



Reactive Power Compensation: How to Unlock New Revenue Opportunities for Solar and Storage Projects

Webinar Q&A | July 29, 2020

Question: What is the best model (not necessarily gold standard) for reactive power compensation based on your experience in RTO markets?

Answer: Currently, there are three models for reactive power compensation. The first and most lucrative model awards fixed monthly payments to qualifying generators for their full operational life based on unit-specific costs and reactive capability. PJM and MISO use this model.

The second model awards fixed monthly payments to qualifying generators based on an RTO-wide stated rate. This method can provide material payments to qualifying generators but is unlikely to yield payments as high as those in PJM and MISO. NYISO and ISO-NE use this model.

The third model awards variable, lost opportunity cost-based payments to qualifying generators when dispatched to provide reactive power support in excess of a standardized power factor requirement range. This is the least lucrative and most uncertain model because generators are seldom dispatched to provide excess reactive power support.

We believe it's fair to say that the third model is the least preferred because it lacks compensation for reactive capability regardless of production, and thus lacks a fixed revenue component. Which of the remaining two approaches is "best" is somewhat subjective depending on the resource owner's view on settlement risk relative to potential revenue upside. While the cost-of-service approach used by PJM and MISO is the most lucrative, it's also the most complex and has the greatest uncertainty in terms of the final revenue value to the asset after settlement with FERC staff. The state rate methodology produces a lower return but is more predictable because revenues are directly attributable to reactive power capability multiplied by the applicable rate.

Question: Can solar projects with an external resource designation in MISO qualify for reactive power compensation?

Answer: Any generation resource which is able to satisfy the eligibility requirements in Schedule 2 of MISO's Open Access Transmission Tariff (OATT) can receive reactive power compensation.

1. The Reactive Power Resource
 - a. operates with its voltage regulators in automatic mode and responds to voltage schedules of the Transmission Provider or Transmission Operator for the pricing zone in which the Reactive Power Resource is located;
 - b. is able to maintain voltage support within its design limits; and
 - c. is capable of a reactive power range of 95% leading to 95% lagging at the Point of Interconnection unless otherwise stated in the Generator Interconnection and Operating Agreement for the Reactive Power Resource;
2. The Reactive Power Resource

- a. can respond to changes in voltage on the system and to changes in voltage schedules if the facility is operating; or
 - b. will provide voltage control specified by the Transmission Provider or Transmission Operator immediately, if intra-day system conditions require additional reactive power supply to maintain reliability, or as instructed by the Transmission Provider or Transmission Operator prior to the Operating Day based on forecasted system conditions, taking into consideration the unit's operating characteristics, and whether the Reactive Power Resource is not operating at the time of the request as a result of an unscheduled or planned outage;
3. The Reactive Power Resource has met all applicable testing requirements for voltage control capability required by the Regional Reliability Council where the Reactive Power Resource is located within the past five years; and
 4. The Reactive Power Resource owner has not included and does not currently include the Reactive Power Resource in the computation of rates for Transmission Service and has submitted a request to the Transmission Provider for Qualified Generator status as outlined in Section II.C.

Question: Are there usually any intervenors in reactive power filings @ FERC?

Answer: PJM and MISO almost always intervenes to monitor the matter but rarely participate in proceeding. The PJM Independent Market Monitor ("IMM") regularly intervenes and opposes the rates based on its general policy against providing revenues to generators through conventional ratemaking methodologies. Sometimes the utility that the project interconnects to will intervene as will some customers. However, this last group are the least active.

Question: How is the initial proposed tariff rate in the FERC application arrived at? How would a plant owner/operator calculate this before their application submittal?

Answer: Please refer to slide 23 of the presentation.

Assumptions				
Input	Units	Total	Row	Source
Total Capacity (nameplate)	MWac	100	a	Assumption
Total Capex (unitized)	\$/kWac	1,250	b	Assumption
Reactive Share of Total Capex	%	20.0%	c	Market Avg
Power Factor	%	80.0%	d	Assumption
Fixed Charge Rate	%/yr	11.0%	e	Market Avg
Settlement Discount	% ARR	50.0%	f	Market Avg

Example Gross Annual Revenue Requirement (ARR)				
Output	Units	Total	Row	Formula
Reactive Fixed Cost Basis	\$	25,000,000	g	$g = a * b * c * 1000$
Reactive Fixed Cost Allocation Factor	%	4.0%	h	$h = (1 - d ^ 2) * e$
Estimated Filed ARR	\$/yr	990,000	i	$i = h * g$
Estimated Settled ARR	\$/yr	495,000	j	$j = i * (1 - f)$
Estimated Settled ARR (unitized)	\$/MW-yr	4,950	k	$k = j / a$

Question: Are these filings public? Do reactive power tariffs filed with other generators have an impact on settlements for solar going forward? Or will this likely have an impact when there are more solar reactive power rates "on file"?

Answered on webinar ([view webinar recording](#))

Question: Who will pay the system owner? PJM and MISO?

Answer: Compensation comes from PJM or MISO through Schedule 2 of their respective FERC-approved Tariffs. However, such costs, like all costs in RTOs, are ultimately allocated to and collected from end-use customers.

Question: To what extent is reactive power compensation available for state-jurisdictional projects? A number of state IAs say that the utility has to pay the interconnection customer for reactive power if it "pays itself" for reactive power. What does that mean and do utilities typically pay themselves?

Answer: Reactive power compensation outside of RTOs and for state-jurisdictional projects varies by state, and sometimes by utility. Additional analysis of individual tariffs is needed in order to answer this question.

Question: What effects on all of this is the petition filed on May 3 with FERC seeking guidance regarding FERC's methodologies for reactive power compensation expected to have?

Answer: If Petitioners' arguments are ultimately adopted by FERC, it will make it easier for merchant generators to use a higher cost of capital proxy value in PJM. This will increase reactive power



compensation for merchant generators in PJM, and reduce litigation expenses because FERC will have issued guidance on this issue – meaning that staff will likely be less likely to push back on applicants seeking to use more representative cost of capital proxy inputs.

Question: Do you know what the MW size ranges are for these settled solar projects in MISO/PJM?

Answer: 3-81 MW (ICAP)

Question: How much sacrifice on solar generation might be made by receiving the fix payment of reactive power payment?

Answer: (We note that the initial question was unclear).

Filing for and receiving reactive revenues has no impact on the generator's operating profile. The ISO/RTOs have a right to dispatch generators to provide reactive service as needed to maintain reliability. Reactive tariffs simply compensate the generator for making the service available to the ISO/RTO.

Question: On counterparty settlement positions how much does it matter who the TO is?

Answer: The tariff rate is filed with FERC and is paid by the RTO, the interconnecting utility should not have any material affect on any risks associated with entering into a reactive power tariff. However, some TOs are more active than others. For example, Dominion tends to intervene more often in reactive case than most other TOs.

Question: You said that PF of solar/storage is usually ~0.8, but a previous slide says that FERC requires all generators to provide reactive power within a PF of +/- 0.95. Can you please elaborate?

Answer: The 0.8 power factor refers to the nameplate rating of the resource. The 0.95 power factor refers to the minimum interconnection requirements for participating in an RTO. Note that the higher the power factor, the lower the reactive capability. This means that a resource with a power factor 0.80 will be able to provide reactive power support in excess of the ISA-required power factor of 0.95. In PJM and MISO, reactive compensation is based on the nameplate rating of each asset – not the minimum ISA-required power factor.

Question: Any insight into how reactive rates can be established in RTOs that don't currently offer them i.e. SPP, ERCOT, and CAISO?

Answer: Each RTO would have to alter its tariffs via existing stakeholder and associated FERC filing processes.

Question: Does this apply to projects without a ferc jurisdictional interconnection?

Answer: Only state-jurisdictional interconnections for projects that also participate in an ISO/RTO organized market. Otherwise, revenues would be addressed in the local utility tariff.

Question: What kind of compliance obligations does this impose on the generator?

Answer: If a qualified generator fails to comply with the TOs voltage control requirements three or more times in a calendar month for reasons other than planned outages, the TO can modify the resource's eligibility to continue receiving payments for reactive support.

Question: How about in the WECC region outside CAISO? also if it's still interconnecting within Western EIM vs not.

Answer: See previous answer related to reactive power compensation outside of RTOs.

Question: Why do so few generators receive compensation for this? Do they just not know about it?

Answer: Solar generators are just starting to understand potential of reactive power compensation, and it was only in 2016 that FERC made it clear that solar resources were required to provide reactive power capabilities.

Question: With PJM/MISO queues filled with Solar and Storage projects, can we expect the value of the Reactive Power fixed payment to get arbitrated lower?

Answer: No. The rate in PJM and MISO is based on each resource's unique costs and reactive capability. In NYISO and ISO-NE, on the other hand, the value of reactive payments can decrease or increase depending on system needs for additional reactive power support.

Question: Can you speculate as to why no storage resources have filed for reactive power revenues? Would there be any physical impacts to a storage system (through, for example, increased cycling) that could potentially limit the desirability, or is this a moot point given that all generators are required to provide reactive power capability?

Answer: It is likely that storage resources have abstained from filing a reactive tariff with the FERC because (1) the cost of filing may exceed the benefit received for smaller resources; and (2) the FERC only began allowing asynchronous resources (e.g., wind, solar, storage) to participate in this market opportunity in late 2016.

Question: Thank you for this. So if nothing is done, a project should receive reactive power (variable payment) in PJM/MISO and then once the FERC payment is approved. That overtakes the variable payment and you only receive the fixed payment MW/yr?

Answer: Fixed and variable compensation for reactive are not mutually exclusive. If you make the FERC filing you can get fixed compensation in addition to any variable compensation that you receive.

Question: Since it is FERC order, will other ISOs like CAISO eventually adopt such fixed payment too?

Answer: Although market participants in CAISO have requested a rule change to allow resources in the CAISO market to receive reactive compensation using a method comparable to that used in PJM and MISO, CAISO has denied these requests. However, there are ongoing stakeholder discussions to evaluate new methods for incentivizing solar and storage deployments in CA through a more robust reactive power compensation model, but it remains unclear if and when CAISO will modify its current market rules governing reactive power compensation.

Question: Do you have an idea of the average cost of the FERC filing?

Answer: Gabel and Nelson Mullins are able to discuss this in more depth on a confidential basis. Many factors impact the cost of filing for reactive power compensation.

Question: Are generators in Regulated Markets able to be compensated for this? Let's say, how would a project in Southern Company incorporate such revenue.

Answer: See previous answer

Question: In NYISO, are the fixed payment for reactive power issued to the generators by default and only the variable payment requires a FERC filing settlement? or do both revenue streams require the FERC filing/settlement?

Answer: Payments in NYISO are not issued by default. Generators must qualify:

To qualify for payments, Suppliers of Voltage Support Service shall provide a Generator that has an AVR, or a Qualified Non-Generator Voltage Support Resource with, other than the Cross Sound Scheduled Line, an AVR, or a synchronous condenser, each of which must be electrically located within the NYCA. All Suppliers of Voltage Support Service must successfully perform Reactive Power (MVAR) capability testing in accordance with the ISO Procedures and prevailing industry standards. The ISO may direct Qualified Suppliers of Voltage Support Service to operate their Voltage Support Resources within these demonstrated reactive capability limits. Qualified Suppliers of Voltage Support Service will test their Voltage Support Resources and provide these services in accordance with ISO Procedures. Rate Schedule 2 - Payments for Supplying Voltage Support Service.

<https://nyisoviewer.etariff.biz/viewerdoclibrary/mastertariffs/9TariffSections/177.htm>

Question: Has FERC initiated a paper hearing on an average ROE in PJM and how would that change reactive filings and settlements.

Answer: FERC has set a hearing in Docket No. EL19-70 that addresses proxy inputs used to calculate merchant generators' cost of capital in PJM, among other issues related to ROE.

Question: Can you retroactively apply for this revenue stream on solar projects with IA signed prior to 2017 and are already built? So long as the project does provide PF below 0.95?

Answer: Yes

Question: For solar without storage, does the ability to provide reactive power at night play into the settled compensation?

Answer: No. Compensation is based on nameplate reactive capability – not utilization. However, resources with a higher reactive capability (e.g., pairing with storage or utilizing inverters with reactive capability outside feed-in operations) or cost structure will receive a higher rate, all else equal.

Question: Why is the fixed payment not available in SPP, CAISO, and ERCOT?

Answer: Each RTO chooses its own model for compensation.

Question: If the second form of compensation is lost opportunity cost is there a net benefit or just a wash?

Answer: It is typically "just a wash"

Question: If filing under Section 205, and accepted, does the generator qualify for both the fixed and variable payments, if any?

Answer: Yes.

Question: What is the current filed rate for reactive power in PJM and what is the range of negotiated rates you are seeing recently?

Answer on webinar



Question: Why do you feel that CAPEX is going to drive the rate (on a /MW basis)? Shouldn't the per unit (\$/kW) CAPEX and the per unit (\$/kW) ARR be linked. The higher \$/kW CAPEX plants were all smaller which is likely the driver of the higher rate, no?

Answer: [question is unclear] Reactive compensation is cost-based, which means the higher the cost to construct and operate the resource, the higher the reactive revenues, all else equal. Measuring settled reactive rates on a \$/MW or \$/kW basis allows for an “apples to apples” comparison across resources of different sizes.

Question: You said two ways for compensation? If its lost opportunity cost is there a net benefit or just a wash?

Answer: The two compensation components are fixed capability payments and lost-opportunity costs for avoided energy revenues due to reactive power production. The later makes the generator whole for providing reactive service at an equivalent value to what it would have otherwise received in the energy market,

Question: Is there any terms in a regular energy PPA that you need to watch out for that would not allow you to get separate reactive power compensation?

Answer: The most important terms to watch out for deal with who is entitled to ancillary services revenue. It isn't that reactive power compensation is necessarily prohibited, however, it may be ambiguous who is responsible for making the filing and entitled to the compensation (i.e. the seller or the offtaker).

Question: This is for transmission connected resources only?

Answer: No. Any resource that is “in front of the meter” (transmission- or distribution-level) may be eligible.

Question: I understand MISO and PJM are focus here and have similar structures for compensation. Can you touch on (1) other RTO/ISOs, and (2) bilateral markets / VIU BAAs?

Answer: See previous responses.

Question: You said that FERC usually settles a discount to filed rate. Typically what range of discount?

Answer: The current average for solar is approximately 50%, meaning if a resource files for a revenue requirement of \$1,000, it can expect to receive \$500 upon settlement, on average.

Question: Would other ISOs soon following suit?



Answer: Vague question. Speculative. No indication that the other RTOs will adopt a similar model.

Question: Is there a specific amount of allotted funds for Fixed Payments that may run out?

Answer: No. TOs flow all charges through their rates to Load.

Question: Where is the power factor measured for reactive capability in regards to compensation?

Answer: generator terminals

Question: What is typical cost (legal, admin, consultants) to submit filing at FERC and reach settlement?

Answer: The costs likely vary by vendor.

Question: By decreasing the power factor, aren't we losing on revenues for the Mwh? Unless the reactive power revenue is higher than the Mwh, isn't this more cumbersome?

Answer: compensation is based on full design capability – not utilization. This means that if a resource is designed with a maximum power factor rating of 0.80 but typically operates at a power factor of 0.99, on average, the reactive rate would still be based on the full design capability even if the resource operates at a much lower reactive output on average.

Question: Once this rate is set by FERC settlement process, can this rate be changed later if there is incremental investment in the solar plant? (not O&M or inverter replacement)

Answer: project owners can file updates to an existing reactive rate or file a completely new reactive rate at any time with no restriction.

Question: Will FERC be changing value and/or processes for how they value reactive power

Answer: FERC has the authority to review and modify the current compensation model but has provided no indication that it intends to do so.

Question: What Utilities in regulated markets (non-RTO) offer fixed reactive power compensation? Where can we find these rates?

Answer: few regulated utilities offer comparable levels of reactive compensation, but some have engaged in bilateral contracts to procure reactive power support from merchant generators using a compensation model that is consistent with that used in PJM and MISO.

