UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

PJM Interconnection, L.L.C.	)	**Docket No. ER19-105-000**

COMMENTS AND LIMITED PROTEST OF THE PJM POWER PROVIDERS GROUP

On October 12, 2018, PJM Interconnection, L.L.C. ("PJM") submitted revisions[1] to the PJM Open Access Transmission Tariff ("Tariff") to revise certain elements of the Reliability Pricing Model ("RPM") auction parameters that PJM is required by tariff to review every four years through an analysis and stakeholder process ("PJM Filing").

On October 15, 2018, the Federal Energy Regulatory Commission (the "Commission" or "FERC") issued a Combined Notice of Filings #1 setting November 2, 2018, as the deadline for filing an intervention or protest regarding the PJM Filing. On October 26, 2018, PJM proposed an extension for filing comments based on a delayed implementation date, and on October 29, 2018, the Commission set November 19, 2018, as the new deadline for filing an intervention or protest. On October 25, 2018, the PJM Power Providers ("P3")[2] filed a doc-less Motion to Intervene. Pursuant to Rules 211 of

[1] *PJM Interconnection, L.L.C.*, Docket No. ER19-105-000 (filed October 12, 2018) ("PJM Filing").

[2] P3 is a nonprofit corporation dedicated to promoting policies that will allow the PJM region to fulfill the promise of its competitive wholesale electricity markets. P3 strongly believes that properly designed and well-functioning competitive markets are the most effective means of ensuring a reliable supply of power to the PJM region, facilitating investments in alternative energy and demand response technology, and promoting prices that will allow consumers to enjoy the benefits of competitive electricity markets. Combined, P3 members own over 87,000 megawatts ("MWs") of generation assets, own over 51,000 miles of transmission lines, serve nearly 12.2 million

the Rules of Practice and Procedure of the Commission, 18 C.F.R. §§ 385.211 (2018), P3 hereby provides these comments and limited protest,[3] in the above-captioned proceeding.

I. BACKGROUND

The PJM Tariff requires that for the 2018-2019 Delivery Year and for every fourth Delivery Year thereafter PJM perform a review of the shape of the Variable Resource Requirement ("VRR") curve used to clear the RPM auctions and key inputs to that curve.[4] In pursuit of that mandate, PJM retained The Brattle Group ("Brattle") as an independent consultant to assist with the quadrennial review. PJM also retained the consulting firm Sargent & Lundy ("S&L") regarding generation plant cost estimates. Brattle conducted one study: The Fourth Review of PJM's Variable Resource Requirement Curve ("2018 VRR Curve Report")[5] and Brattle and S&L conducted a second study titled PJM Cost of New Entry – CT and Combined-Cycle ("CC") Plants with June 1, 2022 Online Date ("2018 CONE Study").[6] Based on the two reports, PJM staff proposed changes to the VRR curve shape, the Cost of New Entry ("CONE") values, and the net energy and ancillary service revenue offset methodology for implementation in connection with the 2019 base residual auction ("BRA") for the

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customers and employ over 55,000 people in the PJM region – encompassing 13 states and the District of Columbia. For more information see www.p3powergroup.com .

[3] The comments contained herein represent the position of P3 as an organization, but not necessarily the views of any particular member with respect to any issue. For more information on P3, visit www.p3powergroup.com

[4] Tariff, Attachment DD, section 5.10(a)(iii).

[5] PJM Filing Attachment G, Affidavit of Samuel A. Newell and David Luke Oates ("2018 VRR Curve Report"); (the 2018 VRR Curve Report is Exhibit 2, to Attachment G).

[6] PJM Filing Attachment E, Affidavit of Samuel A. Newell, John H. Hagerty and Sang H. Gang on Behalf of PJM Interconnection, LLC ("Brattle/S&L CONE Affidavit"), the 2018 CONE Study is Exhibit No. 2 to Attachment E.

2022/2023 Delivery Year.[7] PJM's recommendations, as well as alternative stakeholder recommendations, were discussed at numerous stakeholder meetings. The final meetings of the Markets and Reliability Committee and Members Committee were held on September 27, 2018. P3 member companies actively participated in the stakeholder process. On October 12, 2018, PJM filed the tariff changes with the Commission.

As an organization, P3 has consistently supported efforts to improve and enhance PJM's capacity market. The promise of the capacity market, allowing consumers to access the lowest priced capacity consistent with maintaining reliability, is a meaningful one that demands constant vigilance and evaluation. Properly structured capacity markets offer enormous value to consumers, and the Commission and PJM should be commended for their commitment to improve them.

P3 supports some of the revisions to the Tariff proposed by PJM in its filing as improving a market construct that provides value to consumers. As addressed below, although P3 supports some of the Tariff changes, it specifically protests others and urges the Commission to make further refinements.

II. INTRODUCTION

PJM's filing represents an unprecedented decline in the Cost of New Entry in the RTO. Consider that for the 2018 Base Residual Auction, gross CONE values ranged from $133,413/MW-year to $136,733/MW-year and if the PJM filing is accepted by the Commission, CONE values in the 2019 BRA will range from $105,500/MW-year to $109,700/MW-year. A 25-30% reduction is a dramatic reduction under any circumstances, but it is especially alarming for a market that is plagued with enormous uncertainty as the current market is.

[7] PJM Filing at p 3.

P3 urges the Commission to take a critical look at PJM's Filing. While the Commission is not under any obligation to find the perfect answers to the many questions raised in this proceeding, many of PJM's assumptions and inputs that drive its conclusion are clearly erroneous. The Commission should be mindful that PJM's proposal, even if modified as suggested by P3, will represent a significant and unprecedented drop in CONE in PJM. As a result, capacity revenues to new and existing facilities in PJM are likely to decline at a time when uncertainty in the market is high and most generators are struggling to maintain economic viability.

Nevertheless, anytime that the cost of new generation declines for true economic reasons it is a positive indicator of market forces working. Competitive forces are driving the costs of new entry down and consumers should reap the associated benefits. However, over-estimating the impact of those very forces – as PJM has done – is not just and reasonable and can stifle competition and the realization of consumer benefits.

Generally, PJM's calculation of the prospective net CONE errs in two ways: first, in its choice of an appropriate reference technology and, additionally, in its financial modeling of the cost to construct a marginal new entrant. While PJM correctly maintains a combustion turbine as the reference resource, PJM's selection of the General Electric ("GE") Frame H technology over the GE Frame F technology is inconsistent with the actual development of peaking units that is occurring in PJM and other places.

Second, PJM's proposal contains critical and easily identifiable financial modeling flaws that drive reductions in the CONE below what is just and reasonable. While the cost of new generation has decreased, PJM and Brattle over-estimate the decline by relying on certain faulty financing assumptions in their valuation of a marginal new entrant. As P3 demonstrates through

the attached affidavit of Ms. Tanya Bodell, those assumptions are inconsistent with market indicators and FERC decisions. While PJM made several correct decisions (including the choice of the CT as the reference unit), it missed the target on the technology choice and the after-tax weighted average cost of capital (ATWACC).

III. COMMENTS AND LIMITED PROTEST

A. The PJM Financing Assumptions are Flawed and Do Not Produce a Cost of Capital that Reflects Market Conditions.

As PJM explained in its filing, "[t]he after-tax weighted average cost of capital or ATWACC is used as a discount rate to annualize new entry investment costs."[8] The ATWACC is a critical component of the Gross CONE calculation as financing is a critical cost component of bringing any new capacity on line. There have been significant shifts in the manner in which projects are financed in PJM since the last CONE update and the previously-used "comparable companies" are no longer an appropriate metric for estimating the ATWACC. Unfortunately, both Brattle and PJM fail to recognize these changes.

The PJM roster of market participants investing in new resources has experienced a remarkable shift from public companies building and owning new generation to private equity investors being the principal financiers of generation capacity. Private equity investors have different financing approaches and expectations from their investments than the publicly-traded companies relied upon by PJM. For example, as Tanya Bodell points out, a private equity company generally has lower leverage and invests in individual projects using project-financing

[8] PJM Filing at p. 18.

versus balance sheet funding.[9] PJM's and Brattle's analyses completely ignore this reality, despite the fact that two of their key so-called comparable companies went private.

As detailed in the Bodell affidavit, the so-called "comparable companies" and transactions of Calpine, Dynegy, NRG and Talen, for various reasons, do not represent appropriate companies to serve as a basis for conclusions regarding cost of capital for a merchant peaker plant in PJM. Each of these four companies experienced financial distress during the period of analysis and were engaged in corporate restructuring activities that included asset sales and corporate mergers and acquisitions – activities that a new entrant is not assumed as part of the Net CONE calculations. Reliance on these companies who clearly were under financial distress during the period of analysis should not be allowed given they do not represent appropriate comparable companies.[10] As Ms. Bodell concludes, ". . . Brattle's use of the ATWACCs used in the fairness opinions to determine a proposed rate is inappropriate and should be ignored."[11]

The Canadian companies, including Trans-Alta which serves as the "very high end of the ranges with these merchant generation company reference points" that Brattle purports to rely upon,[12] own predominantly contracted assets, operate in an entirely different market structure than PJM, are subject to exchange rate risk, and correlate to growth in international markets as

[9] Bodell Affidavit at ¶ 76.

[10] Not removing these companies would be inconsistent with the Commission's consideration of similar proxy groups relied on in establishing cost of service rates. In those cases, for example, companies that cut their dividend or are involved in merger activity within the previous six months must be excluded from the proxy group. *See, e.g., Coakly v. Bangor Hydro-Electric Co.*, 165 FERC ¶ 61,030, at ¶ 49 (2018).

[11] Bodell Affidavit at ¶ 40.

[12] PJM Filing, Attachment F, Affidavit of Johannes Pfeifenberger and Bin Zhou on Behalf of *PJM Interconnection, LLC* Exhibit 2, August 21 Supplement ("Pfeifenberger and Zhou Memo"), p. 4.

opposed to U.S. markets, factors that Brattle did not even attempt to account for in its analysis. As a result, Brattle and PJM have failed to offer a sensible group of comparable investors in merchant generation sufficient to support an appropriate ATWACC – the group relied on neither represents the investors actually investing in peaker resources nor does it reflect companies that should be included in such a list given their unique situations.[13] The resulting inconsistency between Brattle's implied asset beta and Commission decisions regarding return on equity confirms their failure.

Perhaps the most obvious and problematic aspect of the PJM filing is that it is based on stale debt financing rates. Simply stated, PJM's assumed debt rate does not reflect market rates. As Tanya Bodell states "The ATWACC presented by PJM incorporates an assumed debt rate of 6.0 percent for a B to BB rated entity. . . This debt rate is too low."[14] Using publicly available sources, debt rates for B and BB rated companies for twenty-year tenors are 7.0% and traded at up to 7.5% over the past year.[15] A critical flaw is that Brattle uses an investment horizon that is significantly shorter than the 20-year investment horizon for an investor in a generation facility – something more akin to a 5-year tenor.[16] Moreover, these debt rates, as explained by Ms. Bodell, do not incorporate anticipated rate increases that the Federal Reserve has stated multiple times should be expected to occur over the next year when a new entrant would be looking to finance. Although Brattle initially included a 50 basis-point adder to account for the rising interest rate environment, the adder inexplicably was dropped and the base rate decreased to 5.5 percent from

[13] See FN11 *supra.*

[14] Bodell Affidavit at ¶ 46.

[15] Bodell Affidavit ¶ 51.

[16] Bodell Affidavit at ¶ 50.

6.5 percent when Brattle had to modify key components of its calculation in response to Ms. Bodell's early criticisms in order to maintain a resemblance to Brattle's initially-recommended ATWACC. PJM attempted to correct Brattle's blatant disregard of market prices for debt by incorporating a 50 basis increase in its final recommendation, but added this to a compilation of rates for BB-rated debt that was for less than 10 years.[17] Given bond yields for corporate debt at the B/BB credit rating, increases that have occurred since Brattle's initial report, and the Federal Reserve's clear signals that interest rates are going to rise, the PJM 6.0% debt rate remains completely indefensible. In light of all the considerations above, Ms. Bodell's testimony indicates that the appropriate debt rate is 7.5%.[18]

Compounding the problem of an unjustifiably low debt numbers are cost of equity assumptions that are similarly out of touch with reality for merchant generators and inconsistent with prior decisions of the Commission in other proceedings. PJM proposes an equity rate of 13.00%[19] which is a reduction from the current equity rate of 13.80%[20] and below the recently-approved FERC cap of 13.08% for New England regulated transmission owners.[21] While these values do not allow for an apples-to-apples comparison, it makes no sense that the allowed return for a regulated transmission owner is above that of a market-dependent generation seller in PJM's markets. Stripping away the assumptions regarding leverage, risk-free rates and market

[17] Bodell Affidavit at ¶ 53.

[18] Bodell Affidavit at ¶ 55.

[19] Pfeifenberger and Zhou Memo, p. 2

[20] 2018 VRR Curve Report at p. 37.

[21] Bodell Affidavit at ¶ 66 referencing165 FERC ¶ 61,030 United States of America Federal Energy Regulatory Commission, Before Commissioners: Kevin J. McIntyre, Chairman; Cheryl A. LaFleur, and Neil Chatterjee, Docket Nos. EL11-66-001, EL11-66-004, EL11-66-005, EL13-33-000, EL13-33-002, EL14-86-000, EL16-64-000, EL16-64-002), October 16, 2018, ¶ 59.

premiums yields the asset beta[22] (also called the unlevered beta) – the real indicator of the assumed risk of an asset and clear indicator of the flaw in the PJM/Brattle results for the proposed cost of equity. In effect, the PJM/Brattle proposal assumes an asset beta of 0.73. This is well below the asset beta of 0.85 that FERC implicitly approved for PJM in 2014 and below the asset beta of 0.84 which FERC implicitly approved for ISO-NE's Net CONE proceedings in 2017. [23] As an initial observation, PJM/Brattle's number assumes that the investment risks associated with merchant generation have gone down. The Commission knows that nothing could be further from the truth. Moreover, PJM's equity value that assumes an asset beta of 0.73, if adopted, would be a direct conflict with FERC's recently-issued NETO order that implicitly set the range for an asset beta for the New England regulated transmission owners at 0.67 to 0.93.[24] In effect, the PJM/Brattle proposed cost of equity reflects the risk of a regulated utility. Approval of a cost of equity squarely in the middle of the range of the FERC-approved return on equity rates for regulated transmission companies in New England would conclude that a merchant generation project in PJM shares the same risk profile as regulated transmission projects in New England. Indeed, it is below the beta of the market as a whole (i.e., "1.0"), indicating that merchant generation investment is less risky than simply investing in a S&P 500 index fund. The Commission knows that merchant generation investment is riskier that regulated utility transmission investment and intuitively should recognize that merchant generation investment is riskier than the entire equity market. The evidence presented suggests that P3's estimation of investment risk for a merchant generation project is the only input that approaches

[22] See Bodell Affidavit ¶¶ 57 – 58 for an explanation of asset beta and its relevance.

[23] See Bodell Affidavit ¶ 63 and Figure 10.

[24] See Bodell Affidavit ¶ 66 and Figure 11.

a valid estimation of such risk and therefore offers an appropriate return to equity for a merchant generation project.

As a result of flawed debt and equity assumptions, PJM's proposed cost of capital is wrong. Brattle's and PJM's faulty assumptions and flawed analyses produce an ATWACC that is unjustified and leads to a material underestimating of the ATWACC by at least 160 basis points. As Bodell explains, the appropriate ATWACC rate is at least 9.8%. "PJM's proposed cost of capital for a merchant generator in PJM is inconsistent with market debt rates, relies on companies that are not comparable to a merchant generator due to contracted assets and company-specific financial distress due to high leverage, and is inconsistent with recent FERC decisions regarding the implied asset betas for PJM, ISO-NE and regulated transmission companies. An appropriate ATWACC should be at least 9.8 percent."[25] This rate, although higher than the ATWACC approved by FERC in 2014 of 8.0%, reflects the following:

1) **Asset Risk:** The same asset beta of 0.84 as was previously approved for PJM, despite the fact that risks are rising for merchant generators due to market fundamentals, regulatory intervention, policy decisions and changing market rules. Recognizing that 0.84 is still lower than the implied asset beta of 0.93 at the high end of FERC's approved rates for regulated transmission owners would imply that a higher asset beta should be required, and Ms. Bodell calculates the required return on equity and associated ATWACC at higher risk levels.[26]

[25] Bodell Affidavit at ¶ 112.

[26] Bodell Affidavit at ¶ 112 and Figure 12. An asset beta of 0.92, for example, results in a required return on equity of 15.5% and an ATWACC of 10.0%.

2) **Debt Rate:** Cost of debt of 7.5% versus PJM's proposal of 6.0% in light of market rates for a 20-year tenor, PJM's assumed credit rating of B to BB, changing market conditions that have occurred since Brattle's report, and the rising interest rate environment.

3) **Tax Rates:** A lower tax rate of 27.15% versus the assumed 40.5% due to tax law changes currently in effect.

4) **Risk Free Rates:** An assumed risk-free rate of 4.0% versus the previously approved 3.4% and PJM's proposed 3.5 percent in light of the rising interest rate environment.

5) **Market Premium:** A market premium of 6.9% in accordance with the PJM/Brattle reliance on Duff & Phelps.

6) **Leverage:** Lower leverage of 55% versus 60% to reflect industry de-levering as indicated by the publicly-traded IPPs that have since been restructured or acquired by private equity. Assuming a lower debt ratio that would be more reflective of a single stand-alone asset financed through project financing could be justified but should not have a substantial impact on the ATWACC if the levered risk to equity is properly accounted for.

B. The Selection of the CT is Appropriate for the Reference Unit. However, Frame F and not Frame H is the Appropriate Technology.

PJM recommends, and P3 agrees, that the Combustion Turbine ("CT") should remain as the reference unit for purposes of calculating a revised Cost of New Entry. While it is undeniable that Combined Cycle units ("CC") are being constructed in PJM, the CT remains the most appropriate reference unit in PJM for the following reasons:

- CTs are smaller, more agile units that can be brought on line more quickly – CTs cost $300 million, as opposed to CCs, which can cost over one billion dollars.

- Since CTs will rely more heavily on capacity market revenues, it is easier to accurately develop a Net CONE for CTs that would be stable over time and not vary according to energy price volatility.

- Although not controlling, New York and New England both use the CT as reference technology.

- Switching between the CT and CC technology simply inserts more risk into capacity market revenues due to market rule changes and could lead to high-priced bids and confusion in the market.

As PJM's Adam Keech concluded, "PJM is not comfortable proposing a dramatic change in the RPM auction parameters on an assumption that CT Plants no longer have a significant role to play in the PJM Region. . . . PJM's prudent choice is well supported."[27] P3 agrees.

While P3 supports the retention of the CT as the reference unit in PJM, P3 disagrees with the selection of the Frame H as the technology choice. As Ms. Bodell observes, "A Frame HA simple cycle peaker plant has NOT been developed in PJM and is not likely to be developed in PJM."[28] As she explains, and Brattle acknowledges, the Frame F is the most common peaker that has been developed in PJM. There is not a single Frame H CT under development or in the PJM queue.[29] Moreover, there are only two Frame 7HA CT plants being developed in the entire country and those are in New England and California with different circumstances surrounding both plants.[30]

[27] PJM Filing at p. 11.

[28] Bodell Affidavit at ¶ 82.

[29] Bodell Affidavit at ¶ 87.

[30] Bodell Affidavit at ¶ 84 and ¶ 91.

Since the Frame H technology is unproven for use as a cycling, peaker plant, cost and revenue estimates could be difficult to ascertain. There is virtually no operational experience with a Frame H in a peaking configuration and whatever experience there is in the combined cycle configuration has been plagued with challenges. As Ms. Bodell concludes, "According to conversations with industry participants, the Frame HA technology suffers from lack of commercial experience in ramping and availability, decreased efficiency with partial loads, unproven flexibility, uncertainty surrounding how often the technology can cycle during the day, and a concern that the larger generation capacity may be difficult to employ fully as a peaker, making it more costly than a Frame F for this type of service."[31] Ms. Bodell reaches the conclusion that, "In order to stay consistent to PJM philosophy and meet the FERC tests for approval, PJM should continue to use a Frame F simple cycle as the reference unit."[32]

For the reasons articulated above and as detailed in the Bodell affidavit,[33] the Combustion Turbine Frame F is the appropriate reference unit and technology for purposes of the calculation of the Gross CONE. This unit is consistent with current market development, consistent with the previously-approved reference unit technology, and provides a logical basis for CONE calculations for the next four years. P3 urges the Commission to accept it.

C. In Light of the Continued Uncertainty in the Market, the Commission Should Reject PJM's Proposal to Shift the Curve 1% to the Left.

In 2014, the Commission approved PJM's proposed VRR curve, in part, because the Commission was concerned that historical data did not accurately reflect certain risks to

[31] Bodell Affidavit at ¶ 97.

[32] Bodell Affidavit at ¶ 111.

[33] Bodell Affidavit at section IV, ¶¶ 77-111.

reliability in the present market.[34] At the time, PJM's Chief Economist, Dr. Paul Sotkiewicz, noted that, "….PJM and the power industry as a whole are facing fast changing and uncertain market, policy and legal conditions, it is prudent to ensure the ability to minimize the probability of being unable to achieve the RFC resource adequacy standard."[35] Specifically, PJM noted at the time that the uncertainties facing the present and future markets were not reflected in the historical data.

In 2014, PJM and the Commission agreed that uncertainties such as the implementation of the Mercury and Air Toxics Standards ("MATS") and the vacatur of Commission Order No. 745 on Demand Response justified a "conservative" approach to the setting of the VRR curve. While some of the uncertainties facing of the market in 2014 have been replaced with different uncertainness in 2018, the benefits of a conservative approach to the setting of the VRR curve remain. Owners of existing generation are under tremendous financial stress in PJM as evidenced by the desire of many resource owners to seek out of market revenue streams and the calls for reforms to outdated energy price formation rules. The financial stress facing many units has manifested itself in the form of announced or proposed deactivations of coal, nuclear, gas and oil units. As a result, the Commission, among other things, is currently considering significant changes to the capacity market to define the relative roles of competitive wholesale markets and state policies in shaping the quantity and composition of resources needed to cost effectively meet future reliability and operational needs. Likewise, uncertainty regarding the regulation of carbon by either state or federal policymakers render long term decisions challenging.

[34] *PJM Interconnection, L.L.C.*, 149 FERC ¶ 61,183 (Nov 28, 2014) at P 52.

[35] Affidavit of Dr. Paul Sotkiewicz on behalf of PJM Interconnection, *PJM Interconnection, L.L.C.* ER14-2940 (Sept. 25, 2014) at P 11.

PJM justified the shift of the demand curve to the right in 2014 largely because of concerns that market uncertainties where not reflected in historical data. Similar market uncertainties – driven both by market fundamentals and politics – continue to cloud capital investment in both new and existing units, which could result in swift exit of large volumes of generation. P3 urges the Commission to err on the side of reliability by continuing to think conservatively about the VRR curve. The Commission should reject PJM's proposal to shift the curve to the left by 1% from its current position.

D. The Inclusion of the 10% Adder is Appropriate.

P3 supports PJM's proposal to close a current gap regarding the treatment of the 10% cost adder for energy market offers. As PJM and this Commission has recognized, "….an incremental cost rate that allows a fair recovery of the incremental cost of generating with a 10 percent adder to provide for a margin over incremental cost is reasonable. Incremental costs plus 10 percent represents a conservative proxy for a reasonable rate available in a competitive market."[36] The same justification that applies to the adder to actual energy market offers would apply to hypothetical energy market offers from the reference unit. It is only logical that the Energy and Ancillary Services estimates for the Reference Resource reflect this market rule. It is the position of P3 that PJM's proposal in regard to this issue should be accepted.

[36] Market-Based Rates For Wholesale Sales Of Electric Energy, Capacity And Ancillary Services By Public Utilities, FERC Order 697 119 FERC ¶ 61,295 at p. 350. Note that New England, New York and NYISO all have the 10% adder - https://pjm.com/~/media/committees-groups/task-forces/gofstf/20150722/20150722-item-04-exclusion-of-10-percent-adder.ashx at 5.

IV. CONCLUSION

For the foregoing reasons, P3 respectfully requests that the Commission, consider its comments, and accept certain elements of PJM's filing while rejecting and revising items as detailed above.

Respectfully submitted,

On behalf of the PJM Power Providers Group
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November 19, 2018

CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing document on each person designated on the official service list compiled by the Secretary of the Federal Energy Regulatory Commission in this proceeding.

Dated at Washington D.C., this 19th day of November, 2018.

On behalf of the PJM Power Providers Group
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Attachment A

Affidavit of
Tanya L. Bodell

UNITED STATES OF AMERICA

BEFORE THE FEDERAL ENERGY REGULATORY COMMISSION

	)	
PJM Interconnection, L.L.C.	)	**Docket No. ER19-105-000**
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AFFIDAVIT OF

TANYA L. BODELL

ON BEHALF OF PJM POWER PROVIDERS

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ON BEHALF OF PJM POWER PROVIDERS

I. INTRODUCTION

1. My name is Tanya L. Bodell. I am the Executive Director of Energyzt, a collection of companies focused on advisory services, business and economic development and analytics. The Energyzt family of companies include Energyzt Advisors, LLC, Energyzt Development Partners, LLC and Energyzt Analytics, LLC. Energyzt is a global collaboration of energy experts who create value for clients primarily in the energy industries. I am based in the Boston, Massachusetts area.

2. As the Executive Director of Energyzt, I manage the day-to-day business operations of the Energyzt entities and provide advisory services to clients, advising on business strategy and investment decisions. I also am responsible for overseeing the development and maintenance of our power market models and the quantitative analysis of industry data that allows our clients to make informed investment decisions. Our analytical service offerings include energy market assessments, long-term price projections using fundamental analyses and stochastic analysis to create a distribution of potential outcomes and risk assessments to inform client decisions. I also oversee asset valuation and have prepared independent appraisals for a number of different types of energy assets, including power plants. Such valuations often include a determination of the appropriate discount rate to apply to projected cash flows.

3. I have been a consultant for more than twenty-five years, providing business advice and expert support to market participants, regulators and policy makers in the energy industry in general and the power sector in particular. Prior to founding Energyzt in 2012, I was a Managing Director and founder of the Electricity Consulting Group at FTI Consulting. Prior to FTI, I was a Vice President in the Energy and Environment practice at Charles River Associates, a company I joined in 2000. Prior to that, I was a consultant at Putnam, Hayes & Bartlett which subsequently merged with Hagler Bailly to become PHB Hagler Bailly before being acquired by PA Consulting. My role at each of these firms served clients in the power sector as well as other industries.

4. I received a B.A. in mathematical economics from Pomona College, an M.A. in public policy from the Harris School of Public Policy at the University of Chicago, and an M.B.A. from the Massachusetts Institute of Technology Sloan School of Management as a Sloan Fellow.

5. I have submitted testimony to FERC in two prior dockets:

   a. **Docket No. ER17-795-000– ISO-New England Net CONE Proceeding:** In 2017, on behalf of the New England Power Generators Association, I submitted expert testimony and surrebuttal testimony to FERC regarding key aspects of the ISO New England Net CONE submission.

   b. **Docket No. ER11-2909-004 – Triennial rate review of Atlantic Path 15, LLC.:** In 2011, on behalf of Atlantic Path 15, LLC, I submitted testimony estimating the benefits of a transmission upgrade using a production cost model to project locational marginal prices in the CAISO market with and without the upgrade (Docket No. ER11-2909-004).

6. I also have testified as an expert witness in a number of other matters before state public utility commissions, arbitration panels and courts of law.

7. My detailed *curriculum vitae* is incorporated herein as Exhibit No. TLB-1.

II. PURPOSE OF AFFIDAVIT

8. The purpose of this affidavit is to provide relevant facts regarding key assumptions incorporated in the PJM Interconnection proposal for Net CONE definitions and parameters proposed for implementation starting in 2019.

9. Based on key information and analyses described in this affidavit, I conclude the following:

   a. **PJM's Proposed ATWACC is methodologically flawed and inconsistent with market conditions:** The proposed after-tax weighted average cost of capital ("ATWACC") is too low, fails to incorporate market information on anticipated debt rates, and is inconsistent with the equity risk ascribed to such assets by FERC in prior dockets, including the previous PJM decision, ISO-NE capacity market parameters and recent FERC decision concerning regulated transmission companies in New England.[1]

   b. **The Proposed Reference Unit does not meet FERC requirements:** The proposed reference unit – a simple cycle Frame H combustion turbine – is an inappropriate reference unit for PJM. The proposed technology fails each of the tests previously described by FERC in its decision adopting the technology

[1] 165 FERC ¶ 61,030 United States of America Federal Energy Regulatory Commission, Before Commissioners: Kevin J. McIntyre, Chairman; Cheryl A. LaFleur, and Neil Chatterjee, Docket Nos. EL11-66-001, EL11-66-004, EL11-66-005, EL13-33-000, EL13-33-002, EL14-86-000, EL16-64-000, EL16-64-002).

for the ISO-New England Net CONE.[2] The technology has not and is not anticipated to be implemented in PJM over the relevant time period, costs cannot be determined with an appropriate level of certainty given limited experience operating the technology in a peaker configuration as well as recent blade defects and other concerns voiced by users. Furthermore, implementing a technology focused on heat rate efficiency is less important for peaking units than flexibility, cycling capabilities and modularity.

10. The proposed reduction in Net CONE of nearly 30 percent is too dramatic a decline to be based in reality, as a more detailed review of the component parts attests.

11. In addition to the analyses presented in this Affidavit, I am sponsoring the following exhibits:

    a. Exhibit No. TLB-1: Curriculum Vitae of Tanya L. Bodell

    b. Exhibit No. TLB-2: PJM Quadrennial Review: Response to Revised Recommendation on ATWACC dated September 12, 2018

    c. Exhibit No. TLB-3: PJM Reference Unit: Issues to Consider on the Frame H CT, dated July 6, 2018

    d. Exhibit No. TLB-4: CCJOnsite, Combined Cycle Journal, "Summary Report of the 7HA User's Conference," dated October 8, 2018

III. PJM'S PROPOSED ATWACC IS FLAWED AND INCORRECT

12. The ATWACC is an important component of the calculation of Net CONE.[3]

13. As the level of Net CONE impacts the starting bid price, position of the demand curve, and market clearing price for PJM's capacity market, it is important to use an appropriate cost of capital in calculating Net CONE.

14. A number of alternative proposals for ATWACC were presented to PJM in the discussions leading up to the PJM submission to FERC:

    a. Energyzt recommends an ATWACC of at least 9.8 percent (see **Figure 10**, p. 20 and section III.E).

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[2] 161 FERC ¶ 61,035 United States of America Federal Energy Regulatory Commission, ISO New England Inc. Docket No. ER17-795-000 ER17-795-002, ORDER ACCEPTING FILING, Issued October 6, 2017, paragraph 38.

[3] For every 100 basis point decline in the ATWACC, the Net CONE decreases by approximately 8 percent. The difference between the PJM ATWACC and the Energyzt recommendation therefore reflects a difference of around 12 percent in the Net CONE, almost half of the proposed decrease.

b. The Internal Market Monitor calculated an ATWACC of 8.5 percent.[4]

c. The Brattle Group proposed an ATWACC of 8.0 percent.[5]

d. FERC previously approved an ATWACC for PJM of 8.0 percent under higher tax rates which significantly decreased the cost of debt and a lower interest rate environment.[6]

15. PJM currently recommends an ATWACC of 8.2 percent.[7]

16. The ATWACC calculated by Energyzt is the only one that is internally and externally consistent with market rates for debt, current market conditions, and prior FERC decisions.

A. The ATWACC has a material impact on Net CONE

17. The ATWACC and its component parts impact Net CONE in a number of different ways.

a. **Return on Equity:** The assumed required return on equity impacts the cost of capital during operations.

b. **Debt Rate:** The assumed cost of debt impacts interest during construction as well as the cost of capital during operations.

c. **Tax Rate:** The assumed tax rate impacts the after-tax cost of debt and income taxes which impact after-tax operating income.

d. **Leverage:** The assumed debt to capital ratio impacts the weightings on each financing component to calculate the ATWACC as well as the cost of equity (high leverage equals higher risk and higher required returns).

e. **Cost of Capital:** The discount rate applied during operations should reflect the after-tax weighted average cost of capital and be consistent with the component parts of financing a project, including the required return on equity, the after-tax cost of debt, and the appropriate weighting of debt versus equity.

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[4] Joe Bowring and Raymond Pasteris, "IMM CONE CT Study Results," MIC Special Session: Quadrennial Review, June 1, 2018, p. 22, http://www.monitoringanalytics.com/reports/Presentations/2018/IMM_MIC_Quadrennial_Review_Special_Session_CONE_CT_Study_Results_20180601.pdf

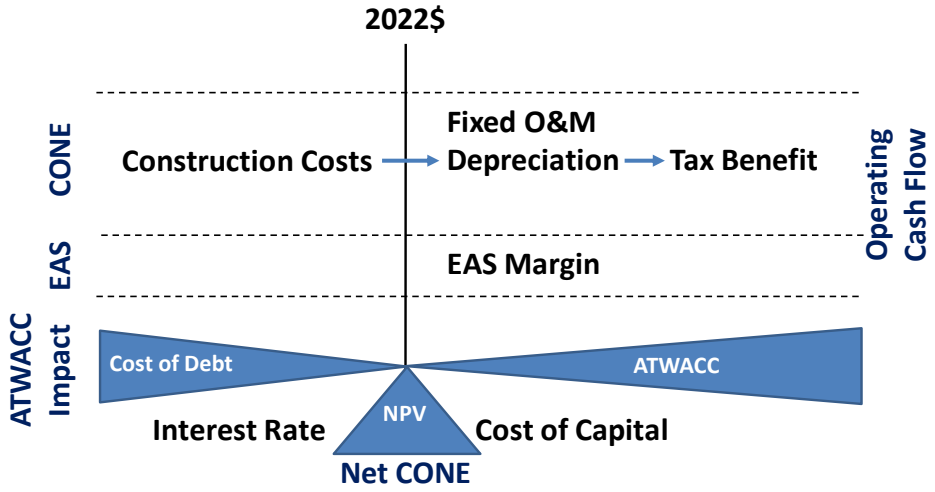
[5] Brattle Group, 2018 Net CONE, August 21 Supplement, Exhibit 2 to Affidavit of Pfeifenberger, et. al., p. 2.

[6] 149 FERC ¶ 61,183 United States of America Federal Energy Regulatory Commission, PJM Interconnection, L.L.C. Docket No. ER14-2940-000, ORDER CONDITIONALLY ACCEPTING TARIFF REVISIONS SUBJECT TO COMPLIANCE FILING (Issued November 28, 2014), ¶ 94.

[7] Affidavit of M. Gary Helm, ¶ 11. The PJM recommendation updates the Brattle debt rate by 50 basis points which, when adjusted for taxes and leverage, increases ATWACC by only 20 basis points (i.e., from 8.0 to 8.2).

The impact of the ATWACC and its component parts is illustrated in **Figure 1**.

Figure 1: Ways the ATWACC Impacts Net CONE



Source: Energyzt

18. According to Brattle, a 50 basis point reduction in the ATWACC (i.e., from 8.0 percent to 7.5 percent) reduces that annual CONE value by 3.7% for combined cycles.[8] Therefore, the 160 basis point shortfall between Energyzt's recommended value and the PJM proposal reduces Net CONE by around 12 percent.[9]

19. The lower Net CONE resulting from an inappropriately low ATWACC creates the risk that efficient new entry may not occur due to an assumed cost of capital that is significantly lower than market requirements.

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8 Brattle Group, 2018 Net CONE, Exhibit 2 to Affidavit of Samuel A. Newell, John M. Hagerty and Sang H. Gang on Behalf of PJM Interconnection, L.L.C., pp. vi, 50 and 51.

9 Energyzt confirmed this potential impact using a detailed Net CONE calculation produced by Concentric Energy Advisors as part of the ISO-NE Net CONE proceedings. Unlike ISO-NE, PJM does not provide the same level of underlying detail supporting its Net CONE calculation. Taking the working papers supporting the ISO-NE calculation of Net CONE using a Frame H combined cycle turbine, and modifying only the cost of capital, indicates that a 160 basis point shortfall in the ATWACC decreases Net CONE by around 12.5 percent. (see ISO-NE_a_e_and_as_model_cc_technology.xlsx).

B. PJM's ATWACC is based on a methodologically flawed approach

20. Brattle's methodology uses three different approaches to derive an ATWACC:[10]

    a. **Independent Power Producers:** So-called "comparable" companies engaged in power generation are used to derive key component parts of an ATWACC, namely a cost of equity calculated from beta, a measure risk and underlying uncertainty associated with the return on assets using the Capital Asset Pricing Model ("CAPM").

    b. **Fairness Opinions:** A simple range of ATWACCs applied in fairness opinions for transactions related to a subset of the independent power producers is used to support the proposed ATWACC without adjusting for leverage or tax rates.

    c. **Comparison to Treasury Bonds:** Brattle uses a comparison of the proposed ATWACC premium against U.S. Treasury Bond rates and previous PJM recommendations made by Brattle to justify the recommended ATWACC.

    Each of these approaches suffers from serious flaws and should not be used as the basis for establishing the ATWACC of the proposed reference unit in PJM.

21. Brattle's approaches are flawed for the following reasons:

    a. Failure to differentiate between sources and uses of capital;

    b. Failure to account for non-systematic risk; and

    c. Failure to recognize the inappropriate comparison metric of U.S. bond rates.

22. PJM's slight modification to the Brattle recommendation to derive an ATWACC of 8.2 versus Brattle's recommended 8.0 percent, based on a 50 basis point increase in the debt rate to 6.0 percent, suffers from the same methodological flaws and inconsistencies. Even with the slight adjustment to the cost of debt, PJM's assumed debt rate continues to be well below market rates for corporations with the same assumed credit-ratings and the reality of financing long-term assets such as a peaker plant in PJM.[11]

23. Inconsistencies between the component parts of the proposed ATWACC and market conditions (described in the following two subsections) illustrate the problem with Brattle's methodology and explain why the resulting ATWACC is too low. This section elaborates on the flaws embedded in Brattle's methodological approach.

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[10] Brattle Group, 2018 Net CONE, Affidavit of Samuel A. Newell, John M. Hagerty and Sang H. Gang on Behalf of PJM Interconnection, L.L.C. and Affidavit of Johannes P. Pfeifenberger and Bin Zhou on Behalf of PJM Interconnection, L.L.C.

[11] Affidavit of M. Gary Helm on Behalf of PJM Interconnection, L.L.C. Regarding Periodic Review of Variable Resource Requirement Curve Shape and Key Parameters.

1. Failure to Differentiate between Sources and Uses of Capital

24. PJM's proposed ATWACC is based on the fallacy that the risk of the source of funds and therefore the cost of capital (i.e., for independent power producers) automatically reflects the risk and cost of an investment (i.e., a merchant generation project).

25. In this case, Brattle uses financial information from a subset of companies that invest in generation (including contracted assets and renewables) as the basis for its recommended ATWACC. In particular, Brattle uses a set of independent power producers to develop a recommendation for the required return on equity using a CAPM calculation to derive the beta for independent power producers that are highly levered.[12] Brattle also uses the discount rate applied in fairness opinions to transactions associated with acquisitions of Calpine, Dynegy and Talen that were issued during the 2016 – 2017 period.

26. Brattle's use of so-called "comparable" firms repeats an approach used in past Triennial/Quadrennial review work for PJM.[13] Although FERC previously found that approach to be valid in estimating the cost of capital,[14] this approach using this particular group of companies during this particular period of time is no longer an appropriate means for measuring the cost of capital for a merchant generator. Specifically,

    a. **Increasing Lack of Comparability:** Falling interest rates during the period and declining spark spreads increased the relative weight of contracted assets to merchant assets rendering the results unsuitable for a merchant facility. The Canadian Companies in Brattle's list are particularly problematic in that most of their assets are contracted or regulated and very few have merchant facilities located in the U.S., thereby introducing "noise" into the CAPM calculation due to exchange rates and correlation of returns for those companies to international markets versus the S&P 500 (i.e., an international beta).

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[12] Brattle originally used this subset of companies to support its proposed debt ratio as well. The initial recommendation of 65% leverage was subsequently modified in light of the unsustainable debt such high leverage represented as indicated by corporate restructuring, mergers and acquisitions of assets and the company by private equity.

[13] PJM Interconnection, L.L.C., Docket No. ER14-2940-000 (filed September 25, 2014) ("PJM 2014 Net CONE Filing),

The Brattle Group, Cost of New Entry Estimates for Combustion Turbines and Combined Cycle Plants in PJM (May 15, 2014), ; PJM Filing Attachment D, http://www.brattle.com/system/publications/pdfs/000/005/010/original/Cost_of_New_Entry_Estimates_for_Combus tion_Turbine_and_Combined_Cycle_Plants_in_PJM.pdf?1400252453 ("Brattle 2014 CONE Report")

The Brattle Group, Third Triennial Review of PJM's Variable Resource Requirement Curve (May15, 2014), PJM Filing Attachment E, http://www.brattle.com/system/publications/pdfs/000/005/009/original/Third_Triennial_Review_of_PJM's_Variable_Resource_Requirement_Curve.pdf?1400252215 ("2014 BRATTLE VRR Curve Report")

[14] See for example,149 FERC ¶ 61,183 UNITED STATES OF AMERICA FEDERAL ENERGY REGULATORY COMMISSION, PJM Interconnection, L.L.C., Docket No. ER14-2940-000, Order Conditionally Accepting Tariff Revisions Subject to Compliance Filing (Issued November 28, 2014).

b. **Company-Specific Financial Distress:** Each of the three U.S. IPPs experienced financial distress during the period of Brattle's analysis rendering the calculated CAPM to be an inappropriate measure of non-diversifiable or non-systematic risk. Price movements were dominated by company events.

Without an appropriate set of publicly traded companies, a more legitimate approach would be to look to FERC decisions and precedent for consistency, which Energyzt did in its presentation to PJM responding to the August 21 Supplement (Exhibit No. TLB-2), and further elaborates upon in this affidavit.

27. One of Brattle's proposed approaches calculates CAPM betas using an inappropriate set of comparable companies that do not reflect the risk of a stand-alone merchant generator plant in PJM.

28. Although the companies identified by Brattle may invest in new generation in PJM, the risk profile of those companies does not reflect the risk of an individual generating asset in PJM, let alone in the United States.

29. **Figure 2** lists the companies and financial metrics calculated by the Brattle Group.[15]

Figure 2: List of Base Companies Underlying Brattle's CAPM Analysis

	Company	Firm Value [1]	S&P Credit Rating [2]	Equity Beta [3]	Return on Equity [4]	Cost of Debt [5]	Debt/ Equity Ratio [6]	After Tax WACC [7]
U.S. Companies	NRG Energy Inc	$23,278	BB-	1.17	10.7%	5.8%	73/27	5.4%
	Calpine Corp	$16,586	B+	1.06	10.0%	5.6%	63/37	5.8%
	Dynegy Inc	$9,903	B+	1.25	11.3%	6.7%	66/34	6.5%
Canadian Companies	TransAlta Corp	$4,020	BBB-	1.47	12.8%	6.3%	66/34	6.8%
	Algonquin Power & Utilities Corp	$7,676	BBB	0.84	8.5%	5.1%	46/54	6.0%
	Northland Power Inc	$9,003	BBB	0.92	9.0%	5.1%	58/42	5.6%
	Capital Power Corp	$3,723	BBB-	0.95	9.2%	3.9%	47/53	6.0%

30. This list creates an inappropriate set of comparable companies.

a. **Companies have contracted assets:** Contracted assets will have a lower risk level and therefore lower required return on equity than merchant generation assets. The inclusion of contracted assets in the company generation portfolios, therefore, results in a lower overall risk for the company than what a stand-alone merchant generator experiences. This fact is recognized by Brattle who then chooses the upper end as the basis for its ATWACC:

[15] Brattle Group, 2018 Net CONE, Exhibit 2 to Affidavit of Samuel A. Newell, John M. Hagerty and Sang H. Gang on Behalf of PJM Interconnection, L.L.C., Table 17, p. 40.

> Because most of the sample companies will have various proportion of their generation assets under long-term contracts (i.e., not operating on a purely merchant basis), we look to the upper range of these results as a reasonable estimate for the cost of equity of merchant generation investments in PJM.[16]

However, there is no basis for knowing whether the high end of the range is high enough to reflect the risk of a pure merchant generating plant and other evidence indicates that the high end of the range is not high enough. In fact, TransAlta Corporation, which is the high end of the range, is not comparable at all to a merchant natural-gas fired peaker plant in PJM.[17]

b. **The Canadian Companies are not comparable due to international influences:** Brattle notes that the international companies have ATWACC results comparable to the U.S. companies and therefore included them in the analysis.[18] However, there is no reason why a Canadian company heavily weighted with contracted assets should be part of an appropriate set of comparable companies for a merchant generator in PJM. The inclusion of these non-US companies is inappropriate due to dissimilar underlying businesses and operating assets as well as the fact that Canadian equity markets differ from U.S. equity markets in investor behavior, supply/demand dynamics, and institutional/retail investor mix. Measuring the beta against the S&P 500, as was done by Brattle, incorporates movements of the company's returns against its own domestic markets (i.e., an international beta) as well as exchange rates associated with foreign investments outside of the United States and should be disregarded unless those factors can be properly accounted for, which Brattle fails to do.[19]

c. **The U.S. Companies all experienced financial distress:** Brattle generally relies on U.S. independent power producers to derive its conclusions regarding the appropriate ATWACC. During the period of Brattle's analysis, however, each of these companies experienced severe financial distress due to excessive leverage that forced them to be restructured or acquired:

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[16] Brattle Group, 2018 Net CONE, Exhibit 2 to Affidavit of Newell, et. al., pp. 38-39.

[17] Out of TransAlta's 67 operating plants in the portfolio, less than one-third are merchant. Those that are merchant are all located in Canada and include 5 coal plants, 5 hydroelectric plants, 10 wind plants, and one partially-merchant gas plant. https://www.transalta.com/facilities/plants-operation/

[18] Brattle Group, 2018 Net CONE, Exhibit 2 to Affidavit of Newell, et. al., p. 38.

[19] One of the factors that would make the beta of a foreign company measured against the S&P 500 lower is the international beta component of the company's movement to a global market measure. Both the international beta and exchange rate beta would have to be removed from the equation to properly reflect an asset beta with equivalent risk of the underlying international assets in the United States that are measured against the S&P 500. https://www.investopedia.com/terms/i/international-capm.asp

i. **Calpine:** After months of speculation in August 2017, Calpine, which was publicly-traded, announced that it would be acquired by a private equity consortium led by Energy Capital Partners. The private equity group led by Energy Capital Partners purchased Calpine in March 2018.

ii. **Dynegy:** In October 2017, Dynegy signed an agreement to merge with Vistra, which had recently emerged from bankruptcy of Energy Future Holdings. The merger closed on April 9, 2018.

iii. **NRG Energy:** Throughout 2017, NRG Energy was restructuring and selling large parts of its generation portfolio, including the merchant assets in subsidiary GenOn that had to enter into bankruptcy.

31. The high leverage ratios were shown to be unsustainable and an inappropriate metric for weighting capital costs as Brattle had done. The company-specific risk associated with distressed assets also renders them unsuitable for measuring the required return on equity using a CAPM approach. Lastly, Brattle's calculation of sensitivities around this collection of companies used as a base suffers from the same fundamental issue. Therefore, Brattle's sensitivity analyses are irrelevant to addressing the question of what the appropriate ATWACC of a stand-alone merchant peaking generation facility in PJM should be.[20]

2. Failure to Account for Non-Systematic Risk

32. Brattle's approach also fails to account for non-systematic risk associated with the base set of companies that were used to calculate CAPM and provide fairness opinion ATWACCs.

33. As already noted, all of the U.S. companies used in Brattle's analyses were under some form of restructuring or financial distress. Even if these companies had been used in the past, the financial condition of these companies during the period of analysis makes them unusable for a stand-alone peaker plant located in PJM which presumably would be financially viable. The lack of comparability is illustrated by corporate actions, including:

a. Debt restructurings and administered reorganizations (e.g., NRG's GenOn).

b. Delistings and privatization transactions (e.g., Calpine and Talen, which did not have enough data to be included in a CAPM analysis but was included in the fairness opinion transactions).

c. Forced asset sales and exits from certain businesses (e.g., Dynegy, NRG).

[20] Brattle's sensitivities modify the cost of debt and risk-free rate, which fails to address the fundamental problem with the use of the designated companies. For example, Sensitivity 1 uses the ratings-based cost of debt as was used in the prior PJM Net CONE studies. Sensitivity 2 uses a forecasted risk-free rate instead of the existing rate. Sensitivity 3 uses both the ratings-based cost of debt and forecasted risk-free rate. None of these sensitivities address the underlying asset beta. Brattle Group, 2018 Net CONE, Exhibit 2 to Affidavit of Newell, et. al., p. 40.

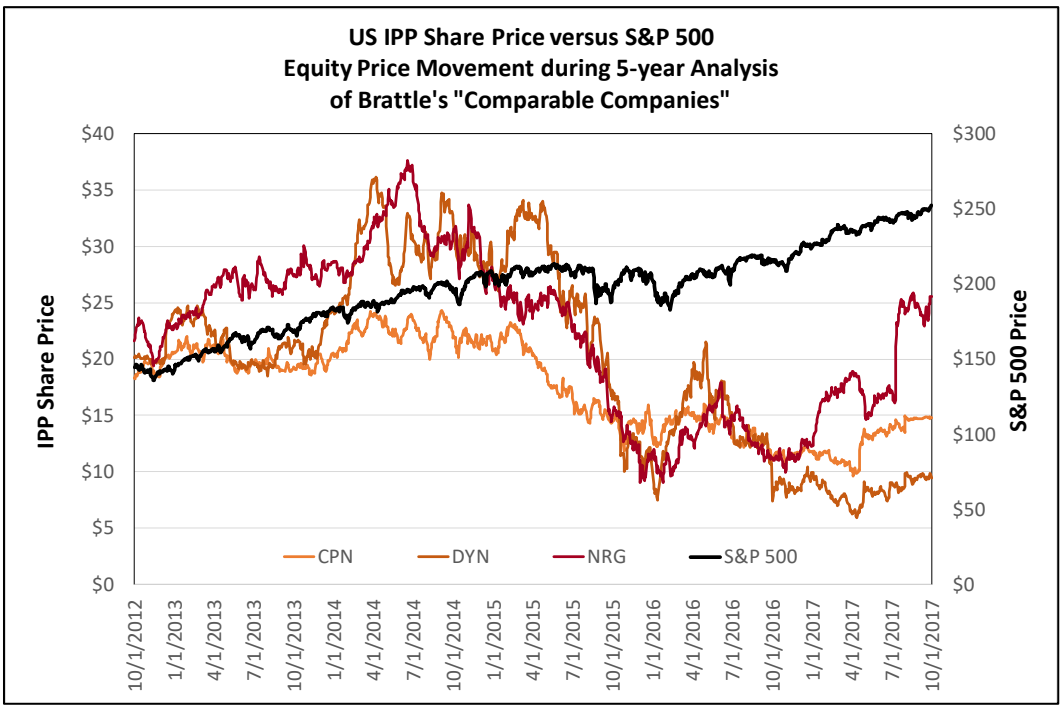
These corporate actions were idiosyncratic, not experienced by the broader equities market, and therefore altered public equity investor sentiment towards these companies, naturally weakening the linkage of returns for these firms with the overall market.

34. Presumably, a new entrant into PJM would be economically viable, anticipated to be profitable, and not subject to operational vagaries associated with financial distress. Therefore, the risk of the U.S. IPPs used by Brattle in its analyses fails to serve as a valid representation of the risk and required return of a new entrant.

35. Systematic risk is the undiversifiable risk or market risk that is supposed to be measured by a company's beta. When company-specific risks outweigh market conditions, any use of the companies for purposes of estimating the required return on equity can be problematic.

36. As illustrated in **Figure 3**, the share price of Calpine, Dynegy and NRG each started to diverge from the trend of the S&P 500 and each other due to high leverage and financial distress that led to a number of efforts to restructure the companies. This unique period of time for these companies between 2015 and 2017 makes them inappropriate for calculating a CAPM or ATWACC appropriate for a new entrant in PJM.

Figure 3: Equity Share Price of U.S. IPPs versus S&P 500



37. Brattle's list of ATWACCs reported in transactions associated with the fairness opinions suffers from the same problem. In the original analysis and the August 21 Supplement,

Brattle indicates an ATWACC used in fairness opinions associated with transactions tied to the following publicly-traded U.S. independent power producers:[21]

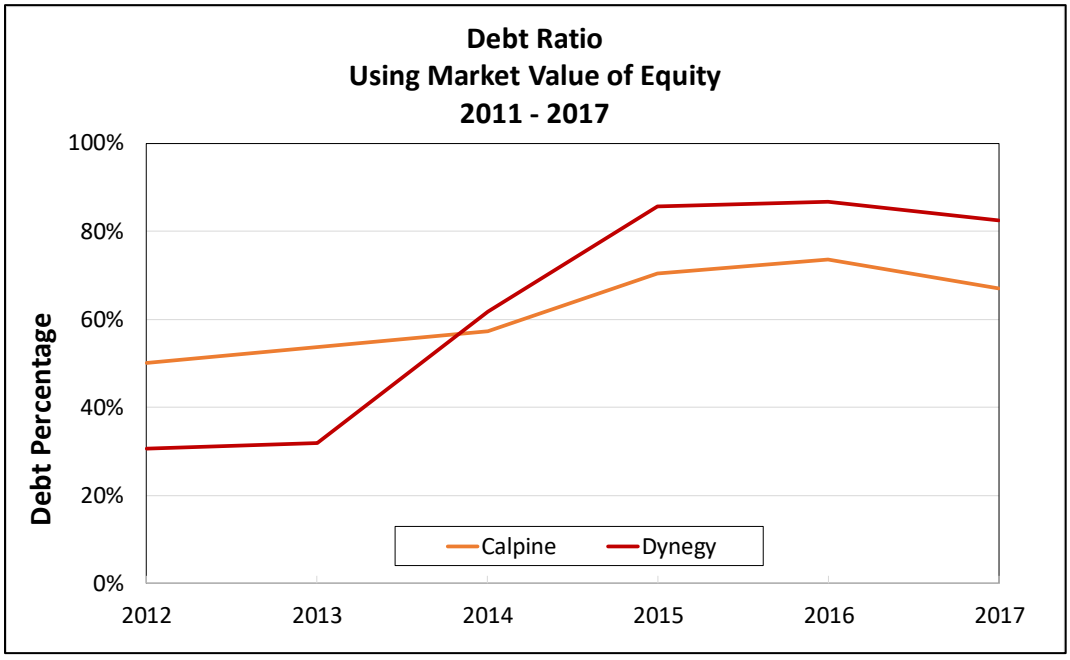
a. Calpine

b. Dynegy

c. Talen

38. The fairness opinions for Calpine and Dynegy occurred before the change in tax rates, are for companies that are not comparable for the reasons stated above, and therefore are not relevant for a merchant peaking plant in PJM.[22] In these two cases, the ATWACC reflects portfolios with contracted assets as well as companies operating under financial distress being purchased or merging with another company as a means of restructuring. These two companies also were highly levered (**Figure 4**), which also could have resulted in a distortion of the ATWACC applied to the Calpine and Dynegy transactions.

Figure 4: Escalating Leverage of Calpine and Dynegy



[21] Brattle Group, August 21 Supplement, Exhibit 2 to Affidavit of Pfeifenberger et. al., Figure 3, p. 6 adds Dynegy to the fairness opinion transactions that originally had been reported in Exhibit 2 to Affidavit of Newell, et. al., Figure 7, p. 41.

[22] The transactions occurred in 2017 under higher effective tax rates and high leverage. Brattle simply lists the ATWACCs used and does not make any adjustments for these factors to attempt to make the discount rate in the fairness opinions more reflective of the assumed capital structure and tax rates of a merchant facility in PJM. As a result, the comparison to the CAPM results and sensitivities are inappropriate.

39. The Talen transaction also was valued prior to the adjustment in tax rates.[23] Yet Brattle does not make any adjustment to the ATWACC in the fairness opinions to reflect lower federal taxes. There are other reasons why the Talen Energy transaction is not comparable. Talen went public in mid-2015 and delisted on December 6, 2016, with shares of Talen common stock being exchanged for $14.00 in cash.[24] Prior to that transaction, Talen sold $1.2 billion in assets during the first quarter of 2016, including the renewables portfolio.[25] Assuming that the fairness opinion relates to the acquisition of Talen by Riverstone, the use of the ATWACC suffers from the following issues:

a. **Company Assets:** Brattle makes no adjustment for the fact that Talen had been restructuring for the previous year through substantial asset sales and therefore had $1.358 billion in cash and cash equivalents as of September 30, 2016.[26]

b. **Buying Cash not Assets:** The equity purchase price of $1.840 billion indicates that nearly 74 percent of the market value of equity was based on cash versus the net present value of future cash flows tied to generating assets.[27] Therefore, the appropriate discount rate should reflect the lower risk of cash, not assets.

c. **High Leverage:** A comparison to total debt of $4.811 billion as of the end of 2015 implies that the relatively low ATWACC simply reflects a leverage of 73 percent debt with coupon rates ranging from 4.6 percent to 6.5 percent and negligible risk to the equity given the high proportion of cash.

Given the company-specific situation, including the high cash position, the risk profile of Talen Energy at the time it was acquired does not reflect the risk of a merchant peaker plant in PJM.

40. The risk of Brattle's base companies is very different from that of a merchant peaker plant in PJM for the projected period. Therefore, Brattle's use of the ATWACCs used in the fairness opinions to determine a proposed rate is inappropriate and should be ignored.

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[23] See August 21 Supplement, Exhibit 2 to Affidavit of Pfeiffenberger, et. al., Figure 2, p. 4. For Quarter 3, 2016, An Analyst presentation indicated that the marginal tax rate was 40 percent. http://talenenergy.investorroom.com/events-and-presentations

[24] Talen Energy, http://talenenergy.investorroom.com/investor-services.

[25] Talen Energy 2015 Annual Report, http://talenenergy.investorroom.com/annual-reports Details underlying the fairness opinions relied upon have not been disclosed and therefore, it is unclear if the fairness opinion relates to the company going private or relates to the asset sales of the company. If the Brattle reference is to the sale of contracted renewables, then the comparison clearly would be invalid. If tied to the IPO, the analysis is dated.

[26] Talen Energy, SEC Form 10-Q, 2016 third quarter as of 2016, http://talenenergy.investorroom.com/SEC-filings?year=2016

[27] Talen Energy, SEC Schedule 14A Proxy Statement Pursuant to Section 14(a) of the Securities Exchange Act of 1934, https://seekingalpha.com/filings/pdf/11532522.pdf

3. Inappropriate Comparison to a U.S. Treasury Bond

41. Brattle justifies its end result by comparing the proposed ATWACC premium above the risk-free rate (i.e., a 20-year bond) with its prior recommendations. Brattle's comparison implies that an ATWACC that is 50 basis points higher than the risk premiums of the ATWACCs from Brattle's prior recommendations can justify the new value.[28]

42. This justification is unfounded. In FERC Order 351, which has since been vacated but from which the factual findings regarding use of the Treasury Bond is still informative, FERC decided to eliminate the Treasury Bond Update because it was no longer relevant.

> The Commission's long-standing practice has been to base this post-hearing adjustment on the change in U.S. Treasury bond yields during the same time period. We now change that practice . . . The premise underlying the use of U.S. Treasury bonds for the post-hearing ROE adjustment is that changes in ROE over time track changes in U.S. Treasury bond yields. However, while U.S. Treasury bond yields are an important indicator of capital market conditions and therefore inform our determination of an appropriate base ROE, the capital market conditions since the 2008 market collapse and the record in this proceeding have shown that there is not a direct correlation between changes in U.S. Treasury bond yields and changes in ROE. Therefore, the premise underlying the Commission's use of U.S. Treasury bond yields for post-hearing ROE adjustments is not always accurate.[29]

43. Brattle's comparison is even more problematic because it is a comparison of the premium of a 20-year Treasury Bond to an ATWACC, which consists of a required return on equity as well as changing leverage assumptions, rising corporate debt rates, and lower tax rates. The Commission concluded that the return on equity alone did not have a direct correlation with changes in U.S. Treasury bond yields. It is untenable to think that an ATWACC would have a constant relationship. Therefore, Brattle's justification of its proposed ATWACC using a comparison to U.S. Treasury bonds should be disregarded.

C. PJM's debt rate does not reflect market rates

44. The flaws in Brattle's methodology become apparent when the component parts of PJM's recommended ATWACC are compared to market conditions.

45. Inconsistency between PJM's assumed cost of debt and market rates cannot be reconciled and illustrate the methodological errors embedded in PJM's proposed ATWACC.

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[28] Brattle Group, August 21 Supplement, Exhibit 2 to Affidavit of Pfeifenberger, et. al., Figure 1, p. 3. A similar comparison also is made in Exhibit 2 to Affidavit of Newell, et. al., Figure 6, p. 37.

[29] FERC Order No. 351, paragraphs 157 - 158.

46. The ATWACC presented by PJM incorporates an assumed debt rate of 6.0 percent for a B to BB rated entity. PJM bases this value on the Federal Reserve compilation of corporate bond yields for B and BB credit-rated companies.[30] This debt rate is too low.

47. The source of PJM's debt rate indicates that average corporate yields for B companies for all tenors were trading at 7.34 percent as of the date of this affidavit (**Figure 5**).

Figure 5: Federal Reserve Corporate Yields for B-rated Companies[31]

48. PJM's source for BB-rated companies long-term debt and the basis for Brattle's recommendation had increased to 5.7 percent as of the date of this affidavit (**Figure 6**). It is important to note that this rate reflects an average tenor of all corporate bond yields, and is not applicable to long-term financing.

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30 Affidavit of M. Gary Helm, footnote 3 references the website of the St. Louis regional office of the U.S. Federal Reserve:

https://fred.stlouisfed.org/series/BAMLH0A1HYBBEY

https://fred.stlouisfed.org/series/BAMLH0A2HYBEY

31 Federal Reserve St. Louis, https://fred.stlouisfed.org/series/BAMLH0A2HYBEY as of November 16, 2018.

Figure 6: Federal Reserve Corporate Yields for BB-rated Companies[32]

49. The debt rates on which PJM relies reflect an average of all publicly-traded bonds, including short-term, mid-term and long-term bonds. The net result is an average tenor that is significantly shorter than the 20-year asset life of a peaker plant in PJM and the 20-year debt tenor supposedly assumed by Brattle and the Internal Market Monitor.[33]

50. For example, as of August 22, 2018 when the Federal Reserve of St. Louis reflected a Corporate Bond yield of 5.04 percent, the forward curve indicated an equivalent rate for a bond with a 5-year tenor (**Figure 7**). Therefore, the debt rates adopted by Brattle implicitly assume around a 5-year tenor instead of longer-term financing. PJM's rate reflects less than 10-year financing for a BB-rated company.

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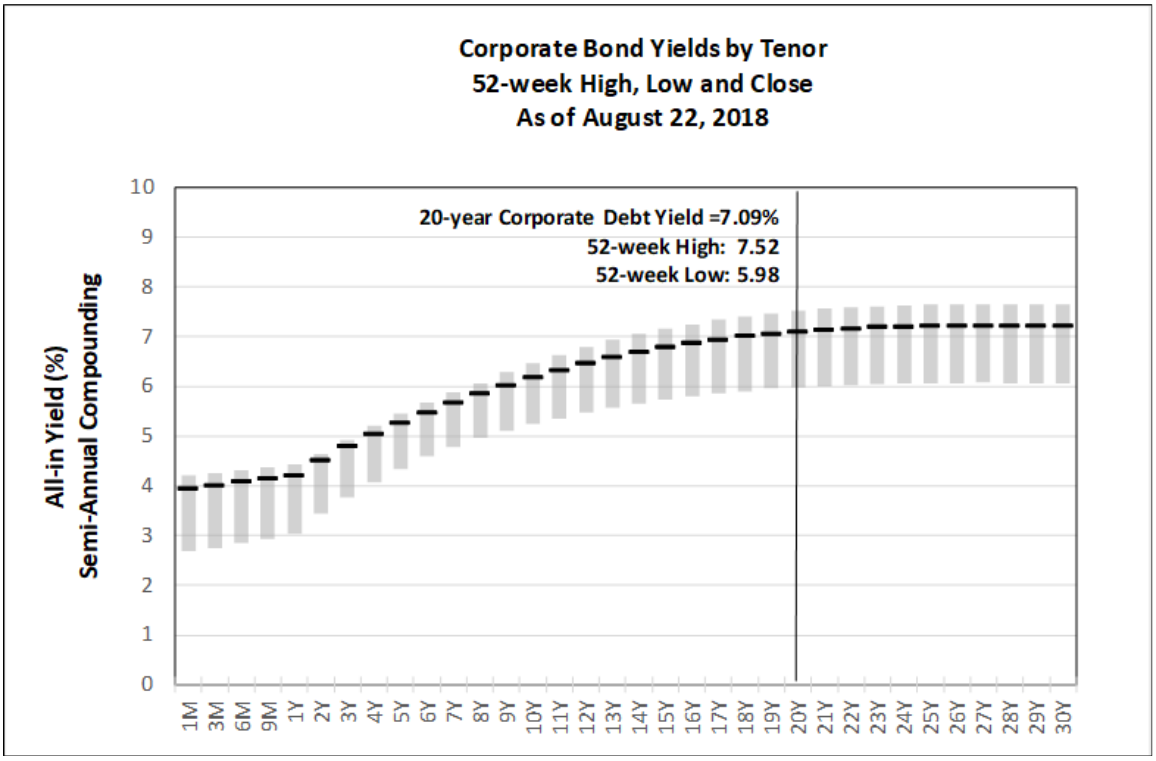
32 Federal Reserve St. Louis, https://fred.stlouisfed.org/series/ BAMLH0A1HYBBEY as of November 16, 2018.

33 Joe Bowring and Raymond Pasteris, "IMM CONE CT Study Results," MIC Special Session: Quadrennial Review, June 1, 2018, p. 22.

Figure 7: Corporate Yields for BB rated Companies[34]



51. The August 22, 2018 data also indicates that Corporate Bond Yields for BB-rated companies reflected a 52-week high of 7.52 and a 20-year Corporate Debt Yield of 7.09 percent. Adopting the initial Brattle recommendation to add 400 basis points to reflect the rising interest rate environment would have supported a corporate debt rate of 7.5 percent.

52. Instead, Brattle inexplicably removed the adder and dropped its recommended cost of debt to 5.5 percent from the initial recommendation of 6.5 percent.[35]

53. Although PJM raised the cost of debt slightly, and adopted a 6 percent cost of debt, PJM's value is similarly problematic and inconsistent with its own justification:

[34] Capital IQ, as of August 22, 2018.

[35] A number of adjustments that Brattle had made to its original analysis became moving targets during discussions regarding the flaws in the Brattle methodology. The use of an adder to reflect rising interest rates is one example of an adjustment that was required to meet Brattle's flawed methodological outcome, but then was dropped when lower leverage and higher equity rates were introduced even though the original support for the adjustment remained the same.

a. **Rising Interest Rate Environment:** Despite quoting Federal Reserve Bank Chairman Jerome Powell's comments from a September 26, 2018 press conference that indicates an expectation of continuously rising rates, PJM fails to add an increase to reflect those rising rates relying instead on three years of historical data.[36] The recent increase of 70 to 80 basis points on both the B and BB rated companies already makes the assumed debt rate outdated and the discrepancy is only likely to grow as interest rates continue to rise.

b. **Credit Rating of B versus BB:** PJM acknowledges that a credit rating of B to BB represents a "reasonable representation of the credit ratings of entities that may finance new plants."[37] Yet, PJM does not reflect the cost of debt for a B-rated company, which currently is averaging a 7.35 percent debt rate for a tenor well below a long-term financing approach.[38]

c. **Short Tenor/Inconsistent Leverage:** By relying on the Federal Reserve compilation of loans with all tenors, PJM implicitly is assuming a 5- to 10-year loan. The short tenor implicit in PJM's assumption does not reflect the longer-lived aspect of a peaker plant in PJM and/or the longer-term loans or refinancing over the life of the asset.

54. To be consistent, PJM either needs to increase its debt rate to reflect a longer tenor or decrease the assumed leverage to reflect a loan pay-back within the first ten years.

55. Correcting for these considerations and reflecting the forward curve for a BB-rated company as of the August 21 Supplement date, plus an adder in consideration of B-rated projects, increasing rates that already have occurred and are stated by the Federal Reserve to continue, an appropriate cost of debt would be at least 7.5 percent.

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[36] The rising interest rate environment was reiterated at the November Federal Reserve meeting where expectation of a fourth interest rate increase in 2018 was confirmed and the Federal Reserve warned of additional interest rate increases in 2019.

Craig Torres, Forbes, "Fed Holds Rates Unchanged Ahead of Expected December Hike," November 8 2018, https://www.forbes.com/sites/jjkinahan/2018/11/08/fed-leaves-rates-unchanged-for-now-but-market-sees-another-rate-hike-next-month/#2157686a77f1

[37] Affidavit of M. Gary Helm, paragraph 9, p. 3.

[38] In reality, a merchant plant would be more likely to be financed with a floating rate plus swaps that fix a large portion of the rate. Assuming capital markets are operating efficiently, the net effect should be similar to a corporate bond yield for an equivalent tenor to the swaps.

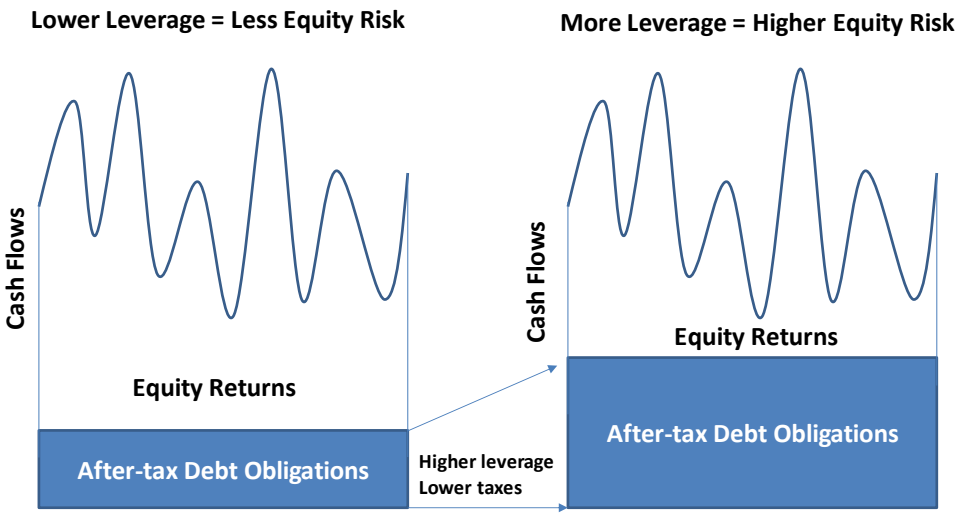
D. PJM's proposed cost of equity is lower than prior FERC decisions

56. As already noted, there are a number of reasons why the base companies on which Brattle bases the ATWACC are inappropriate. This becomes especially clear when the implied asset beta is compared to prior and recent FERC decisions.

57. The asset beta reflects the risk of the underlying asset. It also is called an unlevered beta as it reflects the required return on equity without any debt. Unlike levered betas which include risk associated with how much debt has priority over the equity, asset betas are a pure measure of the underlying risk of the investment and can be compared across assets without adjusting for leverage.

58. The asset beta is distinct from the levered beta because the risk to equity increases as more leverage is placed on a company or asset (**Figure 8**).

Figure 8: Illustration of How Higher Leverage Increases Risk to Equity[39]



59. Higher risk associated with higher debt levels requires a higher return to equity. Therefore, any market measure of required return on equity will reflect the actual leverage of the comparable companies. Unless the asset of interest is assumed to have the same leverage as the base companies, an adjustment is required to reflect the leverage and the associated required return on equity consistent with that leverage.

60. It is fairly easy to calculate the asset beta implied by PJM and Brattle's assumed cost of equity using the delevering formula in **Figure 9**:

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[39] Energyzt illustration. The risk is represented by the variability around expected returns. In the case of lower leverage, actual returns would rarely fall below expected returns to equity due to the "cushion" between debt and equity returns created by the lower leverage. In the case of higher leverage, there is more volatility around expected equity returns, increasing risk and therefore the required cost of equity.

Figure 9: Standard Delevering Formula[40]

$$\text{Unlevered Beta} = \text{Levered Beta} / (1 + ((1 - \text{Tax Rate}) \times (\text{Debt/Equity})))$$

$$\text{Levered Beta} = \text{Unlevered Beta} \times (1 + ((1 - \text{Tax Rate}) \times (\text{Debt/Equity})))$$

61. The first step is to determine the PJM/Brattle levered beta. Assuming the Brattle risk-free rate of 3.5 percent and Brattle's assumed market risk premium of 6.9 percent, a required return on equity of 13 percent equates to a levered beta of 1.38.

62. Applying the unlevered beta formula, the PJM/Brattle assumed debt leverage of 55 percent and tax rate of 27.15 percent, a levered beta of 1.38 equates to an asset beta of 0.73.

63. Stripping away the leverage indicates that the proposed ATWACC actually assumes a lower risk for a merchant generating asset in PJM today than what was assumed previously for PJM and ISO-NE Net CONE proceedings. Instead of the implied asset beta of around 0.85, the PJM and Brattle proposals incorporate an asset beta of 0.73 and arrive at an ATWACC of 8.0 to 8.2 percent (**Figure 10**). In contrast, the Energyzt recommendation adopts the same asset beta that previously was approved in FERC decisions and arrives at an ATWACC of 9.8 percent assuming a risk-free rate of 4.0 percent to reflect rising rates.

Figure 10: Implied Equity Rates in Previous Net CONE Approvals by FERC

Capital Structure	PJM (2013)	ISO-NE (2017)	Energyzt Recommendation	PJM Proposal	Brattle Proposal
Return on Equity	13.80%	13.40%	15.00%	13.00%	13.00%
Cost of Debt	7.00%	7.75%	7.50%	6.00%	5.50%
Capital Structure					
Debt Weight	60%	60%	55%	55%	55%
Equity Weight	40%	40%	45%	45%	45%
Assumed Tax Rate	40.50%	40.20%	27.15%	27.15%	27.15%
Assumed Risk-free Rate	3.40%	2.24%	4.00%	3.50%	3.50%
Assumed Market risk Premium	6.50%	7.00%	6.90%	6.90%	6.90%
Implied Levered Beta	1.60	1.59	1.59	1.38	1.38
Implied Asset Beta	0.85	0.84	0.84	0.73	0.73
WACC	9.7%	10.0%	10.9%	9.2%	8.9%
ATWACC	8.0%	8.1%	9.8%	8.2%	8.0%

64. There is no basis for assuming that the risk of a merchant generating asset in PJM has decreased. Neither Brattle nor PJM provides any justification for or explanation on why the riskiness of a merchant peaker plant in PJM has declined since the last review. If

[40] Ibanking, http://www.ibankingfaq.com/interviewing-technical-questions/discounted-cash-flow-analysis/what-are-the-formulas-for-unlevering-and-levering-beta/

anything, there are a number of reasons why risks have increased, including state policies, market rule changes and proposed intervention in competitive markets to support specific technologies.

65. Incorporating a consistent asset beta along with market debt rates, an adder for rising interest rates, and Brattle's other CAPM assumptions results in an ATWACC of 9.8 percent. It would make sense that the ATWACC should increase by around 180 basis points compared to the FERC-approved rate in the prior PJM Net CONE proceedings given the rising interest rate and risk environment along with the lower tax rate which increases the after-tax cost of debt and implied leverage on the asset.

66. In fact, the PJM/Brattle cost of equity is more reflective of the risk of a regulated utility, illustrated by FERC's recent decision regarding just and reasonable rates for regulated transmission companies in New England.[41]

a. In its decision dated October 16, 2018, FERC established a reasonable rate of return on equity for those regulated transmission companies of 10.41 percent capped at 13.08 percent (p. 37, paragraph 59).

b. The fact that PJM's proposed return on equity of 13 percent for a merchant generator in PJM is below the high end of the range for a regulated transmission company is indicative of a problematic assumption given the lower leverage for the New England Transmission Owners ("NETO") and relative risk profiles in which a regulated company should be less risky than a merchant generator. As Brattle notes:

> Nor do we include electric utilities in cost-of-service regulated businesses, as their businesses are mostly cost-of-service regulated with lower risks and a lower cost of capital than merchant generation.[42]

c. Although the FERC values are based on a compilation of multiple approaches that includes expected earnings, discounted cash flow ("DCF") and CAPM, implicit in the just and reasonable return on equity is an asset beta for regulated transmission assets ranging from 0.63 to 0.87 assuming a 45 percent leverage structure and 0.67 to 0.93 assuming NETO's 40 percent leverage (**Figure 11**).

d. The PJM/Brattle proposed cost of equity falls squarely in the middle of these ranges, wrongly attributing the same risk as a regulated transmission company to a merchant generator peaker plant and is indicative of an underestimated level of risk and a cost of equity that is too low.

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[41] 165 FERC ¶ 61,030 United States of America Federal Energy Regulatory Commission, Before Commissioners: Kevin J. McIntyre, Chairman; Cheryl A. LaFleur, and Neil Chatterjee, Docket Nos. EL11-66-001, EL11-66-004, EL11-66-005, EL13-33-000, EL13-33-002, EL14-86-000, EL16-64-000, EL16-64-002), October 16, 2018.

[42] Brattle Group, 2018 Net CONE, Exhibit 2 to Affidavit of Newell, et. al., Footnote 70, p. 38.

Figure 11: Implied Asset Beta in Recent FERC Decision for Regulated Transmission[43]

Capital Structure	PJM/Brattle Proposal	Proxy Group Leverage		NETO Leverage	
		FERC NETO Mid-Range	FERC NETO Cap	FERC NETO Mid-Range	FERC NETO Cap
Return on Equity	13.00%	10.41%	13.08%	10.41%	13.08%
Cost of Debt	6.00%	6.00%	6.00%	6.00%	6.00%
Capital Structure					
Debt Weight	55%	45%	45%	40%	40%
Equity Weight	45%	55%	55%	60%	60%
Assumed Tax Rate	27.15%	27.15%	27.15%	27.15%	27.15%
Assumed Risk-free Rate	3.50%	3.50%	3.50%	3.50%	3.50%
Assumed Market risk Premium	6.90%	6.90%	6.90%	6.90%	6.90%
Implied Levered Beta	1.38	1.00	1.39	1.00	1.39
Implied Asset Beta	0.73	0.63	0.87	0.67	0.93

67. FERC's recent decision is based on historical capital market conditions and will be applied to historical periods in response to different filings. The decision, however, establishes a base return on equity for the NETO companies in general as of the date of the filing in October 2018 and therefore should be comparable to the proposed return on equity submitted by PJM and Brattle.

68. Therefore, implicit in PJM's proposed cost of equity is an underlying asset risk equal to that of a regulated transmission company.[44] Given that a merchant generator has a higher risk profile than a regulated transmission owner, PJM's cost of equity is too low.

E. An appropriate ATWACC is at least 9.8 percent

69. The internal inconsistency in PJM's ATWACC compared to market rates, implied asset betas in prior FERC decisions and general risk comparisons with contracted assets and regulated utilities confirms the inappropriately low level of the proposed ATWACC.

70. Although a market-based debt rate is readily available, there are no publicly-traded examples of a single peaking plant asset company that would allow for a measured estimate of what an appropriate asset beta for a merchant peaking plant in PJM requires.

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[43] 165 FERC ¶ 61,030 United States of America Federal Energy Regulatory Commission, ¶ 59. Although these values for the required return on equity are preliminary, and subject to further review and modification, they are indicative of FERC's preliminary assessment of underlying risk of the NETO companies, and therefore comparable at this time to the underlying risk assessment for merchant plants submitted by PJM.

[44] These results should not be surprising given that Brattle's recommended ATWACC was based on companies with contracted generating assets.

71. Given financial distress in the industry, the prevalence of non-systematic risk, and the heavier weighting of contracted assets in the independent power producer portfolios, the traditional companies that once were considered comparable with portfolios that included merchant plants no longer can be used to estimate an appropriate cost of equity for a merchant generator. Transactions surrounding these companies are similarly inappropriate.

72. In the absence of any market comps, FERC's prior decisions on Net CONE for PJM and New England incorporate an implied asset beta of around 0.85, which is similar to the asset beta implied in the maximum cap established by FERC as being just and reasonable for a regulated transmission owner. This asset beta should serve as a minimum starting point for calculating an appropriate cost of equity for a merchant generator in PJM.

73. Incorporating the same PJM Net CONE asset beta into a calculation of a levered cost of equity and assuming Brattle's 55 percent debt ratio generates a required return on equity of 15 percent – a rate that would be consistent with prior FERC decisions regarding the risk of a merchant generator in previous net CONE proceedings as well as the higher end of the range for a regulated utility adjusted for the PJM/Brattle higher leverage assumption.

74. However, an argument can be made that a merchant peaker plant in today's uncertain market would require a premium above the high end of the range for cost of equity previously awarded by FERC in prior Net CONE proceedings. The required return on equity for a merchant peaking plant also should reflect a risk that is higher than the upper end of that approved by FERC for a regulated transmission owner. Indeed, the true asset beta could be closer to 1.0 for the following reasons:

    a. **Higher Uncertainty:** There should be no debate that merchant generators are operating in a higher risk environment with greater uncertainty. Market interventions and policy support for specific technologies promise to decrease energy margins. Changes to capacity market rules are squeezing capacity market revenues. Performance penalty programs increases revenue risk.[45] One therefore would expect a higher asset beta than what FERC has approved in prior dockets (i.e., 0.85). In fact, FERC's decisions regarding the higher end of the range for regulated transmission projects issued in October 2018 support this finding, with the cap incorporating a higher implied asset beta for the NETO companies than what was approved for ISO-NE and PJM.

    b. **Premium over Regulated Utilities:** Investors in merchant generation require a premium above the returns for a regulated transmission owner. The mid-point of returns for a merchant generator should be well above the midpoint of returns for a regulated transmission owner and above the maximum return. FERC previously agreed that an adder of 130 basis points above the 6.7 percent mid-

[45] Pay for performance programs have been implemented in both PJM and ISO-NE and include significant penalties if a generator is not available when called upon for capacity.

point of the range for IPPs with contracted assets is reasonable,[46] which equates to a 46.5 percent increase of the asset beta from 0.58 to 0.85, holding all other market conditions and leverage assumptions constant. Adding a similar premium to the mid-point of the implied asset beta for regulated transmission returns recently approved by FERC would support an asset beta of 0.92 to 0.99, a premium above the asset beta for the maximum return on equity for regulated transmission owners of only 6 percent.

c. **Market Risk:** The observed beta of the public overall equity market is 1.0 by definition. The unlevered beta for the S&P 500 market is 0.91 and has ranged between 0.9 and 0.92 for every month since January 2014. In comparison to the overall market, the proxy peaker could be considered an investment with a higher business risk profile, because it is characterized by a small size, has a high percentage of costs that are fixed and therefore a high operating leverage, and is exposed to highly uncertain revenues set one year at a time (i.e., characteristics of a high unlevered asset beta). In this context, an asset beta above the unlevered asset beta of the market could be a more accurate measure of risk.

75. Incorporating the implied asset beta from the NETO cap into Brattle's assumptions with the market debt rate of 7.5 percent results in an ATWACC of 9.7 percent, similar to the Energyzt recommendation. Increasing the asset beta to include a 6 percent premium above the maximum implied asset beta for the regulated transmission companies results in an ATWACC of 10.0 percent to 10.4 percent (**Figure 12**).

76. Furthermore, trends in the industry indicate that the likely investor in a new PJM peaking plant is a private equity investor, supported by the delisting of Talen and Calpine. Such investors generally would have lower leverage and would invest in individual projects using project-financing versus balance sheet funding.[47] The appropriate leverage for a single asset company owning a peaker plant in PJM could be much lower than that of an independent power producer or even a utility. If properly accounted for, the leverage should not impact the ATWACC. However, it would impact the assumed cost of equity.

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[46] 149 FERC ¶ 61,183 United States of America Federal Energy Regulatory Commission, PJM Interconnection, L.L.C. Docket No. ER14-2940-000, ORDER CONDITIONALLY ACCEPTING TARIFF REVISIONS SUBJECT TO COMPLIANCE FILING (Issued November 28, 2014), ¶ 81.

[47] The Internal Market Monitor also assumed that a new project would be built as a stand-alone project, making it more difficult to realize the net operating losses or bonus depreciation that could be realized through balance sheet financing, Joe Bowring and Raymond Pasteris, "IMM CONE CT Study Results," MIC Special Session: Quadrennial Review, June 1, 2018, p. 19.

Figure 12: Implied ATWACC using Market-based Assumptions

Capital Structure	PJM/Brattle Proposal	FERC NETO Cap with Proxy Leverage	FERC NETO Cap with NETO Leverage	ATWACC using NETO Cap and Market Debt Rates and PJM Leverage	ATWACC using Asset Beta = 0.92, Market Debt and PJM Leverage	ATWACC using Asset Beta = 0.99, Market Debt and Market Leverage
Return on Equity	13.00%	13.08%	13.08%	14.90%	15.50%	16.42%
Cost of Debt	6.00%	6.00%	6.00%	7.50%	7.50%	7.50%
Capital Structure						
Debt Weight	55%	45%	40%	55%	55%	55%
Equity Weight	45%	55%	60%	45%	45%	45%
Assumed Tax Rate	27.15%	27.15%	27.15%	27.15%	27.15%	27.15%
Assumed Risk-free Rate	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%
Assumed Market risk Premium	6.90%	6.90%	6.90%	6.90%	6.90%	6.90%
Implied Levered Beta	1.38	1.39	1.39	1.65	1.74	1.87
Implied Asset Beta	0.73	0.87	0.93	0.87	0.92	0.99
WACC	9.2%	9.9%	10.2%	10.8%	11.1%	11.5%
ATWACC	8.3%	9.2%	9.6%	9.7%	10.0%	10.4%

IV. PJM's PROPOSED REFERENCE UNIT CANNOT BE JUSTIFIED

77. PJM's current Tariff defines the Reference Resource as a simple cycle combustion turbine power plant with two General Electric ("GE") Frame 7FA turbines, inlet air cooling, Selective Catalytic Reduction technology and dual fuel capability, with a heat rate of 10.096 mmBtu/MWh.

78. PJM/Brattle propose to establish the reference unit as a Frame HA simple cycle bomustion turbine power plant.

79. Neither PJM or Brattle presents any valid justification for moving away from a dual-unit Frame 7FA reference unit to one using Frame HA technology.

80. The proposed reference unit does not meet FERC criteria for approving a reference unit described in the 2017 ISO-NE decision.[48]

a. **Likelihood of Development:** A Frame HA simple cycle peaker plant has not been developed in PJM and is not likely to be developed in PJM.

b. **Reasonable Cost Estimates:** Cost and revenue estimates cannot be developed with confidence.

c. **Efficient and Needed Entry:** Use of a Frame HA simple cycle unit as a proxy peaker would challenge efficient and needed entry by alternative technologies.

[48] 161 FERC ¶ 61,035 United States of America Federal Energy Regulatory Commission, ISO New England Inc. Docket No. ER17-795-000 ER17-795-002, ORDER ACCEPTING FILING, Issued October 6, 2017, ¶ 38.

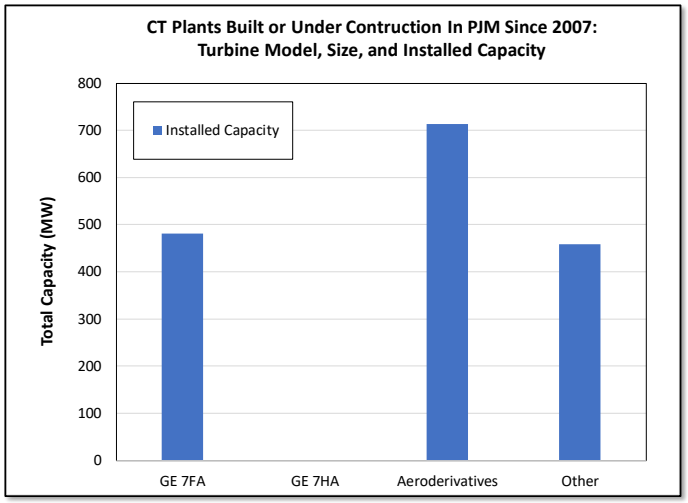
81. Furthermore, use of a Frame H is inconsistent with PJM's philosophy of using a pure capacity plant versus an intermediate generator.

A. A Frame H is not likely to be developed as a peaking plant in PJM

82. A Frame HA simple cycle peaker plant has NOT been developed in PJM and is not likely to be developed in PJM.

83. There is not a single example of a Frame HA simple cycle plant in PJM or in the PJM queue. In contrast, developers are implementing multiple technologies ranging from combined cycle units (Frame F and Frame HA), simple-cycle combustion turbines (Frame F) and aeroderivatives according to the PJM queue (**Figure 13**). Other locations are pursuing reciprocating engines.

Figure 13: New Entry Technologies in PJM and the U.S. Since 2007[49]



Number of CT Plants Built or Under Construction Since 2007: PJM vs US		
Model	**PJM**	**US**
GE 7FA	3	26
GE 7HA	0	2
Aeroderivatives	12	147
Other	8	88
Total	**23**	**263**

84. Brattle acknowledges that the Frame F is the most common peaker unit under development in PJM.[50] PJM identifies only two Frame 7HA-based plants in simple cycle combustion turbine configuration under development – one in New England and one in California.[51]

85. Although the H-class turbines have been installed in combined-cycle configurations, this is a context in which the more efficient heat rate can pay for itself. Whereas baseload or intermediate resources can monetize the value of greater efficiency, a peaking unit receives little benefit from incremental heat rate efficiency.

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[49] Ventyx data for PJM and other markets compared to Brattle Group, 2018 Net CONE, Exhibit 2 to Affidavit of Newell, et. al., Table 8, p. 17.

[50] Brattle Group, 2018 Net CONE, Exhibit 2 to Affidavit of Newell, et al., p. 16.

[51] PJM Filing, p. 17.

86. According to the PJM Internal Market Monitor, an H-frame simple cycle unit would have operated up to 4,089 hours/year in most of PJM – nearly 50 percent of the time.[52] With that many hours of anticipated operation, it would be more economic to simply move to a combined cycle to realize greater heat rate efficiency and higher energy margins for each hour of operation. Perhaps this is one of the reasons why Frame HA technology is only being built as combined cycles in PJM.

87. In fact, there is not a single example of a simple cycle Frame HA unit listed in the PJM queue. A review of the queue in other markets such as ERCOT, MISO and NYISO also provides no indication that a Frame HA is being developed in a simple cycle configuration in those markets (Exhibit TLB-3). Instead, new entrants in those markets include Frame F simple cycle units, reciprocating engines and aeroderivatives[53] – technologies that have higher costs than the estimated cost of a Frame HA calculated by Brattle.[54] Clearly there are other value propositions at play in PJM and these other markets that make a Frame HA simple cycle unit irrelevant.

88. Simply acknowledging the higher efficiency of the Frame HA technology without recognizing the other market value propositions offered by other technologies that are in the PJM queue is not sufficient to justify a transition to the Frame HA.

89. Failing to assess whether an intermediate resource using Frame HA technology would benefit from being in a combined cycle configuration versus a less efficient simple cycle leaves out an important factor that new entrants clearly are considering. PJM and Brattle have simply failed to show that the Frame HA is likely to be developed in PJM in a simple cycle configuration.

B. Cost and revenue estimates cannot be developed with confidence

90. Cost and revenue estimates for a Frame HA turbine in a simple cycle configuration cannot be developed with confidence. The technology is commercially unproven, creating technology risk that developers are reluctant to assume when a traditional Frame F unit is tried and tested.

91. PJM's proposed reference unit is not being built in PJM and has no operating experience. The only two projects that apply a Frame HA technology in a peaking configuration are located outside of PJM and are not yet operational. In addition, both projects are being

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[52] Joe Bowring and Raymond Pasteris, "IMM CONE CT Study Results," MIC Special Session: Quadrennial Review, p. 10. The IMM calculates that the proposed reference unit would have operated 2,278 hours in SWMAAC, 3,387 hours in EMAAC and 3,446 hours in WMAAC.

[53] Brattle Group, 2018 Net CONE, Exhibit 2 to Affidavit of Newell, et. al., Table 8, p. 17.

[54] See Net CONE for alternative technologies calculated by Concentric Energy Advisors as part of the ISO-NE Net CONE proceeding filed in 2017, Concentric Energy Advisors report, "ISO-NE CONE and ORTP Analysis: An evaluation of entry cost parameters to be used in the Forward Capacity Auction to be held in February 2018 ("FCA-12") and forward, January 13, 2017.

built on an existing site, making them brownfield developments with a different set of cost factors than a greenfield project.[55]

92. With only two projects being built in the United States and none in operation, the Frame HA does not have an adequate history of operational experience to understand how it performs as a peaking unit.

93. Furthermore, there is no experience in how Frame HA technology ramps and operates at partial load.

94. Since FERC approved a Frame HA simple cycle as the reference unit for ISO-NE, Frame HA combined cycle plants in service have shown serious technical problems requiring recalls and other remedies, making it difficult to truly know the potential costs associated with the Frame H technology. First introduced as an industry leading H-class turbine in 2014, Frame H installations have since experienced a number of problems with the turbines.

95. At a recent inaugural GE 7HA Users Conference held in Fort Worth, TX on September 12 and 13, 2018, participating owner and operators of more than 30 turbines from over a dozen facilities and five countries, met to discuss their experience with the product as well as the issues that they have endured (Exhibit TLB-4).[56]

a. **Oxidation of Blades:** The biggest problem has been an oxidation issue with the turbine blades which resulted in Exelon's Colorado Bend plant being temporarily shut down. Upon further investigation, GE acknowledged that this was a fleet-wide issue and that could affect all machines shipped to date. While GE claims to have found the root of the problem, JP Morgan's key analyst of GE, Stephen Tusa, believes it may take years for them to fix.[57]

b. **Delays in Operations:** The blade issue also has been causing delays in delivery with some operators reportedly pushing back commercial operating dates, while others claim the 9-10-month delay on spare parts has led them to borrowing blades from other plants.

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[55] **Canal 3** is a brownfield development project located in Sandwich, MA, with a capacity of 333 MW projected to be operational in 2019, http://canalnewgeneration.com/wp-content/uploads/2016/05/nrg-canal-fact-sheet.pdf

Puente Power Project located in Oxnard, California is replacing two aging gas-fired steam units at the existing Mandalay Generating Station, with a capacity of 271 MW projected to be operational in 2020, https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=15-AFC-01

[56] CCJOnsite Combined Cycle Journal, "Summary Report of the 7HA User's Conference," October 8, 2018. http://www.ccj-online.com/7ha-users-wrestle-with-emergent-issues-at-inaugural-meeting/

In addition to the larger items mentioned, users generated a list of at least 11 more issues from water intrusion, to air-filter cleaning systems and various types of leaks were discussed as well as control system complexity.

[57] J.P. Morgan Analyst Report, "General Electric Co. (GE US) 'Voice of the Customer': Turbine Users Feedback Suggests Depth of Technology Issues Worse Than Initially Thought," October 10, 2018, "These are engineering feats that need to be validated, typically taking time measured in years not months . . ."

c. **Failure of the Axial Fuel Staging (AFS) Component:** Aside from issues with oxidation, operators have found damage to the machines due to failure of the AFS component. One plant in particular found the failure of the AFS to not only cause internal damage to the combustion system, but it also impacted the turbine compartment, triggering the fire protection system and tripping the unit. Of the 48 components associated with the AFS, 40 had to be replaced. The root of the AFS tube failure is still unknown.

d. **Excessive Vibration:** Excessive vibrations were another problem some operators discovered to be associated with cold-start and start-to-start operations (which is particularly problematic for a plant performing peaker operations with more than 200 starts per year). Excessive vibration also can lead to secondary issues such as oil leaks, terminal strips coming lose, and failures with exhaust attachments. This was reported as a fleet-wide issue.

96. The GE 7HA users conference reiterates the point that the Frame HA technology is still new and faces various hurdles before it will be fully integrated into the market. As the Combined Cycle Journal noted: "Obviously, it is early days for the technology with respect to commercial operations."[58]

97. Uncertainty surrounding costs associated with the Frame HA is compounded when applied to a simple cycle configuration. According to conversations with industry participants,[59] the Frame HA technology suffers from lack of commercial experience in ramping and availability, decreased efficiency with partial loads, unproven flexibility, uncertainty surrounding how often the technology can cycle during the day, and a concern that the larger generation capacity may be difficult to employ fully as a peaker, making it more costly than a Frame F for this type of service. It is still early to adopt the Frame 7HA as a reference unit for a peaker plant in PJM, especially as other turbine models have proven themselves in the marketplace as reliable, efficient, and cost-effective units.

98. Although GE is addressing its techology issues through recalls and warranties, there are additional costs that are not covered, including development delays, operational shut-down, operating and maintenance, and other actual and lost opportunity costs. Furthermore, there is concern in the industry that GE may not be in a secure financial position given its stock price decline and recent downgrade to a below investment grade credit rating.[60] As the Wall Street Journal summarized:

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58 CCJOnsite Combined Cycle Journal, "Summary Report of the 7HA User's Conference," October 8, 2018, p. 1.

59 As part of the work performed by Energyzt for the P3 Group, we engaged in a survey of nearly 20 industry participants including generation developers, research organizations and lenders. A subset of these comments are reported in Exhibit No. TLB-3.

60 This concern is raised in the J.P. Morgan analyst report, "General Electric Co., Another Shoe Drops: H Frame Blade Failure Risks Franchise Impairment; Lowering PT," September 20, 2018.

> GE had a sterling triple-A credit rating as recently as 2015. This month, investors have pummeled its bond prices into junk territory. Once a giant issuer of ultrasafe commercial paper, it now relies on $41 billion in revolving credit lines from more than 30 banks — the corporate finance equivalent of a wallet stuffed with credit cards.[61]

99. With no operating experience of the Frame HA turbines in a peaking configuration, numerous technical challenges to the Frame HA turbines in a combined cycle configuration, and the financial decline of the primary company supplying those turbines and backing the warranties, there is sufficient uncertainty around the true costs of PJM's proposed reference unit technology that it should be rejected and the existing reference unit using commercially mature Frame F turbines be maintained.

C. A Frame H does not allow for efficient and needed entry

100. The reference unit does not allow for efficient and needed entry.

101. Size is no longer the driving factor for new developments. Flexibility, modularity and smaller sizes are more attractive in PJM and in markets ahead of PJM with respect to integration of renewables.

102. Use of a Frame HA Net CONE as the reference unit across the entire PJM market could prevent new entry by needed units that offer flexibility within constrained zones.

a. Use of a Frame HA proxy design could block out a Frame F choice on the margin.

b. More flexible technologies such as aeroderivatives and reciprocating engines that have proven valuable in other markets as well as PJM also could be blocked out, even in constrained areas where they are most needed, due the lower price cap set by the lower Net CONE.

103. Experience in other markets indicates a move towards smaller unit size and modularity to better address market uncertainty. Smaller units may have a higher cost per unit of installed capacity, but lower costs overall. In a changing market environment where operational flexibility and efficient capital deployment is critical to investors, choosing a reference unit that is focused on efficient *and needed* capacity is more important than a single focus on heat rate efficiency which does not have much value in peaking units.

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[61] Matt Wirz, "Steep fall in General Electric's bonds to junk levels is roiling markets," Wall Street Journal, November 16, 2018, https://www.business-standard.com/article/international/steep-fall-in-general-electric-s-bonds-to-junk-levels-is-roiling-markets-118111600022_1.html

104. To this end, maintaining the Frame F as the reference unit allows for more capital efficient and needed entry by smaller, more flexible units.[62]

D. The proposed reference unit is inconsistent with PJM philosophy

105. The Frame F peaking unit participates less frequently in the energy market compared to a Frame HA, making the Frame F a more ideal reference unit. As Mr. Keech states in his affidavit:

> CC Net Cone, therefore, *might* be reasonable, but it carries greater reliability risk, and that risk arises from the very feature of a CC Net CONE that is most vulnerable, i.e., the inherent uncertainty of a Net CONE calculation that relies to a much greater degree on estimates of energy market revenues.[63]

106. PJM's desirable proxy unit would be more immune from volatility associated with energy market prices and ancillary services. The Frame HA peaking configuration does not meet this criteria given that it would be an intermediate unit operating around 4,000 hours per year per the Internal Market Monitor -- certainly not a peaking plant that is immune to energy and ancillary services revenue.[64] Adoption of a Frame H – a technology that would operate more as an intermediate unit – thus violates PJM's philosophy surrounding the appropriate reference unit for setting Net CONE and introduces volatility into the calculation due to the energy and ancillary services offset.

107. Both ISO-NE and NYISO have adopted combustion turbines as their reference unit.

a. NYISO adopted the Frame FA simple cycle as its reference unit.

b. In ISO-NE, where some of the most efficient combined cycle units operate less than 40 percent of the time and the Canal 3 project cleared the market with a Frame HA simple cycle configuration, Frame HA technology was adopted, albeit before lack of industry acceptance became apparent.

108. Therefore, the industry trend of moving towards combustion turbines for its reference unit as well as PJM's own desire to adopt a technology that does not rely extensively on energy revenues supports maintaining the Frame FA dual-unit simple cycle configuration as the reference unit in PJM as opposed to the Frame HA simple cycle configuration that would operate as an intermediate unit.

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[62] All technologies would have to compete. However, allowing for a higher starting price enables more expensive technologies to bid into the RPM auctions.

[63] Affidavit of Adam J. Keech on Behalf of PJM Interconnection, L.L.C., Regarding Periodic Review of Variable Resource Requirement Curve Shape and Key Parameters, Docket No. ER19-105-000, ¶ 13.

[64] Joe Bowring and Raymond Pasteris, "IMM CONE CT Study Results," MIC Special Session: Quadrennial Review, p. 10. The IMM calculates that the proposed reference unit would have operated 2,278 hours in SWMAAC, 3,387 hours in EMAAC and 3,446 hours in WMAAC.

E. The reference unit should remain a Frame F CT

109. The market has not adopted the use of the Frame HA as a peaking unit. Incremental costs associated with greater heat rate efficiency is not valued in a unit that is built to provide capacity. Lack of operating experience as a peaking unit, along with recently disclosed technology issues, questions about performance, and uncertain operating costs, makes it difficult to estimate the true costs of a Frame HA. In addition, the relatively large size of the Frame H class makes it less modular and less flexible than other options, potentially preventing different technologies (e.g., Frame F, Aeroderivatives and Reciprocating Engines) that have proven to be valuable in PJM and other markets from being built. The intermediate resource nature of the Frame HA makes it riskier than a Frame F turbine.

110. In contrast, the Frame F turbines – the technology previously adopted by PJM for the reference unit – are operational in PJM.

111. In order to stay consistent to PJM philosophy and meet the FERC tests for approval, PJM should continue to use a Frame F simple cycle as the reference unit.

V. CONCLUSION

112. PJM's proposed cost of capital for a merchant generator in PJM is inconsistent with market debt rates, relies on companies that are not comparable to a merchant generator due to contracted assets and company-specific financial distress due to high leverage, and is inconsistent with recent FERC decisions regarding the implied asset betas for PJM, ISO-NE and regulated transmission companies. An appropriate ATWACC should be at least 9.8 percent.

113. PJM's proposal to adopt a Frame 7HA turbine in a simple cycle peaking unit configuration should be rejected as it does not meet any of FERC's stated requirements for a reference unit and is inconsistent with PJM's stated goals of minimizing the volatility of Net CONE associated with energy revenues. Frame HA technology is not being built and is not likely to be built in PJM (or elsewhere per the queues) in a simple cycle configuration, the technology is suffering from a number of operational and technical issues which make it difficult to estimate the true costs, and the lower cost/higher efficiency of the Frame HA would hinder the entry of more flexible and modular technologies in parts of PJM that require alternative value propositions to maintain system reliability.

114. This concludes my affidavit.

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

PJM Interconnection, L.L.C.) **Docket No. ER19-105-000**

AFFIDAVIT

I, Tanya L. Bodell, do hereby swear and affirm under penalty of law that she is the Tanya L. Bodell referred to in the "Affidavit of Tanya L. Bodell" and that the statements in the foregoing were prepared by her or under her direction, that she has read such testimony and is familiar with the contents thereof, and that the facts set forth therein are true and correct to the best of her knowledge, information and belief in this proceeding.

Executed this 19th day of November 2018,

Tanya L Bodell
Tanya L. Bodell

SUBSCRIBED AND SWORN
Before me this 19th day of November, 2018

Notary Public
My commission expires See Attached Certificate

California Jurat Certificate

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

State of California

County of Orange } S.S.

Subscribed and sworn to (or affirmed) before me on this 19th day of November (Month),

20 18, by Tanya L. Bodell (Name(s) of Signer(s)) and

_____ (Name of Signer (2)), proved to me on the basis of

satisfactory evidence to be the person(s) who appeared before me.

_____ (Signature of Notary Public)

M. R. DOHERTY
Notary Public - California
Orange County
Commission # 2242696
My Comm. Expires May 14, 2022

(Seal)

For other required information (Notary Name, Commission No. etc.):

OPTIONAL INFORMATION

Although the information in this section is not required by law, it could prevent fraudulent removal and reattachment of this jurat to an unauthorized document and may prove useful to persons relying on the attached document.

Description of Attached Document

The certificate is attached to a document titled/for the purpose of

USA before the Federal Energy Regulatory Commission (Affidavit)

containing 1 pages, and dated 11-19-18

Additional Information

Method of Affiant Identification

Proved to me on the basis of satisfactory evidence:
○ form(s) of identification ○ credible witness(es)

Notarial event is detailed in notary journal on:

Page # _____ Entry # _____

Notary contact: _____

Other

☐ Affiant(s) Thumbprint(s) ☐ Describe: _____

Exhibit No. 1

Tanya L. Bodell
Qualifications

TANYA L. BODELL

Executive Director

Tanya.Bodell@ energyzt.com

Tanya Bodell is the Executive Director of Energyzt, a global collaboration of energy experts who create value for clients through actionable insights. She is based in Boston, Massachusetts. For more than 25 years, Ms. Bodell has provided business advisory and expert support to clients in the energy industry, advising them on asset valuation, investment strategy, mergers/acquisitions, restructuring, regulatory outreach and market analysis. She also provides expert support in large regulatory and litigation cases pertaining to the energy industry, including expert testimony to the Federal Energy Regulatory Commission (FERC), state public utility commissions, arbitration panels, and courts of law on ratemaking, assessment and valuation of benefits, damages claimed for breach of contract, fraudulent misrepresentation, market manipulation, contingent liability, and restructuring/insolvency issues.

ADVISORY SERVICES

Ms. Bodell interacts directly with investors and senior management of energy companies, adding value through business advice, transaction support and regulatory strategy. Selected services and assignments include the following:

Market Assessments and Electricity Market Design and Implementation

- Regularly performs market assessments of wholesale energy and capacity markets for market participants, including assessment of the impact of alternative market rules and regulations.
- Develops and directs analyses of market conditions using locational marginal pricing market models and industry data.
- Advises on policy recommendations concerning market design and implementation.
- Authors white papers and provides expert testimony regarding research and findings.
- Expert testimony submitted before FERC, the Connecticut Siting Council and Public Utilities Regulatory Authority, Maine Public Utilities Commission, Massachusetts Department of Public Utilities, New Jersey Legislature and California Little Hoover Commission on electricity market rules, design issues and public policy implications on market operations.
- Key advisor to market restructurings worldwide, including the Singapore Public Utilities Board (subsequently Energy Markets Authority) on developing a competitive wholesale and retail electricity market, including market rules, licenses and codes (2000-2004) as well as advisor and project manager to the Ontario Market Design Committee, Ontario Energy Board, Ministry of Energy, Science and Technology and market participants on competitive market design, regulatory structure, environmental policy and risk management (1998 - 2001).

Case Study: For a bank focused on project financing generation assets in the United States, performed a market analysis of the major markets in the United States, including NEISO, PJM, NYISO, MISO, ERCOT and CAISO. The lender incorporated the status of the markets in their assessment of risk associated with their portfolio of generation assets in each market.

Asset Valuation and Acquisition Strategy

Regularly called upon to provide independent asset valuations and acquisition strategy for investors in the electricity industry.

- Performs asset valuation for electric generation, transmission, distribution, natural gas companies and LNG facilities.
- For developers and asset owners of generation, performs benefits study of the plant's impact on environmental emissions and energy prices in the region.
- Serves as an independent appraiser for valuation, transaction support, and disputes, including appraisals of traditional power generation assets, cogeneration facilities, and renewable power portfolios, as well as equity investments tied to shareholder agreement processes.
- For new entrants and emerging players, values enterprises, power assets, power purchase agreements, tolling arrangements, and trade books.
- Provides utilities and independent power producers with due diligence and advice relating to power purchase agreements, contract renegotiations, merchant plant investment opportunities and valuation of non-utility generation assets.
- Develops strategy for expansion into new businesses, technologies, and market segments, including advice on the regulatory structures, government support, and entry strategies for investments in commercial transmission, energy storage solutions, and renewable resources.
- Advises international clients on new entrant strategy for commercial energy investments in the US, including assessment of specific acquisition targets.

Case Study: For an international investor looking to acquire a natural gas and power distribution company in Connecticut, Ms. Bodell provided asset valuation and risk analysis of the targeted company. Her analysis identified critical regulatory challenges that would mitigate potential upside from the acquisition and identified key risks that the new owner would face if the deal were to proceed.

Transmission

Provides new entrant strategy and transaction support for investments in US commercial transmission, advising transmission developers on potential markets, customer acquisition, regulatory strategy and financing options.

- For a large rail company, advised on potential use of existing rights of way for development of transmission lines, including advice on specific transmission opportunities, identification of strategic regions and potential partners.
- For a multi-billion utility, advised on their commercial transmission strategy and development opportunities.
- For a multi-billion dollar oil and gas pipeline company interested in expanding their energy transportation portfolio into electric transmission, provided new entry strategy and successfully

presented to the Board, launching the firm's initiative to develop a commercial transmission business in North America.

- For a large southern utility interested in pursuing a commercial transmission business, provided strategic advice on regions, strategic partners and target projects, including bidding strategy on acquisition of an operational transmission line.
- For the triennial rate review of a transmission upgrade in California, submitted expert testimony on the benefits of the transmission upgrade.
- For a transmission line under development in the southwest, assessed the size and potential markets for transmission service.
- For large utilities interested in developing a commercial transmission business, advised on entry strategy, potential acquisitions, and performed due diligence on specific acquisition targets.
- On behalf of an independent transmission company, assessed transmission asset acquisitions valued at over a billion dollars.
- Advised generation owner on regulatory strategy to create independent transmission company for purposes of developing high voltage interconnection (1,000 MW of capacity).

Case Study: For an independent transmission company looking to grow through acquisition, Ms. Bodell identified potential targets that met the firm's risk-return profile. She subsequently valued the acquisition targets under multiple scenarios which provided the basis for negotiations by the acquiring company.

Renewable Resources

- Assesses value of wind farms and renewable generation assets as merchant and contracted facilities, and incorporates the impact of such assets into market dynamics.
- Possesses deep understanding of environmental attribute markets and regulations, including production tax credit, investment tax credit, net metering credits, RPS requirements. design and implementation of generation information system tracking systems and markets for renewable energy credits.
- Served as key litigation strategist for a client defending against a nearly $1 billion damages claim related to alleged breach of wind turbine supply agreements. Responsible for managing the entire project, including two testifying experts, overseeing research on markets turbine and nacelle prices, availability, market conditions, discovery and damages.
- Served on the Alternative Energy Committee in Cohasset, Massachusetts, responsible for developing solar energy arrays on the school roofs and landfills.
- Advised the Ontario Ministry of Science and Technology on policy to promote green power and renewable resource development.

Case Study: For a commercial company located in Massachusetts, Ms. Bodell analyzed the costs, benefits and risks of pursuing installation of solar energy arrays under the state and federal regulatory regime, assisting the owner with soliciting potential developers.

Competitive Procurement

- Designs and manages competitive procurement processes, including review of power procurement agreement, credit requirements, request for proposal process, and auction.
- Designs and manages transmission open season and bilateral negotiations for transmission capacity.
- Assesses long-term and short-term gas contracts in the context of hedging plays against other energy contracts, including tolling agreements and long-term power purchase agreements.

Case Study: For a large provider of default supply service in the Midwest, Ms. Bodell managed the competitive procurement process for $1.7 billion of energy required to meet the firm's obligations.

Tradebook / Risk Management

- Develops summary synopses on mark-to-market accounting and the marketable value of trade books and examines trader activities for market manipulation and non-compliance with regulatory requirements.
- Analyzes tradebook entries, energy contracts, and hundreds of legal documents to rebook off-balance sheet transactions into the financial statements of a bankrupt energy market's estate.

Case Study: For a large, publicly-traded energy marketer, Ms. Bodell reviewed tradebook for wash trades and market manipulation, revalued tradebook and assessed controls on trading operations before and after conveyance.

Corporate Restructuring

Advises all aspects of the capital structure on valuation of power generation assets and securitization options in high-profile restructurings in the electricity industry.

- For the ad hoc equity committee of a large renewable developer, provided valuation insight into the remaining assets and advice on potential strategies to pursue to obtain standing as an official equity committee.
- For investors in a large Texas utility with a significant competitive generation portfolio, provided pre-bankruptcy filing advice regarding generation asset valuation and impacts of proposed market changes pertaining to Interim Solution B+.
- For the unsecured creditors committee of a bankrupt portfolio of coal plants located in New York, provided industry expertise, valuation, market assessments, and settlement advice.
- For the unsecured creditors committee of a bankrupt coal plant located in New England, provided industry expertise, valuation, power contract assessment, damages calculations, market assessments, and settlement advice.
- For the bondholders of a waste coal facility undergoing restructuring in Pennsylvania, provided project valuation, assessed project cash flows and debt capacity, interfaced with the company's financial advisor, and advised on changing market conditions.

- For the Enron estate, analyzed insolvency analyses under the three legal tests: balance sheet, cash flow and capital adequacy. Analyses included assessing the tradebook for purposes of identifying debt-like transactions and performing cash flow projections of debt repayment and capital requirements. Analyzed tradebook entries, energy contracts, and hundreds of legal documents to rebook more than $3.5 billion of off-balance sheet transactions for purposes of understanding when the company was insolvent. Provided project management for the insolvency team over a two-year period. Settlement with various parties totaled more than $6 billion.

LITIGATION/REGULATION

Ms. Bodell has significant experience in high-stakes litigation in which hundreds of millions of dollars are at risk. She has played a key role in cases arbitrated, mediated, litigated, and heard before regulatory agencies, providing litigation support including assessment of business damages and lost profits, market context, expert testimony, economic arguments in legal filings, and settlements. From 2008 to 2011, she served a three-year term as Vice Chair of Standing Committee for the International Centre for Expertise at the International Chamber of Commerce. Below are selected examples of cases in which she has provided expert support.

Contract Dispute

- For various industry clients, reviewed more than three dozen power purchase agreements to advise on contract renegotiations, merchant plant investment opportunities and valuation of non-utility generation acquisitions.
- For a waste coal facility in Pennsylvania, served as the independent appraiser of the facility to assess the fair market sales value under the remainder of the power purchase agreement and as a merchant plant.
- For a coal plant in Connecticut undergoing contractual restructuring, assessed the value of the facility under the existing power purchase agreement, a proposed tolling agreement, and as a merchant facility.
- For the counterparty to a long-term power purchase agreement with the California Department of Water and Power, reviewed publicly-available contracts and settlements to advise on potential contract restructuring positions.
- For a potential purchaser of a cogeneration project in Oklahoma, performed a market study to assess the regulatory regime and other aspects of the market that could affect the value of the investment, including future gas and electricity price projections.
- For an owner of a cogeneration project in Michigan, analyzed a proposed back-to-back transaction involving the power purchaser and a third party to determine whether the proposed agreement posed additional risks for the project. The analysis included review of the purchaser's stranded cost calculations and regulatory filings, as well as a detailed assessment of the two contracts and associated project documents.

- For a Maryland utility, calculated stranded costs associated with its power purchase agreement and determined potential settlement negotiation positions and strategies that the utility could take with respect to buying down the contract.
- For a Texas cooperative in a power purchase agreement with a cogeneration project, analyzed potential renegotiation positions, including the potential for a buy-out and buy-down of power prices.
- In a dispute over interpretation of the terms of a cogeneration contract in Florida, supported expert testimony on the application of the Public Utility Regulatory Policy Act (PURPA) to the contract. The analysis included a survey of all publicly available non-utility generation project contracts.

Damages

- For a transmission owner being sued for failure to operate in accordance with standard utility practice, critiqued the plaintiff's experts analysis and performed a damages calculation of the opportunity cost of lost sales associated with the transmission line outage.
- In a lawsuit between an electric utility and a cooperative that served multiple load serving entities, assessed the value of the excess energy the utility supplied to the load serving entities due to their breach of the supply contract.
- In a dispute between a large hydroelectric power producer and natural gas independent power producer in the Pacific Northwest over damages exceeding $1 billion, reproduced the independent power project's pro-forma and calculated lost profits to the project under various scenarios including alternative electricity and gas prices and water conditions. Developed the analysis of the required return on equity for highly leveraged non-utility generation projects, including the equity, debt, and financial Betas.
- In a dispute over interpretation of the terms of a power purchase agreement in New Jersey, calculated lost profits under alternative interpretations.
- In a contractual dispute between a U.S. electric utility and qualifying facility in Pennsylvania, analyzed the financial viability of the cogeneration project for a temporary restraining order proceeding, supported the expert testimony of the damages expert and assisted counsel for deposition and cross-examination questions.
- For an electric utility suing contractor for over $55 million over failure to install a fire protection, calculated impact on business due to replacement power costs incurred while the coal plant was down, a key aspect of the damages claim. Coordinated with other experts on related matters including project schedule and appraisal.
- For multiple litigations concerning Westinghouse nuclear steam generator product liability cases in which damages claims exceeded $500 million per case, developed damages approach and calculated alternative damages tied to liability case. Repeated and adjusted analytical approach for four of the ten lawsuits brought against Westinghouse by electric utilities, drafted expert reports, provided document review and deposition questions to counsel, and advised on strengths and weaknesses of case using ex-ante and ex-post approaches.

IRS Tax Litigation

- In a claim concerning proper tax treatment of a contingent debt instrument, defended client against IRS investigation. Analyzed contingent debt instruments in the context of a 20-year, multi-billion dollar coal purchase agreement, drafted expert reports, and advised counsel on depositions.
- In an IRS claim concerning excessive retention of earnings by a privately-held marine transportation business, analyzed working capital and investment cash needs to show that the retained earnings were required to meet legitimate business purposes.

EXPERT TESTIMONY

- On behalf of Calpine Corporation Vista Energy Corporation and Bucksport Generation, LLC (the Generator Intervenors) before the Maine Public Utility Commission, Docket No. 2017-00232.

  "Prepared Direct Testimony of Tanya L. Bodell," submitted April 30. 2018.

  "Prepared Surrebuttal Testimony of Tanya L. Bodell," submitted August 17, 2018.
- Prepared Remarks of Tanya L. Bodell regarding Proposed Support for New Jersey Nuclear Plants before the New Jersey Senate Environment and Energy and the Assembly Telecommunications and Utilities Committee, State House Annex, December 20, 2017.
- American Arbitration Association, Dominion Nuclear Connecticut, Inc. vs. The Connecticut Light and Power Company, Case No. 01-16-0000-6412, "Prepared Direct Testimony of Tanya Bodell on Behalf of the Connecticut Light and Power Company," August 17, 2017.
- On behalf of the New England Power Generators Association, Exhibit NPG-4, Before the Federal Energy Regulatory Committee, Docket No. ER17-795-000.

  "Prepared Direct Testimony of Tanya L. Bodell," submitted February 3, 2017.

  "Prepared Surrebuttal Testimony of Tanya L. Bodell," submitted March 6, 2017.
- Massachusetts Electric Company and Nantucket Electric Company each D/B/A National Grid, Docket No. 1605.

  "Testimony of Tanya Bodell on Behalf of the Massachusetts Attorney General," June 20, 2016.

  "Surrebuttal Testimony of Tanya Bodell on Behalf of the Massachusetts Attorney General," July 18, 2016.
- NSTAR Electric Company and Western Massachusetts Electric Company D/B/A Eversource Energy, Docket No. 15-181

  "Testimony of Tanya Bodell on Behalf of the Massachusetts Attorney General," June 13, 2016.

  "Surrebuttal Testimony of Tanya Bodell on Behalf of the Massachusetts Attorney General," July 12, 2016.

- In the Matter of Hydro-Québec v. Churchill Falls (Labrador) Corporation Limited, Province of Québec, District of Montréal, Superior Court, N: 500-17-078217-133.

  "Continuous Energy: An Overview of Contemporaneous Industry Context," July 10, 2015.

  "Interruptible Power: An Overview of Industry Context and CF(L)Co's Ability to Sell," July 3, 2015.

- Benefits analysis of the Towantic Energy Center, Testimony before the Connecticut Siting Council, Docket No. 192: An Application by Towantic Energy, LLC For a Certificate of Environmental Compatibility and Public Need for the Construction, Maintenance and Operation of a Proposed Electric Generating Facility Located North of the Prokop Road and Towantic Hill Road Intersection in the Town of Oxford, Connecticut Petition of CPV Towantic, LCC (f.k.a. Towantic Energy, LLC) to Reopen and Modify the Decision in Docket No. 192 Due to Changed Conditions.

  Report submitted October 2014 in conjunction with Concentric Energy Advisors, Inc.

- "Analysis and Cost Comparison of Renewable Power in California," Testimony before the Little Hoover Commission, Sacramento, CA, February 28, 2012.

- "Expert Report of Tanya L. Bodell," In the Matter of Arbitration Between Big Rivers Electric and City of Henderson Utility Commission d/b/a Henderson Municipal Power and Light, Defendants, American Arbitration Association Re: 52-198-00173-10, August 24, 2011.

- "Prepared Direct Testimony of Tanya L. Bodell on Behalf of Atlantic Path 15, LLC," Before the Federal Energy Regulatory Commission, Atlantic Path 15, LLC, Docket No. ER11-2909-000, submitted February 18, 2011.

PUBLICATIONS

Ms. Bodell is a regular columnist for Pennwell Publications Electric Light & Power magazine and formerly Wiley Publications Natural Gas & Electricity. Through her columns, she offers monthly insights on business issues facing the energy industry. The following reflects articles written during the past five years.

Column in Electric Light & Power, Pennwell Publications

- "Imagine a Market that . . ." September/October 2018
- "Is the Great Experiment of Wholesale Electricity Competition Ending?" May/June 2018
- "Leveling the Playing Field for Storage: Can Markets Figure It Out?" March/April 2018
- "Big Data, Bit Coin and Blockchain: How will Energy Cash In?" January/February 2018
- "Resistance to Resilience: ISO/RTO Response to DOE's NOPR," November/December 2017
- "Is your SCADA System Safe?" September/October 2017
- "So What's in Your Grid Modernization Plan?" July/August 2017
- "Nuclear Friction: Challenging the Economic Rationale of State Support," May/June 2017
- "Valuing Lost Load: How the Economics have Changed," March/April 2017

- "Digitizing Electrons: How are You Incorporating the Digital Economy into Utility Operations?" January/February 2017
- "What You Can Do to Decrease Operational Risk Part II: Securing your Supply Chain," November/December 2016
- "How Operational Risk is Increasing and What you Can Do About It: Part I," September/October 2016
- "Living on the Edge: Seeing Things in a Different Way to Transform the Grid," July/August 2016
- "Listening to the Supremes: Impacts of Judicial Decisions on Power Markets," May/June 2016
- "When will Oil Prices Recover? Three Economic Theories Provide Different Answers," January/February 2016
- "The Internet of Things: Where the Power Sector Connects," November/December 2015
- "A Synopsis of Changes in the Finalized Clean Power Plan," September/October 2015
- "Priming the Power Sector: Will Performance Pay?" July/August 2015
- "How Big Data is becoming a Bigger Deal for the Power Sector," May/June 2015
- "Pay Attention to the Man behind the Meter," March/April 2015
- "2015 in Preview: Harbingers Ring in the New Year," January/February 2015
- "What do Lower Oil Prices Mean for the Power Sector?" November/December 2014
- "For Sail: Mega Merger Tactics in the Electricity Industry," September/October 2014
- "Who's on First? Ongoing Challenges to FERC's Jurisdiction," July/August 2014
- "How Big Data is Becoming a Bigger Deal for the Power Sector," May/June 2014
- "Transformative Technologies to Watch During the Next 2 Years," March/April 2014
- "Why Google Bought Nest for $2.3 Billion," January/February 2014
- "Restructuring a Challenged Business Model: How Will Electric Utilities Survive?" November/December 2013
- "Leveling the Power Sector Playing Field: When New Entrants Can Compete," September/October 2013
- "Evolving Power Markets: The Long and Short of It," July/August 2013
- "Sifting through Shifting Support for Energy Subsidies," May/June 2013
- "Understanding Obama's Energy Policy: Definitions for the Armchair Economist Part II," March/April 2013
- "Under the Influence of Integrated Energy Markets," January/February 2013

Column in Natural Gas & Electricity, Wiley Periodicals, Inc., a Wiley Publication

- "Shale's Big Impact on US Manufacturing: Boom or Bust?" November 2014
- "Why Virtual Pipelines Transporting CNG are becoming a Reality," August 2014
- "Parallel Play: Coordinating Natural Gas and Electricity Markets," May 2014
- "Understanding the Recent Volley in Natural Gas Prices," March 2014
- "Outlook – Spark Spreads, Dark Spreads, and Bed Spreads Showing Cutthroat Competition," January 2014
- "NGLs versus LNG: The Fight of the Century," November 2013
- "Natural Gas Could Bring Overseas Jobs Back to the United States," October 2013
- "Pop Go Gas Prices: Has the Market Recovered?" July 2013

- "Waste Makes Haste: Low-Cost Power Plants Scramble to Keep Pace," May 2013
- "Price Impacts of Regulating the Worldwide Fracking Frenzy," March 2013
- "Natural Gas Challenges King Coal: Check or Checkmate?" January 2013
- "A Midsummer Night's Dream: Why Natural Gas Prices Still Sleep," November 2012
- "The Yin and Yang of Natural Gas Prices and Renewable Resources," September 2012
- "Electricity and Natural Gas Dance: It Takes More than Two to Contango," May 2012

Articles

- Interviewed by Darlene Bremer and cited in: "Power-System Modeling Becomes More Sophisticated," Electrical Contractor, August 2015
- Interviewed by Alan Rooks and cited in: "Hot Stuff: US Energy Market in Overdrive as Shale Drilling Booms," Cutting Tool Engineering, Vol. 66, Issue 4, April 2014
- "What in the World is Happening to the Power Sector?" Executive Digest Newsletter, Pennwell Publications, July 11, 2012
- Interviewed and cited in: "The New Golden State of Smart Grid," Electric Light & Power, May/June 2010
- Interviewed and cited in: "Special Report: Executive Roundtable on Renewable Energy," Power Engineering, 2009

PRESENTATIONS AND SPEAKING ENGAGEMENTS

Ms. Bodell is an established speaker and moderator at industry conferences, offering market insights and identification of strategic opportunities for attendees, a selection of which is below:

- "Ever Expanding Opportunities in Alternative Energy," Presentation at the MT Forecast Conference, October 11, 2018
- "The Ever Tightening Convergence of Power, Oil, and Gas," Presentation at the MT Forecast Conference, October 11, 2018
- "Evolving New England Energy Markets and what it Means for Consumers," Presentation to the New England Consumer Liaison Group, March 3, 2018
- "Natural Gas Storage in New England and the Impact of LNG on Winter Prices," New England Association of Energy Engineers, January 5, 2016
- "New England Pipeline and Transmission Infrastructure: Recent Studies," New England Electricity Restructuring Roundtable, November 20, 2015
- "Two Perspectives on the Clean Power Plan: New England vs. Texas," Infocast 2nd EPA Clean Power Plan Implementation Summit Multi-State Perspectives, Plans and Implications of 111(d), October 20, 2015
- "Future of Energy Development: Energy Trends and Opportunities," Global Forecasting and Marketing Conference, Association for Manufacturing Technology, October 14, 2015
- "Energy Trends and Opportunities," United States Cutting Tool Institute, Spring Meeting, May 3, 2015

- "Status of Proposed Rules," EPA Clean Power Plan Implementation: Multi-state Perspectives, Plans and Implications of 111(d), April 1, 2015
- "Energy Trends and Opportunities for the Heat Exchange Industry," Heat Exchange Institute, March 22, 2015
- "Economic Impacts of Environmental Regulations on ERCOT: Bringing it down to dollars and sense," Infocast EPA Clean Power Plan Implementation (Conference Chair and Speaker), February 25, 2015
- "Capital Expenditures in the Energy Industry," American Manufacturing Technologies Global Marketing and Forecasting Conference, October 15, 2014
- "The Future of Energy in New England," Northeast Energy Commerce Association Annual Conference, May 14, 2014
- "Impacts on Texas Plant Valuations and Potential M&A," Infocast ERCOT Market Summit (moderator) and Pre-Summit Forum (chair and speaker), February 25, 2014
- "Energy Trends: Why Jobs, Capital Investment and Trade are Heating Up," Association for Manufacturing Technology 2013 Global Forecasting and Marketing Conference, October 16, 2013
- "Energy Trends: Pricing Trends in the Midwest," Infocast Black Gold Conference, September 20, 2013
- "Energy Markets: Pricing Trends in the Midwest," Infocast Reshoring Summit: Brining Manufacturing back to the U.S., March 12-13, 2013
- "The New Dynamics of Integrated Energy Markets," with Jamie Heller and Alan Herbst, Infocast Webinar, November 15, 2012
- "Gas-fired Power Generation as a Driver for New Demand and Pipelines," Marcellus and Utica Infrastructure Summit, Infocast Conference, Pittsburgh, PA, July 12-13, 2012
- "Competitors or Collaborators? Exploring the Interplay between Renewable Energy & Other Fuel Sources," Wall Street Renewable Energy Finance Forum, New York, June 19-20, 2012
- "Executive Briefing: Power Market Trends Impacting the Value of Power Assets," Executive Session Moderator, Power Generation Asset Financing Summit, New York, May 19-21, 2012
- "Trends Shaping the Future," Projects & Money, New Orleans, LA, January 18, 2012
- "A Brief Review of New Institutions and Structures in the Electricity Industry," Presented to the GEMI Power Conference, Houston, Texas, June 29, 2006

PROFESSIONAL AFFILIATIONS (PAST AND PRESENT)

Northeast Energy Commerce Association, Boston, MA

Energy Bar Association

Women's Council on Energy and the Environment, Washington, DC

International Centre for Expertise, International Chamber of Commerce, Paris, France

South Shore Art Center, Cohasset, MA, Board of Directors (2012 - present), President (2016-18)

Cohasset Advisory Committee, Cohasset, MA (2013 - present)

Cohasset Alternative Energy Committee, Cohasset, MA, Chair (2011 - 2013)

EMPLOYMENT HISTORY

Energyzt, Boston, MA

- Executive Director, 2012 to Present

FTI Consulting, Boston, MA

- Managing Director, 2010 to 2012

Charles River Associates, Inc. (CRA International), Boston, MA

- Vice President, 2003 to 2010
- Principal, 2001 to 2002

Putnam, Hayes & Bartlett (subsequently PHB Hagler Bailly), Washington, DC

- Principal, 1999 to 2000
- Senior Associate, 1998
- Associate, 1993 to 1997

EDUCATION

Massachusetts Institute of Technology, Boston, MA

Sloan School of Management, Sloan Fellow Masters in Business Administration

University of Chicago, Chicago, IL

Harris School of Public Policy, Harris Fellow Masters of Arts, Public Policy, with honors

Pomona College

Bachelors of Arts, Mathematical Economics, Magna cum Laude

Exhibit No. 2

PJM Quadrennial Review:
Response to Revised Recommendation on ATWACC

PJM Quadrennial Review:
Response to Revised Recommendation on ATWACC

On behalf of The P3 Group

September 12, 2018

Just Energy / Just Experts

Contents

Objective: Respond to revised recommendation on ATWACC

Agenda:

- Revised ATWACC
- Errors
  - Debt Rate
  - Sources vs. Uses
  - Comparison to 20-year Treasury Bond
  - Asset Beta
- Cost of Equity
- Corrected Calculation
- Conclusion

The revised ATWACC proposal still suffers from significant errors

Revised ATWACC

Changes generally are in the right direction except for debt rate

ATWACC = Equity % * Equity Rate + Debt % * Debt Rate * (1-tax rate)

HIGHER
Changed from
35% to 45%

HIGHER
Changed from
12.8% to 13%

LOWER
Changed from
65% to 55%

LOWER
Changed from
6.5% to 5.5%

LOWER
Changed from
29.25% to 27.715%

Now assumes state taxes are deductible at the corporate level

Impact on ATWACC

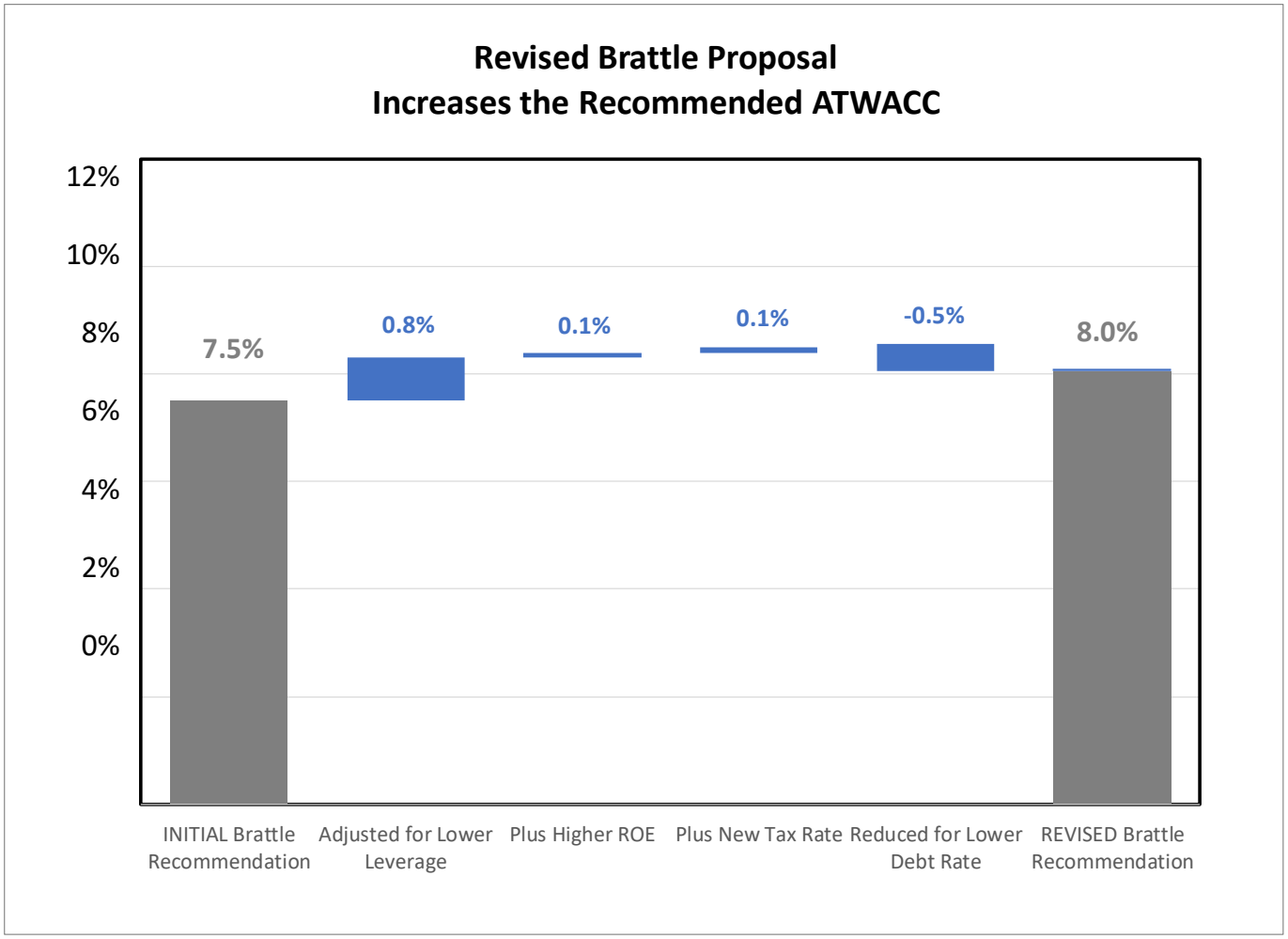
Not enough

Wrong direction

The increase in the asset beta does not go far enough

Revised ATWACC

The lower debt rate offsets a number of improvements



The end result is still too low

Error #1 – Debt Rate

Assumes an average BB rated entity + 40 basis points

ATWACC = Equity % * Equity Rate + Debt % * **Debt Rate** * (1-tax rate)

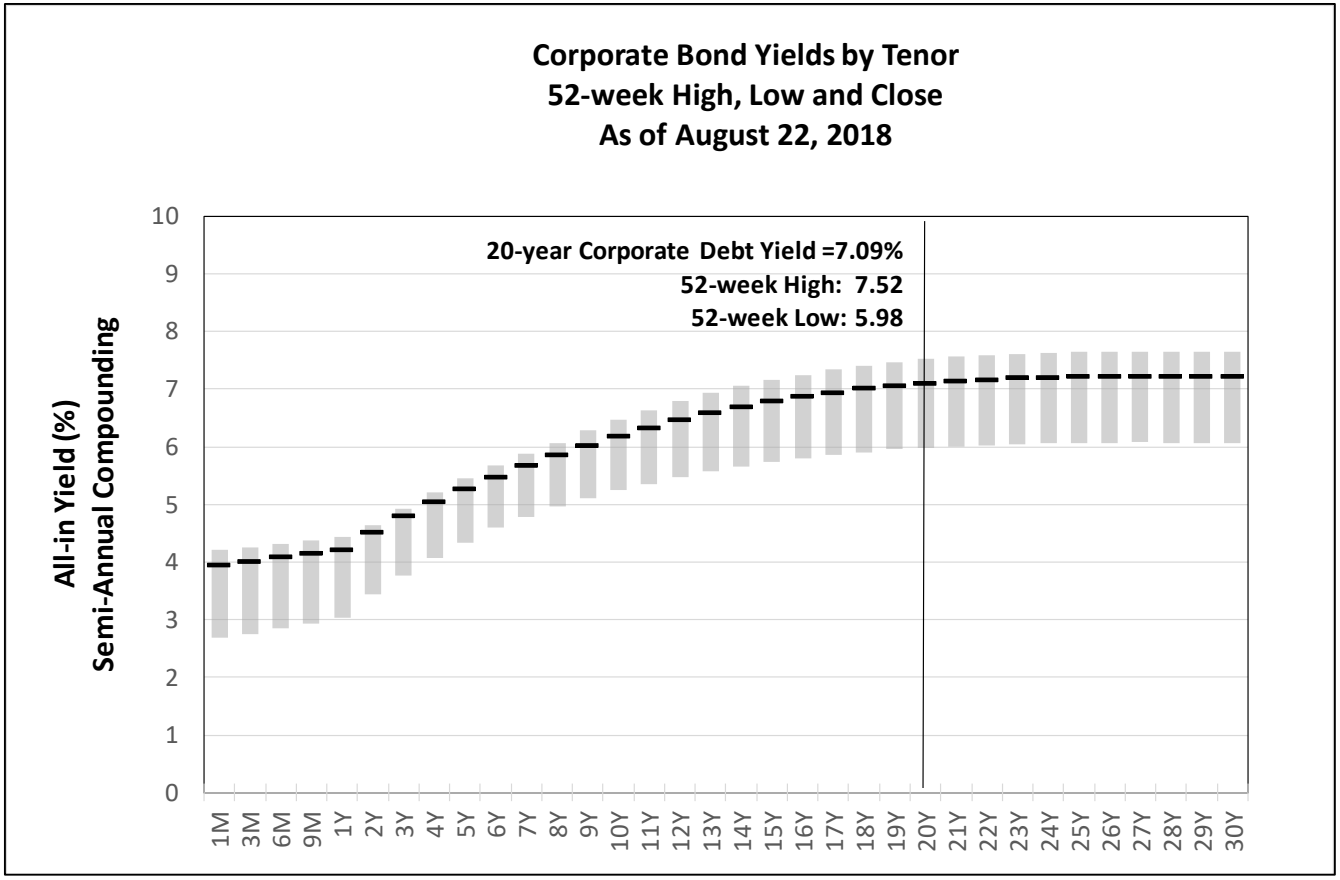
Source: St. Louis Federal Reserve Board, https://fred.stlouisfed.org/series/BAMLH0A1HYBBEY

Despite higher debt rates, the new debt rate is reduced by 100 b.p.

Error #1 – Debt Rate

During the past year, 20-year BB bond yields have exceeded 7.50%

ATWACC = Equity % * Equity Rate + Debt % * **Debt Rate** * (1-tax rate)



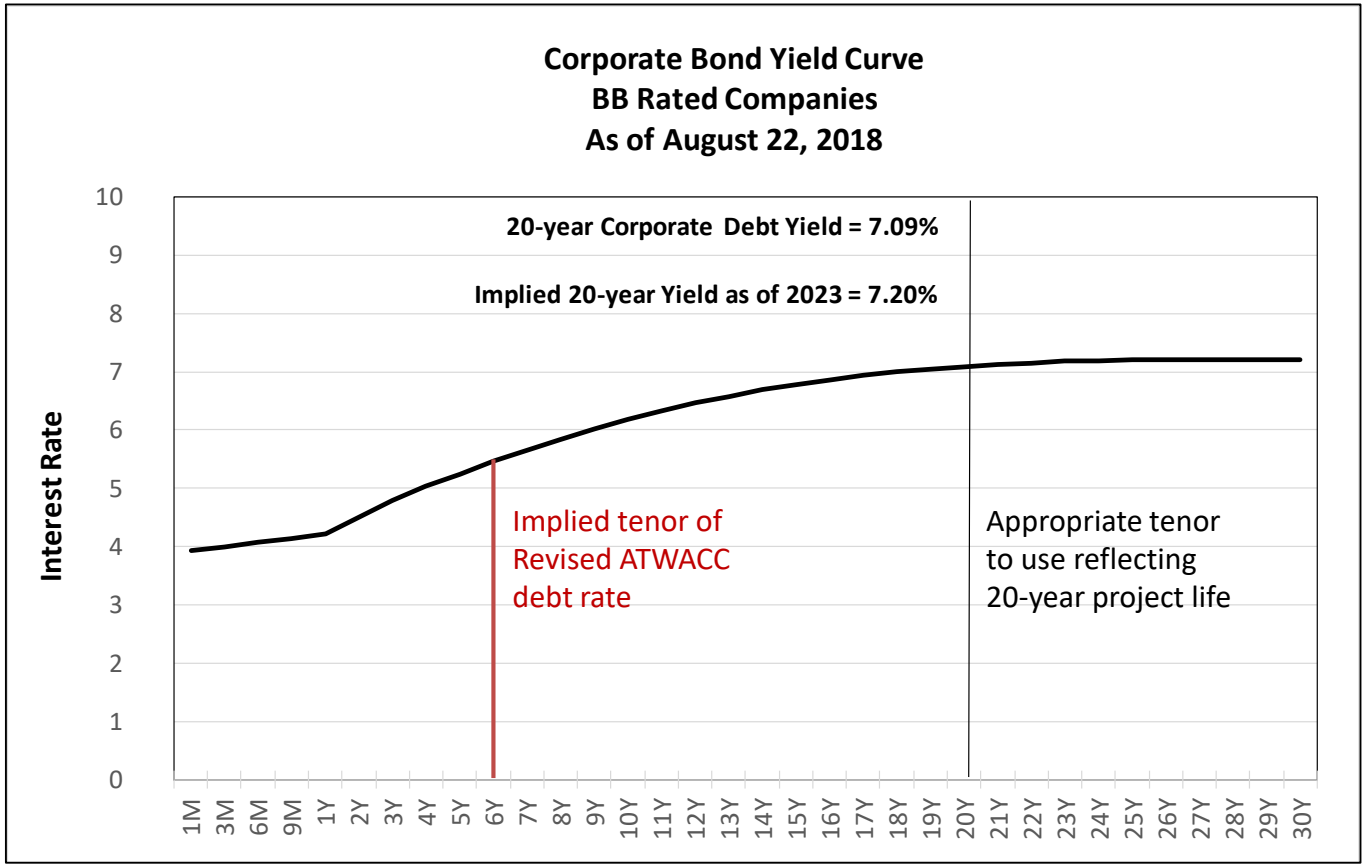
Source: S&P Capital IQ

Brattle's 40 b.p. adder should apply to reflect "future increase in the bond yield"

Error #1 – Debt Rate

The starting debt rate should be at least 7.2% -- or 7.6% with the adder

ATWACC = Equity % * Equity Rate + Debt % * **Debt Rate** * (1-tax rate)



Source: S&P Capital IQ

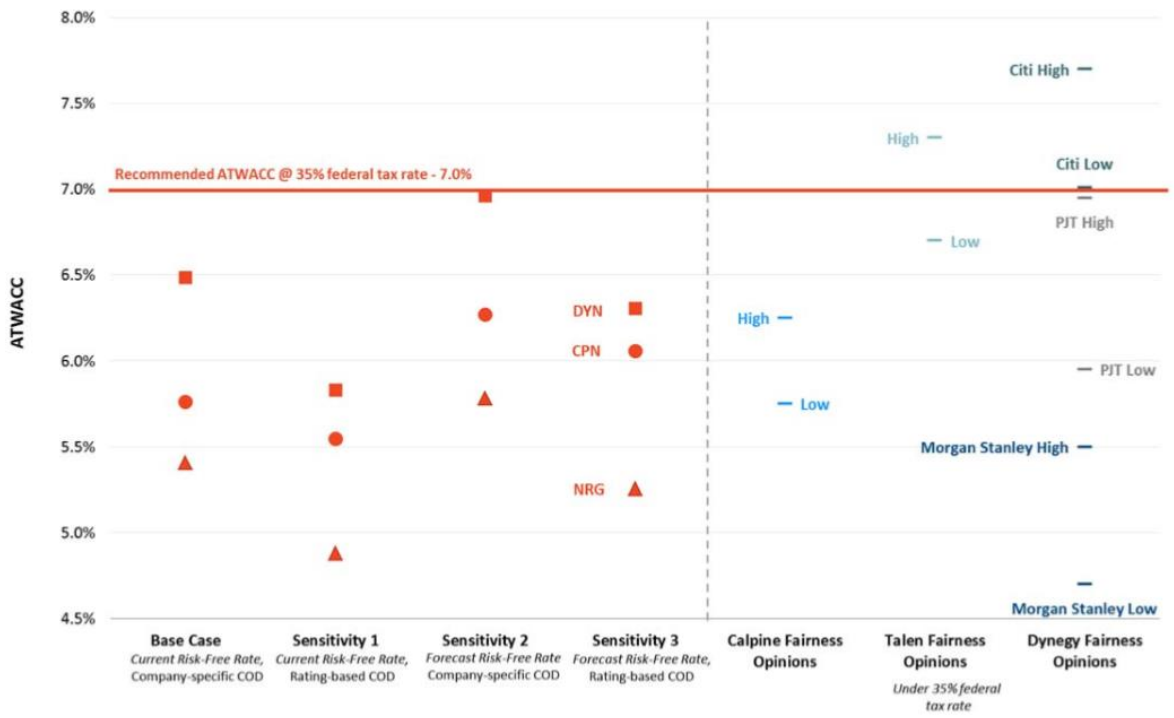
The appropriate debt rate is a twenty-year bond yield at the time of financing

Error #2 – Sources vs. Uses

The approach makes a text-book error in using sources of funding

ATWACC = Equity % * Equity Rate + Debt % * Debt Rate * (1-tax rate)

Figure 2. ATWACC of U.S. IPPs and Discount Rates from Fairness Opinions as of Nov 2017 (35% Federal Tax Rate)



Source: Brattle Memorandum to PJM, re: ATWACC Update for PJM CONE Analysis, August 21, 2018, Figure 2

The developer's ATWACC is not the same as the merchant generator risk

Error #2 – Sources vs. Uses

Text book warnings about project risk versus company risk

ATWACC = Equity % * Equity Rate + Debt % * Debt Rate * (1-tax rate)

"In situations where the new project is considerably more or less risky than the company's normal operation, it may be best to use the capital asset pricing model to calculate a project-specific discount rate.

The normal cost of capital won't act as an effective substitute for risk premium for such a project."

Source: Investopedia, https://www.investopedia.com/ask/answers/052715/what-difference-between-cost-capital-and-discount-rate.asp

Using the company WACC under a fair market valuation exercise is inappropriate

Error #2 – Sources vs. Uses

Brattle itself recognizes the problem in its initial report

ATWACC = Equity % * Equity Rate + Debt % * Debt Rate * (1-tax rate)

"As a pure merchant project in PJM, the risks would be larger than for the average portfolio of independent power producers that have some long-term contracts in place.

As we have done in previous studies, **we make an upward adjustment** towards the upper end of the range from the comparable company results to reflect the relatively higher risk of merchant operations."

Source: Brattle Report, pp. 41-42.

There is no basis for confirming that the high end of the range is high enough

Error #2 – Sources vs. Uses

ATWACC should be higher for a merchant generator

ATWACC = Equity % * Equity Rate + Debt % * Debt Rate * (1-tax rate)

Factors contributing to a higher ATWACC for a single project versus a company:

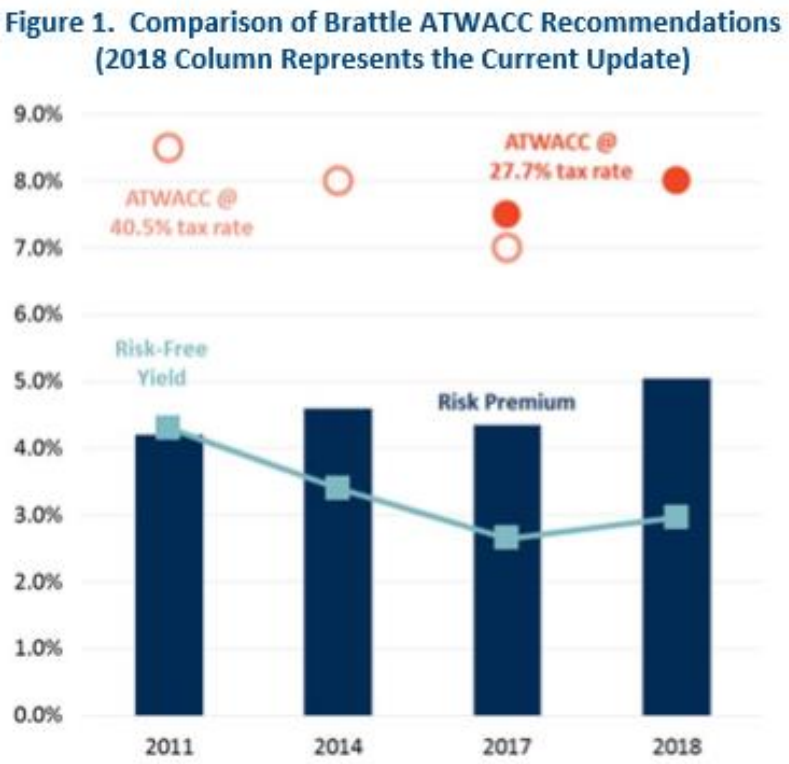
- Merchant generator does not have contracted revenues, unlike the comparable companies
- Mature cash flows are further out in time versus companies with a portfolio of assets, creating more risk
- Single generating asset creates greater risk than a diversified portfolio -- an important factor for lenders

Project-specific risk would be taken into account by lenders and private equity

Error #3 – Comparison to 20-year Treasury Bond

The comparison to the 20-year Treasury Bond is nonsensical

ATWACC = Equity % * Equity Rate + Debt % * Debt Rate * (1-tax rate)



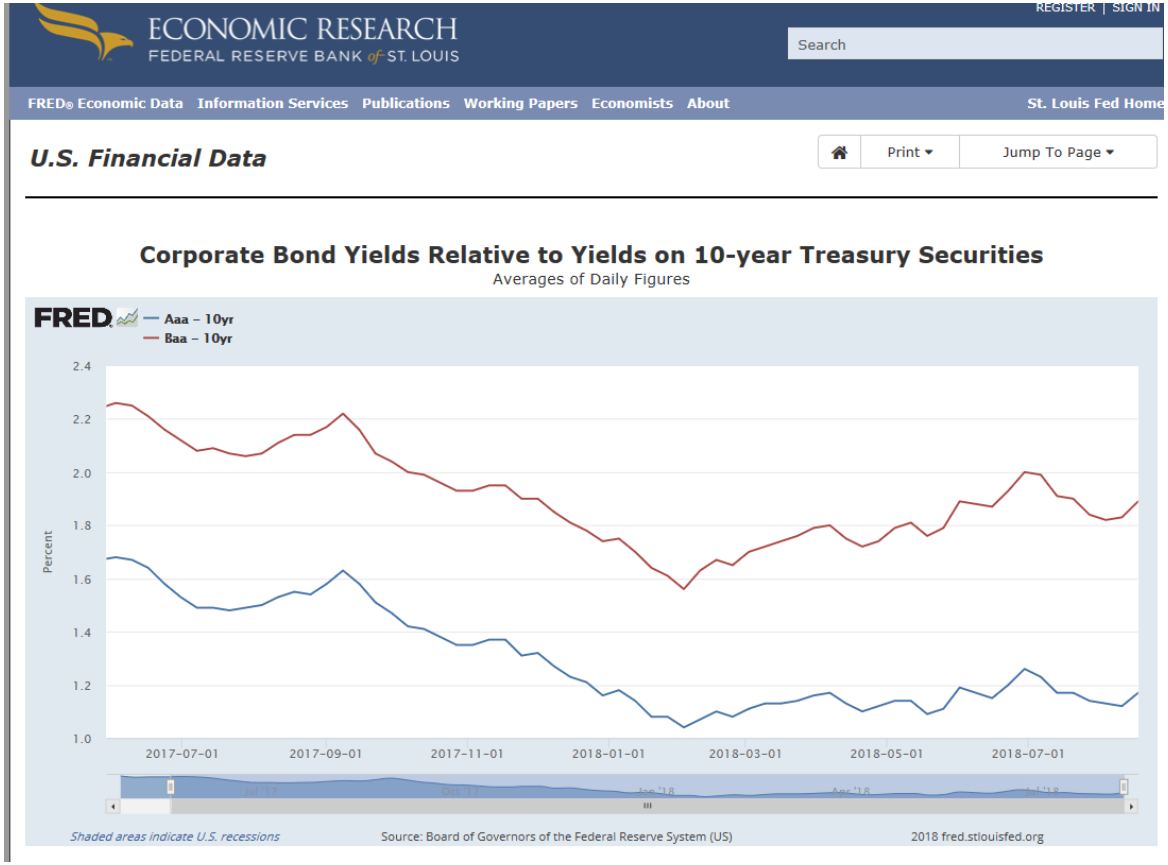
Source: Brattle Memorandum to PJM, re: ATWACC Update for PJM CONE Analysis, August 21, 2018, Figure 1

Why would one expect the premium to a Treasury Bond to stay the same?

Error #3 – Comparison to 20-year Treasury Bond

Premium for credit spreads change, with credit spreads rising

ATWACC = Equity % * Equity Rate + Debt % * Debt Rate * (1-tax rate)



Source: Economic Research, "Corporate Bond Yields Relative to Yields on 10-year Treasury Securities," https://research.stlouisfed.org/datatrends/usfd/page12.php

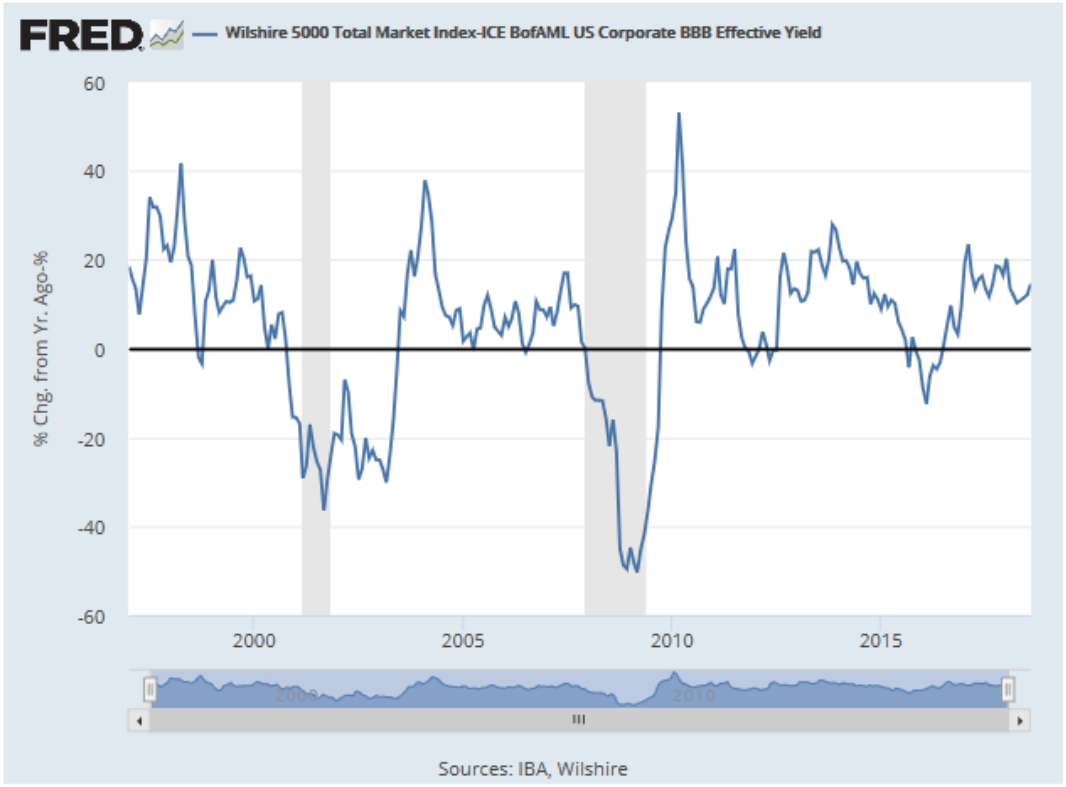
Credit spread for BB Corporate Bonds should be higher

Error #3 – Comparison to 20-year Treasury Bond

Equity risk premium change, especially as interest rates increase

ATWACC = Equity % * Equity Rate + Debt % * Debt Rate * (1-tax rate)

Posted on July 28, 2016



Source: FRED, https://fredblog.stlouisfed.org/2016/07/the-equity-premium/

Why would one expect the equity premium to a Treasury Bond to stay the same?

Error #3 – Comparison to 20-year Treasury Bond

20-year Treasury Bond premium should vary with market conditions

ATWACC = Equity % * Equity Rate + Debt % * Debt Rate * (1-tax rate)

Premium to 20-year Treasury Bond Function of:

Market Risk
Asset Risk

Credit Spreads
Credit Rating

Leverage
Tax Rate

The comparison to a 20-year Treasury Bond rate is not a validation

Multiple factors feed into the premium above a 20-year Treasury Bond

Error #4 – Asset Beta

The revised asset beta is still too low

Capital Structure	Brattle Proposal	REVISED Brattle Proposal	PJM (2013)	ISO-NE (2017)
Return on Equity	12.80%	13.00%	13.80%	13.40%
Cost of Debt	6.50%	5.50%	7.00%	7.75%
Capital Structure				
Debt Weight	65%	55%	60%	60%
Equity Weight	35%	45%	40%	40%
Assumed Tax Rate	29.25%	27.15%	40.50%	40.20%
Assumed Risk-free Rate	3.50%	3.50%	3.40%	2.24%
Assumed Market risk Premium	6.90%	6.90%	6.50%	7.00%
Implied Beta	1.35	1.38	1.60	1.59
Asset Beta	0.58	0.73	0.85	0.84

What has changed since 2013 to make the asset beta less risky?

The implied asset beta is inconsistent with the basis for leverage

- **Lenders indicate a consistent range for cost of equity:**

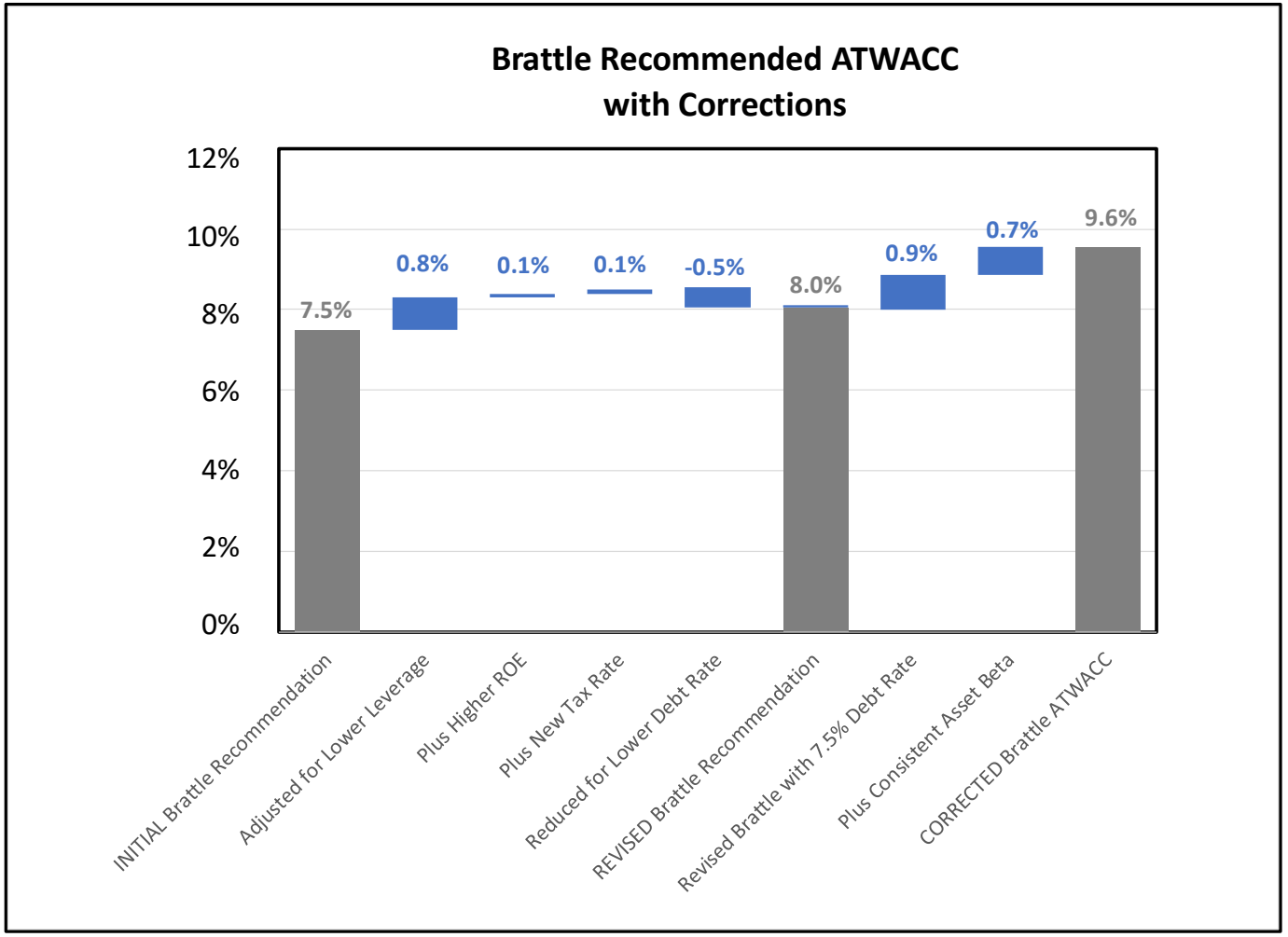
Lender	CC	CT
Lender 1	[redacted]	
Lender 2		
Lender 3		
Lender 4		

- **Lender estimates reflect relative risk**
  - Adjust for leverage
  - Consider relative risk of contracted versus merchant assets
  - Reflect for capacity markets versus energy only markets
  - Account for credit rating when estimating debt

Brattle should not pick and choose some, but not the other, assumptions

Corrected ATWACC Calculation

The net impact of the debt and equity corrections is a higher ATWACC



Corrected for the debt rate and cost of equity, the revised ATWACC should be 9.6%

Corrected ATWACC Calculation

The corrected ATWACC is consistent with the prior recommendation

Capital Structure	Brattle Proposal	REVISED Brattle Proposal	REVISED Brattle Proposal with Correct Debt Rate	REVISED Brattle Proposal with Correct Debt and Equity Rate	PJM (2013)
Return on Equity	12.80%	13.00%	13.00%	14.55%	13.80%
Cost of Debt	6.50%	5.50%	7.50%	7.50%	7.00%
Capital Structure					
Debt Weight	65%	55%	55%	55%	60%
Equity Weight	35%	45%	45%	45%	40%
Assumed Tax Rate	29.25%	27.15%	27.15%	27.15%	40.50%
Assumed Risk-free Rate	3.50%	3.50%	3.50%	3.50%	3.40%
Assumed Market risk Premium	6.90%	6.90%	6.90%	6.90%	6.50%
Implied Beta	1.35	1.38	1.38	1.60	1.60
Asset Beta	0.58	0.73	0.73	0.85	0.85
WACC	8.7%	8.9%	10.0%	10.7%	9.7%
ATWACC	7.5%	8.05%	8.86%	9.55%	8.0%

Higher ATWACC reflects current environment of higher risk/rates

Conclusion

The Revised ATWACC calculation suffers from significant issues.

- A debt rate based on a corporate bond yield averaging 5 years
- Sources vs. uses fallacy
- Inappropriate comparison to 20-year Treasury Bond

The corrected calculation that uses a 20-year debt rate for BB-rated companies plus a consistent asset beta supports a 9.6% ATWACC

- Correcting the debt rate increases the ATWACC to 8.9%
- Correcting the debt and equity rate increases the ATWACC to 9.6%

A corrected version of the revisions should equal a 9.6% ATWACC

Exhibit No. 3

PJM Reference Unit Issues to Consider on the Frame H CT

PJM Reference Unit

Issues to Consider on the Frame H CT

Presented on behalf of The P3 Group

July 6, 2018

Just Energy / Just Experts

Contents

Objective: Review the proposed Frame H CT with respect to FERC reference unit evaluation criteria

Agenda:

- FERC Criteria
- Likelihood of development in PJM
- Ability to develop cost and revenue estimates
- Appropriate demand curve
- Conclusion and Next Steps

FERC evaluation criteria does not support use of the Frame H CT

ENERGYZT

FERC Criteria

FERC's focus is on allowing for necessary new entry at low cost

In the FERC decision regarding ISO-NE's reference unit, FERC indicates that it used three criteria to evaluate the reference level selection:

(1) Is it likely to be developed in the market?

(2) Can cost and revenue estimates be developed with confidence?

(3) Does the reference unit result in a demand curve that allows for entry without unnecessary costs?

> "The criteria should produce demand curves such that a developer sponsoring **efficient and needed new entry** has a reasonable opportunity to recover the full costs of the new resource from . . . markets over its useful life." (emphasis added)

Source: 161 FERC ¶ 61,035 UNITED STATES OF AMERICA FEDERAL ENERGY REGULATORY COMMISSION, ISO New England Inc. Docket No. ER17-795-000 ER17-795-002, ORDER ACCEPTING FILING, Issued October 6, 2017, paragraph 38.

Apply FERC's criteria to assess use of a Frame H CT as the reference unit

FERC Criteria

By FERC's criteria, PJM should not be using a Frame H CT

(1) **The Frame H is NOT being developed as a CT in PJM** – There is not a single example of a Frame H CT in PJM. In contrast, developers are implementing multiple technologies ranging from combined cycle units (Frame F and Frame H), single-cycle combustion turbines (Frame F) and aeroderivatives. Other locations are pursuing reciprocating engines.

(2) **Frame H cost and revenue estimates cannot be verified –** There is no experience in how Frame H technology ramps and operates at partial load. There are only two being built nation-wide as brownfield developments – none in operation in the U.S.. Industry has been reluctant to implement a Frame H as a combustion turbine due to lack of commercial experience in ramping and availability. Brattle only applies historical prices, which does not reflect actual projected operations going forward.

(3) **Results in an inappropriate demand curve –** Size is no longer the driving factor for new developments. Flexibility, modularity and smaller sizes are more attractive in PJM and in markets ahead of PJM with respect to integration of renewables.

Using the Frame F allows for more flexibility; the Frame H squeezes that out

Issues to Consider on the Frame H CT

LIKELIHOOD OF DEVELOPMENT IN PJM

Likelihood of Development in PJM

There is no evidence that a Frame H CT will be developed in PJM

- **No experience with the Frame H as a single unit in PJM**
  - Review of the queue in PJM
  - Review of experience in other Northeast markets
  - Review of other development databases

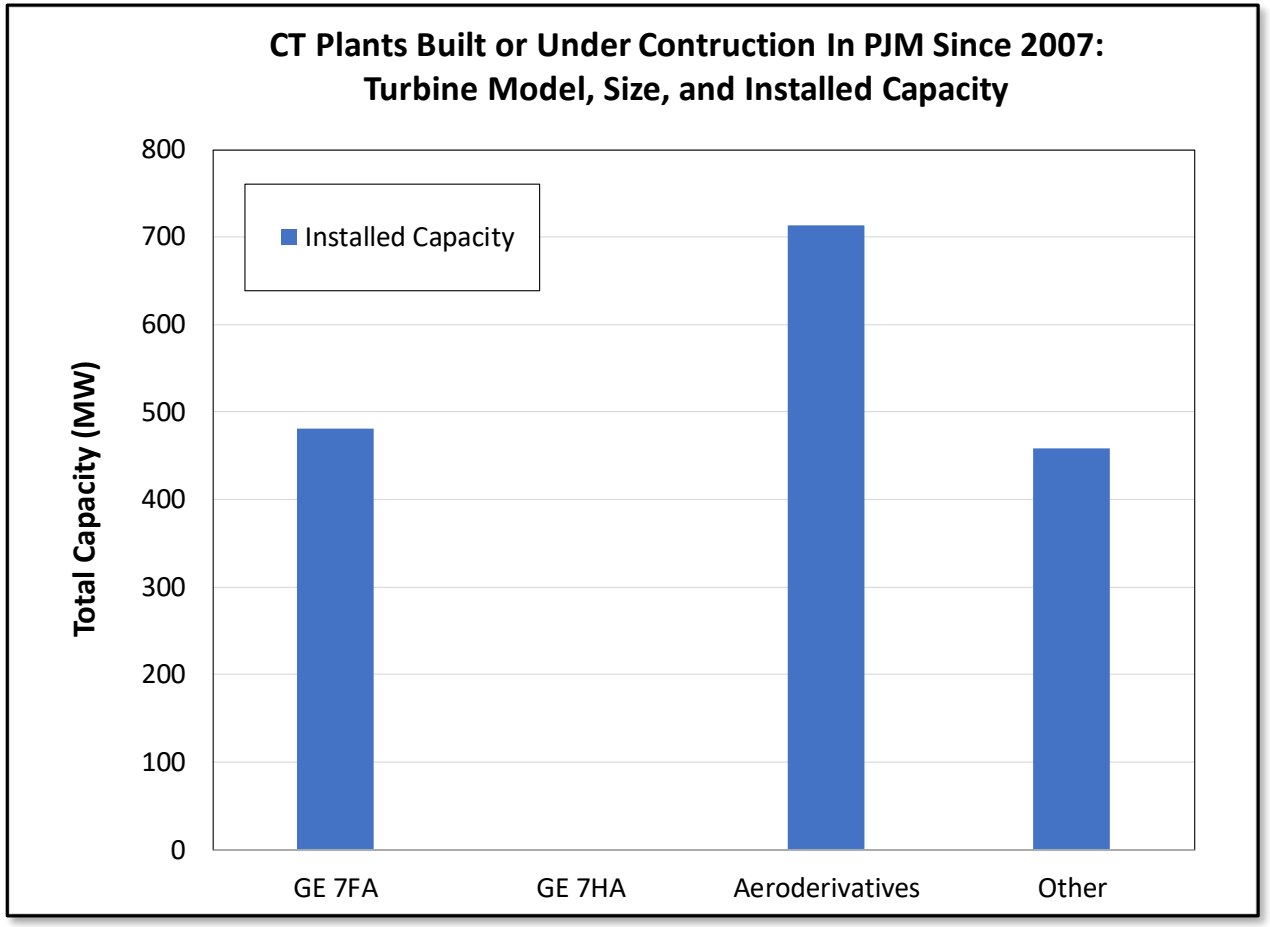
- **Untested quick-start response**
  - Industry research
  - Conversations with developers

- **Increasing need in the market for flexibility**
  - Need for smaller, more modular units
  - Higher integration of renewables anticipated in PJM
  - PJM initiatives in developing frequency market
  - Experience in other markets that see a rising use of reciprocating engines, aeroderivatives and other peaking technologies

The Frame F CT should be retained as the reference unit

Likelihood of Development in PJM

PJM has multiple peaking technologies, but not a Frame H CT



Number of CT Plants Built or Under Construction Since 2007: PJM vs US

Model	PJM	US
GE 7FA	3	26
GE 7HA	0	2
Aeroderivatives	12	147
Other	8	88
Total	**23**	**263**

Source: Summary table of Ventyx data, Brattle Report

Frame H technology has only been used in a CC configuration in PJM, not as a CT

Likelihood of Development in PJM

Nearby markets are not using Frame H as a CT

Turbine Model:	GE 7FA		GE 7HA	
ISO	CC	CT	CC	CT
ISO-NE	674	0	1,485	350
NYISO	1,619	0	480	0
MISO	361	220	0	0
Total	2,654	220	1,965	350

CC = Combined Cycle
CT = Combustion Turbine (single unit)

- NYISO currently uses a GE 7FA CT as the reference unit
- ISO-NE – where a single Frame H CT is being built -- currently uses a GE 7HA CT as the reference unit
  - Existing brownfield site
  - Under construction
  - Operational 2019

Although the GE Frame 7HA is being built in CC configuration across multiple markets, why shouldn't it be the reference unit?

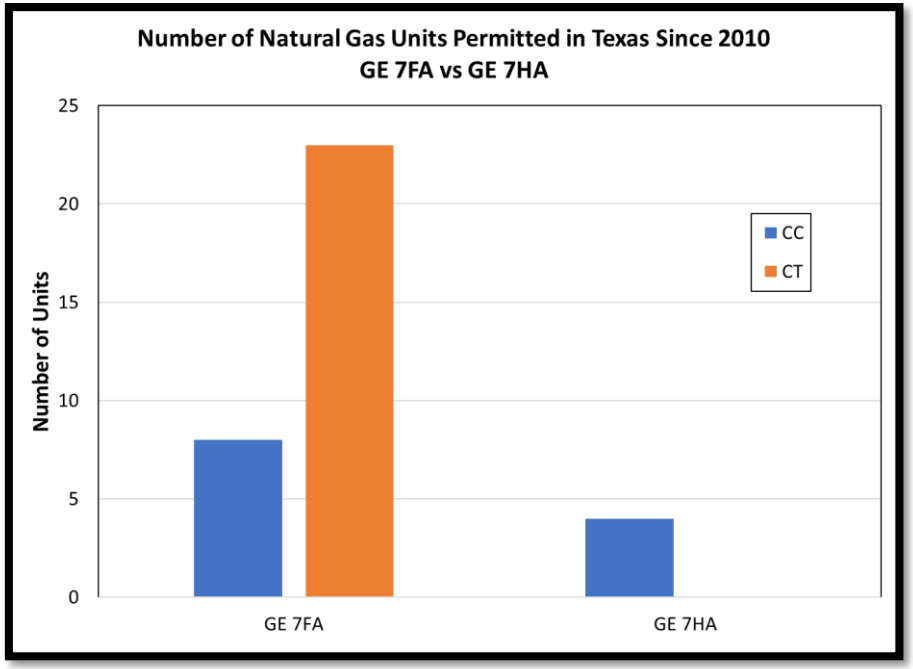
- Inconsistent with previous reference unit specification
- Less stable given volatility of potential energy and ancillary services revenues
- Does not reflect a unit that relies almost exclusively on capacity market revenues
- Too efficient in PJM to allow for new entry of more flexible technologies

Canal 3(MA) is on an existing site – there are no greenfield developments proposed

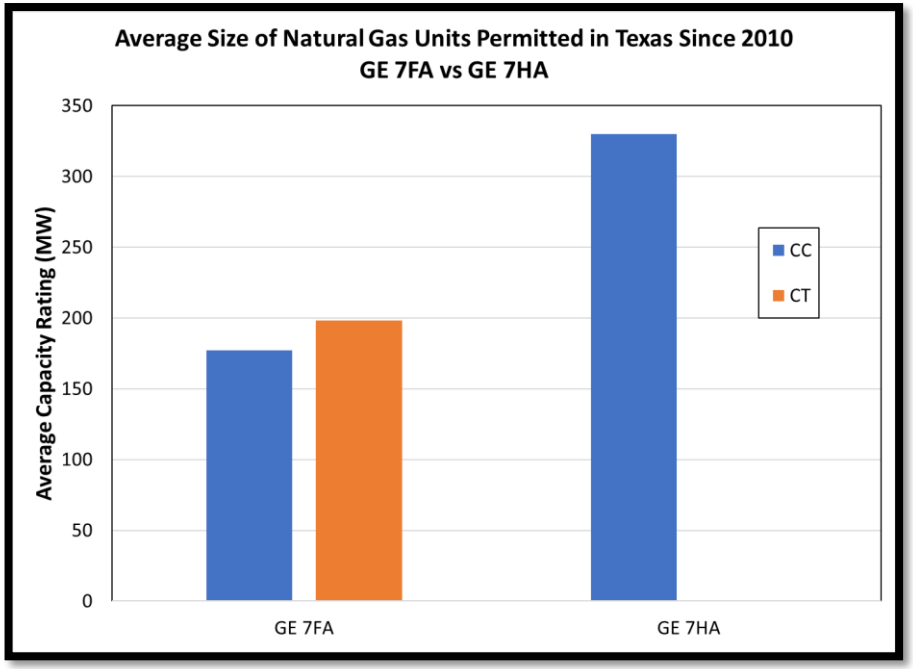
Likelihood of Development in PJM

CASE STUDY: ERCOT has been implementing GE 7FAs as CTs

Number of Permitted Units



Average Size

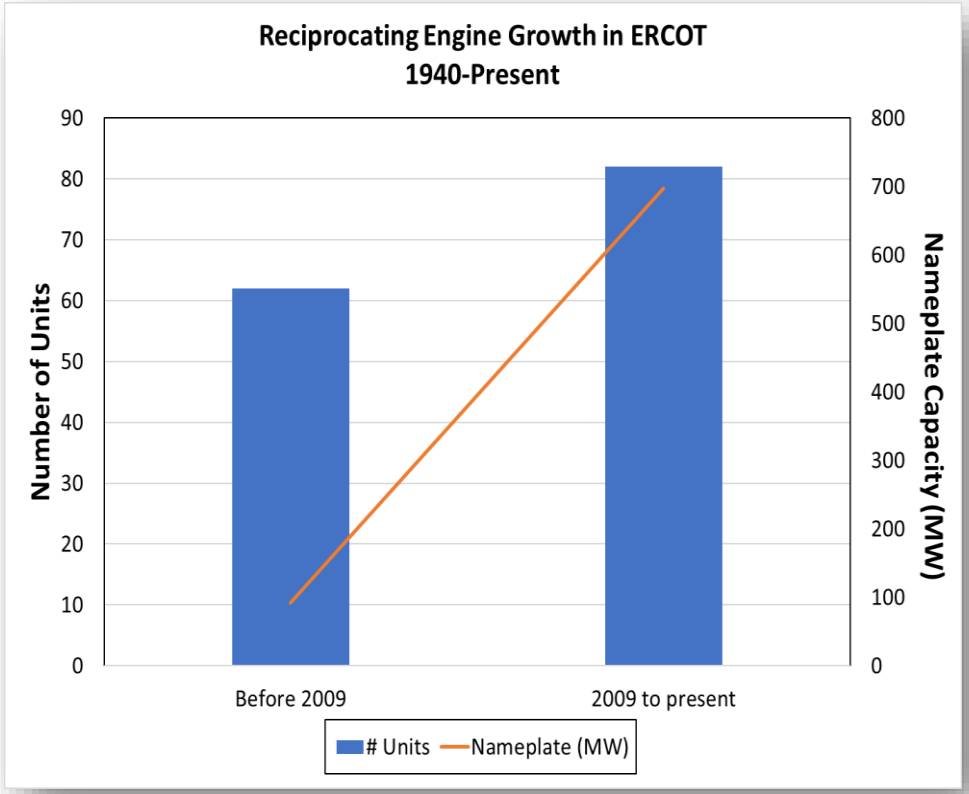


Source: Analysis of Texas Permitted Natural Gas Projects https://www.tceq.texas.gov/.../permitting/air/memos/turbine_lst.xlsx

Although the GE 7HA is common in a CC configuration, there are no Frame H CTs

Likelihood of Development in PJM

CASE STUDY: ERCOT also has seen increases in reciprocating engines



- In recent years wind generation has taken over in Texas, making them the leading state for wind generation in the US
- The intermittent output of wind has resulted in a large demand for flexible, reciprocating engines across the state

PJM may follow a similar trend as the states work to meet their renewable goals

Issues to Consider on the Frame H CT

ABILITY TO DEVELOP COST AND REVENUE ESTIMATES

Ability to Develop Cost and Revenue Estimates

EPRI: Frame H for CT Has Unproven Operational Flexibility

There are many reasons why the **Frame H is not being used** in a combustion turbine configuration

- Larger generation capacity may be difficult to employ fully
- Decreased efficiency with partial loads at less than full output
- New technology without track record of operating experience as a CT
- Unproven flexibility:
  - Ramp-up/Ramp-down times
  - Frequency of multiple cycles during day
  - Availability response time
- Competition with smaller and more flexible alternatives (e.g., Frame F CT, aeroderivatives and reciprocating combustion engines)
- High capital and variable operating costs

Source: Energyzt conversation with contact at EPRI

Unproven flexibility makes it very difficult to estimate longer term costs

Ability to Develop Cost and Revenue Estimates

Brattle recognizes the difficulty in assessing costs and revenues

"**For CTs, there are too few representative existing resources to make a meaningful comparison**, but we believe PJM's approach and assumptions are reasonable.

. . .

Although futures are not liquid beyond one year and do not cover all locations, we propose an approach to extend the available market data further forward and to other locations. **This approach does not work well for CT plants, however, because their dispatch does not closely match any observable forward-traded product.**"

- Brattle Report, pp. v - vi

ISO-NE used a dispatch model to project energy prices and AS revenues

Issues to Consider on the Frame H CT

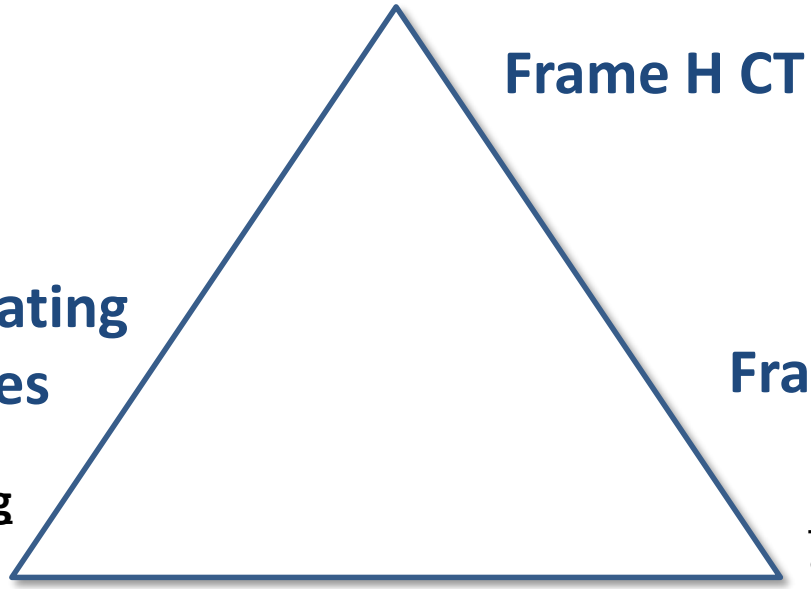
APPROPRIATE DEMAND CURVE

Appropriate Demand Curve

Natural gas generating technologies offer different qualities

Cheaper = More Efficient

- Lower overall cost
- Fuel efficient
- Higher operating profit



Faster = Quicker Ramping

- Qucker start-up times
- Fast ramp-up and ramp-down rates

Better = Reliability

- Commercially proven technology
- Higher availability rates

Each technology provides alternative features that markets increasingly require

ENERGYZT

Appropriate Demand Curve

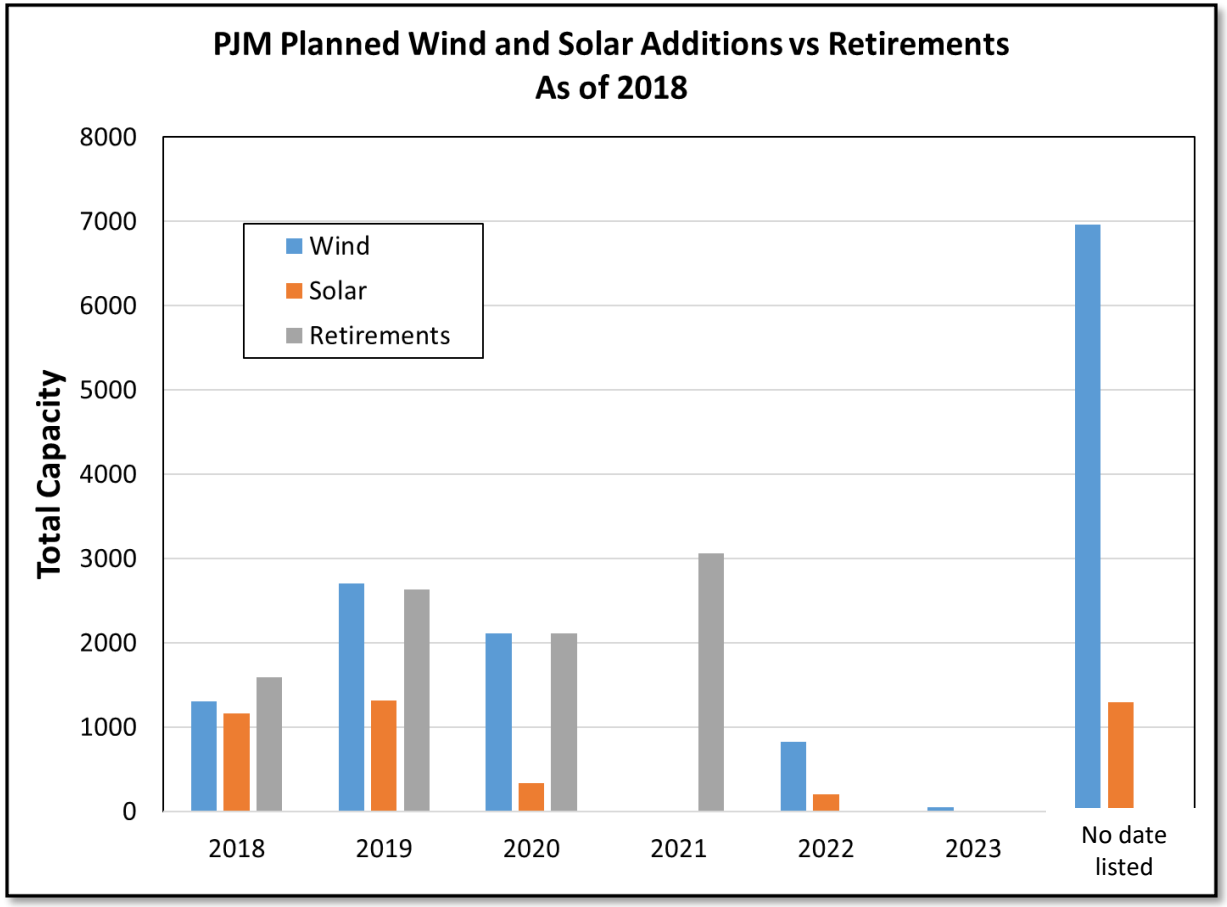
Conversations with Developers: The grid paradigm has shifted

- H-Frame gas turbines are designed for **large, base load combined cycle (CC) applications** to meet needs that were once viewed as grid requirements
  - High efficiency with heat rates less than 7000 Btu/KWh
  - Quicker start capabilities and improved cooling capabilities, make it an ideal intermediate or baseload unit
  - The H-frame is larger than the F-frame
- **The grid paradigm has shifted** with the increase in renewables (wind, solar, bio mass) and potentially electricity storage
  - The larger CCs are at a competitive disadvantage
  - There are more flexible alternatives such as aeroderivatives and natural gas internal combustion engines
  - Speed ramp-up and ramp-down properties are as important as higher efficiency characteristics
- **Availability and how quickly a unit can be called upon** is becoming a more important characteristic in order to make into the bid stack

Sources: Phone conversations with Energyzt connections at Federal Power Company, GEUS (Greenville Electric Utility System), and TClean Energy Technology Associates, June 29, 2018

Appropriate Demand Curve

PJM is experiencing a "paradigm shift" with new renewables



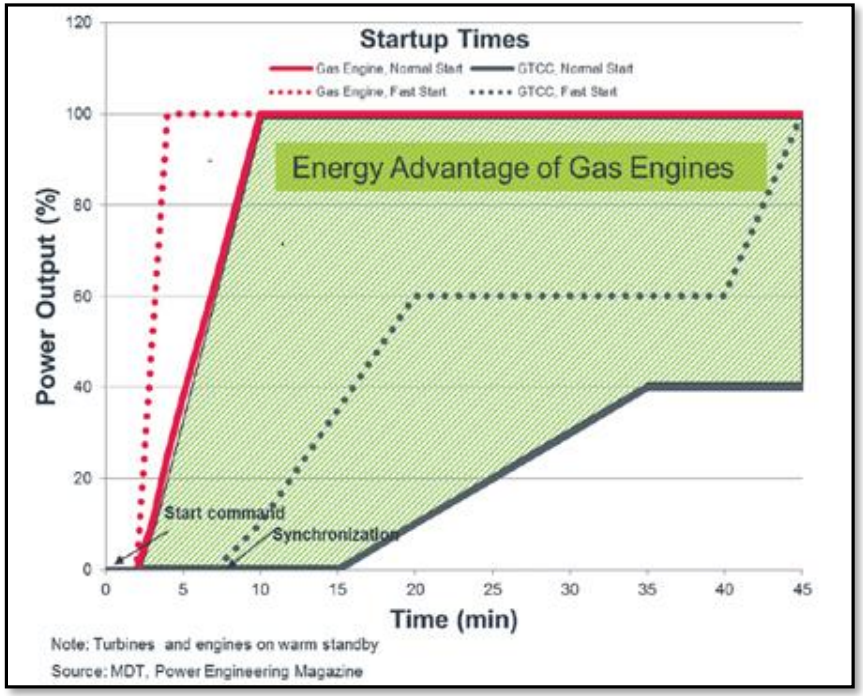
Source: PJM Queue, cross-checked with Ventyx data

The mid-2020s will see a need for smaller units and proven flexibility

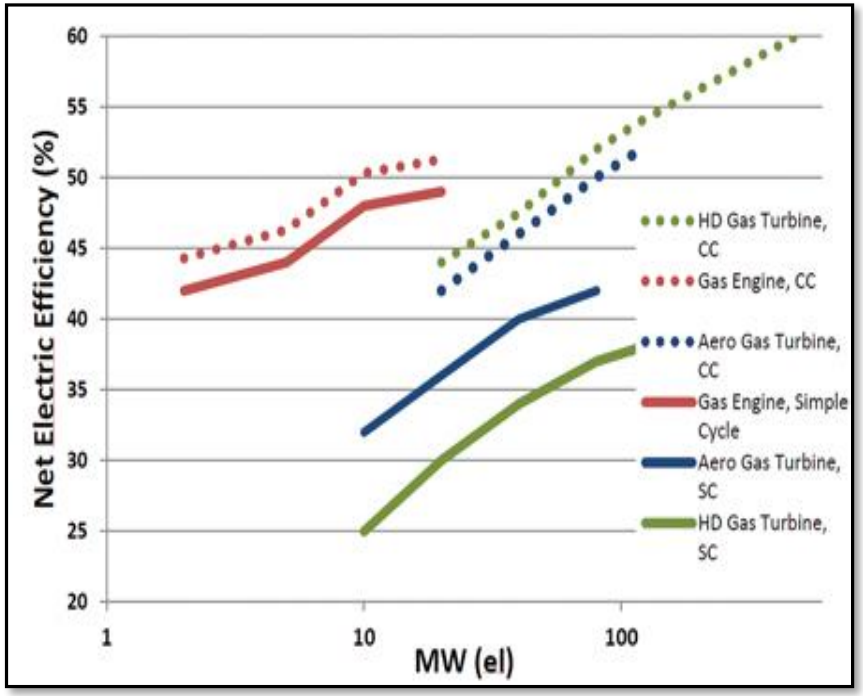
Appropriate Demand Curve

Other technologies offer faster start-times

Startup Times



Net Plant Efficiency

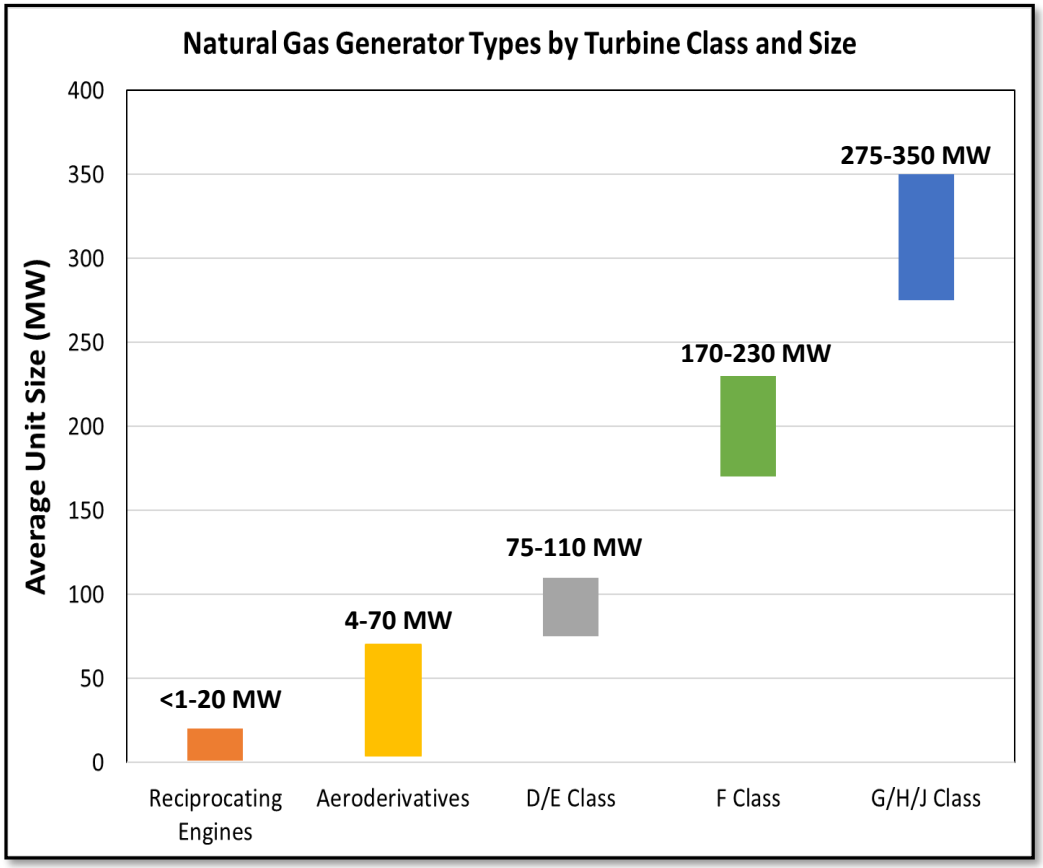


Source: https://www.power-eng.com/articles/print/volume-121/issue-6/features/reciprocating-engine-generator-technology.html

The Frame F CT offers a proven flexibility bridge to new technologies

Appropriate Demand Curve

Other technologies offer smaller sizes and modularity



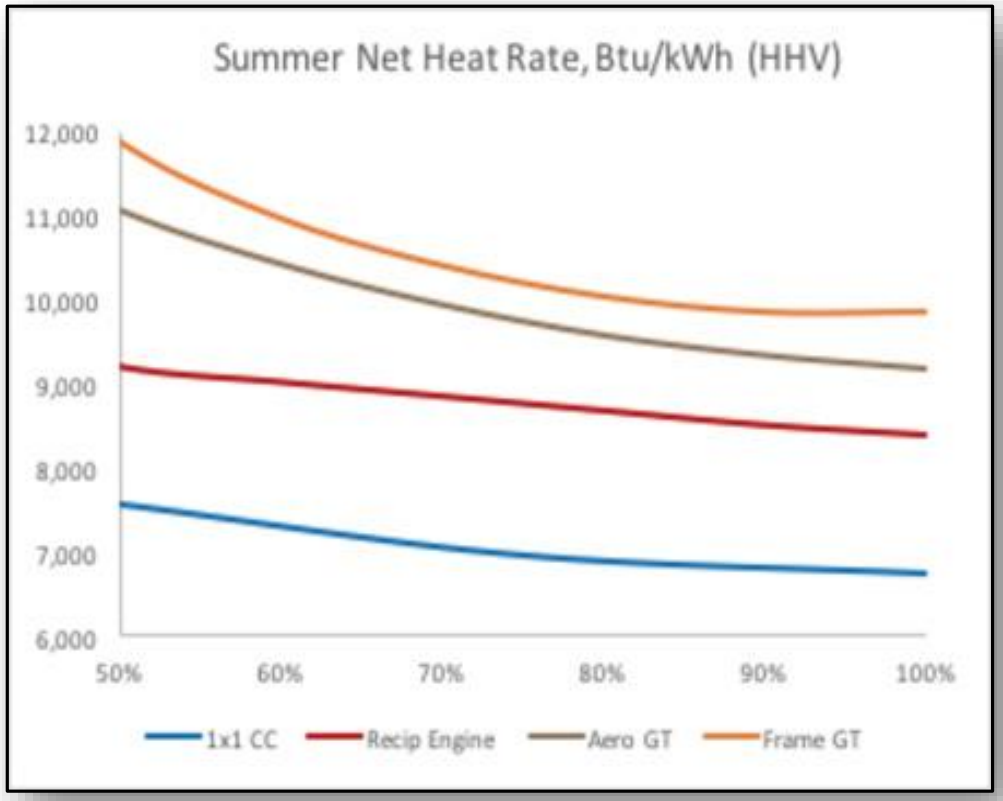
Class	Example Models
D/E-Class	• GE 7F • Siemens SGT6 • Mitsubishi H-100
F-Class	• GE 7F.03-.05 • Siemens SGT6-5000F • Mitsubishi M501 F
G/H/J-Class	• GE 7HA.01-.02. • Siemens SGTg-5000F • Mitsubishi M501J
Aeroderivative	• GE LM6000 • Siemens SGT-A65 • Mitsubishi FT4000
Reciprocating Engines	• Wartsila RT-flex96C • GE Jenbacher

Source: https://www.power-eng.com/articles/print/volume-121/issue-6/features/reciprocating-engine-generator-technology.html

Modularity and smaller size are an advantage in a changing market

Appropriate Demand Curve

Size is no longer an indication of efficiency



Flexibility with multi-unit designs

- Output scalability and load following without sacrificing efficiency
- 95% availability rate common among new models
- Minimized impact of maintenance or unplanned outages

Source: https://www.power-eng.com/articles/print/volume-121/issue-6/features/reciprocating-engine-generator-technology.html

Don't sacrifice flexibility for size and assumed efficiency

Appropriate Demand Curve
View of Consultants: Key trends favor flexibility

"... there are a handful of key trends that stand out in the industry—power density and efficiency, **fuel flexibility, integration with renewables, and the incorporation of telemetry**"

- Director of Product Management, Aggreko

"In the last five to seven years, because of performance enhancements on the heat rate, with the quick-start capability, and penetration of renewables**, utilities are using reciprocating technology** more often. It's become **more competitive with simple-cycle gas turbines**."

- Senior Manager at ICF International

Source: http://www.powermag.com/quick-starts-high-efficiency-grid-balance-engines-on-an-up-cycle/?pagenum=1

The market increasingly is valuing other qualities beyond economies of scale

ENERGYZT

Appropriate Demand Curve

Despite higher prices, Aeros can compete with the Frame F CT curve

ISO-NE 2017
Analysis of Net CONE

Table 2: Net CONE Summary for Candidate Reference Technologies (2021$)

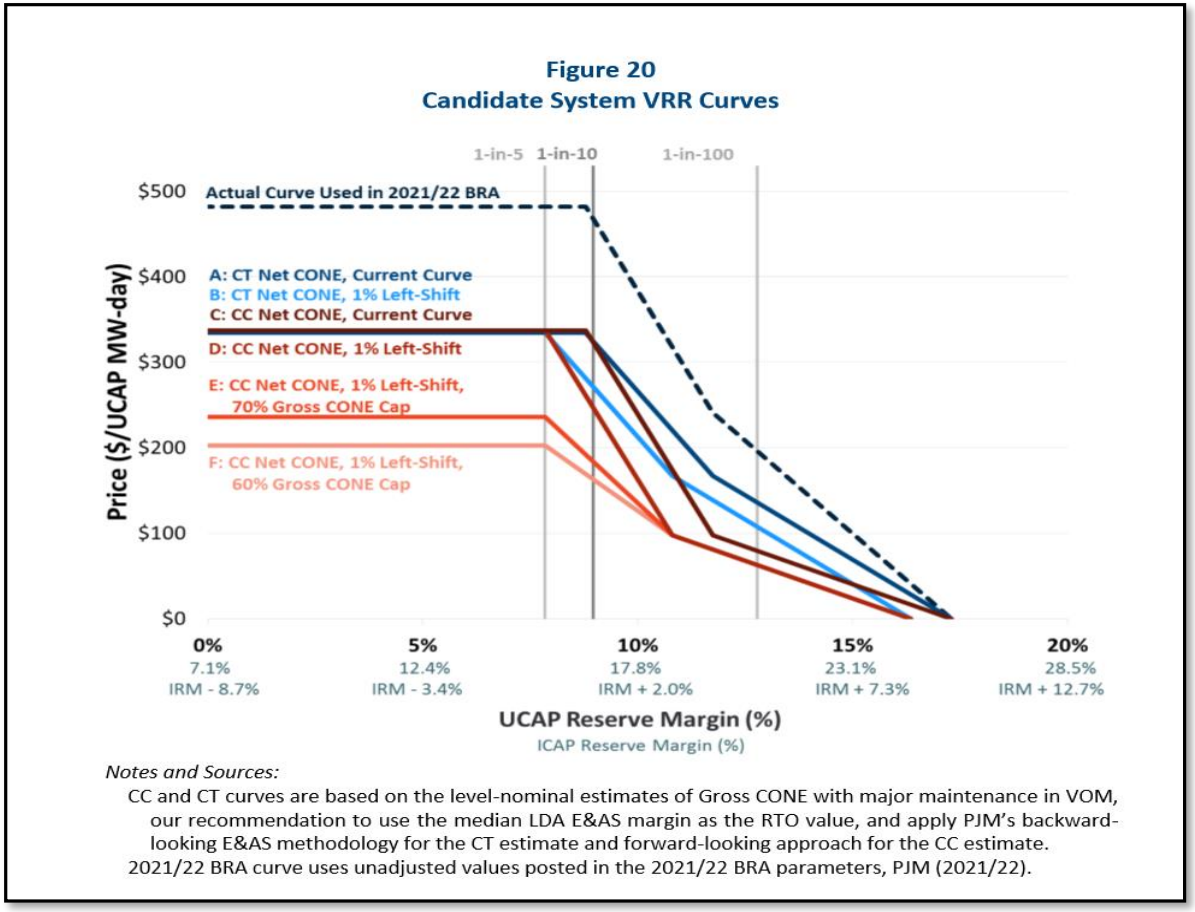
Reference Technology	Installed Capacity (MW)	Installed Cost (000$)	Installed Cost ($/kW)	ATWACC (%)	Fixed O&M ($/kW-mo)	Gross CONE ($/kW-mo)	Revenue Offsets ($/kW-mo)	Net CONE ($/kW-mo)	Net CONE ($/MW day)
1x1 7HA.02 (CC)	533	$598,958	$1,124	8.1	$5.01	$15.62	$5.62	$ 10.00	$ 329
1x0 7HA.02 (CT)	338	$304,179	$900	8.1	$3.21	$11.35	$3.31	$ 8.04	$ 254
2x0 LM6000 PF+ (Aero)	94	$198,363	$2,110	8.1	$6.96	$25.98	$3.63	$ 22.35	$ 735
1x0 LMS100PA (Advanced Aero)	103	$174,644	$1,696	8.1	$5.75	$21.03	$3.67	$ 17.36	$ 571

Source: Concentric Energy Advisors report, "ISO-NE CONE and ORTP Analysis: An evaluation of entry cost parameters to be used in the Forward Capacity Auction to be held in February 2018 ("FCA-12") and forward, January 13, 2017

Adopting the Frame H CT would make it harder for aeros to compete

Appropriate Demand Curve

Moving to a Frame H significantly decreases the VRR curve



Source: Brattle report, "Fourth Review of PJM's Variable Resource Requirement Curve," April 29, 2018, http://pjm.com/-/media/library/reports-notices/special-reports/2018/20180420-pjm-2018-variable-resource-requirement-curve-study.ashx?la=en

The proposed curves make it very difficult for other technologies to compete

Issues to Consider on the Frame H CT

CONCLUSION AND NEXT STEPS

Conclusion and Next Steps

The Frame F CT should be retained as the reference unit

- **There is no support for moving to a Frame H as a single unit in PJM**
  - No Frame H has been built as a CT in PJM
  - None are under development
  - None have cleared
  - None are in the queue
  - A Frame H CT is not likely to be developed

- **There is insufficient experience in other markets to estimate costs of Frame H CT**
  - Limited experience (only 2 under development on brownfield sites – MA and CA)
  - None being built in Texas or New York
  - Unproven technology for purposes of providing peaking services
  - Industry concerns about availability, fast-start and ramping capability
  - Unknown costs associated with cycling due to lack of experience

- **The Frame F CT better reflects industry trends**
  - Smaller size – the market is moving towards smaller units
  - Proven experience – built and operating as peaking units in PJM and other markets
  - Allows for other technologies that provide reliability and adequacy to compete

- **The Combined Cycle Frame H unit would be inconsistent, introduce significant volatility, does not reflect industry trends and would limit entry of other technologies**

The Frame H CT should be rejected and the Frame F CT retained

Formalize the results with a survey to confirm recommendations

- **Survey:** Develop an official survey of developers and lenders on different technologies
  - Technology of choice
  - Impact of increasing regulatory risk
  - Cost of capital

- **Next Session:** Presentation on critique of discount rate

QUESTIONS?

Sources

Turbine Comparisons

- https://www.power-eng.com/articles/print/volume-121/issue-6/features/reciprocating-engine-generator-technology.html
- https://www.power-eng.com/articles/print/volume-120/issue-11/features/turbines-vs-reciprocating-engines.html
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- http://www.powermag.com/quick-starts-high-efficiency-grid-balance-engines-on-an-up-cycle/?pagenum=2
- https://www.skyglobalpartners.com/power-producers-turning-to-reciprocating-engines/
- https://www.burnsmcd.com/services/electric-power-generation/fossil-generation/reciprocating-engine-plants

ISO Queue Data

- PJM: https://www.pjm.com/planning/services-requests/interconnection-queues.aspx
- ISO-NE: https://irtt.iso-ne.com/reports/external
- NYISO: https://www.nyiso.com/public/markets_operations/services/planning/planning_resources/index.jsp
- MISO: https://www.misoenergy.org/planning/generator-interconnection/GI_Queue/

Texas

- https://www.greentechmedia.com/articles/read/ercots-summer-peak-demand-forecast-new-investment-generator-profits-no-blac%23gs.j08n9Kg
- https://www.eia.gov/electricity/data/eia860/

Exhibit No. 4

CCJONsite User Conference Report

7HA users wrestle with emergent issues at inaugural meeting

Posted on October 8, 2018 by Team CCJ

A CCJ ONsite Special Report

Welcome the 7HA Users Group into the pantheon of power-industry organizations seeking peer-to-peer interaction to solve problems expeditiously and provide a collective check on official OEM positions regarding fleet- and plant-level issues.

Representatives from well over a dozen facilities and five countries, responsible for 30+ machines, attended the inaugural 7HA Users Conference, in Fort Worth, Tex, Sept 12-13, 2018. The table illustrates machine operating stats as reported by the participating owner/operators. Obviously, it is early days for the technology with respect to commercial operations.

Post-commissioning operating data reported at inaugural conference organized by GE H users[1]

Unit	Model	COD	Starts	Operating hours	Trips
A	7HA.02	04/2018	69	3700	8
B	7HA.02	04/2018	54	3700	6
C	7HA.02	07/2017	85	10,400	17
D	7HA.02	07/2017	69	10,158	3
E	9HA.01	09/2017	1	8500	1
F	7HA.01	09/2017	19	-	-
G	7HA.01	09/2017	32	-	-
H	7HA.01	09/2017	22	-	-
I	7HA.01	03/2018	10	-	-
J	7HA.01	03/2018	11	-	-
K	7HA.01	03/2018	21	-	-
L	7HA.02[2]	08/2018	54[3]	1350	-
M	7HA.02[2]	09/2018	43[3]	1350	-
N	7HA.02[2]	05/2018	50	3200	21
O	7HA.02[2]	09/2018	15	650	3
P	7HA.02[2]	06/2018	52	-	-
Q	7HA.02	-	15	9160	5
R	7HA.02	-	10	9230	4

[1]Not the total experience with GE H machines
[2]Single-shaft combined cycle
[3]Starts between first fire and commissioning

The scene was reminiscent of the early 1990s when the F-class technology emerged in commercial settings, dozens of units were sold worldwide, engines began operating before any appreciable operating experience had been gained with the fleet leaders, and before long, units were being air-lifted from around the world to have serious deficiencies addressed.

You can read about that experience in "Flaw in Design of Turbines Results in Massive Recall from Utilities All Over," by William M Carley of the *Wall Street Journal,* May 6, 1996.

We don't preface this article this way to create ill will among users and OEMs, but to remind the community that the evolution of high-energy, highly engineered, cutting-edge power systems is rarely a smooth process. To get to today's landscape of F-class machines humming around the world doing what is expected of them, for example, the industry had to get through a tumultuous early to mid-1990s period which deeply affected all five major large-frame OEMs at the time. Now there are three.

What follows is an exclusive industry report from the 7HA Users meeting. All technical issues are described generically out of respect for the extreme sensitivity owner/operators face managing the OEM relationship. GE was there in full force, though, with the meeting structured as first day devoted exclusively to owner/operators, and the second day to the OEM response, followed by a plant tour. CCJ was invited to attend only the part of the OEM session that had nothing to do with addressing issues.

The material, to the extent possible, is organized in priority of fleet issues and/or issues affecting multiple sites. Then a punch list is provided—issues experienced by one or two sites. Learning

Recent Posts

Attention to detail early in the HRSG lifecycle sets the tone for long-term reliable service

through open and transparent discussions among the folks who live and die with the equipment is the fastest route to commercial success with the technology.

Keep in mind that the 7H machine has established new industry records for power output, efficiency, emissions, and turndown flexibility. These achievements were reported in an earlier article.

GE's 7HA.01 and 7HA.02 gas turbines feature 14-stage compressor sections with three stages of variable stator vanes (left in photo) and four-stage turbine sections (right in photo). The 12-can DLN 2.6+ combustion section, the latest engines featuring axial fuel staging, is between them. The Dot 01 is designed to produce 290 MW net at 42% efficiency in a simple-cycle configuration, 880 MW net at 62.6% efficiency in a 2 × 1 combined-cycle arrangement. For the Dot 02, the simple-cycle numbers are 384 MW at 42.5%, with combined-cycle output and efficiency at 1184 MW and 63.3%.

First-stage bucket failure

As if on cue to accentuate the importance of such conferences, the first speaker noted that one of its machines had, just days earlier, experienced a first-stage turbine (S1B) bucket failure after less than 10,000 operating hours. All four units (at two sites) being operated by this company were then shut down as a precaution.

Days after the conference, Reuters reported on September 20 that four GE HA-class machines in the US were shut down because of an "oxidation issue" and the company expected that all 51 machines shipped to date would be affected. The article also noted the fix, according to an OEM spokesperson, would require "minor adjustments." Users at the meeting said GE had "acknowledged that this is a fleet-wide issue.

Others have reported that the oxidation affects a key alloy in the blade and shortens its life. GE, already dealing with existential corporate and Wall Street level complications, was dealt yet another blow by this event.

The bucket issue also has thrown into some turmoil the delivery schedule for machines to US customers, according many present at the conference. One, with a commercial operating date (COD) a few years out, said that the buckets destined for their machine, what were to be the first "Gen II" S1Bs, were now being diverted as replacements in the failed units. This action has postponed COD.

Users wondered aloud whether this "fix" would be the right one, since there is no commercial operating experience with Gen II hardware. The next opportunity to "look at them" in the first machine incorporating them, said the site representative, was not expected until a scheduled outage many months out.

Another operating site rep said the OEM was 9-10 months behind on spare parts and that they were "desperate for spare stage 1 blades," and needed to "get through the fall on someone else's blades." A third site was expecting its S1B replacements in 2019. A fourth noted that they were getting a mix of Gen I and Gen II hardware. Finally, a site with several thousand hours on its HA.01 machines reported that the dampening pins for its first-stage buckets already had been replaced twice.

AFS failure

Some HA combustors feature axial fuel staging (AFS), of which a key component failed and caused damage at one site. The GT was operating at 298 MW when the failure occurred. It not only caused internal damage to the combustion system, but also breached a combustor can into the turbine compartment, triggering the fire protection system and tripping the unit.

There are 48 of these components on each machine with AFS. At the site experiencing the failure, 40 of these components were replaced. At least two other plants have had AFS components replaced.

As later elaborated on by a site representative, the DLN 2.6+ combustion system on such units consists of a fuel flow path referred to as "axial fuel staging" (AFS). Fuel enters the GT compartment and passes into a ring manifold and is delivered to each combustion chamber via "pig tails." Fuel then is equally distributed to four ½-in. tubes attached on the outside of the "Unibody" (but internal to the combustor), and injected into the hot gas path through four nozzles.

The idea behind this flow path is to introduce fuel gas downstream of the flame zone and just upstream of the turbine first-stage nozzle. The fuel gas auto-ignites, increasing the energy available for the power turbine but with no increase in NOx emissions. This also allows for extended turndown while maintaining emissions compliance.

At the site with the AFS tube failure (during normal operation), a flashback occurred causing complete disintegration of two fuel nozzles, damage to the Unibody assembly within the combustor, and some splatter impinging on the turbine first-stage nozzles and buckets within the quadrant of the failed combustor.

There was also a breach of the combustor wall. Hot gases entered the turbine compartment and triggered the fire-protection-system heat detectors, which also automatically initiated protective

501F exhaust-system repairs never ending? Replace to eliminate the problem
INDUSTRY NOTES, November 2018
Factor European experience into O&M practices at US combined cycles, Part I
7HA users wrestle with emergent issues at inaugural meeting
Latest GTs pose special challenges for NOx, CO catalyst system design

action of immediate unit trip. Data review revealed that approximately 45 minutes before unit trip there was an instant spike in NOx, exhaust spreads, and low-band combustion dynamics.

The root cause of the AFS tube failure is unknown at this time pending completion of the analysis effort by the OEM.

Vibration

One site with around 3700 operating hours on its HA.02 machines reported that they had been plagued with cold-start transient vibration and start-to-start vibration issues associated with bearing No. 3, which the OEM had recently acknowledged were fleet-wide issues. The presenter said that half a dozen other machines were experiencing similar problems.

The vibration levels increase over time, and are associated with thermal changes in the unit. Low-load operation makes it worse. The vibration is supposed to be below 5 mils, but at times has been indicated as high as 12 mils, and routinely is around 7. Perhaps the most aggravating thing is there is no real pattern to the deviations, other than they tend to be "stable" at baseload.

Numerous foundation checks by the OEM didn't solve the problem, nor did attempting to correct the balance with strategically placed weights ("shots"). In fact, "placing the shots in the wrong places led to numerous fruitless iterations." An hypothesis of coupling misalignment also has not proven out.

Excessive vibration leads to secondary issues, such as oil leakage at the deflector plate from one of the generator rotor bearings, terminal strips coming loose, and failures of exhaust-thermocouple attachments. "We are replacing many exhaust thermocouples," one said. Another site experiencing similar vibration problems is testing a prototype thermocouple that may be more robust.

One site reported that they had changed out the seals on the leaking generator bearing, added a row of labyrinths, and made some other adjustments which appear to have corrected their problem.

Complex controls

Several attendees commented on the complexity of the H-class control system and the shortage of OEM control-system engineers familiar with the H machines. "Controls are really complicated," one said, "whenever we do a logic change, GE doesn't have enough controls engineers to support us." Another worried that "the digital intelligence is not 100% developed" for these systems. A site experiencing only one trip blamed it on a fieldbus error in the control system and subsequently requested that the GT controls be hard-wired.

A third presenter complained that the original GT/G controls had no redundant vibration configuration and cautioned attendees to "be aware of the primary-frequency response logic for performance tests." This site also had incorrect digital valve position (DVP) firmware settings resulting from miscommunication between the OEM and the sub-vendor. The presenter urged his colleagues to "be familiar with foundation Fieldbus and Profibus for controls as applicable to the Mark VIe GT control platform.

Punch-list items

Those in the queue for their machines, and those considering ordering an H-class unit, will want to consider the following punch list of items discussed at the meeting. These issues have not risen to fleet level issues, or at least not yet, and some may be peculiar to one or two sites, placed in the general category of "teething" issues common to all new facilities, and may have shared responsibility with the EPC contractor.

- **Digital valve positioners.** The same site referenced above with about 3000 operating hours reported failures of digital valve positioners, an "instantaneous event" that leads to a GT trip, while another site reported that temperature-control issues with the DVP led to three trips.
- **Water intrusion.** Fan/blowers in the GT housing reduce heat levels but also create a differential pressure which sucks water in when it rains. A site in an arid climate didn't experience this until the first time the area got a good soaking. These blowers are redundant and both need to be in service because they are critical to maintaining an internal temperature so that electrical and digital electronics don't "burn up." One plant lost a bearing in the motor of one of the fans and had to replace the entire motor.
- **Air-filter cleaning system.** This system has 400 small valves. One plant experiencing leaking in a few of these valves decided to replace all of them. The communication-system bus which "talks" to all the individual valves failed.
- **Online washing.** Several plants do this everyday and had to make modifications to "make sure the pump logic was properly integrated." One user cautioned that the drains are sized for "zero margin," and had to replace a few bad valves and fix loose flanges.
- **Water carryover.** More than one plant has experienced water carryover from the evap cooler into the gas turbine.
- **Generator.** One plant had a flashover event with the collector brushes. The original number of brushes was based on the nameplate rating, but the OEM recommended that they be reduced from 24 to 12. One user cautions that generator end windings have "required lots of money and work." The OEM calls it "normal wear and tear," according to one user, and that you have to be careful negotiating with the OEM because they will accuse you of "improper maintenance."
- **ST/G bearing leak.** A site with a single-shaft combined cycle reported that the No. 1 bearing in the low-pressure steam turbine/generator had sprung a "major leak" and the plant had to "limp through the summer."
- **Miscellaneous heaters.** The same site just above also reported "lots of workarounds" with the startup natural-gas auxiliary heat exchanger, the natural-gas performance heat exchanger, and the air inlet heating system (upstream of the inlet air filters), as well as "lots of issues with the air-cooled condenser."

- **Cap effusion plate.** A site overseas reported minor cracks were detected in the combustor-cap effusion plate following a borescope inspection after around 8500 operating hours.
- **Igniters.** One plant experienced packing leakage and overheated igniter wiring on two machines, discovered during the first inspection. The presenter noted that an igniter had liberated at another site he was familiar with.
- **Lift-oil pumps.** One site experienced failures with the pumps, found a breaker off of one lift-oil pump and another that wouldn't start, and noted that "lube-oil skids are tightly designed, very compact."

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