PUBLIC VERISON

STATE OF NEW JERSEY
BOARD OF PUBLIC UTILITIES

I/M/O Jersey Central Power & Light Company Pursuant to N.J.S.A. 40:55D-19 for a Determination that the Monmouth County Reliability Project is Reasonably Necessary for the Service, Convenience or Welfare of the Public	))))))	**OAL Docket No. 12098-16** **BPU Docket No. EO16080750**

DIRECT TESTIMONY OF PETER J. LANZALOTTA ON BEHALF OF DIVISON OF RATE COUNSEL

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INTRODUCTION

Q. Mr. Lanzalotta, please state your name, position and business address.

A. My name is Peter J. Lanzalotta. I am a Principal with Lanzalotta & Associates LLC, ("Lanzalotta"), 67 Royal Point Drive, Hilton Head Island, SC 29926.

Q. On whose behalf are you testifying in this case?

A. I am testifying on behalf of the New Jersey Division of Rate Counsel ("DRC").

Q. Mr. Lanzalotta, please summarize your educational background and recent work experience.

A. I am a graduate of Rensselaer Polytechnic Institute, where I received a Bachelor of Science degree in Electric Power Engineering. In addition, I hold a Masters degree in Business Administration with a concentration in Finance from Loyola College in Baltimore.

I am currently a Principal of Lanzalotta & Associates LLC, which was formed in January 2001. Prior to that, I was a partner of Whitfield Russell Associates, with which I had been associated since March 1982. My areas of expertise include electric system planning and operation. I am a registered professional engineer in the states of Maryland and Connecticut.

In particular, I have been involved with the planning and operation of electric utility systems as an employee of and as a consultant to a number of privately- and publicly-owned electric utilities and government agencies involved in the regulation of electric utilities over a period exceeding thirty years. I have presented expert testimony before the Federal Energy Regulatory Commission ("FERC") and before regulatory commissions and other judicial and legislative bodies in 22 states, the District of Columbia, and the

Provinces of Alberta and Ontario. My clients have included utilities, state regulatory agencies, state ratepayer advocates, independent power producers, industrial consumers, the United States Government, environmental interest groups, and various city and state government agencies.

A copy of my current resume is included as Exhibit PJL-1 and a list of my testimonies is included as Exhibit PJL-2.[1]

In 1990, I submitted testimony in New Jersey Board of Public Utilities Docket No. EE88-121293 on behalf of the State of New Jersey Department of the Public Advocate, Division of Rate Counsel, regarding a proposed 230kV transmission line connecting the Aberdeen, Taylor Lane, and Red Bank substations. Since then, I have been involved in evaluating several proposed transmission lines on behalf of Rate Counsel[2], and on behalf of other clients in Maryland, Pennsylvania, and Virginia.

Q. What is the purpose of your testimony?

A. I was retained to review the Petition (the "Petition") filed by Jersey Central Power & Light Company ("JCP&L" or "Company") for a determination that the Monmouth County Reliability Project ("Project") is needed for the service, convenience, or welfare of the public, as part of DRC's participation in New Jersey Board of Public Utilities ("BPU" or "Board") Docket No. E016080750 (this "Proceeding"). This testimony presents the results of my review.

Q. Please explain how you conducted your analyses.

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[1] Exhibit PLJ-1 and Exhibit PJL-2 as well as all other Exhibits referenced herein are attached to and incorporated by referenced in this testimony.

[2] In Exhibit PJL-2, See Item Nos. 22 and 72 for transmission-related testimonies before the BPU.

A. I have reviewed the following information in my investigation:

i. The Company's Petition and Direct Testimony in this Proceeding.

ii. The Company's responses to discovery questions submitted by DRC, the Board Staff, and other intervening parties to this Proceeding.

iii. PJM documents, including load forecasts and system planning documents.

iv. Various other documents, including the Company's Annual System performance Report ("ASPR") for recent years.

SUMMARY

Q. Please summarize your conclusions.

A. My testimony concludes:

1. The need for this project, which was initially determined in 2011, has been diminishing ever since. PJM planning rules, recently amended to help reduce, or even eliminate, project cancellations due to changing conditions, have supposedly re-affirmed the need for this project. But, the date of this need appears to be uncertain at best.

2. There are a number of technical approaches to improving reliability that the Company has apparently failed to consider, such as a static var compensator ("SVC") or a STATCOM[3], distributed generation, smart invertors, or smart grid technologies that may potentially avoid or mitigate the NERC[4] violation that drives the need for the Project.

[3] Stands for static compensator.

[4] NERC stands for North American Electric Reliability Corporation.

3. The proposed routing of the transmission line follows a New Jersey Transit ("NJT") rail right of way (ROW"), access to which has yet to be granted, under unknown terms and conditions. The choice of the rail ROW contributes to the height of the line, which ranges up to 210 feet tall in some places.

4. The Company considered a number of alternative existing ROWs for the Project, but eliminated most from consideration for reliability-related reasons before detailed development. All these alternatives will address the stated reliability concerns driving the need for the Project. The Company developed cost estimates only for their preferred route, so there is no basis for comparison between alternatives on a cost basis.

5. I recommend that the Board defer its review of the Project pending: (i) more detailed consideration of technologies regarding voltage management, such as an SVC or a STACOM, and other developing technologies and their ability to address the NERC violation that drives the purported need for the Project; (ii) development of more detail regarding alternative routes, including their costs, and their impacts, such as tower heights; (iii) resumption of load growth such that the load level at which the voltage problems have been observed in planning studies is forecast to occur within the planning horizon; and (iv) a determination of whether and/or the terms and conditions under which the Company will be permitted to use the NJT rail ROW so those terms can be taken into consideration compared to alternative routes.

REVIEW OF NEED FOR THE PROJECT

Q. Please discuss the need for the Project.

A. The need for the Project was first identified as part of PJM's 2011 Regional Transmission Expansion Plan ("RTEP").

PJM is a FERC-approved Regional Transmission Operator[5] which coordinates the movement of wholesale electricity across a high voltage transmission system in all or parts of 13 states and the District of Columbia. PJM has responsibility for the adequacy of the transmission system as explained in this excerpt from the 2011 RTEP report:

As a Federal Energy Regulatory Commission (FERC) approved Regional Transmission Organization (RTO), one of PJM"s core functions encompasses regional transmission planning. PJM's Regional Transmission Expansion Plan (RTEP) identifies transmission upgrades and enhancements that are required to preserve the reliability of the transmission system. The PJM system is planned such that it can be operated to supply projected customer demands and projected firm transmission service over a range of forecast system demands under contingency conditions that have a reasonable probability of occurrence. PJM reliability planning encompasses a comprehensive series of detailed analyses that ensure reliability and compliance under the most stringent of the applicable NERC, Regional Entity (RFC or SERC as applicable), PJM and local criteria. To accomplish this each year, a baseline assessment is completed for applicable facilities

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[5] "Independent System Operators [ISOs] grew out of Orders Nos. 888/889 where the Commission suggested the concept of an Independent System Operator as one way for existing tight power pools to satisfy the requirement of providing non-discriminatory access to transmission. Subsequently, in Order No. 2000, the Commission encouraged the voluntary formation of Regional Transmission Organizations to administer the transmission grid on a regional basis throughout North America (including Canada). Order No. 2000 delineated twelve characteristics and functions that an entity must satisfy in order to become a Regional Transmission Organization." http://www.ferc.gov/industries/electric/indus-act/rto.asp

over the near term (1-5 years) and longer term (years 6 – 15). All bulk electric system (BES) facilities are included in the RTEP baseline assessment process as required by NERC standards.[6]

The North American Electric Reliability Corporation (NERC) is a "not-for-profit international regulatory authority whose mission is to assure the reliability of the bulk power system in North America. NERC develops and enforces Reliability Standards; annually assesses seasonal and long-term reliability; monitors the bulk power system through system awareness; and educates, trains, and certifies industry personnel."[7] FERC has designated NERC as the Electric Reliability Organization for the United States. NERC promulgates transmission planning reliability standards, compliance with which is mandatory. These standards include planning for various contingencies on the electric transmission system while serving future forecast load levels.

Contingency studies are transmission planning studies that look at outages to critical system elements so that the loading of and voltage on the remaining system elements can be studied. When these studies are run with and without specific facilities, such as the Project, they help study the impact of including or excluding those specific facilities on the loading of or the voltage on other system elements. Contingency studies typically study: (i) whether system facilities are overloaded before or after specified contingencies; and (ii) whether system facilities are at an acceptable range of voltages before or after specified contingencies. When these studies show an overloaded system or an out-of-

[6] 2011 PJM Baseline Reliability Assessment, March 30, 2012, pp. 1-2.

[7] http://www.nerc.com/Pages/default.aspx

range voltage in their analysis of NERC-mandated contingencies, this situation is commonly referred to as a NERC violation.

The Project was needed to prevent local voltage collapse[8] on the JCP&L 34.5 kV system for a contingency involving the loss of both existing 230 kV transmission lines running from the Atlantic substation to Red Bank substation. These two transmission lines share the same set of transmission towers. The loss of both these transmission lines to simultaneous or near simultaneous outages due to the same cause is referred to as a common mode outage.[9] The 2011 RTEP projected this voltage collapse potential to occur in the year 2016. The proposed solution of building a new 230 kV transmission line to Red Bank was estimated to cost $22 million at the time.

Q. Please discuss how the need for the Project has changed since the 2011 RTEP.

A. Since the 2011 RTEP, forecast peak loads for the Company have decreased significantly. The 2011 RTEP reflects loads from the 2012 PJM peak load forecast. Exhibit PJL-4 shows an excerpt from the 2012 PJM load forecast which depicts the summer peak load forecast for PJM's Mid-Atlantic zone, which includes the Company designated as "JCPL." As shown in Exhibit PJL-4, the PJM 2012 peak load forecast for JCP&L for the year 2016, in which the voltage collapse was first observed, was 6,696 MW.

Since the time of that forecast, JCP&L future forecasted peak loads have been decreasing. All else equal, I would expect the probability of a voltage collapse from the

[8] A voltage collapse is a condition where there is insufficient voltage to permit the electric system to operate, and all the facilities in the area of the collapse suffer an outage.

[9] A common mode outage is one in which multiple system components suffer an outage due to the same, or a common, cause. In the case of the Project, the common mode outage takes two transmission lines, which occupy the same set of towers, out of service due to the same cause, say a lightning strike. Another example of a common mode outage is where a substation circuit breaker fails to operate properly when a fault has occurred on a transmission line, thereby causing a substation bus to suffer an outage in addition to the transmission line.

common mode contingency to decrease as the Company's projected peak load decreases. An excerpt from the most recent PJM load forecast, the 2016 load forecast which was released by PJM in early 2016, is included as Exhibit PJL-5. This excerpt depicts the summer peak load forecast for PJM's Mid-Atlantic zone, which includes the Company designated as "JCPL". As shown in Exhibit PJL-5, the JCP&L 2016 peak load forecast decreased down to 5,958 MW, a decrease of 738 MW from the 6,696 MW forecast in the PJM 2012 load forecast.[10] This decreasing forecast of peak load growth reflects increasingly efficient use of electricity, increases in self-generation, changes in demand response resources, and changes to the load forecast model.[11] The 2016 PJM Load Forecast projects a summer peak load for JCP&L of 6,255 MW in the year 2031, the furthest projected year in the 15 year planning horizon used by PJM. Exhibit PJL-5. The load level from the 2012 PJM load forecast at which the voltage collapse was modelled to occur, i.e., 6,696 MW in 2016, is never reached by JCP&L in any of the 15 years, through 2031, reflected in the 2016 load forecast. Exhibit PJL-5. The highest forecasted load for the Company in the 2016 PJM load forecast occurs in the year 2031. It is 6,255 MW, which is lower than the load level 6,696 MW, at which the 2011 RTEP projected a voltage collapse for JCP&L.

Q. Since the 2011 RTEP, have there been planning studies showing the potential voltage collapse at a JCP&L projected system peak load lower than the 6,696 MW load level at which the 2011 RTEP projected problems?

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[10] Based on an estimate of 5 kW per customer, each MW reflects about 200 customers. 738 MW would then reflect 147,600 customers.

[11] PJM Load Forecast Report, January 2016, pp. 1-2.

A. Yes. The Company has prepared an analysis using a load level of 6,359 MW and found that the common mode contingencies referenced above would cause a need for system reinforcement.[12] I note that this level of load is higher than any of the Company loads in the PJM's 15 year planning horizon, which currently has a peak JCP&L forecast load of 6,255 MW in 2031.

Q. PJM issued a preliminary version of its 2017 Load Forecast Report on December 14, 2016. Please discuss any changes to JCP&L's peak load forecast over the next 15 years compared to the PJM 2016 peak load forecast discussed above.

A. The preliminary 2017 Load Forecast Report for JCP&L lowers the 2031 forecast peak for JCP&L from 6,255 MW down to 6,219 MW, and projects a peak load in 2032 of 6,277 MW. Exhibit PJL-9.

Both of these load levels are lower than the load levels discussed above at which the common cause contingencies were found to cause a need for system reinforcement.

Q. As projected peak loads, or other system conditions change, please discuss PJM's policy regarding the cancellation of previously approved transmission projects.

A. As discussed in the testimony of PJM's Mark Sims[13], in early 2012, PJM changed its Operating Agreement[14] to move away from use of a "bright line" test to determine the

[12] See Hozempa Direct, 17:7-12

[13] See Mark Sims Direct Testimony, page 10, line 1 to page 11, line 14.

[14] The Operating Agreement is an agreement defining the respective rights and obligations of all PJM members and entities with respect to the coordinated operation of their electric supply systems and the interchange of electric capacity and energy among their systems.

need for transmission system reinforcements or additions.[15] Under this approach, for example, when loading of a particular system element reached 100% of its operating limit in transmission planning studies, a system modification was required to lower that loading level. If, however, the loading of that element only reached 99%, no modification was required.

PJM believed that this "bright line" test encouraged what it calls "the whipsaw effect of taking projects in and out of the RTEP due to changing conditions."[16] Mr. Sims specifically mentions the cancellations by the PJM Board of the PATH and MAPP transmission projects that were initiated and later cancelled, earlier in this decade, due to changing conditions.[17]

The "bright line" approach was replaced by the current approach which allows for flexible transmission planning criteria which expand PJM's analyses beyond a strict application of the reliability criteria. This approach permits PJM to go beyond the current NERC reliability criteria: (i) using sensitivity analyses; (ii) changing the modeling assumptions; (iii) changing the planning scenarios; (iv) taking public policy objectives into consideration; and (v) taking potential changes in expected future conditions into consideration, as well as including other considerations. Given this

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[15] This test is referred to as "bright Line" because it defines a clearly delineated "bright line" between needing reinforcements at loading levels of 100% of capability, while not needing reinforcements at 99% of capability, when referring to equipment overloads.

[16] Sims Direct, 11:12-14.

[17] Potomac-Appalachian Transmission Highline ("PATH") and the Mid-Atlantic Power Pathway ("MAPP") were both cancelled by the PJM Board on August 24, 2012. See PJM 2012 RTEP, Book 1, pp. 7.

planning flexibility, the likelihood of a project cancellation is substantially reduced, if not completely eliminated.

While PJM may have virtually unlimited flexibility to keep a transmission project alive once it has been approved by the PJM Board, as discussed above, the information in the Company's testimony indicates that this need is currently past 2031, well into the future. To the extent that it is advantageous to take time for additional analysis before reaching a decision, it appears that time is available.

PROJECT ALTERNATIVES

Q. Please discuss the alternatives to the project considered by the Company.

A. The Company considered alternatives that provided for the construction of a new 230 kV transmission line into the Red Bank substation from various locations. These alternatives included:

(i) extending a 230 kV tap off the Atlantic-Raritan River 230 kV line;

(ii) constructing a third 230 kV line from Atlantic;

(iii) extending a 230 kV line from Oceanview substation; or

(iv) tapping the Freneau-NJT Aberdeen 230 kV line.

The alternatives were evaluated based on their ability to address immediate and future reliability needs in the Red Bank area and surrounding areas.[18] Each of these alternatives would remedy the NERC violation that is driving the need for the Project, i.e., the voltage collapse. So, these alternatives were judged, in part, by how well they addressed reliability needs other than this NERC violation.

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[18] Hozempa Direct, pp. 17:19 to 18:4.

Q. Please address why none of these alternatives were chosen in preference to the Project.

A. None of these alternatives were deemed to be as robust as the Project, and each was judged as being less reliable than the Project in some way. However, all of these alternatives would fix the voltage collapse.

The reliability shortcomings of these alternatives are not NERC transmission planning violations. For example, it was judged to be a reliability shortcoming by JCP&L to tap an existing 230 kV transmission line for a new 230 kV feed into Red Bank because this increases the length of the line which is exposed to potential faults. Of course, the Project creates a new transmission line of about 10 miles in length that will be exposed to potential faults, thereby increasing the electric system's exposure to faults in this manner. Therefore, this "shortcoming" is shared to some extent by all the overhead alternatives, including the Project.

Another reliability shortcoming attributed by the Company to all of these alternatives is that they do not provide a second supply line to some substations that currently have only a radial supply. A substation with a single supply transmission line, or feed, is said to have a radial supply. If that one line experiences a contingency, the substation's loads are out of service. The Project is credited with providing a second supply line to the NJT Aberdeen and NJT Red Bank substations.[19] The Company does not represent that such radial feeds reflect NERC violations.

[19] See response to RCR-ENG-12. (Exhibit PJL-6)

The alternative of building a 3rd 230 kV transmission line from Atlantic substation to Red Bank was rejected because it added a transmission line to an existing transmission ROW, thereby increasing exposure of the electric system to events affecting the Atlantic to Red bank ROW. The Company opines that: (i) while it is more reliable to have every transmission line on its own set of towers in its own ROW, this is not practical from cost, social, or environmental perspectives; and (ii) that reliability is compromised when more transmission facilities share the same ROW or transmission structures.[20] The Company does not state that this is a NERC violation.

Q. Please discuss the cost implications of choosing the Project in comparison to choosing one of these alternatives.

A. The Company did not develop cost estimates for these alternatives, so it is difficult to say how much the Company would spend for the additional benefits the Company attributes to the Project. Since the terms and conditions under which NJT may grant the Company access to its ROW are as yet unknown, the development of information about these alternatives would be needed to compare these alternatives based on cost. This is an area that requires additional consideration, in my opinion. While there may be additional reliability benefits associated with the Project compared to the alternatives, we should be able to consider how much these benefits are going to cost. The Board should require the Company to prepare cost estimates for these alternatives.

Q. Please discuss the non-transmission alternatives considered by the Company.

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[20] See response to RCR-ENG-12. (Exhibit PJL-6)

A. The Company did not consider any non-transmission alternatives. The Company chose not to review non-transmission alternatives because the contingencies causing the NERC violation involve the loss of two 230 kV transmission lines, and because of the magnitude of the potential voltage collapse. The Company states ... "it was apparent that a 3rd line into Red Bank would be required to effectively address this violation."[21]

The Company did not consider the extent to which alternatives other than a new transmission line would address the NERC violation, or what these alternatives would cost. So, there is no basis for the Company's assertion that only a new transmission line will effectively address the NERC violation. While it may be apparent that a new transmission line into Red Bank would address the violation, it is not apparent that a new transmission line would be required in order to do so, or that a new transmission line is the only reasonable alternative.

Q. Please discuss alternatives other than building a new transmission line that should be considered as a way to address the voltage collapse NERC violation.

A. A voltage collapse of the type involved in this case is typically driven by a shortage of reactive power. Reactive power is a component of electric power that is required to supply inductive loads, such as air conditioning compressors, elevator drives, and industrial motors. The outage of the two 230 kV transmission lines from Atlantic to Red Bank would cause an outage of the 230 kV to 34.5 kV transformers at Red Bank. These transformers feed into the 34.5 kV network in Monmouth County. When they are out of service, other transformers that supply 34.5 kV will try to pick up the slack. The power

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[21] Hozempa Direct: 18:15-19.

from these other transformers will have to travel further over more heavily loaded lines, causing voltage to sag. Frequently, devices such as capacitors are used to provide additional voltage support in times of need, but, switching capacitors takes more time than is typically available in order to prevent a voltage collapse.

There are approaches, other than building a new transmission line, to help control system voltage and to provide a very fast response to system voltage changes caused by faults or other causes. Attached as Exhibit PJL-3 is a description of a piece of equipment called static var compensator ("SVC"). This equipment monitors and supports electric system voltage through reactive power management. As described in Exhibit PJL-3:

SVC is the preferred tool for dynamic reactive power support in high voltage transmission grids. Thanks to its inherent capability for high-speed, cycle-by-cycle control of vars, it will counteract the often hazardous voltage depressions that follow in conjunction with faults in the grid.[22]

Another candidate to help control system voltage and to provide a very fast response to system voltage changes caused by faults or other causes is called a STATCOM, short for static compensator, which is a class of SVC. Attached as Exhibit PJL-10 is a description of the use of a STATCOM to supply reactive power and dynamically regulate system voltages[23].

[BEGIN CONFIDENTIAL] [redacted]

[22] See Exhibit PJL-3, pp. 4. Vars, which stands for volt-amperes reactive, is a metric that measures reactive power.

[23] Exhibit (PJL-10) is available in its entirety at http://www.sustainablepowersystems.com/wp-content/uploads/2016/03/GTM-Whitepaper-Integrating-High-Levels-of-Renewables-into-Microgrids.pdf

[redacted] [END CONFIDENTIAL] Thermal line overloads are a different type of NERC violation than the voltage collapse being used as the reason the Project is needed. I note that the need to reduce thermal line loading has not been featured as a reason for the Project. And, as for the need to react quickly, the SVC's reaction times are fast enough for "cycle by cycle" control, where a cycle is one-sixtieth of a second. An SVC alternative, if effective, could reduce costs and impacts compared to the Proposal. This alternative should be evaluated.

Q. Other than an SVC or STATCOM, please discuss any other potential non-transmission alternatives that might help address the NERC violation.

A. The possibility of using distributed generation, smart inverters, or smart grid technologies has been discussed in responses to discovery.[25] These have not been considered by the Company to address the NERC violation in this proceeding. Part of the reason for this is based on the same reasoning that the Company uses to justify its choice of a new transmission line; the fact that: (i) the contingencies causing the NERC violation being addressed by the Project involve the loss of two 230 kV transmission lines; and (ii) the magnitude of the potential voltage collapse make it apparent to the Company… "that a 3rd line into Red Bank would be required to effectively address this violation."[26]

As stated previously, the Company did not consider the extent to which alternatives other than a new transmission line would address the NERC violation, or what these

[24] See response to RCR-ENG-5 f. (CONFIDENTIAL) (Exhibit PJL-8)

[25] See responses to S-MCRP-20, RAGE-JCPL-91, and RAGE-JCPL-92.

[26] Hozempa Direct: 18:15-19.

alternatives would cost. So, there is no basis for the Company's assertion that only a new transmission line will effectively address the NERC violation. While it may be apparent that a new transmission line into Red Bank would address the violation, it is not apparent that a new transmission line would be required in order to do so, or that a new transmission line is the only reasonable alternative.

The Company also states that distributed generation or smart inverters, are market-driven responses which can't be used by PJM as a solution to NERC violations.[27] While there may be bureaucratic hurdles to PJM using these technologies in their system planning, there should be a place for trying to integrate them into the Company's operations. A first step would be to determine the extent to which such technologies can help address the NERC violation, and at what cost.

The Board should require an evaluation by the Company as to the ability of these and other technologies to enable the system to survive the NERC violation voltage collapse driving the Project. If these developing technologies have the potential to help efficiently alleviate the NERC violation, then the Board can make an informed decision as the value of considering ways to integrate them into the Company's planning and operations in order to overcome or bypass the bureaucratic hurdles to their use in transmission system planning and/or operations.

<u>TOWER HEIGHTS</u>

Q. Please discuss the heights of towers for the Project and for potential alternatives.

[27] Response to RAGE-JCPL-89 and RAGE-JCPL-90.

A. According to the Company's direct testimony, the towers for the Project are expected to range in height from 100 feet to 210 feet in height.[28] The Company compares these heights with typical 230 kV lines which range in height from 80 feet and higher.[29] There are indications that the tower heights proposed for the Project are considerably higher than for some other new 230 kV transmission line towers currently under consideration in New Jersey. For example, Atlantic City Electric Company ("ACE") is currently seeking Board approval of a new 230 kV double circuit transmission line in BPU Docket No. E016010043. Of the seven sections of the proposed ACE transmission facilities, one section has an estimated height of up to 130 feet, while four sections have estimated heights of up to 125 feet, and the remaining two sections have estimated heights of up to 115 feet and 105 feet.[30] When compared against the estimated peak height of 210 feet for the tallest towers in the JCP&L Project, the tallest tower in the ACE line, at 130 feet, is 80 feet shorter.

Most of the Project as proposed will be located above or near the catenary[31] of the NJT rail line. Complying with National Electric Safety Code ("NESC")[32] clearance requirements and NJT's additional clearance requirements[33] will result in conductors

[28] Whisner Direct, 6:16-17.

[29] Whisner Direct, 7:12-13.

[30] See ACE Petition, BPU Docket No. E016010043, pp. 10-16.

[31] The catenary is made up of overhead electrified wires from which an electrically-propelled train will draw electric power from above.

[32] NESC defines the minimum clearance distance required for electric wires of various voltages in various situations.

[33] NJT requires 10 feet of added clearance relative to NESC requirements.

being installed higher above ground compared to a transmission line installed above vacant ground.[34]

The Company did not perform any detailed design analysis on the transmission alternatives, so it has not been possible to compare tower heights for each of the transmission alternatives with those proposed for the Project. If any of the transmission alternatives have tower heights more in line with the proposed ACE 230 kV transmission line, this would represent a big decrease in tower heights, along with potential cost savings and reduced visual impacts that a significantly shorter transmission line could reflect. The Board should require more detailed information about the tower heights for the various transmission alternatives, so that a more meaningful comparison may be made.

CONCLUSION

Q. Please summarize your conclusions.

A. My testimony concludes:

1. The need for this project, which was initially determined in 2011, has been diminishing ever since. PJM planning rules, recently amended to help reduce, or even eliminate project cancellations due to changing conditions, have supposedly re-affirmed the need for this project. But, the date the proposed transmission line may be needed is uncertain and, based on the 2016 load forecast, does not appear to fall within PJM's 15 year planning horizon.

[34] See response to S-MCRP-48. (Exhibit PJL-7)

2. There appears to be a number of technical approaches to improving reliability that may avoid or mitigate the NERC violation that drive the need for the Project that the Company has apparently failed to consider. These include a static var compensator ("SVC"), distributed generation, smart invertors, or smart grid technologies.

3. The proposed routing of the transmission line follows a NJT rail ROW, access to which has yet to be granted. Whether access will be granted and what the terms and conditions of such access may be are currently unknown. The choice of the rail ROW contributes to the height of the line, which ranges up to 210 feet tall in some places.

4. The Company considered a number of alternative existing ROWs for the Project, but eliminated most from consideration for reliability-related reasons before detailed development. All these alternatives will address the stated reliability concerns driving the need for the Project. The Company developed cost estimates and tower heights only for their preferred route, so there is no basis for comparison between alternatives on a cost basis or on a visual impact basis.

5. I recommend that the Board defer its review of the Project pending: (i) more detailed consideration of technologies regarding voltage management, such as an SVC or STACOM, and other developing technologies; (ii) development of more detail regarding alternative routes, their costs, and their impacts, such as tower heights; (iii) resumption of load growth such that the load level at which the voltage problems have been observed in planning studies is forecast to occur within the planning horizon; and (iv) determination of whether NJT will allow use of its ROW and, if so, the terms and conditions under which the Company will be permitted to use the NJT rail ROW.

Q. Does this conclude your direct testimony?

A. Yes, at this time. However, I reserve the right to supplement this testimony as needed.

PJL – Exhibit 1 – Prior Experience of Peter J. Lanzalotta

Prior Experience Of Peter J. Lanzalotta

Mr. Lanzalotta has more than thirty-five years experience in electric utility system planning, power pool operations, distribution operations, electric service reliability, load and price forecasting, and market analysis and development. Mr. Lanzalotta has appeared as an expert witness on utility reliability, planning, operation, and rate matters in more than 110 proceedings in 25 states, the District of Columbia, the Provinces of Alberta and Ontario, before the Federal Energy Regulatory Commission, and before U. S. District Court. He has developed evaluations of electric utility system cost, system value, reliability planning, transmission and distribution maintenance practices, and reliability of service.

Prior to his forming Lanzalotta & Associates LLC in 2001, he was a Partner at Whitfield Russell Associates in Washington DC for fifteen years and a Senior Associate for approximately four years before that. He holds a Bachelor of Science in Electric Power Engineering from Rensselaer Polytechnic Institute and a Master of Business Administration with a concentration in Finance from Loyola College of Baltimore.

Prior to joining Whitfield Russell Associates in 1982, Mr. Lanzalotta was employed by the Connecticut Municipal Electric Energy Cooperative ("CMEEC") as a System Engineer. He was responsible for providing operational, financial, and rate expertise to Coop's budgeting, ratemaking and system planning processes. He participated on behalf of CMEEC in the Hydro-Quebec/New England Power Pool Interconnection project and initiated the development of a database to support CMEEC's pool billing and financial data needs.

Prior to his CMEEC employment, he served as Chief Engineer at the South Norwalk (Connecticut) Electric Works, with responsibility for planning, data processing, engineering, rates and tariffs, generation and bulk power sales, and distribution operations. While at South Norwalk, he conceived and implemented, through Northeast Utilities and NEPOOL, a peak-shaving plan for South Norwalk and a neighboring municipal electric utility, which resulted in substantial power supply savings. He programmed and implemented a computer system to perform customer billing and maintain accounts receivable accounting. He also helped manage a generating station overhaul and the undergrounding of the distribution system in South Norwalk's downtown.

From 1977 to 1979, Mr. Lanzalotta worked as a public utility consultant for Van Scoyoc & Wiskup and separately for Whitman Requart & Associates in a variety of positions. During this time, he developed cost of service, rate base evaluation, and rate design impact data to support direct testimony and exhibits in a variety of utility proceedings, including utility price squeeze cases, gas pipeline rates, and wholesale electric rate cases.

Prior to that, He worked for approximately 2 years as a Service Tariffs Analyst for the Finance Division of the Baltimore Gas & Electric Company where he developed cost and revenue studies, evaluated alternative rate structures, and studied the rate structures of other utilities for a variety of applications. He was also employed by BG&E in Electric System Operations for approximately 3 years, where his duties included operations analysis, outage reporting, and participation in the development of BG&E's first computerized customer information and service order system.

Mr. Lanzalotta is a member of the Institute of Electrical & Electronic Engineers, the Association of Energy Engineers, the National Fire Protection Association, and the American Solar Energy Society. He is also registered Professional Engineer in the states of Maryland and Connecticut.

PJL – Exhibit 2 – Proceedings in Which Peter J. Lanzalotta Has Testified

Proceedings In Which
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1. **In re: Public Service Company of New Mexico**, Docket Nos. ER78-337 and ER78-338 before the Federal Energy Regulatory Commission, concerning the need for access to calculation methodology underlying filing.

2. **In re: Baltimore Gas and Electric Company**, Case No. 7238-V before the Maryland Public Service Commission, concerning outage replacement power costs.

3. **In re: Houston Lighting & Power Company**, Texas Public Utilities Commission Docket No. 4712, concerning modeling methods to determine rates to be paid to cogenerators and small power producers.

4. **In re: Nevada Power Company**, Nevada Public Service Commission, Docket No. 83-707 concerning rate case fuel inventories, rate base items, and O&M expense.

5. **In re: Virginia Electric & Power Company**, Virginia State Corporation Commission, Case No. PUE820091, concerning the operating and reliability-based need for additional transmission facilities.

6. **In re: Public Service Electric & Gas Company**, New Jersey Board of Public Utilities, Docket No. 831-25, concerning outage replacement power costs.

7. **In re: Philadelphia Electric Company**, Pennsylvania Public Utilities Commission, Docket No. P-830453, concerning outage replacement power costs.

8. **In re: Cincinnati Gas & Electric Company**, Public Utilities Commission of Ohio, Case No. 83-33-EL-EFC, concerning the results of an operations/fuel-use audit conducted by Mr. Lanzalotta.

9. **In re: Kansas City Power and Light Company**, before the State Corporation Commission of the state of Kansas, Docket Nos. 142,099-U and 120,924-U, concerning the determination of the capacity, from a new base-load generating facility, needed for reliable system operation, and the capacity available from existing generating units.

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10. **In re: Philadelphia Electric Company**, Pennsylvania Public Utilities Commission, Docket No. R-850152, concerning the determination of the capacity, from a new base-load generating facility, needed for reliable system operation, and the capacity available from existing generating units.

11. **In re: ABC Method Proposed for Application to Public Service Company of Colorado**, before the Public Utilities Commission of the State of Colorado, on behalf of the Federal Executive Agencies ("FEA"), concerning a production cost allocation methodology proposed for use in Colorado.

12. **In re: Duquesne Light Company**, Docket No. R-870651, before the Pennsylvania Public Utilities Commission, on behalf of the Office of Consumer Advocate, concerning the system reserve margin needed for reliable service.

13. **In re: Pennsylvania Power Company**, Docket No. I-7970318 before the Pennsylvania Public Utilities Commission, on behalf of the Office of Consumer Advocate, concerning outage replacement power costs.

14. **In re: Commonwealth Edison Company**, Docket No. 87-0427 before the Illinois Commerce Commission, on behalf of the Citizen's Utility Board of Illinois, concerning the determination of the capacity, from new base-load generating facilities, needed for reliable system operation.

15. **In re: Central Illinois Public Service Company**, Docket No. 88-0031 before the Illinois Commerce Commission, on behalf of the Citizen's Utility Board of Illinois, concerning the degree to which existing generating capacity is needed for reliable and/or economic system operation.

16. **In re: Illinois Power Company**, Docket No. 87-0695 before the State of Illinois Commerce Commission, on behalf of Citizens Utility Board of Illinois, Governors Office of Consumer Services, Office of Public Counsel and Small Business Utility Advocate, concerning the determination of the capacity, from a new base-load generating facility, needed for reliable system operation, and the capacity available from existing generating units.

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17. **In re: Florida Power Corporation**, Docket No. 860001-EI-G (Phase II), before the Florida Public Service Commission, on behalf of the Federal Executive Agencies of the United States, concerning an investigation into fuel supply relationships of Florida Power Corporation.

18. **In re: Potomac Electric Power Company**, before the Public Service Commission of the District of Columbia, Docket No. 877, on behalf of the Public Service Commission Staff, concerning the need for and availability of new generating facilities.

19. **In re: South Carolina Electric & Gas Company**, before the South Carolina Public Service Commission, Docket No. 88-681-E, On Behalf of the State of Carolina Department of Consumer Affairs, concerning the capacity needed for reliable system operation, the capacity available from existing generating units, relative jurisdictional rate of return, reconnection charges, and the provision of supplementary, backup, and maintenance services for QFs.

20. **In re: Commonwealth Edison Company**, Illinois Commerce Commission, Docket Nos. 87-0169, 87-0427, 88-0189, 88-0219, and 88-0253, on behalf of the Citizen's Utility Board of Illinois, concerning the determination of the capacity, from a new base-load generating facility, needed for reliable system operation.

21. **In re: Illinois Power Company**, Illinois Commerce Commission, Docket No. 89-0276, on behalf of the Citizen's Utility Board Of Illinois, concerning the determination of capacity available from existing generating units.

22. **In re: Jersey Central Power & Light Company**, New Jersey Board of Public Utilities, Docket No. EE88-121293, on behalf of the State of New Jersey Department of the Public Advocate, concerning evaluation of transmission planning.

23. **In re: Canal Electric Company**, before the Federal Energy Regulatory Commission, Docket No. ER90-245-000, on behalf of the Municipal Light Department of the Town of Belmont, Massachusetts, concerning the reasonableness of Seabrook Unit No. 1 Operating and Maintenance expense.

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24. **In re: New Hampshire Electric Cooperative Rate Plan Proposal**, before the New Hampshire Public Utilities Commission, Docket No. DR90-078, on behalf of the New Hampshire Electric Cooperative, concerning contract valuation.

25. **In re: Connecticut Light & Power Company**, before the Connecticut Department of Public Utility Control, Docket No. 90-04-14, on behalf of a group of Qualifying Facilities concerning O&M expenses payable by the QFs.

26. **In re: Duke Power Company**, before the South Carolina Public Service Commission, Docket No. 91-216-E, on behalf of the State of South Carolina Department of Consumer Advocate, concerning System Planning, Rate Design and Nuclear Decommissioning Fund issues.

27. **In re: Jersey Central Power & Light Company**, before the Federal Energy Regulatory Commission, Docket No. ER91-480-000, on behalf of the Boroughs of Butler, Madison, Lavallette, Pemberton and Seaside Heights, concerning the appropriateness of a separate rate class for a large wholesale customer.

28. **In re: Potomac Electric Power Company**, before the Public Service Commission of the District of Columbia, Formal Case No. 912, on behalf of the Staff of the Public Service Commission of the District of Columbia, concerning the Application of PEPCO for an increase in retail rates for the sale of electric energy.

29. **Commonwealth of Pennsylvania, House of Representatives**, General Assembly House Bill No. 2273. Oral testimony before the Committee on Conservation, concerning proposed Electromagnetic Field Exposure Avoidance Act.

30. **In re: Hearings on the 1990 Ontario Hydro Demand\Supply Plan**, before the Ontario Environmental Assessment Board, concerning Ontario Hydro's System Reliability Planning and Transmission Planning.

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31. **<u>In re: Maui Electric Company</u>**, Docket No. 7000, before the Public Utilities Commission of the State of Hawaii, on behalf of the Division of Consumer Advocacy, concerning MECO's generation system, fuel and purchased power expense, depreciation, plant additions and retirements, contributions and advances.

32. **<u>In re: Hawaiian Electric Company, Inc.</u>**, Docket No. 7256, before the Public Utilities Commission of the State of Hawaii, on behalf of the Division of Consumer Advocacy, concerning need for, design of, and routing of proposed transmission facilities.

33. **<u>In re: Commonwealth Edison Company</u>**, Docket No. 94-0065 before the Illinois Commerce Commission on behalf of the City of Chicago, concerning the capacity needed for system reliability.

34. **<u>In re: Commonwealth Edison Company</u>**, Docket No. 93-0216 before the Illinois Commerce Commission on behalf of the Citizens for Responsible Electric Power, concerning the need for proposed 138 kV transmission and substation facilities.

35. **<u>In re: Commonwealth Edison Company</u>**, Docket No. 92-0221 before the Illinois Commerce Commission on behalf of the Friends of Illinois Prairie Path, concerning the need for proposed 138 kV transmission and substation facilities.

36. **<u>In re: Commonwealth Edison Company</u>**, Docket No. 94-0179 before the Illinois Commerce Commission on behalf of the Friends of Sugar Ridge, concerning the need for proposed 138 kV transmission and substation facilities.

37. **<u>In re: Public Service Company of Colorado</u>**, Docket Nos. 95A-531EG and 95I-464E before the Colorado Public Utilities Commission on behalf of the Office of Consumer Counsel, concerning a proposed merger with Southwestern Public Service Company and a proposed performance-based rate-making plan.

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38. **In re: South Carolina Electric & Gas Company, Duke Power Company, and Carolina Power & Light Company**, Docket No. 95-1192-E, before the South Carolina Public Service Commission on behalf of the South Carolina Department of Consumer Advocate, concerning avoided cost rates payable to qualifying facilities.

39. **In re: Lawrence A. Baker v. Truckee Donner Public Utility District**, Case No. 55899, before the Superior Court of the State of California on behalf of Truckee Donner Public Utility District, concerning the reasonableness of electric rates.

40. **In re: Black Hills Power & Light Company**, Docket No. OA96-75-000, before the Federal Energy Regulatory Commission on behalf of the City of Gillette, Wyoming, concerning the Black Hills' proposed open access transmission tariff.

41. **In re: Metropolitan Edison Company and Pennsylvania Electric Company** for Approvals of the Restructuring Plan Under Section 2806, Docket Nos. R-00974008 and R-00974009 before the Pennsylvania PUC on behalf of Operating NUG Group, concerning miscellaneous restructuring issues.

42. **In re: New Jersey State Restructuring Proceeding** for consideration of proposals for retail competition under BPU Docket Nos. EX94120585U; E097070457; E097070460; E097070463; E097070466 before the New Jersey BPU on behalf of the New Jersey Division of Ratepayer Advocate, concerning load balancing, third party settlements, and market power.

43. **In re: Arbitration Proceeding In City of Chicago v. Commonwealth Edison** for consideration of claims that franchise agreement has been breached, Proceeding No. 51Y-114-350-96 before an arbitration panel board on behalf of the City of Chicago concerning electric system reliability.

44. **In re: Transalta Utilities Corporation**, Application No. RE 95081 on behalf of the ACD companies, before the Alberta Energy And Utilities Board in reference to the use and value of interruptible capacity.

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45. **In re: Consolidated Edison Company,** Docket No. EL99-58-000 on behalf of The Village of Freeport, New York, before FERC in reference to remedies for a breach of contract to provide firm transmission service on a non-discriminatory basis.

46. **In re: ESBI Alberta Ltd.,** Application No. 990005 on behalf of the FIRM Customers, before the Alberta Energy And Utilities Board concerning the reasonableness of the cost of service plus management fee proposed for 1999 and 2000 by the transmission administrator.

47. **In re: South Carolina Electric & Gas Company,** Docket No. 2000-0170-E on behalf of the South Carolina Department of Consumer Affairs before the Public Service Commission of South Carolina concerning an application for a Certificate of Environmental Compatibility and Public Convenience and Necessity for new and repowered generating units at the Urquhart generating station.

48. **In re: BGE,** Case No. 8837 on behalf of the Maryland Office of People's Counsel before the Maryland Public Service Commission concerning proposed electric line extension charges.

49. **In re: PEPCO,** Case No. 8844 on behalf of the Maryland Office of People's Counsel before the Maryland Public Service Commission concerning proposed electric line extension charges.

50. **In re: GenPower Anderson LLC,** Docket No. 2001-78-E on behalf of the South Carolina Department of Consumer Affairs before the Public Service Commission of South Carolina concerning an application for a Certificate of Environmental Compatibility and Public Convenience and Necessity for new generating units at the GenPower Anderson LLC generating station.

51. **In re: Pike County Light & Power Company,** Docket No. P-00011872, on behalf of Pennsylvania Office of Consumer Advocate before the Pennsylvania Public Utility Commission concerning the Pike County request for a retail rate cap exception.

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52. **<u>In re: Potomac Electric Power Company and Conectiv,</u>** Case No. 8890, on behalf of the Maryland Office of People's Counsel before the Maryland Public Service Commission concerning the proposed merger of Potomac Electric Power Company and Conectiv.

53. **<u>In re: South Carolina Electric & Gas Company,</u>** Docket No. 2001-420-E on behalf of the South Carolina Department of Consumer Affairs before the Public Service Commission of South Carolina concerning an application for a Certificate of Environmental Compatibility and Public Convenience and Necessity for new generating units at the Jasper County generating station.

54. **<u>In re: Connecticut Light & Power Company,</u>** Docket No. 217 on behalf of the Towns of Bethel, Redding, Weston, and Wilton, Connecticut before the Connecticut Siting Council concerning an application for a Certificate of Environmental Compatibility and Public Need for a new transmission line facility between Plumtree Substation, Bethel and Norwalk Substation, Norwalk.

55. **<u>In re: The City of Vernon, California,</u>** Docket No. EL02-103 on behalf of the City of Vernon before the Federal Energy Regulatory Commission concerning Vernon's transmission revenue balancing account adjustment reflecting calendar year 2001 transactions.

56. **<u>In re: San Diego Gas & Electric Company et. al.,</u>** Docket No. EL00-95-045 on behalf of the City of Vernon, California before the Federal Energy Regulatory Commission concerning refunds and other monies payable in the California wholesale energy markets.

57. **<u>In re: The City of Vernon, California,</u>** Docket No. EL03-31 on behalf of the City of Vernon before the Federal Energy Regulatory Commission concerning Vernon's transmission revenue balancing account adjustment reflecting 2002 transactions.

58. **<u>In re: Jersey Central Power & Light Company,</u>** Docket Nos. ER02080506, ER02080507, ER02030173, and EO02070417 on behalf of the New Jersey Division of Ratepayer Advocate before the New Jersey Board of Public Utilities concerning reliability issues involved in the approval of an increase in

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base tariff rates.

59. **In re: Proposed Electric Service Reliability Rules, Standards, and Indices To Ensure Reliable Service by Electric Distribution Companies,** PSC Regulation Docket No. 50, on behalf of the Delaware Public Service Commission Staff before the Delaware Public Service Commission concerning proposed electric service reliability rules, standards and indices.

60. **In re: Central Maine Power Company,** Docket No. 2002-665, on behalf of the Maine Public Advocate and the Town of York before the Maine Public Utilities Commission concerning a Request for Commission Investigation into the New CMP Transmission Line Proposal for Eliot, Kittery, and York.

61. **In re: Metropolitan Edison Company,** Docket No. C-20028394, on behalf of the Pennsylvania Office of Consumer Advocate, before the Pennsylvania Public Utility Commission concerning the reliability service complaint of Robert Lawrence.

62. **In re: The California Independent System Operator Corporation,** Docket No. ER00-2019 *et al.* on behalf of the City of Vernon, California, before the Federal Energy Regulatory Commission concerning wholesale transmission tariffs, rates and rate structures proposed by the California ISO.

63. **In re: The Narragansett Electric Company,** Docket No. 3564 on behalf of the Rhode Island Department of Attorney General, before the Rhode Island Public Utilities Commission concerning the proposed relocation of the E-183 transmission line.

64. **In re: The City of Vernon, California,** Docket No. EL04-34 on behalf of the City of Vernon before the Federal Energy Regulatory Commission concerning Vernon's transmission revenue balancing account adjustment reflecting 2003 transactions.

65. **In re: Atlantic City Electric Company,** Docket No. ER03020110 on behalf of the New Jersey Division of Ratepayer Advocate before the New Jersey Board of Public Utilities concerning reliability issues involved in the approval of an increase in base tariff rates.

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66. **In re: Connecticut Light & Power Company and the United Illuminating Company,** Docket No. 272 on behalf of the Towns of Bethany, Cheshire, Durham, Easton, Fairfield, Hamden, Middlefield, Milford, North Haven, Norwalk, Orange, Wallingford, Weston, Westport, Wilton, and Woodbridge, Connecticut before the Connecticut Siting Council concerning an application for a Certificate of Environmental Compatibility and Public Need for a new transmission line facility between the Scoville Rock Switching Station in Middletown and the Norwalk Substation in Norwalk, Connecticut.

67. **In re: Metropolitan Edison Company, Pennsylvania Electric Company, and Pennsylvania Power Company,** Docket No. I-00040102, on behalf of the Pennsylvania Office of Consumer Advocate before the Pennsylvania Public Utility Commission concerning electric service reliability performance.

68. **In re: Entergy Louisiana, Inc.,** Docket No. U-20925 RRF-2004 on behalf of Bayou Steel before the Louisiana Public Service Commission concerning a proposed increase in base rates.

69. **In re: Jersey Central Power & Light Company,** Docket No. ER02080506, Phase II, on behalf of the New Jersey Division of Ratepayer Advocate before the New Jersey Board of Public Utilities concerning reliability issues involved in the approval of an increase in base tariff rates.

70. **In re: Maine Public Service Company,** Docket No. 2004-538, on behalf of the Main Public Advocate before the Maine Public Utilities Commission concerning a request to construct a 138 kV transmission line from Limestone, Maine to the Canadian border near Hamlin, Maine.

71. **In re: Pike County Light and Power Company,** Docket No. M-00991220F0002, on behalf of the Pennsylvania Office of Consumer Advocate before the Pennsylvania Public Utility Commission concerning the Company's Petition to amend benchmarks for distribution reliability.

72. **In re: Atlantic City Electric Company,** Docket No. EE04111374, on behalf of the New Jersey Division of Ratepayer Advocate before the New Jersey

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Board of Public Utilities concerning the need for transmission system reinforcement, and related issues.

73. **In re: Bangor Hydro-Electric Company,** Docket No. 2004-771, on behalf of the Main Public Advocate before the Maine Public Utilities Commission concerning a request to construct a 345 kV transmission line from Orrington, Maine to the Canadian border near Baileyville, Maine.

74. **In re: Eastern Maine Electric Cooperatve,** Docket No. 2005-17, on behalf of the Main Public Advocate before the Maine Public Utilities Commission concerning a petition to approve a purchase of transmission capacity on a 345 kV transmission line from Maine to the Canadian province of New Brunswick.

75. **In re: Virginia Electric and Power Company,** Case No. PUE-2005-00018, on behalf of the Town of Leesburg VA and Loudoun County VA before the Virginia State Corporation Commission concerning a request for a certificate of public convenience and necessity for transmission and substation facilities in Loudoun County.

76. **In re: Proposed Electric Service Reliability Rules, Standards, and Indices To Ensure Reliable Service by Electric Distribution Companies,** PSC Regulation Docket No. 50, on behalf of the Delaware Public Service Commission Staff before the Delaware Public Service Commission concerning proposed electric service reliability reporting, standards, and indices.

77. **In re: Proposed Merger Involving Constellation Energy Group Inc. and the FPL Group, Inc.,** Case No. 9054, on behalf of the Maryland Office of Peoples' Counsel before the Maryland Public Service Commission concerning the proposed merger involving Baltimore Gas & Electric Company and Florida Light & Power Company.

78. **In re: Proposed Sale and Transfer of Electric Franchise of the Town of St. Michaels to Choptank Electric Cooperative, Inc.,** Case No. 9071, on behalf of the Maryland Office of Peoples' Counsel before the Maryland Public Service Commission concerning the sale by St. Michaels of their electric franchise and service area to Choptank.

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79. **<u>In re: Petition of Rockland Electric Company for the Approval of Changes in Electric Rates, and Other Relief,</u>** BPU Docket No. ER06060483, on behalf of the Department of the Public Advocate, Division of Rate Counsel, before the New Jersey Board of Public Utilities, concerning electric service reliability and reliability-related spending.

80. **<u>In re: The Complaint of the County of Pike v. Pike County Light & Power Company, Inc.,</u>** Docket No. C-20065942, et al., on behalf of the Pennsylvania Office of Consumer Advocate before the Pennsylvania Public Utilities Commission, concerning electric service reliability and interconnecting with the PJM ISO.

81. **<u>In re: Application of American Transmission Company to Construct a New Transmission Line,</u>** Docket No. 137-CE-139, on behalf of The Sierra Club of Wisconsin, before the Public Service Commission of Wisconsin, concerning the request to build a new 138 kV transmission line.

82. **<u>In re: The Matter of the Self-Complaint of Columbus Southern Power Company and Ohio Power Company Regarding the Implementation of Programs to Enhance Distribution Service Reliability,</u>** Case No. 06-222-EL-SLF, on behalf of The Office of The Ohio Consumers' Counsel, before the Public Utilities Commission of Ohio, concerning distribution system reliability and related topics.

83. **<u>In re: Central Maine Power Company,</u>** Docket No. 2006-487, on behalf of the Maine Public Advocate before the Maine Public Utilities Commission concerning CMP's Petition for Finding of Public Convenience & Necessity to build a 115 kV transmission line between Saco and Old Orchard Beach.

84. **<u>In re: Bangor Hydro Electric Company,</u>** Docket No. 2006-686, on behalf of the Maine Public Advocate before the Maine Public Utilities Commission concerning BHE's Petition for Finding of Public Convenience & Necessity to build a 115 kV transmission line and substation in Hancock County.

85. **<u>In re: Commission Staff's Petition For Designation of Competitive Renewable Energy Zones,</u>** Docket No. 33672, on behalf of the Texas Office

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of Public Utility Counsel, concerning the Staff's Petition and the determination of what areas should be designated as CREZs by the Commission.

86. **In re: Virginia Electric and Power Company,** Case No. PUE-2006-00091, on behalf of the Towering Concerns and Stafford County VA before the Virginia State Corporation Commission concerning a request for a certificate of public convenience and necessity for electric transmission and substation facilities in Stafford County.

87. **In re: Trans-Allegheny Interstate Line Company,** Docket Nos. A-110172 et al., on behalf of the Pennsylvania Office of Consumer Advocate, before the Pennsylvania Public Utility Commission, concerning a request for a certificate of public convenience and necessity for electric transmission and substation facilities in Pennsylvania.

88. **In re: Commonwealth Edison Company,** Docket No. 07-0566, on behalf of the Illinois Attorney General, before the Illinois Commerce Commission, concerning electric transmission and distribution projects promoted as smart grid projects, and the rider proposed to pay for them.

89. **In re: Commonwealth Edison Company,** Docket No. 07-0491, on behalf of the Illinois Attorney General, before the Illinois Commerce Commission, concerning the applicability of electric service interruption provisions.

90. **In re: Hydro One Networks ,** Case No. EB-2007-0050, on behalf of Pollution Probe, before the Ontario Energy Board, concerning a request for leave to construct electric transmission facilities in the Province of Ontario.

91. **In re: PEPCO Holdings, Inc.,** Docket No. ER-08-686-000, on behalf of the Maryland Office of Peoples' Counsel, before the Federal Energy Regulatory Commission, concerning a request for incentive rates of return on transmission projects.

92. **In re: PPL Electric Utilities Corporation and Public Service Electric and Gas Company,** Docket No. ER-08-23-000, on behalf of the Joint Consumer Advocates, including the state consumer advocacy offices for the States of

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Maryland, West Virginia, before the Federal Energy Regulatory Commission, concerning a request for incentive rates of return on transmission projects.

93. **<u>In re: PPL Electric Utilities Corporation,</u>** Docket Nos. A-2008-2022941 and P-2008-2038262, on behalf of Springfield Township, Bucks County, PA, before the Pennsylvania Public Utility Commission, concerning the need for and alternatives to proposed electric transmission lines and a proposed electric substation.

94. **<u>In re: PEPCO Holdings, Inc.,</u>** Docket No. ER08-1423-000, on behalf of the Maryland Office of Peoples' Counsel, before the Federal Energy Regulatory Commission, concerning a request for incentive rates of return on transmission projects.

95. **<u>In re: Public Service Electric and Gas Company, Inc.,</u>** Docket No. ER09-249-000, on behalf of the New Jersey Division of Rate Counsel, before the Federal Energy Regulatory Commission, concerning a request for incentive rates of return on transmission projects.

96. **<u>In re: New York Regional Interconnect Inc.,</u>** Case No. 06-T-0650, on behalf of the Citizens Against Regional Interconnect, before the New York Public Service Commission, concerning the economics of and alternatives to proposed transmission facilities.

97. **<u>In re: Central Maine Power Company and Public Service of New Hampshire,</u>** Docket No. 2008-255, on behalf of the Maine Public Advocate, before the Maine Public Utilities Commission, concerning CMP's and PSNH's Petition for Finding of Public Convenience & Necessity to build the Maine Power Reliability Project, a series of new and rebuilt electric transmission facilities to operate at 345 kV and 115 kV in Maine and New Hampshire.

98. **<u>In re: PPL Electric Utilities Corporation, Docket No. A-2009-2082652 et al,</u>** on behalf of the Pennsylvania Office of Consumer Advocate, before the Pennsylvania Public Utility Commission, concerning the Company's application for approval to site and construct electric transmission facilities in Pennsylvania.

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99. **In re: Bangor Hydro-Electric,** Docket No. 2009-26, on behalf of the Maine Public Advocate, before the Maine Public Utilities Commission, concerning BHE's Petition for Certificate of Public Convenience & Necessity to build a 115 kV transmission line in Washington and Hancock Counties.

100. **In re: United States, et al. v. Cinergy Corp., et al.** Civil Action No. IP99-1693 C-M/S, on behalf of Plaintiff United States and Plaintiff-Intervenors State of New York, State of New Jersey, State of Connecticut, Hoosier Environmental Council, and Ohio Environmental Council, before the United States District Court for the Southern District of Indiana, concerning the system reliability impacts of the potential retirement of Gallagher Power Station Unit 1 and Unit 3.

101. **In re: Application of Potomac Electric Power Company, et al.** Case No. 9179, on behalf of the Maryland Office of Peoples' Counsel before the Maryland Public Service Commission concerning the application for a determination of need under a certificate of public convenience and necessity for the Maryland portion of the MAPP transmission line, and related facilities.

102. **In re: Potomac Electric Power Company v. Perini/Tompkins Joint Venture,** Case No. 9210, on behalf of Perini Tompkins before the Maryland Public Service Commission concerning a review of PEPCO's estimates of electric consumption by Perini Tompkins Joint Venture's temporary electric service at National Harbor during a 29 month period for which no metered consumption data is available.

103. **In re: Duke Energy Ohio, Inc.,** Case No. 10-503-EL-FOR, on behalf of the Natural Resources Defense Council and Sierra Club before the Public Utilities Commission Of Ohio, concerning a review of the reliability impacts that would result from closure of selected generating units as part of a review of Duke's 2010 Electric Long-Term Forecast Report and Resources Plan.

104. **In re: Detroit Edison Company,** Case Nos. U-16472 and 16489, on behalf of the Michigan Environmental Council and the Natural Resources Defense Council, before the Michigan Public Service Commission, concerning a review looking for studies of the reliability impacts that would result from closure of selected generating units as part of an electric rate increase case.

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105. **In re: Potomac Electric Power Company,** Case No. 9240, on behalf of the Maryland Office of Peoples' Counsel, before the Maryland Public Service Commission, concerning electric service reliability performance.

106. **In re: ISO New England, Inc.,** Docket No. ER12-991-000, on behalf of the Conservation Law Foundation, before the Federal Energy Regulatory Commission, concerning proposals for procedures for obtaining temporary regulations addressing emissions from electric generating facilities.

107. **In re: Western Massachusetts Electric Company, Docket No. D.P.U. 11-119-C** on behalf of the Attorney General of the Commonwealth of Massachusetts, before the Massachusetts Department of Public Utilities, concerning storm preparation, performance, and restoration of electric service.

108. **In re: Delmarva Power & Light Company,** Case No. 9285, on behalf of the Maryland Office of Peoples' Counsel, before the Maryland Public Service Commission, concerning storm restoration expenses and tree trimming expenses as part of a base rate increase case.

109. **In re: Potomac Electric Power Company,** Case No. 9286, on behalf of the Maryland Office of Peoples' Counsel, before the Maryland Public Service Commission, concerning storm restoration expenses and tree trimming expenses as part of a base rate increase case.

110. **In re: Fitchburg Gas And Electric Company,** Civil Action No. 09-00023, on behalf of Marcia D. Bellerman, et al., before the Commonwealth of Massachusetts Superior Court, concerning company and electric system preparedness and execution in dealing with a major winter storm.

111. **In re: Duke Energy Indiana, Inc.,** Cause No. 44217, on behalf of Citizens Action Coalition of Indiana, Sierra Club, Save The Valley, and Valley Watch, before the Indiana Utility Regulatory Commission, concerning the role of transmission planning studies as part of the process of deciding whether to retire coal-fired generation or equip such generation with environmental retrofits.

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Has Testified

112. **In re: Indianapolis Power & Light Company,** Cause No. 44242, on behalf of Citizens Action Coalition of Indiana and the Sierra Club, before the Indiana Utility Regulatory Commission, concerning the role of transmission planning studies as part of the process of deciding whether to retire coal-fired generation or equip such generation with environmental retrofits.

113. **In re: Consumers Energy Company,** Case No. U-17087, on behalf of Michigan Environmental Council and Natural Resources Defense Council, before the Michigan Public Service Commission, concerning the role of transmission planning studies as part of the process of deciding whether to retire coal-fired generation or equip such generation with environmental retrofits.

114. **In re: Potomac Electric Power Company,** Case No. 9311, on behalf of the Maryland Office of Peoples' Counsel, before the Maryland Public Service Commission, concerning electric service reliability matters and tree trimming expenses as part of a base rate increase case.

115. **In re: Jersey Central Power & Light Company,** BPU Docket No. ER12111052, on behalf of the New Jersey Division of Rate Counsel, before the New Jersey Board of Public Utilities, concerning reliability issues and storm performance involved in the approval of an increase in base tariff rates.

116. **In re: Delmarva Power & Light Company,** Case No. 9317, on behalf of the Maryland Office of Peoples' Counsel, before the Maryland Public Service Commission, concerning electric service reliability matters as part of a base rate increase case.

117. **In re: PPL Electric Utilities Corporation,** Docket Nos. A-2012-2340872 et al., on behalf of the Pennsylvania Office of Consumer Advocate, before the Pennsylvania Public Utility Commission, concerning the need for and alternatives to proposed electric transmission lines and proposed electric substations as part of the Northeast Pocono Reliability Project.

118. **In re: Baltimore Gas & Electric Co.,** Case No. 9326, on behalf of the Maryland Office of Peoples' Counsel, before the Maryland Public Service

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Has Testified

Commission, concerning electric service reliability matters as part of a base rate increase case.

119. **In re: Jersey Central Power & Light Company,** BPU Docket Nos. EO13050391 and AX13030196, on behalf of the New Jersey Division of Rate Counsel, before the New Jersey Board of Public Utilities, concerning the prudency of costs incurred in response to major storms.

120. **In re: Potomac Electric Power Company,** Case No. 9336, on behalf of the Maryland Office of Peoples' Counsel, before the Maryland Public Service Commission, concerning electric service reliability matters as part of a base rate increase case.

121. **In re: Baltimore Gas & Electric Co.,** Case No. 9355, on behalf of the Maryland Office of Peoples' Counsel, before the Maryland Public Service Commission, concerning electric service reliability matters as part of a base rate increase case.

122. **In re: American Transmission Company LLC and Northern States Power Company – Wisconsin,** Docket No. 5-CE-142, on behalf of Citizens Energy Task Force, Inc. and Save Our Unique Lands of Wisconsin, Inc., before the Public Service Commission of Wisconsin, concerning the need for and the benefits expected from proposed transmission facilities.

123. **In re: Potomac-Appalachian Transmission Highline, LLC and PJM Interconnection, LLC,** Docket Nos. ER09-1256-002 and ER12-2708-003, on behalf of Intervenors' State Agencies, including the Virginia Office Of The Attorney General's Division Of Consumer Counsel, the Delaware Division Of The Public Advocate, the Maryland Office Of People's Counsel, the Maryland Public Service Commission, the Delaware Public Service Commission, and the Pennsylvania Office Of Consumer Advocate, before the Federal Energy Regulatory Commission, concerning transmission line abandonment costs.

124. **In re: The Matter of the Merger of Exelon Corporation and Pepco Holdings, Inc.,** Case No. 9361, on behalf of the Maryland Office of Peoples' Counsel, before the Maryland Public Service Commission, concerning electric service reliability-related matters as part of a proposed merger case.

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Has Testified

125. **In re: the Matter of the Application of the Ohio Edison Company, the Cleveland Electric Illuminating Company and the Toledo Edison Company for Authority to Provide for an Electric Security Plan,** Case No. 14-1297-EL-SSO, on behalf of the Sierra Club, before the Public Utilities Commission Of Ohio, concerning electric system reliability and transmission matters.

126. **In re: Delmarva Power & Light Company,** Case No. 9393, on behalf of the Maryland Office of Peoples' Counsel, before the Maryland Public Service Commission, concerning an application for a CPCN for a new 138 kV electric transmission line.

127. **In re: The Baltimore Gas & Electric Company,** Case No. 9406, on behalf of the Maryland Office of Peoples' Counsel, before the Maryland Public Service Commission, concerning electric service reliability-related matters as part of a base rate increase case.

128. **In re: The Potomac Electric Power Company,** Case No. 9418, on behalf of the Maryland Office of Peoples' Counsel, before the Maryland Public Service Commission, concerning electric service reliability-related matters as part of a base rate increase case.

129. **In re: The Matter Of Nova Scotia Power Performance Standards ,** Case No. M07387, on behalf of the Nova Scotia Consumer Advocate, before the Nova Scotia Utility and Review Board, concerning electric service reliability-related performance standards.

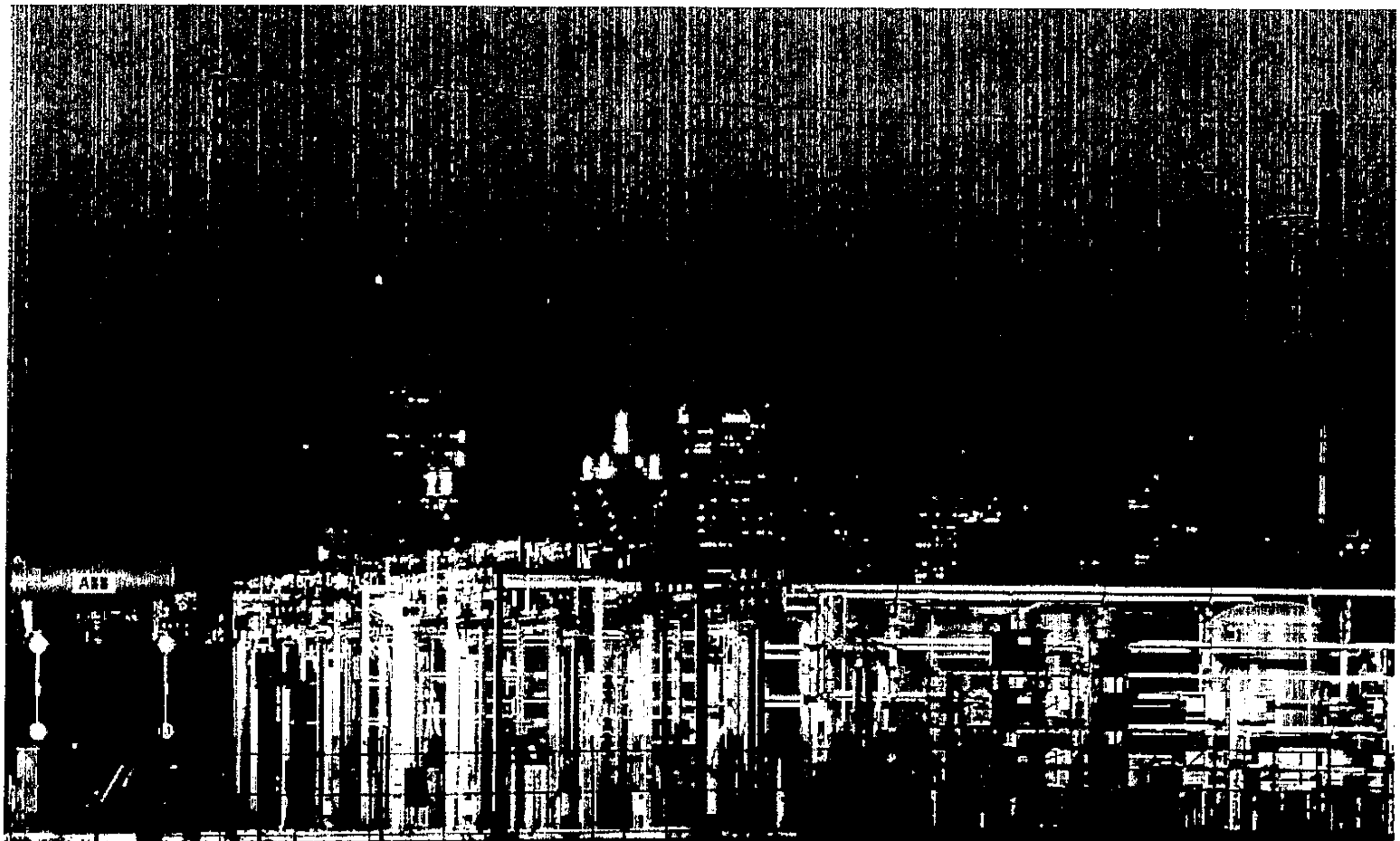
130. **In re: the Matter of the Application of the Ohio Power Company,** Case No. 13-1939-EL-RDR, on behalf of the Ohio Consumers' Counsel, before the Public Utilities Commission Of Ohio, concerning Phase 2 of its gridSMART Project and its gridSMART Phase 2 Rider.

131. **In re: PECO Energy Company,** Docket No. P-2016-2546452 et al., on behalf of the Pennsylvania Office of Consumer Advocate, before the Pennsylvania Public Utility Commission, concerning a proposed microgrid pilot plan and recovery of its costs.

Proceedings In Which
Peter J. Lanzalotta
Has Testified

132. **In re: The Delmarva Power & Light Company,** Case No. 9424, on behalf of the Maryland Office of Peoples' Counsel, before the Maryland Public Service Commission, concerning electric service reliability-related matters as part of a base rate increase case.

PJL – Exhibit 3 – SVC Static Var Compensator



An insurance for improved grid system stability and reliability

Power and productivity

ABB

It's not the power in that counts...
...it's the power that comes out!

Increased efficiency in power systems

Demand is rising all the time and modern society would cease to function without access to electricity. As the volume of power transmitted and distributed increases, so do the requirements for high quality and reliable supply.

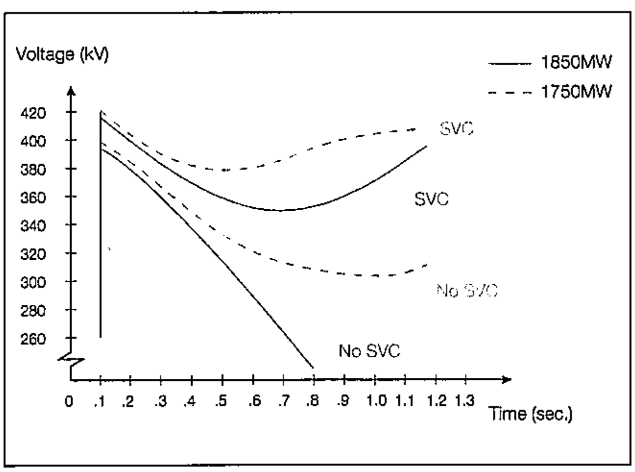
At the same time, rising costs and growing environmental concerns make the process of building new power transmission and distribution lines increasingly complicated and time-consuming. Making existing lines as well as new ones more efficient and economical, then becomes a compelling alternative.

Major savings at reasonable cost
Optimum power transmission and distribution also entails the reduction of transfer losses and provision of adequate power quality and availability at the receiving end.

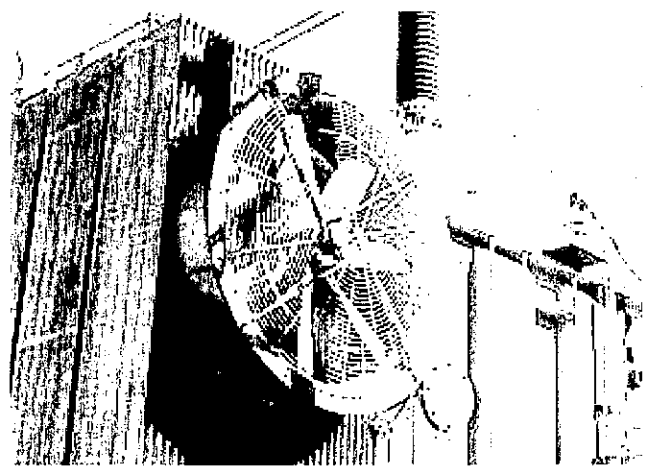
The SVC is a solid-state reactive power compensation device based on high power thyristor technology.

An SVC can improve power system transmission and distribution performance in a number of ways. Installing an SVC at one or more suitable points in the network can increase transfer capability and reduce losses while maintaining a smooth voltage profile under different network conditions. The dynamic stability of the grid can also be improved, and active power oscillations mitigated.

By developing efficient semiconductors (thyristors) dimensioned for high power ratings, ABB has created the perfect environment for reactive power compensation. This technology has also proved highly effective in HVDC applications and thyristor drives for industry.

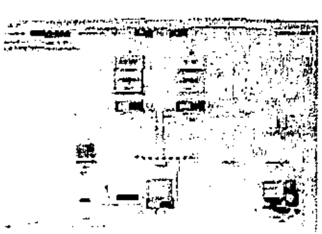


These voltages demonstrate post fault stabilizing effect of an SVC.

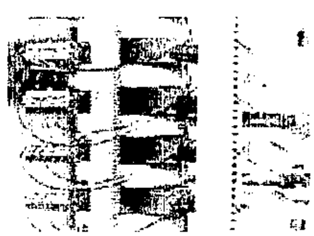


Power Transformer

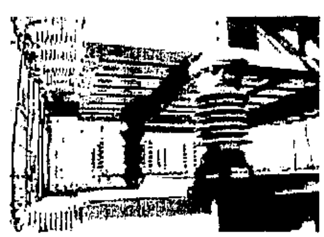
The ABB static var compensator includes the following major components:



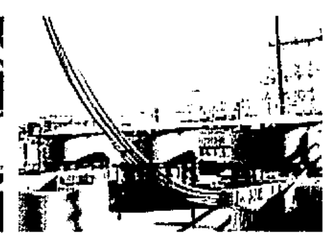
Control System



Thyristor Valves



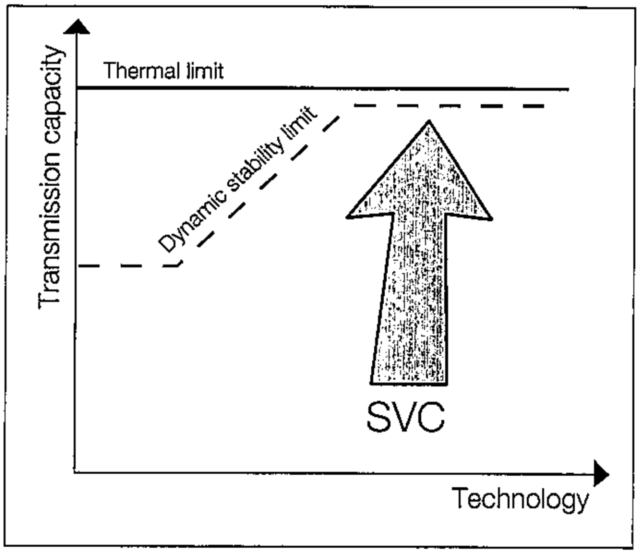
Capacitor Banks

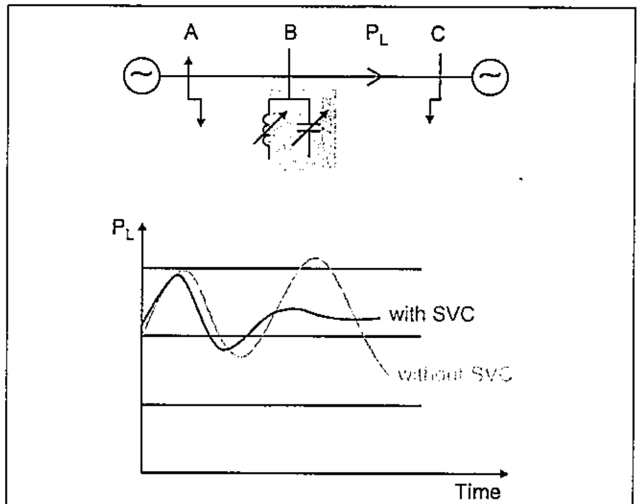


Reactors

To obtain overall control of the reactive power in a network, thyristor controlled reactors and thyristor switched capacitors are often combined with mechanically switched shunt reactors and capacitors, controlled by the SVC.

An SVC can considerably improve grid reliability and availability





Damping of power oscillations

The global trend is towards ever larger power networks, longer transmission lines, and higher consumption. Energy is also becoming increasingly expensive. To cope, power transmission and distribution systems have to become more efficient.

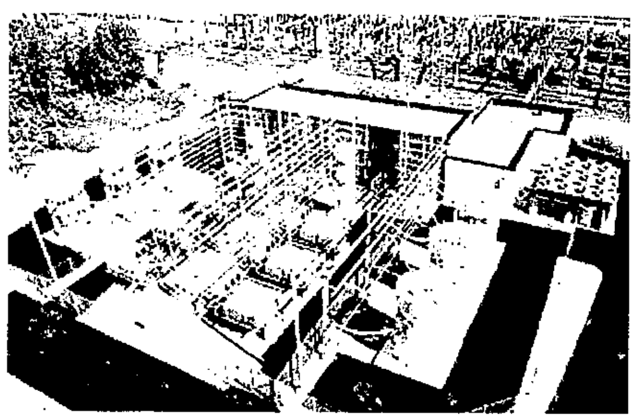
In installations all around the world, ABB SVC technology has done exactly this. It has proved second to none in increasing power transmission and distribution capacity at a lower cost.

The benefits of SVC to power transmission:
- Stabilized voltages in weak systems
- Reduced transmission losses
- Increased transmission capacity, to reduce, defer or eliminate the need for new lines
- Higher transient stability limit
- Increased damping of minor disturbances
- Greater voltage control and stability
- Power oscillation damping

Systems interconnected via a relatively weak link often experience power oscillation problems. Transmission capability is then determined by damping. By increasing the damping factor (typically by 1-2 MW per Mvar installed) an SVC can eliminate or postpone the need to install new lines.

In other cases, transient (angular) stability will be a limiting factor on power transmission capacity. SVC will often help to mitigate such situations, as well.

The benefits of SVC to power distribution:
- Stabilized voltage at the receiving end of long lines
- Increased productivity as stabilized voltage means better utilized capacity
- Reduced reactive power consumption, which gives lower losses and improved tariffs
- Balanced asymmetrical loads reduce system losses and enable lower stresses in rotating machinery
- Enables better use of equipment (particularly transformers and cables)
- Reduced voltage fluctuations and light flicker
- Decreased harmonic distortion



The SVC is an excellent tool for achieving dynamic voltage control of power systems.

Voltage stabilisation

SVC is the preferred tool for dynamic reactive power support in high voltage transmission grids. Thanks to its inherent capability for high-speed, cycle-by-cycle control of vars, it will counteract the often hazardous voltage depressions that follow in conjunction with faults in the grid. These highly dynamic events, where the ever increasing use of induction motors (like those in air-conditioning units and wind power turbine-generators) stresses the grid, will need an SVC to maintain the grid voltage and safeguard the fault ride-through capability.

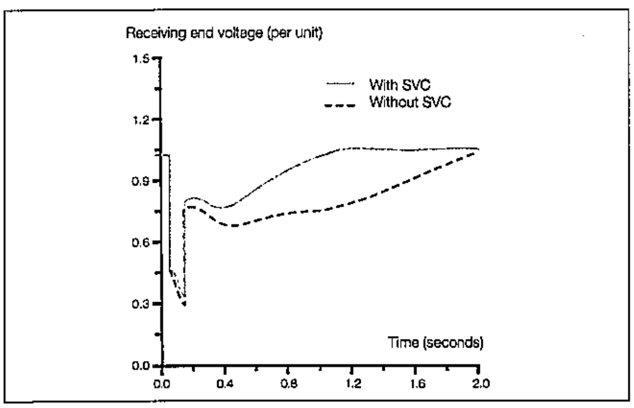
Additionally, if the SVC includes var absorbtion capability, it will effectively suppress temporary overvoltages that may appear upon fault clearing. The SVC will make sure the grid voltage always stays within acceptable limits. In steady-state it will also assist the operators with accurate voltage control so that the voltage profile of the grid is optimized.

Boosting transmission capacity

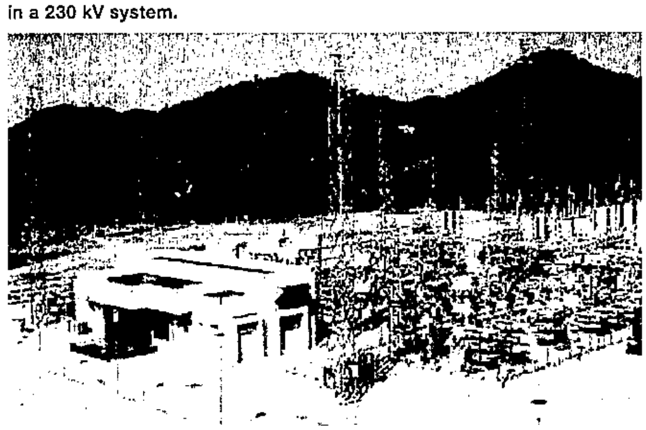
The SVC will ensure that the system voltage does not sag even when the power flow grows heavy. This means that more power can be transmitted through the system under stable conditions over existing lines.

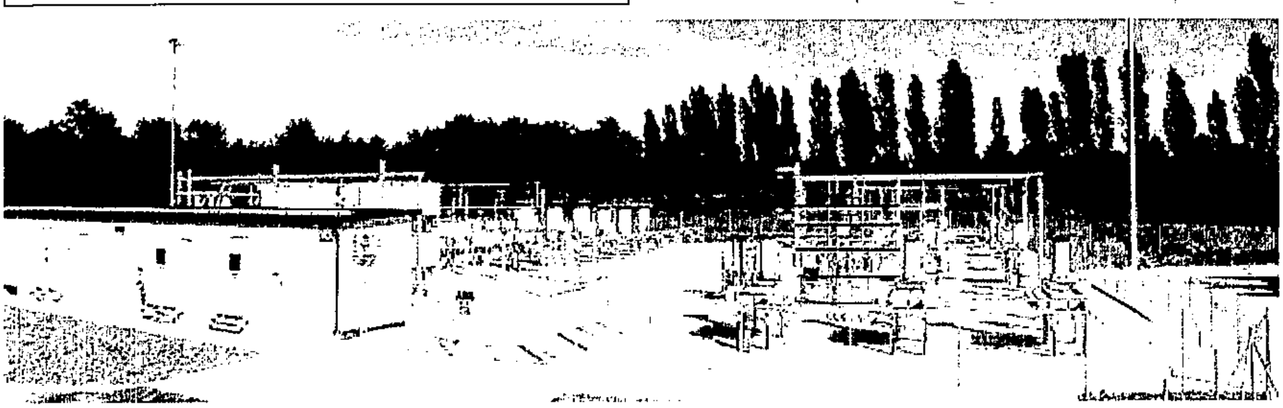
An ABB SVC can boost transmission capacity by tens of percent in most cases. Optimum improvement is sometimes achieved in combination with series compensation.

Post fault voltage recoveries with and without SVC.



This SVC has boosted power transmission capacity by over 50 percent in a 230 kV system.

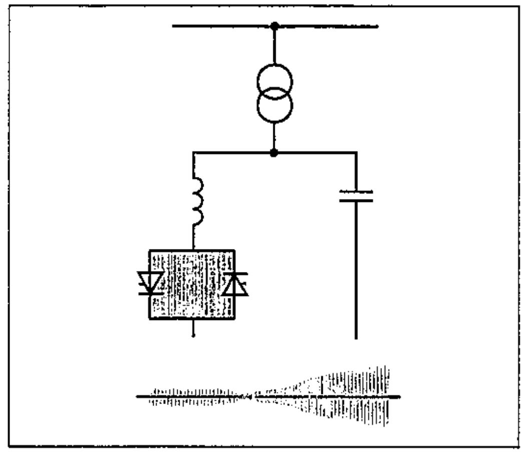




SVC for voltage stabilisation of a large pulsating load.

Basic SVC schemes

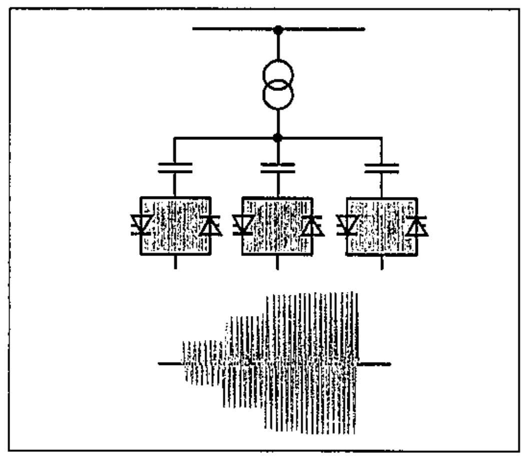
Thyristor controlled reactor and fixed capacitor, TCR/FC
A reactor and thyristor valve are incorporated in each single-phase branch. Power is changed by controlling the current through the reactor via the thyristor valve. The on-state interval is controlled by delaying triggering of the thyristor valve relative to the natural zero current crossing.



A thyristor controlled reactor (TCR) is used in combination with a fixed capacitor (FC) when reactive power generation or alternatively, absorption and generation is required. This is often the optimum solution for sub-transmission and distribution.

TCR/FCs are characterized by
- Continuous control
- No transients
- Elimination of harmonics by tuning the FCs as filters
- Compact design

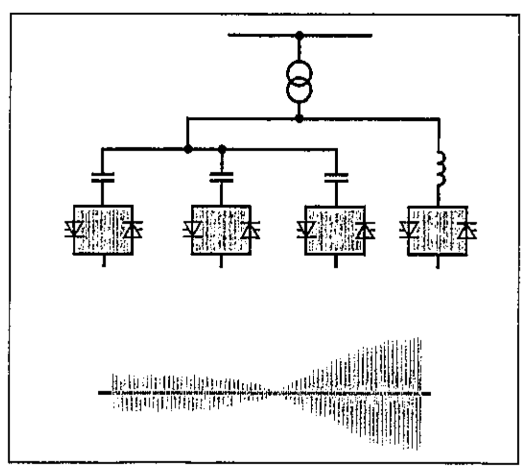
Thyristor switched capacitor, TSC
A shunt capacitor bank is divided into an appropriate number of branches. Each branch is individually switched on or off via a thyristor valve. Switching takes place when the voltage across the thyristor valve is zero, making it virtually transient-free.



Disconnection is effected by suppressing the firing pulses to the thyristors which will be blocked when the current reaches zero.

TSCs are characterized by
- Stepped control
- No transients
- No harmonics
- Low losses
- Redundancy and flexibility

Thyristor controlled reactor/Thyristor switched capacitor, TCR/TSC
A combined TCR and TSC is the optimum solution in many cases. With a TCR/TSC compensator, continuously variable reactive power is obtained across the entire control range plus full control of both the inductive and the capacitive parts of the compensator.



The principal benefit is optimum performance during major disturbances in the power system, such as line faults and load rejections.

TCR/TSC combinations are characterized by
- Continuous control
- No transients
- Elimination of harmonics via filters or TSR (thyristor switched reactor) control
- Low losses
- Redundancy
- Flexible control and operation

Control and protection: MACH

ABB's SVC controls are based on a high performance platform called MACH. The platform is used throughout FACTS and HVDC applications, and thus becomes a well-known associate to the power transmission industry. The platform is based on standardized hardware, Windows-applications, a user-friendly high-level functional programming tool and open interfaces. MACH is built to be recognized with ease.

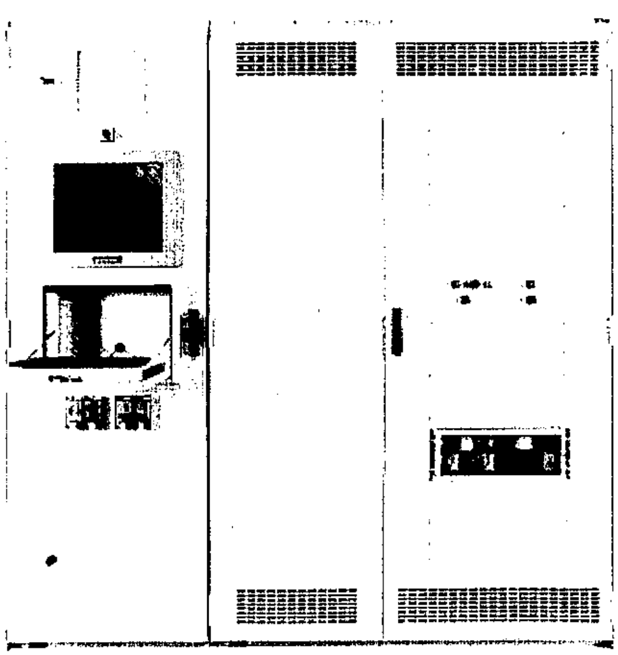
The SVC performance requirements are high as sub-cycle action is often needed. MACH uses an industrial PC equipped with state-of the-art signal processors, powerful enough to ensure accurate switching of the SVC thyristors, even for the most demanding applications. Processor capacity can easily be expanded, and similarly the set of input and output circuitry can be adapted in order to be compatible with local conditions. ABB's vast FACTS experience is behind every application program that is tailored for customers worldwide.

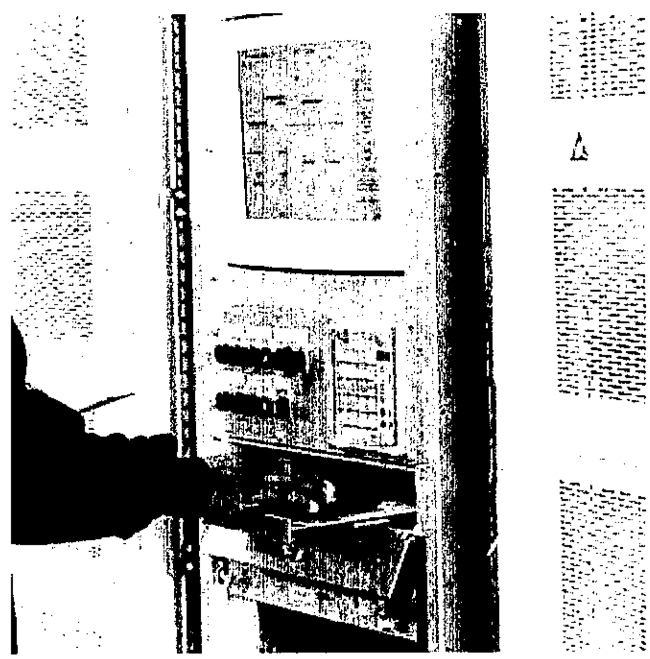
Field proven controls include:

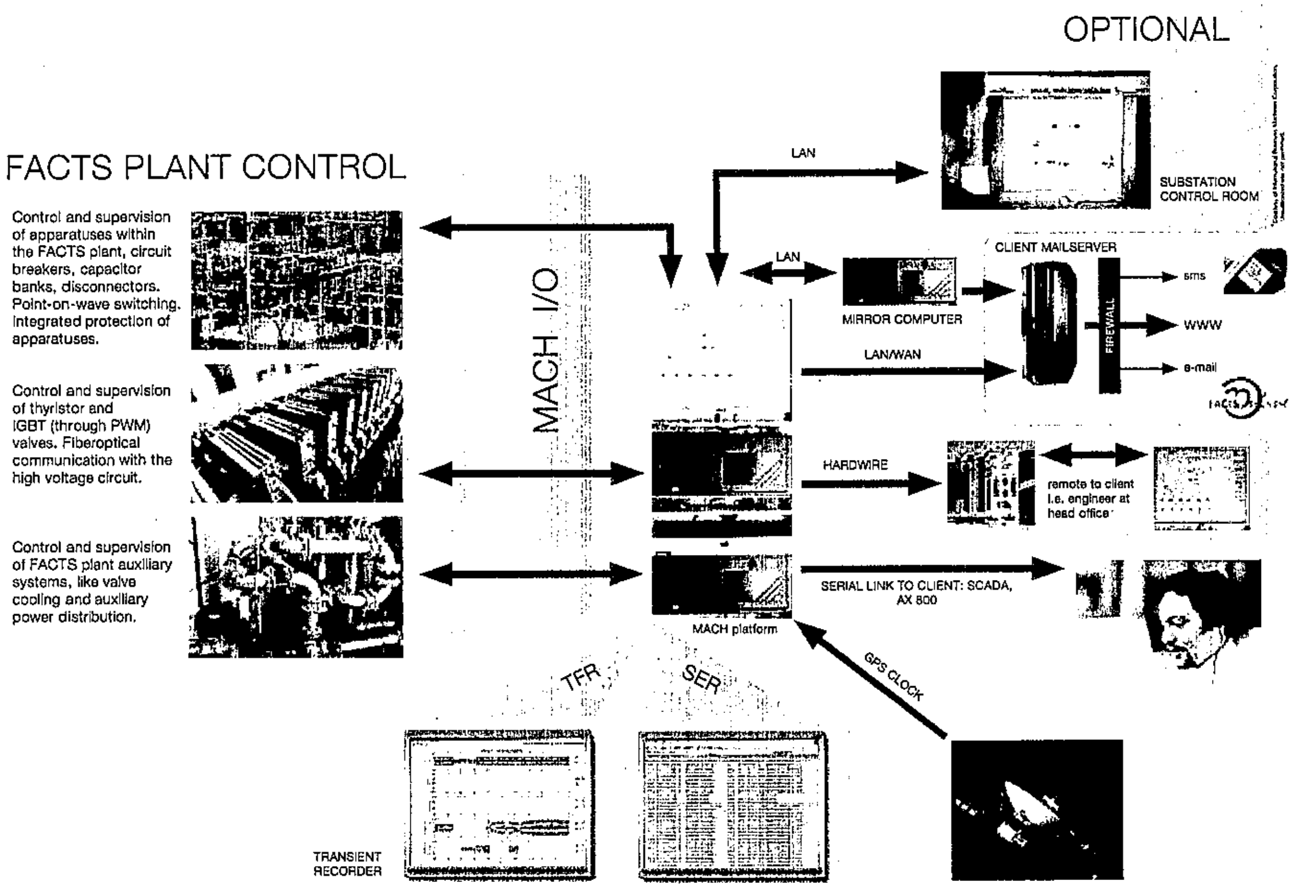
- symmetrical as well as negative-phase sequence voltage control
- adaptive gain control [1]
- transient voltage control strategies [2]
- power oscillation damping algorithms
- coordinated control of other reactive power elements (Mechanically switched capacitors and reactors (MSC, MSR))
- SVC self-test modes

The MACH concept is built with open interfaces. This elegantly enables remote control and interrogation to be implemented. ABB has developed an internet-based concept for remote control and supervision of FACTS installations, we call it FACTS ON-LINE. This way we are never far away.

[1] To optimize control speed and stability at varying grid strengths
[2] Including active voltage support during system faults and mitigation of possible overvoltages at fault clearing







The FACTS control applications within MACH are supported by a Human Machine Interface (HMI). The HMI uses the hardware platform (dedicated industrial PC), into which user friendly databases and information applications are programmed. The customer is provided with precise, relevant and accurate information, either locally or over industry standard communication links. Since an SVC is normally unmanned the focus of the HMI is to provide simplicity and accuracy when needed, rather than asking for attention on a continuous basis. Extensive diagnostic systems and event handling facilities make sure that the operator and/or the trouble-shooting engineer will always have correct and relevant information. This way the SVC will be reliable, available and perform its best under critical circumstances.

Successful thyristor technology...
...the foundation of ABB's SVC lead

Decades of development work in semiconductor technology, especially in the field of power thyristors, has helped us achieve and maintain our market leading position.

Our high-power thyristors are precision manufactured and subjected to stringent testing. Their dependability has paved the way for further dynamic development of various applications incorporating thyristor technology.

For instance, we have applied this technology to HVDC, which involves both very high currents and ultra high voltages, plus exacting demands for reliability. The development of thyristor valves for Static Var Compensators is based on this know-how.

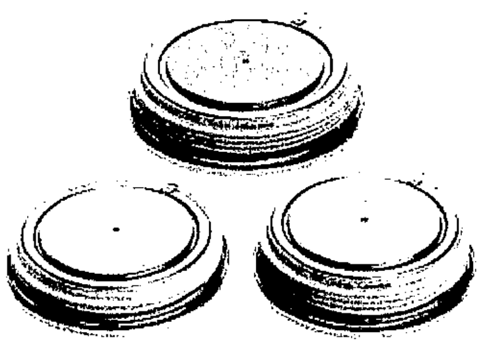
ABB has chosen to use the ETT (Electrically Triggered Thyristor) concept for both FACTS and HVDC referring to the vast available experience and track records of operation reliability.

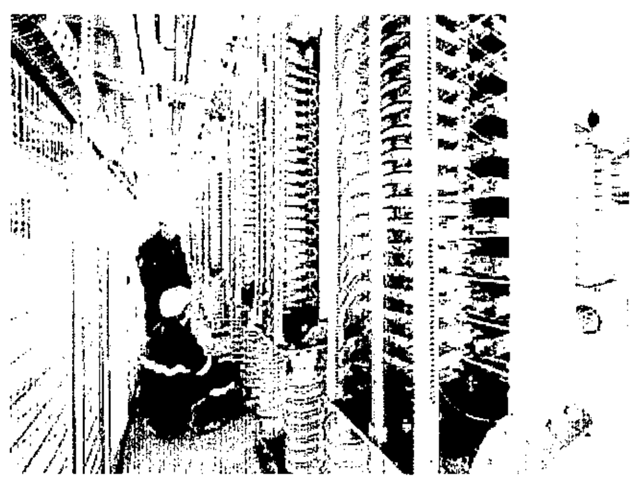
Our range of thyristor valves for SVC includes water-cooled valves for different voltages which enables us to offer optimum solutions for the majority of applications.

For SVC applications, ABB has a comprehensive programme of high power thyristors in 4" and 5" sizes, voltage classes up to 6.5 kV, and current handling capabilities of well over 3000 A per device without any need of paralleling.

ABB offers both PCT (Phase control thyristor) and BCT (Bi-directionally controlled thyristor). BCTs are particularly suitable in situations where room is scarce and current handling capability moderate.

In the BCT, anti-parallel thyristors have been integrated on a common silicon wafer and therefore, only one thyristor stack is required instead of two (one for each current direction). With this arrangement, only half the number of thyristor housings is needed. The number of components in a valve is reduced, saving space as well as complexity.





Cooling system

The cooling system consists of a closed loop piping circuit where a mixture of de-ionized water and glycol is pumped through the thyristor valves and outdoor water to air heat exchangers. There are two water-circulating pumps, one is in operation and the other is stand-by. In case of a pump failure an automatic switch over to the stand by unit will be initiated. A small portion of the flow is by passed through a water treatment circuit where the coolant is continuously de-ionized and filtered.

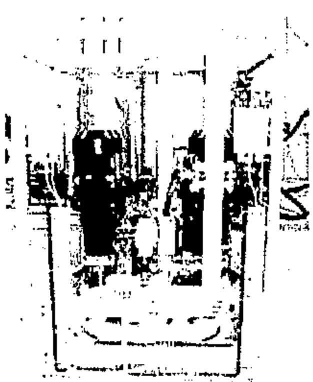
An outdoor dry air blast cooler is used, connected directly over the main circuit. Low noise fans are employed for reducing sound levels. All fans are individually controlled to ensure sufficient cooling with minimum losses.

The cooling system is automatically controlled by the MACH system.

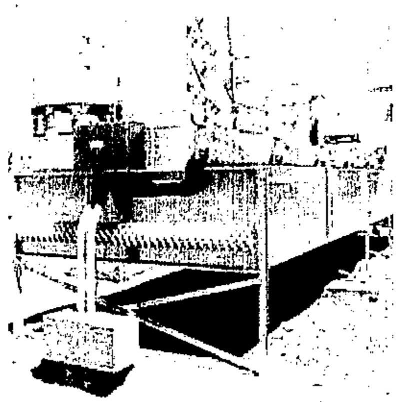
Directly connected SVC

A directly connected SVC is an SVC where there is no need for a step-down transformer to be connected between the SVC and the power system. ABB offers direct connection for system voltages up to 69 kV. This, of course, brings benefits to the project of a variety of kinds:

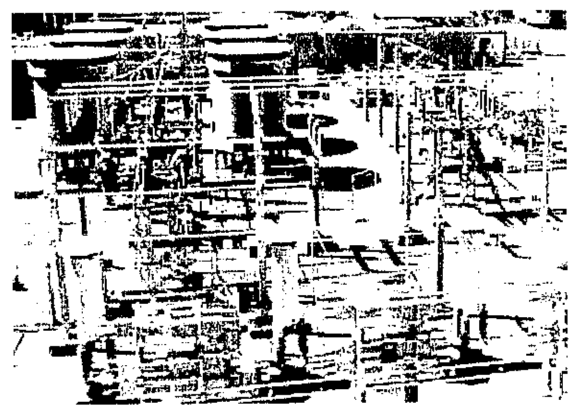
- A simplified SVC scheme
- A substantial hardware cost saving
- A saving in transportation cost, weight and volume
- A saving of site footprint
- A saving of plant losses
- No need to handle transformer oil
- No fire hazard
- No transformer maintenance costs
- Easy expandability since transformer rating and secondary voltage rise is not an issue when adding branches.
- Shorter lead times, not influenced by long transformer delivery times.



Cooling water pump unit



Dry air blast cooler



Directly connected SVC

Shunt capacitors and reactors

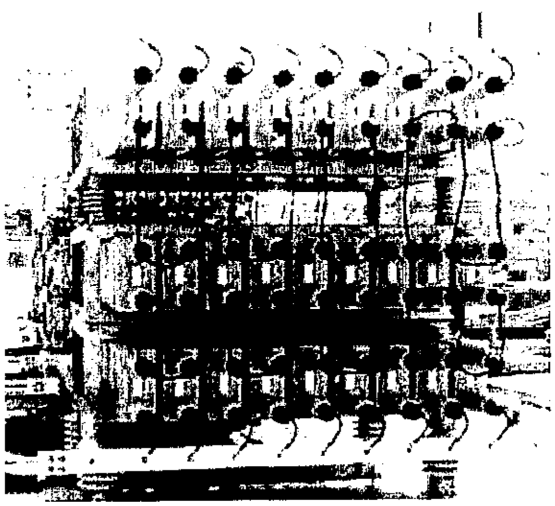
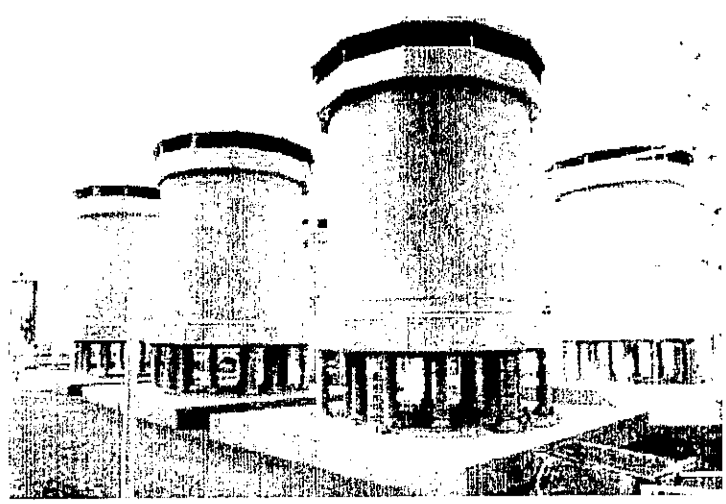


ABB has a comprehensive, high density capacitor programme, with up to 1 Mvar or more in one single can. This ensures a compact build-up of capacitor banks.



Low noise shunt reactors help fulfil the strictest requirements on noise reduction from SVCs.

Relocatable SVC

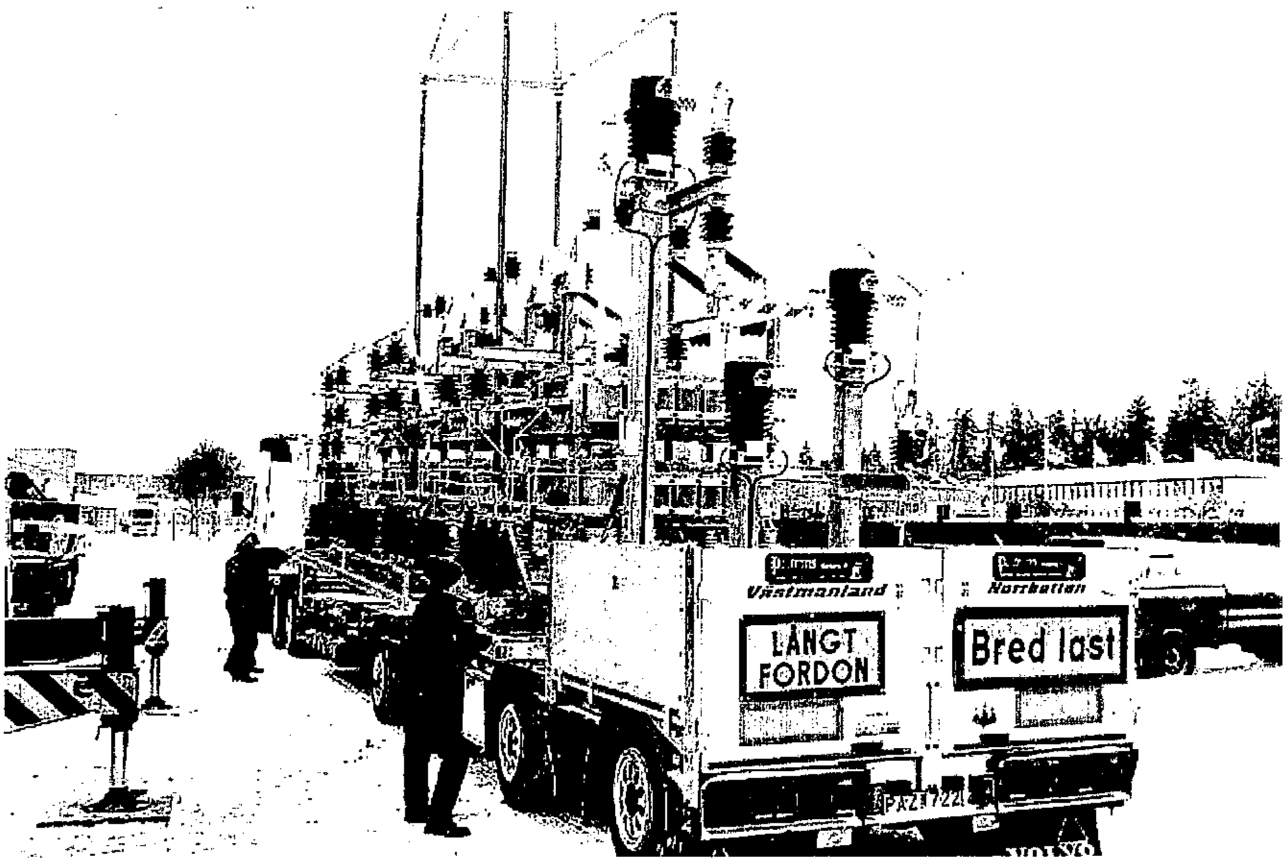
Power industry deregulation is introduced to meet growing market demands for flexibility. If this is to be the case in practice, technical solutions must also be flexible.

ABB's relocatable Static Var Compensator concept (RSVC) was conceived precisely for this purpose. This SVC mobility means dynamic voltage support can be obtained where it is most needed in the power grid to meet the current demand for network stability.

Modular design
The truly mobile design of the RSVC enables an installation to be fully relocated within weeks. The RSVC is modular and transportable by road by means of standard vehicles. Its compact design and technical excellence guarantee quiet operation and low magnetic interference, thereby lessening the environmental impact.

Easy to erect and commission
The modular design facilitates simple on site erection and commissioning. Prefabricated buswork and cabling ensures quick and easy inter-module connection.

The modular build-up also enables much of the equipment and system testing to be done in the workshop prior to delivery, which also saves time and money.



Wind and Railways

For **wind power,** SVC aids in a number of tasks:

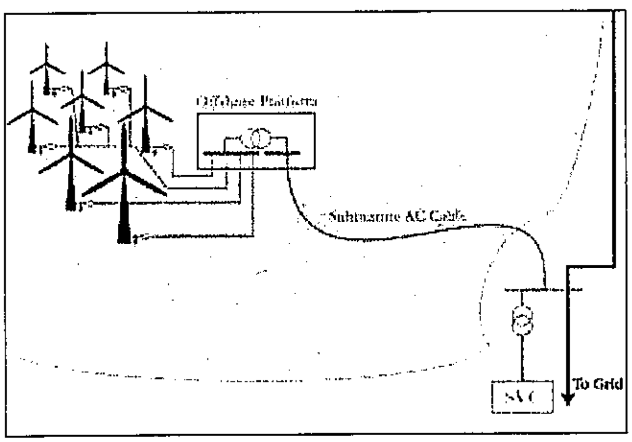
- Steady-state and dynamic voltage stabilization
- Continuous power factor control
- Enabling fault ride-through of the wind farm
- Power quality control by mitigation of flicker (caused by tower shadow effect, fluctuating wind, and/or starts and stops of WTGs); also harmonic reduction and reduction of phase imbalance.

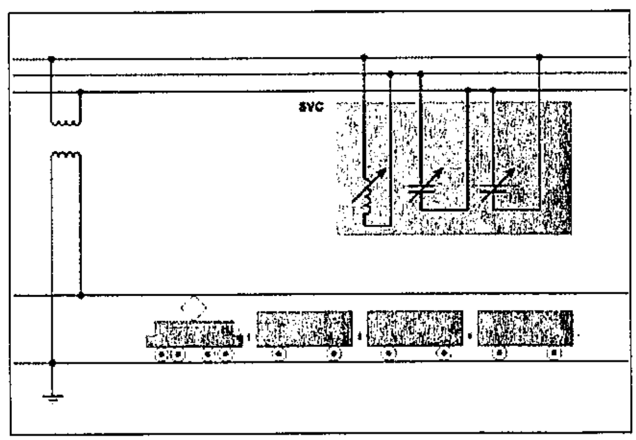
For **off-shore** wind generation, comprehensive AC sea cable networks call for additional elaborate reactive power control. The overall scope of reactive power control should encompass the wind farm just as well as the sea cables, to bring about a well regulated reactive power balance of the whole system, answering to the same demands on reactive power regulation as any other medium to large generator serving the grid.

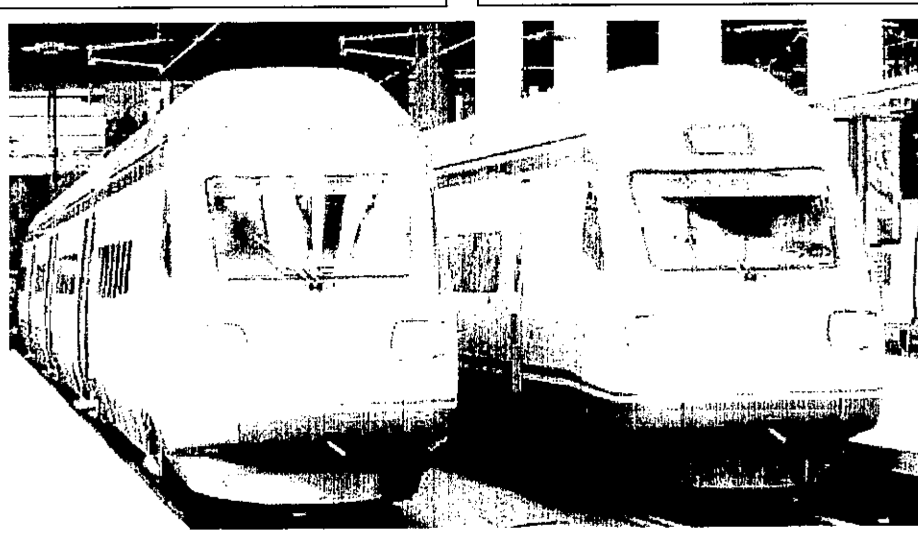
Railways

The increase in traffic on existing tracks combined with new high-speed rail projects mean rail traction is fast becoming an important load on electrical supply grids. This in turn is focusing a lot of attention on the efficiency of the catenary as well as the power quality of the surrounding grids. Trains taking power from the catenary need to be sure the supply voltages are stable and do not sag.

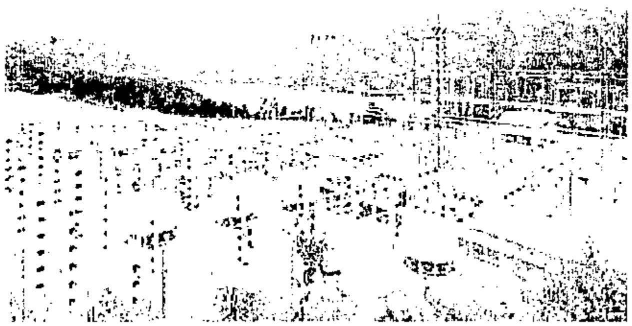
Voltage and current imbalances between phases of three-phase AC supply systems must also be confined in magnitude and prevented from spreading through the grid to other parts of the system. Likewise, voltage fluctuations and harmonics need to be controlled if they are to stay within the stipulated limits. This is where SVC comes in.





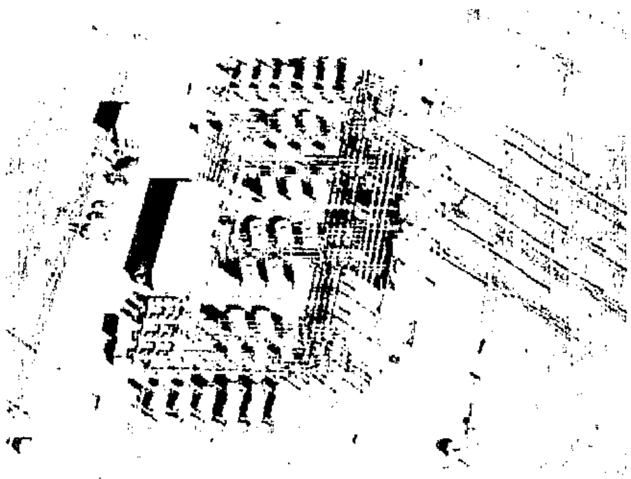


SVCs for all applications



As a result of large power demanding industry development in central Norway, the demand in the region has increased dramatically and is expected to grow further. The power import capacity to the region has previously been limited for system stability reasons. As a remedy, two SVCs were installed in the 420/300 kV grid, each rated at -/+ 250 Mvar. With the installation of the SVCs, the power import capacity to the region under stable conditions has increased considerably.

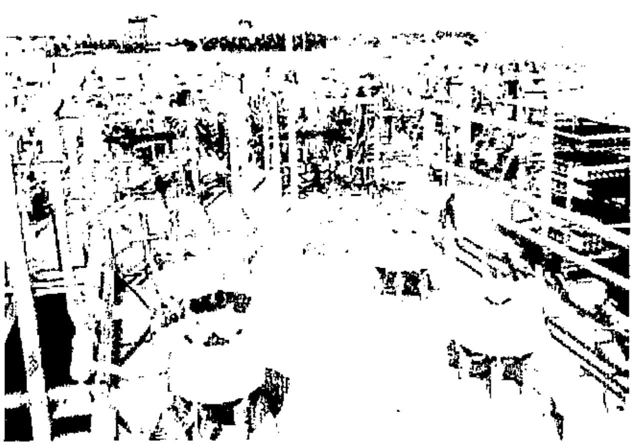
The SVCs are equipped for damping of system electro-mechanical oscillations by means of Power Oscillation Dampers based on active power measurements. They are furthermore equipped with Q Optimizers, which enables coordinated control between the SVCs and mechanically switched shunt capacitors also employed in the grid. This ensures that the SVCs have maximum dynamic capability available to provide fast response to counteract grid disturbances.



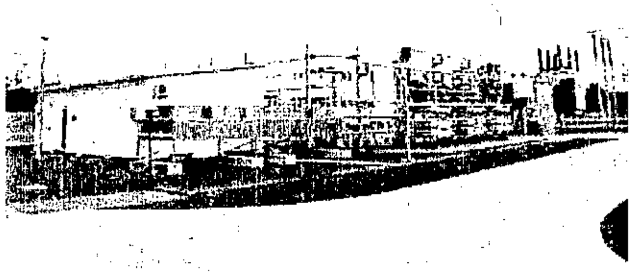
A very large SVC was commissioned at the end of 2007 at a key substation near Rawlings, Maryland in USA. The installation enhances the reliability on the 500 kV transmission system – one of the most heavily-loaded in the PJM (Pennsylvania, Jersey, Maryland) Interconnection area – by quickly changing reactive power levels to control the line's voltage.

In addition to improving reliability, the SVC enables increased transmission capacity across the PJM region. Enabling more power to flow on existing lines is an efficient use of resources and an important step in keeping pace with the region's increased demand for electricity.

The SVC is rated at 500 kV, -145/+575 Mvar. The turnkey project was completed in 14 months, a record time given its scope, size, and complexity. The SVC is equipped with an advanced control system capable of controlling not only the operation of the SVC itself, but also the switching of two local 500 kV Mechanically Switched Capacitor banks (MSC).



The Saudi Electricity Company operates a power transmission system comprising 380 kV OH lines and underground cables. Operating conditions are special due to the hot climate, with up to 80% of the total load consisting of air conditioners. From a grid point of view, air conditioning is a particularly demanding kind of load, with slow voltage recovery, motor stalling or even voltage collapse in conjunction with short circuits in the transmission or sub-transmission network. To get to grips with this situation, three large SVCs have been installed in the region, with the explicit purpose of keeping the grid voltage stable as air conditioners all over the place are running at full speed. The SVCs, rated each at 110 kV, -60/+600 Mvar, were taken into service in 2008 and 2009.

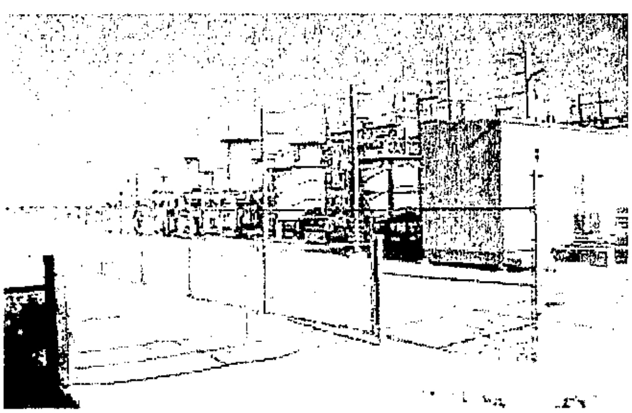


Two SVCs are in operation in the power grid in Bretagne, France, one rated at 225 kV, -100/+200 Mvar and the other at 225 kV, -50/+100 Mvar. Grid voltage control is a key issue in the region and the SVCs have the following tasks:

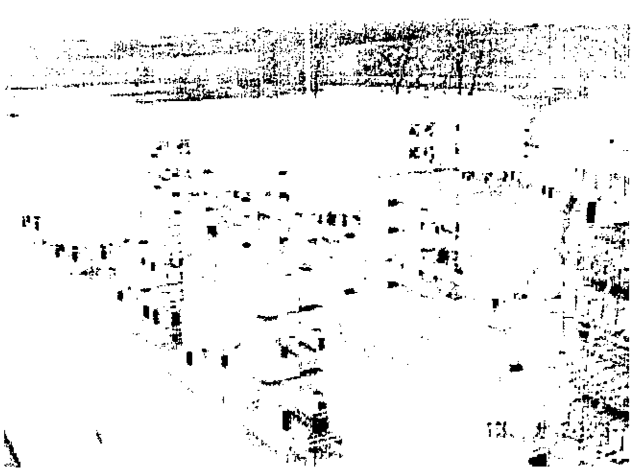
- Allow fast supply of reactive power upon the appearing of faults in the grid.
- Absorb reactive power to control the grid voltage during low load or high level of distributed generation.
- Add flexibility and smoothness to grid voltage control.
- Prevent tripping of wind farms located in the region.

The SVCs have proved their usefulness in the power grid. They have sustained the network during situations with low grid voltage and all available MSCs connected. They have also brought increased flexibility into network management, and have increased the voltage stability due to TCR fine adjustment.

A mining complex in Peru, situated in the Andes mountains at an altitude of more than 4.000 meters above the sea level, is a major copper and zinc producer, one of the largest in the world. A prerequisite for production was the development of adequate utility infrastructure to feed the mine complex, as the feeding grid system was too weak to support the loads without proper measures taken. As a solution, an SVC was installed, rated at 45 Mvar inductive to 90 Mvar capacitive. Its purpose is to stabilize the 220 kV voltage at the mine feeding substation to within ± 5%, permitting safe operation of very large mining machinery even under the most restrictive power system conditions.



Western Texas, USA has an abundance of wind power. Adequate dynamic reactive power support is necessary to maintain system operation at acceptable voltage levels. To improve and maintain voltage stability, ABB has supplied and installed three SVCs in the system. Each SVC is rated at -40/+50 Mvar. Two SVCs are connected directly to 69 kV without any need for step-down transformers. The third is connected to the 34.5 kV tertiary winding of an existing 345/138 kV autotransformer. Each installation was initially scheduled to take 11 months from the time of initiation to the end of commissioning. Two of the SVCs were actually completed in just 10 months.



A total of seven SVCs were supplied to High Speed 1, the 108 km high-speed rail line between London, UK and the channel tunnel at Dover. With this link in operation, it is possible to travel between London and Paris in just over two hours at a maximum speed of 300 km/h. Six of the SVCs, each rated at -5/+40 Mvar single-phase are used mainly for dynamic voltage support. The seventh SVC, rated at -80/+170 Mvar is needed for dynamic balancing of asymmetrical loads between phases.

ABB – the pioneer

...and market leader of SVC

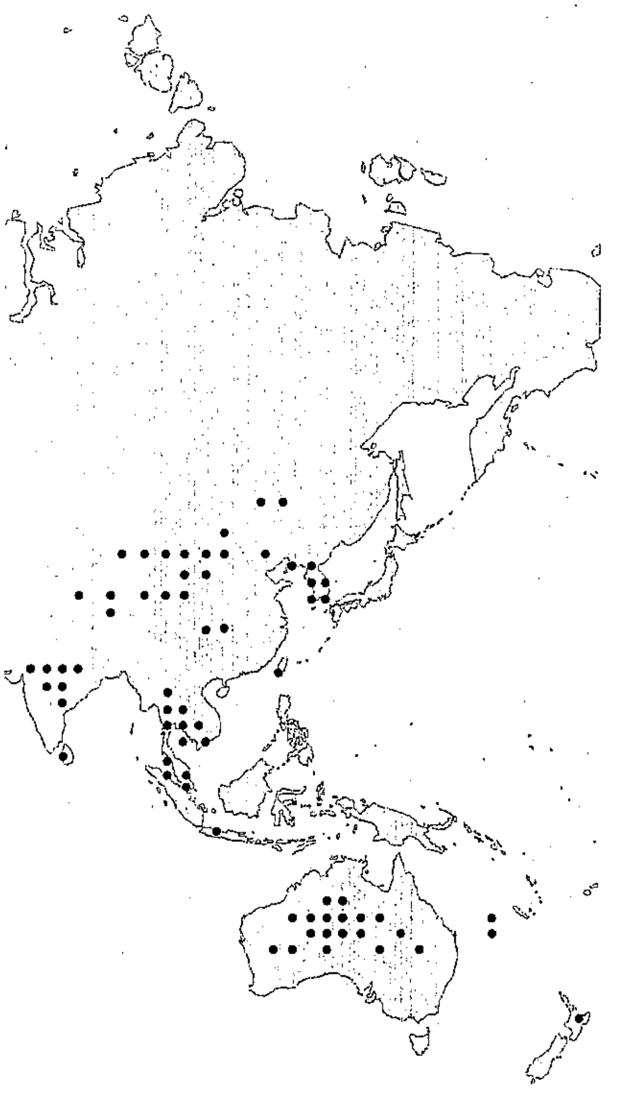


ABB was one of the first companies to identify the importance of effective and rapid control of reactive power. As the market leader in static var compensation, ABB's know-how in this field is acknowledged world-wide.

We commissioned the first large commercial thyristor-switched capacitor installation (1972) and also launched the first combined type Static Var Compensator, TCR/TSC (1979). Many of these are still in operation.

ABB SVCs have been installed by power utilities and industrial plants around the world for all existing voltages between 10 kV and 800 kV. And the technical and economy advantages of this technology are becoming increasingly recognized.

Today, close to 500 ABB SVCs are in operation or under installation all over the world. A selection of these are shown in the world map.

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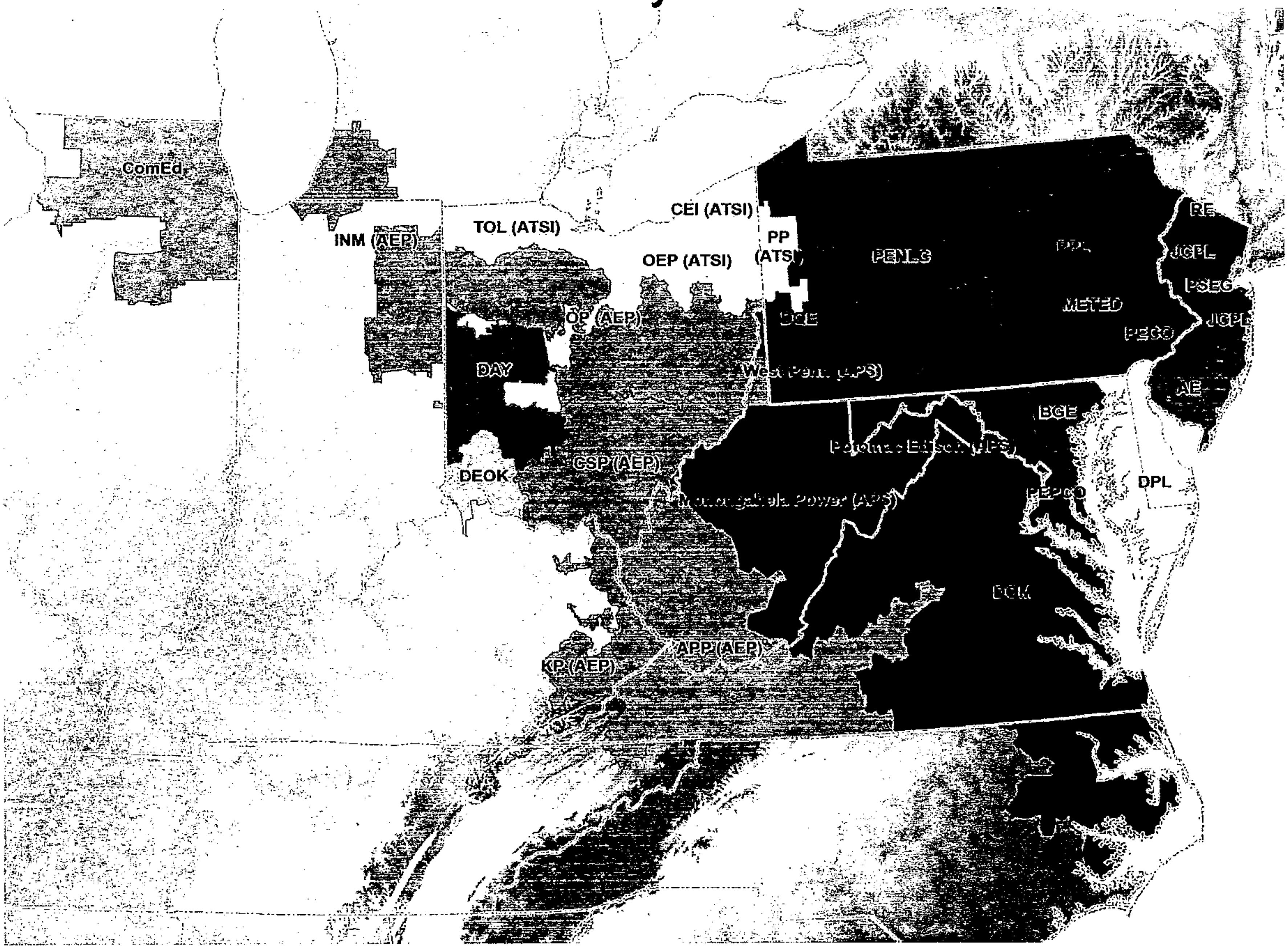
PJL – Exhibit 4 – Excerpt from 2012 Load Forecast

PJM Load Forecast Report
January 2012



Prepared by PJM Resource Adequacy Planning Department

Table B-1

SUMMER PEAK LOAD (MW) AND GROWTH RATES FOR EACH PJM MID-ATLANTIC ZONE AND GEOGRAPHIC REGION 2012-2022

		METERED 2011	UNRESTRICTED 2011	NORMAL 2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Annual Growth Rate (10 yr)
AE		2,966	2,966	2,630	2,703	2,734	2,793	2,847	2,885	2,905	2,927	2,949	2,974	2,996	3,017	1.1%
	%				2.8%	1.1%	2.2%	1.9%	1.3%	0.7%	0.8%	0.8%	0.8%	0.7%	0.7%	
BGE		7,236	7,616	7,240	7,221	7,314	7,457	7,595	7,677	7,744	7,802	7,878	7,967	8,028	8,086	1.1%
	%				-0.3%	1.3%	2.0%	1.9%	1.1%	0.9%	0.7%	1.0%	1.1%	0.8%	0.7%	
DPL		4,241	4,338	4,070	4,111	4,166	4,256	4,342	4,393	4,438	4,485	4,545	4,604	4,649	4,695	1.3%
	%				1.0%	1.3%	2.2%	2.0%	1.2%	1.0%	1.1%	1.3%	1.3%	1.0%	1.0%	
JCPL		6,604	6,675	6,200	6,244	6,338	6,474	6,605	6,696	6,759	6,815	6,875	6,946	7,006	7,063	1.2%
	%				0.7%	1.5%	2.1%	2.0%	1.4%	0.9%	0.8%	0.9%	1.0%	0.9%	0.8%	
METED		3,125	3,208	2,930	2,974	3,030	3,113	3,188	3,246	3,289	3,328	3,374	3,425	3,470	3,513	1.7%
	%				1.5%	1.9%	2.7%	2.4%	1.8%	1.3%	1.2%	1.4%	1.5%	1.3%	1.2%	
PECO		8,984	9,286	8,710	8,781	8,932	9,141	9,333	9,468	9,582	9,699	9,819	9,945	10,054	10,156	1.5%
	%				0.8%	1.7%	2.3%	2.1%	1.4%	1.2%	1.2%	1.2%	1.3%	1.1%	1.0%	
PENLC		3,128	3,128	2,850	2,917	2,984	3,079	3,170	3,240	3,288	3,330	3,386	3,440	3,492	3,538	1.9%
	%				2.4%	2.3%	3.2%	3.0%	2.2%	1.5%	1.3%	1.7%	1.6%	1.5%	1.3%	
PEPCO		7,023	7,024	6,870	6,876	6,940	7,056	7,149	7,187	7,234	7,283	7,345	7,419	7,458	7,494	0.9%
	%				0.1%	0.9%	1.7%	1.3%	0.5%	0.7%	0.7%	0.9%	1.0%	0.5%	0.5%	
PL		7,527	7,527	7,180	7,243	7,375	7,548	7,701	7,806	7,866	7,939	8,035	8,147	8,222	8,303	1.4%
	%				0.9%	1.8%	2.3%	2.0%	1.4%	0.8%	0.9%	1.2%	1.4%	0.9%	1.0%	
PS		10,933	10,998	10,530	10,575	10,707	10,877	11,037	11,147	11,217	11,269	11,359	11,450	11,522	11,588	0.9%
	%				0.4%	1.2%	1.6%	1.5%	1.0%	0.6%	0.5%	0.8%	0.8%	0.6%	0.6%	
RECO		436	436	420	419	425	433	440	445	448	451	454	458	461	464	1.0%
	%				-0.2%	1.4%	1.9%	1.6%	1.1%	0.7%	0.7%	0.7%	0.9%	0.7%	0.7%	
UGI		216	216	190	195	197	201	205	207	209	210	212	214	215	217	1.1%
	%				2.6%	1.0%	2.0%	2.0%	1.0%	1.0%	0.5%	1.0%	0.9%	0.5%	0.9%	
DIVERSITY - MID-ATLANTIC (-)					802	573	545	529	449	508	584	498	581	541	486	
PJM MID-ATLANTIC		61,662	63,115	59,320	59,457	60,569	61,883	63,083	63,948	64,471	64,954	65,733	66,408	67,032	67,648	1.3%
	%				0.2%	1.9%	2.2%	1.9%	1.4%	0.8%	0.7%	1.2%	1.0%	0.9%	0.9%	
FE-EAST		12,810	13,002	11,800	11,955	12,192	12,508	12,792	13,018	13,162	13,314	13,482	13,645	13,801	13,958	1.6%
	%				1.3%	2.0%	2.6%	2.3%	1.8%	1.1%	1.2%	1.3%	1.2%	1.1%	1.1%	
PLGRP		7,737	7,738	7,340	7,405	7,549	7,720	7,871	7,985	8,051	8,126	8,225	8,332	8,406	8,497	1.4%
	%				0.9%	1.9%	2.3%	2.0%	1.4%	0.8%	0.9%	1.2%	1.3%	0.9%	1.1%	

Note:
Normal 2011 and all forecast values are non-coincident as estimated by PJM staff.
Normal 2011 and all forecast values represent unrestricted peaks, priorto reductions for load management and energy efficiency.
All average growth rates are calculated from the first year of the forecast.

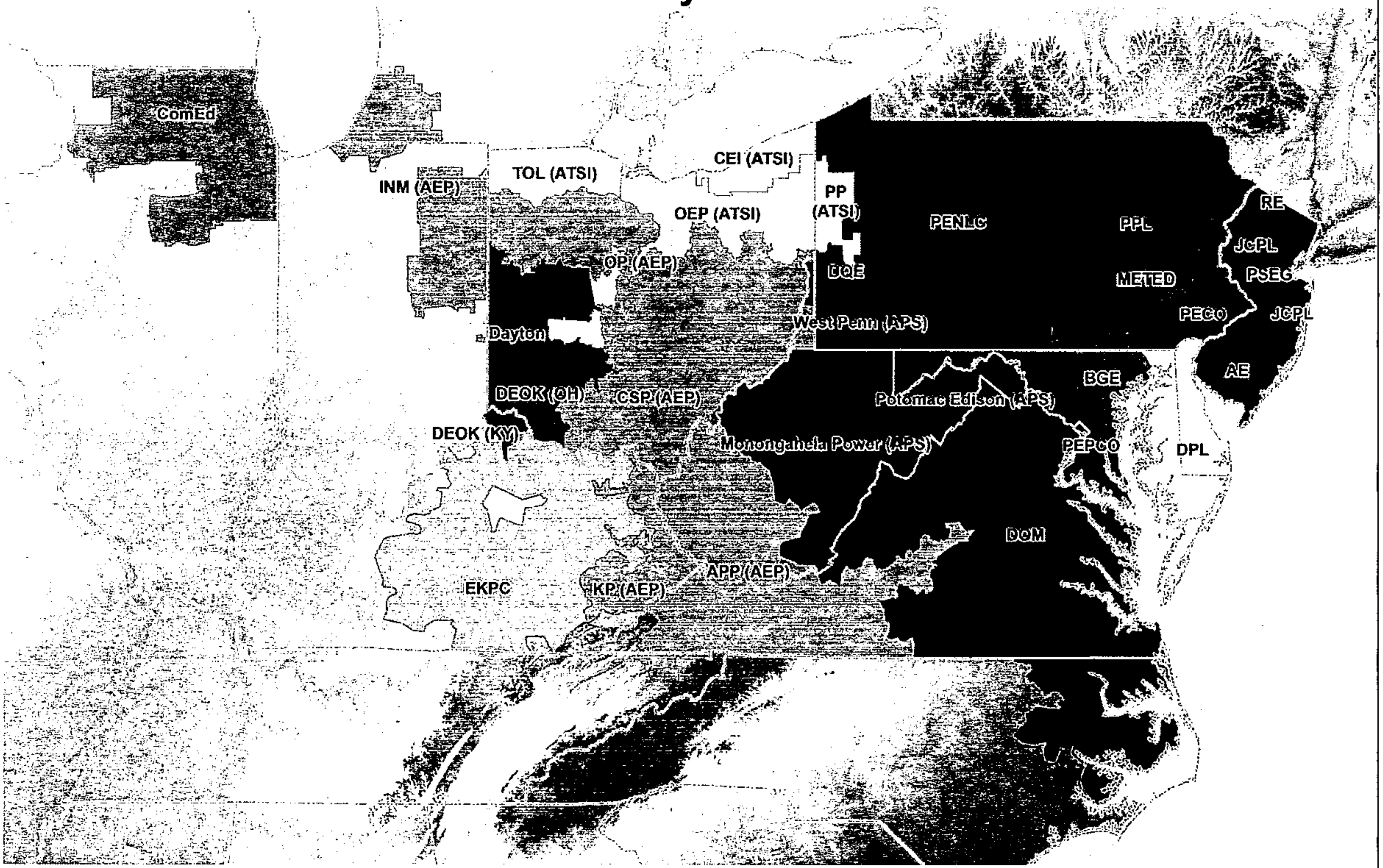
Table B-1 (Continued)

SUMMER PEAK LOAD (MW) AND GROWTH RATES FOR EACH PJM MID-ATLANTIC ZONE AND GEOGRAPHIC REGION 2023-2027

		2023	2024	2025	2026	2027	Annual Growth Rate (15 yr)
AE		3,037	3,059	3,082	3,106	3,130	1.0%
	%	0.7%	0.7%	0.8%	0.8%	0.8%	
BGE		8,157	8,234	8,310	8,390	8,457	1.1%
	%	0.9%	0.9%	0.9%	1.0%	0.8%	
DPL		4,748	4,808	4,863	4,914	4,961	1.3%
	%	1.1%	1.3%	1.1%	1.0%	1.0%	
JCPL		7,122	7,183	7,249	7,313	7,377	1.1%
	%	0.8%	0.9%	0.9%	0.9%	0.9%	
METED		3,555	3,599	3,648	3,694	3,739	1.5%
	%	1.2%	1.2%	1.4%	1.3%	1.2%	
PECO		10,263	10,376	10,488	10,596	10,700	1.3%
	%	1.1%	1.1%	1.1%	1.0%	1.0%	
PENLC		3,586	3,632	3,682	3,729	3,773	1.7%
	%	1.4%	1.3%	1.4%	1.3%	1.2%	
PEPCO		7,540	7,596	7,654	7,699	7,739	0.8%
	%	0.6%	0.7%	0.8%	0.6%	0.5%	
PL		8,364	8,452	8,550	8,636	8,703	1.2%
	%	0.7%	1.1%	1.2%	1.0%	0.8%	
PS		11,640	11,727	11,804	11,878	11,952	0.8%
	%	0.4%	0.7%	0.7%	0.6%	0.6%	
RECO		467	470	473	476	480	0.9%
	%	0.6%	0.6%	0.6%	0.6%	0.8%	
UGI		218	219	221	223	224	0.9%
	%	0.5%	0.5%	0.9%	0.9%	0.4%	
DIVERSITY - MID-ATLANTIC (-)		506	518	580	599	568	
PJM MID-ATLANTIC		68,191	68,837	69,444	70,055	70,667	1.2%
	%	0.8%	0.9%	0.9%	0.9%	0.9%	
FE-EAST		14,103	14,257	14,420	14,571	14,720	1.4%
	%	1.0%	1.1%	1.1%	1.0%	1.0%	
PLGRP		8,564	8,648	8,749	8,828	8,896	1.2%
	%	0.8%	1.0%	1.2%	0.9%	0.8%	

PJL – Exhibit 5 – Excerpt from 2016 Load Forecast

PJM Load Forecast Report
January 2016



Prepared by PJM Resource Adequacy Planning Department

Table B-1

SUMMER PEAK LOAD (MW) AND GROWTH RATES FOR
EACH PJM MID-ATLANTIC ZONE AND GEOGRAPHIC REGION
2016 - 2026

	METERED 2015	UNRESTRICTED 2015	NORMAL 2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Annual Growth Rate (10 yr)
AE	2,553	2,553	2,580	2,524	2,530	2,534	2,534	2,521	2,507	2,506	2,502	2,503	2,506	2,502	(0.1%)
				-2.2%	0.2%	0.2%	0.0%	-0.5%	-0.6%	-0.0%	-0.2%	0.0%	0.1%	-0.2%	
BGE	6,508	6,508	6,750	6,945	6,989	7,060	7,064	7,079	7,064	7,060	7,078	7,140	7,190	7,220	0.4%
				2.9%	0.6%	1.0%	0.1%	0.2%	-0.2%	-0.1%	0.3%	0.9%	0.7%	0.4%	
DPL	3,822	3,822	3,930	3,991	4,030	4,055	4,068	4,071	4,064	4,071	4,076	4,092	4,121	4,135	0.4%
				1.6%	1.0%	0.6%	0.3%	0.1%	-0.2%	0.2%	0.1%	0.4%	0.7%	0.3%	
JCPL	5,819	5,819	6,010	5,968	6,038	6,096	6,103	6,097	6,091	6,076	6,082	6,100	6,131	6,156	0.3%
				-0.7%	1.2%	1.0%	0.1%	-0.1%	-0.1%	-0.2%	0.1%	0.3%	0.5%	0.4%	
METED	2,791	2,792	2,870	2,940	2,975	3,019	3,051	3,045	3,055	3,068	3,075	3,123	3,147	3,176	0.8%
				2.4%	1.2%	1.5%	1.1%	-0.2%	0.3%	0.4%	0.2%	1.6%	0.8%	0.9%	
PECO	8,095	8,095	8,390	8,547	8,658	8,745	8,797	8,809	8,797	8,842	8,885	8,954	9,012	9,122	0.7%
				1.9%	1.3%	1.0%	0.6%	0.1%	-0.1%	0.5%	0.5%	0.8%	0.6%	1.2%	
PENLC	2,819	2,819	2,940	2,890	2,900	2,904	2,908	2,907	2,899	2,901	2,899	2,903	2,908	2,919	0.1%
				-1.7%	0.3%	0.1%	0.1%	-0.0%	-0.3%	0.1%	-0.1%	0.1%	0.2%	0.4%	
PEPCO	6,268	6,268	6,090	6,563	6,614	6,630	6,669	6,702	6,672	6,680	6,693	6,716	6,750	6,813	0.4%
				7.8%	0.8%	0.2%	0.6%	0.5%	-0.4%	0.1%	0.2%	0.3%	0.5%	0.9%	
PL	6,580	6,580	6,920	7,193	7,270	7,338	7,377	7,362	7,376	7,405	7,424	7,469	7,517	7,560	0.5%
				3.9%	1.1%	0.9%	0.5%	-0.2%	0.2%	0.4%	0.3%	0.6%	0.6%	0.6%	
PS	9,595	9,595	9,910	10,090	10,173	10,234	10,239	10,214	10,191	10,187	10,179	10,186	10,207	10,222	0.1%
				1.8%	0.8%	0.6%	0.0%	-0.2%	-0.2%	-0.0%	-0.1%	0.1%	0.2%	0.1%	
RECO	398	398	405	407	409	411	411	411	409	409	409	409	410	410	0.1%
				0.5%	0.5%	0.5%	0.0%	0.0%	-0.5%	0.0%	0.0%	0.0%	0.2%	0.0%	
UGI	189	189	195	188	190	191	191	190	189	189	189	190	190	190	0.1%
				-3.6%	1.1%	0.5%	0.0%	-0.5%	-0.5%	0.0%	0.0%	0.5%	0.0%	0.0%	
DIVERSITY - MID-ATLANTIC(-)				1,072	1,040	1,023	948	885	1,004	956	876	944	793	872	
PJM MID-ATLANTIC	54,890	54,890	56,495	57,174	57,736	58,194	58,464	58,523	58,310	58,438	58,615	58,841	59,296	59,553	0.4%
				1.2%	1.0%	0.8%	0.5%	0.1%	-0.4%	0.2%	0.3%	0.4%	0.8%	0.4%	
FE-EAST	11,267	11,267	11,670	11,538	11,655	11,762	11,810	11,771	11,765	11,795	11,831	11,882	11,929	11,982	0.4%
				-1.1%	1.0%	0.9%	0.4%	-0.3%	-0.1%	0.3%	0.3%	0.4%	0.4%	0.4%	
PLGRP	6,759	6,759	7,110	7,336	7,417	7,487	7,525	7,513	7,521	7,548	7,576	7,620	7,666	7,714	0.5%
				3.2%	1.1%	0.9%	0.5%	-0.2%	0.1%	0.4%	0.4%	0.6%	0.6%	0.6%	

Notes:
Normal 2015 and all forecast values are non-coincident as estimated by PJM staff.
Normal 2015 and all forecast values represent unrestricted peaks, after reductions for distributed solar generation and prior to reductions for load management.
All average growth rates are calculated from the first year of the forecast (2016).
Summer season indicates peak from June, July, August.

Table B-1 (Continued)

SUMMER PEAK LOAD (MW) AND GROWTH RATES FOR EACH PJM MID-ATLANTIC ZONE AND GEOGRAPHIC REGION 2027 - 2031

	2027	2028	2029	2030	2031	Annual Growth Rate (15 yr)
AE	2,497	2,493	2,489	2,484	2,485	(0.1%)
	-0.2%	-0.2%	-0.2%	-0.2%	0.0%	
BGE	7,231	7,238	7,299	7,321	7,374	0.4%
	0.2%	0.1%	0.8%	0.3%	0.7%	
DPL	4,140	4,155	4,171	4,181	4,200	0.3%
	0.1%	0.4%	0.4%	0.2%	0.5%	
JCPL	6,181	6,174	6,210	6,218	6,255	0.3%
	0.4%	-0.1%	0.6%	0.1%	0.6%	
METED	3,205	3,213	3,259	3,301	3,332	0.8%
	0.9%	0.2%	1.4%	1.3%	0.9%	
PECO	9,161	9,237	9,320	9,404	9,487	0.7%
	0.4%	0.8%	0.9%	0.9%	0.9%	
PENLC	2,919	2,920	2,924	2,933	2,942	0.1%
	0.0%	0.0%	0.1%	0.3%	0.3%	
PEPCO	6,811	6,833	6,847	6,893	6,935	0.4%
	-0.0%	0.3%	0.2%	0.7%	0.6%	
PL	7,619	7,659	7,714	7,769	7,831	0.6%
	0.8%	0.5%	0.7%	0.7%	0.8%	
PS	10,241	10,243	10,253	10,271	10,297	0.1%
	0.2%	0.0%	0.1%	0.2%	0.3%	
RECO	410	410	411	411	412	0.1%
	0.0%	0.0%	0.2%	0.0%	0.2%	
UGI	191	191	192	193	194	0.2%
	0.5%	0.0%	0.5%	0.5%	0.5%	
DIVERSITY - MID-ATLANTIC(-)	1,002	877	913	961	804	
PJM MID-ATLANTIC	59,604	59,889	60,176	60,418	60,940	0.4%
	0.1%	0.5%	0.5%	0.4%	0.9%	
FE-EAST	12,036	12,095	12,164	12,216	12,290	0.4%
	0.5%	0.5%	0.6%	0.4%	0.6%	
PLGRP	7,770	7,816	7,876	7,924	7,986	0.6%
	0.7%	0.6%	0.8%	0.6%	0.8%	

Notes:
All forecast values represent unrestricted peaks, after reductions for distributed solar generation and prior to reductions for load management.
All average growth rates are calculated from the first year of the forecast (2016).
Summer season indicates peak from June, July, August.

PJL – Exhibit 6 – RCR-ENG-12

In the Matter of the Petition of Jersey Central Power & Light Company Pursuant to N.J.S.A. 40:55D-19 for a Determination that the Monmouth County Reliability Project is Reasonably Necessary for the Service, Convenience or Welfare of the Public

BPU Docket No. EO16080750
OAL Docket No. PUC 12098-2016N

DATA REQUEST RESPONSE

RCR-ENG-12.

In the direct testimony of Lawrence Hozempa, on page 17 line 19 to page 18 line 3, four alternative approaches to constructing a new 230 kV line into Red Bank are mentioned:

i. Tapping the Atlantic – Raritan River 230 kV line
ii. Constructing a third 230 kV line from Atlantic
iii. Extending a 230 kV line from Oceanview, or
iv. Tapping the Freneau-NJT Aberdeen 230 kV line.

a. Please discuss how each of the alternatives compromises reliability in any way.
b. Please discuss whether and the extent to which each of the alternatives adds exposure to existing networked transmission lines.
c. Please discuss whether and the extent to which each of the alternatives adds transmission lines to existing corridors.
d. Please discuss whether and the extent to which each of the alternatives leaves parts of the transmission radial.
e. Please discuss the desirability of creating new transmission corridors versus adding transmission lines to existing corridors.

Response:

a.
  i. Tapping the Atlantic-Raritan River 230 kV line adds exposure to the Atlantic-Raritan River 230 kV line.
  ii. Constructing a third 230 kV line from Atlantic substation, if built utilizing the existing corridor or existing tower line, would decrease the reliability of the existing 230 kV lines from Atlantic substation by the addition of another facility on the existing towers or within the current right-of-way.
  iii. Extending a 230 kV line from Oceanview does not compromise reliability.
  iv. Tapping the Freneau–NJT Aberdeen 230 kV line would add exposure to the existing Freneau–NJT Aberdeen 230 kV line.

b. See the response to (a.i.) and (a.iv.) above.
c. See the response to (a.ii.) above.
d. Every alternative would leave the NJT Aberdeen and NJT Red Bank 230 kV stations radial.
e. From the Transmission Planning perspective it is desirable to have every transmission line in its own corridor and on its own structure since that is the most reliable design. Common mode and common corridor contingency events would be eliminated. However desirable that is, it is not practical from a cost, social, or environmental perspective. From a social and environmental perspective, utilization of existing transmission corridors is preferred, but there is a compromise to reliability the more transmission facilities there are that share the same structures or corridors.

PJL – Exhibit 7 – S-MCRP-48

In the Matter of the Petition of Jersey Central Power & Light Company Pursuant to N.J.S.A. 40:55D-19 for a Determination that the Monmouth County Reliability Project is Reasonably Necessary for the Service, Convenience or Welfare of the Public

BPU Docket No. E016080750
OAL Docket No. PUC 12098-2016N

DATA REQUEST RESPONSE

S-MCRP-48.

Provide details on those measures JCP&L is taking to reduce the magnetic field exposure from the proposed 230 kV line and upgraded substation facilities to as low as reasonably achievable.

Response:

The conductors of the 230 kV line are proposed to be installed in a vertical configuration with the conductors spaced approximately 20 feet apart. As compared to larger conductor spacing, the 20 foot spacing is a more compact design that reduces magnetic field levels of the transmission line.

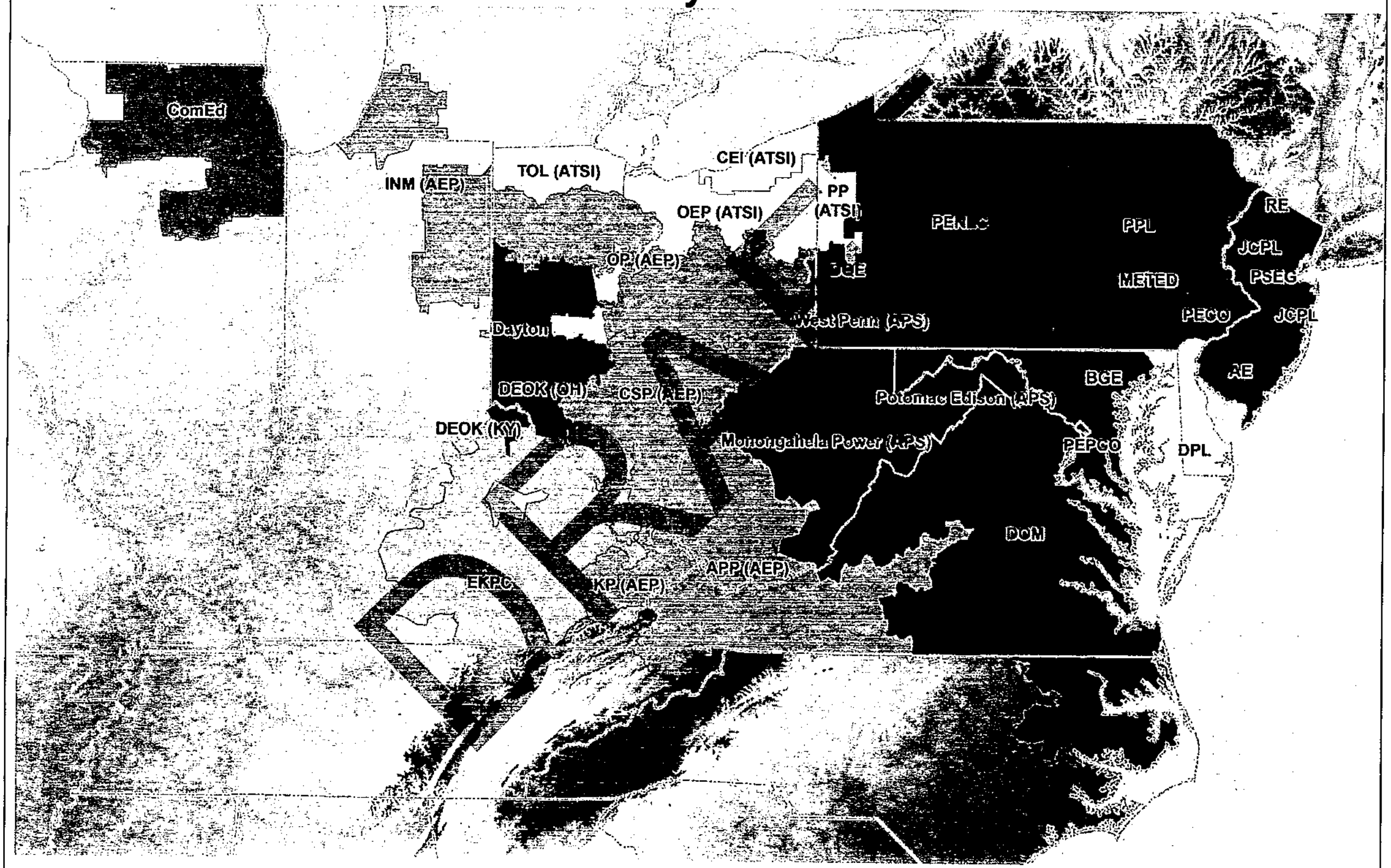
The majority of the proposed project is located above or near the catenary of the New Jersey Transit rail line. Complying with the National Electrical Safety Code clearance requirements for installing the project above the catenary as well as New Jersey Transit's additional clearance requirements, results in the conductors being installed higher above the ground as compared to a similar transmission line located above vacant ground. Installing the conductors higher above the ground reduces the strength of the magnetic field at the ground level.

The expansion of the Taylor Lane Substation is located adjacent to and as close to the existing substation as is practical.

PJL – Exhibit 8 – RCR-ENG-5 Confidential

PJL – Exhibit 9 – Excerpt from 2017 Load Forecast

PJM Load Forecast Report
January 2017



Prepared by PJM Resource Adequacy Planning Department

Table B-1

SUMMER PEAK LOAD (MW) AND GROWTH RATES FOR EACH PJM MID-ATLANTIC ZONE AND GEOGRAPHIC REGION

2017 - 2027

	METERED 2016	UNRESTRICTED 2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Annual Growth Rate (10 yr)
AE	2,674	2,674	2,495	2,486	2,475	2,454	2,442	2,451	2,435	2,434	2,436	2,440	2,445	(0.2%)
				-0.4%	-0.4%	-0.8%	-0.5%	0.4%	-0.7%	-0.0%	0.1%	0.2%	0.2%	
BGE	6,601	6,932	6,889	6,953	6,860	6,879	6,824	6,786	6,784	6,811	6,886	6,905	6,911	0.0%
				0.9%	-1.3%	0.3%	-0.8%	-0.6%	-0.0%	0.4%	1.1%	0.3%	0.1%	
DPL	4,127	4,127	4,028	4,037	4,024	3,995	3,952	3,937	3,936	3,943	3,966	3,980	3,983	(0.1%)
				0.2%	-0.3%	-0.7%	-1.1%	-0.4%	-0.0%	0.2%	0.6%	0.4%	0.1%	
JCPL	5,955	5,955	6,056	6,085	6,080	6,054	6,033	6,014	6,018	6,026	6,050	6,084	6,108	0.1%
				0.5%	-0.1%	-0.4%	-0.3%	-0.3%	0.1%	0.1%	0.4%	0.6%	0.4%	
METED	2,948	2,948	2,940	2,976	2,991	2,983	2,971	2,973	2,964	2,988	3,007	3,022	3,028	0.3%
				1.2%	0.5%	-0.3%	-0.4%	0.1%	-0.3%	0.8%	0.6%	0.5%	0.2%	
PECO	8,364	8,364	8,547	8,614	8,643	8,597	8,583	8,586	8,581	8,610	8,636	8,693	8,693	0.2%
				0.8%	0.3%	-0.5%	-0.2%	0.0%	-0.1%	0.3%	0.3%	0.7%	0.0%	
PENLC	2,910	2,910	2,891	2,899	2,904	2,893	2,878	2,869	2,856	2,855	2,855	2,860	2,847	(0.2%)
				0.3%	0.2%	-0.4%	-0.5%	-0.3%	-0.5%	-0.0%	0.0%	0.2%	-0.5%	
PEPCO	6,584	6,584	6,614	6,616	6,599	6,550	6,515	6,503	6,492	6,502	6,518	6,533	6,543	(0.1%)
				0.0%	-0.3%	-0.7%	-0.5%	-0.2%	-0.2%	0.2%	0.2%	0.2%	0.2%	
PL	6,841	6,841	7,132	7,185	7,201	7,186	7,169	7,162	7,125	7,137	7,162	7,186	7,186	0.1%
				0.7%	0.2%	-0.2%	-0.2%	-0.1%	-0.5%	0.2%	0.4%	0.3%	0.0%	
PS	9,801	9,801	10,057	10,071	10,047	10,000	9,965	9,963	9,960	9,947	9,964	9,996	10,012	(0.0%)
				0.1%	-0.2%	-0.5%	-0.4%	-0.0%	-0.0%	-0.1%	0.2%	0.3%	0.2%	
RECO	402	402	404	404	403	403	401	401	402	401	403	404	404	0.0%
				0.0%	-0.2%	0.0%	-0.5%	0.0%	0.2%	-0.2%	0.5%	0.2%	0.0%	
UGI	200	200	191	192	192	190	188	187	186	186	185	185	185	(0.3%)
				0.5%	0.0%	-1.0%	-1.1%	-0.5%	-0.5%	0.0%	-0.5%	0.0%	0.0%	
DIVERSITY - MID-ATLANTIC(-)			1,080	1,186	1,089	967	1,132	1,102	1,066	1,074	934	961	1,161	
PJM MID-ATLANTIC	56,261	56,666	57,164	57,332	57,330	57,217	56,789	56,730	56,673	56,766	57,134	57,327	57,184	0.0%
				0.3%	-0.0%	-0.2%	-0.7%	-0.1%	-0.1%	0.2%	0.6%	0.3%	-0.2%	
FE-EAST	11,692	11,692	11,618	11,689	11,699	11,630	11,593	11,587	11,582	11,605	11,626	11,669	11,693	0.1%
				0.6%	0.1%	-0.6%	-0.3%	-0.1%	-0.0%	0.2%	0.2%	0.4%	0.2%	
PLGRP	7,025	7,031	7,276	7,328	7,337	7,327	7,312	7,302	7,262	7,271	7,302	7,324	7,326	0.1%
				0.7%	0.1%	-0.1%	-0.2%	-0.1%	-0.5%	0.1%	0.4%	0.3%	0.0%	

Notes:
All forecast values are non-coincident as estimated by PJM staff.
All forecast values represent unrestricted peaks, after reductions for distributed solar generation and prior to reductions for load management.
All average growth rates are calculated from the first year of the forecast (2017).
Summer season indicates peak from June, July, August.

Table B-1 (continued)

SUMMER PEAK LOAD (MW) AND GROWTH RATES FOR EACH PJM MID-ATLANTIC ZONE AND GEOGRAPHIC REGION 2028 - 2032

	2028	2029	2030	2031	2032	Annual Growth Rate (15 yr)
AE	2,454	2,460	2,460	2,471	2,481	(0.0%)
	0.4%	0.2%	0.0%	0.4%	0.4%	
BGE	6,887	6,972	6,968	7,031	7,043	0.1%
	-0.3%	1.2%	-0.1%	0.9%	0.2%	
DPL	4,002	4,017	4,029	4,058	4,057	0.0%
	0.5%	0.4%	0.3%	0.7%	-0.0%	
JCPL	6,120	6,163	6,170	6,219	6,277	0.2%
	0.2%	0.7%	0.1%	0.8%	0.9%	
METED	3,016	3,031	3,023	3,015	3,006	0.1%
	-0.4%	0.5%	-0.3%	-0.3%	-0.3%	
PECO	8,717	8,719	8,697	8,652	8,629	0.1%
	0.3%	0.0%	-0.3%	-0.5%	-0.3%	
PENLC	2,835	2,815	2,789	2,755	2,724	(0.4%)
	-0.4%	-0.7%	-0.9%	-1.2%	-1.1%	
PEPCO	6,567	6,589	6,609	6,640	6,654	0.0%
	0.4%	0.3%	0.3%	0.5%	0.2%	
PL	7,167	7,155	7,107	7,060	7,018	(0.1%)
	-0.3%	-0.2%	-0.7%	-0.7%	-0.6%	
PS	10,049	10,073	10,074	10,128	10,185	0.1%
	0.4%	0.2%	0.0%	0.5%	0.6%	
RECO	405	406	407	409	410	0.1%
	0.2%	0.2%	0.2%	0.5%	0.2%	
UGI	184	183	181	180	178	(0.5%)
	-0.5%	-0.5%	-1.1%	-0.6%	-1.1%	
DIVERSITY - MID-ATLANTIC(-)	1,085	1,150	1,121	954	1,119	
PJM MID-ATLANTIC	57,318	57,433	57,393	57,664	57,543	0.0%
	0.2%	0.2%	-0.1%	0.5%	-0.2%	
FE EAST	11,726	11,750	11,730	11,713	11,726	0.1%
	0.3%	0.2%	-0.2%	-0.1%	0.1%	
PLGRP	7,302	7,292	7,237	7,195	7,157	(0.1%)
	-0.3%	-0.1%	-0.8%	-0.6%	-0.5%	

Notes:
All forecast values are non-coincident as estimated by PJM staff.
All forecast values represent unrestricted peaks, after reductions for distributed solar generation and prior to reductions for load management.
All average growth rates are calculated from the first year of the forecast (2017).
Summer season indicates peak from June, July, August.

PJL – Exhibit 10 – Excerpt from GTM Whitepaper re STATCOM

INTEGRATING HIGH LEVELS OF RENEWABLES INTO MICROGRIDS:

Opportunities, Challenges and Strategies

A GTM Research White Paper

Sponsored by ABB

gtmresearch ABB

February 2016

3.4. STATCOM: Voltage Control

The power system considerations discussed in the two previous subsections deal with active power, but reactive power is also crucial to power system stability. When voltage levels drop in a power system, impacts are very visible to end users in the form of dimming lights, equipment malfunctions, etc. Utilities primarily depend on synchronous generators, as well as a range of assets (such as capacitor banks and static VAR compensators), to maintain voltages within certain limitations (generally 5% of unity).

When in grid-connected mode, microgrids can often depend on the utility for voltage support. However, in islanded mode, the microgrid operator must be able to independently support power quality and accommodate any changes to system voltage levels.

If a microgrid has on-line thermal generation (such as a reciprocating engine), the synchronous machine can be used to supply reactive power and dynamically regulate system voltages. However, if a significant amount of power is being generated from renewables, other devices must be used to generate these VARs. Several devices can be used in microgrids to supply these functions, including STATCOMs, which supply fast-acting continuous voltage regulation. If a microgrid already has an installed energy storage system, the front-end inverter of this flywheel or battery storage devices can typically fulfill this role when properly sized.

3.5. Standalone: Grid Referencing in Islanded Mode

When a microgrid is operating in grid-connected mode, the utility provides a convenient, reliable voltage and frequency reference to maintain microgrid synchronous operation. But when a microgrid is islanded from the grid, it must rely on its internal assets to provide this reference. Currently, most islanded microgrids rely on synchronous fossil-fuel-fired generators to provide that reference.

A unique challenge exists for islanded microgrids operating completely on renewable generation. Such a system is often entirely inverter-based and lacks any spinning generators. Therefore, it must rely on intelligent inverters coupled with storage, which can operate in voltage and frequency control mode to provide its own reference points. Managing this process is one of the core control functionalities of a fully renewable microgrid.

3.6. Smoothing: Capacity Firming

In addition to addressing how power intermittencies of 1 second or less affect system stability, a microgrid must also be able to manage overall renewable production patterns in relation to a system's portfolio of flexible and non-dispatchable load.

A microgrid must accommodate slight changes in the renewable contribution to the total grid capacity. When renewable input deviates from its forecasted pattern, energy storage or dispatchable generators are often used to bridge this gap. Depending on the size and duration of