Chapter 16

Building Codes

New buildings and those undergoing substantial renovation in New Jersey must comply with or exceed requirements of the Uniform Construction Code (UCC) that sets standards in its subcodes for building, electrical, energy, fire protection, mechanical, plumbing and other systems. These codes are designed to assure that buildings are safe, protect the health and welfare of occupants, and perform adequately for their intended uses. This chapter focuses on residential buildings because of their important and unique role in our society:

- The house is by far the largest investment made by most consumers.
- Neither consumers nor lenders can adequately assess the quality of a completed building; codes assure both parties that minimum quality concerns are met to protect their investments.
- In general, houses are used for scores of years and become part of the state's economic infrastructure, giving the state an interest in adequate construction and performance.

This chapter reviews the current energy subcode used in New Jersey and documents the cost-effective improvements in energy efficiency that would be expected from tightening this code. In this context, we define cost-effective to mean that any incremental capital costs must be offset by the dollar value of energy savings within 10 years (simple payback) at 1988 energy prices.

The DCA is responsible for the construction codes that set forth fire protection, building, plumbing, electrical, mechanical and conservation standards and for training the inspectors who enforce them. The DCA uses the BOCA National Building and Energy Conservation Codes as amended, adopted as part of the New Jersey Administrative Code (*N.J.A.C.* 5:23 *et seq.*), as the standard code for the state; municipalities are not permitted to promulgate alternative standards.

To construct a building in New Jersey, a builder must first obtain a construction permit, which is granted only if the proposed structure meets or exceeds the requirements set forth in the UCC. The DCA has designated the nationally recognized model codes and standards of various professional organizations as the UCC subcodes. The energy subcode currently in force comprises the National Energy Conservation Code/1990, of the Building Officials and Code Administrators International, Inc., (BOCA) and the LEM-1-1982 of the Illuminating Engineering Society.

New Jersey's first energy subcode came in 1977, when DCA incorporated into the Uniform Construction Code the BOCA Basic Energy Conservation Code - 1977. Subsequently, under the Department of Energy Act, the authority to adopt the energy subcode was transferred to the Department of Energy (DOE), while the authority to enforce its provisions was retained by DCA.

Over the years, DOE strove to promote energy efficiency in new construction and major renovations by continuing to use the BOCA Basic Energy Conservation Code while adopting amendments periodically to raise the minimum requirements and to reflect cost-effective efficiency improvements.

On January 18, 1982, DOE upgraded the energy subcode by adopting the 1981 edition of the BOCA Basic Energy Conservation Code and amending it (*N.J.A.C.* 14A:3-4.1 *et seq.*) to be consistent with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90A-1980. The procedures contained in the Illuminating Engineering Society's (IES) publication LEM-1-1982 were also adopted as part of the UCC Energy Subcode.

On August 10, 1984, the subcode was further amended to incorporate the higher post-January 1, 1984 equipment performance requirements specified in ASHRAE Standard 90A-1980.

New Jersey's Building Code Today

The BOCA Basic Energy Conservation Code is based upon an ASHRAE standard that sets limits for the combined thermal transmittance (U_o) value of each of the components of the structure or, as an option, the overall structure. It also specifies standards for equipment performance, and lighting.

The U-value is a quantitative measurement of the rate at which energy migrates through a building material such as wood or fiberglass; each material has an associated U-value. The standard unit of U is Btu/ft^2/hour/degree. The term R-value is more familiar to non-engineers because it is used to rate insulation. The R-value is the thermal resistance of a material. It is the reciprocal of the U-value. When used with a subscript "o", *i.e.*, U_o, the term indicates the rate of energy loss through a building component such as a wall or ceiling, which is made up of various materials, each with its own U-value.

Some of the BOCA Basic Energy Conservation Code requirements are prescriptive, others are performance. Prescriptive requirements tell a builder precisely what to do or what materials to use. Performance requirements allow the builder to use any materials or methods as long as the final product can perform according to the requirement. An important feature of the BOCA Basic Energy Conservation Code is that it affords an opportunity to deviate from the specific design criteria of Articles 3 through 6 if it can be demonstrated that the alternative building systems and equipment design will result in annual energy consumption equal to or less than that resulting from compliance with the specific criteria. In order for proposed alternative designs to be approved, they must be accompanied by documentation in accordance with the exemptions specified in Sections 10 and 11 of ASHRAE Standard 90B-1980.

Analysis

In 1985, DOE issued its Energy Master Plan, which identified the requirements of the Farmers Home Administration (FmHA) as meeting its thermal efficiency goals for new residential construction. Accordingly, DOE amended the energy subcode to incorporate the thermal transmittance (U_o) value equivalents of the FmHA prescriptive R-values for insulation levels. The FmHA had required that, to be eligible for FmHA loans, a building be constructed to certain specifications. They included requirements for insulation of a particular R-value in walls and ceilings. Prior to this proposal, DOE compared the operating costs of a typical home built to FmHA standards against a home meeting the then-existing subcode as well as other codes. A computer model analyzed the BOCA Basic Energy Conservation Code of 1984, the Proposed Energy Subcode contained in the 1985 Draft Energy Master Plan, and the FmHA Code. Each code was modeled for a typical home heated by the following equipment: gas furnace, electric heat pump, electrical resistance, and fuel oil furnace. For each of the computer runs, a design heating and cooling load was calculated based upon a 1,800 square foot house. DOE determined that the U_o values derived from FmHA were economically justified based upon a payback period of four years for all assemblies, except the ceiling/roof assembly which required a slightly longer payback.

In 1986, when responsibility for adopting the energy subcode was returned to DCA by Reorganization Order No. 001-1986, DCA essentially agreed with DOE's approach, *i.e.*, a nationally recognized code could be adopted and amended as deemed appropriate. With minor modifications, DCA incorporated DOE's amended U_o values into *N.J.A.C.* 5:23-3.18 Energy Subcode.

Authority to Change Code

On June 30, 1988, as a result of a lawsuit, the Appellate Division of the Superior Court of New Jersey ruled in favor of the New Jersey Builders Association (NJBA), which challenged regulations adopted by DCA that amend the energy subcode. NJBA argued that: (1) under the Uniform Construction Code Act, DCA's authority is limited to adopting the entire model code of nationally recognized organizations as a subcode; and (2) DCA does not have the authority to amend the model code it adopts. This decision resulted in a retreat to the thermal standards in place in 1982 for all new construction and major renovations in the residential sector.

The lawsuit did not affect the energy subcode as it applies to commercial and other nonresidential buildings because all of the upgrade amendments applied only to housing. Residential buildings far outnumber commercial and other nonresidential buildings. In addition, commercial buildings may be designed specifically for more knowledgeable owners who are aware of the effect of energy cost. Another factor that greatly affects energy costs is the method of operation of the building, which cannot be controlled by the energy subcode. Still, there may be potential for cost effectively saving energy in the commercial sector through the energy subcode.

Alternatives

The BPU has reviewed the model energy codes of several nationally recognized organizations. The 1989 Model Energy Code of the Council of American Building Officials (CABOMEC) closely approximates the performance standards of the energy subcode that was invalidated by the court while meeting the court's requirements for a nationally recognized model code maintained by a national organization.

Analysis demonstrates that it is cost-effective to have U_O values somewhat lower (*i.e.*, more stringent) than those of the current New Jersey Energy Subcode U_O values (*i.e.*, BOCA values) for a 5,500 heating degree day (HDD) climate. For simplicity, the New Jersey Energy Subcode requires the use of 5,500 HDD values for all areas of the state. Actual climate in the state varies from 4,800 to 6,300 HDDs. Cost-effectiveness is highly sensitive to assumptions regarding fuel type and building costs, the discount rate, etc.

In a comparative analysis, the DEPE evaluated a sample one-story, 1,300 square-foot, three-bedroom ranch with a conditioned walk-out basement using U_O values described in Table 16-1. The comparison involves compliance pursuant to current BOCA U_O values at 5,500 HDD and CABOMEC U_O values at 5,000 HDD. The CABOMEC U_O

TABLE 16-1

Standards for Thermal Performance of Detached One- or Two-Family Dwelling (three stories or less)

	N.J. Current Energy Subcode	CABO MEC	Cost Effective
	Maximum Composite U Value (U_0)		
Wall	0.185	0.140	0.102
Roof/Ceiling	0.045	0.033	0.030
Floor	0.080	0.050	0.048
	Comparable Composite R-Value (R_0)		
Wall	5	7	10
Roof/Ceiling	22	30	30
Floor	12	20	21

Notes: Assumes 5,000 HDD climate for CABOMEC.
Assumes 5,500 HDD climate for NJ Energy Subcode.

Sources: BOCA National Energy Code - 1990
Council of American Building Officials,
Model Energy Code 1989, for NJ Energy Subcode.

values used in the example are approximately 25 percent more stringent than current BOCA U_O values.

Savings at 1988 energy costs, assuming natural gas for heating and only the U_O value differences between BOCA and CABOMEC, are about $80 annually for the sample 1,300 square-foot ranch-style home. The increase in construction cost upgrades from BOCA to CABOMEC is estimated at approximately $400.

The New Jersey Builders Association (NJBA) evaluated a different sample home using different assumptions. The NJBA estimated that upgrades of a two-story 2,400 square-foot home from the current energy subcode to CABOMEC at 5,000 HDD would cost approximately $1,300. Annual energy savings (assuming natural gas heat) for the two-story home are estimated at $180.

The R_o values in the table reflect the composite of individual R-values of each of the components for a home in a location with a 5,000 degree day heating season. For example, a wall is made up of framing, insulation between the framing members, plasterboard, sheathing, siding, windows, and doors - each with its own R-value. One way to meet the CABOMEC standard for walls in a typical house is to use storm windows, an uninsulated full wood door, and 3 1/2 inch fiberglass batts (R-11) in the wall cavity. When the R-11 of the fiberglass is combined with the R-values of all of the other components, the wall has a composite R-value of 7.25, which is an equivalent U_o of 0.138.

In a 1991 report, *Better Building Codes for Energy Efficiency*, the Alliance to Save Energy (ASE) compared the 1989 CABOMEC with current state energy codes. It found that the energy savings in an average single-family house built using the CABOMEC code would exceed the costs of the additional mortgage payments to finance the energy upgrades starting in the first year. The study considered several home types—bi-level, ranch, two-story, split-level—with six different foundation types. It weighted these types according to saturation data for four regions of the country and used regional construction cost data from ASHRAE and NAHB. This analysis comes close to accounting for the types of homes currently being built.

The investment in a thermally efficient structure via a reasonable energy subcode is compatible with economic development. The goal is to minimize life cycle costs. By investing a little more in construction, energy bills can be remarkably reduced. For the homeowner, the ultimate *bottom line* is not the mortgage payment, but the sum of the mortgage and the energy bill.

Air Infiltration

For the Energy Subcode to require as much efficiency as is cost effective, it must also address air infiltration. This area is not covered quantitatively in any of the model codes. For example, the CABOMEC states that *the...envelope shall be caulked, gasketed, weatherstripped or otherwise sealed in an approved manner.* The code does not require that a performance test be made to determine if the prescribed sealing has been effective. A performance test can be easily made, however.

One type of tightness test used for single and multi-family units is a blower door test. With the use of a fan in a doorway, a positive or negative pressure differential develops in the structure, which in turn causes air to flow at an increased rate through any leaks. These air leaks can be located with the use of a smoke stick or infrared device and then corrected. Separate tests check fireplaces, exhaust fans, bottoms of doors, and ceiling stack-driven leaks. Another tightness test uses a tracer gas, which is injected and dispersed into the interior of the building. A gas detector measures the concentration of the tracer gas at various interior locations while natural leakage takes place. This test is more precise because it measures leakage conducted under natural conditions, but has less diagnostic value, since it does not help locate specific sites of leaks. Cost of a performance test for ventilation could be offset by energy savings.

These same tests can also assure that the house has not been sealed too tightly. Legitimate health concerns arise about the adverse consequences of reducing a home's natural air infiltration below the level necessary to remove indoor pollutants. If natural ventilation is insufficient, a heat recovery mechanical ventilator can be installed to maintain air quality without energy losses of natural ventilation via air leaks. Cost of existing technology may outweigh energy savings in moderate climates like New Jersey's. Channeling ventilation to preferentially remove pollutants can be more cost effective.

Outside air introduced into buildings by natural infiltration or mechanical ventilation costs money for heating and cooling but dilutes indoor air pollutants. To balance economic and pollution control needs, ventilation standards or maximum allowable pollutant concentrations can be prescribed. National standards include those from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Its most recent update of ventilation codes, entitled 62-19-89, sets a minimum of 0.35 air changes per hour (0.35 ACH) or 15 cubic feet per minute per occupant (15 cfm/occupant), whichever is greater. The amended code limits for indoor radon are a maximum of four picocuries per liter. However, a maximum ambient air level standard could be more effective in protecting the public health. Codes set minimum but not maximum ventilation levels. The most effective means of maintaining and improving indoor air quality is reduction of pollutant sources, smoking, and aerosol or solvent use, among others.

Utilities and private sector companies have implemented several programs to improve quality of construction. Typically, these programs directly address both infiltration and air duct deployment. Some programs utilize plastic vapor barriers on walls and ceilings, while others rely more on effective caulking. Most use blower doors or other measurements to evaluate the tightness of the structure. Programs such as *Super Good Cents* and the Philadelphia Electric *EEE* system are described in Chapter 14, along with Home Energy Rating Systems, but are noted here as market-driven methods that offer consumers the option of seeking out houses that perform beyond code.

Mechanical Equipment Requirement

A major drawback of all of the current model energy codes, including BOCA and CABOMEC, is in the mechanical equipment requirements. The CABOMEC specifies furnace, boiler, water heater, and air conditioner efficiencies that are lower than the efficiencies of commonly available equipment on the market.

Federal appliance efficiency standards in the National Appliance Energy Conservation Act of 1987 will become effective soon. However, the DEPE and the DCA should encourage BOCA and ASHRAE to promote the most cost-effective and energy efficient construction, appliances, and equipment. Such changes may result in an improved energy subcode.

Findings

- Houses are the largest investment made by most consumers, they are used for scores of years and are part of the state's economic infrastructure. The state's economy benefits from adequate construction and performance.
- The energy subcode currently in force comprises the National Energy Conservation Code/1990 of the Building Officials and Code Administrators International, Inc., (BOCA) and the LEM-1-1982 lighting standards of the Illuminating Engineering Society.
- The the owner's cost burden in housing is not the mortgage payment alone, but the sum of mortgage and energy costs.
- All current model energy codes lag behind the marketplace in terms of thermal performance and mechanical equipment requirements. Specified efficiencies for furnaces, boilers, water heaters, and air conditioners are lower than the efficiencies of commonly available equipment on the market.
- Increased building stock efficiency adds to the initial cost of a home but reduces long-term fuel/utility costs—a significant portion of monthly carrying costs. Increased building efficiency helps to moderate winter natural gas peaks, summer electricity peaks and reduce New Jersey's strong dependence on petroleum. (See Chapters 3, 4, 8 and 11.) Further, any efficiency measures that reduce the need to burn fossil fuels serve the state's goal of preserving New Jersey's environment.

Policy

- The New Jersey Energy Subcode requirements should prescribe the maximum cost-effective levels of efficient construction (calculated at current energy prices) in order to reduce life-cycle costs to a minimum.
- The State should evaluate state-of-the-art air infiltration/ventilation standards for occupied buildings, analyze the costs and benefits of their adoption, and consider the need for procedures to measure compliance.
- In keeping with the State's policy of expanding affordable housing opportunities throughout New Jersey, the state needs a mechanism that will: (1) overcome the barriers of higher initial cost for an energy efficient home; (2) recognize the savings potential and long term benefit—to the homeowner and the state—of investments in more energy efficient housing; and (3) factor avoided fuel/utility costs associated with an efficient home into a lending ratio.

Implementation

- The DCA and the DEPE should evaluate measures to achieve greater energy efficiency in new construction. These measures can include future changes in building code and utility incentive programs or tariff design.
- A joint DCA-DEPE-Department of Health task force should study the issue of air infiltration/ventilation control in occupied buildings. The task force should evaluate and recommend appropriate standards and procedures.
- The State should work with representatives of the building, utility, real estate, banking and home financing industries to develop an innovative mechanism that will consider the impact of reduced fuel/utility bills on a mortgage applicant's ability to finance a high efficiency home. Factoring energy savings in the lending ratio could alleviate public, government and industry concerns over the affordability of high efficiency homes and would help remove barriers to the adoption of a strengthened energy subcode that simultaneously serves the economic, environmental and energy goals of the state.

Chapter 17

Home Energy Rating System

Building buyers and prospective tenants expect some uncertainty in their purchase/rental decisions but justifiably seek to minimize it. Houses (including townhouses and condominiums) are often the largest expenditures consumers make, and highly variable energy costs are usually the third largest cost of ownership (after mortgage payments and local taxes). New Jersey has no measurement scheme (analogous to the *miles per gallon* ratings of cars) to allow buyers to select more efficient buildings and to enable builders and developers to market better buildings more effectively.

This chapter discusses home energy rating systems (HERS), which could give consumers this information. HERS programs are also useful to builders who meet standards better than building code requirements. They can advertise more efficient buildings and show that housing costs (*i.e.*, mortgage plus energy costs) can be lower with better structures than with code-compliant buildings. In addition, bankers can use energy efficiency information to adjust lending ratios, offering larger loans to those who can show that purchasing better built houses will reduce their monthly costs.

Clearly, the concepts can be extended to commercial buildings, but less work has been done in this area, and it will not be specifically discussed in this chapter.

New Jersey residents now spend more than $4 billion a year on energy to heat and cool their homes and power household appliances. Most live in single-family or small multifamily buildings (up to four units) and spend an average of $1,400 to $1,600 per unit each year on electricity, gas, and oil.[1] For the more than 2 million units of that type (see Table 17-1), energy costs more than $3.2 billion a year. Other residents live in apartment units in larger buildings and spend an average of $1,000 a year per unit. For the more than 750,000 apartments, energy costs an additional $750 million every year.

At the present rate of residential construction and present level of fuel use, the dollars leaving the economy will rise by $31.8 million every year.[2]

Knowing the benefits of alternatives would encourage buyers to choose cost-effective conservation. By reducing energy outlays just 5 percent and spending that money in the state, residents would provide a direct boost for the New Jersey economy of $79 million per year.

It is feasible to build homes in which people can live comfortably and well but spend only one-half or one-third as much for fuel.[3] Those homes are carefully designed, well-built, superinsulated, or solar- and wind-oriented homes. It costs somewhat more to build low-energy-consuming homes, but over the life of the home, large savings due to decreased fuel use will accrue. Innovative construction techniques make it possible to construct and market homes that cost less than $400 a year to heat and supply with hot water, even in northern climates.[4] Even if energy-saving homes cost more (some designs for the superinsulated house could raise its purchase price), the benefits to occupants far exceed the boost to the initial price tag. Annual energy savings up to two-thirds (or $1,000), which rapidly offset the higher cost, await the buyer of such a house. Clearly, the economy would benefit in the long run if builders would construct and buyers would purchase energy efficient housing.

Conversely, the largest part of the housing stock in New Jersey was built before there was an energy code and 65 percent before 1973 when the sharp rise in energy prices began. These approximately 1,790,000 housing units consume the bulk of residential energy. They will continue to require excessive energy and cost their owners increasing amounts for the many years they will stand. Their great demand for gas, oil, and electricity in the coldest part of the winter and in the hottest part of the summer strains the supply system. Their requirements exacerbate problems of load management and create peak demands for additional utility power production and distribution facilities.

The reasons are not hard to find. The real estate industry wants to keep sales prices as low as possible and is concerned that energy efficient housing is more expensive. If the focus shifted from minimum sales price (minimum construction cost) to minimum monthly costs or minimum life cycle costs, then the market could change. With appro-

TABLE 17-1

New Jersey Residential Housing - 1989

Type of Unit (separately metered)	No. of Units Existing	1989 Building Permits Issued	Percent of Existing Units
Single-family/ 1- to 4-family	2,359,003	21,641	0.92
5 families or more	652,182	8,288	1.27
Totals	3,011,185	29,929	.99

Sources: Existing Units - 1980 U.S. Census of Housing, Table 60, p.63, plus building permits minus demolitions as reported in annual building permit summaries, 1980-1989 prepared by N.J. Department of Labor. Building permits reported for public housing were included in totals for "5 family or more" category. Units Constructed Per Year - number of building permits issued during 1989, Building Permit Summary 1989, N.J. Department of Labor, July 1990.

priate information tools, builders, realtors, and bankers could all help establish the value of energy efficiency.

Several mortgage programs, available to homebuyers in states with an established home energy rating system, recognize the value of an energy efficient home. Potential homebuyers can find mortgage ratio flexibility that can increase their buying power on homes financed through Fannie Mae and Freddie Mac. For an approved energy efficient home, the amount of gross monthly income available for mortgage payment is increased from 28 to 30 percent. Buyers with an annual income of $50,000 would be able to finance an additional $15,000—much more than the actual incremental cost of building an energy efficient home. This expanded mortgage ability could increase access to home ownership for many potential buyers who now have difficulty qualifying for home ownership due to the high cost of New Jersey housing stock.

Houses contain electrical appliances and equipment. Depending on the heating source, they use 35 percent of the electricity, 5 percent of the oil, and 32 percent of the natural gas consumed nationally.[5] The most important energy-using appliances are heating sources, such as the oil furnace and the water heater, followed by cooling sources, notably the refrigerator and the air conditioner. Each affects both the primary source of power (*i.e.*, the electricity to run the refrigerator), and the secondary or derived source (*i.e.*, the fuel used to create the electricity). Conservation tactics must take into account a wide variety of cross-cutting factors; it is important to consider the time of day and season of the year during which the appliance operates and the potential to control or shift the time of operation.

As with the building shell, the appliance user is not always the person who specified the appliance. The buyer is typically the same home building contractor who wants to keep the initial price low, even though the user will pay wastefully high energy bills. Such an attitude works as badly when applied to appliances as it does in the housing design and construction process.

Several kinds of Home Energy Rating Systems have been developed. They vary according to:

- the metric employed such as a qualitative scale (bronze star, silver star,...), a relative scale (1 through 10), or a quantitative estimate of actual energy used (Btu/square foot - degree day);
- the method used to gather source data (*e.g.*, a walk-through building audit, analysis of blueprints, or analysis of utility or oil consumption bills.); and
- the target population (*e.g.*, existing or new construction, single- family, or all residential property).

Nonetheless, it is possible to design programs as useful to consumers, builders, and bankers as the miles per gallon (mpg) data for automobiles, and with comparable accuracy. While the mpg rating is only an approximation based on measurements of the miles per gallon sample cars can achieve under carefully controlled testing conditions, it provides a baseline number to assist the purchaser in comparing the operating costs of new cars. It has become a valued and accepted part of the American vocabulary. A HERS would provide a similar rating for dwellings.

Types of Rating Systems

Many home energy rating systems have been developed for residences. They vary in design, complexity, and accuracy. There are three generic types of home energy rating systems: prescriptive, calculational, and performance.

Prescriptive Systems

Prescriptive systems rate a structure based on the presence of specified energy-efficient features (a pass-fail rating). These features may include wall, ceiling, attic, slab, crawlspace, and basement insulation; duct insulation; caulking and weatherstripping; vapor barriers; window glazing; storm doors and shutters; fireplace dampers, air intakes, and glass doors; lighting systems; heating, ventilation, and air conditioning (HVAC) systems; hot water systems (including pipe insulation and low-flow shower heads); appliances; and active and passive solar features.

These systems are extensions of energy audits. They consider various energy features of a house, such as its level of insulation, and rate the features based on their efficiency levels. The ratings use the assumed or specified insulation properties, the R-values or U-values, of the building surface materials and then calculate, using engineering models, the energy required to maintain specified interior temperatures. The rating number is generally given as Btu per square foot of building floor area or surface area per degree day or is derived for that value.

For homes that meet the standard, the homeowner receives a certificate indicating that the house has met the criteria of the rating program. Other prescriptive systems include point score ratings (where the number of points reflects the number of energy-efficient features present), category ratings (*e.g.*, bronze and silver categories, based on presence of particular features), and energy use ratings (where energy use is estimated from point scores).

Calculational Systems

Calculational systems estimate the energy needs of a structure by primarily considering heating and air conditioning loads and secondarily considering appliance and hot water loads. The aims of the rating system vary by region, with different emphases on heating and cooling loads. The rating itself is likely to be presented in terms of Btu per square foot, per hour, or per degree day. These rating systems may use hand calculator models or slide calculators for the calculations, or detailed computer models, such as the nationally recognized CIRA, DOE-II, and CAL-PAS.

Performance Systems

Performance systems are based on information from past energy bills, which are used to predict future energy bills (in terms of consumption or cost). Houses can be compared to similar housing stock within the same climate zone, controlling for household size. Comparing the energy use for a particular house to average energy use (for a typical house or for a group of similar houses) is often the basis for some type of category certification (such as average, above average, or below average). These systems can give quantitative energy use estimates or qualitative rankings, or data converted to dollars per year.

Analysis

Even with careful measurements and adjustments, it is difficult to predict accurately how much energy a dwelling will use. The MPG rating for cars assumes sufficient quality control that tests on a sample of cars will be valid for others cars of the same model. However, quality controls for residential construction are less comprehensive for houses than for cars. Builders may leave openings in the building surface or in the heating/cooling distribution system. Engineering models do not account for excessive infiltration or incorrectly installed distribution systems, but those conditions greatly affect the energy requirements of that building.

Another complicating factor is that appliances may account for one-third to one-half of the total energy cost of a house. Estimating the cost attributable to appliances depends largely on the types of appliances and habits of the residents using them. Some experts indicate that the energy cost of a home may vary by as much as 100 percent depending on the residents' habits.[6]

The *1985 Energy Master Plan* identified home energy rating systems as a useful program for New Jersey. It proposed adding a rating system to the energy audit of existing buildings. The DEPC evaluated the rating systems in other states, reviewed pilot systems run by utilities in the state, and held a conference with the utilities and builders to explore the possibility of expanding the use of rating systems in New Jersey. These evaluations served to emphasize the importance of responding to the concerns of the major groups (homeowners and buyers, builders, utilities, lending institutions, and realtors) to be affected by a home energy rating system, if it is to be successful.[7]

In New Jersey, as a result of the 1985 Energy Master Plan, utility interest has risen for rating programs. In 1985, Elizabethtown Gas Company added rating analyses to energy audits of existing homes. By 1990, all four electric utilities serving New Jersey either had a rating program for newly constructed homes in place or had one proposed. Their model, the Good Cents program, was developed by a southern utility to rate new construction and uses criteria about as stringent as New Jersey's present state building code.

Some utilities use rating programs to ensure that new construction is efficient enough to be comfortable if heated and cooled by a heat pump. Newer designs of heat pumps can both heat and cool dwellings but do not produce heat as quickly as furnaces. Heat pumps cannot heat poorly constructed homes or can do so only at great cost, causing many complaints to builders and to utilities. An innovative program promoted by Philadelphia Electric includes empirical envelope testing in its rating system. The dwelling will achieve a positive rating only if it passes a test for air infiltration, as well as a review of the basic building specifications. Many flaws in housing construction are not visible, where the construction as specified or poor quality construction negates the effectiveness of the specified material.

Technically, using all information available strengthens HERS programs. In particular, engineering analyses, such as the HOme Energy Savings Program (HESP), can become rating systems with little additional effort, if analysis of energy bills is incorporated. Several uncertainties make the results of an engineering analysis questionable for existing homes. The Princeton Center for Energy and Environmental Studies (CEES) has found that calculations of potential savings for certain retrofit measures often overstate the savings by as much as 100 percent.[8] Other factors may affect the results, such as lifestyle variations or moderation of temperature setbacks, so the engineering model is not necessarily an accurate predictor of use in existing housing. In the intact house it is impossible to be sure of conditions within the walls such as the type, amount, and quality of application of insulation. To be more accurate, one or more of the following changes must occur: the audit must be more thorough, the engineering model more comprehensive, the adjustments for lifestyle more precise, or the model must incorporate empirical data, such as the blower door test results, into the model.

Another possibility is to use gas and electric meter readings, which are readily available from billing data, to rate a dwelling against itself with corrections for external changes from year to year, such as degree days and changes in lifestyle. This methodology, using the Princeton Scorekeeping Method (PRISM), was developed by the Princeton CEES. The PRISM is a statistical scorekeeping system using regression analysis techniques to evaluate energy consumption from meter readings taken before and after a conservation measure is installed along with average daily temperature. This type of evaluation would be accurate only for one family in one house. It could be difficult to translate into a rating comparing one house to another, where lifestyle and use patterns vary strongly.

In some cases the rating, in combination with the size of the home and other factors, may be translated into estimated annual energy consumption and cost. Often suggestions for home energy improvements are included on the rating form along with a new rating that would be received if the improvements were made.

Findings

- Home energy rating systems can be based on engineering analyses of existing houses, calculations from blueprints for proposed units, or analysis of energy consumption (billing data).
- Ratings can be qualitative (bronze star/gold star), relative (0 through 9), energy estimates (Btu/yr), or economic ($/yr). The selection depends on marketing goals of the program.

- All systems proposed have systematic or random errors, but many systems provide consumers and bankers with useful information and offer builders data that they use for marketing the energy efficiency of their products.
- Market-driven programs backed by the credibility of the utilities have advantages over attempts to impose mandatory programs.

Policies

- The DEPE and the BRC should establish a home energy rating system for New Jersey. Such a system would provide the right incentives to buyers and sellers, by providing unbiased information to all parties.
- A home energy rating system for New Jersey should be based on voluntary participation by builders.
- The home energy rating system adopted should be consistent in the state and administered by the state's utilities. The DEPE and the BRC, in developing a home energy rating system, should consider using billing analysis as back-up to the prescriptive or calculation methods.

Implementation

- To implement a home energy rating system: (1) the DEPE could initiate a proceeding pursuant to the requirements of the Administrative Procedure Act, or (2) the DCA, as the lead agency with responsibility for the Uniform Construction Code, could propose a home energy rating system by administrative rulemaking.

NOTES

1. *New Jersey Annual Energy Profile*, 1987.
2. .40 [($1,600/unit x 45,000 existing units) + ($1,000/unit x 19,000 new units)]
3. "Passive Solar - A Better Way to Build," pamphlet by Passive Solar Industries Council.
4. J. D. Ned Nisson and Gautam Dutt, *The Superinsulated Home Book* (New York: John Wiley and Sons, 1985), p. 63.
5. Energy Information Administration, *State Energy Data Report, 1960-1986*, pp. 22-25.
6. R. Socolow, *Saving Energy in the Home*, (Cambridge, MA: Ballinger, 1978).
7. Edward Vine, B. K. Barnes & Ronald Ruschard, "Implementing Home Energy Rating Systems," *Energy*, vol. 13, p. 404.
8. E. Hirst, "Cooperation and Community Conservation, Final Report," Hood River Conservation Project, DOE/BT-11287-18, June 1987, p. 38.

Chapter 18

Land Development Patterns for Energy Efficiency

Over the past few decades, development has spread across New Jersey. As a result, more of the state's citizens must travel greater distances to go to work, shop, and run errands, while opportunities for mass transportation use have diminished. This chapter discusses the implications of development patterns on transportation energy demand and identifies policies and programs that establish land use arrangements to provide options for reduced and efficient travel.

Compact, mixed land use development requires less energy for transportation. Many factors contribute:

- Travel distances decrease between places where people live, work, shop, and carry out other day-to-day activities.
- Dependence on the private automobile decreases as walking, cycling, and mass transit are more available or feasible.
- Mass transit becomes more cost- and fuel-efficient where there are more potential riders per unit area.
- Traffic congestion is relieved.
- The need for road network expansion is reduced.

The location of the higher density development is an important factor.[1] Residences, businesses, and other travel destinations must be sufficiently concentrated to support transit routes and facilities.[2] The distribution of offices and businesses to areas where dispersed residential development has already been established may reduce transportation energy consumption. However, these businesses must serve and be staffed by the local population. Conversely, businesses that draw their workforce from regional labor pools and rely on customers from large geographic areas diminish transportation energy consumption when they are sited in central locations served by transit systems.[3]

The Emergence of Today's Land Use Patterns in New Jersey

Since the 1940s the population has been moving away from major urban centers toward the suburbs and beyond. (See Table 18-1.) In 1940, 36 percent of New Jersey's residents lived in the state's 10 largest cities. Only 15 percent live in those cities today. Nine of these cities have lost residents since 1940 while the state population has nearly doubled. Large portions of several outlying New Jersey counties had only 50 persons per square mile in 1940 and

TABLE 18-1

Change in Population of New Jersey's Ten Largest Cities
1940 - 1990

City	1940 Population (thousands)	Percent of State Population	1990 Population Estimate (thousands)	Percent of State Population	Percent Population Change
Newark	429.8	10.3	275.2	3.6	-36.0
Jersey City	301.2	7.2	228.5	3.0	-24.1
Paterson	139.6	3.4	140.7	1.8	0.9
Trenton	124.7	3.0	88.7	1.1	-28.9
Camden	117.5	2.8	87.5	1.1	-25.5
Elizabeth	109.9	2.6	110.0	1.4	.1
Bayonne	79.2	1.9	61.4	0.8	-22.5
East Orange	68.9	1.7	73.6	1.0	6.4
Atlantic City	64.1	1.5	37.9	0.5	-40.8
Passaic	61.4	1.5	58.0	0.7	-5.5
Cities Total	1496.3	36.0	1161.7	15.0	-22.4
State	4159.9		7730.2		46.1

Source: N.J. State Data Center, N.J. Population Trends, 1790-1980, Table 6.
1990 Census of Population and Housing, Table prepared by N.J. Dept. of Labor: Feb 1991.

now have more than 1,000 persons per square mile.[4] The largest density increases have taken place mainly in outlying counties. (See Appendix: Population Density by Counties.)

In more recent years, the locus of the workplace has been shifting as well from central urban areas to suburban and exurban locations. Data comparing county employment figures between 1970 and 1984 show that most employment growth took place in outlying counties.[5]

Longer commuting distances and reduced reliance on efficient transportation modes are evident. Table 18-2 shows a steady decline between 1960 and 1980 in the percentage of workers employed in the same county where they reside, suggesting that workers must travel greater distances to work. Census data in Table 18-3 show a steady decline in the percentage of workers who walk or use mass transit to commute.

TABLE 18-2

Workplace Relative to Place of N.J. Residence

	1960	1970	1980
Work in county of residence	69%	65%	63%
Work outside county of residence	31%	35%	37%
Total workers who report to place of work (thous.)	2,215	2,617	2,944

Sources: Census of Population: 1960, Vol. 1, Characteristics of The Population, 32-178, Table 63.
Census of Population: 1970, Vol. 1, Characteristics of The Population, 32-247, Table 61.
Census of Population: 1980, Vol.1, General Social & Economic Characteristics, segment 5, 32-728,729, Table 174.

TABLE 18-3

Means of Transit to Work in N. J.

	1960	1970	1980
Alone (car, truck, van)	61%	63%	64%
Carpool/Vanpool	*	11%	18%
Public Transit (all forms)	19%	14%	9%
Walked	9%	8%	6%
Worked at Home	4%	2%	1%
All Other	2%	2%	1%
Not Reported	5%	*	*
Total all forms (#'s in thousands)	2,340	2,849	3,223

Note: 1960 figures combine workers commuting in single occupancy vehicles and those commuting by car/vanpool.
* Information not available

Sources: Census of Population: 1960, Vol.1, Characteristics of the Population, 32-178, Table 64.
Census of Population: 1970, Vol.1, Characteristics of the Population, 32-247, Table 61.
Census of Population: 1980, Vol.1, General Social & Economic Characteristics, segment 1, 32-100, Table 65.

Analysis

Comparison of Energy Demand for Travel

Table 18-4 compares estimated travel and energy demand differences between two hypothetical individuals who differ in access to mass transit and distances to their destinations. The comparisons attempt to reflect conservative travel demands in both cases precipitated by fuel shortages or high prices. The individual represented in Case #1 resides in an area characterized by compact, mixed use development. Consequently, most destinations are close to home and are conveniently accessible by foot or mass transportation. The individual represented in Case #2 resides in an area characterized by a sprawled development pattern, which requires long travel distances and total auto dependence.

Travel between home and workplace and shopping locations can account for a significant proportion of trips generated by most families, particularly when two-income households are so prevalent. Consequently, having a variety of land uses located close to each other and/or in places served by mass transportation can greatly diminish energy demand. Development of these land uses in urban areas or nearly self-contained "cluster" communities will maximize proximity and access to the transit system.

Existing Programs and Policies

Many existing state programs and policies foster energy-efficient development patterns. These measures respond to a broad range of concerns, such as urban blight, open space needs, farmland preservation, underutilized utility infrastructure and fiscal assistance to urban municipalities. They help to establish an energy-efficient growth pattern

TABLE 18-4

Energy Required for Auto Travel Under Three Scenarios

CASE #1 - Inside Urbanized Area

Purpose	Round Trip Distance	Trips/Year	Miles/Year	Gallons/Year
Work	16.8	0	0	0
Family/Personal Business	11.0	365	4,015	241
Civic/Education/ Religious	9.8	180	1,764	106
Social/Recreation	21.2	104	2,205	132
Other	12.0	52	624	37
Total			8,608	516

CASE #2 - Outside Urbanized Area

Purpose	Round Trip Distance	Trips/Year	Miles/Year	Gallons/Year
Work	19.2	130	2,496	150
Family/Personal/ Business	14.0	365	5,110	307
Civic/Education/ Religious	13.2	180	2,376	143
Social/Recreation	20.8	104	2,163	130
Other	18.2	52	946	57
Total			13,092	785

Note: Trip distances by purpose are based on the Nationwide Personal Transportation Survey, 1983, Table E-30. In both cases, vehicles are assumed to have fuel efficiency of 16.65 mpg. Individual in Case #1 commutes to work via bus. Individual in Case #2 carpools with a co-worker. Mile/year and gallon/year rounded to nearest whole.

Source: DEPE

by stabilizing and stimulating development in urban areas, containing urban sprawl, and encouraging a mix of land uses.

In July 1991, the New Jersey State Planning Commission created by the State Planning Act (*N.J.S.A.* 18A-196 *et seq.*, P.L. 1985, c. 398) issued the Interim State Development and Redevelopment Plan. The Interim Plan is the second iteration of an in-process planning document supporting a statewide consensus-building process known as *cross-acceptance*. Cross-acceptance is a three-phase planning process to ensure that government at all levels and the public participate in preparing and adopting the State Plan.[6] The Final State Plan is expected to be released in 1992 after completion of the Issue Resolution phase of cross-acceptance and six public hearings.

The Interim Plan organizes growth into a Resource Planning and Management Structure consisting of compact forms of development known as Centers and five geographically delineated Planning Areas.[7] The Plan identifies five types of Centers:

- Urban Centers
- Towns
- Regional Centers
- Villages
- Hamlets

The Planning Areas reflect distinct geographic and economic units within the state and serve as an organizing framework for application of statewide policies. The Planning areas are:

- Metropolitan Planning Area
- Suburban Planning Area
- Fringe Planning Area
- Rural Planning Area
- Environmentally Sensitive Planning Area

Each Planning Area is characterized by the kind and intensity of existing development, the character of the existing environments, the proximity of existing areas of development and the character and location of public and private infrastructure.[8] The Interim Plan proposes growth in all Planning Areas but emphasizes development and redevelopment in the Metropolitan and Suburban Planning Areas where mass transportation exists which, in turn, could reduce travel dependency. The Resource Planning and Management Structure recognizes the importance of higher densities and integrated uses to provide accessibility that permits less reliance on the private automobile and enhances the prospects for public transportation.

Findings

- Population shifts to the suburbs and formerly rural areas have increased reliance on the automobile.
- The subsequent movement out of urban centers by employers who rely on a regional labor market, while reducing travel distances for some commuters, increases travel distances for others and diminishes options for the use of mass transportation.
- A concentrated development pattern is essential to establish and maintain an efficient mass transportation system that provides an alternative to the automobile. Dispersed development does not have the population density required to support traditional mass transit.
- A concentrated development pattern brings residences and destination points closer together to reduce travel distances and enhance opportunities for nonmotorized transportation modes.
- The State has established many programs and policies that serve to promote residential, commercial, and industrial investment in urban areas that will help to establish an efficient land use pattern.

Policies

- The State should encourage redevelopment and revitalization of urban areas to create and maintain densities necessary to support the use of mass transportation and to provide for reduced travel distances between housing, employment, and services.
- The State should encourage an appropriate mix of land uses to shorten travel distances and to maximize access to destination points by nonmotorized transportation modes.
- The State should encourage compact clustered development to improve options for the use of mass transportation and to shorten travel distances.

Implementation

- The State should stimulate urban redevelopment and encourage public and private investment in areas where mass transit systems exist and people rely less on automobile travel to meet their daily needs.
- The State should encourage economic development and redevelopment in higher density mixed-use centers that accommodate the use of alternative modes of transportation and reduce the need to travel.

NOTES

1. A study by the New York Regional Plan Association estimated that doubling residential density from five dwelling units per acre to ten dwelling units per acre within one mile of a downtown of 10 million square feet would increase per capita use of public transit trips 17 times as much as if the density were increased by the same degree 10 miles from the central business district. The same study concluded that placement of a high-rise building in an isolated location will not facilitate public transit use. Corbin Crews Harwood, *Using Land to Save Energy* (Cambridge: Ballinger Publishing Co., 1977), p. 68.
2. Harwood, p. 68.
3. A study that simulated future patterns of development for Washington, D.C., to evaluate the impacts on transportation energy use found the following:

   A dense center pattern with higher density development concentrated near the metropolitan center and a transit oriented pattern with new housing and employment development concentrated along transit lines were significantly more energy efficient than a pattern of sprawl characterized by low density, scattered fringe growth. "Energy Efficient Land Use", American Planners Association report #341, pp. 9-10.
4. Wallace, Roberts and Todd, *Trends and Patterns of Growth*, Draft Technical Reference Document prepared for the New Jersey Office of State Planning, 1987. p. 3.
5. George Sternlieb, "From Caboose to Locomotive" in New Jersey Issues: Papers from the Council on New Jersey Affairs, p. 122.
6. The Interim State Development and Redevelopment Plan, p. VII.
7. The Interim State Development and Redevelopment Plan, p. 5.
8. The Interim State Development and Redevelopment Plan, p. 26.

Chapter 19

Energy Efficiency and the Environment

Environmental impacts of using fossil and nuclear fuel occur at several stages: drilling or mining, transport, processing, and combustion or extraction. In New Jersey the major impacts arise from fossil fuel combustion, the source of 92 percent of the state's non-renewable energy.[1] Products and by-products of combustion become air pollutants. The state can moderate local environmental impacts of energy use by increasing use efficiency. Broader impacts—atmospheric warming and its consequences, and acid rain—require national and international action. Investments in energy efficiency/productivity as outlined in this Plan can reduce the amounts of pollutants generated by fossil fuel combustion in New Jersey 25 percent by the year 2000.[2] (See Chapter 24.)

The energy in fossil fuels—natural gas, petroleum, and coal—derives from combustion of carbon compounds and produces usable heat, waste heat, water, carbon dioxide, carbon monoxide, nitrogen oxides, and particulate matter. Combustion of coal or oil, chemically heterogeneous mixtures, produces numerous other compounds as well. Natural gas, as distributed, is principally methane, a compound easily combustible into carbon dioxide and water.[3]

Environmental impacts of energy use occur at global, national, regional, state, local, and building levels. This chapter analyzes the environmental impacts of energy use and energy efficiency techniques as an air management tool. It describes the implications of the Clean Air Act Amendments on state public utility commissions and offers state initiatives to address the concerns of acid rain and global warming related to fossil fuel emissions from utility sources.

TABLE 19-1

Carbon Dioxide Released by Combustion of Fossil Fuels in New Jersey by Energy Type - 1989

	1989 Purchased TBtu	Carbon Million Mtons
Natural Gas	465	6.62
Petroleum	888	17.11
Coal	200	5.00
TBtu-not Combusted	575	--
Total	2,128	28.73

Note: Not combusted includes petroelum for feedstocks, asphalt, road oil, etc; and uranium fuel purchased for instate generation.Total TBtu excludes jet fuel transferred to NY state. petroleum for feedstocks, asphalt, etc; uranium fuel input. Emissions based on Machado and Piltz, Renew America, 1988. Mtons=metric tons.

Source: DOE/EIA-0214(89); Appendix Table A-24-1.

TABLE 19-2

Combustion and Process Emissions of Sulfur Dioxide and Nitrogen Oxides in New Jersey - 1985

Source	SO_2 Thous. Tons	NO_x Thous. Tons
In-State Utility	102	63
Industrial Combust	14	23
Industrial Process	15	18
Transportation	28	219
Other	25	33
Total	184	356

Note: SO_2 - Sulfur Dioxide
NO_x - Oxides of Nitrogen

Source: EPA-600/7-89-012a, Nov.1989.
1985 National Acid Precipitation Assessment Program (NAPAP) Inventory (version 2), the most currently available and complete data.

Environmental Impact of Energy Use Today

Over the past two decades combustion of fossil fuels has supplied nearly all of the state's non-renewable energy. Figure 1-2 in Chapter 1 shows the percentages from 1960 to 1989.[4] The state's utilities own more than 4,000 MW of nuclear generating capacity, but fossil fuels supply more than 82 percent of energy for the state.[5]

Combustion Emissions

For 1989, the Energy Information Administration (EIA) estimated that fossil fuel burned in the state—both utility and nonutility—amounted to 1,553 TBtu. Fuel input to electricity imported to New Jersey from other states amounted to 252 TBtu. The total (excluding petroleum used for feedstocks, products, waxes, asphalt, and lubricants) reflects combustion of 194 million barrels (1,098 TBtu) of petroleum fuels, 457 billion cubic feet (469 TBtu) of natural gas and 3,545 short tons (94 TBtu) of coal.[6]

Table 19-1 shows the amount of carbon dioxide, calculated at standard conversion efficiencies, New Jersey fuel combustion produces. Annual carbon dioxide production amounted to 28.73 million metric tons (10^6 metric tons), a small fraction of the approximately 5 gigatons (10^9 metric tons) of carbon released globally each year.[7] Table 19-2 shows the National Acid Precipitation Assessment Program (NAPAP) estimate of sulfur dioxide and nitrogen oxides. NAPAP estimates for 1985, the best documented data available, are 184,000 tons SO_2 and 356,000 tons NO_x.[8] The CO_2 is an unavoidable product of carbon fuel combustion. CO, SO_2, and NO_x are controllable, and the federal Clean Air Act and state regulation set limits for their release.[9]

Air Quality Standards

The New Jersey Department of Environmental Protection (DEPE) is responsible for enforcing the federally set National Ambient Air Quality Standards (NAAQS) for certain (criteria) pollutants.[10] All these pollutants result directly or indirectly from fossil fuel combustion. (See Appendix: Criteria Pollutants.) Figure 19-1 shows the levels of criteria pollutants in New Jersey since 1980. The levels of nitrogen oxides, total suspended particulates, sulfur dioxide, lead, and recently, of carbon monoxide, remain below 100 percent of standard. Ozone levels remain above federal standards. Only lead levels have substantially decreased over the period.

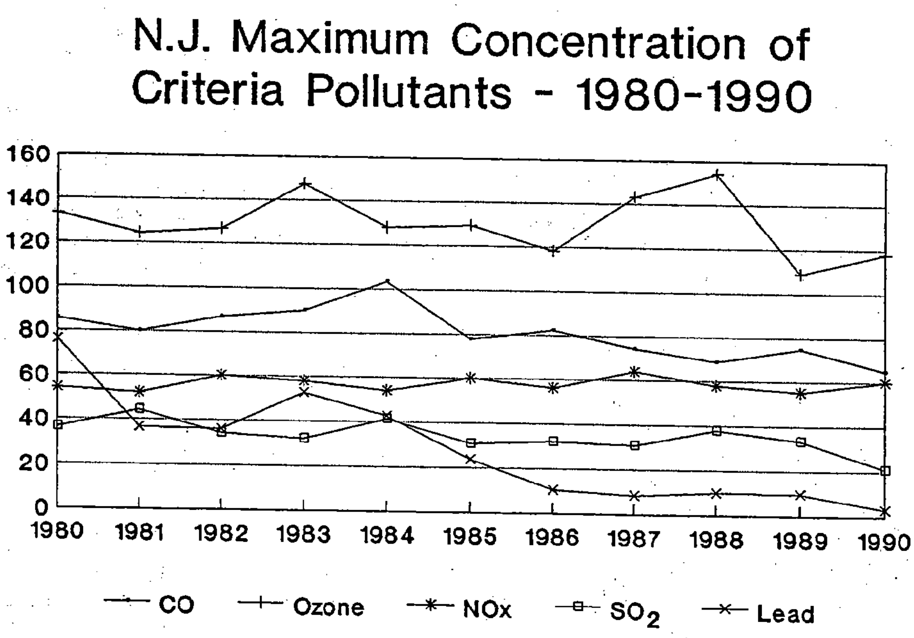
New Jersey's air quality in 1990 complied with the primary (public health) standards for all of the criteria pollutants except ozone. In 1986, airquality violated standards for four of the criteria pollutants: carbon monoxide, lead, particulates, and ozone.[11] In 1987, for the first time since the DEPE began its monitoring program, the primary ambient air quality met standards for carbon monoxide at all monitoring sites. DEPE attributes the improvement in ambient levels of carbon monoxide to the effectiveness of New Jersey's Inspection/Maintenance Program and the Federal Motor Vehicle Control Program.[12]

Unregulated Pollutants Related to Fossil Fuel Combustion

No federal ambient air quality standards (air concentration standards) exist for other air toxics related to fossil fuel combustion.[13] New Jersey has been monitoring many of these compounds to determine their present distribution and concentration. Scientists are carrying out risk assessments for several of these pollutants to determine their effects on human health and what dosages are reasonably safe. For several substances the state has already established emissions standards, based on the potential risk, and may eventually establish ambient air quality standards.[14] The air toxics include volatile organic substances (VOS) and particulate organic matter and heavy metals (including mercury).

The state has regulations limiting the emissions of some non-criteria pollutants from many industrial and commer-

FIGURE 19-1



Note: NAAQ - National Ambient Air Quality Standards
Source: DEPE

cial sources. The regulations, Subchapter 17 of the New Jersey Air Quality Regulations, cover 11 toxic volatile organic substances.[15]

Other Impacts

Impacts of cooling water used by centralized large-scale electric generation include damage to aquatic resources, such as entrainment and impingement of aquatic organisms in cooling and make-up water intakes, and habitat modification.

Analysis of Environmental Impacts

Acid Deposition

Acid deposition consists of dry and wet deposition, the latter known as acid precipitation or acid rain.[16] Both result from sulfur dioxide and nitrogen oxide emissions, which react in air to become sulfates and nitrates and ultimately return to the ground as dry or wet acid deposition. Acid aerosol (fine particulates) may aggravate respiratory ailments, but it is better known for being harmful to some freshwater and forest ecosystems. High acidity in certain bodies of water has destroyed many of the species that lived there. Acid precipitation also affects building materials, such as stone and metal.[17]

Rain in New Jersey in 1987 was the most acidic on record. Precipitation samples from 71 storm events in 1987 at Washington Crossing State Park had an average pH of 4.06, the most acidic annual average concentration recorded in New Jersey since the DEPE began sampling in 1982. In 1986, the average pH of samples from the Washington Crossing site was 4.24. Average annual precipitation acidity increased at all sites in 1987 with the greatest increases observed during the summer when, for the first time on record, all sites had average pH values below 4.0.[18]

Nitrogen Oxides

High temperature combustion oxidizes nitrogen in combustion air to nitrogen oxides. They are precursors of ozone and respiratory irritants. Further oxidation forms nitrates, which may contribute excess nutrients to some aquatic systems, leading to algae blooms and oxygen depletion in surface waters.

In 1990, the DEPE announced a preliminary finding (in conjunction with its air permit review of a Chambers Cogeneration Limited Partnership project) that selective catalytic converters (SCRs) should be considered the best available control technology for NOx emissions on coal-fired plants. This decision will limit future NOx emissions; however, it also escalates project costs. Given the fixed price nature of power sales agreements between utilities and APPs, regulators may want to consider whether power purchase contracts should be modified to allow for unanticipated environmental regulation compliance costs. Typically, the risk associated with changes in project costs (up or down) rests solely on the developer. Such modification would represent a shift of project risk to utility ratepayers and would likely require commensurate increased regulatory oversight for a project.

Sulfur Oxides

Combustion oxidizes sulfur compounds found in oil and coal to sulfur dioxide. Further oxidation forms sulfates. The release of sulfur dioxide correlates with increasing acidity of rainfall, dry deposition of sulfates, and, in turn, with acidification of surface waters.[19] Acid rain causes damage to forests and other vegetation, as well as potential leaching of heavy metal ions from soil into groundwater.[20]

The DEPE regulates the level of sulfur emitted from major new, expanded, or reconstructed steam generating units. The DEPE also regulates the amount of sulfur in fuel oil and solid fuel in trade, sold, or used in the state.[21] The regulation applies to fuel burned in the state but not to fuel burned for electric generation in out-of-state plants owned by New Jersey utilities. Figure 19-2 shows the national trend in sulfur dioxide emissions as well as the large amount of emissions from electric utilities.

Utility plant emissions are a major identifiable and controllable source of sulfur dioxide and acid deposition. The density of sulfur dioxide emissions from non-natural sources is high throughout the Midwest, particularly in states west of New Jersey. New Jersey utilities and industries burn relatively little coal. (Coal is source for about 20 percent of in-state generated electrical energy.) However, coal-producing states to the west burn large amounts of coal for electric generation and industry. Sulfur emissions from that burning reach New Jersey by the prevailing winds.[22]

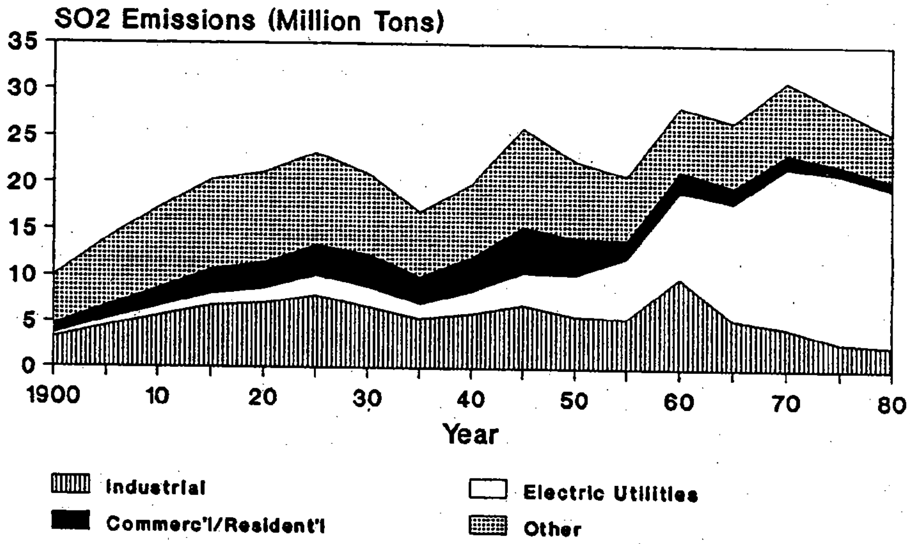
New Jersey utilities import nearly half the electricity distributed here from Pennsylvania and neighboring and midwestern states. West Virginia, Pennsylvania, Indiana, and Kentucky were the largest eastern US net exporters of electricity in 1986 and generated most electricity from coal. Like most other coal-producing states, these states place no upper limits on sulfur in fuel for utility generation.[23] Out-of- state environmental impacts of generation raise state jurisdiction and user responsibility issues. The impact of CO_2 emissions raises the same issues. New Jersey, to the extent that it imports electricity from states having no limits on sulfur in fuel, shares responsibility for the acid deposition resulting from emissions from those generating units.

New Jersey utilities distribute electricity purchased from the PJM power pool which, in turn, may purchase power generated by midwestern utilities. PJM and those utilities generate electricity with units having lowest running cost, generally the nuclear and coal-fired units. Without federal or state limits on sulfur emissions or content of fuel, the Pennsylvania and midwestern units burning high sulfur coal have low running costs.

Congress recently passed, and President Bush signed into law, major revision to the Clean Air Act (CAA). Title IV of the 1990 Amendments to the CAA is intended to reduce the adverse effects of acid deposition through reductions in annual sulfur dioxide (SO_2) emissions of 10 million tons from 1980 levels and, in combination with other provisions of the acts, of nitrogen oxides (NOx) by 2 mil-

FIGURE 19-2

Trends in Sulfur Dioxide Emissions in US
By Source Category



Source: EPA-600/7-88-009a, May 1988

lion tons from 1980 levels in the lower 48 states and the District of Columbia. Certain provisions of Title IV are also intended to encourage energy conservation and promote the use of renewable energy and clean alternative technologies as a means of reducing air pollution and other adverse impacts of energy production and use.

Phase I reductions are required by January 1, 1995 from 110 so-called *affected units*. Located in 21 eastern and midwestern states, these plants are larger than 100 MW in capacity and have emission rates exceeding 2.5 pounds SO_2 per million Btu. All affected units are required to meet a 2.5 lbs./mmBtu SO_2 emission rate limit by January 1, 1995. Any Phase I unit employing a qualifying technology or transferring its requirement to a unit employing such a technology may receive a two-year extension of the Phase I deadline. A qualifying technology is one that achieves a 90 percent reduction in SO_2 emissions from the level of emissions that would have resulted from the combustion of untreated fuels.

One plant located in New Jersey, Atlantic Electric Company's B.L. England plant, is on the list of Phase I affected units. The Conemaugh plant, located in western Pennsylvania and owned in part by PSE&G and AE, will also be affected by Phase I requirements.

Each affected unit will be issued allowances based on a 2.5 lbs./mmBtu emission rate multiplied by a baseline quantity of fuel consumed. In general, the average annual fuel consumption in the years from 1985, 1986 and 1987 will serve as the baseline. Each allowance represents one ton of SO_2 emission. Once allocated, allowances can be used by affected sources to cover emissions, banked for future use or sold to others.

In Phase II, which begins on January 1, 2000, all utility plants emitting sulfur dioxide at a rate above 1.2 lbs./mmBtu will have to reduce emissions to a level equal to 1.2 times the baseline fuel consumption. Beginning in 2000, the total number of allowances to be issued is not to exceed 8.9 million tons. This effectively caps emissions at 8.9 million tons of SO_2. As a result, any new units will need to obtain allowances from other sources to cover incremental emissions.

The act also provides that 300,000 allowances be made available for allocation to utilities that implement qualified conservation and renewable energy measures. Subject to limitations, utilities will receive an allowance for each ton of SO_2 emissions avoided through the use of one of these technologies. A number of additional bonus allowances are earmarked for specific categories of sources.

The federal Environmental Protection Agency will create a special reserve of allowances by setting aside 2.8 percent of each affected unit's allocation for auction and sale to generators that otherwise could not procure allowance through the open market. Sales are to be made at a fixed price of $1500 per allowance, adjusted to the consumer price index . Sales will be made on a first-come-first-served basis subject to priority for IPPs.

The CAA amendments were designed and are intended to result in an active allowance trading market in order to reduce overall compliance cost. The State should encourage the proliferation of a successful allowance trading market that has the potential to reduce the overall cost of CAA compliance. The DEPE and the Board of Regulatory Commissioners (BRC) should open a dialogue with regulators in other regional states to enhance interstate coordination and planning. The DEPE and the BRC should also establish a regulatory framework that provides guidelines by which utility compliance plans will be assessed.

The power pools now purchase electricity based on *economic dispatch*, bringing units on line as needed, in order of increasing cost subject to transmission constraints. A possible technical mechanism for reducing sulfur emissions would require power pools to bring generating units on line in order of least emissions, using *environmental dispatch*. An alternative economic mechanism would include in the economic dispatch model a proxy cost representing environmental costs. The problem would be establishing an agreed-upon value for environmental costs.[24]

The debate over utility compliance with the CAA revisions has included discussions on the propriety of using the environmental dispatch concept as a means of achieving compliance on a pool-wide basis. Under such an approach, the cost of emission allowances could be used, in whole or in part, to set the value of environmental costs. This approach, especially if environmental costs beyond the cost of allowances are included, has the potential to increase consumer power costs substantially. Nonetheless, the benefits and costs associated with this mechanism and other means of achieving regional economics should be explored.

Ozone

New Jersey's most persistent air pollution problem is ozone. Unlike most other pollutants, ozone is not directly emitted by a source. Instead it forms in the atmosphere from nitrogen oxides (NO_x) and volatile organic substances (VOS) that react in the presence of strong sunlight and warm temperatures. Its formation and destruction result from reactions of oxygen, depending on processes that control levels of atmospheric carbon monoxide, hydrocarbons, and nitrogen oxide.[30] Air currents can transport these precursor compounds, along with ozone itself, over great distances; they do not necessarily originate within New Jersey.

Ozone is a powerful oxidant and reacts readily with a wide range of substances. Exposure to ozone in concentrations greater that the federal NAAQS limit, 0.12 parts per million, causes a significant decrease in human pulmonary function and affects the lungs' ability to resist infections. It is a respiratory irritant seriously affecting those with chronic respiratory illnesses. Damage to plant leaves is one of the earliest and most obvious results of high ozone levels. Subsequent effects include reduced plant growth and decreased crop yield.[31] One study estimates that present ozone levels probably lead to yield losses in U.S. crop production of 5 to 10 percent.[32] Ozone also causes degradation of natural rubbers and synthetic polymers. These materials become hard and brittle at a faster rate as a result of the oxidizing ability of ozone.

The DEPE regulates ambient air concentrations of nitrogen oxides through Subchapters 13, motor vehicles through Subchapters 14 and 15, and volatile organics through Subchapter 16 of *N.J.A.C.* 7:27. Subchapter 8 has a *state of the art* provision applied to NO_x during permitting of stationary (industrial, commercial, and utility) sources. The subchapters have controlled emissions to the atmosphere of nitrogen dioxide since 1973 and of volatile organic substances since 1976, but ozone has remained a problem. Figure 18-1 shows that the concentration of ozone has remained above 120 percent of the NAAQS standard for all of the last 10 years.

The ozone concentration in New Jersey ambient air in late spring and summer often exceeds the NAAQS federal standards. Ozone concentrations exceeded this standard on 45 days between May and September of 1988. Exceedances[33] of the primary ozone standard in New Jersey have increased over recent years, from 45 in 1986 to 119 in 1987, to 212 during the period April 1 through August 31, 1988. In Camden the primary ozone standard was exceeded on 23 days, and an ozone concentration over twice the standard was recorded on one occasion at a site near Trenton. This unusually poor air quality was associated with the extended number of hot, sunny days in June and July 1987 and again in 1988.[34]

The state regulates nitrogen oxides emissions through standards for automobiles and stationary sources. Figure 18-1 shows that state levels have remained about 60 to 70 percent of the NAAQS standard over the last 10 years. However, with increases in vehicle miles traveled, the projection is for only temporary decrease in nitrogen oxides.[35] Figure 18-3 shows the historical trends in nitrogen oxide emissions in the United States. The fuel sources showing an increasing trend are coal, natural gas, and gasoline/diesel fuel.

Recent amendments to state regulations aim to further reduce emissions of volatile organic substances. The Stage II vapor recovery regulations require installation of special nozzles on service station pumps at facilities with more than 10,000 gallons average monthly throughput. The regulations are phased in, for stations with throughput above 40,000 gallons, by the end of 1988, and for the remaining affected stations by the end of 1989.

The DEPE estimates that the vapor recovery regulations, when completely in effect, will prevent 13,500 tons of gasoline vapor and 270 tons of benzene from evaporating into the atmosphere annually, based on the volume of gasoline dispensed in 1984. Most of the reduction, 76 percent, is in the first phase when the approximately 2,000 facilities having 40,000 gallons or greater monthly outputs must install vapor recovery equipment.[36]

Benefits of the vapor recovery regulations include substantial expected savings in gasoline. The DEPE estimates that New Jersey can save over 3.7 million gallons of gasoline annually, otherwise vaporized during motor vehicle refueling, once the program is fully implemented. Health benefits include reduction of emissions of benzene, a known human carcinogen, and ethylene diobromide and ethylene dichloride, both regulated by the DEPE as hazardous air pollutants under Subchapter 17.[37]

Additional regulations the DEPE has proposed to control VOS include requiring more commercial and manufacturing VOS users to control VOS evaporation in storage and in processes. The DEPE estimates that, on full implementation, strengthened regulations on architectural coatings will prevent emissions of 5,250 tons of VOS, on household products 3,300 tons (*e.g.,* paint), on surface coatings and storage tanks 8,190 tons.[38]

November 1990 Clean Air Act amendments require that all private motor vehicles in areas labeled for severe nonattainment of EPA ozone standards use reformulated gasoline beginning in 1995. In addition, motor vehicle fleets of 10 or more vehicles capable of central fueling will be required to phase in the use of alternative fuels such as methanol or natural gas. Beginning with model year 1998, 30 percent of new fleet acquisitions must run on alternative fuels; the requirement escalates to 50 percent for model year 1999 fleet purchases and 70 percent for model year 2000. Eighteen of the state's 21 counties (i.e., all but Warren, Atlantic and Cape May counties) earned the severe nonattainment designation for ozone air pollution by virtue of their proximity to Philadelphia and New York City—two of nine cities nationwide ranked as severe. It is likely that the reformulated gasoline and alternative-fuel fleet requirements will be enforced statewide by DEPE.

Airborne Particulates

Total suspended particulate (TSP) levels have decreased over the past two decades, but problems still occur in heavily industrialized and heavily trafficked areas. In 1987, air quality violated the 24-hour TSP secondary standard on one occasion in New Brunswick and four times in Newark. In Newark and Perth Amboy particulate levels exceeded the 12-month primary standard.

In 1987 the Federal government changed the indicator for the standard for particulates from total suspended particulates to inhalable particulates, or PM-10, particulate matter ten microns in size or smaller. No violations of PM-10 standards were recorded in New Jersey in 1987.[39]

Carbon Monoxide

Fossil fuel combustion with insufficient oxygen produces carbon monoxide, a respiratory inhibitor fatal in small concentrations.[40] Operators of large boilers carefully monitor and control combustion to prevent carbon monoxide formation. However, most fossil fuel combustion occurs in automobile engines (52 percent) and home furnaces or boilers (17 percent).[41] U.S. Environmental Protection Agency (USEPA) estimates that, for the nation, transportation sources produce 70 percent of total carbon monoxide emissions.[42]

Carbon Monoxide Outdoors

The state monitors carbon monoxide concentrations in areas of vehicular congestion, primarily urban centers, where most high levels occur. The state has made progress in reducing carbon monoxide exceedances at its monitoring stations. However, exceedances still occur in metropolitan areas. A recent study by the Northeast States for Coordinated Air Use Management (NESCAUM) listed seven exceedances of the air quality standard for carbon monoxide in New Jersey in 1986, and one in 1987. Two were in the Bergen-Passaic Metropolitan Statistical Area (MSA), two in the Jersey City MSA, and four in the Newark MSA. Exceedances in New York City were 40 in 1986 and 86 in 1987. The DEPE regulates carbon monoxide and hydrocarbon emissions through the motor vehicle inspection program.[43]

Carbon Monoxide Indoors

Recent Canadian studies found sublethal concentrations of carbon monoxide in insufficiently ventilated houses or furnace rooms.[44]

Studies of health effects of sublethal levels of carbon monoxide show *that low levels of carboxyhemoglobin (COHb) produce significant effects on cardiac function during exercise in subjects with coronary artery disease.*[45]

Provisions to supply adequate air to combustion equipment can prevent build up of carbon monoxide in residences. However, residents may close up air supply openings, not realizing their purpose or necessity. Foundation and window air leaks are the usual source of outside air for combustion equipment. If those leaks are closed during basement renovation or weatherizing and no air source remains, combustion will pull air from other areas of the house, making the house drafty. Exhaust fans in bathrooms and kitchens may overcome natural drafts providing air to combustion equipment or to fireplace flues. Either of these situations may reduce oxygen supply to the combustion equipment or fire and may pull normally exhausted carbon monoxide back into the building.[46]

Two approaches can eliminate the possibility of carbon monoxide poisoning from fuel-fired heating equipment in residences: public education, or sealed combustion units that control the path of supply and exhaust air. Since human activity plays a large role in determining the flow of air within a building, more effort should go to public awareness of the need for a proper air flow to combustion equipment in existing buildings. Availability of many models on the market suggests cost-effectiveness of high efficiency sealed combustion units.

Outside air introduced into buildings by natural infiltration or mechanical ventilation costs money for heating and cooling but dilutes indoor air pollutants. To balance economic and pollution control needs, ventilation standards or maximum allowable pollutant concentrations can be prescribed. National standards include those from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Its most recent update of ventilation codes, entitled 62-19-89 (in press), sets a minimum of 0.35 air changes per hour (0.35 ACH) or 15 cubic feet per minute per occupant (15 cfm/occupant), whichever is greater. The amended code limits for indoor radon are a maximum of 4 picocuries per liter. However, a maximum ambient air level standard could be more effective in protecting the public health. Codes set minimum but not maximum ventilation standards. The most effective means of maintaining and improving indoor air quality is reduction of pollutant sources, smoking, and aerosol or solvent use, among others.

Carbon Dioxide and Global Atmospheric Change

The balance between solar energy reaching earth and radiation back through the atmosphere from the earth maintains our climate. Certain trace gases in the atmosphere, primarily carbon dioxide and methane, alter that balance by absorbing radiant energy. Climate models indicate that increased concentrations of these gases, though they total less than one percent of earth's atmosphere, could dramatically affect climate by increasing earth's temperature in what is called a *greenhouse* effect.

Since the beginning of the Industrial Revolution, about 1800, the global concentration of CO_2 has increased from about 280 ppm to more than 340 ppm, a 25 percent change attributed to combustion of fossil fuels and other industrial processes.[47] Numerous scientific studies document this change.

The effects of climate change would be great and raise the questions of urgency and effectiveness of responses.

Scientists have two sources of information on climate trends: weather records from around the world, for as far back as they exist; and computer climate models in which they can vary the input parameters (sunlight distribution, etc.) to determine effects on temperature and precipitation in different regions.

The trends of high latitude and of global mean surface temperatures over the past century are difficult to determine from data that vary greatly over short time periods. In spite of the normal variation, several studies have concluded that global temperatures have increased by approximately 0.5° C since the beginning of the century and note the preponderance of very warm summers in recent years.[48]

Computer modeling results agree on global trends but diverge on the details of regional distributions of temperature changes, precipitation patterns, and other features.[49] These models integrate knowledge of physics in atmospheric processes and attempt to include chemical, hydrological, agricultural, meteorological, and (in some cases) oceanic interactions.

The models predict warming with greater effects in in higher latitudes. This change could cause polar ice cap and glacier melting, raising sea level. Because many of New Jersey's cities, population, and agriculture lie near sea level, planners must assess this potential carefully. Most models estimate that sea level is likely to rise at least 0.5 meter in the next century, which would devastate New Jersey's shore communities.[50]

Increasing temperatures and changed precipitation patterns will also strongly affect crops and the distribution of high yield agricultural regions in ways that are hard to predict with current models. However, the high temperatures of 1988 and the continued drought of the 1988-89 winter demonstrate the nation's vulnerability to natural processes. The state energy division previously calculated that New Jersey's annual carbon dioxide production amounts to nearly 30 million metric tons, almost 1 percent of the estimated global release of five gigatons (10^9 metric tons).

Other compounds in the atmosphere including methane act like carbon dioxide in absorbing radiant energy, and their presence contributes to the global warming.

TABLE 19-3

Comparison of Carbon Dioxide Emitted from Direct Combustion of Fuels

Fuel	CO_2 Emission Rate ($kgC/10^9J$)	Ratio Relative to Methane
Methane	13.5	1.00
Ethane	15.5	1.15
Propane	16.3	1.21
Butane	16.8	1.24
Gasoline	18.9	1.40
Diesel Oil	19.7	1.46
No.6 Fuel Oil	20.0	1.48
Bituminous Coal	23.8	1.73
Subituminous Coal	25.3	1.87

Source: Dr. Gordon MacDonald, MITRE Corp. from Mintzer, Public Power, November-December 1988.

Since greenhouse effects are a serious concern, action to limit global warming is necessary. Policymakers are considering many kinds of action, no one of which alone will be sufficient to prevent future deterioration:

1. End use and generating efficiency can dramatically reduce the amount of produced to accomplish a task, as detailed in Part III.

2. Reforestation can remove CO_2 from the atmosphere and store it in trees. For example, a proposed Connecticut coal-burning power plant will offset its CO_2 releases by planting trees in Guatemala.[51] However, reforestation is not a general solution because there is not enough land to plant trees to compensate for CO_2 into the atmosphere. CO_2 released by burning coal and oil.

3. Fuels vary by almost a factor of 2 in the CO_2 produced per unit of useful work (See Table 19-3), so a shift toward hydrogen-rich fuels and away from carbon-rich ones will decrease carbon dioxide effects. This practice favors natural gas over coal, with petroleum in between.

4. Other energy sources produce no CO_2 (except that associated with their manufacture). For example, if nu-

clear power can be made acceptable and cost-effective, it can serve additional needs, possibly including fuel for electric cars (or hydrogen fuel from hydrolysis of water). Photovoltaic cells could satisfy many present electrical needs or supply the basis for new conversion technologies.

Global climatic change due to the release of greenhouse gases will occur, probably within the working lives of the authors and readers of this Energy Master Plan. Prudence requires attention to the problem and beginning to solve it.

Nuclear Energy Impacts - Releases and Waste

Nuclear environmental impacts arise from mining, transport, releases, and accidents. The energy of nuclear reactions comes from fission of radioactive atoms. The products are low-level radioactive waste, useful heat, waste heat, and spent nuclear fuel.[52] Impacts within the state include any relating to transportation of liquids or solids and any resulting from gaseous or liquid effluent releases.[53]

Since 1969 nuclear energy has supplied electricity for state use and recently as much as one-half of electricity generated in-state. Even recently nuclear has supplied about 10 percent of all TBtu used in the state.[54] Four nuclear generating units operate in New Jersey, two boiling water and two pressurized water reactors (total capacity 4,003 MW). New Jersey utilities also own portions of out-of-state units.[55]

Nuclear generating stations release radioactive material daily in several forms. Operators may release liquid waste, after monitoring and required dilution, to the cooling water source and ship the solids to one of two nuclear waste facilities, either Hanford, Washington or Beatty, Nevada for burial.[56] The gaseous releases, continuously monitored for level of radioactivity, travel with prevailing winds.[57]

Regulations on radioactive releases from nuclear generating stations limit concentrations of liquid releases and potential human exposure, but do not limit the volume or quantity of releases. A monitoring plan sets requirements for each reactor to measure releases and to alert both plant operators and state authorities if releases exceed specified limits.[58]

Gaseous radioactive releases from both types of generating units are predominantly noble gases (xenon and krypton). The liquid effluents from pressurized water reactors contain primarily tritium. Boiling water reactors release little radioactivity in liquid form. The amount of radioactivity a reactor releases depends upon the amount of time the reactor is operating at full power.[59] Off-site releases from each New Jersey nuclear plant are well within the NRC regulatory limits for the plants.

The utilities report gaseous and effluent releases to the Nuclear Regulatory Commission (NRC) semiannually. The reports, published by the NRC, contain information on the regulatory limits, measurement techniques, summaries of effluent releases, solid radioactive waste from the plant, radiological impact to humans, and meteorological data.[60]

Disposal of spent nuclear fuel presents a critical problem. Now plant operators are storing spent fuel on site. The storage is an interim solution until the federal government constructs storage facilities for high level radioactive waste at a national disposal site presently being proposed for location in Nevada.[61]

Disposal of low-level radioactive waste produced in New Jersey, three-quarters of which arises from nuclear plant operations, also awaits designation of long-term storage sites. Under federal legislation New Jersey has joined with Connecticut to identify disposal sites within the two states for low-level wastes. In 1987, the state legislature passed the Regional Low-Level Radioactive Waste Disposal Facility Siting Act, which sets up an advisory board to select sites.[62]

The impact of nuclear generation on the environment attracted additional attention in 1990 when it was revealed that a DEPE study found that large numbers of fish are being sucked into the cooling system at the Salem nuclear plant and die from the sudden change in water temperature. Based on study results, the DEPE is now studying whether the utilities should build cooling towers at the plant to mitigate this problem. Although this environmental problem is not an issue of radiation, it does impact the state's environment. Substantial costs may be imposed on AE and PSE&G should the utilities be required to erect cooling towers. The BRC is studying the financial and rate impact of such an outcome.

Use Efficiency Can Bring Improvements

Although extensive regulation controls emissions in New Jersey, over the last decade most pollutant levels have not decreased. What measures, then, can New Jersey take to influence energy-related pollutant levels?

Efficiency, utilized at the level of today's best available technologies, can reduce total energy use. Chapter 24 Choices for New Jersey 2000, provides estimates for emissions reductions within the state, based on potential energy use reductions.

The technology now available to provide energy services, heat, light, motor power, and transport using far fewer TBtus can enable the state to reduce energy-related radioactive releases and fossil fuel-related emissions or, at least, to reduce a projected increase. The Demand Side Management (DSM) Resource Plan rules (*N.J.A.C.* 14:12) adopted by the Board of Regulatory Commissioners in September 1991 include a valuation of environmental externalities that must be incorporated in the net benefit assessment of utility DSM programs.

Findings

- Energy efficiency, in addition to its other advantages, is the single most effective means of reducing combustion-related emissions.

- CO_2 released by fossil fuel combustion is building up in the earth's atmosphere. The implications of this build up are critically important in the mid- to long-term. While New Jersey alone cannot control the build up, it can prepare to meet scientific and public concerns that are now surfacing.
- Nitrogen oxides and sulfur dioxide emissions cause acid precipitation. Acid precipitation contributes to the acidity of lakes and streams, and the resulting adverse effects on living organisms. Acid precipitation may harm plant life. It may affect soil acidity that controls the movement of toxic heavy metals through soils and into aquifers.
- Ozone, formed in the atmosphere from nitrogen oxides and organic substances, results, at least in part, from fossil fuel emissions. Exceedances of the ozone standard are increasing, possibly as a result of hot summer weather. The number of days with poor air quality has increased because of high ozone levels.
- Volatile organic substances, petroleum, petrochemicals, solvents, and other organic compounds are released into the air in part from fuel use. Gasoline vapor released at gas pumps is a major source. These compounds are precursors of ozone. Many are suspected of causing cancer.
- Particulate matter resulting from incomplete combustion of fossil fuel, particularly diesel fuel, contains particulates with the carcinogen benzo(a)pyrene.
- The DEPE has already instituted the most cost-effective technically available controls for the controllable pollutants. Ozone formation remains a problem.
- Carbon dioxide release from fossil fuel combustion is not now controllable by technical solutions such as emissions controls. The alternatives are increased use of nuclear electric generation, alternative energy sources, or greater end use efficiency.

Policy

- The State should encourage energy efficiency to the greatest extent consistent with cost-effective investment.
- The State should review its own investments in transportation, water supply and water treatment infrastructure, its policy affecting land use, and its own operations to find opportunities for fuel efficiency.
- The State should encourage use of renewable energy, landfill gas, and photovoltaics to the maximum extent technically feasible by assessing their potential in all decisions that affect energy supply, price or use.
- The State should encourage research on energy storage, photovoltaics, and other promising technologies that might reduce dependence on fossil fuels, particularly imported petroleum. The New Jersey congressional delegation should work to reallocate research funds from non- renewable fuel research to renewable research.
- The State should require inclusion and refinement of environmental costs and benefits in energy planning cost/benefit analyses. It shall foster the development of appropriate methodology and design of means to internalize environmental costs.
- The DEPE and the BRC should continue to work with regional air management agencies and neighboring state regulatory agencies whose electric utilities comprise the PJM Interconnection to develop, to the extent practicable, planning methods and energy efficiency programs for regional air management.

Implementation

- The State should target motor vehicle emission for more stringent enforcement.
- The State should require new residential construction using combustion heating equipment to install high-efficiency sealed combustion units or to ensure adequate ventilation of indoor spaces not sealed from the combustion unit.
- The DEPE and the BRC should confer to develop an integrated response to the Clean Air Act amendments. As part of this effort, the BRC should: (1) require the electric utilities to study the economic and environmental impacts to New Jersey consumers of the continuation of purchases of large quantities of power from out-of-state utilities where SO_2 emission requirements are less stringent than those in New Jersey, and (2) require electric utilities to internalize environmental costs in least cost planning process.
- The DEPE and the BRC should establish a regulatory framework that provides guidelines to assess utility Clean Air Act compliance plans.
- The proposed Clean Air Act requires utilities to offset SOx and NOx emissions from new facilities by retiring, plant, switching to cleaner fuels, improving emissions control at other plants, or purchasing offsets from other utilities in their region. Offsets by other means such as planting trees, or investing in energy efficiency should be considered by the DEPE.
- The State should employ life-cycle costing for all government-purchased energy-consuming equipment to guarantee consideration of energy savings benefits.
- The State should encourage implementation of energy conservation measures to the maximum extent practical to reduce air pollution emissions.
- The State should develop methodologies to fully reflect environmental costs so that all electric users would pay their share of emissions reduction costs based on their share of use. This process is known as internalization of environmental externalities.
- The State should continue to support energy efficiency and conservation as a means to meet environmental goals.

NOTES

1. Energy Information Administration (EIA), *State Energy Data Report* DOE/EIA-0214(86) (Washington, D.C.: US Department of Energy, 1987), calculated from tables 198-203, pp.. 207-212. The calculations assume coal is the source for imported electricity.
2. Irving Mintzer, *A Matter of Degrees: The Potential for Controlling the Greenhouse Effect* (Washington: World Resources Institute, 1987) and estimates of increased efficiency in New Jersey energy use, based on moderate decrease of use (average 2 percent annual decrease) through incorporation of best currently available technology in all present uses.
3. New Jersey Department of Environmental Protection (DEP) *1986 Reasonable Further Progress Report for Ozone and Carbon Monoxide* (Trenton, N.J.: DEP, December, 1987) p. 2.
4. EIA, p. 212.
5. *Commercial Nuclear Power: Prospects for the United States and the World*. (Washington: Energy Information Administration, (EIA) 1986) DOE/EIA-0438(86), Appendix C, p. 71.
6. EIA, p. 207. These amounts include fuel burned in-state for generating electricity. EIA petroleum TBtu includes other petroleum, asphalt, road oil, and lubricants, as well as an estimated 178.9 TBtu of jet fuel delivered by pipeline to New Jersey but subsequently distributed to New York airports. These amounts subtracted from EIA's Petroleum total of 1273.1 TBtu leaves 892.8 TBtu of petroleum products combusted in New Jersey.
7. Sheila Machado and Rick Piltz, *Reducing the Rate of Global Warming: The States' Role* (Washington: Renew America, November 1988), p. 19, provided estimates of New Jersey carbon dioxide emissions.

   Atmospheric Carbon Dioxide and the Global Carbon Cycle (Washington: USDOE, Carbon Dioxide Research Division, Office of Basic Sciences, December, 1985), p. 72, provided estimates of global carbon dioxide emissions.
8. U.S. Environmental Protection Agency, *National Emissions Data System State Emissions Report*. 09/27/88.
9. Federal Clean Air Act and *N.J.A.C.* 7:27.
10. *Ibid.*, Criteria pollutants are those for which the federal government has set National Ambient Air Quality Standards (NAAQS) under authorization of the Clean Air Act.
11. DEP, DEQ, p. 3.
12. *Ibid.*
13. *Ibid.*, p. 4.
14. *N.J.A.C.* 7:27 - 6.l *et seq.* establishes emissions standards for particulates, sulfur, carbon monoxide, hydrocarbons, volatile organics and nitrogen oxides, benzene, tetrachloroethylene, total volatile organics, substances contributing to ozone formation. The regulations also require modeling of criteria pollutants that new sources might emit.
15. *N.J.A.C.* 7:27-16.1 *et seq.*
16. DEP, DEQ., p. 6., Acidity is a measure of the hydrogen ion concentration reported in pH units on a scale from 1 to 14, where 1 is very alkaline, and 7 is neutral. Each decreasing unit is 10 times more acidic. Normal rainwater naturally contains some acidic compounds, and has a pH range of 5.0 to 5.6.
17. Interagency Task Force on Acid Precipitation, *National Acid Precipitation Assessment Program (NAPAP) Annual Report 1984* (Washington, D.C.,1984) pp.. 49-54.
18. DEP, DEQ, p. 5.
19. Interagency Task Force on Acid Precipitation, pp.. 49-54.
20. James J. MacKenzie and Mohamed T. El-Ashry. *Ill Winds Airborne Pollution's Toll on Trees and Crops* (Washington: World Resources Institute, l988), p. 19.
21. *N.J.A.C.* 7:27-9.1 *et seq.* and 7:27-10.1 *et seq.*
22. National Acid Precipitation Assessment Program (NAPAP) Annual Report 1984, pp. 49-54.
23. James S. Cannon, *Acid Rain and Energy: A Challenge for New Jersey* (New York: INFORM, Inc. 1984), p. 6.
24. *Ibid.*, p. 12.
25. *Ibid.*, p. 21.
26. *Ibid.*, p. 22.
27. *Ibid.*, p. 27.
28. Environmental Defense Fund, Petition Before the New Jersey Department of Environmental Protection and Board of Public Utilities, March 29, 1988.
29. U.S. Committee for an International Geosphere - Biosphere Program (IGBP), Commission for Physical Science, Mathematics and Resources, National Research Council, *Global Change in Geosphere - Biosphere* (Washington: National Academy Press, 1986), p. 83.
30. *Ibid.*, p. 63.; DEP, DEQ, p. 5.
31. DEP, Proposed Regulations on Control and Prohibition of Air Pollution by Volatile Organic Substances: Stage II Vapor Recovery, Docket No. 052-87-10. 1987, p. 4; Proposed Regulations amending *N.J.A.C.* 7:27-16.1, 16.2, 16.5, and 16.6, p. 6, Docket No. 044-88-11.
32. Walter W. Heck *Assessment of Crop Losses from Air Pollutants in the United States, in Multiple Air Pollutants and Forest and Crop Damage in the U.S.*, (working title) Yale University Press, Spring 1989.
33. Exceedance includes violations at any monitor. Exceedances may have occurred at several monitors in any one day.
34. DEP, DEQ, p. 5.
35. Northeast States for Coordinated Air Use Management (NESCAUM), *Critical Analysis of the Federal Motor Vehicle Control Program*, July, 1988, p. 10.
36. DEP, Proposed Regulations on Control and Prohibition of Air Pollution by Volatile Organic Substances: Stage II Vapor Recovery, Docket No.052-87-10. 1987 amending *N.J.A.C.* 7:27-16.1 and 16.3.
37. *Ibid.*
38. DEP, Proposed Regulations on Control and Prohibition of Air Pollution by Volatile Organic Substances, Docket No. 044-88-11, amending *N.J.A.C.* 7:27-16.1, 16.2, 16.5, and 16.6; Docket No. 030-88-07, amending *N.J.A.C.* 7:27-23.
39. DEP, DEQ., p. 5.
40. Hatch Associates, Ltd., *Hazardous Heating and Ventilating Conditions in Housing*, (Toronto: Canada Mortgage and Housing Corporation, 1983) p. 9.
41. Amounts of fossil fuel burned in NJ in 1986, in small engines or burners with the potential for producing carbon monoxide if improperly controlled:

    Residential natural gas - 162.4 Tbtu or 10%; residential petroleum - 106.3 Tbtu or 7%; and transport petroleum - 656.7 Tbtu or 52%, yielding a small burner and internal combustion engine total - 925.4 Tbtu or 69%
42. NESCAUM, p. 7.
43. *Ibid.*, p. 5.
44. Hatch Associates Ltd., p. 9.

45. Health Effects Institute Study "Acute Effects of Carbon Monoxide On Individuals With Coronary Artery Disease," quoted in NESCAUM, *Critical Analysis of the Federal Motor Vehicle Control Program*, 1988, p. 112.
46. Roscue J. Clark, presentation at Excellence in Housing 88, Portland Maine, April 28, 1988.
47. Stephen H. Schneider, "The Greenhouse Effect: Science and Policy," *Science*, Vol. 243 (February 10, 1989), p. 772.
48. Richard A. Houghton and George M. Woodwell, "Global Climatic Change," *Scientific American*, Vol. 260, No. 4 (April 1989), pp.. 37-38.
49. U.S. Committee for IGBP, p. 83.
50. Conference on Global Climate Change, Ithaca, New York, March 3, 1984, Scientific Workshop Findings, p. 16.
51. Lecture "Environmental Modification" presented by Greg Marland at Global Climate Change Linkages: Acid Rain, Air Quality and Stratospheric Ozone Conference, Nov. 15-16, in Washington, sponsored by: The Center for Environmental Information, Inc., Rochester, NY.
52. Telephone discussion with Duncan White, DEP, Nuclear Environmental Engineering Section, 12/15/88.
53. Public Service Electric and Gas Co. (PSE&G), *Radioactive Effluent Release Report, Unit Nos. 1 & 2, July - December 1987 Salem Generating Station.*, Report No. SGS-RERR-23, p. 7.
54. EIA, DOE/EIA-0214(86), and 1987 NJ Profile p. 25.
55. New Jersey utilities own 2793 MW of the 3899 in-state units and 1237 MW of out-of-state capacity.
56. PSE&G, *Radioactive Effluent Release Report*, p. 4.
57. *Ibid.*, Reports for each nuclear power plant contain wind direction and speed tables for actual conditions at that plant for each two-month period. The wind data are integrated into the model of distribution of gaseous releases.
58. *Ibid.*, and telephone discussion with Duncan White DEPE Nuclear Environmental Engineering Section 12/15/88.
59. Communication from Duncan White DEPE Nuclear Environmental Engineering Section, 9/30/88.
60. PSE&G, *Radioactive Effluent Release Report*, p. 4.
61. Telephone discussion with Duncan White, DEPE, Nuclear Environmental Engineering Section, 12/15/88.
62. Regional Low Level Radioactive Waste Disposal Facility Siting Act, P.L. 1987, c. 333, effective 12/22/87.

Chapter 20

Emergency Plans

Energy service disruptions cause energy emergencies. Whether the origin is an oil embargo, unprecedented heat waves driving electricity consumption to levels the system cannot sustain, or natural gas unavailability, advance planning is required to minimize the effects of the disruption.

As a result of the 1973-74 Arab oil embargo, the Governor by Executive Order created two offices—the State Office for Petroleum Allocation (SOPA) and the State Energy Office (SEO). SOPA implemented the state set-aside mandated by federal regulations.

SEO issued a report to the Governor, which recommended drafting legislation to organize an energy department and to manage emergencies. These recommendations were incorporated in the Department of Energy Act (*N.J.S.A.* 52:27F-1 *et seq.*), the Energy Emergency Preparedness Act (P.L. 1983, c. 599), and New Jersey Energy Emergency Regulations (*N.J.A.C.* 14A:2-1.1 *et seq.*). Under this legislation, the Department of Environmental Protection and Energy (DEPE), through its receipt of the Division of Energy Planning and Conservation's statutory responsibilities, has primary responsibility for energy emergency planning.

The Energy Emergency Preparedness Act requires systematic preparation for energy emergencies. Energy emergency planning during the past 18 years has reflected catastrophic events, such as the Middle Eastern oil disruptions of 1973 and 1979, the massive electricity blackouts suffered by New York City in 1965 and 1974, and the natural gas curtailment experienced by New Jersey in the winter of 1976-77.

State energy emergency planning includes:

- Ability to monitor emergency situations and obtain valid energy data.
- Integration with existing emergency plans for natural disasters, civil emergencies, etc.
- Direct communication between the emergency coordinator and the affected constituencies.
- Flexible response capability.

The Department of Energy Act recognizes the role of energy data management for both long-term planning and emergency management in two major sections: Section 2, the legislative findings; and Section 11, powers of the Commissioner. The most significant mandates are subsections of Section 11:

> *(a) Manage the department as the central repository within state government for the collection of energy information.*
>
> *(f) Establish an energy information system which will provide all data necessary to insure a fair and equitable distribution of available energy and to provide the basis for long-term planning related to energy needs.*

Energy Emergency Response Plans

The energy emergency response plans respond to shortages of petroleum products, electricity, or natural gas with specific measures necessary for any one or a combination of energy sources. Because some of these measures will have more economic impact than others, implementation progresses from the least action deemed necessary toward the more severe measures as circumstances warrant. All of these measures have been effective in the past and therefore should be viable if an energy emergency develops in the near future.

Common to all energy emergency plans is a finding by the DEPE that an emergency exists based upon evaluation of an evolving situation by the DEPE emergency coordinator. The DEPE then recommends that the Governor declare an energy emergency by Executive Order, which activates the energy emergency regulations. Interpretation of the regulations is the responsibility of the DEPE

Petroleum Energy Emergency Response Plan

The Petroleum Energy Emergency Response Plan addresses problems associated with inadequate supplies of crude oil and refined petroleum products in the absence of federal price and allocation controls. It provides a framework for dealing with various petroleum supply shortage situations.

Evaluation of petroleum shortage severity is difficult because the oil market is international. In 1989, imported crude supplied 47 percent of petroleum product used in the United States and approximately 80 percent of that used on the East Coast.[1] Further, the country participates in an international agreement, the International Energy Program, to share its petroleum supply in the case of an international petroleum supply interruption of a certain magnitude.

The U.S. Strategic Petroleum Reserve (SPR) somewhat moderates oil vulnerability. Congress authorized the SPR in the 1975 Energy Policy and Conservation Act (P.L. 94-163) that mandated establishment of SPR with up to 1 billion barrels of petroleum products. Goals of the SPR are to reduce the impact of petroleum supply disruptions and to meet the country's obligations under Agreement of the International Energy Program.[2]

The SPR contained more than 581 million barrels at year end 1989. At present rate of use, this reserve equals about an 80-day supply within the U.S. These stocks are large enough to provide a cushion in the event of a short-term supply disruption, significantly reducing the adverse effects that might otherwise be felt.[3]

Upon determination by the President to use the SPR, the primary method to distribute SPR oil is competitive sale and delivery to the highest bidders. However, the Secretary of Energy, at his/her discretion, may direct the distribution of up to 10 percent of the volume of oil sold in a given month in any manner.[4] Under the present physical drawdown/distribution capability, the SPR can be utilized for almost one year. Distribution would be as follows: about 51 percent of the reserve in 90 days, 95 percent in 180 days, and 100 percent in 350 days.[5]

To determine the existence of a petroleum shortfall, the DEPE assesses:

1. the perception at time of disruption concerning both the magnitude and the probable duration of the petroleum supply shortfall;
2. the availability of excess petroleum production capacity;
3. potential military petroleum requirements;
4. the level of petroleum stocks in the U.S. and worldwide and whether such stocks are or will be drawn down; and
5. the volume of petroleum imports destined for the terminals and the drawdown of the strategic petroleum reserve.

Upon finding that any combination of domestic and international conditions may adversely affect all or any part of the state, the DEPE begins an internal petroleum supply alert.

If the petroleum supply situation would result in a supply of less than 100 percent of the estimated volume of each covered product to be sold for consumption within the state in the next several months, and would endanger the public health, safety, or welfare, the DEPE recommends that the Governor declare a petroleum energy emergency.

The petroleum energy emergency regulations, which regulate and control the sale of motor gasoline and the state set-aside for all petroleum products listed therein, can be activated only by Executive Order of the Governor.

Upon the Governor's declaration of a petroleum energy emergency, the DEPE designates the emergency coordinator (EC), information officer, allocation officer and monitor. As needed, additional personnel come from current DEPE staff, other state departments, and new or temporary hires.

By Administrative Order of the DEPE, a series of mandatory response measures commence. Mandatory measures that deal with coping and demand restraint include:

- public information;
- ridesharing expansion options;
- revised work schedule options;
- reduced staff travel; and
- fleet management.

Measures to be implemented by other agencies include:

- speed limit enforcement;
- public transit augmentation;
- preference lane;
- parking management; and
- preferential toll and fare.

These measures reduce motor fuel consumption and are both economically and technically viable. Some measures, *e.g.*, ridesharing expansion options, revised work schedule options, and public transit augmentation, are more appropriate for long-term problems. These would take some time to implement but would allow employees to continue to earn normal income without undue inconvenience while reducing usual transportation costs. Others, such as reduced staff travel, speed limit enforcement, preference lane, preferential toll and fare, can be implemented immediately for even short-term problems.

In addition, the DEPE may establish a state set-aside for any petroleum product. Set-aside volumes allow the DEPE to meet hardships and emergency requirements of wholesalers, purchasers, retailers, and end-users. From the petroleum set aside each month, the DEPE calculates percentages and assigns a prime supplier to eligible applicants.

Natural Gas Energy Emergency Response Plan

The natural gas energy emergency regulations have been in effect since 1977. New Jersey has no indigenous fossil fuel sources. The four local gas distribution companies serving New Jersey obtain virtually all their supplies by direct purchase from five interstate pipeline companies and through transportation gas purchase agreements.

The organization of gas utility customer classes protects the residential consumer. Certain commercial and industrial customers, as part of their service contracts, receive lower rates because they are subject to service interruptions. The utilities have established procedures for load shifting among customer classes. If the state's gas distribution companies experience curtailment of natural gas supplies, Board of Regulatory Commissioners (BRC) personnel implement the regulations in concert with the gas distribution companies. During the early stages of a natural gas curtailment, individual consumers would experience slight impact. However, as the curtailment continues, business operations and customers' lifestyles are more severely affected.

Curtailment of natural gas for general business and residential customer classes is extremely disruptive, since utility personnel must relight pilots on appliances in most buildings to restore service.

If an emergency condition threatens, the emergency coordinator works with the gas utilities to evaluate the supply situation. In addition, the BRC makes public appeals requesting that consumers reduce their use of natural gas.

If a natural gas supply shortage results in the curtailment of firm customers, which would endanger the public health, safety, or welfare, and voluntary customer load curtailment cannot provide sufficient relief, the BRC recommends that the Governor declare a natural gas energy emergency and activate the natural gas energy emergency regulations by Executive Order.

Electric Energy Emergency Response Plan

The electric energy emergency regulations have been in effect since 1977. New Jersey's three major electric utilities are members of the PJM Interconnection, which coordinates the dispatch of electricity in most of New Jersey, Pennsylvania, Maryland, Delaware and Washington, D.C. and a small section of northeastern Virginia. BRC personnel implement the regulations in concert with PJM and the utilities when a problem is imminent. The procedures are well-defined and effective. The early stages of an electric emergency involve little impact on individual consumers. However, if the emergency becomes more severe, the measures become more intrusive on customers' use of electrical equipment.

If an electric energy emergency condition threatens, the emergency coordinator contacts the electric utilities and PJM, if necessary. The emergency coordinator monitors the evolving electric supply situation for the possibility that a 5 percent voltage reduction will be implemented.

If the electric energy emergency may ultimately result in a sustained voltage reduction that would endanger the public health, safety, or welfare, the BRC recommends that the Governor declare an electric energy emergency and activates the electric energy emergency regulations by Executive Order.

Radiological Emergency

One special area of concern is nuclear electric generating stations. Under the authority of the Radiation Response Act, the DEPE, the State Police, and the Office of Emergency Management (OEM) have overall responsibility for managing a radiological emergency and have formulated the radiological emergency response plan (RERP). The BRC has the responsibility under RERP to assure motor fuel supplies to service stations that will remain open to provide motor fuel for evacuation.

To assess the adequacy of the RERP, the DEPE and the OEM conducts exercises semiannually. In general, the Federal Emergency Management Agency specifies the drill scenarios. No prior notification of the type of emergency is given to simulate conditions that would occur during an actual emergency situation.

Natural Disaster Operations Plan

The Governor has directed that OEM be responsible for the coordination of emergency response activities of all state agencies in the event of a natural disaster. Under the natural disaster operations plan, the BRC assures adequate supplies of electricity and natural gas, while the DEPE assures equitable allocation of petroleum products if normal distribution channels fail. The procedures to carry out these responsibilities are contained in the individual emergency plans.

Analysis

Since 1977, energy emergency management and the gathering of energy information have been the responsibilities of the state. In the past, when petroleum allocation based on federal estimates seemed to affect some states adversely, most states were unable to provide independent estimates of their own consumption. In 1979 during the Iranian oil cutoff, New Jersey's energy information system allowed for systematic management of petroleum supplies.

The New Jersey Energy Data System (NJEDS) meets both emergency and long-term planning goals. Each month the DEPE generates reports directly from data retrieved from the system. The reports give prices for a complete range of oil products, electricity, and natural gas and provide up-to-date analyses and historical comparisons. In addition, regularly collected energy consumption data provide a basis of comparison with federal statistics for crisis situations as well as for long-term planning.

The electric and natural gas industries, regulated public utilities, have planned for emergencies. The electric utility plans rank first in terms of scope and detail. The petroleum industry, almost totally unregulated in the area of planning, ranks lowest in scope and detail of state-level emergency planning.

In order to ensure the timely gathering and dissemination of information to the Governor's Office and the OEM, the BRC established an Emergency Information Center (EIC) to function during times of major disruptions of utility services. The EIC is the result of a collaborative effort between state agencies and utility companies. The EIC will be staffed by the Emergency Coordinator and alternates, and additional BRC staff as deemed necessary. Representatives from the utilities may also be required at the EIC if warranted. The EIC will also be operative if energy supply emergencies curtail or disrupt utility services. As presently configured, the EIC is the first of its kind in the nation and could serve as a model for other states.

In addition, the BRC is exploring the possibility of enhancing the capability of the EIC by establishing an Emergency Alert System (EAS) utilizing cable television. This capability will enable the BRC, in conjunction with the OEM, to transmit emergency alerts to cable viewers on a statewide or regional basis. When operational, the EAS will augment the Emergency Broadcast System and, as with the EIC, be the first of its kind in the nation.

The dissemination of accurate, up-to-date energy emergency information is essential during crises. Therefore, the DEPE is the single point of contact for energy emergency information in state government. To ensure consistency and accuracy, the DEPE should clear all related information released from other state agencies.

Energy emergency planning and response measures must provide general direction and ensure that individual response measures are goal-oriented. A workable plan should be flexible enough to allow emergency response personnel to use sound judgment in the field. Flexibility is particularly vital in the areas of electricity and natural gas.

The OEM, responsible for coordination of emergency response in natural disasters, does not conduct exercises or drills on energy emergencies other than radiological emergencies. In contrast, California holds regular energy shortage-related exercises.[6]

The OEM publishes an *Emergency Procedures Directory* that identifies each state department's designated emergency coordinator and a concise statement of each agency's emergency responses functions. This directory also refers to the Governor's Advisory Council on Emergency Services whose responsibilities include the review, evaluation, and periodic recommendation of changes to existing emergency master plans.[7]

Findings

- In the event of an emergency that results in a major energy supply dislocation or interruption, an emergency plan of restoration must be available.
- The energy emergency plan objective should be to mitigate the effects of any supply disruption.
- In addition, an emergency plan should provide for the protection and safety of the public and potential environmental degradation.
- The availability of timely, accurate and reliable information and data at the time of the emergency and all during the various phases of restoration must be in place and properly functioning and administered by the DEPE.
- Periodic drills and tests must be held to test the reporting and response mechanisms that would be activated in the event of an actual incident.
- The DEPE, in conjunction with the Office of Emergency Management and the Governor's Office, play an important and integral role in the gathering and dissemination of energy data during an emergency.

Policy

- Greater emphasis should be placed on maintaining, updating and drilling in the various emergency response plans.
- The DEPE should evaluate the effectiveness of the Energy Emergency Information Center. In an emergency, the Center receives, evaluates and disseminates energy information to the Office of Emergency Management and the Governor's Office.

Implementation

- In addition to RERP drills and under the auspices of the DEPE and the OEM, a variety of exercises should be held to test the responsiveness of the various emergency units and their effectiveness.
- The State should conduct other simulated exercises involving regional dislocations that occur on an interstate level, such as loss of the electric grid system among New York, New Jersey and Pennsylvania.

NOTES

1. Energy Information Administration (EIA), *Petroleum Supply Annual*, 1989, Volume 1, May 1990, pp. 2-3.
2. Strategic Petroleum Reserve, Annual/Quarterly Report, USDOE February 15, 1988, p. 1.
3. EIA, *Petroleum Supply Annual*, 1989, Vol. 1, p. 6,7.
4. *Ibid.*, p. 14.
5. *Ibid.*, p. 15.
6. Charles Imbrecht, Chairman, California Energy Commission with Harvey M. Sachs, Assistant Commissioner, DCEED, personal communication.
7. Emergency Procedures Directory, Office of Emergency Management, p. 3.

Chapter 21

Implementation of Least-Cost Planning

Least-cost planning as defined by the National Association of Regulatory Utility Commissioners is *a way of analyzing the growth and operation of utilities that considers a wide variety of both supply and demand factors so the optimal way of providing electric service to the public can be determined. A path is chosen that will ensure reliable service for the customers, economic stability and a reasonable return on investment for the utility, environmental protection, equity among ratepayers, and the lowest costs to the utility and the consumer*. Utility planning efforts historically have focused almost exclusively on refining accurate customer demand forecasting methods and then identifying new energy supply sources to meet increasing demand. Today, pursuit of activities that reduce or shift customer demand and alleviate the need to tap new energy sources has become a critical component of the utility planning process. Installing measures that reduce customer end use often can be more cost-effective than constructing a new electric generating station or increasing the capacity of interstate pipelines. Too, the range of available supply options capable of competing with traditional sources of incremental energy and capacity broadened in the 1980s.

On both the national and state levels, utilities regulators have embraced the concept of integrated least-cost planning. In New Jersey, the Board of Regulatory Commissioners and the state's electric and gas utilities have increasingly incorporated least-cost strategies into short- and long- term energy planning. Within the context of least-cost planning, an appropriate goal is the minimization of electricity bills. However, with regard to utility-sponsored conservation programs, the impact of such endeavors on non-participants is also of concern.

A number of regulatory initiatives have spurred the evolution of least cost planning in New Jersey. In response to the energy shortages and price spikes experienced in the 1970s, actions were taken on both the state and national levels to encourage energy efficiency. The enactment of the federal Public Utilities Regulatory Policies Act (PURPA) in 1978 facilitated the development of non-utility cogeneration and small power production facilities by requiring utilities to interconnect with qualifying alternative power producers. The PURPA sought to reduce the nation's dependence on foreign fuel supplies, increase overall energy efficiency and tap renewable energy sources.

On the state level, the Board established guidelines and policies throughout the 1980s to encourage New Jersey electric utilities to purchase electricity from non-utility cogeneration and small power production facilities when these sources could provide electricity more cheaply than could the utility through its own traditional generating facilities. The Board also established a payment formula to govern APP electricity sales to utilities ensuring that the APPs would obtain a fair rate for electricity sold to utilities—the sole available purchasers for the APP market.

Concurrently, the state encouraged electric and gas utilities to actively pursue energy conservation and load management programs. Utility-sponsored conservation programs for the residential, commercial and industrial sectors promote energy efficient building construction and attempt to influence customer behavior in the purchase and use of energy consuming appliances/equipment. Utility planners and government regulators conduct ongoing reviews of conservation programs to improve their marketing, delivery and cost-effectiveness.

In the electric industry, the development of the APP industry and the market for conservation measures ultimately led to the Board adoption, in 1988, of a bidding procedure that the state's electric utilities use to satisfy incremental needs for power. Under the competitive bidding procedure, utilities annually announce a block of power for which they wish to solicit bids. APPs and energy service companies compete to supply power or cut customer usage to meet the utility's needs. The bidding procedure ranks the various supply and demand side projects according to established parameters of cost, project viability and reliability, environmental impact and fuel diversity. The process is designed with the intent that the projects selected are those that enable the utility to provide reliable service at the lowest possible cost.

Two notable exclusions from the bidding process are inter-utility purchases and construction of additional utility generating capacity. Utilities are permitted to set aside a block of capacity to be filled by new utility plant or purchase of power from another utility rather than procuring the needed power through the bidding procedure. However, the Board closely examines all set-asides to ensure that they are consistent with least-cost planning principles. The utilities must demonstrate that construction of their own facilities or purchase from other utilities will result in reliable service at the lowest possible price to customers. Further refinements to the Board's review process for: (1) utility construction or purchases and (2) ratemaking treatment could foster more refined comparisons and may further contribute to least-cost planning endeavors.

For example, the cost of utility-constructed generating plant is included in rate base and permitted to earn a return. On September 25, 1991 the Board adopted rules (*N.J.A.C.* 14:12) to afford utilities an opportunity to earn profits on conservation investments. For utilities to fully embrace least-cost planning, it may be necessary to provide incentive opportunities for utility purchases of power from APPs or other utilities when such purchases are consistent with least-cost planning. Any analysis of such mechanisms, however, should include an assessment of the relative risks of the various supply and demand side alternatives.

The natural gas utilities' approach to least-cost planning differs from the electric utility because the LDCs do not produce or manufacture their own supplies of energy. Nonetheless, the LDCs must integrate supply- side planning with demand-side management in order to secure adequate supplies to serve their firm customers at prices sufficiently competitive with fuel oil to retain interruptible customers.

Demand side measures include conservation efforts that seek to increase end user efficiency and the marketing of additional off-peak gas services to improve load factor. Energy audit programs that offer customers technical guidance and incentive programs that provide customers with rebates for the purchase of efficient appliances attempt to reduce consumption so that the gas utility can satisfy more end uses without having to add capacity at significant capital cost or pursue additional supply contracts. Providing service to customers at the lowest possible cost in the gas industry is also a function of load factor: if LDCs increase off-peak sales (*e.g.*, for alternative power production or gas air conditioning) then fixed costs are distributed over a larger of volume of sales, thus reducing per unit costs. (Refer to Chapter 4 for more discussion of least-cost planning applications for natural gas utilities.)

Natural gas and electric utility supply planning has become an increasingly complex endeavor due to the environmental, economic, and financial risks associated with each option in an increasingly deregulated supply market. Utilities should continue to develop their least-cost planning procedures to ensure that they fully assess every option and achieve the proper balance or mix of cost-effective options. Proper planning at the front end can reduce the risk of excessive costs being imposed on ratepayers and shareholders and can reduce regulatory delays. Utilities should take into account the risks, costs and benefits of all options.

Consistent with least-cost planning, all wholesale purchases of power by New Jersey electric utilities should receive Board approval. Although some questions have been raised with respect to federal preemption over such transactions, this requirement is necessary to assure that all options, including wholesale purchases, are considered for supplying the state's future energy needs. New Jersey's electric utilities have been complying with the Board's directive that they file all such power purchase contracts for Board approval. Wholesale purchases must be considered under the common framework of least-cost planning to assure that the goals of economic efficiency and reliability at the lowest possible cost are met. Meeting these goals requires that the Board include wholesale purchases within the framework established for least-cost planning.

The natural gas utilities should seek out increased pipeline capacity to our State with emphasis on both diversity of supply and primary consideration of conservation activities.

Least-cost plans for the electric and natural gas utilities should be designed as both economic regulatory and air pollution management instruments. Full achievement of this goal requires the development of sound quantitative methods to calculate the cost of environmental externalities. To ensure that the least-cost planning process is consistent with the state's environmental goals, planners must consider the cost of environmental degradation of the state's resources as well as the impact of New Jersey energy decisions on national and even global environmental issues. The Board and the DEPE should collaborate to develop methods that quantify these costs.

The incentive rules adopted by the Board in September 1991 will remove many obstacles that impeded the full development of demand side options in the least-cost planning process. The rules provide financial incentives for utilities to pursue conservation measures consistent with the earnings potential now available to utilities on the construction of supply-side facilities.

For the electric utilities, this element means that energy efficiency would become a much larger component of its profit making businesses. To minimize the combustion of fossil fuels for the generation of electricity, the utility would be permitted to earn incentive rates of return on energy efficient programs. For the natural gas utilities, least-cost planning must include load balancing programs and commitments to efficient building programs to ensure that natural gas is used as efficiently as possible.

Continued refinement of the methodologies employed to perform cost/benefit studies of conservation programs will enhance Board and utility ability to assess the least-cost planning implications of these crucial endeavors. The results of the New Jersey Conservation Analysis Team (NJCAT) will aid regulators and utility planners in targeting programs that can conserve the greatest amount of energy at the least-cost. NJCAT study results are due to be released in August of 1990.

The Least-Cost Plan

While the Board has put in place procedures to ensure that utilities pursue a least-cost plan for providing energy services to customers, the dynamic state of the energy industry and other emerging issues require that the Board continue to evaluate the feasibility of enhancing the process. Should future evaluation indicate the need for more formal guidelines, the Board could undertake a rulemaking that would encompass the following points:

- the needed services in the utility's service territory;
- supply and demand options needed to provide such services;
- financial, regulatory, economic, reliability, and risk criteria for evaluating the desirability of these options;
- a schedule for a periodic review and adjustment of such plan.

A framework for preparing the least-cost plan for a utility consists of the following elements:

1. a forecast of load shape, peak load, and energy consumption by customer class—first without demand-side options—to show a base system load shape, then adjusted for the effects of demand-side efforts.
2. a demand-side planning analysis that includes:
   a. analysis of the utility's conservation efforts with a reference to its obligation under the applicable conservation plans and including the cost-benefit characteristics of the utility's conservation efforts.
   b. a comprehensive review of demand-side management programs in other states and of cost recovery mechanisms employed for these investments.
   c. analyses of the utility's efforts via tariffs or rebates to promote load shaping demand for its services and the consequent adjustments to the utility's load shape. (Demand and energy reductions due to these efforts must be clear.)
3. a supply-side planning analysis that includes:
   a. for the gas utilities:
      i. an analysis of gas availability (long-term, short-term, and spot);
      ii. the LDC's gas purchase strategies supported by detailed analyses of the risks and benefits of the choice of long-term pipeline supply and capacity contracting and/or spot gas purchases. This analysis should also show efforts and impediments to diversification of supply and capacity and the utility's estimates and projections of the potential availability of diversified sources.
      iii. the LDC's supply planning strategy indicating:

         1. the criteria for scheduling purchases and operation of storage to reduce system cost while maintaining reliability;

         2. an analysis of the pros and cons of acquiring new sources of supply;

         3. the criteria for renegotiating capacity contracts with the pipelines;

         4. the criteria and justification for the duration of pipeline supply contracts;

         5. a strategy for response to changes in pipeline rate structures.
      iv. The local distribution company should pursue programs that ensure that natural gas is used for the most energy-efficient purpose. Examples of such programs are gas industrial air conditioning and refrigeration, co-firing of utility and industrial boilers and building efficiency improvements.
   b. For the electric utilities:
      i. an analysis of the utility's power generation options indicating existing and planned power generation resources, such as nuclear plants, combined cycle and combustion turbine generation, hydro power generation, purchased power options (including the impact of the state's cogeneration stipulation and policies) as well as nonconventional options such as geothermal, solar, and wind-generated power.
      ii. a catalog of existing units and a schedule for construction of new plants.
      iii. *mortality analysis* for existing units, identifying opportunities for life extension, costs of environmental retrofits that may be required, and threats (economic, environmental, or operational) to continued high availability of each plant.
      iv. an analysis of the cost/benefit, load, and energy impact of new or existing power generation units and criteria for acquiring new generation units.
      v. a designation of qualified energy conservation measures and renewable measures implemented to avoid emissions from combustion of fossil fuels in electricity generation.

         Submittals should include calculations on the number of tons avoided by implementation of such measures or the use of renewable energy resources.

         (DEPE and the Board should, in a joint endeavor, identify the method of calculating such avoided emissions.)
      vi. an analysis of wholesale purchases to be considered under the common framework of least-cost planning to assure that the goals of economic efficiency and reliability at the lowest possible cost are met. This goal requires that the Board include wholesale purchases within the framework established for least-cost planning.

         Consistent with least-cost planning, all wholesale purchases of power by New Jersey electric utilities should receive approval by the Board.

Data Requirements

The following data could be made part of a utility's compliance plan in order to demonstrate that:

1. in preparing its least-cost plan, it has used to the fullest extent possible all economical means of conservation, cogeneration, and other load management techniques as a primary source of energy supply;
2. it has taken into account its assessments of all economic and demographic parameters that may affect its energy service;
3. it has prepared a least-cost mix of supply options, taking into account reliability criteria to meet system load;
4.
   a. for gas utilities;
      i. its supply forecasts include estimates of available gas supplies (production [propane], pipeline, storage), their costs, capacities, delivery

rates and contract provisions (such as flow minima and/or maxima), minimum bill provisions;

ii. a description of the LDC's distribution system network and its capabilities (receipt and delivery points, interconnections); future pipeline extensions and construction and their impact on the LDC distribution network.

b. for electric utilities,

i. forecast and analysis of projections and uncertainties concerning load growth; its schedule of capital additions, operating cost, lead times of generating technologies, construction lead time, purchased power requirements and costs, and fuel prices;

ii. presentation of optimized choices of fuel contract mix.

5. the proposed plan is a least-cost plan in accordance with proposed methodology supported by:

a. a demonstration that the plan fully considers all available, practical, and economical conservation, renewable resources, load management alternatives, and improvements in energy efficiencies;

b. a discussion of how the utility has determined the appropriate level of reliability and its influence on estimates; a discussion of the operating and capital costs of planned facilities and expected financial impacts and requirements of construction and operation;

c. a demonstration that the utility's rate design accurately reflects the long-term cost of service for each customer class or group and provides adequate incentives for each customer class or group to conserve energy.

Much of the data listed above is currently being provided by electric and gas utilities within the context of their annual bidding submissions and other regulatory filings. The Board would have to take this into account when establishing a filing schedule within the least-cost planning rulemaking process.

Conclusion

Least-cost planning considerations are central to the utility regulatory process in New Jersey and should continue to be the driving force behind utility planning decisions. However, it is essential that the quantification of the lease possible cost reflect the cost of environmental degradation related to any supply option to ensure that the state's environmental quality standards are nor compromised in the least-cost planning process.

The Board will consult with each utility to ensure that the utility's least-cost planning process is consistent with the state's goals and objectives.

The Board will continue to evaluate the need to refine the least-cost planning procedures. To that end, the Board should consider the promulgation of regulations set forth formal guidelines for utility least-cost planning.

Chapter 22

Developing an Energy-literate Society

There is no doubt: today, society is more energy conscious than it was twenty years ago when Americans expected—indeed, if they thought about it at all—to have unlimited and cheap energy into the future. When foreign countries restricted access to oil supplies and drove up prices in the 1970s, the nation's energy awareness received a jolt. Conservation became the watchword as people braced to "freeze in the dark" and do without and sat for hours on gas lines.

New Jerseyans reacted vigorously. Business and industry had to move quickly to develop more efficient processes and improve buildings simply to stay competitive. Some even began generating their own electricity. Residents weatherized their homes as they began buying energy efficient appliances and driving smaller, more fuel efficient cars. Government policymakers strove to forecast and plan for the future.

The 1980s have held their own surprises. Oil prices fell instead of continuing to rise; deregulation and competition are changing the electric and gas industries; and environmental concerns demand increased attention. Rather than equating "conservation" with "doing without," conservation gained recognition as a way to accomplish the same task or maintain the same level of comfort with less energy through efficiency. To some degree, the surge of energy conservation awareness carried over from the 1970s; many people weatherized their homes, considered efficiency ratings when buying appliances, and purchased cars with high fuel economy (mpg) ratings. As the economy grew, however, energy awareness dimmed, and as a result, conservation was not a high priority. There was no urgent and visible need to conserve, so the efforts of the 1970s slackened.

As the year 2000 approaches, many energy related issued confront the state and the nation. The OPEC nations are increasing oil prices and the world is now witnessing a grave threat to Middle East stability. While growth in overall New Jersey electric demand has slowed, peak demand continues to climb and single occupancy vehicles increasingly jam the state's roads. More and more decisions that significantly impact daily life will be energy related, and it is important that New Jersey citizens be able to make educated, intelligent choices. Specifically, attaining the draft Energy Master Plan goals of energy efficiency, least-cost services, and improved environmental quality will require the commitment and education of all New Jerseyans.

Energy Education in New Jersey

From 1985 to 1988, the state sponsored an energy curriculum program for New Jersey schools that reached more than 185,000 students in some 435 schools. Offered at first in middle school science classes, the program was soon being used by students ranging from gifted fifth grade classes to senior high school general science as well as in the areas of social studies, economics, and vocational-technical education. In a survey of teachers using the curriculum, 91 percent of the respondents found the materials effective or extremely effective in terms of student learning and motivation, and 99 percent rated the program components useful in their courses.[1] The program was funding with federal oil overcharge monies that are no longer available for this program.

Today, the Department of Environmental Protection and Energy (DEPE) works to educate and inform all New Jerseyans through a variety of methods. Outreach activities at conferences and conventions, the development and distribution of energy-related literature and participation in nonprofit educational groups are all part of DEPE activities. In addition, the DEPE maintains a toll-free energy information line that averages 800 calls per month. Callers can request information on weatherization techniques, efficient appliance purchases, state energy assistance programs and utility sponsored incentive programs.

Greater pro-active education activities should be developed and efforts are being made to stimulate energy-awareness education in New Jersey through combined efforts of the DEPE and the Department of Education.

Analysis

In times of relative stability of price and supply, it is even more critical to maintain high-profile efforts to heighten energy awareness.

It is not enough to hope that people will "buy in" to the concept of energy efficiency only to reduce monthly utility bills. For the long-term, preservation of New Jersey's economic effectiveness, energy security and environment require a permanent change in attitudes. New Jersey must learn from the past as it looks to the future: the state must develop an energy-literate society.

Findings

- Energy-related issues will impact all areas of life for New Jersey citizens.
- Sound energy decisions require informed citizens; energy education efforts should be heightened during times of energy supply and price stability when energy efficiency issues attract little attention on their own.

Policy

- The DEPE should continue efforts to provide New Jersey residents and business owners with information on how they may cost-effectively increase energy efficiency.

Implementation

- The DEPE will work to continue to secure federal energy monies to fund the toll-free energy information line and the printing and dissemination of literature on energy efficiency for New Jersey homes and businesses.
- The DEPE and the Department of Education should examine possibilities for the incorporation of energy-awareness programs in New Jersey schools.
- The State should explore the use of community access cable television programs and public service announcements to provide information to the general public about energy efficiency.

NOTES

1. Enterprise for Education, Survey of Teachers Using Energy 80 Curriculum, January, 1987.

Chapter 23

Energy Research and Development

Energy research, development, and demonstration (RD&D) covers a wide range of subjects from physical science—physics, geology, and environmental science—to applications—electronic equipment control and building construction—to social sciences—economics and user psychology. Organizations fill one or several roles in energy RD&D: many gather data and organize it into data bases for use by researchers; some analyze data for certain segments of supply, price or use; others construct models to examine interrelationships of energy, environmental, and economic data and to develop forecasts.

U.S. Government-supported RD&D

Several federally funded agencies collect and analyze data, and carry out or fund energy research:

The **United States Department of Energy (USDOE)** carries out research on nuclear, fossil, and renewable sources, on conservation, energy emergencies, environmental safety and health, environmental restoration and energy waste management, civilian radioactive waste management and on new production reactors. It funds studies through grants to universities and other agencies. The USDOE conducts the majority of its research and development in nine large multi-program laboratories, 12 major single- program laboratories and 10 smaller laboratories. The programs induce basic scientific research, applied research and engineering development.

The **Energy Information Administration (EIA)** collects and analyzes state, regional, national and international data on energy supply price and nations or regional data on energy use. On an annual budget of $62.9 million in fiscal year 1989, it compiles, analyzes, prepares forecasts and reports its results in weekly, monthly, and annual publications, many of which this Plan references.

The **National Renewable Energy Laboratory (NREL)**, formerly the Solar Energy Research Institute (SERI) in Boulder Colorado, studies the physics of capturing solar energy, technology applications for solar thermal and photovoltaic energy, geothermal, biomass, and wind energy.

The **Brookhaven National Laboratory (BNL)** at Upton, Long Island, is a large research institution of 700 research professionals, scientists and engineers, and 2450 support staff and visiting professionals. Supported by USDOE, it studies high energy physics, nuclear physics and chemistry, reactor safety analysis and safeguards.

The **Lawrence Berkeley Laboratory** at the University of California at Berkeley is one of the largest energy research groups. Its nearly 1,000 research professionals and nearly 3,000 support staff study new energy technology and geothermal, fossil, solar and fusion energy. They also study conservation and its economic affects.

The **National Science Foundation (NSF)** in Washington, D.C. provides funds for basic scientific research including energy. Its Environmental Measurements Laboratory in New York City conducts environmental research on energy related pollutants.

The **Oak Ridge National Laboratory (ORNL)**, in Oak Ridge, Tennessee, evaluates economic aspects of energy use, particularly least cost planning and transportation energy use.

The **United States Geological Survey (USGS)**, of the Department of the Interior, provides maps, geologic profiles and models, analyses and geological studies of oil, gas and coal reserves in the United States.

Utility Ratepayer-supported RD&D

The **New Jersey Conservation Analysis Team (NJCAT)** project represents a cooperative effort to evaluate benefits and costs of state utility funded conservation programs. It examined eight categories of programs targeted to residential and commercial customers of all seven New Jersey utilities: the Home Energy Savings Program (HESP), subsidized home energy loan programs, home weatherization/seal-up programs, residential rebate programs, low-income direct investment programs, the Commercial and Apartment Conservation Service (CACS) program, commercial air conditioner rebate programs, and two high efficiency lighting programs. It developed a ratio between benefits and costs for each program, but did not examine or include environmental benefits in the evaluation because methods for estimation of those benefits vary.

The **Electric Power Research Institute (EPRI)**, in Palo Alto, CA, was founded in 1972 by member electric utilities to develop and manage a program to improve electric power production, distribution, and utilization. Its primary areas of research are: advanced power systems, coal combustion systems, energy management and utilization, and nuclear power. New Jersey ratepayers provided about $10 million for EPRI in 1989. Its 1989 revenues were about $395 million, of which $365 million supported research, development, and application.

The **Gas Research Institute (GRI)** in Chicago, IL, established by the natural gas industry, plans and raises funds for research designed to advance gas supply, transport, storage, and end-use technologies and also conducts related basic research. It funds almost 500 active projects with manufacturers, gas pipeline and distribution companies, gas producers, service companies and government agencies. Its budget for calendar year 1989 exceeded $190 million, of which more than $147 million supported research and development.

The **National Regulatory Research Institute (NRRI)**, established in 1976 by the National Association of

Table 23-1

N.J. Electric Utility 1989 Expenditures for
Research, Development and Demonstration

Utility	PSE&G	JCP&L	AE	Electric Total
Operating Revenues (OR) ($ millions)	3,332.4	1,551.4	716.9	5,600.7
Research, Development Demonstration (RD&D) ($ millions)	14.6	6.0	2.6	23.2
RD&D Percent of OR	0.44%	0.38%	0.36%	0.41%
Conservation RD&D Percent of OR	0.00%	0.00%	0.01%	0.00%

Source: NJ Electric Utilities Annual Reports, 1990.

Regulatory Utility Commissioners (NARUC), undertakes research on economics, engineering, finance, accounting and legal aspects of gas and electric utility-supplied energy.

The **North American Electric Reliability Council (NERC)**, in Princeton, NJ, on an annual budget of $2.2 million for 1990, gathers statistical information on the performance of major types of electric generating units. Its statistical data sets provide information to coordinate and promote electric industry reliability.

Energy Industry-supported RD&D

The **American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)** in Atlanta, GA, sponsors research at universities, and laboratories on heating and air conditioning applications. It has 90 technical committees that develop and provide standards for equipment and construction practices. ASHRAE's Standard 90A-1980 is the basis for the Building Officials and Code Administrators (BOCA) Basic Energy Conservation Code that forms part of the Uniform Construction Code (UCC) for New Jersey under *N.J.A.C.* 5:23 *et seq.*, the standard construction code for the entire state (see Chapter 16, Building Codes).

The Exxon Research and Engineering Company (ER&E) in Florham Park was one of the nation's first industrial laboratories. With 2,000 scientists, engineers and support staff in New Jersey, it conducts research and develops petroleum products, sythetic fuels and chemicals.

The **Illuminating Engineering Society (IES)** develops and provides standards for lighting. Its lighting code is part of New Jersey's UCC.

The **Mobile Corporation** operates technical facilities at Paulsboro, Princeton and Edison where scientists and engineers develop technology to process crude oil and natural gas products into high quality petroleum and petrochemical products.

Research Groups Associated with Local Universities

The **Center for Energy and Environmental Studies (CEES)** at Princeton University's School of Engineering in Princeton, NJ, established in 1971, studies energy technology, energy policy, and environmental impacts. Specifically, the CEES research focuses on radon sources and mitigation, energy conservation in buildings and peak shaving—all subjects of importance to New Jersey.

Table 23-2

N.J. Gas Utility 1990 Expenditures for
Research, Development and Demonstration

Utility	PSE&G	NJN	E'TOWN	SJ	Gas Total
Operating Revenues (OR) ($ million)	1,236.7	294.9	250.7	207.4	1,989.7
Research, Development Demonstration ($ million)	3.10	0.03	0.00	0.00	3.13
RD&D Percent of OR	0.25%	0.01%	0.00%	0.00%	0.15%
Conservation RD&D Percent of OR	0.00%	0.00%	0.00%	0.00%	0.00%

Source: NJ Gas Utilities Annual Reports, 1990.

The **Center for Energy Policy and Research** at the New York Institute of Technology in Old Westbury, NY conducts research into energy utilization and conservation.

The **Clean Fuel Institute** at the City College of New York studies coal conversion technology, gasification, liquefaction, pyrolysis, and fluidization. It receives about $500,000 annually for research from USDOE, NSF, and industry sources.

The **Lehigh University Energy Research Center** in Bethlehem, PA studies energy supply and use and associated environmental affects.

The **Princeton Plasma Physics Laboratory (PPPL)** operated by Princeton University under a USDOE contract is one of the largest energy research organizations in New Jersey. Since 1951, PPPL has been the country's leading laboratory in developing magnetically confined fusion. It has a budget of approximately $96 million and a staff of more than 800.

Private Foundation, Corporate, and Citizen-supported Policy Research Organizations

The **American Council for an Energy Efficient Economy (ACEEE)**, in Washington, D.C., conducts research, publishes reports and sponsors conferences to provide the public with information on energy conservation and its relation to environmental and economic issues.

The **Environmental Policy Institute (EPI)** in Washington, D.C. studies synthetic fuel issues and provides information on energy and environmental issues.

The **World Resources Institute (WRI)** in Washington, D.C., studies energy, climate change, atmospheric pollution, and global resources. It is funded by private foundations, the United Nations and governmental agencies, corporations and individuals.

New Jersey electric utilities spent $26.5 million on RD&D in the calendar year 1989. Public Service Electric and Gas (PSE&G) provided $15.2 million of that total. The contributions averaged about one-half of 1 percent of each utility's operating revenues for that year. (See Table 23-1.)

Table 23-2 shows the amount New Jersey gas utilities spent on RD&D in calendar year 1989. PSE&G contributed nearly $3.3 million, about 99 percent of the total. Most of that contribution was to the Gas Research Institute and PSE&G's Institute of Gas Technology.

Findings

- Federal government, utilities and energy industries support data accumulation, energy supply, utility operations and industry specific research and development.
- Relatively little support goes to research and development of appliance and equipment efficiency automobile efficiency or other means to maintain energy services with less fuel input.
- Only one organization, the National Renewable Energy Laboratory, exclusively studies opportunities to utilize renewable energy.

Policy

- New Jersey, which has no non-renewable energy sources, should support research and development of renewable energy and encourage development and demonstration of appliance equipment and auto fuel efficiency.
- New Jersey should encourage any means to provide energy services—warmth, cool, light and motor power—with less dependence on non-renewable energy.

Implementation

- The Board of Regulatory Commissioners should encourage utilities to develop and demonstrate methods to use electricity and gas efficiency, a part of their least cost plan.
- The Board of Regulatory Commissioners should study the equity, security, environmental, revenue and economic aspects of differing taxes on competing fuels.
- The State should encourage NJ Transit to develop new methods of providing transportation services that might better serve to reduce fuel use.
- The DOT should develop and demonstrate ways to encourage ridesharing and vanpooling for trips to work.

Chapter 24

Choices for New Jersey 2000

New Jersey has choices. By the end of this decade energy use could exceed 3,300 TBtu per year or could be half that amount. This chapter presents alternative scenarios. Each would have different impacts on New Jersey's future economy and environment. The choices are complicated, but must be made.

Annual increases in energy use will mean either substantial highway congestion or many additional roads; either frequent brown-outs or much new generating capacity and transmission rights-of-way; either acid rain and ozone or more regulation and capital investment in environmental control; either energy dependence or development of alternative energy sources.

Alternatively, a moderate annual decrease through incremental adoption of the best technology available will mean getting the same services while spreading out peak period use on roads and on utility grids and getting better economic value from these high cost infrastructures. It will also mean reduced environmental impacts.

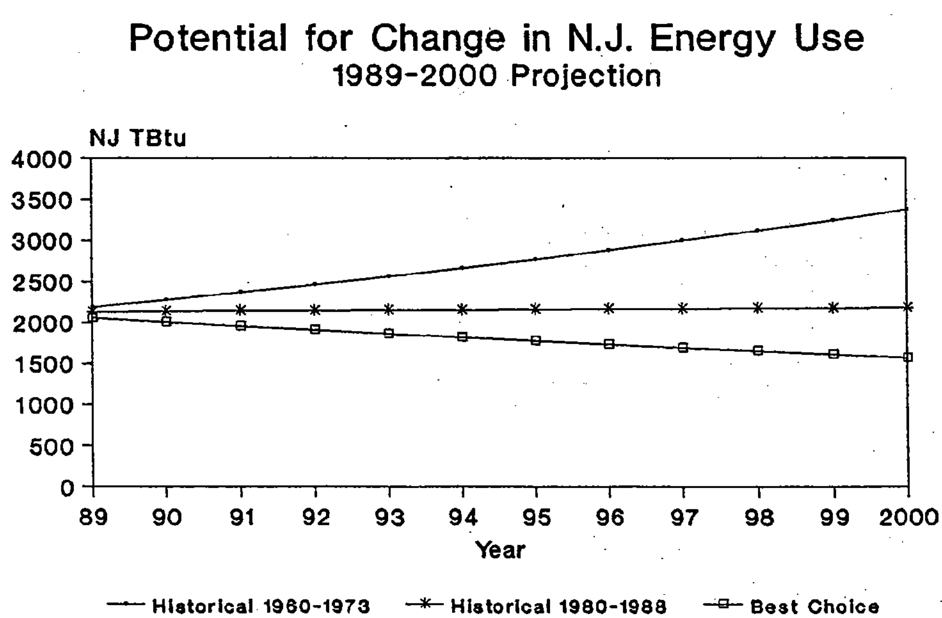
This option is technically feasible based on projections by the DEPE, the BRC and other organizations. Figure 24-1 shows straight line extrapolations of historical rates of change and of the best choice option. These are projections, not forecasts. A *projection* postulates a future condition based on certain rules and assumptions. Projections may assume continuations of past conditions, present conditions, or trended changes in historical conditions. The number of projections is infinite. A *forecast*, on the other hand, is a projection based on a judgment that specific conditions will occur. It is a prediction. All forecasts are projections, but not all projections are forecasts.[1]

Best Choice Scenario

The best choice scenario illustrates potential energy use based on specific assumptions. It is not a forecast. The best choice scenario presents energy use that would result from incremental investments in the most efficient appliances, equipment and construction methods available today to heat, cool, light and power homes.

Incorporation of the most efficient appliances, equipment, building practices and technology—the *best choice* scenario—best meets the state's goals of energy security, economic stability and environmental quality. Chapters 11, 12 and 13 quantify the technically achievable potential for this scenario. Achievement of this potential depends on

Figure 24-1



Note: TBtu-trillion Btu
Source: EIA-0214(89), adjusted by DEPE.
Projection based on Ch. 11, 12 and 13.

many factors: changes in the price of energy, economic stability and prosperity, and public interest. Normal replacement of lighting and of water and space heaters could account for a major fraction of the savings. Clock thermostats, controls that closely match service delivery to time of use, and routine maintenance can produce large savings at relatively low cost and could account for a large fraction of the retrofit savings. The calculations for this scenario are based on changes that are relatively easy to quantify. Some energy users will not replace appliances or equipment but others will install retrofits that produce savings that exceed the best choice scenario's assumptions. Average savings statewide could reach the potential shown at some future date; implementation of policies outlined in this 1991 Plan will accelerate the state's progress towards capturing a significant portion of these savings—wherever they are cost-effective—over the next decade.

Table 24-1 enumerates the potential for each use sector but does not consider economic or customer growth. Less easily quantifiable but greater opportunities to save—improved operation and maintenance practices, use of sensors and digital controls that closely match use to need, and options such as telecommuting—can compensate for economic and population growth.

The best choice scenario targets savings in both aggregate energy consumption and peak period demand. Aggregate energy consumed is the total of fuel—barrels of petroleum, cubic feet of natural gas, tons of coal, and tons of uranium—that provide energy for New Jersey use. Conversion of the various fuel units to a common fuel value, TBtu, simplifies presentation. Environmental impacts such as acid rain and CO_2 emissions correlate with aggregate use.

Peak demand—the highest use at any time—is most significant for delivery of electric power because few means are available to store electric power. Power must be made available at the time of peak demand and providing this power requires significant investments in plants that operate only during short peak periods at a high incremental cost. The summer of 1988, with its long hot periods and need for air conditioning, was a critical one for meeting electric peak demand and showed the necessity to plan for and control that demand. Peak demand for gas during cold spells affects gas utilities and customers when pipeline and distribution limitations force curtailment of interruptible service to some large users on the coldest days to meet the demands of firm delivery customers. Peak demand for petroleum heating fuel during December 1989 illustrated the interconnections and limitations of the worldwide petroleum product distribution network.

Figure 24-1 shows how energy use might grow if it increased as it has historically. The historical high growth projection shows energy use increasing at about 4 percent annually as it did over the period from 1960 to 1973, a period of relatively low energy prices. The historical low growth projection shows energy use changing at about 0.2 percent annually as it did from 1981 to 1988, a period of high energy prices. The lower line in the graph illustrates the best choice projected energy use scenario.

The best choice scenario shown as the potential in Tables 24-1 through 24-8 defines the changes possible, assuming no other changes, if energy users weatherized buildings and replaced all today's appliances, equipment, and motor vehicles with the most energy efficient models on the market—a 2.6 percent per year per capita decline in energy use. The calculations that underlie Tables 24-1 through 24-6 are set out in Appendix A-24-1. Chapters 11, 12 and 13 explain best choice scenario assumptions.

Normal incremental replacement of inefficient automobiles, lighting, air conditioning and refrigerators combines with some car pooling and switching to mass transit where possible for the trip to work could bring about two- thirds of the potential reduction envisioned. Table 24-1 summarizes savings by sector. One quarter of the best choice scenario savings opportunities arise from commercial, industrial and residential lighting retrofits—the conservation measure with generally the quickest payback. Nearly half of the opportunities are in motor vehicle mile-per-gallon upgrades. Normal incremental replacement of high use vehicles with mile 5 to 10 mpg more efficient would accomplish a large portion of this savings scenario.

For residential use, the scenario assumes electric savings for lighting, refrigeration, freezers and dryers but not for air conditioning since the switch from chlorofluorocarbons (CFCs) may require less effective refrigerants. It assumes 40 percent petroleum and natural gas savings for space heating and 29 percent for kitchen ranges offset by a 14 percent increase in natural gas space heating to account for shifts from petroleum to natural gas as a primary residential heating fuel. It assumes that insulation and other technological advances will overcome the CFC replacement problem for refrigerators and freezers. Overall, the technical potential for residential savings would be 32 percent.

For commercial use, the scenario assumes 70 percent electric savings for lighting, 50 percent for air conditioning

Table 24-1

Summary of Present Use and Potential Savings by Sector for New Jersey

	1988 Purchased TBtu	Potential Purchased TBtu	Potential Change TBtu
Residential	529	382	-147
Commercial	475	318	-156
Industrial	521	512	-9
Ttransportation	613	387	-226
Total	2,138	1,599	-538

Note: See Chapters 11, 12, and 13 for explanation and assumptions. Use includes TBtu purchased for direct use and for input to electricity generated for sale in New Jersey.

Source: DOE/EIA-0214(89); Appendix Table A-25-1

Table 24-2

Summary of Present Cost and Potential Savings by Sector and at Present Unit Cost In New Jersey

	1991 $ Cost	Potential $ Cost	Potential % Change
Residential	$4,070	($1,146)	-28%
Commercial	$3,346	($1,174)	-35%
Industrial	$3,332	($151)	-05%
Transportation	$5,336	($2,022)	-38%
TOTAL	$16,083	($4,493)	-28%

Note: Costs based on 1991 average unit cost for type applied to present and potential purchased energy requirement. Does not account for additional cost to purchase most efficient equipment or appliances or to insulate buildings.

Source: NJ Energy Data System, Appendix Table A-25-1.

and 18 percent for motor drives. It assumes a 50 percent increase in electric space heating attributable to greater use of heat pumps and a 20 percent space heating savings that is fully offset by an equal shift from petroleum to natural gas as a primary heating fuel.

For industrial use, the scenario assumes an 18 percent savings for motor drive efficiencies, partly offset by an increase in the number of motors per customer, and a 32 percent lighting efficiency gain. It assumes a continuation of the industrial trend to substitute natural gas for petroleum for process heat and steam.

For transportation, the scenario assumes a 50 percent efficiency gain in automobiles, 45 percent in light trucks and 24 percent in heavy trucks miles per gallon. It assumes that some cars, vans and buses will run on natural gas. It assumes that propane for vehicles will nearly double.

By sector, transportation accounts for 42 percent of the total 538 TBtu technical potential for savings under the best choice scenario; commercial sector for 29 percent; residential sector 27 percent and the industrial sector for less than 2 percent of the whole. Table 24-2 summarizes potential dollar savings at 1991 prices. It does not include the additional cost to purchase equipment or to renovate buildings.

Under present market conditions the best choice strategies will not reach 100 percent saturation within this decade. Conversely, through the decade equipment and appliances with even higher efficiency will be available. Thus, the best choice scenario is a proxy for a mix of persisting inefficiency and newer technology. Full achievement of the potential assumes that energy users will weatherize all their buildings to use 25 percent less space heating than in 1988 and replace existing equipment and appliances with the most efficient models and controls now commercially available. The table shows the potential assuming the existing number of residential electric customers and appliance saturation per customer remains at the level reported by PSE&G.[2] If one allows for a 10 percent increase in the total number of customers over that period (about the same rate of increase as in the previous decade), total energy use would still decrease from the 1988 level.

Table 24-3

Summary of Present Use and Potential Savings by Energy Type for New Jersey in Energy Units

	Units	1990 Purchased Units/Yr.	Potential Purchased Units/Yr.	Potential Change Units/Yr.
Electric	GWH	62,325	44,444	-17,832
Natural Gas	MMTHM	3,518	3,539	21
Petroleum	MBBL	149,272	84,612	-63,812
PE-Unburned	MBBL	36,060	36,060	0
Coal	MMST	305	305	0

Note: See Chapters 11, 12 and 13 for explanations and assumptions. PE-unburned is petroleum purchased but not combusted; feedstocks, asphalt, road oil, and lubricants.

Source: NJ Energy Data System, Appendix Table A-25-1.

Best Choice Electric, Natural Gas and Petroleum Use and Cost

In 1990, New Jersey electric utilities sold over 62,000 gwh to their residential, commercial, and industrial customers. If these customers over the next decade weatherized their buildings and replaced existing appliances and equipment with the most energy efficient models available in 1988, these same customers could use under 45,000 gwh.

Table 24-3 shows the technical potential to reduce natural gas use but includes increases in use that might occur if users substituted natural gas for petroleum for a portion of space heating and process heat and steam needs. The best choice scenario assumes minor change in industrial energy use. It assumes for residential and commercial use that, steadily over the next decade, all customers weatherize all their buildings to use 25 percent less space heating gas than in 1988 and replace existing equipment and appliances with the most efficient equipment and appliances available. The table shows the potential assuming the existing number of residential natural gas customers and appliance saturation per customer remains at the level reported by PSE&G.[3]

Table 24-4

Present Cost and Potential Savings by Energy Type, at Present Unit Cost

	1991 $ Cost	Potential % Change
Electric	$5,679	-29%
Natural Gas	$2,054	1%
Petroleum	$6,643	-43%
PE-Unburned	$1,692	0%
Coal	$ 15	0%
	$16,083	

Note: Costs based on 1991 average unit costs applied to present and potential purchased energy requirement. Does not account for additional cost to purchase most efficient equipment appliances or to insulate buildings.

Source: NJ Energy Data System, Appendix Table A-25-1

Tables 24-3 and 24-4 show the potential to decrease petroleum use through improved vehicle efficiency. The decrease in petroleum also assumes a continued trend of users switching from petroleum to natural gas for heating fuel. It does not include the potential to use ridesharing and mass transit for commutation. As motor fuels account for almost two-thirds of transportation energy use, improvements in motor vehicle efficiencies can significantly affect total state energy use.

Environmental impacts of decreasing energy use are summarized in Tables 24-5 and 24-6. Without dramatic technological change or improvement in energy use and electricity generation efficiency, environmental impacts increase or decrease directly with use of electricity.

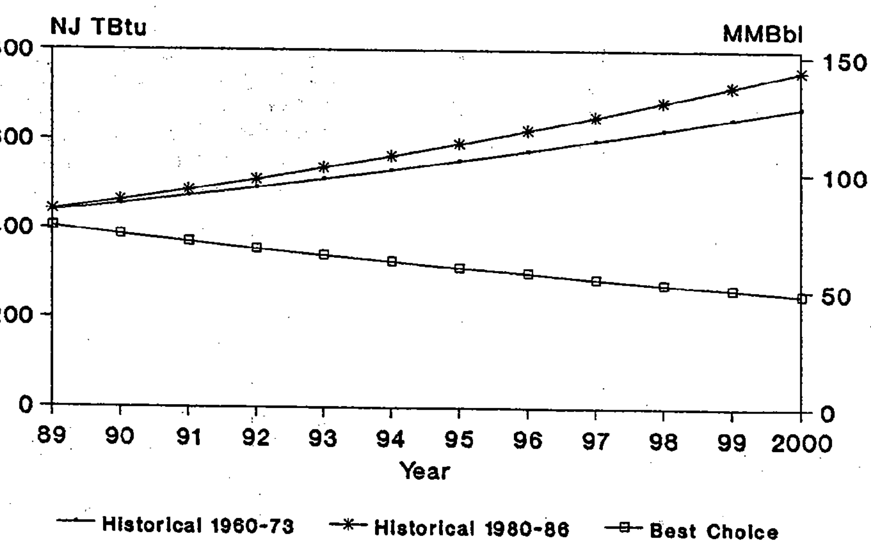
Best Choice Transportation Energy Use

Figure 24-2 presents three scenarios for motor fuels consumption. The first projects a 4 percent per year increase, *i.e.*, the rate of increase between 1960 and 1973; the second a 5 percent per year increase, *i.e.*, the rate of increase between 1981 and 1986—a period during which regular leaded fuel prices declined 34 percent. The third projects a scenario for motor fuel use based on policies that would speed the introduction of the most efficient vehicles available on the market. Vanpooling and ridesharing that reduce dependence on single passenger vehicle travel for long trips to work could reduce motor fuel demand further still.

Long term increases in fuel prices could bring about the third scenario but, as Chapter 18 points out, workers have limited alternatives for the trip to work. Many workplaces are located away from public transit and are often too spread apart to allow easy carpooling. The most effective measure to allow the flexibility of single passenger travel with less fuel demand would be higher miles per gallon vehicles. Congress has rejected a strong proposal to increase new vehicle efficiency standards, however, the technology

Figure 24-2

Potential Change In N.J. Motor Fuel Use
1989-2000 Projection



Note: Projection based on Chapter 13.
Source: EIA-0214(89), adjusted by DEPE.

Table 24-5

New Jersey Present and Potential Carbon Dioxide Emissions from Fossil Fuel Combustion

	1989 Million Mtons	Potential Million Mtons	Potential % Change
Natural Gas	6.62	6.70	1%
Petroleum	17.11	9.88	-42%
Coal	5.00	3.64	-27%
Total	28.73	20.21	-30%

Note: Emissions based on Machado and Piltz, Reducing the Rate of Global Warming, Renew America, Washington D.C. 11/88
Mtons = metric tons carbon

Source: Appendix Table A-25-1

to increase auto fuel efficiency has progressed. Manufacturers now produce small cars that achieve 50 mpg and have introduced technology to attain significantly greater efficiency in subcompacts. The 50 miles per gallon level in the best choice projection now possible in subcompacts

Table 24-6

Potential Change in Sulfur Dioxide and Nitrogen Oxides Emitted from Fossil Fuel Use in Processes and Combustion

Source	1989 SO_2 Thous. Tons	POTENTIAL SO_2 Thous. Tons	1989 NO_x Thous. Tons	POTENTIAL NO_x Thous. Tons
Utility	117	84	72	52
Industrial	22	17	36	28
Industrial	18	18	22	22
Transportation	29	17	225	135
Total	186	137	355	237
		% CHG		% CHG
Total		-27%		-33%

Note: SO_2 - sulfur dioxide, NO_x - Nitrogen oxides

Source: 1988- by proportion from EPA-600/7-89-012a, 11/89
Potential - from proportion of 1988 fossil fuel combustion as shown in Scenario, Appendix Table A-24-1

may soon be possible for compacts and eventually for midsize vehicles.[4]

Vanpool/rideshare programs that displaced one out of 20 single occupancy vehicle trips to work could save an estimated 26 to 28 million gallons of gasoline a year, and reduce air pollution emissions and traffic congestion during peak driving hours. Such an upgraded vanpool program would require 6,000-7,000 vanpools in the state where we now have about 1,000, and a like increase in the number of rideshare participants. Connecticut, a state with less than half the population of New Jersey, had 1,274 vanpools registered as of September 1988.[5] Table 24-7 shows some of the differing consequences of the three motor fuel use scenarios.

Electric Peak Demand Scenarios

Peak demand for electricity depends on many factors. Weather related use of air conditioners during hot spells is an important component. Summer peak demand may last only a few hours over several days but electric utilities must invest in facilities or contract for capacity or interruptible service sufficient to prepare for them. Gas utilities likewise must invest in sufficient capacity to meet weather related winter peak demand.

Incorporation of efficient appliances and widespread use of digital controls could reduce aggregate annual sales of electricity by 33 percent—for the same number of customers and level of economic activity. If customers used electricity in the same time distribution pattern as in 1987-90, at a load factor of 53.3 percent, the peak load would be 10,112 MW and, at 20 percent reserve margin, would require a capacity of 12,134 MW.[6] That capacity is well within the 15,000 megawatts New Jersey utilities expect to have available at the end of the decade.[7] See Figure 8-18.

Table 24-8 shows two scenarios for potential change in peak demand in New Jersey. The table shows a straight line projection that does not take into account the potential for installing new demand-spreading technology. The utility peak scenario derives from the projections developed by AE, JCP&L and PSE&G as described in their September 1988 white paper, *New Jersey's Electric Energy Future...Issues and Challenges.* The utilities forecasted that peak demand would rise to 16,741 MW by the year 2000.

In contrast, the best choice peak scenario shows how peak demand could fall—at a rate controlled by weatherization of buildings and steady replacement of existing appliances and equipment with the most energy efficient models available. Chapters 11 and 12 define the specific assumptions and provide the numbers underlying this projection. Reduction of peak demand at that rate could reduce year 2000 peak demand to 10,112 MW, well below the 1990 peak or the utility expected growth scenario peak.

Generating Capacity Requirements

These two scenarios have significantly different generation capacity requirements. Table 24-8 sums up the capacity New Jersey utilities would require in 2000 when the state's electric utilities expect to have 18,289 MW of capacity available.[8]

The utilities expected growth peak scenario with 20 percent reserve margin is 1,800 MW above the generating capacity available for year 2000. Only the best choice scenario peak would be lower than projected year 2000 installed capacity, and lower than 1990 installed capacity. Only that scenario would not require additional generating capacity.

Generating Capacity Construction Needs

The difference between the utilities' projected installed capacity for the year 2000 and total required capacity requirements equals the construction needs. Table 24-8 identifies those needs. For reference, we also express capacity in equivalent coal- fired generating plant units at 400 MW/plant.

The difference between the projected needs and projected installed capacity is 1,800 MW, equivalent to the capacity of five coal facilities. The best available technology scenario would require no additional generating capacity.

The prospect of multiple new coal generating stations brings out the myriad problems of financing, siting, constructing, and operating large centralized generation and transmission facilities to deliver power to load centers in a densely populated, environmentally conscious state.

Financing Needs

Table 24-8 summarizes the financing needs for new capacity. Multiplication of the $1500/KW construction cost of coal-fired units gives some measure of the financial impact of the alternative construction needs. If utilities were to provide capacity for their expected growth scenario through constructing central generating stations, the cost would be $3 billion. For comparison, the electric utilities total embedded investment in presently existing physical infrastructure is $14 billion.[9]

The decentralized capacity alternative costs only one-third as much. If, instead of constructing central generating capacity, utilities were to fulfill capacity needs by constructing or contracting with gas turbine generators at an average cost of $600 per kilowatt, the financial burden drops to $1 billion for the utility expected growth. Decentralized capacity would be gas turbine and/or combined cycle cogeneration.

The best choice scenario would require utility investment to replace aging facilities and incremental investment by utilities or consumers in weatherization of buildings and steady replacement of equipment and appliances with the most efficient models available. It would substitute payment for utility capital construction through utility rates with direct costs to utilities or consumers for improvement to customers' property. The utility or consumer investment would be the normal cost for equipment and appliance replacement plus a marginal additional cost for purchase of the most efficient equipment and appliances available at the time of replacement. The Conservation Incentive regulations now in place encourage utilities to provide capital for conservation as an alternative to construction of new capacity.

Operating Costs

Capital costs for the decentralized generation are lower than for central power stations, However, operating costs for the decentralized generation are higher. Operating

Table 24-7

Potential Environmental Impact of Alternative Scenarios for Motor Fuel Use in New Jersey

	1988	High Growth	Best Choice
Diesel Fuel (thousand barrels)	95,905	172,226	52,143
Congestion (Vehicles/roadmile/day)	4,700	8,440	2,555
Vehicle Emissions		0	0
Nitrogen Oxides(NO_x) (1,000 tons/year)	223	400	121
Carbon Monoxide (1,000 tons/year)	1,069	1,920	581
Carbon Dioxide (million tons c/year)	12.44	22.34	6.76

Note: High growth based on transportation 1981/86 5% annual rate of increase
Best Choice based on Appendix Table A-25-1, Transportation section
Each impact is changed proportionally to ratio of fuel sales.

Sources: NJ Sales - DOE/EIA-0214(88), NO_x based on 1985 NAPAP inventory.
CO-NJDEPE, CO_2 calculation based on Machado & Pilitz, Renew America
Congestion - Highway Statistics 1988, FHWA-PL-89-003.

costs for the highest efficiency equipment must include maintenance adequate to maintain their operating efficiency. For each of these scenarios, the Board of Regulatory Commissioners would have to decide how utilities will finance such projects and any ancillary transmission reinforcements or construction.

Siting Requirements

Table 24-8 summarizes land requirements for new capacity. The remaining open areas in the state near an adequate supply of cooling water are near or within environmentally sensitive, protected zones. The Hope Creek, Salem I, and Salem II generating stations have 2,000 uninhabited acres and open water of Delaware Bay surrounding them. Additional nuclear central generating facilities would need comparable space or more stringent engineering measures to keep radiation releases within required parameters.

Table 24-8

Electric Generating Capacity Requirements to Supply New Jersey Under Two Scenarios

Year 2000 Projections		Utilitity Expected Peak MW	Best Choice Peak MW
Projected peak demand		16,741	10,729
Capacity = Peak MW X 1.2		20,089	12,875
Capacity available		18,289	18,289
Projected Utility Additions		1,800	0
Alternative Ways to Provide Capacity			
Baseload Coal Fired Generation			
Capacity/unit (MW)	400		
Units required		5	0
Cost ($/kW):	$1,500		
Capital cost ($ milllion)		$3,000	(a)
Yrs to operation	10	10	(b)
Acreage/facility	400	2,000	0
Combined Cycle Gas Turbine			
Capacity/unit (MW)	200		
Units required		9	0
Cost ($/kW):	$600		
Capital cost ($ milllion)		$1,080	(a)
Yrs to operation	2	2	(b)
Acreage/facility	40	360	0

Note: MW capacity/unit, $/kW capital cost/facility, years & acreage/unit from recently proposed facilities.
(a) The cost for best choice is the added marginal cost to purchase the most efficient equipment and appliances available in the year of replacement and to install the best insulation and control technology available in year of purchase.
(b) installation will occur incrementally on replacement.

Sources: Utility Expected: NJ's Energy Future 9/88.
Best Choice: Appendix Table A-24-1.

Both nuclear and fossil fuel-powered central generating facilities require sufficient water to reduce discharge temperatures to acceptable levels. Nuclear facilities require, in addition, water to dilute their liquid radioactive releases. On average, centralized electric generation facilities capture only 30 percent of the heat value of fuel as electric energy. The facilities release the remaining 70 percent of the fuel Btu as heat.

Emissions

Emissions from nuclear and fossil fuel generating facilities are related to the amount of energy produced rather than to the capacity of the plant. If we assume that electric use will rise or fall at the same rate as peak use, then emissions will rise or fall as a function of use.

The placement of nuclear power stations in open areas allows greater dilution of the airborne radioactive releases by air currents before the releases might reach the off-site population. Emissions from central fossil fuel plants are likewise diluted by release from high stacks. However, scientists can show the negative downwind effects of fossil fuel plant emissions and provide a basis for regulations to control emissions from new facilities. As scientific ability to demonstrate public health and environmental effects of fossil fuel plant emissions increases, the air quality standards may become more stringent. A short-term possibility is action to limit acid deposition in New Jersey.[10]

Lead Times

Table 24-8 summarizes the lead time requirements for new capacity. Consideration of the environmental aspects of siting by the public and regulators adds to construction lead times for coal-fired or nuclear baseload capacity. Public concern results in lengthy appraisal of any major new facility by legislators and the media as well as by regulators. Recently lead times have been 10-15 years for central generating facilities. Permit applications would be necessary for each proposed facility or site.

Lead times to bring decentralized generating capacity on line have been less, about two years. These facilities also require permits, but since the impacts are small, public discussion, media attention, and time for granting permits are relatively short. A new 165 MW cogeneration facility in Bayonne required two years to obtain permits. Ancillary transmission construction may require fewer permits and less time because small facilities may be at or closer to load centers.

Longer Term Considerations

Calculations using projected capacity for the year 2000 are misleading because they do not take into account the

Table 24-9

U.S. Balance of Payments and Petroleum Imports
(Millions of Current Dollars)

	1984	1986	1988	1990
Balance on Current Account	-99,006	-145,393	-126,236	-92,123
Petroleum & Products Net Imports	-57,629	-33,046	-38,441	-58,087
Net Petroleum Imports as Percent of Deficit	58.2	22.7	30.5	63.1

Source: "Survey of Current Business", U.S. Department of Commerce, June 1991, Vol. 70, No. 6, p. 45, Table 1, and pp. 54, 56, Table 2.

aging of utilities' existing generating capacity beyond that period. By the year 2000, some 3,000 MW of steam electric production will be more than 40 years old. (See Appendix: Existing Plants—AE, JCP&L and PSE&G). By the year 2000, 2,410 MW of nuclear baseload capacity will be beyond 20 or more years of its normal 30- year operating license life. Oyster Creek (620 MW) will have been in service for 31 years; Peach Bottom 2 (524 MW), Peach Bottom 3 (519 MW), and TMI-1 (194 MW) will have been in service for 26 years; and Salem 1 (553 MW) will have been in service for 23 years.

In summary, almost one-third of the utilities' installed capacity will be approaching and/or exceeding its service life by 2000. The 1988 utility study states that utilities will retire or phase out 5,800 MW of capacity and purchases by 2010.[11]

Advantages of the Best Choice Peak Scenario

By 2000 less than half of today's electric generating capacity will be within its normal service life. Considering the long-lead times and environmental limitations on building new central generating station capacity, clearly the state will need to reduce peak demand or utilities will need to contract for other generating capacity. Since the best choice peak demand scenario has the shortest lead time and requires the least investment, it offers the best alternative for meeting the state's needs for capacity.

The means to achieve the best choice peak demand scenario is through the best choice use scenario. The low peak would be possible only if users replaced the majority of today's equipment and appliances as Chapters 11 and 12 describe. The residential, commercial and electric use envisioned by those chapters and in Appendix table A-24-1 at a load factor of 53.3 percent would cause a peak demand of 10,112 MW.

Progress Toward Energy Goals

Balance of Payments Impacts

The health of New Jersey's economy is tied to that of the country as a whole. Too great a dependence on foreign oil imports adversely affects both. Oil imports are increasing and make up a significant portion of the U.S. balance of payments deficits. (See Table 24-9). Large balance of payments deficits can seriously impair the nation's ability to pursue policies conducive to growth and result in an outflow of national wealth to other countries.

Oil imports have risen steadily since 1986 as domestic oil production has fallen while domestic oil consumption has increased. Analysts forecast a steady increase in oil imports that will continue the drain on balance of payments deficits and threaten economic prosperity of the nation and the state.

Energy Dependence Impacts

Closely related to the issue of economic growth is that of dependence: the greater its dependence on energy sources from outside the state, the more vulnerable New Jersey's economy will be to price volatility, unanticipated surges in demand, and supply disruptions.

New Jersey is dependent for its energy supplies in a number of ways. The state produces only about two-thirds of the electricity it uses and imports the balance from the PJM grid, other states, and Canada. It imports all of the petroleum it uses, 78 percent of which comes from outside the country. It imports all of the natural gas that it uses. The system of interstate pipelines that transport the natural gas to New Jersey begins over 1500 miles away in the Southwest where the gas is produced, and a few giant corporations increasingly dominate the pipeline industry.[12]

The policies set forth in this Energy Master Plan aim to foster economic growth and reduce dependence through more intensively using the energy resources we have and more efficiently using the resources we consume. Methane from landfills and heat from passive solar can contribute to New Jersey's energy needs.

The money spent to design, engineer, construct, operate, and monitor the facilities to utilize energy from wastes will likely be spent in New Jersey instead of being paid out to a foreign oil producer or western coal miner.

Environmental Impacts

The scenarios have markedly different environmental impacts. Tables 24-5, 24-6 and 24-8 show the benefits of the best choice scenario in reduced emissions of sulfur dioxide, nitrogen oxides and carbon dioxide. It would require no additional land. Replacement of existing generating capacity could occur at existing sites.

Emissions of carbon dioxide, sulfur dioxide, and nitrogen oxides from fossil fuel plants could increase by 30 percent under the utility expected scenario and a continuation of present petroleum use, or drop under the best choice scenario.

Cooling water requirements could rise by 30 percent under the utility expected scenario or drop under the best choice scenario. If replacement generating capacity is cogeneration, the cooling water requirements could drop further, as the waste heat becomes a valuable product.

Choice of Scenario

We can also reduce our dependence by using energy more efficiently. Efficiency is the most cost-effective way to find new energy supplies. Advanced heat pumps, boiler optimization, vanpool programs, and school bus fleet management are a just a few of the ways that will repay their costs in the value of energy saved in a short time period. The possibilities for implementing efficiency are many and require a modest investment from the state to pay off.

As the activity of the federal government in the energy area has been diminished in the 1980s, state governments have a correspondingly greater opportunity and responsibility to ensure that energy policies conducive to economic growth and reducing dependency are adopted. For New Jersey the scenario called best choice describes a level of energy used that is achievable and embodies consequences for the economy, the transport network, and the electric generating system that its citizens generally perceive as desirable.

NOTES

1. New Jersey Department of Labor, Division of Planning and Research, Office of Demographic and Economic Analysis *Population Projections for New Jersey and Counties 1990 to 2020*, Vol. 1, Nov. 1985.
2. PSE&G Electric Appliance Residential Forecast, 1987-2017. Based on 1987 New Jersey total residential sales of 19,044 gwh, NJEDS. New England Energy Policy Council (NEEPC), *Power to Spare*, (Boston: NEEPC, July 1987).
3. PSE&G Residential Gas Appliance Model Forecast: 1987-2017.
4. DiFiglio, Duleep and Greene indicate that the mileage standard chosen here may be optimistic. See Carmen DiFiglio, K. G. Duleep and David L. Greene, *Effectiveness of Future Fuel Economy Improvement*, paper submitted to The Energy Journal, January 1989.
5. U.S. Department of Energy, *Conservation Update*, September 1988.
6. Load Factor is the ratio of the average load in kilowatts supplied during a designated period to the peak or maximum load in kilowatts occurring in that period.
7. Atlantic Electric, Jersey Central Power and Light/ General Public Utilities, and Public Service Electric and Gas, *New Jersey's Electric Energy Future, Issues and Challenges*, September, 1988.
8. *Ibid.*, p. 2.
9. *Ibid.*, p. 2.
10. Environmental Defense Fund, Petition Before the New Jersey Department of Environmental Protection and Board of Public Utilities, March 29, 1988.
11. AE, JCP&L, PSE&G, *N.J. Electric Future*, 1988.
12. *Wall Street Journal*, February 6, 1989.