

Section 7: Market Efficiency Studies



7.0: Introduction

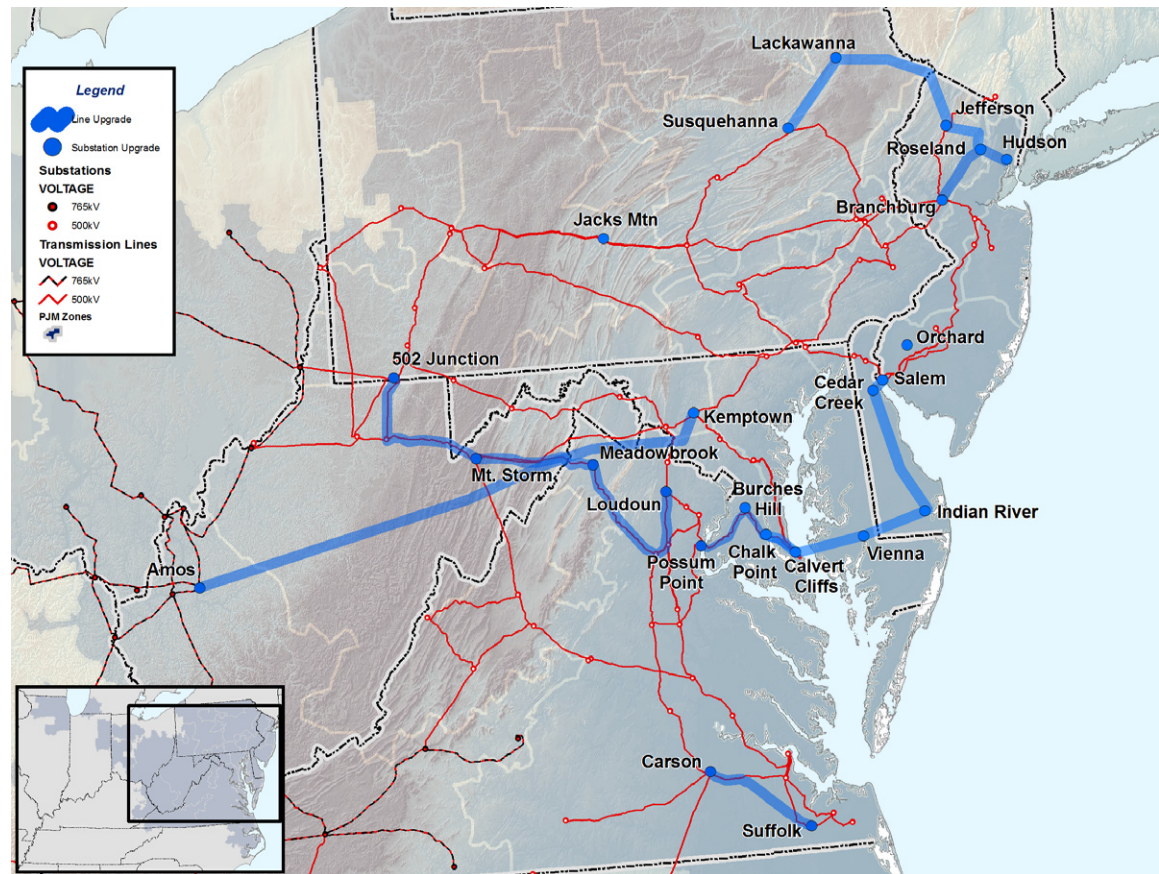
PJM's RTEP Process includes market efficiency analysis the goal of which is to accomplish the following objectives:

1. Determine which reliability upgrades, if any, have an economic benefit if accelerated.
2. Identify new transmission upgrades that may result in economic benefits.
3. Identify economic benefits associated with modification to reliability-based enhancements already included in RTEP that when modified would relieve one or more economic constraints. Such upgrades resolve reliability issues but are intentionally designed in a more robust manner to provide economic benefits in addition to resolving those reliability issues.

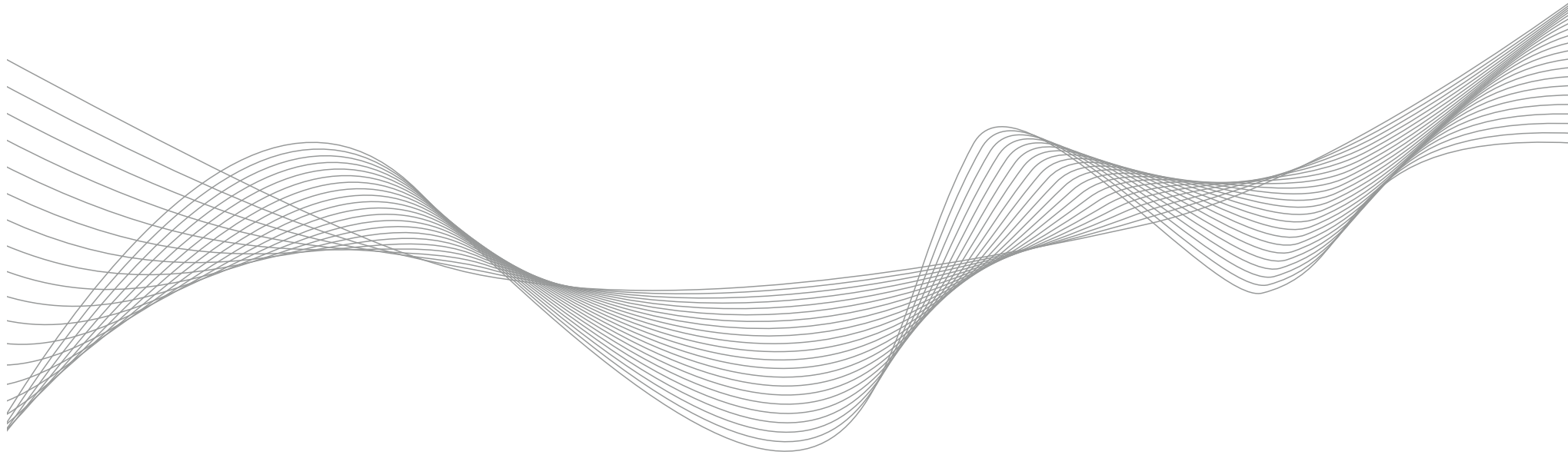
The results of PJM's 2008 analysis have revealed that no economic upgrades or acceleration of reliability upgrades for economic reasons are being recommended.

For reference, Map 7.1 shows PJM Board approved RTEP Backbone Upgrades to resolve reliability criteria violations.

Map 7.1: PJM Board-Approved RTEP Backbone Upgrades



The right-of-way routes shown on this map are for illustrative purposes only and may not depict the actual routes that may eventually be chosen. Substation locations may also be modified if more beneficial connections are determined by PJM.





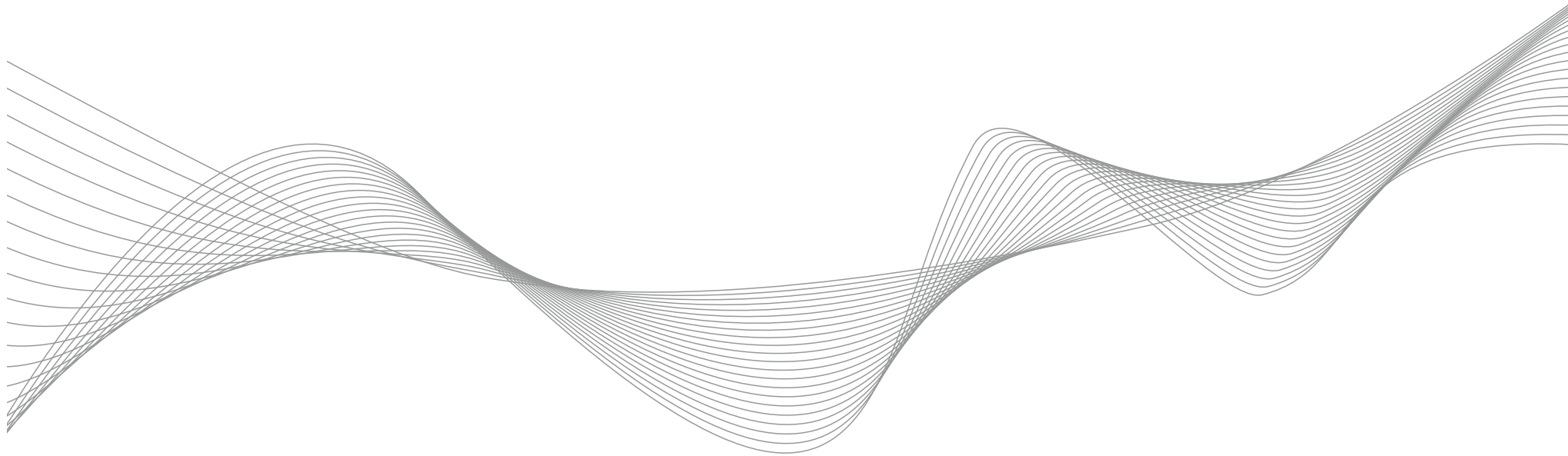
7.1: Simulation Methodology and Assumptions

PJM market efficiency analysis employs a market simulation tool that models hourly security-constrained generation commitment and dispatch over a defined future annual period. Economic benefits of transmission upgrades are determined by comparing results of simulations with and without defined transmission upgrades

PJM’s 2008 market efficiency analysis included market simulations for 2008, 2011, 2014 and 2017. Prior to the initiation of each annual market efficiency analysis, the PJM Transmission Expansion Advisory Committee (TEAC) reviews and the PJM Board approves key analysis parameters including fuel costs, emissions costs, future generation scenarios, load forecasts and demand response projections, shown in Figure 7.1.

Figure 7.1: Market Efficiency Analysis Parameters







7.2: 2008 RTEP Market Efficiency Analysis

7.2.1 – Summary of Results

PJM’s 2008 market efficiency analysis assessed the economic impact of all upgrades identified as part of PJM’s RTEP process up through and including those identified as part of the 2007 RTEP cycle. This collective set of upgrades includes the following baseline backbone lines:

- 502 Junction – Loudoun 500 kV Line (TrAIL)
- Amos – Kemptown 765 kV Line (PATH)
- Susquehanna – Roseland 500 kV Line
- Possum Point – Salem 500 kV Line (MAPP)

Results have indicated that approved RTEP upgrades will significantly reduce PJM constrained operations. PJM system congestion costs fall to levels 90% lower than costs expected absent the upgrades. The majority of the congestion cost reduction can be attributed to the addition of the new 765 kV and 500 kV RTEP backbone projects listed above. These facilities are responsible for nearly 90% of the total congestion cost reduction. The remaining 10% of congestion cost reduction is associated with the non-backbone upgrades listed in Table 7.1

7.2.2 – 2008 and 2011 Study Year Results

Assessments of transmission system topology impacts are conducted with different transmission system topology models while keeping all other

Table 7.1: Non-Backbone 2012 RTEP Upgrades that Contribute to Congestion Cost Reduction

Facility Upgrade	Date Required
4th Bedington 500/138 kV Transformer	5/1/2009
Add 600 MVAR SVC at Elroy 500 kV Substation	6/1/2009
Reconductor Doubs-Aqueduct-Dickerson 230 kV Line	6/1/2009
Red Lion 500/230 kV Transformer	6/1/2009
Replace Kammer 765/500 kV transformer	11/1/2009
Add 200 MVAR Capacitor at Meadowbrook 500 kV Substation	12/1/2009
Airydale 500 kV substation and 400 MVAR capacitor	6/1/2010
Add 400 MVAR Capacitor at Branchburg 500 kV Substation	6/1/2010
Replace Doubs 500 / 230 kV Transformers: #2, #3 & #4	6/1/2011 12/2010 6/2010

input assumptions constant for a given study year. Market simulations for study years 2008 and 2011 were conducted under three transmission topology models:

1. 2008 “as-is” PJM transmission system topology
2. PJM transmission system topology based on upgrades up through the 2007 RTEP process cycle without the four new baseline backbone lines noted earlier
3. PJM transmission system topology based on upgrades up through the 2007 RTEP process cycle including the four new baseline backbone lines noted earlier

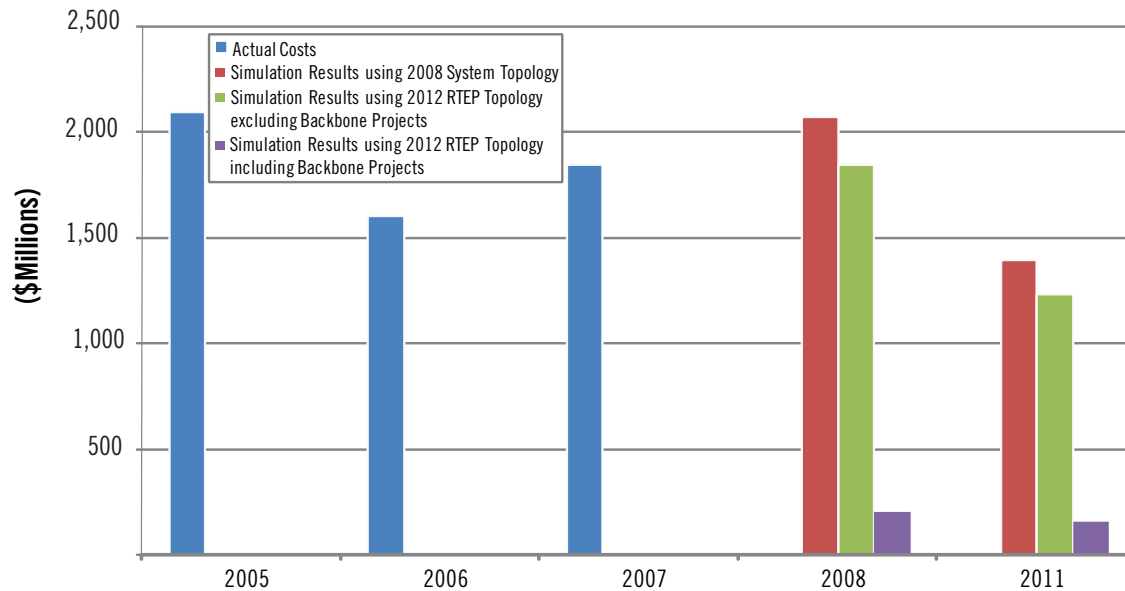
Figure 7.2 shows actual PJM system congestion costs for years 2005, 2006 and 2007 and congestion costs derived from market simulations

for years 2008 and 2011. Simulations were conducted with and without the four major 765 kV and 500 kV backbone projects delineated earlier in order to isolate and more clearly identify the congestion impact of identified upgrades.

2008 Study Results

Figure 7.2 shows that PJM RTEP upgrades have a significant impact on PJM system congestion costs. Simulations using the 2008 transmission system topology show PJM system congestion costs of nearly \$2.1 billion. Congestion costs in year 2008 are reduced to \$1.8 billion when all RTEP upgrades except for the backbone projects are modeled. Inclusion of the backbone projects reduces PJM system congestion cost for study year 2008 to \$203.5 million.

Figure 7.2: Actual and Simulated PJM System Congestion Costs



2011 Study Results

For study year 2011, simulations made using the 2008 transmission system topology show PJM system congestion costs of nearly \$1.4 billion. PJM system congestion costs for study year 2011 are reduced to \$1.2 billion when all 2012 RTEP upgrades except for the 765 and 500 kV backbone projects are modeled. Including the backbone projects reduces the PJM system congestion cost for study year 2011 to \$157.9 million.

Congestion Impact of New Transmission

The simulations for study years 2008 and 2011 under the three system study topologies show similar impacts on transmission congestion. In both study years, the addition of RTEP upgrades identified and approved up through the 2007 RTEP cycle reduce total PJM system congestion costs to levels approximately 90% lower than congestion costs absent the upgrades. The bulk of the congestion cost reduction, slightly less than 90% of the total reduction, is attributed to the addition of the four major 765 kV and 500 kV backbone projects contained in the RTEP. The remaining 10% of the congestion cost reduction is attributable to non-backbone upgrades contained in the 2012 RTEP as listed in Table 7.1.

NOTE

The term “transmission system topology” refers to that aggregate of transmission lines, transformers, substations, capacitors and other power system elements that constitute a transmission system model for power flow and economic analysis.

Comparing 2008 and 2011 Results

Figure 7.2 compares the reduced PJM congestion costs in 2011 with that in the 2008 study. For example, simulations made using the 2012 RTEP topology minus the backbone projects show PJM system congestion costs of \$1.8 billion in 2008 versus \$1.2 billion in 2011.

Because both simulations were run against the same transmission system topology model, the congestion cost reduction from 2008 to 2011 is unrelated to transmission system upgrades and is instead a function of different input assumptions made for each study year. Further investigation showed that a majority of this reduction is due to the study’s use of a fuel price forecast that predicted lower gas and oil prices in 2011 than those for study year 2008.

The lower gas prices predicted for study year 2011 coupled with the introduction of a system-wide CO₂ adder in study year 2011 study year had the effect of a lower cost differential between coal and gas generation consequently yielding lower congestion costs. About 70% of the total congestion cost reduction between study years 2008 and 2011 is due to the combined impact of the study’s input assumptions of lower gas prices and the introduction of a region-wide CO₂ adder. The remaining 30% of the total congestion cost reduction from study year 2008 to study year 2011 is associated with the addition of new base-load and intermediate-load generation in eastern and southern PJM.

While the economic impact of transmission system topology changes is the focus of market efficiency analysis, this additional investigation illustrates the congestion impacts of generation fuel prices and the location of new generation.

7.2.3 – 2014 and 2017 Study Results

PJM also conducted market efficiency analyses to assess the impact of approved RTEP upgrades in study years 2014 and 2017. Similar to simulation results for study years 2008 and 2011, simulations of study years 2014 and 2017 revealed congestion levels well below levels seen in recent history, the result of adding the four backbone projects noted earlier.

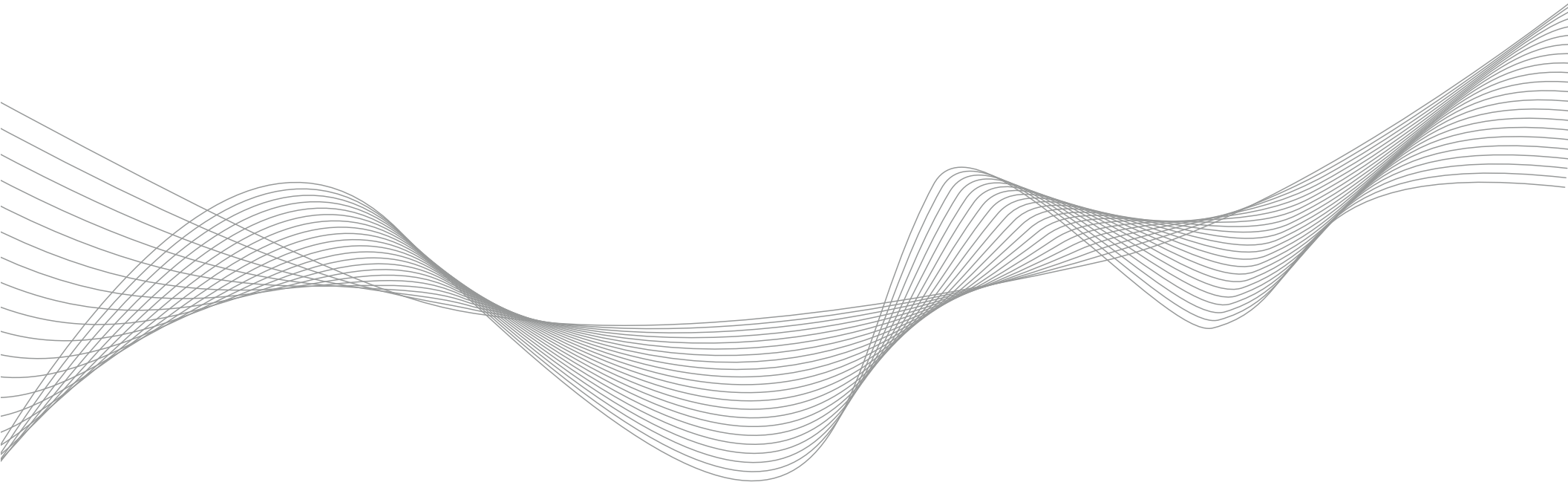
The results summarized in Table 7.2 include those constraints causing more than \$2 million of congestion costs in either of the study years. Several constraints in Table 7.2 already have solutions in response to previously identified reliability criteria violations:

- PJM's 2008 RTEP baseline assessment identified reliability criteria violations on the Burtonsville - Sandy 230 kV line and Bradford - Planebrook 230 kV line. As a result, specific upgrades to resolve those violations have already been developed by PJM and approved by the PJM board.
- PJM's 2008 RTEP baseline assessment included reactive studies that identified reliability voltage criteria violations at specific 500 kV substations. Implementation of upgrades already identified by PJM and approved by the Board will enable PJM to operate to higher limits on the AP South, PJM Central interface and PJM Eastern interface.
- A merchant transmission project to add a Bath County Special Protection Scheme (SPS) is expected to reduce or eliminate congestion on the Cloverdale-Lexington 500 kV circuit. This SPS is expected to be implemented by summer 2009.

Table 7.2: Congestion-Causing Constraints for Study Years 2014 and 2017

Constraints with Congestion Greater Than \$2 million	2014 Study Year		2017 Study Year	
	Frequency (hours)	Congestion (\$ million)	Frequency (hours)	Congestion (\$ million)
PJM 500 kV Central Interface	1121	54.3	1254	60.1
Cloverdale - Lexington 500 kV Line	588	30.0	320	18.8
PJM 500 kV Eastern Interface	58	17.3	70	9.1
Burtonsville - Sandy Springs 230 kV Line	117	13.5	135	14.9
AP South 500 kV Interface	46	9.2	132	43.6
Clover 500 / 230 kV Transformer	119	5.6	183	8.1
Pontiac - Wilton 345 kV Line	49	5.0	503	66.8
Bradford - Planebrook 230 kV Line	47	4.0	178	5.2
Total		138.9		226.7

As a result, transmission expansion solutions for most of the constraints in Table 7.2 have been developed already and will help further alleviate the congestion associated with each.





7.3: Market Simulation Model Input Assumptions

Prior to the initiation of each annual market efficiency analysis, the PJM TEAC reviews and the PJM Board approves the key analysis input parameters. Such parameters include fuel costs, emissions costs, load forecasts and demand response projections. Full details are described in the proceedings of the PJM Transmission Expansion Advisory Committee (TEAC) available on PJM's Web site via the following URL link: <http://www.pjm.com/committees-and-groups/committees/teac.aspx>.

General Fuel Cost Assumptions

PJM uses a commercially available Ventyx Powerbase database tool which includes fuel cost forecasts for each fuel type. Forecasts for short-term gas and oil prices are derived from NYMEX futures prices. Long-term forecasts were obtained from Platts and the DOE's Energy Information Administration (EIA). Coal price forecasts were obtained from Platts directly. Powerbase uses basis adders to account for commodity transportation cost to each PJM zone.

Load and Energy Forecasts

PJM's January 2008 PJM Load Forecast Report provided the load and energy data modeled in these market simulations.

Demand Response

The 2008 study year values were based on the sum of the ILR and DR (cleared and FRR) from the 2008/2009 RPM auction. The values used for study year 2011 and beyond are based on the sum of the ILR and DR (cleared and FRR) from the 2011/2012 RPM simulation. Demand response MWs are distributed among the PJM zones based on the zonal apportionment of the forecasted ILR and cleared DR and FRR.

Generation Modeling

The generation capacity modeled included in-service generation plus active queue generation with an executed Interconnection Service Agreement (ISA) minus expected future deactivations.

The net internal demand is consistent with the 2008 PJM Load Forecast Report and equates to the PJM Summer unrestricted peak forecast minus the projection of load management placed under PJM control. Overall, projected total capacity is expected to be able to meet expected reserve margin through 2012. The PJM reserve requirement exceeds the total capacity of installed generation by approximately 3,500 MW, 11,000 MW and 22,600 MW in the years 2014, 2017 and 2022, respectively.

New generation needed to maintain PJM's reserve margin in study years 2014, 2017 and 2022 was added to the model according to the location and fuel type of generation interconnection requests in recent PJM queues.

Emission Allowance Price Assumptions

The Powerbase database PJM uses models four major effluents: SO₂, NO_x, Hg and CO₂. Each is assigned to generators based on generator location. Release rates are from a variety of sources including Platt's BASECASE, EPA CEMS data and specific EPA studies. Emissions allowance prices are also from a variety of sources including Platt's BASECASE, Evomarkets.com and EPA studies.

A national CO₂ allowance trading program was assumed in-place starting with study year 2011. The Powerbase database does not include a CO₂ allowance price forecast. Instead, the allowance prices assumed for CO₂ are based on a base forecast from Synapse Energy Economics.

