gas can also be transported or stored by converting it to LNG. LNG is natural gas that has been cooled to a liquid, reducing by 1/600 its original volume for storage and when transporting natural gas a long distance overseas. Williams Gas Pipeline operates an LNG terminal in Carlstadt, NJ

Table A-3: Ten Largest Plants by Generating Capacity in NJ, 2002[60]

Plant	Primary Energy Sources	Operating Company	Net Capacity (MW)
1. Salem	Petroleum, Nuclear	PSEG Nuclear LLC	2,259
2. Bergen	Other, Gas	PSEG Fossil LLC	1,224
3. Hudson	Other, Petroleum, Gas	PSEG Fossil LLC	1,120
4. Hope Creek	Nuclear	PSEG Nuclear LLC	1,049
5. Linden Cogeneration	Petroleum, Other, Gas	Cogen Technologies Linden Venture LP	900
6. Burlington	Other, Gas	PSEG Fossil LLC	802
7. AES Red Oak LLC	Gas	AES Red Oak LLC	792
8. Mercer	Other, Gas, Coal	PSEG Fossil LLC	777
9. Linden	Other, Petroleum, Gas	PSEG Fossil LLC	775
10. Kearny	Other, Petroleum, Gas	PSEG Fossil LLC	764

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[59] See Energy Information Administration, U.S. Department of Energy (EIA), Electric Power Annual 2002, December 2003.

[60] See EIA, State Electricity Profiles 2002, January 2004.

named Transco Station 240. LNG storage facilities also provide additional gas reserves during times of peak demand. When it is needed, LNG is converted to a vapor and delivered back into the pipeline system. Companies are considering transporting LNG by sea vessel to a port along the east coast. One such plan is by BP to place an LNG port in Logan Township, New Jersey.[61] BP believes that this is a more efficient way to meet demand for natural gas in New Jersey and the region than by expanding the current natural gas long-distance pipeline system that has to travel from the Gulf of Mexico. Once the LNG vessel docks at the port, the LNG is regasified for further distribution by local pipelines to homes, electricity plants and industry in the region.

A.E. Electricity Bulk Power System

The electricity power system supplies the electric power needed to serve the demands of New Jersey's residences and businesses. The facilities that make up this system include long-haul transmission lines, local distribution lines and the power plants that supply the electricity generated from a variety of energy sources. Not shown are the smaller distributed generation and renewable energy facilities that exist in the state.

The amount of electricity generated in a given year within the state depends on a larger system of electricity supply and transmission. Market transactions are managed through an independent entity, a regional transmission organization—PJM Interconnection. PJM coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia. PJM monitors the high-voltage transmission grid 24 hours a day, seven days a week to keep the electricity supply and demand in balance by telling power producers how much energy should be generated and by adjusting import and export transactions.[62] Figure A-3 shows the electricity generated in New Jersey to supply the system and the breakdown among the various sources of electricity generation. For most of the last decade nuclear has been the largest single source of electricity generation. Natural gas is growing as a fuel to meet increasing demand for electricity.

The amount of electricity by each power plant in New Jersey varies from year to year depending on the cost of different fuel sources for the power plant, demand and other market factors. Table A-3 lists the ten largest power plants in New Jersey by generating capacity. As shown in the table, these ten plants are capable of producing a total of 10,462 MW. Generating capability in New Jersey has grown from 1990 to 2002 from 15,837 MW to 18,384 MW. The growth in generation capacity in the last decade has been largely in the area of natural gas and dual-fired power plants. Dual-fired plants use both petroleum and natural gas, but mostly use natural gas as their fuel.

A.i. Nuclear Generation

Despite growth in natural gas and dual-fired plants, as previously discussed, nuclear energy continues to be a large percentage of electricity generation in NJ. Figure A-4 graphs the nuclear

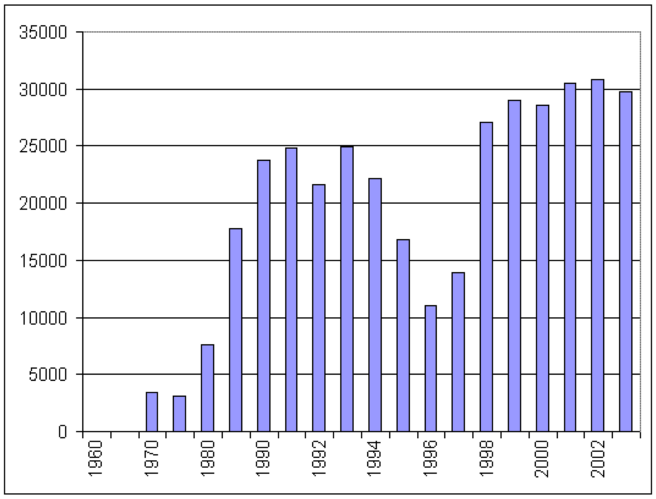

Figure A-4: Nuclear Generation in New Jersey, 1960 through 2003[63]

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[61] See BP Website, Crown Landing: Natural Gas for the Northeast, accessed December 15, 2004. (http://www.bplng.com/products/services_crown-landing.asp)

[62] See PJM Interconnection website, About PJM – Overview, accessed January 10, 2005. (http://www.epjmtraining.com/about/overview.html)

[63] See EIA, U.S. Nuclear Reactors - State Nuclear Industry, New Jersey, August 4, 2004.

Table A-4: Nuclear Power Plants in New Jersey Data for 2003[64]

Plant Name	Nuclear Units	License Expiration	Capacity Net MWe	Share of State Nuclear Generation	Operator/Owner
Hope Creek	Unit 1	April 11, 2026	1,049	29 %	PSE&G Nuclear LLC/Same
Oyster Creek	Unit 1	April 4, 2009	605	16 %	AmerGen Energy Co./Same
Salem	Unit 1 Unit 2	August 13, 2016 April 18, 2020	2,221	55 %	PSE&G Nuclear/PSE&G Nuclear (57.4%) and Exelon Corp. (42.6%)
Total	**4 Reactors**		**3,875**	**100 %**	

power output in New Jersey since the 1970s. This may change if licenses for nuclear energy plants are not renewed. According to the U.S. Nuclear Regulatory Commission (NRC) as shown in Table A-4 below, the license for Oyster Creek expires in 2009. There is an intense debate currently underway in New Jersey among stakeholders on whether this license should be renewed or extended. The licenses for Hope Creek and Salem 2 expire after 2020 and no application for renewal is anticipated in the near future. The license for Salem unit 1 expires in 2014, and no application is anticipated in the near future.

A.ii. Renewable Energy and Distributed Generation

As Figure A-3 previously showed, the percentage of energy from renewable sources is under 2 percent currently in New Jersey. However, it is expected that the use of renewables will grow over time, in part due to the State's renewable portfolio standard. Net-meeting provisions allow for small-scale on-site generation to sell back to the grid electricity not being used for on-site purposes. The infrastructure needed to handle these small inputs of electricity is small given the amount being generated.

There is a growing business infrastructure for photovoltaic (PV) systems in New Jersey, with 57 commercial and residential installers of photovoltaic systems registered in the state. Two dozen distributors, installers, manufacturer/integrators are headquartered in New Jersey with another 23 located in neighboring states.[65] These installers also provide services as integrators, distributors and/or PV module manufacturers. For on-shore wind powered systems the infrastructure is much less developed. There is a proposed 7.5 MW Atlantic City wind installation that will be installed as a cluster of smaller wind turbines each generating a portion of its overall electricity generation.[66] This leads to higher costs for installation but lower costs for interconnection because the facility will be able to interconnect into the local distribution system and eliminate the need for transmission line extensions. Unlike solar, key equipment is generally imported from foreign sources, although there are several tower and two large turbine manufacturers in the United States. Only secondary equipment, such as gearboxes and electronics, are located in New Jersey. For off-shore wind, there is currently little to no infrastructure located domestically.

In the area of biomass, New Jersey already has a system and infrastructure in place to collect tree and yard waste at the county and municipal levels.[67] This system could be modified to fuel biomass generation. Wood and paper products provide nearly 5% of New Jersey's total manufacturing workforce. Whereas nationally, this industry provides half of its own energy needs through biomass, New Jersey falls well below that level.[68] New Jersey also has a large and well-established infrastructure for landfills that are monitoring their landfill gas that can provide

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[64] Ibid.

[65] See Navigant Consulting, Inc. for Center for Energy, Economic and Environmental Policy (CEEEP), New Jersey Renewable Energy Market Assessment, August 2, 2004.

[66] Ibid.

[67] Ibid.

[68] Ibid.

power. The wastewater infrastructure also provides an existing level of monitoring of biogas and a sunken investment that could be adapted to provide power. Besides these three areas, there is little or no biomass power capacity and supporting infrastructure. The Department of Energy, Energy Information Agency statistics on New Jersey's biomass capacity reveals only 1 MW beyond landfill gas or incineration.[69] In addition, there are few biopower technology vendors, manufacturers or installers in New Jersey. In other states, biomass co-firing with fossil fuels is an option that is used in other states because it provides stability in power generation and improves operation.

Hydrogen and fuel cell systems are another source of electricity generation. Currently four New Jersey universities (Stockton College, The College of New Jersey, Ramapo College, and Ocean County Community College) as well as a number of New Jersey companies are operating hydrogen-powered fuel cells to provide some of their electricity needs. The installations are all examples of distributed generation. Whereas hydrogen can be converted through a number of processes from sources of oil, coal, natural gas, biomass and water, currently all fuel cells in operation in New Jersey are powered by natural gas. The natural gas is reformed with steam to break off the hydrogen atoms from the natural gas molecules. The resulting products of the process are water, CO2 and hydrogen gas. The water is used again or discarded and the CO2 is vented. The hydrogen is then passed through the fuel cell, which through a chemical process combines with oxygen from air to release electricity and water. The technology is still in the demonstration and early-commercialization phase. The business infrastructure in New Jersey is also limited, but there are several major fuel cell firms in nearby states like Connecticut.

A.F. Transportation Facilities

New Jersey's transportation facilities are also an important aspect of New Jersey's energy patterns. As will be discussed in greater detail in the energy use section below, New Jersey consumes more energy on transportation than on residential, commercial or industrial uses. New Jersey's population density and its location as a major byway on the east cost situated between New York City and Philadelphia, make it a natural hub for transportation among the region and within the state. These needs are met by the use of a large system of railroads and federal, state, county and local roads traversed by personal automobiles and trucks. Figure 13 on the opposite page shows a broad overview of the entire transportation network. This section will provide some detail on the infrastructure used to support transportation.

A.i. Railroads

Freight railroads are an important component of the transportation system. In 2000, railroads

Table A-5. Freight Railroads Operating in New Jersey by Class: 2000[70]

Railroad	Miles operated in New Jersey
Class I railroads	**1,581**
CSX Transportation	648
Norfolk Southern Corporation	933
Canadian railroads (Canadian Pacific Railway)	**68**
Regional railroads (New York, Susquehanna, & Western Railway)	**78**
Local railroads	**196**
Switching and terminal railroads	**875**
Conrail Inc.	831

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[69] Ibid.

[70] See Association of American Railroads, Railroads and States – New Jersey, 2002 (http://www.aar.org/AboutTheIndustry/StateInformation.asp).

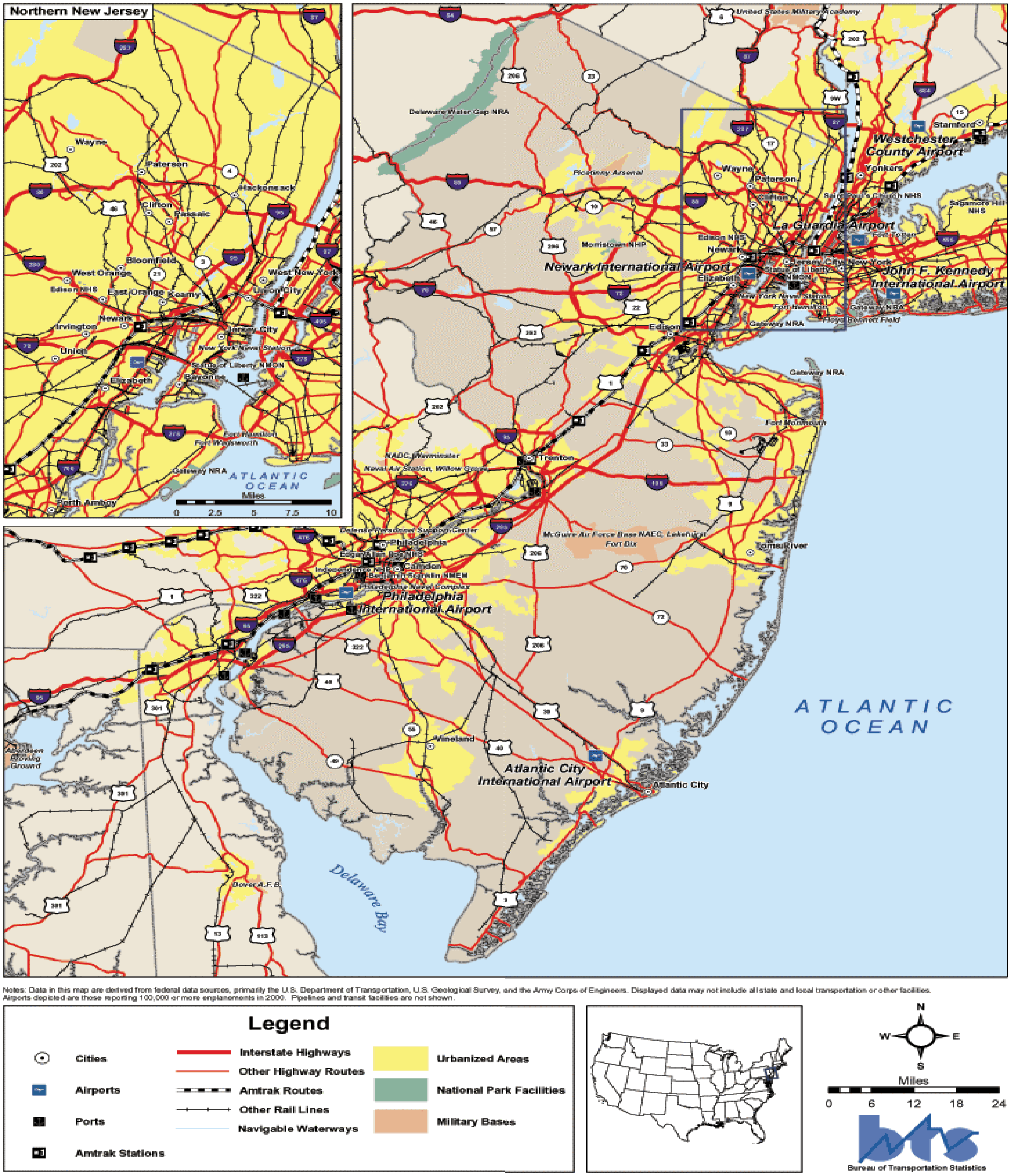

Figure A-5: Major Transportation Facilities in New Jersey[71]

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[71] See Bureau of Transportation Statistics, U.S. Department of Transportation, New Jersey Transportation Profile, 2002. (http://www.bts.gov/publications/state_transportation_profiles/new_jersey).

Table A-6: New Jersey and U.S. Motor-Vehicle Registrations, 2000[72]

Motor vehicle type	Private and commercial	Publicly owned	New Jersey total	United States total
All motor vehicles	6,353,002	148,882	6,501,884	225,821,241
Automobiles	4,406,435	44,284	4,450,719	133,621,420
Buses	18,366	3,172	21,538	746,125
Trucks*	1,816,771	101,003	1,917,774	87,107,628
Motorcycles	111,430	423	111,853	4,346,068

*Includes light trucks (pickups, vans, sport utility vehicles, and other light trucks) as well as medium and large trucks.

handled more than 40 percent of the nation's intercity freight traffic (measured in ton-miles), and were the predominant mode of transportation for coal, motor vehicles, and other commodities.[73] As shown in Table A-5, New Jersey has 2798 miles of operated railroad track. The major categories of track are Class 1 and switching and terminal railroads. Class 1 railroads are railroads with 2002 operating revenues of at least $272 million dollars and switching and terminal railroads are those non-Class 1 railroads engaged primarily in switching and/or terminal services for other railroads. In the case of Conrail in New Jersey, it is owned jointly by the two Class 1 railroads to provide local freight service for the owners.

A.ii. Roads and Highways

As the most densely populated state, New Jersey also has a dense network of roads and highways as shown in Figure A-5 above. As Table A-6 shows, New Jersey has over 6.5 million vehicles registered in the state. These vehicles travel on 36,000 miles of road, owned by the municipal, county, state and federal jurisdictions.[74] In 2000, New Jersey drivers traveled a total of 67 billion highway vehicle-miles, placing it 13th among the states. In per capita terms, however, New Jersey traveled a total of 8 million highway vehicle-miles in 2000 placing it 46th among the states.[75]

Congestion is a common occurrence in New Jersey's road and highway infrastructure. In a report by New Jersey Institute of Technology's National Center for Transportation and Industrial Productivity and International Intermodal Transportation Center, it found that congestion is a major drain on resources in New Jersey. The report found that approximately 261 million person-hours are lost to delay in New Jersey annually. For each licensed driver in the state, the average time lost to delay was 45 hours per year. The annual congestion costs to auto and bus users were $4.7 billion in lost time plus $400 million in wasted fuel. The additional operating costs to truck operators are $2.2 billion annually. About 35 percent of New Jersey's peak period vehicle-miles of travel (VMT) take place under congested conditions.[76]

A.III. Energy Use

Data for the state of New Jersey for 2000 reveal a larger percentage of end-use energy devoted to transportation than in the nation as a whole, which makes the state more vulnerable to changes in

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[72] See U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 2000, Washington, DC, 2001, tables MV-1 and MV-9.

[73] See Association of American Railroads Website, RR Industry Info - Railroads and States, accessed 2004. (http://www.aar.org/AboutTheIndustry/StateInformation.asp)

[74] See U.S. Department of Transportation, Federal Highway Administration, Highway Statistics, Washington, DC, February 1, 2002, table HM-14. (http://www.fhwa.dot.gov/ohim/hs00/hm14.htm)

[75] See U.S. Department of Transportation, Federal Highway Administration, Highway Statistics, December 6, 2001. (http://www.fhwa.dot.gov/ohim/ ohimstat.htm)

[76] See New Jersey Institute of Technology, National Center for Transportation and Industrial Productivity and International Intermodal Transportation Center, Mobility and the Costs of Congestion in New Jersey, 2001 Update, 2001.

Table A-7: Energy Consumption and Type – United States and New Jersey 2000[77]

END USE	U.S.	New Jersey	ENERGY TYPE	U.S.	New Jersey
Transport	27%	34%	Coal	23%	4%
Residential	19%	20%	Natural Gas	23%	23%
Commercial	15%	19%	Petroleum	39%	47%
Industrial	39%	27%	Nuclear Electric Power	8%	11%
			Hydroelectric Power	3%	-0.05%
			Wood and Waste	3%	1%
			Other	0.4%	0.03%
			Net Inflows	0%	14%

petroleum supply. In this state, 34 percent of energy consumption goes to transportation, 27 percent to industrial uses, 20 percent to residential, and 19 percent to commercial uses. Of total energy used in the state in 2000, 47 percent came from petroleum and 23 percent was from natural gas. Only 4 percent came from coal, 11 percent from nuclear electric power, and about 2 percent from a combination of alternative sources, such as wood and solid waste, hydroelectric power, and a combination of geothermal, wind, photovoltaic (PV), and solar thermal energy. Within the residential sector, about 67 percent of the homes in New Jersey are heated by natural gas, with fuel oil accounting for the next largest share at 19 percent.[78]

In energy consumption and imports, state rankings for the year 2000 published by the Energy Information Administration reveal the state of New Jersey to be among the largest consumers of energy. As shown in Table A-8, New Jersey ranks among the top 15 states in all sectors – residential, commercial, industrial, and transportation. With transportation being the largest source of consumption, it is not surprising that New Jersey ranks 8th among the states in transportation consumption. However, when total consumption is calculated per capita, New Jersey ranks below the middle of the pack at 32 out of 50. As Figure A-6 shows, in absolute terms, New Jersey consumes 29 billion Btu a year less than the national per capita consumption. However, in the region it still consumes more than New York, Maryland and Massachusetts. Only Pennsylvania is much higher due to strong industrial sector consumption.

Table A-8: New Jersey's Ranking in the Nation in Energy Consumption 2000[79]

CATEGORY	RANK	CATEGORY	RANK
Per Capita Consumption		*Sector Consumption*	
Coal	36th	**Residential**	11th
Natural Gas	9th	**Commercial**	9th
Petroleum	9th	**Industrial**	15th
Electricity	20th	**Transportation**	8th
Total	32nd	**Total**	12th

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[77] See EIA, "Table S1. Energy Consumption Estimates by Source and End-User Sector, 2000," State Energy Data 2000, Washington: GPO, 2002.

[78] See Bamberger, Robert, CRS Report IB87050: Strategic Petroleum Reserve, Washington, DC: Congressional Research Service - Resources, Science, and Industry Division, August 2, 2001.

[79] See EIA, "Table R2. Energy Consumption by Source and Total Consumption per Capita, Ranked by State, 2000," State Energy Data 2000, Washington, DC: GPO, 2002.

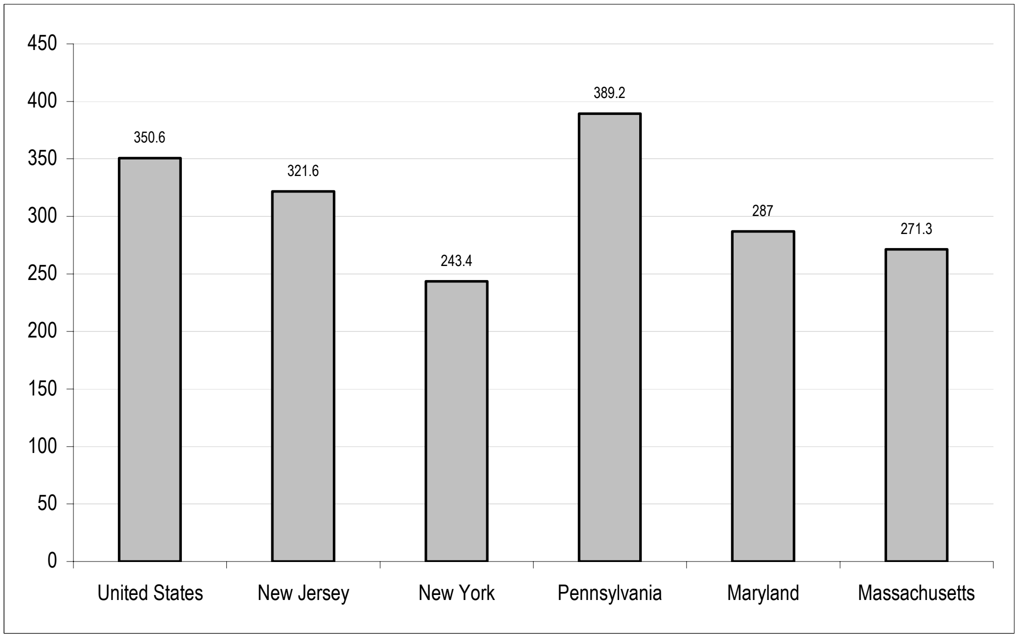

Figure A-6: Per Capita Energy Use - 2000 (billion Btu)[80]

Another method to examine consumption in New Jersey and to compare it across other states of different populations and different sized-economies is to look at energy intensity. Energy intensity measures the ratio of energy consumption to economic output, in this case gross domestic product (GDP) for the U.S. and gross state product (GSP) for each state. The National Energy Policy released by the Bush administration in 2001 calls for continued reductions in energy intensity. Figure A-7 shows the energy intensities for

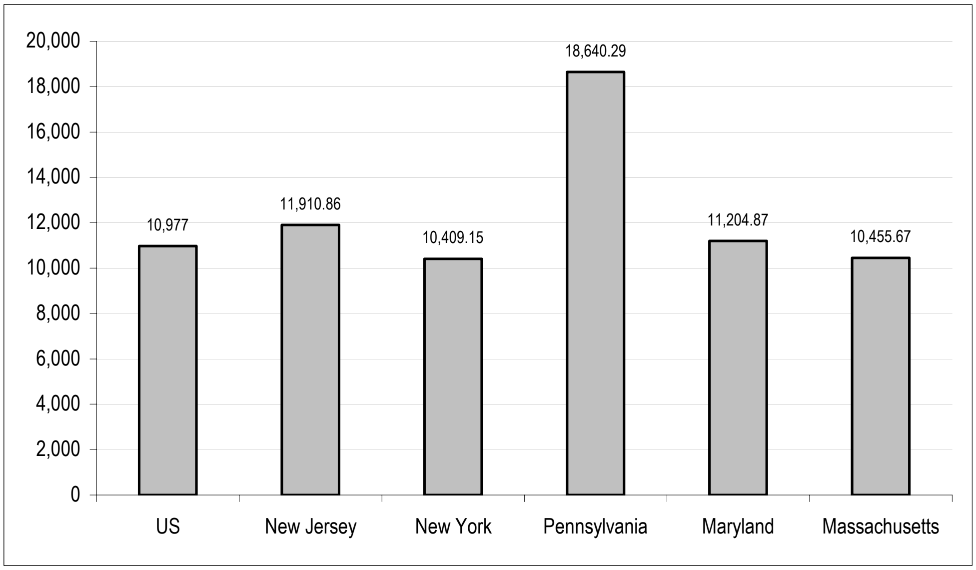

Figure A-7: Energy Intensity - 2000 (Btu per Dollar of GDP/GSP)[81]

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[80] Per capita energy use calculated from energy consumption data from EIA, State Energy Data 2000, Washington, DC: GPO, 2002 and from population data from U.S. Census Bureau, 2000 Census of Population and Housing.

[81] Energy Intensity is calculated from the energy consumption data for the U.S. and states divided by their Gross Domestic Product or Gross State Product respectively. Dollar is adjusted to 1995 value of U.S. dollar. See State Energy Data 2000, Washington, DC: GPO, 2002 and U.S. Census Bureau, 2000 Census of Population and Housing.

Table A-9: Energy Efficiency and Distributed Generation Market Potential[82]

Program Concept	Market Potential (MW)	Market Potential (GWh)	Market Potential (MTherm)
Residential Electric & Gas			
New Construction	18	50	11
Low Income	304	875	173
HVAC	1,307	1,630	714
Energy Star	118	2,264	122
Commercial/Industrial Electric & Gas			
Retrofit	1,538	6,665	-
Renovation/ New Construction	26	98	-
Industrial Processes	146	896	-
Commercial/Industrial Gas	-	-	314
Distributed Generation			
Commercial and Industrial	583	-	-
Fuel Cells	218	-	-
Zero Emission Homes	132	-	-

the United States, New Jersey and four other states in the region. In energy intensity, New Jersey consumes almost 1,000 Btu per dollar of economic output more than the United States and exceeds New York, Maryland and Massachusetts. Again, Pennsylvania with its energy intensive industrial sector is well ahead of New Jersey and the nation with over 6,500 Btu per dollar. A RAND study[83] of changes in energy intensities showed that New Jersey experienced a 2 percent decline in its energy intensity over the period of 1988 to 1999. During that same period, the U.S. statewide average saw a 1.62 percent decline. The reductions in New Jersey came in the commercial and residential sector, enough to offset increases in intensity in the industrial and transportation sectors. The U.S. statewide experienced a much larger increase in transportation energy intensity over the same time period of .84 percent. A decrease in industrial and commercial energy intensity was high enough to offset this increase during this time period.

A.A. Energy Management and Distributed Generation

Besides producing more energy to meet growing demand, managing energy through energy efficiency programs and distributed generation can also change both the level of energy use, but also the infrastructure involved. This section discusses the technical and market potential of both energy efficiency and distributed generation and its potential impact on infrastructure.

An August 2004 report for the Center for Energy, Economic and Environmental Policy at Rutgers University by KEMA, Inc. (KEMA Report)[84] examined a number of energy efficiency and distributed generation programs to estimate their technical, economic and market potential for saving electricity and natural gas consumption. These programs included residential targeted energy efficiency programs for new construction, low-income residents, HVAC installations and Energy Star certified products. For commercial and industrial energy efficiency programs, the report examined programs for retrofitting, renovation and new construction, and industrial process improvements. In the area of distributed generation, the KEMA report examined the programs involving commercial and industrial on-site generation, fuel cells and zero emission homes. Table A-9 below displays some of the results of that study and the level of market potential for both electricity and natural gas savings.

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[82] GWh – GigaWatt-hours or 109 Watt-hours, MTherm – MegaTherm or 106 Therms. See KEMA, Inc. for CEEEP, New Jersey Energy Efficiency and Distributed Generation Market Assessment, August 2004, page ES-19, Tables ES-4, ES-5. (http://policy.rutgers.edu/ceeep/images/Kema%20Report.pdf)

[83] See Mark Bernstein, et al., RAND Science and Technology Policy Institute for the U.S. Department of Energy, State-Level Changes in Energy Intensity and Their National Implications, 2003.

[84] See KEMA, Inc. for CEEEP, New Jersey Energy Efficiency and Distributed Generation Market Assessment, August 2004, page ES-19, Tables ES-4, ES-5. (http://policy.rutgers.edu/ceeep/images/Kema%20Report.pdf)

Chapter 3: Energy Infrastructure Investment Policy Barriers

I. Introduction

This chapter outlines several proposed initiatives to promote levels of energy infrastructure investment by investor-owned utilities that are aligned with state goals. The initiatives presented here were formed through discussions with various stakeholders in direct interviews and through CEEEP's Strategic Issues Forum. Before turning to these proposed initiatives, this chapter discusses the policy barriers to infrastructure investment and examines the different categories of barriers to understand better their influence on investment decisions. The proposed initiatives are then articulated in the context of overcoming these policy barriers.

II. Policy Barriers to Energy Infrastructure Investment

It is important to consider mutually the various influences on investment that may create policy barriers. The following is a brief summary of potential barriers that are discussed in this section:

- Uncertain cost recovery – Inability to recover full costs of infrastructure investments leads to under-investment or to choosing a less effective technology or location for the investment. The cost uncertainty is particularly pronounced since energy infrastructure investments are long-term.
- Regulatory and market incentives – These incentives may not be aligned with the goals of the state's energy infrastructure policy. Various market and regulatory structures may hinder effective policy making and implementation.
- Jurisdictional conflicts – Differences in local, state and federal policymaking may affect choices in level, type and location of investments and create a lack of consistency and coordination across policymaking and decision-makers.
- Difficulties in quantifying benefits, especially compared to costs – With many policies, such as those with substantial environmental benefits, benefits are hard to quantify and uncertain, which creates barriers in explaining and justifying these policies.

A. Uncertain Cost Recovery

The risk of changing policies can inhibit investment decisions. Between the extremes of guaranteed recovery and second guessing by regulators lies a balance of interests that can encourage investment in directions intended by policy makers. Regulatory risk from uncertain cost recovery will arise in numerous settings. An inability to recover full costs of infrastructure investments can lead to under-investment or choosing a less effective technology or location for the investment. Such cost uncertainty is particularly pronounced with regard to energy infrastructure since these investments are long-lived. Moreover, prudency reviews are conducted after-the-fact, and it is possible that decisions that may have been prudent at the time turn out to be uneconomic, exposing the utility to the risk of under recovery of its investment. Stranded costs due to electricity restructuring illustrate this dynamic.

Another example is the potential impact upon the introduction of new technologies. By definition, these technologies are less proven than existing ones and therefore are vulnerable in an after-the-fact prudence review. Stakeholders must make decisions about new technologies based on unverified claims or with partial information. A technology's performance in one geographical area under one set of circumstances may be entirely different in another state or locality having its own particular characteristics. Renewable energy investments are a good illustration of this. The effectiveness and therefore their investment return of windmills, geothermal, hydroelectric and solar PV installations are heavily dependent on their location of deployment. The stage of commercial development for the technology also is an important factor. Installations of fuel cells are still in a demonstration stage and newer more effective models may replace any investment in them before their full life has been met.

In addition, changes in policy direction or political climate can increase uncertainty and risk. Regulation and policymaking are constantly evolving and external events may cause unanticipated changes in direction. Elections and appointments of new policymakers, which are not bound by their predecessors' policies, are examples of this issue. Initiatives that may make sense in one policy context, no longer do in another, and utilities may be reluctant to take such initiatives, particularly if cost-recovery is uncertain. Changes in regulatory policies, particularly when combined with long-lived assets and uncertainty in cost recovery, can prompt companies to avoid long-term investments and to stretch the life of existing assets, perhaps at a greater cost and with reduced performance than new ones. Mechanisms to extend the decision-making horizon and expand the universe of possible solutions, such as developing an energy master plan, investing in new technologies, and building an alternate resource base, tend to be given lower priorities than short-term concerns.

B. Coordinating Regulatory Policies and Market Incentives

Incentives can create a barrier to appropriate infrastructure investment when not aligned with the goals of energy infrastructure policy. The existing cost-of-service rate structure provides strong incentives to plan, build, and operate facilities in a certain manner, which may not be consistent with policy objectives. For instance, increased levels of efficient distributed generation may be discouraged because utilities recover some of their fixed costs via a throughput charge. Regulatory regimes are typically designed around the development of the facilities and infrastructure that carry the commodity and so favor the status quo versus new alternate technologies or systems.

When there is a combination of regulation and markets, different regulatory regimes may cause unintended investment decisions. Depending on the energy source, energy infrastructure can be provided by the market (e.g., oil, conservation measures), regulated companies (distribution of electricity and natural gas), or partially regulated and market-based enterprises (e.g., electricity generation). In addition, some regulatory policies are market-based, such as emission allowances, whereas others are command-and-control. These various market and regulatory structures may hinder effective policy making and implementation. Aligning state goals and incentives across markets or different levels of regulation can be very difficult. For example, incentives for distributed generation must cross both the generation market, which in the case of electricity is deregulated, and transmission and distribution, which are regulated. Solar PV competes with both the nuclear power plant and the distribution lines carrying power to its destination.

Also, policies have a reach beyond the regulatory agency that is fashioning them and the industry to which the policies are applied. For example, clean air regulations have both energy and environmental policy implications. Barriers can occur when policies try to address one aspect across agencies or industries. The interaction of New Jersey's renewable portfolio standard with emission caps and allowance markets illustrates this issue. There are both energy and environmental impacts from each of these policies and attempting to align the clean air, energy efficiency and energy independence goals, among others, across these domains is difficult.

C. Jurisdictional Conflicts

Differences in local, state and federal policymaking may affect choices in the level, type and location of investments. One energy infrastructure investment that exacerbates jurisdictional conflicts is transmission. Transmission lines can cross many jurisdictions, particularly local ones, and are generally regulated by the federal government. Siting is primarily a state and local concern, but as part of the Energy Policy Act of 2005, the federal government retains backstop authority to site transmission within "national interest electric transmission corridors" that need to be upgraded to improve reliability and relieve congestion.[85] Another potential conflict is that an agency may be asked to issue the required permits and licenses for a policy initiated by a different agency. Lack of consistency and coordination across policymaking and decision-makers also affects investment decisions. Different government agencies, even within the same jurisdiction, may have unaligned, competing or contrary policy goals and policies.

Differences in jurisdiction between the federal and state governments lead to conflicting policies. For example, substantial differences exist between current federal and New Jersey's energy efficiency and conservation policies. The Federal Energy Regulatory Commission may grant expansion of interstate transmission capacity that may not be aligned with state governmental policies on smart-growth and the environment. In the wholesale electricity market, decisions on where electricity will be purchased to supply a region may affect a state's economic development policies. For example, wholesale market decisions may lead to the closing of uneconomic plants in one state and encourage growth of new plants in another.

Similarly, conflicts may occur across two or more states over differences in policies. In a region, states may pursue policies that would be more effective and less expensive if implemented on the federal level or regionally than if implemented solely state by state. The implementation of different Renewable Portfolio Standards is one example. Pennsylvania includes the use of coal waste in their standard, while Connecticut allows for fuel cell technology, even though New Jersey recognizes neither uses in its RPS programs. The differences in these programs may hinder the development of a liquid and competitive renewable energy sector and instead result in a fragmented industry.

Even within a state there are conflicts due to jurisdictional issues among different governmental authorities and entities. Coordination of policies may be inadequate, for instance, between the NJ BPU and NJ DEP. Both have policies that affect air quality in New Jersey and must find ways to align their policies to overall state and federal goals. Ancillary or competing policies may create conflicts that hinder achieving these goals. Finally, conflict will also occur among different levels of government within a state. Local counties and municipalities have competing interests amongst each other and vis-à-vis the state government. This most often manifests itself in siting decisions. The conflict can come from determining which path an undesirable transmission line or pipeline may travel or siting an economically plant that may bring jobs and other benefits to a community. The decisions facing the Pinelands Commission regarding the extension of a natural gas pipeline through southern New Jersey is an example where the state and local communities all had different stakeholder viewpoints on what the outcome should be.

D. Difficulties in Quantifying Benefits

With many policies, the costs are relatively known and certain compared to the benefits. Even policies in which the benefits may substantially trump the cost are difficult to justify due to their uncertainty. For instance, policies with substantial environmental benefits that are hard to quantify and monetize may not be pursued because of this issue. Policy issues where aesthetic criteria are involved also are very hard to quantify. The siting of a tall wind tower on the shore or other areas of high tourism activity may result in

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[85] Energy Policy Act of 2005, Public Law 109-58 (Section 1221), signed August 8, 2005.

costs or losses of economic activity that would be hard to predict or quantify.

Uncertainty in the benefits and/or costs on policies will occur with almost any policy issue of some complexity. The uncertainty arises out of the inability to determine the outcomes of policies. Efforts can be made to reduce uncertainty through studies, demonstrations or other analyses, each of which carriers with costs in time and money and can often only reduce uncertainty but not eliminate it. Event with these efforts, different stakeholders will reasonably come to different conclusions about outcomes. For example, environmental groups can differ on their views as to when and how oil will run out as an energy source. Exacerbating the difficulties in quantifying benefits is that stakeholders with opposing views or agendas can then take advantage of the inherent uncertainty of outcomes to take advantage of these reasonable differences in predicting outcomes. For example, global warming's high level of complexity has created great uncertainty about outcomes and the policies that should be undertaken to address it. Opponents of policies to prevent global warming will point to studies that minimize its affects while proponents of these same policies will highlight those studies that maximize the dangers.

What is certain is that decisions must be made before outcomes are fully understood, and uncertainty should not benefit the status quo. As stated previously, while actions can be taken to reduce uncertainty, decisions are still made that precede the outcome. One obviously cannot wait to determine when oil runs out or what global warming's effects are to implement a policy initiative. By the same token, doing nothing is always an option, and uncertainty can be used by some stakeholders to encourage maintaining by default the current course. Uncertainty can also prevent political leadership from making a decision or from changing the status quo in order to avoid alienating some stakeholders. However, the decision to take no action should be evaluated as a decision according to the same criteria as the other policy options. This highlights the importance of first identifying values and objectives, then clearly defining the barriers to achieving an objective. If the difficulty in quantifying benefits and costs due to uncertainty is identified as a barrier, then this will help to avoid having policies default to the status quo. Efforts can be then made to better quantify benefits and costs and identify policies that would otherwise be overlooked due to the pressure to maintain the status quo in the face of uncertainty. The pressures created by uncertainty also work against wholesale policy changes and encourages incremental and flexible initiatives that may reduce risk or minimize short-term impacts on stakeholders.

III. Policy Initiatives and Recommendations

This section discusses three initiatives for policymakers to consider:

- The institutionalization by the NJ BPU of pilot programs for new technology by investor-owned utilities.
- The explicit assignment of an infrastructure planning function within the Energy Master Plan committee to better guide investment across New Jersey.
- The study by the state of the impacts of changes in rate regulation through decoupling.

Policy initiatives can fall into two primary categories: process solutions or program solutions. Process solutions attempt to improve the framework of deciding how to decide in order to increase discussion of policy options, expand stakeholder input, and provide better policy outcomes. They may reduce regulatory risk by providing greater certainty or reduce transactional costs associated with the regulatory process. Program solutions are specific mechanisms designed to obtain appropriate levels of investment. These program mechanisms may be broken down in a variety of ways, (e.g. regulatory versus market driven program solutions or incentive versus mandated driven program solutions), or as a combination of these options.

Potential policy initiatives should link back to the values, objectives and criteria discussed in the first chapter. To recap from Chapter 1, the main value identified is improving the quality of life for New

Policy Highlight #4 - The Benefits of Having a Centralized Energy Infrastructure Database

Previously, the report highlights the interdependencies of different infrastructures, especially the interrelationship among energy infrastructure and transportation, telecommunications, financial, security and water infrastructures. Policymaking across these domains requires a high level of coordination among political leaders and stakeholders regarding investment decisions. In Policy Highlight #2, a series of basic questions and policy steps are recommended in order to identify policy affects from one infrastructure domain on another and resolved conflicts that may arise. This policy highlight proposes the assignment of New Jersey infrastructure planning tasks to the existing Energy Master Plan committee to further coordination of state infrastructure planning.

Policymakers face barriers in implementing new initiatives on infrastructure investment due to different jurisdictional authorities and the difficulties in quantifying benefits from such investments. Jurisdictional differences in local, state and federal policymaking affect choices in the level, type and location of investments. Also, with many policies, the costs are relatively known and certain compared to the benefits. This is exacerbated when the costs or benefits accrue across different interdependent infrastructures.

Having the Energy Master Plan committee tasked to conduct infrastructure planning would help to address both barriers. Having a single entity that, through planning, can examine options and attempt to quantify the complete costs and benefits of the proposed facilities would reduce barriers created by not fully investigating these issues in multiple, fragmented jurisdictional reviews across different levels of authority and government. Most importantly, through this assignment the Energy Master Plan committee would enable the state to look at infrastructure in a comprehensive, integrated fashion given the interdependencies among critical infrastructures in New Jersey, across various jurisdictions and governmental entities.

New Jersey government currently and in the past has had cross-departmental planning entities charged with different responsibilities similar in nature to what is being proposed. They include the Energy Master Plan committee established, following the energy crisis of the 1970s, to help guide the state's long-term energy policy; the Smart Growth Policy Council created, within the Governor's Office in 2002, to ensure that State agencies incorporate the principles of smart growth and the State Plan; and the State Planning Commission which has a similar membership to the Council but includes public and local government members. In practice, the updates to the Energy Master Plan by the committee have been irregular and the size and scope of their content has varied. Both the Smart Growth Policy Council and the State Planning Commission were products of previous gubernatorial initiatives and their effectiveness or level of activity has been dependent on Governor's office.

With the proposed assignment of infrastructure planning the Energy Master Plan committee would be responsible for submitting to the Legislature and the Executive Branch a periodic report detailing all pending major energy utility infrastructure projects. The report would examine the interrelationships to other projects and infrastructure, identify any gaps or overlaps, and study whether each project is aligned with state policies and goals. Included in this report would be the timeline and status for each of these projects and a discussion of potential investment options. The Energy Master Plan committee is a multi-member board with representation from the Departments and Agencies that have oversight of different aspects of New Jersey's energy utility infrastructure appointed by the Governor.

To carry out the proposed statewide planning function, its first task would be to maintain a database of all current energy utility infrastructures in the state, their capacity and potential needs for replacement, upgrade or new growth. The second task would be to set short-term, mid-term and long-term planning goals for the state to encourage investment in energy utility infrastructure that is aligned with state policies and goals. By examining investment decisions early enough, this would allow a wider set of potential options to be considered and better decisionmaking on which options would provide the means to meet these state goals.

In assigning these infrastructure planning tasks to the Energy Master Plan committee, this report makes several recommendations:

- Each governmental entity on the Energy Master Plan committee should create an action plan to arrive at an agreed level of informational collection to meet the needs of coordinating policy.
- The Energy Master Plan committee should have a standardized process where the Board members meet regularly and their expected output is well defined.
- Emphasis should be placed on identifying policy recommendations to be implemented by the Governor and Legislature to avoid having proposed initiatives end up on a shelf.
- Explicit identification should be made that energy infrastructure investment is directly related to other infrastructures and should be considered by all state departments and agencies involved.
- Further study is needed on whether the Energy Master Plan committee should be empowered to study infrastructure at the broader level of all critical infrastructure such as transportation and telecommunications.

Assigning these infrastructure planning tasks to the Energy Master Plan committee will coordinate state planning on investment while improving decision making and reducing the barriers to policy implementation. Whereas these recommendations hope to avoid the pitfalls that previous cross-departmental commissions faced, the importance of building a strong institutional authority either by the stature of its members or the engagement of the Governor and his staff cannot be underestimated in the ultimate success of the committee and the recommendations it makes.

Jersey's residents. The top-level objectives include economic strength, human health and safety, and protection of natural resources. Each of these objectives is then broken down even further within each category. The discussion among stakeholders is not unanimous as to what the main value should be and highlights the fact that different actors will have divergent views on the values, objectives and criteria. For example, as discussed in Chapter 1, stakeholders have divergent views on characterizing the top-level value, with some arguing for the primary value as "reliability." In the framework that is used for this report, reliability is considered a criterion or means to achieve the top-level objective of economic strength. So while there may be different views on the values, objectives, and criteria, identifying them is an important exercise to ensure that initiatives discussed are grounding in a framework that will aid policymakers in deciding how to decide across multiple objectives. The policy initiatives discussed in this chapter attempt to further one or more of the objectives defined in this hierarchy, by addressing the barriers discussed previously.

A. Institutionalizing Pilots and Pre-approving New Technologies

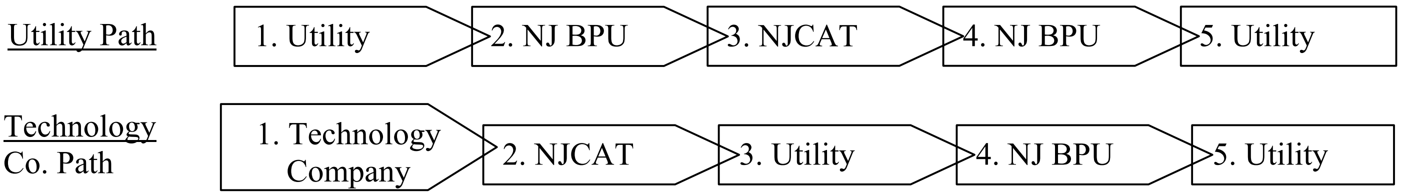
The initiative proposed here is to institutionalize the verification and pre-approval of new technologies related to electricity and gas infrastructure for use in pilots. The NJ BPU has already approved piloting of new technologies on an ad hoc basis and provided informal guidance on potential cost recovery. However, this ad hoc process can be time consuming and requires NJ BPU staff to evaluate technology claims without the assistance of independent experts. This process could be formalized and improved by establishing standardized rules for pilot programs and by partnering with the New Jersey Corporation for Advanced Technology (NJCAT) to perform verification of new technologies. NJCAT currently performs environmental technology verification through a partnership with the NJ DEP. Technology companies could also use the NJCAT verification process to provide themselves with independent verification of claims as they seek to market their technology to a utility.

Pilots have been recognized by both investor-owned utilities and regulators as an effective mechanism to demonstrate new technologies, new regulatory programs and other innovative ideas. PSE&G's recent pilot of smart metering technology is one example. Encouraging these pilots and institutionalizing the process of their approval, data collection, subsequent evaluation, and finally the decision to either expand or end the pilot program would greatly enhance the innovation process. One barrier is the risk of cost recovery for introducing new technologies. New technological development generally outpaces the schedules of utility cost-recovery decisions. Investor-owned utilities must sometimes weigh the options of whether to introduce the technology based on informal guidance without a determination of cost-recovery or to delay introduction until a formal decision is made about its approval for use. Without the ability to obtain pre-approval or conduct a pilot, the utility may pursue conventional technologies where the risks are less than with newer technologies. Technology companies seeking to introduce their innovations to utilities also face similar barriers without a certification of their technology as to its performance. A second barrier is the time it takes to implement an ad hoc process each time a new technology is implemented in a pilot. The cost and delay associated with recreating a process for each individual pilot is another barrier to the successful implementation of the technology itself. The NJ BPU also faces a risk when it must determine if piloting a new technology is a prudent investment based solely on claims made by the utility, without having knowledgeable experts on staff to verify these claims.

The need to reduce risk for new technologies is the same problem that the NJ DEP faced in its permitting process. The permitting process was long and cumbersome, the risk was high to grant permits to untested technologies, and new technologies posed safety, health and other liability issues. All of this contributed to discouraging investment and deployment in new environmental technologies. An initiative created to address these barriers was the formation of the NJCAT. NJCAT is a private/public partnership that combines the resources of business and industry, entrepreneurs, university research centers, utilities and government to promote the development and commercialization of new environmental technologies. The NJ DEP, under statutory authority and through collaboration with NJCAT, established an environmental technology verification program for the selection, promotion and commercialization of innovative environmental technologies that have significant environmental benefit for the State.

This process has evolved to also include mandatory verification for certain technologies. For example, stormwater management technologies are required to go through the NJCAT process as part of new laws and regulations enacted by the state.

Similar to NJCAT's current verification process, the utility or technology company would be responsible for the costs of the NJCAT review process. As shown in Figure 11 above, the utility or a technology company would submit an application to NJCAT or the new entity with details about the new technology along with a list of claims regarding the benefits and performance of the pilot or new technology. The utility or technology company would describe in its application how the new technology would advance state goals of increasing reliability, affordability, demand-side management, distributed generation, renewable energy and/or energy efficiency.



Utility Path - a utility wishing to pilot a new technology would: **1.** Submit to the NJ BPU its Pilot Plan for approval with the technology's claims. **2.** The NJ BPU would examine the Plan and if it deemed the technology needed verification it would send the claims to NJCAT. **3.** NJCAT would take the Utility's claims and data supporting those claims and would put together an expert panel to verify them. If verified, NJCAT would give the technology a verification certification and provide the results of their review to the NJ BPU. **4.** The NJ BPU then would approve the technology for piloting by the Utility. **5.** The Utility would then Pilot the technology and provide regular data updates to the NJ BPU on its performance.

Technology Company Path – a technology company could also start the process: **1.** By going directly to NJCAT for verification of its technology's claims. **2.** NJCAT would verify the claims as in Path A and provide certification if warranted. **3.** With certification, the technology company would then market its technology to utilities that may wish to pilot it. **4.** The utility then would take the verification certification to the NJ BPU as part of its Pilot Plan for approval. **5.** If the Plan is approved, the Utility would then pilot the technology and provide data updates on the technology's performance to the NJ BPU.

Figure 11. Pilot Approval and Technology Verification Process

A verification committee, or expert panel, would be formed using representatives from academia and other research and development organizations collaborating with NJCAT. This committee would then identify the claims to be verified and determine the criteria on which the pilot program or new technology would be measured against. Once the criteria are set, the committee would verify those claims by reviewing data and other information submitted by the utility or technology company. If the claims were verified under this process, then the new technology would be given an approval certification by the NJ BPU. This approval would give the utility a reduced risk for piloting these certified new technologies by providing guidance on potential cost-recovery.

After the introduction of the verified technology in the pilot, each investor-owned utility would be required to submit data periodically collected on the new technology's operation to help the NJ BPU determine whether it is meeting its anticipated claims as well as the goals of the pilot. If the utility decides to expand the deployment of the pilot program or new technology, then it can use the pre-approval certification to expedite review by the NJ BPU to carry its current terms forward to the expanded deployment. However, there should be an overall cap on investment in new technology to limit adverse impacts on the rate-base. Technology companies receiving the certification would be able to bring their certified technology to a utility with the guarantee that if the utility chooses to deploy their technology they would also receive the same verification benefits.

The NJ BPU must decide whether to keep the technology verification process voluntary before piloting or implementing new technology. In making this decision, the NJ BPU must evaluate whether a mandatory process would put a burden on the incumbent utility at the expense of alternative energy companies and other competitors. This is especially true in light of the goal to speed up and encourage introduction of new technologies by investor-owned utilities. By creating an institutionalized process by which investor-owned utilities can invest in new technologies, the local distribution system can become a platform from which future innovation emerges. The NJ BPU should also periodically review the technical expertise of its staff to ensure that personnel with strong technical qualifications to oversee pilots and the verification process are available.

Table 5. State Energy Infrastructure Planning and Siting Entities

State	Entity or Mechanism	Mission	Oversight
Massachusetts	Facilities Siting Board	Siting	Electricity Power Plants, Transmission Lines, Natural Gas Pipelines and Storage Facilities
Ohio	Power Siting Board	Siting	Same as Massachusetts
Florida	Siting Coordination Council with Governor & Cabinet	Siting	Same as above and Hazardous Waste Facilities
New York	Board of Electric Generation Siting and the Environment and Article X, Public Service Law*	Siting and Planning	Same as Florida
Minnesota	Chapter 212, 2001 Minnesota Laws	Planning	Same as Florida
New Hampshire	Office of Energy Planning	Planning	All Energy Infrastructure
Wyoming	Wyoming Infrastructure Authority	Economic Development	Electric Transmission Facilities

**Article X of the NY Public Service Law expired in 2002*

B. New Jersey Infrastructure Planning

This report proposes to assign an infrastructure planning component to the Energy Master Plan committee to examine proposed energy utility infrastructure investments and to attempt to quantify their costs and benefits and a full discussion of investment options. The Energy Master Plan committee is the same entity that conducts the energy master planning for the State and would be tasked with this additional function and be provided the necessary staff to do so. This would reduce barriers created by multiple, fragmented jurisdictional reviews across different levels of authority and government that are able to investigate fully these issues. Most importantly, such a responsibility with the Committee would address the need to look at energy utility infrastructure in a comprehensive, integrated fashion given the interdependencies among critical infrastructures in New Jersey. As detailed in the first chapter, energy infrastructure is dependent on and interacts with other critical infrastructures such as transportation, telecommunications, economic, security, water and waste infrastructure. This report proposes an initiative assigning an infrastructure planning function to the Energy Master Plan committee to meet these goals.

The Energy Master Plan committee as proposed would now be responsible for submitting to the Legislature and the Executive Branch a periodic report detailing all pending major energy utility infrastructure projects. The report would examine the interrelationships to other projects and infrastructure, identify any gaps or overlaps, and study the whether the project is aligned with state policies and goals. Included in this report would be the timeline and status for each of these projects and a discussion of potential investment options. The Energy Master Plan committee would examine non-energy infrastructure only as it impacts energy utility infrastructure and in the context of the important linkages among them.

The Energy Master Plan committee is a multi-member board with representation from the Departments and Agencies that have oversight of different aspects of New Jersey's energy utility infrastructure appointed by the Governor. Unlike most states which have energy siting or planning boards, as highlighted below, this proposal is suggesting a broader policy initiative that includes examining proposed energy utility infrastructure in the context of their inter-relationship with other state infrastructure and its alignment with state goals.

As a statewide planning board, one of the first new tasks for the Energy Master Plan committee would be to provide for the maintenance of a database of all current energy utility infrastructures in the state, its capacity and potential needs for replacement, upgrade or new growth. Similar to the work done in chapter two of this report, such a portfolio would establish the baseline and current state of energy utility infrastructure in New Jersey. The second new task would be to set short-term, mid-term and long-term planning goals for the state to encourage investment in energy utility infrastructure that is aligned with state policies and goals. Such longer term planning would allow enough time to explore alternatives to growth, avoiding decision making by crisis. The Energy Master Plan committee's assignment of these infrastructure planning tasks would accomplish its responsiblities while keeping in mind the goals discussed in Chapter 1 of economic strength, human health and safety, and protection of natural resources. By examining various investment decisions early enough, this will allow a wider set of potential options to be considered and better decision making on which options will provide the means to meet these state goals.

The challenge of having infrastructure planning of value is to ensure that another layer of decisionmaking or bureaucracy is added that can lead to unnecessary delay. By assigning this responsibility to the already established Energy Master Plan committee, this will help to avoid this pitfall, while coordinating with and enhancing the existing responsibilities the committee already has. Obtaining a more rational, forward looking and balanced process will require that the authority and responsibility assigned to the Energy Master Plan committee must be crafted with care to prevent additional barriers from being placed in front of needed investment, whether in traditional or alternative infrastructure. The impacts of disaggregation of the vertically integrated utility has not only increased the need for better planning and coordination, but has made it more complex, especially in the regional context of mergers and PJM's management of capacity.

Some stakeholders have raised the concern that increased or improved state energy planning will not solve the problem without a parallel reform of the siting process in New Jersey. Their concern is that delays in siting of state and local energy facilities will result in an increasing backlog of infrastructure plans that will negatively impact further long-term planning or remove less costly infrastructure choices from the table. In addition, they point to the shorter approval processes for federal projects combined with a reduction in state generation capacity. This may result in facilities being built that will remove energy from the local electricity pool to be delivered to out of state markets, creating further strain on transmission within the state. In light of these concerns, the state should study if there are ways to reduce the time it takes for siting approval and prevent decisions being made in a crisis environment. One option stakeholders have proposed is an entity to act as the decision-maker to approve or reject siting proposals for construction of new energy utility facilities and infrastructure that cross multiple jurisdictions.

i. Comparison with Current State Planning Entities

New Jersey government currently has cross-departmental planning entities charged with different responsibilities similar in nature to what is being proposed. A review of them provides some insight into what structure and role the new infrastructure planning assignment should have in order to be successful at its proposed mission.

Following the energy crisis of the 1970s, New Jersey adopted an energy master plan process to help guide the state's energy policy. The adoption of an Energy Master Plan is required to be a collaborative and participatory process with the public and industries involved in any and all aspects of energy in the state of New Jersey. The primary New Jersey agency and departments that have direct oversight regarding

energy decision-making include the Board of Public Utilities, the Department of Environmental Protection and the Department of Transportation. State statutes set forth that a new Energy Master Plan for New Jersey be adopted by a committee that includes the heads of these three governmental entities, as well as the following departments and agency heads:
Commerce and Economic Development, Community Affairs, Health and Human Services, Treasury, and the Ratepayer Advocate. The goal of the master plan is to cover a period of ten years on the production, distribution, consumption and conservation of energy in New Jersey. The plan is supposed to be revised and updated once every three years and includes long-term objectives with measures for interim implementation of policies consistent with those objectives. In practice, the updates have been irregular and the size and scope of their content has varied.

Another state planning entity, the Smart Growth Policy Council was created within the Governor's Office in 2002. Its purpose was to ensure that State agencies incorporate the principles of smart growth and the State Plan into their functional plans and regulations. Like the Energy Master Plan Committee, its membership is composed of the key agencies and departments in state government. The Council has a number of responsibilities regarding promoting the principles of smart growth and in particular related to infrastructure in the state. A similar entity to this is the State Planning Commission, which has a similar membership but also includes public and local government members. However, the NJ BPU President is not on the Commission and that would be essential for any infrastructure planning activities. Both of these entities were products of previous gubernatorial initiatives and their effectiveness or level of activity has been dependent on Governor's office.

These entities point to important improvements that would be needed for the assignment of infrastructure planning to the Energy Master Plan committee to avoid their current limitations. First, the assigned infrastructure planning component would need a uniform process where the Energy Master Plan committee members would meet more regularly and the output expected of the committee would need to be well defined. In addition, if possible, emphasis on identifying policy recommendations to be implemented by the Governor and Legislature would be key to avoid having proposed initiatives end up on a shelf. In launching this initiative, explicit identification needs to be made that energy infrastructure investment is directly related to the policies and investments in other infrastructures and should be considered by all involved state departments and agencies.

ii. Other State's Planning and Siting Entities

Seven states were examined that have either infrastructure planning and siting boards or divisions within the government responsible for overseeing policymaking and planning with regard to energy infrastructure. The seven states are Massachusetts, Ohio, Florida, New York, Wyoming, Minnesota, and New Hampshire. The table below provides a summary of the attributes of each state's entity charged with infrastructure policy.

As the Table 4 shows, 3 states (Massachusetts, Ohio and Florida) have primarily siting boards charged with giving permission and certification to utilities to locate their facilities. Minnesota and New Hampshire both have energy planning functions that rather than adjudicating siting applications, are responsible for examining the state's energy needs and planning the infrastructure that would be needed to meet future energy needs. New York had both functions in its Siting Board. It was responsible under its enabling legislation for both reviewing siting applications and forecasting future energy and infrastructure needs. In most cases, these entities have other duties such as representing the state at FERC proceedings or other regional bodies regarding infrastructure siting and planning. Wyoming's board is unique in that it is the only entity that has an explicit economic development mission as part of its operation. The Wyoming Infrastructure Authority is charged with facilitating from siting to construction of electricity transmission lines to help Wyoming better deliver electricity generated in the state to the region and spur economic growth.

Many states have infrastructure boards and commissions that have an explicit siting review component. The state should study whether such a component is needed in New Jersey. Such a study should consider whether legislation should empower the Board with reviewing siting of energy utility infrastructure to ensure state goals are being met and to reduce cross-jurisdictional issues created by the location of such investments. The study should examine the criteria by which the Infrastructure Board would review applications for approval. One example of a criterion is the establishment of appropriate and reliable infrastructure that minimizes health, safety and environmental impacts, at reasonable cost. The study should also examine whether such a siting board should be charged with examining the impacts of siting on other interdependent infrastructures, reviewing the applications in a timely manner while expanding stakeholder input. The study should consider whether a siting board should be made responsible for examining proposed infrastructure's environmental impacts to air quality, water resources, and water supply, as well as visual, noise, safety and land use impacts, and the cost of mitigating those impacts. The importance of studying such an option is whether by having such a siting authority, by cutting across all of the state's regulatory jurisdictions, it would help to resolve the barriers created by multiple and potentially contradictory proceedings.

While this initiative has focused on energy utility infrastructure investments as this report has focused on investor owned utilities, it could be argued that there is merit in having an infrastructure planning board examine infrastructure at a broader level. As reiterated throughout the report, energy infrastructure is interdependent with other utility infrastructure in New Jersey such as water and telecommunications infrastructure. As policymakers examine the initiative to create an Infrastructure Planning Board for energy utility infrastructure, it may be worth studying whether there are benefits to be gained by having the Board examine more than just the energy utility domain. Furthermore, broader critical infrastructures for transportation, safety and economic development also all have relationship to energy infrastructure. The tradeoffs to be weighed; however, are whether as the scope is broadened to ever greater levels of infrastructure, would the detail of oversight and the level of coordination become too difficult to manage.

iii. Multi-State and Regional Planning Efforts

In addition to these state efforts, there are regional planning efforts as well. One example is the Western Interstate Energy Board. The Board is an organization of 12 western states and three western Canadian provinces, which are associate members of the Board. The governor of each state appoints a member to the Board. The legal basis of the Board is the Western Interstate Nuclear Compact. The Compact provides for the President of the United States to appoint an ex-officio member to the Board. The Compact states that the purpose of the Board is to provide the instruments and framework for cooperative state efforts to "enhance the economy of the West and contribute to the well-being of the region's people." The Board seeks to achieve this purpose through cooperative efforts among member states/provinces and with the federal government in the energy field. The Board serves as the energy arm of the Western Governors' Association.

Much of the work of the Board is conducted through committees. Committee members are appointed by Board representatives and often have expertise on a particular issue. The Committee on Regional Electric Power Cooperation consists of the public utility commissions, energy agencies and facility siting agencies in the western states and Canadian provinces in the western electricity grid, has been working to improve the efficiency of the western electric power system. Western Governors have called for pro-active transmission planning to be performed to enhance electricity markets and reliability. Members of the Committee on Regional Electric Power Cooperation have been encouraging and participating in the transmission planning efforts of the Seams Steering Group-Western Interconnection (SSG-WI) and sub-regional transmission planning efforts. SSG-WI serves as the discussion forum for facilitating the creation of a Seamless Western Market and for proposing resolutions for issues associated with differences in RTO practices and procedures across the California ISO, the WestConnect RTO and Grid West.

C. Studying Decoupling Profits from Delivery

There has been much discussion about decoupling by various states in the U.S. and in the literature. What decoupling means and how it can be implemented varies and the term "decoupling" will be defined here so that we can avoid having this current "buzzword" from becoming all things to all stakeholders. The discussion revolves around how different states have approached this form of regulation and its examination in the larger context of performance- and incentive-based ratemaking. Recently, New Jersey Natural Gas and South Jersey Gas Company submitted decoupling proposals to the NJ BPU for its review and approval. The need for a more comprehensive study of decoupling and consideration of its many facets is ripe for discussion.

This report recommends that the state study possible policy options and potential effects of decoupling on energy infrastructure and investment in New Jersey. There are many concerns about and perceptions of decoupling and any consideration would require much further analysis than currently is available. Such a study would examine how decoupling in New Jersey would be designed to align utilities' financial incentives with the state's goals. It would also study alternative incentive-based ratemaking mechanisms such as adjustments for lost revenues, premium rates of return on demand-side management and distributed generation investments, and plans that split savings from energy efficiency and distributed generation between the end user and the investor-owned utility.

The existing cost-of-service rate structure provides strong incentives to plan, build, and operate facilities in a certain manner, which may not be consistent with policy objectives. All ratemaking is incentive-based in that it rewards some patterns of conduct and deters others. The challenge is to set up the incentives inherent in ratemaking to encourage explicitly investments aligned with the state's energy infrastructure goals. Proponents argue that decoupling transmission and distribution cost recovery from the delivery of the commodity (electricity, natural gas, water) would encourage operations that are not focused solely on increasing the volume of commodity delivered. Through decoupling of recovery from the delivery of the commodity, goals such as energy efficiency and distributed generation could be promoted. Investor-owned utilities lose sales and revenues when end users carry out demand-side management programs or distributed generation deployments without appropriate ratemaking or incentive programs. In short, proposals in this policy area would require decoupling profits from delivery of the commodity, with the goal of making the utility financially indifferent to its volume of sales, but focus on performance and meeting state infrastructure goals. The paragraphs that follow introduce some of the issues associated with decoupling and highlight the experiences of several states that have enacted some form of decoupling policy.

i. Issues and Concerns with Decoupling

The definition of the decoupling program is essential in determining what effects, both positive and negative, it may have on energy infrastructure investment decisions. All decoupling programs break the link between sales and revenues. Beyond that, decoupling can take on various options in the next step of tying a utility's revenues to another benchmark other than commodity sales. Possible mechanisms include explicit revenue adjustments intended to track the determinants of fixed costs – like cost of capital, the number of customers. The need for revenue adjustment mechanisms is important when examining distribution costs, inflation with or without a productivity offset, or other factors that determine the overall cost of energy sales. The key policy decision is whether to tie revenue to tracking fixed costs or some other determinant for sales, or to simply put a cap on revenue agreed to by the regulator and utility with regular rate cases to adjust.

Besides determining what linkage to revenues will replace sales in decoupling, there are other issues that must be considered by policymakers when examining decoupling regimes. These include deciding whether to decouple for all or only some rate classes, whether to link revenues to something other than sales on a class-specific or system-wide basis, whether to apply the decoupling-induced rate adjustments to energy charges only or to both energy and demand charges, and at what interval and conditions rates will be adjusted through regulatory proceedings.

In addition to the issues of defining what approach New Jersey might take if it were to consider decoupling, there are a number of other concerns and issues that should be studied as the state examines what effects decoupling could have on ratemaking and infrastructure in New Jersey. Proponents argue that decoupling is important because linking revenues to sales does not guide market participants actions to make appropriate infrastructure decisions. However, more study is needed to determine whether the alternatives offered by decoupling, whether it is revenue per customer or some other mechanism, would create significantly better market signals to result in the desired outcomes.

Another benefit of decoupling that is often argued is that it will result in less regulatory costs. This is because under revenue caps, the utility has more flexibility with setting prices and will not require long and onerous ratemaking proceedings. However, experiences in the states discussed below have shown that even the annual adjustments of the decoupling mechanisms elements have resulted in lengthy and contentious proceeding by the utility, regulator, and consumer and environmental groups.[86] If the utility under decoupling sees a drastic reduction in revenues it may seek regulatory or judicial relief in a separate proceeding or court case. If the utility's revenues are viewed as too high, consumer groups and other stakeholders will argue that the mechanism is favoring the utility and seek regulatory or legislative changes to reduce rates for customers or target additional revenues to other public policy goals.

As part of the investigation of a potential decoupling mechanism, it should be studied whether the disaggregation of the utilities in a post-EDECA environment has reduced or eliminated the incentives or drivers for utilities to increase consumption of energy by the end-user to increase revenue. In addition, the goals of lowering rates through deregulated markets should be examined in light of its potential to increase consumption. Conversely, the use of seasonal rates and time-of-use tariffs that increase rates at peak demands to reduce consumption should be compared to changes under a decoupling mechanism. Ultimately, many stakeholders will judge regulatory constructs based on the rates that they create and the costs borne by end users.

Finally, before a state decides to implement a decoupling mechanism, it is important for policymakers to first determine what outcomes it is seeking. Understanding the future state of infrastructure, the state's energy portfolio, the state's energy goals, energy forecasting and the indicators that will be used to measure success are all important components that are needed before New Jersey moves towards decoupling. As recommended, New Jersey should study these and other elements of decoupling to better understand whether such a mechanism would be an appropriate policy initiative for the state's energy goals.

ii. Review of Other State Approaches

Two states, California and Oregon, have recently established decoupling mechanisms. California's initial approach was through the creation of a decoupling mechanism called the Electric Revenue Adjustment Mechanism (ERAM) that sets revenue caps based on costs. The utilities' rates were set every three years with annual adjustments based on cost of capital. Certain costs such as wage rates and material costs for the utility were set against price indexes to create some external competition or pressure on the utility's own costs in these areas. After electricity restructuring, decoupling was temporarily

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[86] Hirst, Eric, Decoupling for Idaho Power Company, Report submitted to Idaho PUC. March 30, 2004.

abandoned but more recently reintroduced on a utility specific basis. Two California utilities have adopted a decoupling mechanism with revenue limits per customer for distribution costs and another has adopted an inflation index to target fixed-generation costs. Oregon has taken a similar approach as the original California ERAM mechanism, with the revenue capped using a base calculated over a two-year prior period with adjustments made every 6 months based on monthly revenue benchmarks and adjustments based on weather. Oregon allows for the adjustments to be amortized over 18 months and spread across customer classes. Oregon also has a partial decoupling mechanism for natural gas customers of Northwest Natural Gas. In addition, Oregon set up an independent fund to manage energy efficiency and demand side management programs separate from the utilities.

Previous mechanisms that were abandoned by other states include those adopted by Washington and Maine in the early 1990s. In both cases, sharp increases in rates led to pressure to change policies. Sharp increases in power-supply costs due to restructuring led to a sudden rise in rates due to the decoupling mechanisms in Washington. In Maine, slower than forecasted economic growth let to a abrupt rise in rates based on that state's model. These experiences point to the importance of the initial design of the decoupling mechanism in determining the future success within each state and that different factors can lead to unintended and unpredicted consequences in rates due to mechanism design.

iii. Discussion of Incremental Policies

Instead of broad explicit decoupling of sales and revenue in order to eliminate disincentives to energy efficiency and distributed generation, the regulator and policymakers can set up direct incentives to offset these concerns. In 1999, as part of a comprehensive electric utility restructuring law, New Jersey initiated a Societal Benefits Charge (SBC) that is added to the cost of each kilowatt-hour of electricity sold in the state. The SBC supports renewable and energy efficiency programs with a quarter earmarked for renewable energy technologies. The SBC is a good example of a direct incentive that can be used to offset concerns about the current link between sales and revenues. These programs are designed to encourage the deployment of certain technologies and infrastructure that further goals set by the regulator and policymakers in New Jersey. Requiring investor-owned utilities to pay the SBC as part of their rates, and then investing the funds raised into targeted areas of infrastructure, is essentially an implicit form of decoupling revenues from sales. Whether this mechanism and the programs it funds are enough to overcome the disincentives that proponents of decoupling say the current ratemaking regime creates is still open to debate and requires further study.

Another proposed incremental policy towards decoupling is to shift away from volumetric customer charges to fixed charges. In the short run, distribution costs are independent of consumption and that these costs can and should be recovered through fixed charges in order to send the proper price signals. However, in the long-term, this policy might result in faster growth and require equipment replacements and new transmission and distribution facilities in order to handle higher volumes of consumption. One solution is for making customers pay higher distribution costs as their electricity consumption grows. There can also be alternatives for combining a different balance of both fixed and volumetric rates that can be broken down even further by customer class or pattern of usage. In addition, incentives for efficiency can be made explicit in order to reduce any long-term incentive to increase energy consumption due to the fixed charges.

Compensating utilities for the lost profit through reduced sales due to energy efficiency and distributed generation programs may remove the disincentive to their investment. Creating such a mechanism would require verification that the level of consumption was indeed affected by such investments or programs. The regulatory entity would need to police the program to ensure compliance. Furthermore, a pure lost-profit adjustment program would not eliminate the short-term gain from increasing sales between rate cases created by linking sales and revenues. Therefore, while providing incentives to energy efficiency and distributed generation, there would still be the underlying incentive that decoupling tries to eliminate.

Also, some opponents of this initiative argue that aggressive efficiency codes and standards would still threaten fixed cost recovery since they result in a reduction in throughput.[87]

IV. Conclusion

This chapter has discussed the various barriers affecting the appropriate level of investment in energy infrastructure. The four main categories of barriers impacting investment included the affect of uncertain cost recovery, differing regulatory and market incentives, jurisdictional conflicts, and the difficulties in quantifying benefits, especially compared to costs. Just as it is important to have values and objectives defined and the criteria by which they will be achieved, defining the barriers to achieving these objectives is equally important towards sound policymaking. Also, just as in with defining values and objectives, while there may be disagreement among stakeholders as to what the barriers are, the importance is that by identifying them, it will aid in making decisions among different initiatives to overcome these barriers.

Using the barriers identified here as our guide, several policy initiatives were proposed that seek to achieve New Jersey's infrastructure goals. Improving the certainty of cost recovery and reducing regulatory and technology risk was proposed through institutionalizing pilot programs that reviewed new technology claims and reduced the risk for their introduction by utilities and the regulator. By using the expertise that is available through partnerships among academia and the private sector, not only is risk reduced but also the commercialization of new technologies may increase at a greater pace through this collaboration. Reducing jurisdictional conflicts and improving the quantification of benefits was proposed through an Infrastructure Planning Board. The Board would bring together different jurisdictional policymakers to examine not only energy infrastructure but also the impacts of interdependent infrastructures. Through better planning and earlier examination of potential investment decisions, it is hoped to achieve a better understanding of the benefits of different infrastructure options and propose the best option to meet the state's goals. Whether the infrastructure should only examine energy utility infrastructure or be broadened to contain all utility or all critical infrastructure given the interrelationships among all infrastructure is something for policymakers to weigh against the obvious difficulties in managing such a diverse portfolio of projects. Finally, studying how different decoupling mechanisms may create a better alignment of infrastructure investment incentives is proposed in order to better align market and regulatory incentives with the state's goals of infrastructure investment. Given the amount of discussion currently ongoing regarding decoupling and the controversial nature of the differing views among stakeholders about its benefits or ills, further study is warranted so that future discussions will be grounded more in factual analysis rather than speculation and definitional misunderstanding.

While each of these proposals are certainly not the only possible initiatives to the four barriers discussed, these are next steps that New Jersey can undertake to partially address them and are proposed to further discussion that may lead to other policy initiatives that encourage investment in energy infrastructure aligned with the state's goals. As in each of the previous chapters, we have built a framework for discussion that will hopefully stoke not only further analysis and discussion of the topics herein but also spur policy action in the areas identified by policymakers and other decision makers in New Jersey.

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[87] Carter, Sheryl, National Resources Defense Council. "Breaking The Consumption Habit: Ratemaking for Efficient Resource Decisions," The Electricity Journal, December 2001.

Appendix B: State Infrastructure Policies and Boards

B.I. Massachusetts [88]

The Massachusetts Energy Facilities Siting Board (Siting Board) is a nine-member review board charged with ensuring a reliable energy supply for the Commonwealth with a minimum impact on the environment at the lowest possible cost. The Siting Board's primary function is to license the construction of major energy infrastructure in Massachusetts, including large power plants, electric transmission lines, natural gas pipelines and natural gas storage facilities. The Siting Board also represents Massachusetts before the Federal Energy Regulatory Commission on cases involving the construction of energy infrastructure in Massachusetts, and coordinates state and local permitting of Massachusetts hydropower projects. The Siting Board is staffed by the DTE's Siting Division. Siting Division staff also review requests filed with the Department of Telecommunications and Energy (DTE) for zoning exemptions, eminent domain, and permission to construct electric transmission lines.

The Siting Board's members include: three Commissioners of the Department of Telecommunications and Energy; the Secretary of Environmental Affairs; the Director of Economic Development; the Commissioner of the Division of Energy Resources; and three public members appointed by the Governor. The Siting Board's environmental review covers a broad range of issues, including air quality, water resources, water supply, and visual, noise, safety and land use impacts, and the cost of mitigating those impacts. The Siting Board acts as a fact finder, and approves or rejects a proposed project based on the evidence developed during the proceeding.

B.II. Ohio[89]

The Ohio Power Siting Board (OPSB) is responsible for reviewing and approving plans for the construction of new energy facilities in Ohio. Before any company can build a major utility facility like a new power plant, or an electric transmission line, or a gas transmission pipeline, the OPSB assures that it benefits Ohio's citizens, promotes the state's economic interests, and protects the environment and land use. The chairman of the Public Utilities Commission of Ohio (PUCO) serves as the chairman of the Ohio Power Siting Board. The Board is comprised of 11 members, seven who vote and four who are non-voting members. In addition to the chairman, the other six voting members are the directors of: Ohio Environmental Protection Agency; Ohio Department of Agriculture; Ohio Department of Development; Ohio Department of Health; Ohio Department of Natural Resources; and a public member. The public representative, who must be a licensed engineer, is appointed by the Governor from a list of nominees submitted by the Ohio Consumers' Counsel. The four non-voting members are legislators – two from the Ohio House of Representatives and two from the Ohio Senate.

According to law, the OPSB must make findings and determinations of the following: the need for the facility; the probable environmental impact of the proposed facility; that the facility represents the

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[88] Massachusetts Siting Board, http://www.mass.gov/dte/siting_board.htm, Accessed on May 4, 2005.

[89] Ohio Power Siting Board, http://www.opsb.ohio.gov/. Access on May 4, 2005.

minimum adverse environmental impact, considering available technology and the nature and economics of alternatives; in the case of electric transmission lines, that the facility is consistent with regional plans for expansion of the electric power grid of the electric systems serving Ohio and interconnected systems and that the facility will serve the interests of electric system economy and reliability; that the facility will comply with all air and water pollution control and solid waste disposal laws and regulations; the facility will serve the public interest, convenience, and necessity; the facility's impact on the continued agricultural viability of any land in an existing agricultural district; and that the facility incorporates maximum feasible water conservation practices as determined by the Board, considering available technology and the nature and economics of various alternatives.

B.III. Florida[90]

The Florida Department of Environmental Protection is the lead agency responsible for coordinating the interagency review and certification (licensing) under four "Siting Acts", and provides assistance for one other. The Siting Coordination Office (SCO), in conjunction with the Office of General Counsel (OGC), has been assigned by the Department to perform the administrative and legal tasks of the coordination process. However, the actual licensing entity under these Acts is the Governor & Cabinet, not the Department or the other lead agencies. Certification is an umbrella permit for all affected state, regional and local agencies, and includes any regulatory activity that would be applicable under these agencies' regulations for the facility. Certification can also include authorization to use or connect to lands or works of state agencies. It is a life-of-the-facility approval, authorizing construction, operation, and maintenance of the facility.

The four "Siting Acts" include: Threshold steam-electric power plants under the Electrical Power Plant Siting Act; Threshold Electrical Transmission Lines under the Transmission Line Siting Act; Threshold Intrastate Natural Gas Pipelines under the Natural Gas Transmission Pipeline Siting Act; and Threshold Hazardous Waste Facilities under the Statewide Multipurpose Hazardous Waste Facility Siting Act.

B.IV. New York[91]

The New York State Board on Electric Generation Siting and the Environment (Siting Board) oversees implementation of Article X of the Public Service Law. Article X is a unified and expedited review process in New York State for consideration of any application to construct and operate an electric generating facility with a capacity of 80 megawatts or more. Any applicant is required to meet Article X requirements in order to obtain a "Certificate of Environmental Compatibility and Public Need" before constructing such a facility. Any application filed under Article X is ultimately ruled on by the Siting Board. The Siting Board is made up of four commissioners, one each from the New York State Departments of Environmental Conservation, Health, Economic Development, and Public Service or their designees. Also, two additional members are named by the Governor after an application is filed: one from the judicial district and one from the county where the facility is proposed to be located. The Chairman of the Public Service Commission (who directs the management of New York State Department of Public Service) serves as the Chairman of the Siting Board. In addition, staff of the Department of Public Service functions as staff to the Siting Board.

Section 168 of the Public Service Law, requires that the Siting Board, in reviewing an Article X application, must determine: Whether construction of the facility is reasonably consistent with the most recent State Energy Plan, or the facility was selected based on the fact that electricity generated by it will

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[90] Florida Department of Environmental Protection, http://www.floridadep.com/siting/. Accessed on May 4, 2005.

[91] New York State Board on Electric Generation Siting and the Environment, http://www.dps.state.ny.us/articlex.htm. Accessed on May 4, 2005.

be sold into the competitive market; the nature of the probable environmental impact; that the facility minimizes adverse environmental impact, given environmental and other pertinent considerations; that the facility is compatible with the public health and safety; that the facility will not discharge or emit any pollutants in violation of existing requirements and standards; that the facility will control the disposal of solid and hazardous wastes; that the facility is designed to operate in compliance with state and local legal provisions, other than those local legal provisions that the Siting Board finds unreasonably restrictive; and that the construction and operation of the facility is in the public interest.

B.V. Wyoming[92]

Wyoming Infrastructure Authority (WIA) was created to diversify and expand the Wyoming economy through improvements in the state's electric transmission infrastructure and to facilitate the consumption of Wyoming energy by planning, financing, constructing, developing, acquiring, maintaining an operating electric transmission facilities and related supporting infrastructure and undivided or other interests therein to facilitate the transmission of energy. The WIA is an instrumentality of the State of Wyoming that was created by the Wyoming State Legislature in 2004. It was formed in order to facilitate transmission expansions necessary to deliver power from generation facilities in Wyoming to load centers outside the state. Five members make up the WIA, appointed by the governor. Three must be qualified voters of the state of Wyoming with special knowledge, as evidenced by college degrees or courses, or with at least five years experience in managerial positions, in the field of electric transmission or generation development, or natural gas or coal production, transportation, marketing or industrial or municipal consumption.

B.VI. Minnesota[93]

Minnesota passed in 2001 new legislation designed to improve energy infrastructure planning. The 2001 Minn. Laws, Chapter 212 is the first comprehensive energy legislation in Minnesota in several decades. Article 7, Section 30, Transmission Planning, requires the Minnesota PUC to maintain a list of certified high voltage transmission line projects. Each year, utilities are to identify deficiencies in the transmission system, alternative means of addressing those deficiencies and any other issues associated with them. The PUC may certify any transmission line project noted by a utility and place it on the certified list. Certification of a transmission line in this process satisfies the existing requirement for a certificate of need. This is a new process that seeks to allow a broader approach to approving transmission line projects in relation to each other and to system-wide needs instead of the former practice of analyzing each proposal individually.

B.VII. New Hampshire[94]

The New Hampshire Office of Energy and Planning (OEP) is part of the Executive Department within the Office of the Governor. The Director of OEP is appointed by and serves at the discretion of the Governor. OEP is responsible for: promoting the principles of smart growth at the state, regional, and local levels through the municipal and regional planning assistance program; ensuring the reliability, availability, and security of the state's energy supply through a comprehensive statewide energy plan; offering community services such as heating fuel aid, refugee relocation assistance, flood insurance, statewide population data information, and the availability of a statewide computerized geographic information system; promoting energy efficiency and reducing energy costs by supporting programs for

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[92] Wyoming Infrastructure Authority, http://wyoming.gov/governor/boards/boardinfo.asp?BoardName=Infrastructure+Authority. Accessed on May 4, 2005.

[93] Minnesota Energy Security and Reliability Act, Minnesota Laws 2001, Chapter 212 (codified in Minn. Statutes Chapter 216B).

[94] New Hampshire Office of Energy and Planning, http://www.nh.gov/oep/index.htm. Accessed on May 4, 2005.

low-income households, state government buildings, businesses and industry, and school and towns; exploring opportunities to expand the use of renewable, domestic energy resources such as biomass, wind and solar energy; promoting land use efficiency through a state-wide comprehensive outdoor recreation plan and the monitoring of the state's investment in conservation land; supporting programs that focus on protecting and managing the natural resources of heavily populated areas of the state such as the coastal watersheds; and, coordinating with the Office of Information Technology to create an online grants portal that will inform interested parties of current statewide grant opportunities. In response to these duties and responsibilities, OEP undertakes a number of programs and activities. Financial support for these programs comes from federal grants and the State's General Fund.

Appendix C: State Decoupling Experiences

During the early 1990s, various forms of decoupling were deployed in Maine, New York, California, and Washington. During the mid-1990s these programs were ended as electricity restructuring and competition legislation was enacted. However, in the late 1990s, Oregon and, more recently, California both instituted decoupling programs.

California in 1981 adopted its Electric Revenue Adjustment Mechanism (ERAM) designed to decouple rates from sales. ERAM created rules that required the California Public Utilities Commission (CPUC) to set the rates for each utility every three years. Rates were set based on a future base year and the amount of fixed costs allowed to be recovered were also set in the proceeding. In annual proceedings, the CPUC then adjusted the utility's cost of capital based on an attrition mechanism.[95] Certain costs were based on price indices related to operating costs, such as wage rates and material costs. New York in the late 1980s and early 1990s adopted similar decoupling mechanisms. With restructuring of electricity utilities in California, decoupling was later abandoned but has been more recently reintroduced due to new state legislation. Each utility has adopted different decoupling mechanisms. Southern California Edison has decoupled distribution costs only on a revenue-per-customer basis, but has a proposal pending to add fixed-generation costs similar to the old ERAM policy. PG&E is using an inflation index decoupling fixed costs for both generation and distribution and SDG&E has a revenue-per-customer decoupling mechanism.[96]

Washington and Maine's approach, both adopted in the early 1990s, differed from New York and California. These states allowed fixed costs to grow based on the customer growth. However, both states abandoned these mechanisms after rates increases put pressure on the public utility commissions of both states to change their policies. Washington's increase was related to power-supply costs that were part of the decoupling mechanism and slow economic growth led to sharp rate increases in Maine.[97]

In 1993, the Oregon PUC ordered the PG&E utility to come up with decoupling proposals. The PG&E proposal established a base revenue over a 2 year test period, established monthly revenue benchmarks, adjustments to sales and revenues based on weather, rate adjustments biennially with amortization over 18 months, and rate spreading of the adjustments among customer classes. The proposal was adopted in 1995. Oregon's PacifiCorp utility was ordered in 1998 to adopt decoupling for their distribution functions. In 2001, PG&E proposed limiting decoupling to distribution in residential and small nonresidential customers on a per customer basis, but was rejected by the

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[95] During the proceeding the CPUC makes adjustments to base rates for changes in non-fuel costs, especially due to inflation. The CPUC adopts a set of formulas for adjusting base rates based on changes to labor, non-labor, and financing costs that are out of the utilities' control. By limiting the types of cost changes that can be made in attrition year rate adjustments, the goal is to create incentives for efficiency by the utilities.

[96] Bachrach, D. and S. Carter, "Status of California's Policy Efforts to Eliminate Utilities' Disincentive to Invest in Energy Efficiency and Distributed Generation," National Resources Defense Council, San Francisco, CA. February, 27, 2004.

[97] Hirst, Eric, Decoupling for Idaho Power Company, Report submitted to Idaho PUC. March 30, 2004.

Oregon PUC.[98] Also in 2001, Northwest Natural Gas Company proposed a partial decoupling mechanism for its natural gas customers and to separate out its demand side management programs to an independent agency – the Energy Trust of Oregon. Energy Trust of Oregon is a nonprofit organization that promotes energy efficiency and clean renewable energy for Oregon customers of Pacific Power, Portland General Electric and Northwest Natural Gas. The Oregon PUC approved this proposal in September 2002 for a three-year period.

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[98] Lesh, P.G., "Advice No. 01-03, distribution Decoupling Adjustment," Letter to Oregon PUC. Portland, OR. March 19, 2001.

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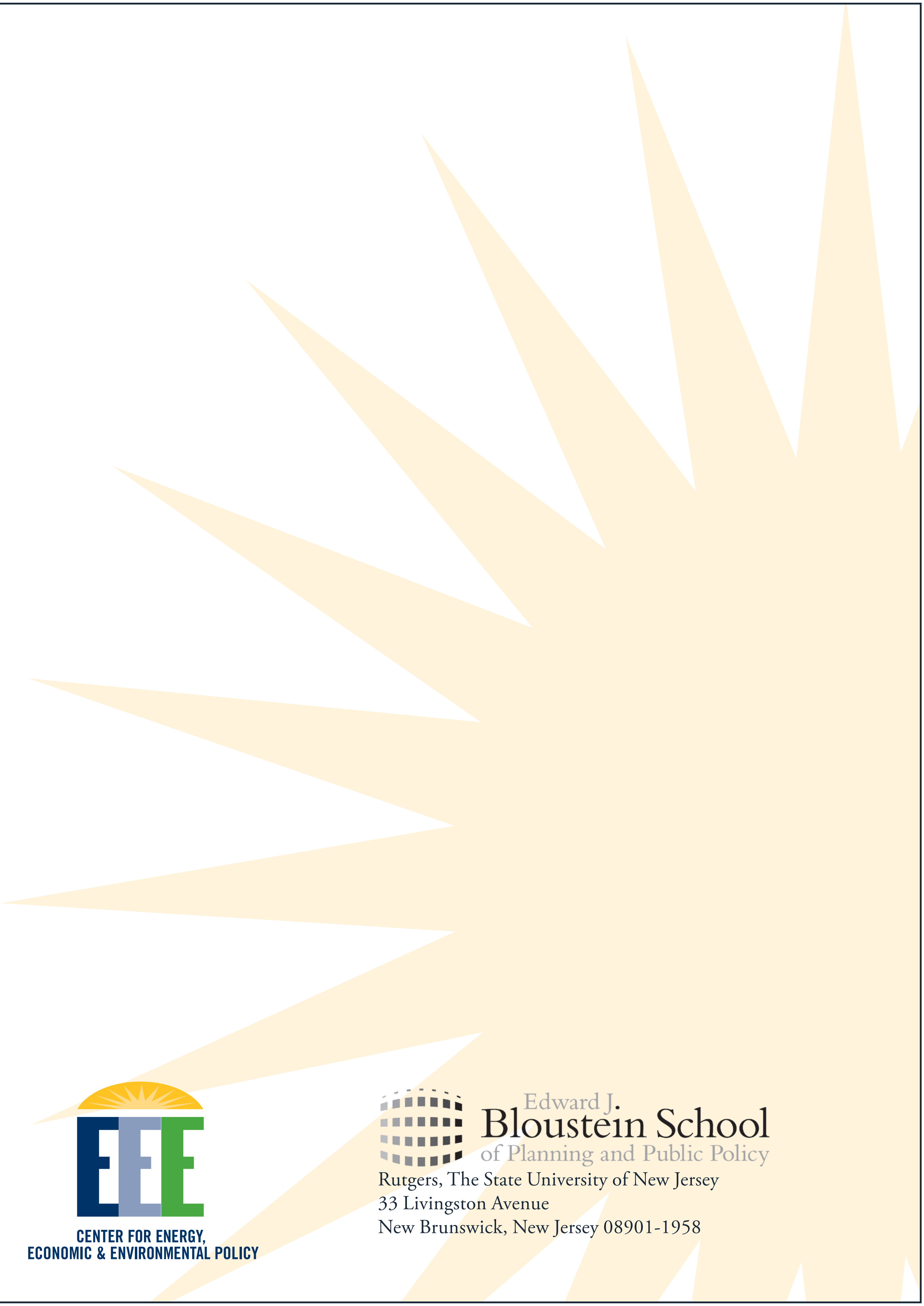

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