

# Reactive Power Compensation Overview

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November 5, 2021



**Reactive power** helps support appropriate voltages on the transmission system to allow for the movement of real power across transmission lines.

Measured in  
VARs or MVARs.

***Important:***  
*“VARs do not travel well”*

Transmission lines dissipate reactive power more quickly than real power, and accordingly reactive power cannot be efficiently transferred long distances on transmission lines.

Ensuring that reactive power is adequate to support transmission service is an important responsibility of the transmission planner and operator.

- In organized wholesale markets, the system operator (ISO/RTO) and transmission owners jointly set “voltage schedules” for generators in each transmission owner area, and consider future reactive power needs as part of transmission system planning.
- A “voltage schedule” is a coordinated target voltage with a tolerance band or voltage range. This target is set to control an agreed-upon reference voltage, typically a transmission bus voltage. The automatic voltage control mode is typically used to meet the voltage schedule, but generators may also use automatic MVAR or automatic power factor control modes. The voltage schedule is needed for voltage support and is incorporated into system studies.

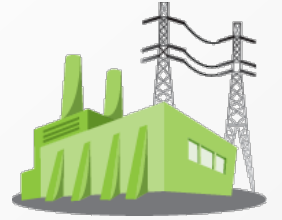
The provision of reactive power from generators usually refers to operating with “**leading**” or “**lagging**” reactive power.

- In PJM, operating with “**lagging**” reactive power refers to supplying reactive power, while operating with “**leading**” reactive power refers to consuming reactive power.
- Generally the reactive power “**capability**” of a generator refers to the ability to operate with leading/lagging reactive power.

**“Power factor”** is the ratio between a generator’s real power (MW) and apparent power (MVA), where apparent power is the vector sum of real and reactive power.

A device with a lagging power factor tends to raise system voltage, while a device with a leading power factor tends to lower system voltage.

All interconnected generators must have a minimum level of reactive capability when interconnecting under FERC jurisdiction.



### PJM ISA:

- min PF of 0.95 lead/0.90 lag (synchronous);
- min PF of 0.95 lead/0.95 lag (non-synchronous).

Reactive power compensation is a byproduct of “functional unbundling” under Order No. 888 (1996) – one of the original six ancillary services required under a *pro forma* OATT. See Order No. 888, FERC Stats. & Regs. ¶ 31,036 at 31,707.

Functional unbundling required separately stated rates for generation, transmission, and ancillary services (including reactive power).

FERC identified **two** ways reactive power can be provided:

- Installing facilities that are part of the transmission system (not unbundled – i.e. remain rolled into FERC-jurisdictional transmission rates).
- Using generation facilities (unbundled from transmission service; separate and distinct ancillary service): “Reactive Supply and Voltage Control Service”

In Order No. 2003, the Commission required that units interconnecting have a minimum power factor range of 0.95 leading to 0.95 lagging, unless the transmission provider establishes a different power factor range.

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- Required that generators be paid when requested to operate outside of established power factor range.
- Did not require that units be compensated when operating within the established power factor range. See Order No. 2003, 104 FERC ¶ 61,103 at P 546 (2003). As a result, payment for reactive power capability varies nationally:
  - some transmission providers make no payments for reactive power capability within the 0.95 leading to 0.95 lagging power factor range;
  - some transmission providers make cost-based payments for reactive power capability to compensate for the costs incurred to provide service.

In Opinion No. 440 (88 FERC ¶ 61,141 (1999)), the Commission approved a methodology presented by AEP to recover costs for reactive power.

- Three** components of a generation plant related to the production of reactive power:
- 1) the generator and its exciter;
  - 2) accessory electric equipment that supports the operation of the generator-exciter; and
  - 3) the remaining total production investment required to provide real power and operate the exciter.

Because these plant items produce both real and reactive power, AEP developed an allocation factor to sort the annual revenue requirements of these components between real and reactive power production (the AEP methodology). Capability is measured at the generator terminals.



In PJM, generators are compensated for reactive power in *two* primary ways:

**Operating Costs**

**1**  
Tariff, Att. K-App./OA, Schedule 1, section 3.2.3B –  
**“Reactive Service”**

- Paid LOC when dispatched down to provide reactive; paid uplift when dispatched up.
- Allocated to benefited load zone.

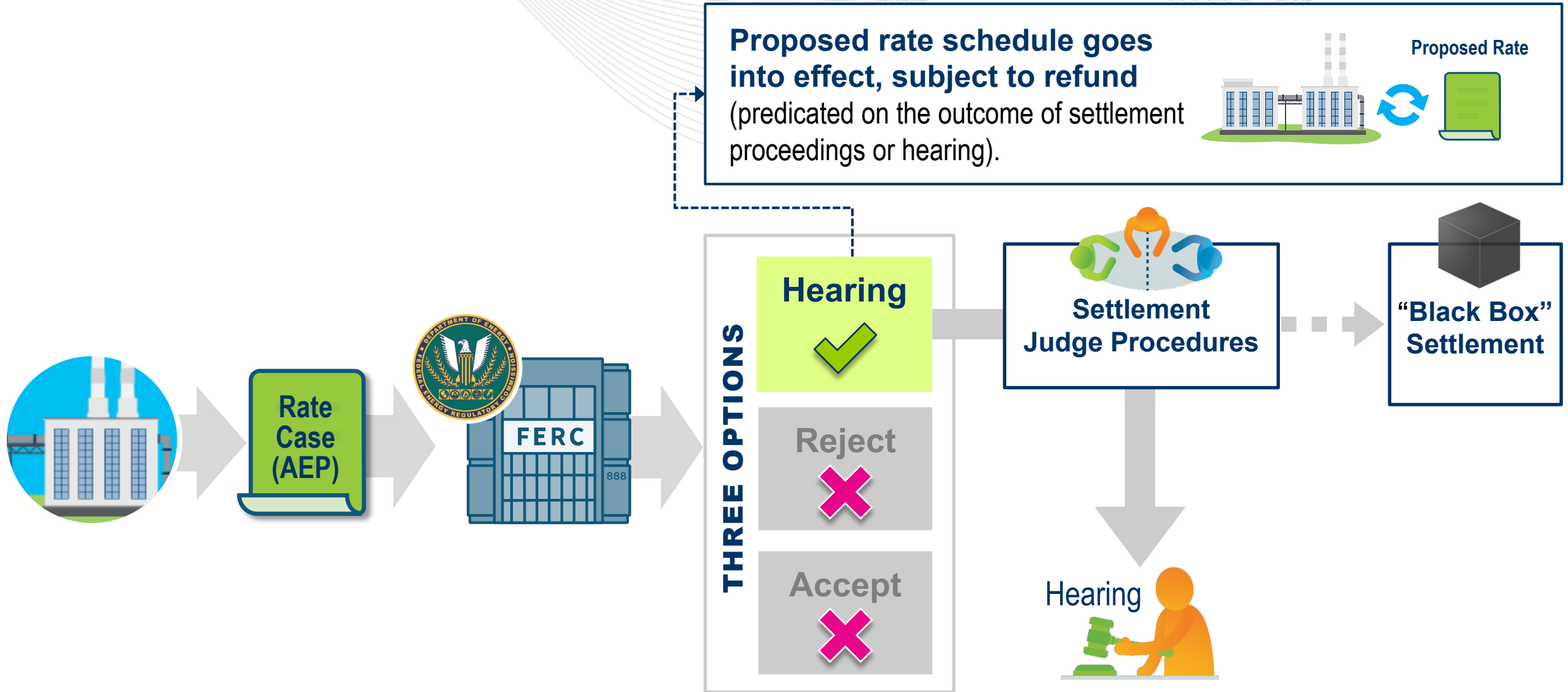
**Mainly Capital Costs**

**2**  
Tariff, Schedule 2 - Reactive Supply & Voltage Control  
**“Reactive Supply”**

Annual Revenue Requirement must be filed with/accepted by FERC.

- Credits on monthly PJM invoice (charges allocated to Transmission Customers in zone where generator is located).

# Current Framework for Reactive Supply



- PJM Legal & Settlement Departments monitor reactive supply rate cases, and implement revenue requirements consistent with legally-binding actions in those proceedings. *These include:*
  - FERC order accepting proposed rate schedule, subject to refund, and setting for hearing/settlement judge procedures.
  - FERC order approving settlement.
  - Settlement judge granting interim rate relief.
- PJM also intervenes in rate cases to:
  - Ensure the settlements can be implemented.
  - Provide information to the parties during settlement negotiations.

Schedule 2 (as of 2015) requires that, at least 90 days prior to a unit's deactivation or disposition, the owner must either:

- File to revise or terminate the revenue requirement; or
- Submit an informational filing to FERC and provide a copy to PJM.

# How Do Other RTOs Compensate for Reactive Supply?

		Construct
<b>RTO</b>	<b>MISO</b>	Rate Case
	<b>NYISO</b>	Flat Rate
	<b>ISO-NE</b>	Flat Rate
	<b>SPP</b>	N/A (Variable Payment Only)
	<b>CAISO</b>	N/A (Variable Payment Only)

- FERC Staff **2005** Reactive Power Compensation Report (February 4, 2005, Docket No. AD05-1-000):  
<https://elibrary.ferc.gov/eLibrary/filedownload?fileid=0071DB31-66E2-5005-8110-C31FAFC91712>
- FERC Staff **2014** Reactive Power Compensation Report (April 22, 2014, Docket No. AD14-7-000):  
<https://www.ferc.gov/sites/default/files/2020-05/04-11-14-reactive-power.pdf>
- Open Reactive Supply compensation docket (AD16-17-000)
  - Technical conference held in 2016.
  - Currently dormant.

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**Please send questions/comments to  
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