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Date of Hearing: 1/24/2019

Case No. 18-501-EL-FDR, 18-1392-EL-RDR, 18-1393-EL-ATA **PUCO**

PUCO Case Caption: 2018 Long-Term Forecast Report of Ohio Power
Company and Related Matters, Application of Ohio Power
Company for Approval to Enter Into Renewable Energy
Purchase Agreements for Inclusion in the Renewable
Generation Roster, and Application of Ohio Power Company for
Approval to Amend its Tariffs.

List of exhibits being filed: Volume VII

- AEP 18 #19
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Reporter's Signature: Karen Sue Gibson
Date Submitted: _____

BEFORE THE PUBLIC UTILITIES COMMISSION OF OHIO

- - -

In the Matter of the 2018 :
Long-Term Forecast Report : Case No. 18-501-EL-FOR
of Ohio Power Company and :
Related Matters. :

In the Matter of the :
Application of Ohio Power :
Company for Approval to :
Enter Into Renewable : Case No. 18-1392-EL-RDR
Energy Purchase :
Agreements for Inclusion :
in the Renewable :
Generation Rider. :

In the Matter of the :
Application of Ohio Power : Case No. 18-1393-EL-ATA
Company for Approval to :
Amend its Tariffs. :

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PROCEEDINGS

before Ms. Sarah Parrot and Ms. Greta See, Attorney
Examiners, at the Public Utilities Commission of
Ohio, 180 East Broad Street, Room 11-A, Columbus,
Ohio, called at 9:00 a.m. on Thursday, January 24,
2019.

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VOLUME VII

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PV PPA Prices

UTILITY-SCALE SOLAR - RETURN TO PROJECT PAGE

Utility-Scale Solar

Power Purchase Agreement (PPA) Prices for PV

Source: Berkeley Lab, *Utility-Scale Solar 2018 Edition*



Data shows levelized power purchase agreement (PPA) prices for PV projects since 2006. Size of circle reflects size of PV project.

Move slider controls to change the year range.

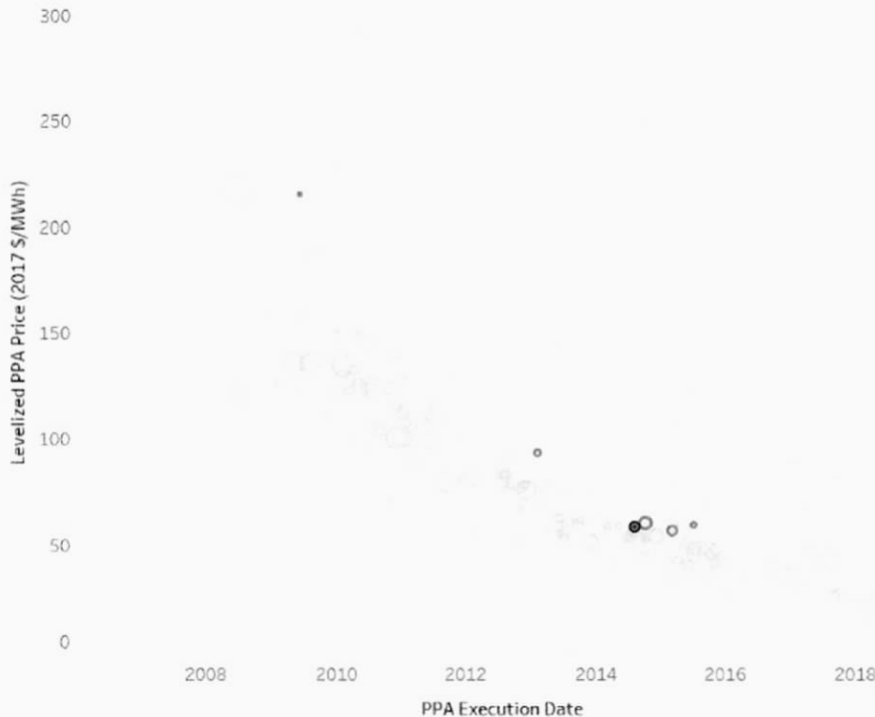
Click on region text and colors to highlight a region.

PPA Execution Year

2006 2018



Region



Source: Berkeley Lab, *Utility-Scale Solar 2018 Edition*. <https://emp.lbl.gov/utility-scale-solar/>



PJM FUEL SECURITY FAQs

Updated - November 21, 2018

Area	Sub-Area	ID	FAQ	Response
General	Definition	1	What is fuel security?	Fuel security refers to risks in the fuel supply and delivery systems to generators; it is a vital component of grid resilience. Fuel security is the ability of the system's supply portfolio to continue serving electricity demand through disruptive events that could impact fuel delivery systems or the availability of generation over extended periods of time. As with reliability standards, PJM believes the most effective way to address fuel security is to define and establish fuel security criteria and then use markets to allow all resources to compete to meet those criteria.
General	Definition	2	How does fuel diversity play into fuel security?	Fuel diversity is an important factor in assessing the reliability of the system. In fact, it was the impetus for the March 2017 study, PJM's Evolving Resource Mix & System Reliability. Fuel Diversity is the measure of the relative penetration of different fuel types. A diverse fuel portfolio alone, however, does not necessarily make a system more reliable. A fuel-diverse system is more likely to be flexible and adaptable to a variety of risks and volatility factors, but is not a solution in and of itself. Unlike fuel diversity, fuel security can signal the requirements needed by system operators to ensure the continued service of electricity through disruptive events.
General	Definition	3	How does fuel security relate to resilience?	Fuel security is a component and one measure of the system's total resilience. Resilience is how grid operators manage the risk of high-impact disruptions that are system-wide, and can be of long duration. These disruptions can happen simultaneously or persist for a long period. Operators must prepare for, be capable of operating through and be able to recover from these events in a timely manner, no matter what the cause. PJM's other resilience initiatives range from protecting the grid against coordinated physical or cyber-attacks to ensuring the availability of system restoration resources that can respond after a major event.
General	Rationale	4	Has the concept of resilience that PJM is using been approved by FERC? Wouldn't that be the first step before embarking on this path?	The FERC proceeding is looking at a large contingent of items related to resilience including transmission, operations, the role of markets, governance, etc. Fuel security is a component and one measure of the system's total resilience. This analysis is attempting to help inform how the PJM system views the concept of fuel security.
General	Rationale	5	Why is PJM doing this? Will the system soon be unreliable?	There is no reliability concern about the system in the short term or long term. The grid is reliable, and there is no immediate threat to its reliability – as evidenced by the study results. As part of PJM's responsibility and ongoing efforts to ensure and enhance grid resilience now and into the future, it is important to test the limits of the system and probe for possible vulnerabilities. The fuel security study stems from our March 2017 report, PJM's Evolving Resource Mix & System Reliability, which analyzed how the combination of public policies, lower fuel prices, generating plant deactivations and technology improvements has altered the traditional mix of resources serving customers. That report concluded that the PJM system can remain reliable with the addition of more natural gas and renewable resources, but that heavy reliance on any one resource type raises questions about electric system resilience. The report did not answer the question of whether this evolution would open PJM up to vulnerabilities in delivery and availability of fuel to power the grid under extreme, unforeseen circumstances. The fuel security study addresses that question.
General	Rationale	6	Isn't this about helping coal and nuclear units?	No. PJM is fuel neutral. The energy industry and the PJM fuel mix is evolving. This evolution includes retirements due to market forces or the age of generators. While coal and nuclear have been in the news, aging gas plants also have retired. PJM's current resource mix is more diverse than it has ever been, at approximately 30 percent coal, 30 percent nuclear, 30 percent gas and 10 percent renewables. From a capacity perspective, PJM recently cleared 11,000 megawatts of year-round demand response. As PJM President and CEO Andrew Ott testified before Congress earlier this year, PJM needed all of those resources – including gas, nuclear and coal – to get through the cold snap this past December and January. The competitive markets remain the best mechanism to maintain a reliable and secure system at the lowest reasonable cost to customers. The March 2017 PJM evolving resource mix analysis concluded that the PJM system can remain reliable with the addition of more natural gas and renewable resources, but that an increased reliance on any one fuel delivery infrastructure introduces potential resilience risks not captured by existing reliability standards.
General	Stakeholder Process	7	Can you describe these different phases a bit more? How long will each phase take? What can the stakeholders expect? Where will these discussions take place? Will there be gradual and ongoing sharing of info or will PJM go off and come back in a few months?	In Phase 1, PJM will identify the data needed, get feedback from members on the assumptions and start the analysis. PJM will schedule more special MRC meetings to communicate with stakeholders once results begin to come in. This process likely will take four to six months. In Phase 2, PJM will work on modeling and figuring out how to tackle any identified issues through a market construct. That will also include working with stakeholders, and will take several months. In Phase 3, PJM will engage federal and state entities for input into what PJM should consider as a credible threat. PJM is open to ongoing coordination that could happen at any time in the process, including in parallel to the other phases.

PENGAD 800-631-6989

EXHIBIT

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AEP

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General	Stakeholder Process	8	How will stakeholders participate in this process?	PJM welcomes all stakeholder feedback, including from federal and state agencies, regarding the scope, methodology and results of this analysis. To that end, PJM requested written comments on the draft study scope within 30 days of its posting. PJM also will hold periodic Special MRC meetings on fuel security to inform stakeholders of our progress and to invite further discussion and input.
General	Rationale	9	How is fuel security different from Capacity Performance?	Capacity Performance places the requirements on individual generators to perform when needed by the system, in five-minute increments. Fuel security focuses on broader systemic risks -- no amount of investment by an individual generator could address scenarios such as pipeline breaks, cyber-attacks on delivery systems, transportation disruptions affecting fuel deliveries etc. Fuel security is the ability of the whole generation system's supply portfolio to continue serving electricity demand through more severe, longer-term events and disruptions.
General	Stakeholder Process	10	Is PJM really going to use stakeholder feedback in designing this analysis? How will it use the comments?	PJM is capturing stakeholder feedback and will utilize this input as appropriate in designing model sensitivities and constraints. A problem statement is expected to be issued first quarter 2019 to identify changes that might improve fuel security under stressed system conditions.
General	Definition	11	Is fuel security being considered at a system level or a unit level?	Fuel security is achieved at system or sub-system level. The individual supply resources themselves are assessed in contributing to fuel security.
General	Definition	12	What are fuel security baseline characteristics?	The actual fuel security baseline characteristics or definition will be informed by Phase 1 study results but determined through the Phase 2 stakeholder process. One possible definition is the ability of a resource to generate continuously for xx hours at specified MW capability. See PJM's 7/26/18 MRC slides for additional detail.
General	Stakeholder Process	13	How will PJM communicate the phase process, timeline and results?	PJM has established an 'Issues Tracking' work space as part of the webpage at PJM.com > Committees & Groups > Markets & Reliability Committee. This space will contain materials and notifications related to this topic throughout the effort. PJM will also setup additional opportunities to review progress at stakeholder meetings.
General	Definition	14	Why isn't PJM focusing on fuel diversity?	Fuel diversity is more of a potential outcome than solution in and of itself. Unlike fuel security, fuel diversity does not signal requirements needed by system operators to ensure the continued service of electricity through credible disturbance events. One potential outcome of a fuel secure system may be a fuel diverse system.
General	Definition	15	What does PJM consider to be "significant disruptive events"?	Physical fuel delivery disruptions that impact the availability of clusters of PJM generation, and potentially, PJM's ability to serve load.
General	Stakeholder Process	16	Should other parties beyond PJM stakeholders be brought into the process? Especially those that have dissenting thoughts on resilience?	PJM has engaged fuel industry companies as well as trade associations to assess credible scenarios and vulnerabilities in defining the scope of this assessment. Regular involvement in the PJM stakeholder is encouraged.
General	Background	17	What report or reports does PJM have that provide(s) the results of the changes made to the capacity market as a result of Capacity Performance?	Please refer to PJM's June 2018 report, "Strengthening Reliability: An Analysis of Capacity Performance".
General	Background	18	What information is available about impacts of historical winter events in PJM?	Polar Vortex: Analysis of Operational Events & Market Impacts During the January 2014 Cold Weather Events
				2015/16 Winter Report
				2016/17 Winter Report
				2017/18: PJM Cold Snap Performance Report
Study	Assumptions	19	What exactly did PJM study?	PJM analyzed more than 300 different scenarios, ranging from typical winter operations to extreme but plausible scenarios, varying critical elements including retirements, customer demand, fuel delivery and fuel disruptions. In order to develop a robust and realistic set of assumptions, sensitivities and scenarios, PJM used historical data spanning more than 45 years, researched previously completed studies, issued supplemental surveys to PJM generation owners and met extensively with industry groups, generation owners, various companies in the fuel supply chain in the PJM footprint, government agencies and other system operators. The analysis is neither meant to be predictive of future conditions nor meant to imply that analyzed scenarios are unavoidable.
Study	Assumptions	20	What is PJM considering its baseline system?	PJM looked five years into the future and taking into account the announced retirements, new generation slated to be in operation by 2023, transmission upgrades and interstate pipeline build-out. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.
Study	Rationale	21	Why was winter demand studied when the system reaches its peak load in summer?	Though PJM consistently sees its highest customer demand during the summer, the greatest strain on fuel supply occurs in the winter. This is primarily because during the winter, the needs of commercial and residential heating are competing with natural-gas-fired and dual-fuel generators (which generate more than 30 percent of the energy produced in PJM) for natural gas, fuel-oil, pipeline transportation, and oil deliveries.
Study	Assumptions	22	Will PJM look at distribution and transmission disruptions?	Transmission and distribution disruptions may be outside the current scope of the analysis. However, transmission and distribution outage impacts are related to other resilience efforts PJM is working on.

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Study	Assumptions	23	What is PJM's process, tools and metrics for identifying, evaluating and measuring realistic scenarios?	<p>Weather: PJM analyzed historic weather data for the current PJM footprint to forecast peak load and hourly profiles for an average (Base) winter and an extreme winter.</p> <p>Physical disruptions to fuel delivery infrastructure: Considerations of historical disruptions and information obtained in outreach efforts.</p> <p>See PJM's 7/26/18 MRC slides for reference. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.</p>
Study	Assumptions	24	Will PJM consider the growth of renewable resources?	Yes, to the extent that this growth is reflected in the interconnection queue. Commercial probabilities will be taken into account when selecting replacement energy for retirement scenario. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.
Study	Assumptions	25	Will PJM consider the number of emergency hours as well as their duration?	The study will focus on the number of unserved energy hours across the study scenario period which may include some of PJM's current (M13) emergency procedure periods. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.
Study	Assumptions	26	How will PJM differentiate running out of fuel for economic reasons versus running out for reliability reasons?	The available fuel inventory of the resource, under differing sensitivities, will be assessed. The planned approach is to focus on physical capabilities in the analysis. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.
Study	Assumptions	27	How would PJM account for fuel cost volatility? Should "economic resilience" be incorporated in the analysis?	<p>Fuel price volatility is a financial risk not a reliability risk. Managing financial risk is up to the market participant given their willingness to accept risk. There are financial tools available to manage this risk.</p> <p>That said, economics of generation in terms of fuel prices will be taken into account in the simulation of economic dispatch. Fuel prices will be derived from currently forecasted futures pricing for January 2024 and historical day-to-day volatility consistent with average and extreme winter weather scenarios. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.</p>
Study	Assumptions	28	How is PJM factoring in non-wholesale distributed energy resources (DER) and energy-only resources?	Non-wholesale DER is reflected in the load forecast. All wholesale resources (including Energy-only) that are currently modeled in the 2023/24 RTEP case will be included in the study. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.
Study	Assumptions	29	Will PJM look at how firm critical load units are? Will PJM look at the blackstart component as well?	The fuel security study does not analyze restoration. There is a separate stakeholder initiative dealing with fuel assurance of blackstart resources.
Study	Assumptions	30	Is PJM considering what would replace retiring coal and nuclear resources?	Yes. PJM believes it is the most logical to use the existing interconnection queue as the starting point for replacement. It is expected the queue would be assessed to account for the historical probability of commercial operation for various resource types and locations. PJM believes feedback on how to assess the existing interconnection queue may prove the most beneficial. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.
Study	Assumptions	31	How will PJM account for dual fuel usage in the analysis?	The study will simulate generation switching fuels for both economic and physical reasons based on weather-related and physical disruption assumptions. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.
Study	Assumptions	32	Does PJM have all of the operating history and generator survey data it needs or should there be a formal request sent out to resource owners?	In addition to using information gathered from annual surveys, PJM issued a generator survey in June 2018 to support the fuel security initiative and has continued outreach with members to ensure PJM has the information needed to perform the analysis.
Study	Assumptions	33	Much of PJM's threat assessment data is related to the electric grid – is PJM comfortable that it has the same level of understanding/assessment of critical fuel supply chains?	PJM is focused on increasing knowledge of supply chain risks, and is conducting outreach with industry groups to better understand risks and make assumptions for purposes of the analysis. The fuel security study is a first step for enhancing PJM's understanding of these risks.
Study	Assumptions	34	Will PJM consider the correlation of different risk factors, for example, fuel assurance, supply chain risk factor, common mode of failure, weather-related factors? How will PJM include them in the analysis?	Correlation is considered but not quantified. The analysis will consider the impact of both weather and physical supply chain disruptions. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.
Study	Assumptions	35	How will PJM develop reasonable scenarios of threats without disclosing confidential or critical information? Should some aspects of the study remain confidential?	Today as part of the PJM capacity market planning parameters, PJM assess and posts information as it relates to the electric deliverability into a given deliverability region. The underlying models used to determine that information are classified under CEII protocols. To the extent similar concerns exist as the result of this study, PJM envisions the employment a similar process.

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Study	Assumptions	36	Did PJM consider the probability of each scenario?	PJM did not analyze the probability of each scenario (combination of inputs) occurring, and this may not be something that can be done. PJM does believe it is prudent, knowing the risks, vulnerabilities, and impacts, to consider what the solutions could be to then be able to weigh the solutions and their associated costs against the potential impacts. There may be some solutions that are prudent and cost-effective for mitigating a risk, no matter the probability of that risk.
Study	Findings	37	What were the study's general findings?	The study showed that the PJM system is reliable under sustained, highly stressed conditions. In an extended period of cold weather with typical customer demand, PJM's system can withstand an extended period of stress while remaining reliable. Even in an extreme scenario, such as an extreme winter demand combined with a pipeline disruption, PJM's system would still be reliable and fuel-secure, but there were scenarios in which a combination of generation retirements and stressed conditions revealed vulnerabilities. Key elements such as on-site fuel inventory, oil deliverability, location of a fuel supply disruption, availability of non-firm natural gas service, pipeline configuration and demand response become increasingly important as the system comes under more stress. PJM believes that these potential risks could be mitigated through a market-based approach to be determined by PJM members through the stakeholder process.
Study	Findings	38	What factors contribute to a fuel-secure system?	As important as the results, the study identified the variables that are key to the grid responding well to stressed conditions. These variables include fuel-oil deliverability, pipeline redundancy, and firmness of gas service. Firm gas service guarantees delivery to the generator at all times during the term of a contract, as opposed to "interruptible" service, which is less expensive but may be interrupted in times of need for customers with firm contracts, such as residential customers.
Study	Findings	39	How do PJM's risk factors compare to other parts of the nation? What are PJM's unique risk factors?	This will be better understood once PJM completes its initial assessment in Phase 1, however, the NERC's 2018 Summer Reliability Assessment offers an initial comparative outlook for the different regions.
Study	Findings	41	Will PJM perform additional scenarios based on member requests?	PJM has built a model for this study that is adjustable and reusable. PJM will be determining how best to handle requests for additional modeling as either part of phase 2 or phase 3 of the fuel security study.
Study	Assumptions	42	How did PJM model transmission constraints?	Announced retirement scenarios encompass comprehensive set of transmission constraints, and transmission enforcements for retirements are included. Since transmission enforcements for additional retirements under the escalated scenarios are not within the scope of the analysis, imports into eastern PJM was limited based on 1 in 25 Capacity Emergency Transfer Objective (CETO) and 15% additional transfer capability. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.
Study	Assumptions	43	What is the meaning of looped and single pipeline disruptions?	"Single" refers to a single segment of pipeline in certain parts of the interstate pipeline network. "Looped" refers to multiple pipeline paths in parallel. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.
Study	Assumptions	44	How did PJM develop assumptions about the availability of firm and non-firm natural gas generation?	PJM used data from generations surveys, the U.S. Energy Information Administration (EIA) and NERC's Generating Availability Data System (GADS), and engaged in discussions with generation owners and industry groups. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.
Study	Assumptions	45	How did PJM develop assumptions about pipeline disruptions?	In addition to utilizing information PJM has collected through existing gas electric coordination efforts, PJM also worked with major interstate pipelines and natural gas industry groups in developing these assumptions. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.
Study	Assumptions	46	How did PJM form the fuel inventory assumptions used in this analysis?	PJM collected data from generations surveys and engaged in discussions with generation owners and industry groups. Additional detail will be provided in the paper and technical appendix, slated for release in December 2018.
Study	Assumptions	47	What resource type were disrupted in the analysis?	In Phase 1 the availability of all resource types is impacted by forced outage rates, but focus – in terms of detailed sensitivities – was placed on analyzing the risks to generation in PJM with less than 14 days of onsite fuel (oil and natural gas). In Phase 3, more impacts to coal and nuclear will be considered given a change in study duration (longer than 14 days).
Study	Findings	48	Will locational details of results be provided?	PJM will provide information about results as granularly as possible to provide transparency, while balancing the need to secure information about threats to specific areas of the grid.
Post Study	Stakeholder Process	49	How will a resource qualify to be fuel secure?	This will be determined through the Phase 2 stakeholder process.
Post Study	Stakeholder Process	50	How will PJM anticipate the role of further technological advancement in fuel security? Can resources with "fuel" be "fuel secure"?	A definition of fuel secure resource will be developed such that any technology can qualify so long as it can demonstrate it meets the fuel security baseline characteristics or definition - this will take place in Phase 2. This approach will allow for future technology solutions.
Post Study	Stakeholder Process	51	Will PJM considering RTO aspects of fuel security in addition to locational aspects of fuel security in developing a solution?	Yes, this will be addressed in Phase 2.
Post Study	Stakeholder Process	52	Is PJM considering a maximum or minimum amount of fuel security needed?	The study will need to identify what is the adequate level of required fuel security for a given region. How that is ultimately modeled - as a minimum of fuel security assets, or a maximum on non-fuel secure assets - will be explored in Phases 2 and 3 of this effort.

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Post Study	Stakeholder Process	53	How will PJM model constraints in the capacity market?	This will be addressed in Phase 2 of the effort. PJM is open to input on how to accomplish this.
Post Study	Stakeholder Process	54	Has PJM considered the trade-offs of focusing on fuel security? Will it mean giving up flexibility?	PJM will consider how to manage this potential tradeoff in Phase 2 of the scope. To first assess any tradeoff, it will require knowing what required levels of fuel security exist, in which locations, and what resources may qualify today or in the immediate future as being fuel secure.
Post Study	Stakeholder Process	55	Will the fuel security characteristics favor older units vs. new units? Since eFORD is higher for older units, is it possible the characteristic will send a signal to a retiring unit to stay around and keep out new units? How will PJM balance this?	PJM will consider how to manage this potential tradeoff in Phase 2 of the effort.
Post Study	Stakeholder Process	56	Why do customers need to pay additional money for something they already paid for with Capacity Performance?	This will be addressed during Phase 2. Fuel security and Capacity Performance value distinct attributes to serve load amid undergoing an evolving fuel mix. To the extent fuel security attributes require specific valuation because a need exists, establishing a discrete, locational market signal best specifies the need for this attribute by demand.
Post Study	Stakeholder Process	57	How would PJM model constraints in RPM?	This will be addressed in Phase 2 of the effort.
Post Study	Stakeholder Process	58	What is the right level of granularity for fuel security?	At this point, it is premature to identify and is better addressed in Phase 2 of the effort. At the outset, a deliverability area appears the most logical level of granularity to ensure adequate power supplies amid modeled scenarios.
Post Study	Stakeholder Process	59	Will locations of fuel security needs be related to the same LDAs used for transmission constraints? Or will they be based on the location of fuel secure resources?	This will be addressed in Phase 2 of the effort.
Post Study	Stakeholder Process	60	Will PJM consider the interaction concurrent market changes in the analysis, or in developing a solution?	PJM will be determining how best to handle the requests for additional modeling as either part of Phase 2 or Phase 3 of the fuel security study. The impacts of any changes to markets - including those currently in the stakeholder process - will be taken into account in evaluation of potential solutions as part of Phase 2.
Post Study	Stakeholder Process	61	If there is no immediate threat to the reliability of the PJM RTO, why is PJM talking about a Problem Statement and Issue Charge?	PJM has identified that in the future, given certain situations, there are risks and vulnerabilities in the system. PJM believes it is prudent to be proactive and consider what alternatives and solutions could be put in place to help mitigate future risks. This includes consideration of market based and low cost options in discussions with the stakeholders.
Post Study	Stakeholder Process	62	What are the next steps? What action items, if any, are needed?	While there is no imminent threat, fuel security is vital. To continue stakeholder engagement, PJM will: Host a follow-up Special Markets & Reliability conference call on November 26, 2018 at 1:00 – 3:00 pm to address questions that may arise as stakeholders review the study results further after the Nov. 1st presentation. Publish a whitepaper detailing the background, method/approach, analysis results, conclusions and next steps in mid-December 2018. Schedule a Special Markets & Reliability meeting after the scheduled Markets & Reliability meeting on December 20, 2018 to discuss the additional detail provided in the whitepaper. Introduce a Problem Statement and Issue Charge for stakeholder consideration in first quarter 2019 with any potential market rule changes targeted to be filed with FERC in early 2020. As part of Phase 3 work efforts, PJM will continue to work with the Federal Government and impacted industries to further define a DOE informed Fuel Security scenario.

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