



December 2019 Baseline Market Efficiency Recommendations

TEAC

Dec. 3, 2019

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Contents

Summary	1
<i>2018/2019 RTEP Long-Term Proposal Window Activity.....</i>	2
Identified Congestion Drivers	2
Recommendation: PJM-MISO Interregional Baseline Project b3142: Rebuild Michigan City-Trail Creek-Bosserman 138 kV Line	3
<i>South-Central Pennsylvania and Northern Maryland Congestion</i>	5
Recommendation	5
Project 9A and Alternative Project 9A	8
Project 5E, as Approved by the Board	10
PJM's Recommendation of Project H-L	12

Summary

PJM is making several baseline market efficiency recommendations based on two recent bodies of Regional Transmission Expansion Plan (RTEP) analyses that addressed the following:

1. 2018/2019 RTEP Long-Term Window Proposals
2. South-Central Pennsylvania and Northern Maryland (inclusive of the AP South Interface and related constraints) congestion relief

With respect to the first body of RTEP analyses, the 2018/2019 RTEP Long-Term Window yielded two market efficiency proposals evaluated by PJM that warrant recommendation to the PJM Board to alleviate congestion. The first recommendation is baseline project b3142, a PJM-MISO interregional project to rebuild the Michigan City-Trail Creek-Bosserman 138 kV transmission line. The second PJM recommendation is baseline project b3145 to rebuild the Hunterstown-Lincoln 115 kV line.

With respect to the second body of RTEP analyses – which includes additional RTEP analyses subsequent to the Transmission Expansion Advisory Committee’s Nov. 14, 2019 review and comment – PJM has reviewed market efficiency projects that address congestion drivers in South-Central Pennsylvania and Northern Maryland.

More specifically, PJM’s RTEP analyses reviewed:

- The Board-approved baseline project b2743/2752 known as the Independence Energy Connection (IEC) Project (Project 9A) submitted in the 2014/2015 RTEP Long-Term Proposal Window
- The Board-approved baseline project b2992 in the Bagley/Graceton area of BGE (Project 5E) submitted in the 2016/2017 RTEP Long-Term Proposal Window
- The baseline project b3145 to rebuild the Hunterstown-Lincoln 115 kV line (Project H-L), noted above, submitted in the 2018/2019 RTEP Long-Term Proposal Window, which PJM recommends to the Board for inclusion in the RTEP.

Additionally, in the ongoing siting proceedings in Pennsylvania and Maryland, several of the parties have filed a settlement that, if approved, would not alter the western segment of Project 9A as approved by the Board, but offers an alternative configuration of the eastern portion of Project 9A (the Alternative IEC East Portion). In light of this development, PJM’s RTEP analyses have also considered:

- The IEC Project inclusive of the Alternative IEC East Portion, (Alternative Project 9A)
- Project 5E (which is already in the RTEP)
- Project H-L (which PJM is recommending to the Board for inclusion in the RTEP)

As discussed in greater detail below, PJM’s analyses have determined that in the combinations set forth above, these projects exceed the benefit/cost ratio of 1.25, significantly reduce congestion in South-Central Pennsylvania and Northern Maryland, and solve reliability criteria violations identified in study year 2023 that PJM found to otherwise arise with certain of these projects removed from the base case.

Each of PJM’s recommendations is now presented in more detail.

2018/2019 RTEP Long-Term Proposal Window Activity

PJM opened its third Long Term proposal window starting on November 2, 2018 through March 15, 2019 to solicit proposals addressing the identified congestion drivers shown in Table 1.

Market efficiency analysis is a part of the overall RTEP process to accomplish the following objectives:

1. Determine which reliability upgrades, if any, have an economic benefit if accelerated or modified.
2. Identify new transmission upgrades that may result in economic benefits.
3. Identify economic benefits associated with “hybrid” transmission upgrades. Hybrid transmission upgrades include proposed solutions, which encompass modifications to reliability-based enhancements already included in the RTEP that when modified would relieve one or more economic constraints. Such hybrid upgrades resolve reliability issues but are intentionally designed to provide economic benefits in addition to resolving reliability issues.

PJM conducts market efficiency analysis using market simulation tools of future annual periods for both the capacity market and energy market. Economic benefits of specific transmission projects are determined by comparing results of simulations that include each project with simulations that do not include the project. Projects are measured using two Tariff/Operating Agreement criteria. First, the project must address either an identified congestion driver or a capacity market constraint. Second, the project’s total energy and capacity benefits must exceed costs (benefit to cost ratio) by at least 25 percent. Project energy benefits are measured by comparing the benefits in the form of net load payments and/or production costs with and without the proposed project for a 15-year study period. Projects affecting the capacity market derive additional capacity benefits in the form of net load capacity payments and/or capacity costs.

Identified Congestion Drivers

PJM posted a list of identified congestion drivers – facilities and their simulated congestion levels -- as part of soliciting proposals during the 2018/2019 Long-Term Proposal Window, as shown in **Table 1**.

Table 1. **2018/2019 Long-Term Window Congestion Drivers**

Constraint	Area	2023 Congestion Frequency (hours)	2023 Market Congestion (\$, million)	2026 Congestion Frequency (hours)	2026 Market Congestion (\$, million)
Hunterstown-Lincoln 115 kV Line	MetEd (PJM)	1,720	\$20.77	1,832	\$29.62
Monroe #1 and #2-Wayne 345 kV Lines	MISO	45	\$1.44	30	\$0.61
Marblehead North Bus #1 161/138 kV Transformer	MISO	195	\$1.41	138	\$1.18
Bosserman-Trail Creek 138 kV Line	AEP-MISO	66	\$1.47	89	\$1.69

Twelve parties submitted 34 proposals during the 2018/19 RTEP Long-Term Proposal Window that closed in March of 2019. Proposals ranged in cost from \$0.1 million to \$290.95 million and included transmission upgrades from

transmission owners and greenfield projects from incumbent transmission owners and non-incumbent entities, as summarized in **Table 2**.

Table 2. **Proposals by Type Submitted in the 2018/2019 Long Term Proposal Window**

Congestion Driver	Number of Proposals	Greenfield Proposals	TO Upgrade Proposals
Hunterstown-Lincoln 115 kV Line	22	19	3
Bosserman-Trail Creek 138 kV Line	5	4	1
Marblehead #1 161/138 kV Transformer	2	1	1
Monroe #1 and #2-Wayne 345 kV Lines	3	0	3
No PJM Driver	2	1	1
Total	34	25	9

PJM evaluated the proposals according to Schedule 6 of the Amended and Restated Operating Agreement of PJM Interconnection, L.L.C. (Operating Agreement). PJM is recommending for Board approval a market efficiency interregional solution to provide congestion relief on the Bosserman-Trail Creek line. PJM is also recommending for Board approval the Hunterstown-Lincoln 115 kV rebuild as part of a combination of transmission projects to address congestion in South-Central Pennsylvania and Northern Maryland. Because the proposals submitted to address congestion on the Marblehead transformer and the Monroe-Wayne transmission lines did not satisfy PJM criteria, PJM is not recommending any of those proposals to the Board for approval.

Recommendation: PJM-MISO Interregional Baseline Project b3142: Rebuild Michigan City-Trail Creek-Bosserman 138 kV Line

PJM-MISO interregional baseline project b3142, a rebuild of the Michigan City-Trail Creek-Bosserman 138 kV Line, is the first interregional proposal submitted during the Long-Term Proposal Window that PJM is recommending to the Board for approval and inclusion in the RTEP.

PJM, working with MISO through the Interregional Planning Stakeholder Advisory Committee (IPSAC), completed a two-year Interregional Market Efficiency Project (IMEP) study in parallel with PJM's 2018/2019 Long-Term Proposal Window process. As part of the IMEP Study, PJM and MISO separately received project proposals that addressed at least one congestion driver identified in each region's respective planning process. Under the terms of the PJM/MISO Joint Operating Agreement, interregional proposals are separately submitted to, and evaluated by PJM and MISO, and subject to each RTO's respective regional processes.

As shown earlier in **Table 1**, The Bosserman-Trail Creek 138 kV line in Northern Indiana Public Service Company (NIPSCO) – in the MISO footprint – was identified as an interregional targeted congestion facility. Simulations performed in advance of the 2018/2019 Long Term proposal window identified over \$1.4 million in market congestion on this facility based on 2023 input assumptions and simulation results. PJM received a cluster of five proposals (four greenfield proposals and one upgrade proposal) from five entities to address the Bosserman-Trail Creek congestion. The proposed project cost estimates ranged from \$19 million to \$266 million.

Solution Selection

The energy benefits associated with the proposed projects were determined using the methodologies specified in Schedule 6 of the Operating Agreement. PJM's annual energy benefits calculation for lower voltage facilities is weighted 100 percent to zones with a decrease in net load payments as a result of the proposed project. Change in net load payments comprises the change in gross load payments offset by the change in transmission rights credits. No capacity benefits were identified with these proposed projects.

PJM evaluated each of the five proposals, out of which two exceeded the 1.25 benefit-to-cost ratio and fully mitigated congestion: (1) proposal BT_481 to rebuild the Michigan City-Trail Creek-Bosserman 138 kV line; and, (2) proposal BT_129 to build a new Kuchar substation and new Kuchar-Luchtman 138 kV line. PJM conducted further analysis on these two proposals to determine how the projects addressed the identified congestion and to evaluate project constructability risk.

Based on the analysis performed, PJM selected proposal BT_481 shown on **Map 1** – a rebuild of the Michigan City-Trail Creek-Bosserman 138 kV line – as the more efficient or cost effective solution to the identified congestion driver. Proposal BT_481:

- Has a benefit-to-cost ratio of 2.63, which was the highest benefit-to-cost ratio across the proposals submitted for the Bosserman-Trail Creek constraint; cost estimates were from PJM's own constructability analysis
- Fully addresses the congestion driver
- Is an upgrade and has lower constructability risk compared to the four greenfield proposals, including BT_129

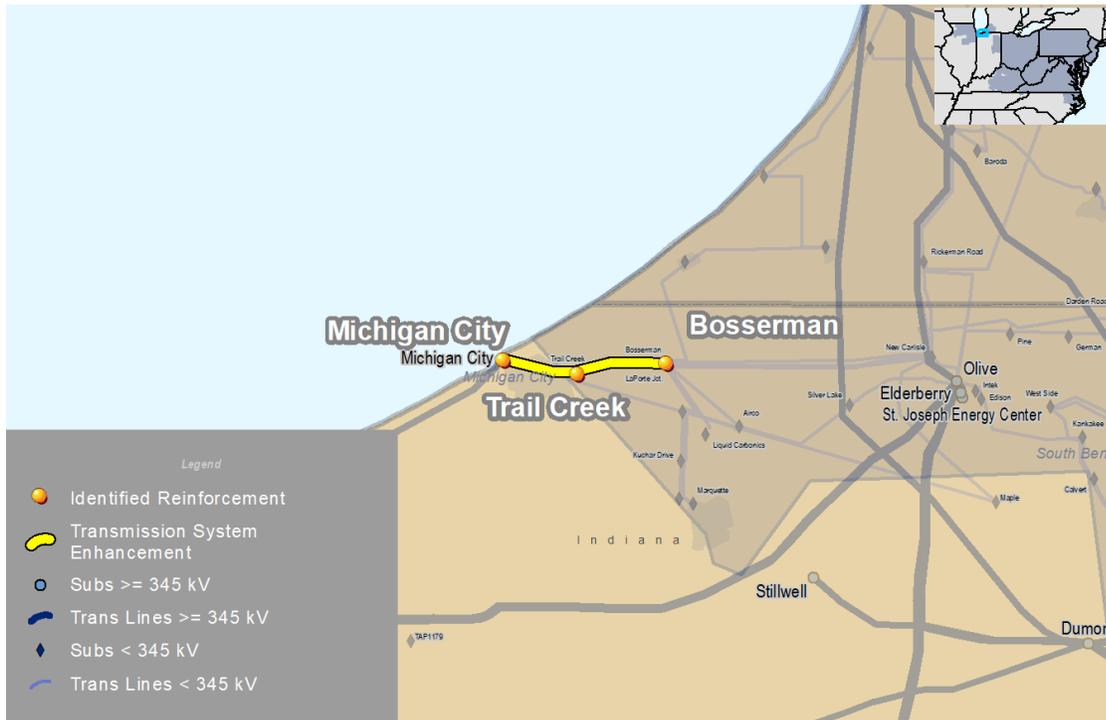
In addition to the market efficiency base case analysis for the recommended proposal BT_481, PJM also performed sensitivity analysis on key input variables: natural gas prices, PJM load forecasts, generation expansions, and generator outage patterns. The benefit to cost ratio exceeded 1.25 in each instance. An RTEP process reliability analysis of the project did not identify any reliability criteria violations. PJM also conducted a constructability review of the components proposed by project BT_481 and did not identify any significant issues.

In conclusion, PJM is recommending proposal BT_481 to the PJM Board for provisional approval as an interregional baseline project, pending approval by the MISO Board as well. Both the PJM and MISO boards must approve the project in order for it to be included in each entity's regional transmission plan. BT_481 project elements will be designated to NIPSCO, the proposing entity and transmission owner of the project elements in the MISO footprint:

- Reconductor Bosserman-Trail Creek 138 kV line
- Reconductor Michigan City-Trail Creek 138 kV line
- Michigan City Substation Upgrades
- Trail Creek Substation Upgrades

The estimated cost for the project is \$24.69 million (in service dollars) with a January 2023 in-service date required. Based on the PJM to MISO benefit ratio, 89.1 percent of the cost (\$22.00 million) will be allocated to PJM.

Map 1. **Baseline Project b3142: Bosserman-Trail Creek-Michigan City 138 kV Proposal**



South-Central Pennsylvania and Northern Maryland Congestion

The following discussion relates to three projects addressing congestion in South-Central Pennsylvania and Northern Maryland, including congestion on the AP South Interface and related constraints. The first project (Project 9A) was submitted in the 2014/2015 RTEP Long-Term Proposal Window and approved by the PJM Board in August 2016. The second project (Project 5E) was submitted in the 2016/2017 RTEP Long-Term Proposal Window and approved by the PJM Board in April 2018. PJM is recommending the third project (Project H-L), which was submitted in the 2018/2019 RTEP Long-Term Proposal Window, for approval by the PJM Board. Because this combination of projects addresses interrelated congestion drivers, PJM has reviewed these projects to consider interactions among them given the dynamic nature of the market efficiency base case through changes in the 2014/2015, 2016/2017, and 2018/2019 RTEP Years, and in light of potential reliability criteria violations otherwise found to arise in 2023 in South-Central Pennsylvania and Northern Maryland with certain of these projects removed from the base case.

Recommendation

PJM’s RTEP analyses relative to the South-Central Pennsylvania and Northern Maryland congestion include a review of Project 9A, Project 5E, and Project H-L, as well as a review of Alternative Project 9A, Project 5E, and Project H-L.

As discussed in greater detail below, PJM’s RTEP analyses have determined that in the combinations described, these projects exceed the benefit-to-cost ratio of 1.25, significantly reduce congestion, and solve reliability criteria violations identified in study year 2023 that otherwise were found to arise with certain of these projects removed from the base case.

As such, PJM recommends that:

- Project H-L be added to the RTEP
- Project 5E, as approved, remain in the RTEP
- Project 9A, as approved by the Board, continues to exceed the benefit-to-cost ratio and should remain in the RTEP
- Alternative Project 9A exceeds the benefit-to-cost ratio and, if approved by the Maryland and Pennsylvania Commissions through their respective CPCN application processes, Alternative Project 9A would be recommended for approval by the PJM Board of Managers as memorialized in a Board Resolution. Upon approval by both State Commissions, PJM would present Alternative Project 9A to the Board for final approval and inclusion in the RTEP.

Table 3 summarizes PJM's RTEP analyses relating to the projects noted above. As is made clear below, the benefit-to-cost ratios exceeded the 1.25 threshold in the scenarios where PJM studied Project 9A, Project 5E, and Project H-L in the aggregate, and Alternative Project 9A, Project 5E, and Project H-L in the aggregate.

Table 3. **Summary of Recent RTEP Analyses**

RTEP Analyses ¹	Date Presented	Benefit to Cost Ratio
Alternative Project 9A	May 8, 2019	1.39 (using \$466.44M as cost est.) - 1.52 (using \$426.02M as cost est.)
Re-evaluation of Project 9A	Oct. 17, 2019	2.10
Re-evaluation of Project 5E	Nov. 14, 2019	1.11 ²
Project H-L	Nov. 14, 2019	76.41
Alternative Project 9A	Nov. 14, 2019	1.60
Re-evaluation of Project 5E (assuming Board approval of Project H-L)	Nov. 14, 2019	1.80
Project 9A + Project 5E + Project H-L	To be presented at the December TEAC.	2.87, aggregate
Alternative Project 9A + Project 5E + Project H-L	To be presented at the December TEAC.	2.25 (using \$561.68M as cost est.) - 2.33 (using \$533.99M as cost est.), aggregate

The individual elements of each of the projects described above are shown schematically in **Figure 1**.

PJM conducted RTEP analyses of the two combinations noted in the last two rows of **Table 3**, above. PJM proceeded in this manner because the two combinations are comprised of:

¹ The market efficiency base case was updated in July 2019 and further revised in September 2019.

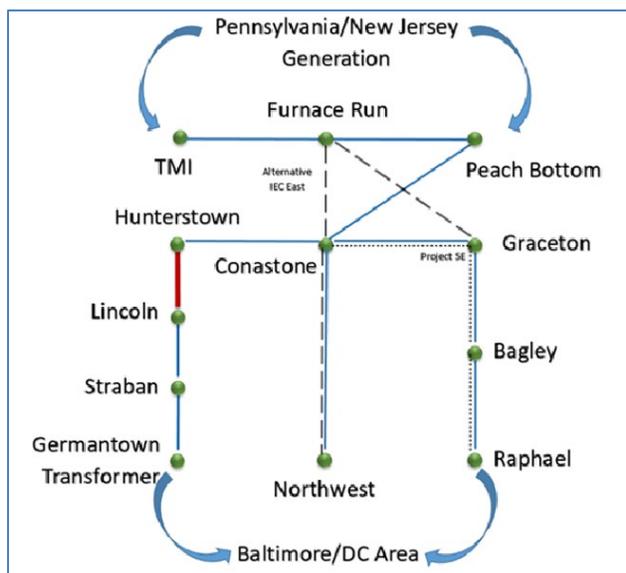
² For further discussion, see the section of this paper regarding Project 5E, below.

- Project 9A or Alternative Project 9A, a project that is nearing a decision in the state siting processes (and, notably, in the case of Alternative Project 9A, the siting processes might culminate in a Commission-approved settlement reflecting a compromise among certain parties to the proceeding)
- Project 5E, a project that is advanced in both its engineering and procurement phases
- Project H-L, which is a relatively modest upgrade

In the aggregate, PJM's RTEP analyses show that these combinations of projects exceed the benefit-to-cost ratio of 1.25, significantly reduce congestion, and solve reliability criteria violations identified in study year 2023 that otherwise were found to arise with certain of these projects removed from the base case.

It is important to note that if Project 9A or Alternative Project 9A were to be removed from further consideration, PJM's RTEP analysis has previously identified a number of reliability criteria violations starting in the 2023 study year. Some of these reliability criteria violations include conductor overloads on 500 kV transmission lines which, in PJM's experience, are likely to be resolved only through the construction of additional greenfield transmission. Should these combinations of projects inclusive of Project 9A or Alternative Project 9A be removed from the RTEP, resultant reliability criteria violations would be identified during the 2020 RTEP analysis, and potential solutions to such reliability criteria violations would not be identified to the Board until late 2020 or early 2021. Furthermore, removing these combinations of projects from the RTEP would fail to address the congestion that would be re-introduced into South-central Pennsylvania and Northern Maryland. Any proposal window to address this re-introduced congestion would not be held until 2021, with solutions not likely to be presented to the Board until late 2021. In light of this timing, and based on the likely need for greenfield transmission, PJM predicts that new CPCN applications for not-yet-identified reliability and market efficiency drivers would not be filed until 2022 or 2023. Conservatively assuming one to two years for state siting proceedings, reliability and market efficiency solutions likely could not be constructed sufficiently quickly to remediate reliability criteria violations, and further would leave customers subject to significant congestion for a number of years to come.

Figure 1. **South-Central Pennsylvania and Northern Maryland Congestion**



Project 9A and Alternative Project 9A

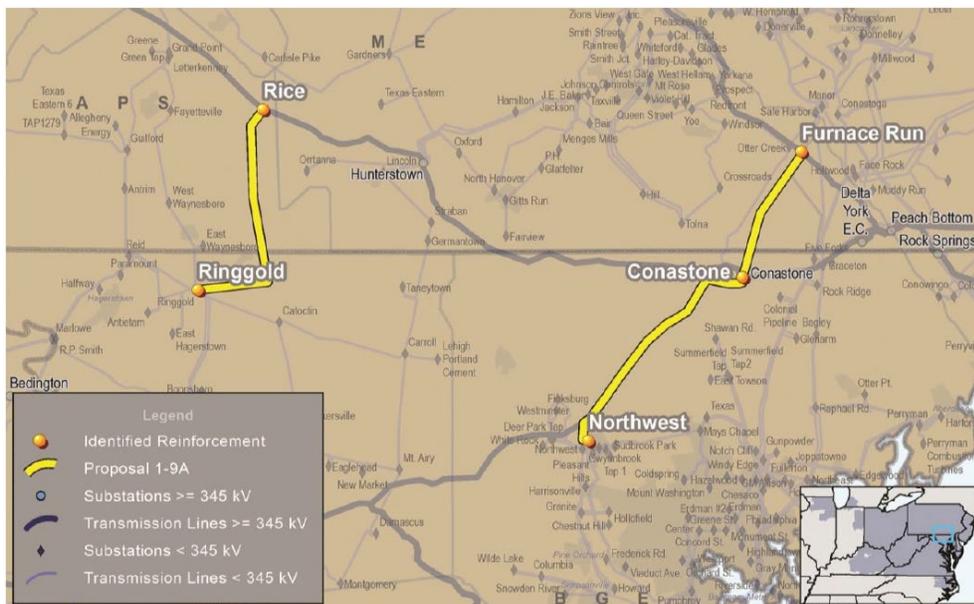
Project 9A, as approved by the Board, continues to exceed the 1.25 Benefit-to-Cost Ratio

The PJM Board approved Project 9A in August 2016 to address persistent congestion in South-Central Pennsylvania and Northern Maryland. Project 9A includes a western component – the Rice-Ringgold 230 kV line – and an eastern component – the Furnace Run-Conastone-Northwest 230 kV line – shown on **Map 2**.

Five subsequent re-evaluations (Sept. 14, 2017; Feb. 8, 2018; Sept. 13, 2018; March 7, 2019; and Sept. 24, 2019) reaffirm PJM’s recommendation that Project 9A be included in the RTEP, as discussed in detail in PJM’s Nov. 15, 2018 white paper³ and in testimony filed in the pending state siting proceedings. The below chart summarizes RTEP analyses of Project 9A from its presentation to the Board in August 2016 through the present, demonstrating that Project 9A continues to exceed the 1.25 benefit-to-cost ratio.

For the reasons discussed in this paper, Project 9A, as approved by the Board, continues to exceed the benefit to cost ratio and should remain in the RTEP.

Map 2. **Project 9A**



Alternative Project 9A Exceeds the 1.25 Benefit-to-Cost Ratio and Reflects a Compromise Among Certain Parties in the Pending CPCN Proceedings in Maryland and Pennsylvania

Alternative Project 9A is the product of data requests, analysis and agreement among several of the parties⁴ in the Maryland and Pennsylvania siting proceedings. Those parties have executed and filed a proposed settlement before the Maryland and Pennsylvania state Commissions seeking the approval of Alternative Project 9A (such approval

³ <https://www.pjm.com/-/media/committees-groups/committees/teac/20181108/20181108-transource-white-paper.ashx>

⁴ PJM is not a party to that proceeding, though PJM has run analysis, offered testimony and sponsored data requests in the matter.

being in the alternative to state Commission approval of Board-approved Project 9A). Discovery is ongoing and additional procedural orders are anticipated relating to Alternative Project 9A and the settlement.

Alternative Project 9A (as shown on Map 3) is comprised of the same western segment in Project 9A, as approved by the Board. Alternative Project 9A reflects modifications to the eastern segment of Board-approved Project 9A and involves less greenfield transmission than Project 9A because Alternative Project 9A uses a pre-existing right of way that requires expansion. In Maryland, the eastern segment of Alternative Project 9A would be constructed, owned and maintained by Baltimore Gas and Electric Company (BGE) within its existing utility rights-of-way. BGE would add a second 230 kV circuit on the existing Otter Creek-Conastone 230 kV line. BGE would also replace eight lattice structures that currently hold the single-circuit Manor-Graceton 230 kV line with approximately eight monopole structures, which would then carry a second 230 kV line. In Pennsylvania, PPL Electric Utilities Corporation (PPL) would construct, own and maintain the lines within PPL's expanded existing rights-of-way.

In the course of the state siting proceedings, PJM was asked to analyze Alternative Project 9A. **Table 4** summarizes the body of RTEP analyses PJM has conducted regarding Alternative Project 9A.

Table 4. **Summary of Recent RTEP Analyses Involving Alternative Project 9A**

RTEP Analyses ⁵	Date Presented	Benefit-to-Cost Ratio
Alternative Project 9A	May 8, 2019	1.39 (using \$466.44M as cost est.) - 1.52 (using \$426.02M as cost est.)
Alternative Project 9A	Nov. 14, 2019	1.60
Alternative Project 9A6 + Project 5E + Project H-L	To be presented at the December TEAC.	2.25 (using \$561.68M as cost est.) - 2.33 (using \$533.99M as cost est.), aggregate

PJM's RTEP analyses show that a combination of Alternative Project 9A, Project 5E, and Project H-L exceed the benefit-to-cost ratio of 1.25, significantly reduce congestion, and solve reliability criteria violations identified in study year 2023 that otherwise were found to arise with Alternative Project 9A removed from the base case.

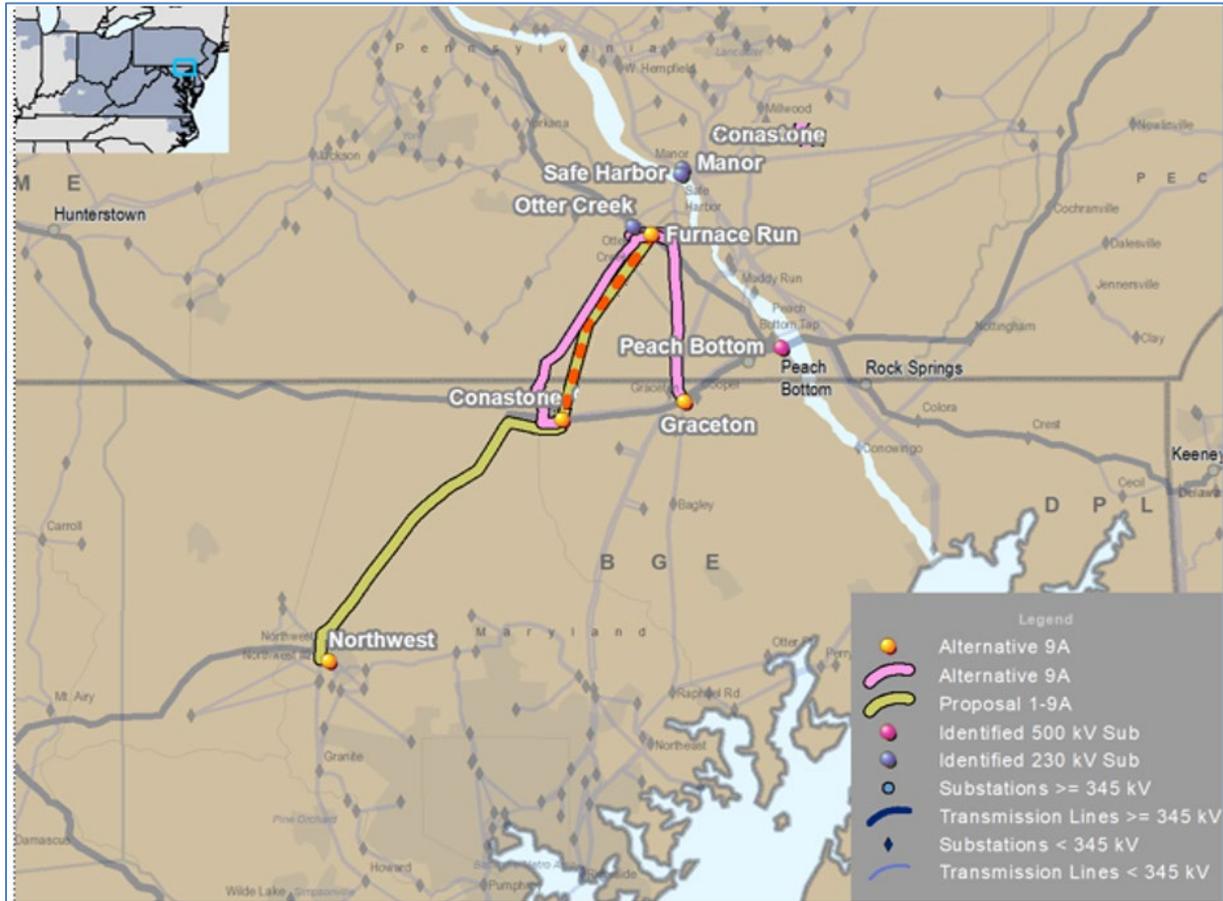
For the reasons discussed in this paper, Alternative Project 9A exceeds the benefit-to-cost ratio and, if approved by the Maryland and Pennsylvania Commissions through their respective CPCN application processes, Alternative Project 9A would be recommended for approval by the PJM Board of Managers as memorialized in a Board

⁵ The market efficiency base case was updated in July 2019 and further revised in September 2019.

⁶ PJM has performed a constructability analysis of the western portion of Alternative Project 9A and used a cost for Alternative Project 9A's eastern segment that reflects a 25 percent sensitivity to the PPL and BGE elements (elements that have not been reviewed for constructability). Costs for the alternative configuration of the eastern portion would have to increase by a significant margin in order for the benefit-to-cost ratio for Alternative Project 9A to fall below the 1.25 threshold. At this stage of the CPCN proceedings and based on the significant margin that exists in the benefit-to-cost ratio, it is unnecessary to commission a partial constructability analysis of the alternative configuration of the eastern portion of Alternative Project 9A.

Resolution. Upon approval by both State Commissions, PJM would present Alternative Project 9A to the Board for final approval and inclusion in the RTEP

Map 3. **The Alternative Configuration of the Eastern Portion of Project 9A (the Alternative IEC East Portion)***



* Note: Dotted red line depicts originally proposed Furnace Run-Conastone 230 kV line now being rerouted.

Project 5E, as Approved by the Board

In April 2018, the PJM Board approved baseline Project 5E with a benefit to cost ratio of 5.23 (calculated using an initial cost estimate of \$39.65 million). This market efficiency project would alleviate congestion on the Conastone-Graceton-Bagley 230 kV line in the BGE zone. Submitted by BGE, the project comprises reconductoring the Conastone-Graceton and Raphael Road-Northeast 230 kV lines together with adding bundled conductor to the Graceton-Bagley-Raphael Road double circuit lines, as shown on **Map 4**.

A re-evaluation of Project 5E in September 2018 yielded a benefit to cost ratio of 9.18, reaffirming the basis for PJM's recommendation that Project 5E be included in the RTEP.

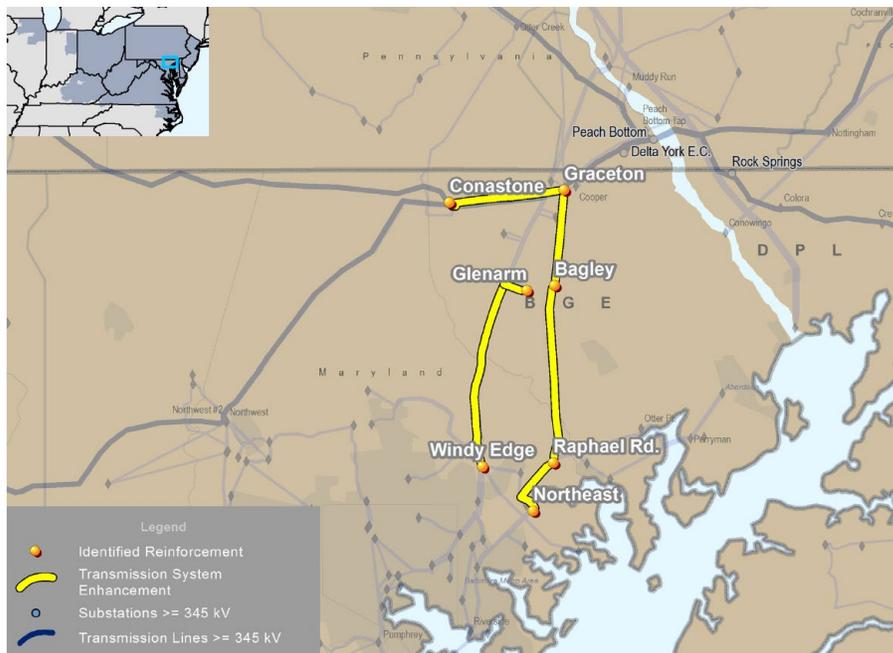
At present, the estimated cost for Project 5E is \$48,295,868 (2021 dollars). **Table 5** summarizes the recent body of RTEP analyses PJM has conducted regarding Project 5E.

Table 5. Summary of Recent RTEP Analyses Involving Project 5E

RTEP Analyses ⁷	Date Presented	Benefit-to-Cost Ratio
Re-evaluation of Project 5E	Nov. 14, 2019	1.11 ⁸
Re-evaluation of Project 5E (assuming Board approval of Project H-L)	Nov. 14, 2019	1.80
Project 9A + Project 5E + Project H-L	To be presented at the December TEAC.	2.87, aggregate
Alternative Project 9A + Project 5E + Project H-L	To be presented at the December TEAC.	2.25 (using \$561.68M as cost est.) - 2.33 (using \$533.99M as cost est.), aggregate

Although an initial re-evaluation of Project 5E indicated that the project no longer satisfied the benefit-to-cost criteria due to the continued evolution of the RTEP and increased cost estimates, PJM's RTEP analyses described above have studied the interaction of Project 5E, Project H-L and Project 9A or Alternative Project 9A. PJM's analyses indicate that it would not be accurate to conclude that Project 5E is no longer performing because the project combinations analyzed show that when Project 5E is studied in context, it no longer binds first and continues to exceed the 1.25 benefit-to-cost ratio threshold. For the reasons discussed above, PJM recommends that Project 5E remain in the RTEP.

Map 4. Project 5E



⁷ The market efficiency base case was updated in July 2019 and further revised in September 2019.

⁸ For further discussion, see the section of this paper regarding Project 5E, below.

PJM's Recommendation of Project H-L

PJM opened a Long-Term Proposal Window on Nov. 2, 2018, that closed on March 15, 2019. For the reasons that follow, and because of the interactions between Project H-L, Project 5E and Project 9A or Alternative Project 9A, PJM recommends that the Board approve Project H-L and include it in the RTEP.

Project H-L consists of upgrades and changes to existing equipment designated to the incumbent transmission owner:

- Rebuild the Hunterstown to Lincoln 115kV line
- Upgrade substation equipment at Hunterstown Substation
- Upgrade substation equipment at Lincoln Substation

The estimated cost for proposal Project H-L is \$7.21 million, and the in-service date is June 2023.

As presented in Table 1 and on **Map 5**, PJM identified the Hunterstown-Lincoln 115 kV line as a targeted congestion facility. Simulations performed in advance of the 2018/2019 Long-Term Proposal Window identified over \$20.77 million in market congestion on this facility based on 2023 input assumptions and simulation results. The below serves as a description of the analysis that was conducted for this proposal window.

PJM received a cluster of 22 proposals (19 greenfield proposals and three upgrade proposals) from seven entities to address the Hunterstown-Lincoln congestion driver. The proposed project costs ranged from \$4.65 million to \$290.95 million.

PJM analyzed the proposals to determine which, if any, satisfied the 1.25 benefit-to-cost ratio criteria and provided the greatest degree of congestion relief. The energy benefits associated with the proposed projects were determined using the methodologies specified in Schedule 6 of the Operating Agreement. PJM's annual energy benefits calculation for lower voltage facilities is weighted 100 percent to zones with a decrease in net load payments as a result of the proposed project. Change in net load payments comprises the change in gross load payments offset by the change in transmission rights credits. No capacity benefits were identified with these proposed projects.

Of the proposals that did pass the benefit-to-cost ratio criteria in the base case, PJM selected the highest five benefit-to-cost ratio proposals for further evaluation. PJM then conducted market efficiency sensitivity analysis on those five proposals.

Of these five solutions, three proposals fully addressed the congestion driver. These three proposals included: (1) Project H-L (presented to stakeholders as HL_622), which rebuilds the Hunterstown-Lincoln 115 kV line; (2) HL_469, which installs a SmartValve⁹ on the Hunterstown-Lincoln 115 kV line; and (3) HL_960, which builds an additional Hunterstown-Lincoln 115kV line. PJM ultimately narrowed this list of three projects to two.

⁹ SmartValve, a Smart Wires Inc. product, acts as a variable impedance device that can vary the impedance on the line the device is installed on.

Figure 2 shows a comparison of the top two proposals highlighting the challenges involved with the SmartValve proposal.

Figure 2. Comparison of Proposals for Hunterstown-Lincoln 115 kV Line

Criteria	HL_622 Upgrade Solution	HL_469 SmartValve™ Solution
Constructability Risk	Upgrade, no additional property needed	Greenfield, permitting risk related to new property for substation due to location near historically sensitive area
PJM Operations and Markets	No changes needed to real-time operations procedures and practices	At this time, real-time operations would not be able to fully utilize the dynamic capabilities of this device without additional changes
Additional Integration Cost with Operations and Markets	No additional costs	May require updating Day-Ahead, Real-Time, SCADA systems to support full operational range of this type of device
Industry experience	Established well known solution	Limited experience with SmartValve™ device
Additional System Capability/Flexibility	Yes/No	No/Yes

**SmartValve is a Trademark of Smart Wires Inc.*

Based on the analysis performed, PJM selected Project H-L (HL_622), which rebuilds the Hunterstown-Lincoln 115 kV line as more efficient or cost effective solution because Project H-L:

- Has a benefit-to-cost ratio of 76.41
- Fully addresses the target congestion driver
- Is an upgrade and has less constructability risk
- Consistently delivers a high benefit-to-cost ratio, passes all sensitivity scenarios, and given the comparison criteria shown in **Figure 2**, was the preferred solution
- Did not cause any reliability issues under PJM's RTEP reliability analysis.

PJM's RTEP analyses described above have studied the interaction of Project 5E, Project H-L, and Project 9A or Alternative Project 9A. PJM's analyses indicate that Project H-L continues to play an important role in the mitigation of congestion in South-Central Pennsylvania and Northern Maryland as reflected in **Table 6**. In conclusion, Project H-L shown in **Table 7** is being recommended to the Board for approval for inclusion in the RTEP.

The local transmission owner/proposing entity, Mid-Atlantic Interstate Transmission (MAIT), would be designated to complete this work. Cost allocation for the project can be found in **Table 8**.

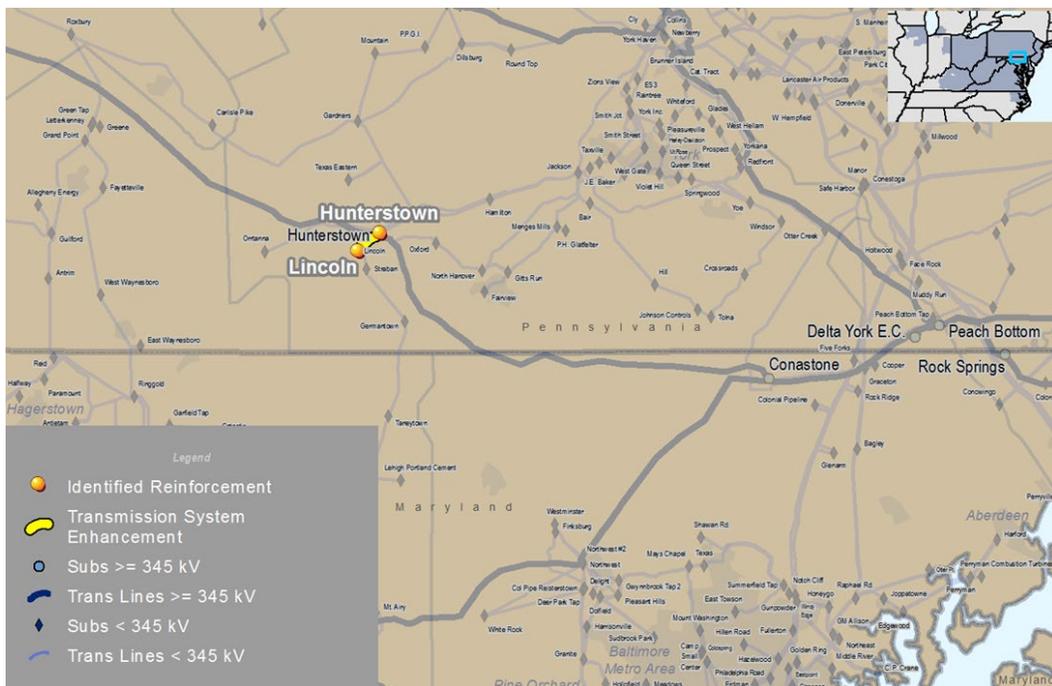
Table 6. Summary of Recent RTEP Analyses Involving Project H-L

RTEP Analyses ¹⁰	Date Presented	Benefit to Cost Ratio
Project H-L	Nov. 14, 2019	76.41
Project 9A + Project 5E + Project H-L	To be presented at the December TEAC.	2.87, aggregate
Alternative Project 9A + Project 5E + Project H-L	To be presented at the December TEAC.	2.25 (using \$561.68M as cost est.) - 2.33 (using \$533.99M as cost est.), aggregate

Table 7. Identified Market Efficiency Projects

PJM Baseline ID	PJM Window Project ID	Project Description	Transmission Zone	Constraint Project Addresses	Project Cost (\$M)	In-Service Date	B/C Ratio
b3145	201819_1-622	Rebuild the Hunterstown - Lincoln 115 kV 962 line (~2.6 mi.). Upgrade limiting terminal equipment at Hunterstown and Lincoln.	MetEd	Hunterstown -Lincoln 115 kV	7.21	2023	76.41

Map 5. Project H-L



¹⁰ The market efficiency base case was updated in July 2019 and further revised in September 2019.

Table 8. **Cost Allocation Factors for Project H-L**

b3145	Rebuild the Hunterstown - Lincoln 115 kV line (No.962) (~2.6 mi.). Upgrade limiting terminal equipment at Hunterstown and Lincoln.	\$7.21	ME	AEP (16.60%) APS (8.09%) BGE (2.74%) Dayton (2.00%) DEOK (0.35%) DL (1.31%) Dominion (52.77%) EKPC (1.54%) OVEC (0.06%) PEPSCO (14.54%)	June 1, 2023
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