ALTERNATIVES ANALYSIS –

BELL BEND NUCLEAR POWER PLANT (BBNPP)

SITE SELECTION

PARTIAL DRAFT

March 2009

ACRONYMS (being added to as sections are added)

PROJECT INTRODUCTION: The Evolutionary Power Reactor

I. THE NEED FOR POWER

ACRONYMS

AEPS	Alternative Energy Portfolio Standards
BBNPP	Bell Bend Nuclear Power Plan
COLA	Combined License Application
CRP	Conservation Reserve Program
CT	Census Tract
DOE	Department of Energy
DSM	Demand-Side Management
FBC	Fluidized Bed Combuster
EPACT	Energy Policy Act of 2005
EPRI	Electric Power Research Institute
ESRP	Environmental Standard Review Plan
FERC	Federal Energy Regulatory Commission
GEIS	Generic Environmental Impact Statement
IGCC	Integrated Gasification Combined Cycle
kWh	Kilowatt Hours
MSW	Municipal Solid Waste
MW	Megawatt
MWe	Megawatt Electric
NEPA	National Environmental Policy Act of 1969
NERC	North American Electric Reliability Corporation
NID	Net Internal Demand
NRC	Nuclear Regulatory Commission
NREL	National Renewable Energy Laboratory
PADEP	Pennsylvania Department of Environmental Protection
PJM	Pennsylvania Jersey Maryland Regional Transmission Organization
PPL	PPL Bell Bend, LLC
PPL EU	PPL Electric Utilities Corporation
PPUC	Pennsylvania Public Utilities Commission
PSEB	Pennsylvania Sustainable Energy Board

RFC	Reliability *First* Corporation
RGGI	Regional Greenhouse Gas Initiative
ROI	Region of Interest
RTEP	Regional Transmission Expansion Plan
RTO	Regional Transmission Organization
USEPA	United States Environmental Protection Agency

ALTERNATIVES ANALYSIS –

BELL BEND NUCLEAR POWER PLANT (BBNPP) SITE SELECTION

Part of PPL's current and ongoing process of obtaining licensing for the BBNPP includes a complete alternatives analysis, including assessments and studies in the following five major areas:

- **I. The Need for Power (Reference: ER Chapter 8.0)**
  Overview of requirements and estimated future demand.

- **II. Alternatives to Proposed Action (Reference: ER Chapter 9.0)**
  Examination of actions other than building the proposed BBNPP.

- **III. Site Selection Process (Reference: ER Chapter 9.3)**
  Selecting the site to construct the proposed BBNPP.

The following report documents the efforts that have been made to date to achieve the best possible results in this endeavor and to comply and cooperate to the fullest extent with all involved federal, state, and local regulatory agencies. Information and data contained in sections I through III are condensed and summarized from the existing sections of the Bell Bend Environmental Report as noted above. Section I is based on Chapter 8 of the Environmental Report; sections II and III are based on Chapter 9 of the Environmental Report.

Figures and tables extracted from those documents and included here retain their original labeling to facilitate locating them within the context of the original documents. All other figures included here but not included in the COLA Environmental Report are numbered sequentially, beginning with Figure 1 in Section I.

PROJECT INTRODUCTION: The Evolutionary Power Reactor

The facility proposed for construction at the Bell Bend site in Luzerne County, Pa., is an Evolutionary Power Reactor (EPR) with a rated design net electrical output of approximately 1,600 megawatts electric (Mwe). The EPR is expected to achieve commercial operation in December 2018. The BBNPP would be developed as a merchant facility (one that sells or conveys its capacity and electricity in competitive markets) owned by PPL Bell Bend, LLC (PPL) providing baseload energy for the electricity market.

Baseload facilities typically produce large amounts of electricity, are operated most of the time providing a constant source of power to the energy grid. Peaking facilities are generally used to augment baseload power when demand exceeds capacity for short periods of time – usually weekdays. .

Most power generating facilities run in a similar fashion in the way that they operate by using some form of energy to drive a generator to produce electricity. These energy sources can include uranium, coal, natural gas, oil, and water (hydroelectric), wind, and solar. Each of these technologies has different performance characteristics, entails different capital costs, and carries different operation and maintenance costs. Baseload facilities are generally in continual operation and are least expensive to run. These facilities provide electricity to meet the base demand requirements on the system and are typically natural gas/coal fired or nuclear facilities. Because they run continuously, it is desirable for baseload facilities to utilize the least expensive fuels.

I. THE NEED FOR POWER (BBNPP ER 8.0)

PJM – the Pennsylvania, Jersey, Maryland Regional Transmission Organization – is the electricity control area (the electric grid) for New Jersey and all or parts of in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia. The entire PJM classic market is shown in Figure 1.

The geographic scope or primary market area for the BBNPP has been generally defined as the eastern part of the PJM Interconnection, LLC (PJM) "classic" market area (See BBNPP ER Figure 8.0-1).

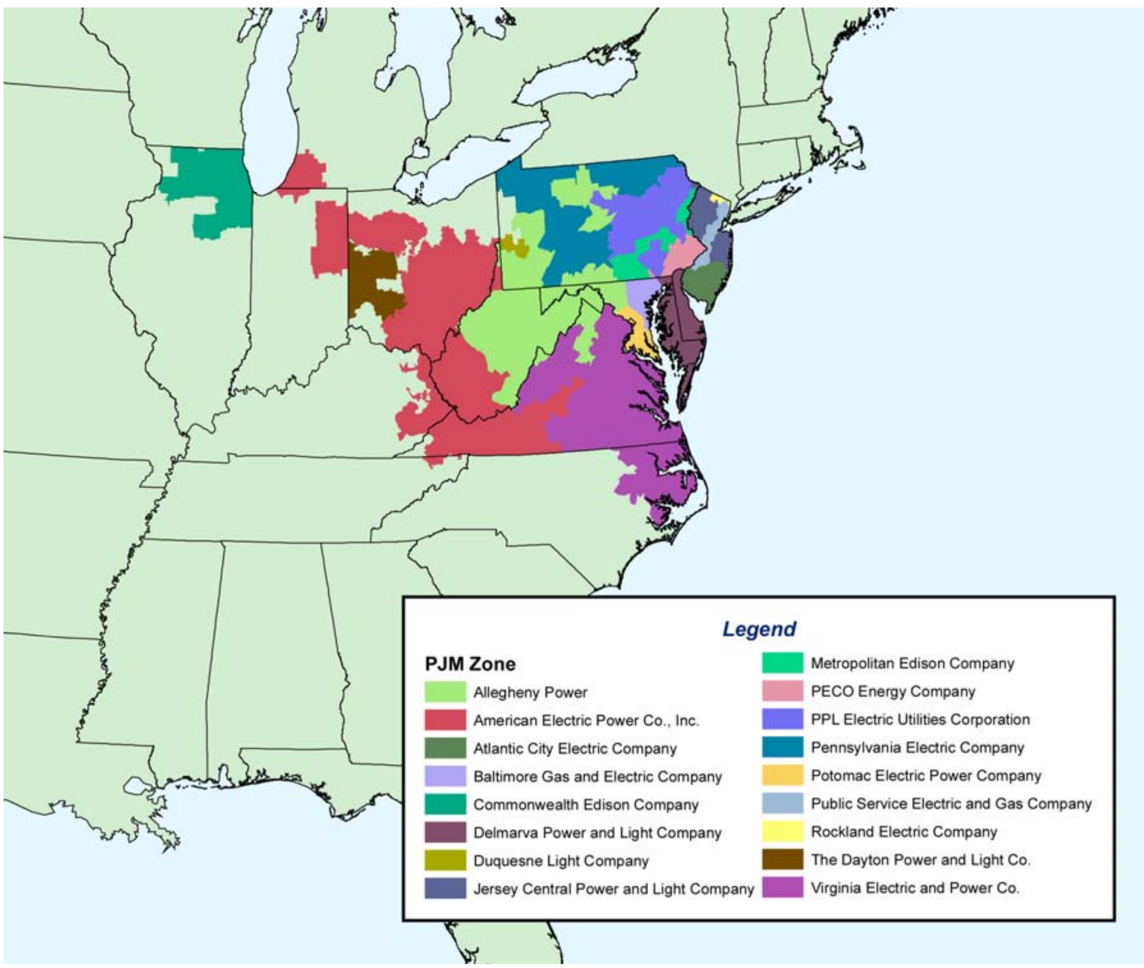
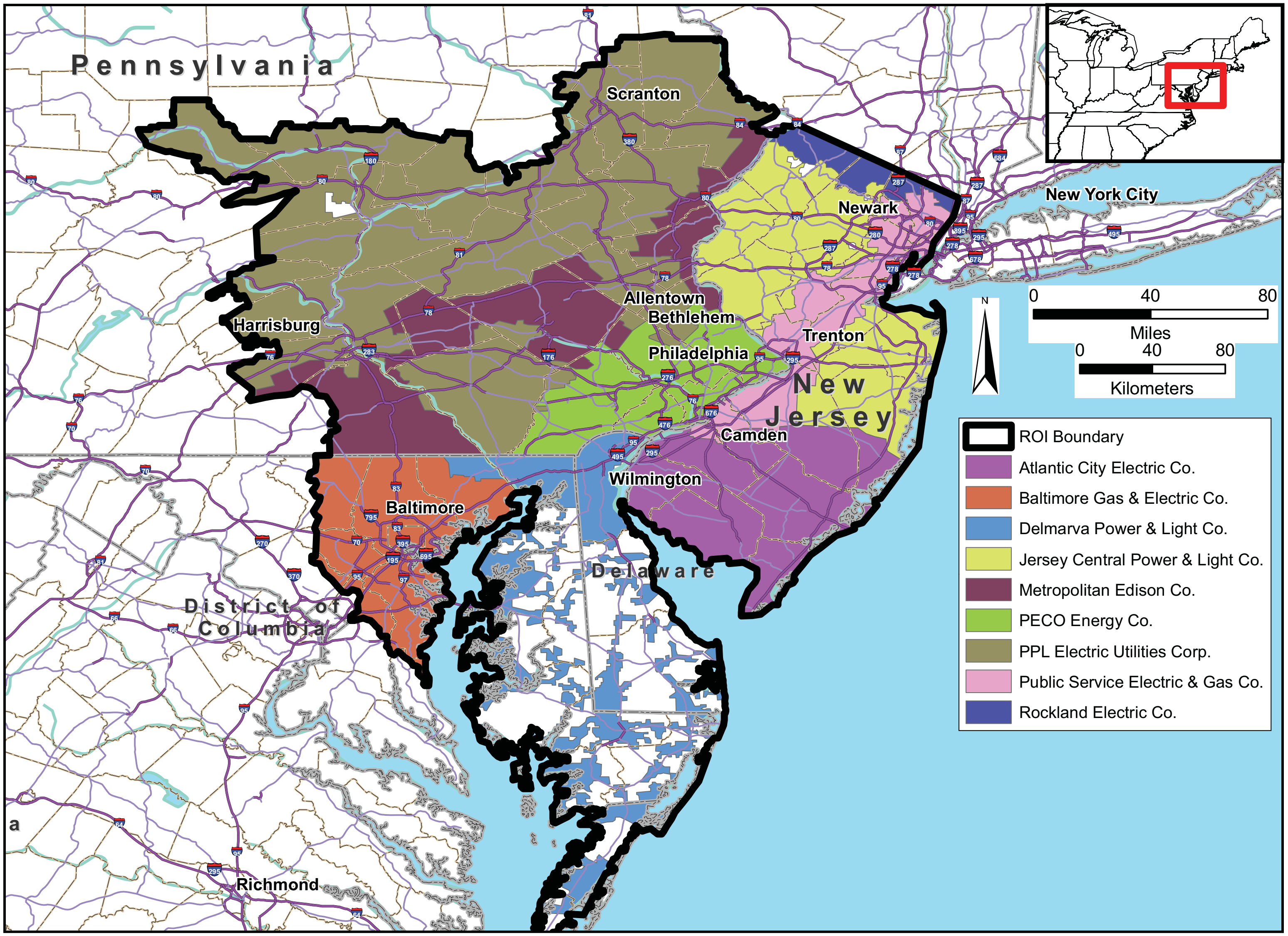


Figure 1. PJM "Classic Market" broken out by provider.
(Graphic courtesy of www.PJM.com)

Figure 8.0-1 {Primary Market Area - Region of Interest}



PJM serves approximately 51 million people and includes the major U.S. load centers from the western border of Illinois to the Atlantic coast. These load centers include the metropolitan areas in and around Baltimore, Chicago, Columbus, Dayton, Newark, northern New Jersey, Norfolk, Philadelphia, Pittsburgh, Richmond, and Washington D.C. PJM has more than 500 members and dispatches more than 165,000 MW of generation capacity over 56,000 miles (mi), 90,123 kilometers (km), of transmission lines — a system that serves nearly 20% of the U.S. economy.

PJM ensures that there is enough power to meet expected customer electricity demand at all times and that an additional reserve margin above the peak demand is ready and deliverable in the control area; It also ensures the reliability of the electric grid.

The task of evaluating the region's power supply lies with the PJM Regional Transmission Organization (RTO) and the regional electric reliability organization Reliability *First* Corporation (RFC). The RFC is one of nine regional electric reliability councils under the North American Electric Reliability Corporation (NERC), which was formed in 1967 following the Northeast Blackout of 1965 to "ensure that the bulk power system in North American is reliable."

PJM has projected continuing load growth in the primary market area. The U.S. Department of Energy has identified New Jersey, Delaware, eastern Pennsylvania, and eastern Maryland as a Critical Congestion Area. PJM expects expanded exports of power into New York, further exacerbating the situation.

In addition to concerns of long-term supply assurance, reliance on power imported from other states increases demand on west to east transmission capabilities, resulting in heightened vulnerability to transmission related interruptions. In fact, the U.S. Department of Energy (DOE) has identified the Atlantic coastal area from Metropolitan New York southward through northern Virginia as one of two Critical Congestion Areas within the United States, stating the following (DOE, 2006):

> The area from greater New York City south along the coast to northern Virginia is one continuous congestion area, covering part or all of the states of New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, and the District of Columbia. This area requires billion of dollars of investment in new transmission, generation, and demand side resources over the next decade to protect grid reliability and ensure the area's economic vitality. Planning for the siting, financing, and construction of these facilities is urgent.

The DOE study also notes that, while the eastern portion of PJM experiences continuing load growth, it also faces power plant retirements and limited new generation projects. (The eastern portion of the PJM is discussed as the Region of Interest, or the "primary market," under the Site Selection Process.) Transmission constraints are causing significant congestion in both the western and eastern portions of PJM because the grid cannot accommodate delivering the available lower cost Midwest coal and nuclear-fueled generation to the East (DOE, 2006).

One of PJM's objectives is to provide a transmission system that can accommodate power needs in all areas while maintaining a reliable network. The existing PJM high-voltage backbone transmission network provides lines appropriate for use by an EPR facility (500kV or 345 kV). In June 2007, PJM authorized a new 500 kV line connecting the existing Susquehanna 500 kV substation with the Roseland substation in northern New Jersey. This Susquehanna-Roseland line is being added independent of the proposals to construct BBNPP or other generating facilities. Planned to be in service by 2012, this line will become part of the "existing" transmission network for the BBNPP.

The Susquehanna-Roseland project addresses numerous overloads projected to occur on critical 230 kV circuits across eastern Pennsylvania and northern New Jersey, with multiple lines projected to exceed their conductor rating as early as 2013. (PJM, 2008) PJM regularly reviews performance issues associated with specific transmission facility overloads and outages as experienced in actual operations. This new circuit was justified on the basis of reliability as identified by reliability criteria violation tests in PJM's Regional Transmission Expansion Plan (RTEP) process deliverability studies. (RTEP is part of an annually recurring plan to expand the transmission system based on the changing dynamics of the system such as load growth, changes in flow patterns, generator retirements, etc.) From an economic perspective, the line was not proposed to facilitate access of specific new generation proposals, even though this additional backbone capability can present economic opportunities for them. The ability of each generation request to interconnect safety and reliably is addressed in specific RTEP interconnection process studies.

As the Regional Transmission Organization, PJM performs systematic reliability planning. PJM's Capacity Adequacy Planning Department is responsible for determining and monitoring the generation reliability requirements of PJM. This includes analyzing the growth of electrical peak load within the region. Also, PJM continues to focus on planning the enhancement and expansion of transmission capability on a regional basis.

A number of factors continue to reduce system reliability in the eastern part of the PJM classic market area. These factors include:

- Load growth
- Imminent start of large power exports to New York City and Long Island over merchant transmission facilities
- Deactivation/retirement of generation resources
- Sluggish development of new generating facilities
- Continued reliance on transmission to meet load deliverability requirements and to obtain access to more economical sources of power west of the Delaware River

The Commonwealth of Pennsylvania deregulated electric utilities in 1996. Now the Pennsylvania Public Utilities Commission (PPUC) looks to regional entities, such as PJM, for the management of the electric system. PJM makes use of market forces to encourage independent owners to build the needed facilities. However, if the market does not appear to be providing sufficient incentive to ensure continuing system reliability, PJM then steps in to assist with directing when and where new power generation or transmission facilities might be needed (PPUC, 2007).

The measures of reliability generally are divided between probabilistic measures (loss of load probability, frequency, and duration of outages) and non-probabilistic measures (reserve margin and capacity margin). The commonly used "capacity margin" is the ratio of reserve capacity to actual capacity.

Reserve margin is the supply capacity maintained in excess of anticipated demand. This excess helps maintain reliable load regardless of unanticipated interruptions in supply (generation or transmission capacity) or increases in demand. Reserve margins are typically established to maintain the risk of unscheduled interruptions to 1 day in 10 years.

The reserve margin, or reserve capacity, is a measure of unused available capacity over and above the capacity needed to meet normal peak demand levels. For a power generator, it refers to the amount of capacity it can generate above what is normally required. For a transmission company, it refers to the capacity of the transmission infrastructure to handle additional energy transport if demand levels rise beyond expected peak levels. Producers and transmission facilities are usually required to maintain a constant reserve margin of 10 to 20% of normal capacity by regulatory authorities. This provides an assurance against breakdowns in part of the system or sudden increases in energy demand. As of August 28 2008, PJM forecasted summer peak reserve margins of 19.7% for the planning year 2012/2013.

With the addition of more than 3,000 MW of planned new capacity by 2010, the reserve margins are expected to remain above 15% through 2010. (See BBNPP ER Table 8.4-1.) Three sets of reserve margins are listed in the table: one based on the existing (2007) capability, a second based on existing and planned capability, and a third set of reserve margins based on the existing planned, and potential capability. Based on existing resources, projected retirements and capability changes through summer 2016, the reserve margins based on the summer peak net internal demand (NID) are projected to decline from a high of 20.4% in 2007, to a low of 5.1% in 2016. This is an improvement over last year's 18.0% reserve margin for 2007 that is projected to decline to 1.6% by 2016. The projected reserve margins for the summer peak NID, based on existing and planned capacities plus the existing uncommitted and energy only resources, decline over the period from 23.3% in 2007 (compared with 21.3% last year) to 9.6% in 2016 (compared with 9.2% last year).

These two projections of reserve margins from 2007 to 2016 represent the likely range for the actual reserve margin, although neither extreme is considered likely to occur. A third reserve margin projection (existing and planned resources) depicts the reserve margins when the uncommitted and energy only resources are excluded from the total resource capability.

Table 8.4-1 {Demand, Capability, and Margins 2007 – 2016 (Summer)}

	2007	2008	2009	2010	2012	2012	2013	2014	2015	2016
Demand										
RFC NID, MW	180,400	182,500	185,600	188,400	191,300	194,100	196,900	199,500	202,400	205,300
Capability										
Existing Seasonal Capacity (NSC), MW	217,129	216,751	216,033	216,140	215,960	215,926	215,801	215,801	215,801	215,801
Planned Additions (NSC), MW		1365	2440	3047	3747	3847	3847	3847	3847	3847
Planned Seasonal Capability (NSC), MW	217,129	218,116	218,473	219,187	219,697	219,773	219,648	219,648	219,648	219,648
Uncommitted and Energy-Only Capability (NSC), MW	5300	5300	5300	5300	5300	5300	5300	5300	5300	5300
Potential Seasonal Capability (NSC), MW	222,429	223,416	223,773	224,487	224,987	225,073	224,948	224,948	224,948	224,948
Reserve Margins (MW & % of NID)										
Reserve Margins with Existing Resources	36,729 20.4%	34,251 18.8%	30,433 16.4%	27,740 14.7%	24,650 12.9%	21,826 11.2%	18,901 9.6%	16,301 8.2%	13,401 6.6%	10,501 5.1%
15% Reserve Margin – Surplus (Deficit)	9669	6976	2593	(520)	(4045)	(7289)	(10,634)	(13,624)	(16,959)	(20,294)
Reserve Margins with Existing and Planned Resources	36,729 20.4%	35,616 19.5%	32,873 17.7%	30,787 16.3%	28,397 14.8%	25,673 13.2%	22,748 11.6%	20,148 10.1%	17,248 8.5%	14,348 7.0%
15% Reserve Margin – Surplus (Deficit)	9669	8241	5033	2527	(298)	(3442)	(6787)	(9777)	(13,112)	(16,447)
Reserve Margins with Existing, Planned, and Potential Resources	42,029 23.3%	40,916 22.4%	38,173 20.6%	36,087 19.2%	33,697 17.6%	30,973 16.0%	28,048 14.2%	25,448 12.8%	22,548 11.1%	19,648 9.6%
15% Reserve Margin – Surplus (Deficit)	14,696	13,541	10,333	7827	5002	1858	(1487)	(4477)	(7812)	(11,147)

Note:
NSC = Net seasonal Capability
MW = MegaWatt
NID = Net Internal Demand
Installed Reserve Margin (IRM) -is the percentage which represents the amount of installed capacity required above the forecasted peak load required to satisfy a loss of load expectation (LOLE) of 1day/10 years. The IRM is expressed in units of installed capacity.
Calculated IRM - is the installed reserve that is determined by a PJM study performed each spring using a probabilistic model that recognizes, among other factors, historical load variability, load forecast error, scheduled maintenance requirements for generating units, forced outage rates of generating units and the capacity benefit of interconnection ties with other regions.
Approved IRM - is the installed reserve that is approved by the PJM Board, as a result of the review process and recommendations of the calculated IRM study by the PJM committee structure and the PJM Members Committee to the PJM Board.

The earliest date when reserve margin would be expected to fall below 15% is 2010, assuming no new capacity additions. The amount of new capacity needed to meet a 15% reserve margin in 2010 is about 500 MW after retirements and changes to existing capacity. Retirements and changes are expected to provide a net reduction of existing capability by about 1,000 MW.

While uncertainty in the existing data prevents a precise forecast of when the reserve margins may decline below 15%, there appears to be sufficient lead time for the industry to respond such that a 15% reserve margin can be maintained. As a result, there will be not only a need for power from the BBNPP but also a need for a substantial amount of other new generating capacity.

In this regard, a number of companies, considered to be probable competitors, have announced their intentions to build new baseload generating capacity in the PJM region Additionally, other companies have announced their intentions to construct other types of generation capacity, including fossil fueled facilities and wind turbine systems. However, only the following capacity which may be utilized as baseload capacity were included in the 2007 PJM resources forecast:

- 670 MW of new gas fired generation capacity (in 2008),
- 750 MW of coal fired generation capacity (in 2012), and
- 800 MW of coal fired generation capacity (in 2012).

The load serving entities have a capacity obligation determined by evaluating individual system load characteristics, unit size, and operating characteristics. Additionally, PJM conducts load deliverability tests that are a unique set of analyses designed to ensure that the transmission system provides a comparable transmission function throughout the system. The transmission system reliability criterion used is one event of failure in 25 years. This is intended to design transmission so that it is not limiting the planned generation system to a reliability criterion of one event in 10 years. (PJM, 2008b)

In summary, the RFC and PJM assessments have forecasted a shrinking reserve margin that does not satisfy RFC and PJM goals to maintain system reliability by 2010. (See Table 8.4.1, above.)

PJM assumed the following factors for its growing concern about reliability and power supply:

- Continued load growth including impending exports of power to the New York City area. The New Jersey area, the greater Baltimore area, the nation's capital, and the Delmarva Peninsula are fast-growing major population centers.
- Retirement of generation resources. There has been a high level of generation retirements announced in parts of the RTO with little advance warning.
- Sluggish development of new generation facilities. Underlying trends of comparatively low generation additions exist.

- Continued reliance on transmission to meet load deliverability requirements and to obtain additional sources of power from the west. Constraints principally occur on flows into eastern Pennsylvania and New Jersey (and from there to New York City) from western Pennsylvania and from the Chesapeake Bay region.

The following criteria suggest the continuing benefits of and the need for a new merchant baseload generating facility:

- The relevant region's need to diversify sources of energy (e.g., using a mix of nuclear fuel and coal for baseload generation).
- The potential to reduce the average cost of electricity to consumers.
- The nationwide need to reduce reliance on petroleum.
- The case of a significant benefit cost advantage being associated with plant operation before system demand for the plant capacity develops.

In addition, recent state and national policy statements assert the benefits of baseload capacity that reduces greenhouse gases. The increasing concern about greenhouse gases and consequent climate change has triggered a number of national policy trends:

The Clear Skies Act of 2003 amends Title IV of the Clean Air Act to establish new cap and trade programs requiring reductions of sulfur dioxide, nitrogen oxides, and mercury emissions from power generating facilities, and it amends Title I of the Clean Air Act to provide an alternative regulatory classification for units subject to the cap and trade programs. Under this Act, retail prices are projected to increase by approximately 2.1% to 4.2% between 2005 and 2020. In 2003, the U.S. Environmental Protection Agency anticipated that the health benefits in Pennsylvania would total approximately $1.8 to $9.3 billion and include approximately 700 to 1,200 fewer premature deaths and 1,800 fewer hospitalizations and emergency room visits for asthma.

As part of Pennsylvania's renewable and sustainable energy efforts, four funds were created as a result of the restructuring plans of five electric companies. The funds are designed to promote the development of sustainable and renewable energy programs and clean air technologies on both a regional and statewide basis. The funds have provided more than $20 million in loans and $1.8 million in grants to over 100 projects. The Statewide Sustainable Energy Board was formed in 1999 to enhance communications among the four funds and state agencies. The board includes representatives from PPUC, the Pennsylvania Department of Environmental Protection (PADEP), the Department of Community and Economic Development, the Office of Consumer Advocate, the Pennsylvania Environmental Council, and each regional board (PPUC, 2007).

The four renewable and sustainable energy funds include:

- West Penn Power (Docket No.: R 00973981)
- METED (Docket No. R 00974008) and PECO (Docket No. R 00974009)
- PPL Sustainable Energy Fund of Central/Eastern Pennsylvania (Docket No. R 00973954)
- PECO Energy (Docket No. R 00973953)

In summary, the benefits of the proposed BBNPP include the following:

- The proposed BBNPP would alleviate existing congestion in the west-to-east transmission of energy across the Allegheny Mountains.
- The proposed BBNPP would provide much needed baseload power for an area that is expected to have the average annual peak forecast grow between 1.2 and 1.5% per year over the next 10 years.
- The proposed BBNPP would allow PJM to continue to meet the growing demand for an average of 1,654 MW per year of added capacity since 2000.
- The proposed BBNPP would enable PJM to sustain the reserve margins necessary to prevent a reduction in the supply of energy and to meet the expected future demand trends.
- Given concerns throughout the northeastern United States about climate change and carbon emissions, the proposed BBNPP serves another important need by reducing carbon emissions. The proposed BBNPP would displace significant amounts of carbon as soon as the plant becomes operational, as compared to the coal fired generation that likely would be expected to meet the identified need for power.

References

DOE, 2006. "National Electric Transmission Congestion Study," August 2006.

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