Reactive Power Requirements for Asynchronous Resources Initiative

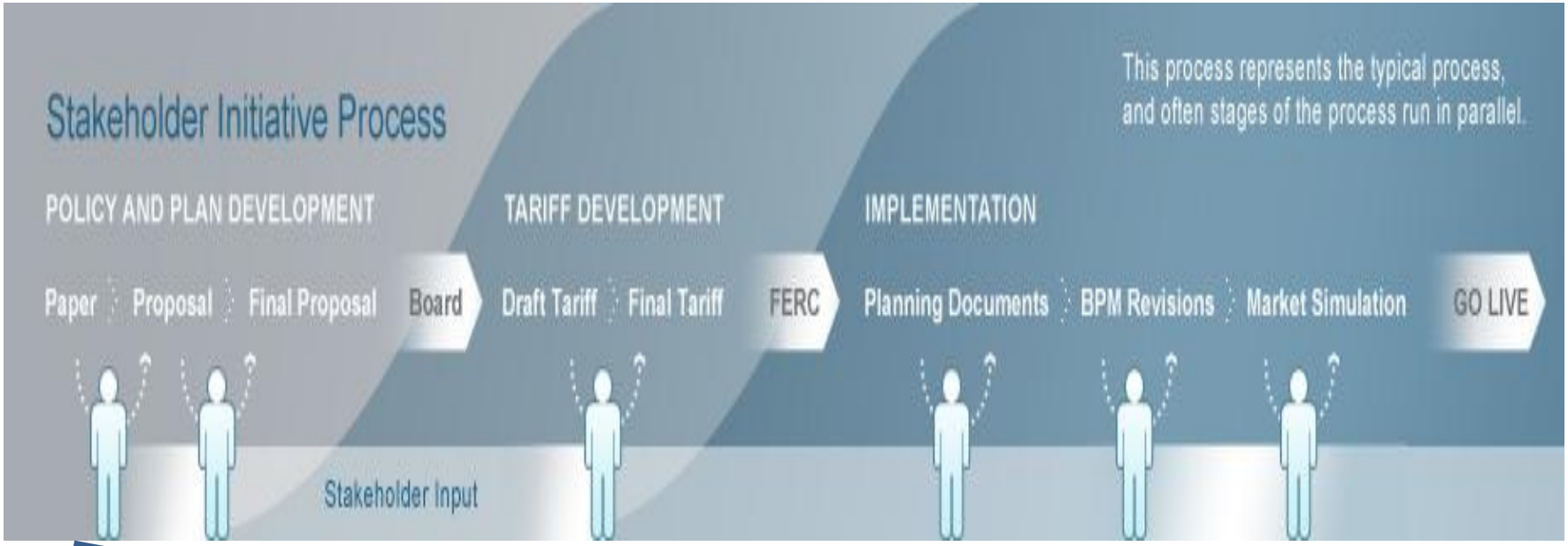
Stakeholder Web Conference

March 13, 2015

Agenda

Time	Agenda Item	Speaker
9:00-9:10	Introduction, Stakeholder Process	Kim Perez
9:10-9:20	Background and context	Tom Flynn
9:20-9:40	Description of the current approach	Robert Sparks
9:40-10:00	Issues with the current approach	Robert Sparks
10:00-10:50	Straw proposal	Clyde Loutan
10:50-11:00	Next Steps	Kim Perez

ISO Stakeholder Initiative Process



We Are Here

Stakeholder process schedule

Step	Date	Event
Round 1	March 5	Post issue paper & straw proposal
	March 13	Stakeholder web conference
	March 20	Stakeholder comments due
Round 2	April 8	Post revised straw proposal
	April 16	Stakeholder web conference
	April 30	Stakeholder comments due
Round 3	May 21	Post draft final proposal
	May 28	Stakeholder web conference
	June 11	Stakeholder comments due
Board approval	July 16-17	ISO Board meeting

Background and context

Importance of reactive power in an alternating current (AC) electric system

- Reactive power is needed to support delivery of real power.
  - Maintains voltage stability on the system that connects generation to load.
  - A mismatch in the amount of reactive power needed will degrade the ability for any generating resource, including renewable resources, to operate.
- Lack of reactive power control can result in:
  - Unstable conditions that jeopardize delivery of power to end-use customers.
  - Malfunction of the electric grid or even catastrophic failure due to voltage collapse.
  - Exceeding acceptable operating limits causing equipment to trip off line.

The shift to renewable energy sources is changing the reactive power landscape

- Asynchronous resources are rapidly displacing synchronous resources in the generation mix.
  - Synchronous resources have historically provided reactive power capability.
  - Asynchronous resources do not inherently have reactive power capability unless the inverters used provide this capability.
- Modern inverter technology enables asynchronous resources to serve as a reliable source of reactive power.
  - Inverter manufacturers now include the capability to provide or absorb VARs as a standard feature.

The ISO proposes to replace the current system impact study approach with a uniform requirement

- Current approach uses system impact studies to identify which asynchronous resources must provide reactive power capability.
- As the supply of synchronous generation declines, the current approach has increased in importance.
- The current approach has several shortcomings.
- ISO proposes to remedy these shortcomings through the adoption, on a going forward basis, of a uniform requirement for asynchronous resources to provide reactive power capability.

Description of the current approach

Overview of current study approach

- A reactive power capability analysis is performed in each cluster Phase II interconnection study.
- This analysis determines whether
  - Asynchronous facilities proposed in the current cluster are required to provide 0.95 leading/lagging power factor at the Point of Interconnection (POI).
  - Network upgrades, including system VAR resources, are needed to mitigate reactive power deficiency.

Power flow and transient stability studies are performed to identify the need for reactive power capability

- The ISO initially conducts the study assuming unity power for each asynchronous resource in the current cluster using four base cases.
- Contingency analysis is performed on all four base cases to determine whether the addition of current cluster projects causes excessive voltage deviation.
- Further analysis is performed on critical contingencies that result in excessive voltage deviation using post-transient power flow to determine whether the system has sufficient reactive margin according to the planning standards.

Power flow and transient stability studies (continued)

- Any deficiencies would require asynchronous generators in the current cluster to provide 0.95 leading/lagging power factor at the Point of Interconnection.
- Then the ISO modifies the four base cases to model the required power factor capability and performs the same contingency analysis and post-transient voltage stability analysis again.
- If the study results still indicate reactive power deficiencies, then transmission system upgrades will be required to mitigate the remaining problems.

Issues with the current approach

The current approach has several shortcomings

- Relies heavily on the assumptions of future conditions, which may not prove true.
- Once an asynchronous project interconnects and is commercially operable, actual system conditions could be far different from the conditions the ISO studied during the interconnection process.
- Cannot reasonably anticipate all operating conditions.
  - Unplanned retirements that could occur before the end of a resource's useful life.
  - Transmission or generation outages that could occur as a result of maintenance or unexpected equipment failure.
  - Wind and solar production during low demand periods.

Shortcomings of current approach (continued)

- System impact studies do not—and cannot within current process timelines—cover all operational scenarios or future conditions that may require a resource to provide reactive power capability.
- To perform a more comprehensive assessment, the cost and time required for the system impact study process would increase.
- ISO estimates this would take at least another four months at an additional cost of $2 million for each interconnection cluster.
- ISO believes that adoption of a uniform requirement is a more reliable, efficient, and equitable approach than the current approach.

Straw Proposal

Timing/applicability of proposed uniform requirement

- ISO proposes to apply these new rules on a going-forward basis to those resources that interconnect through the GIDAP.
  - Beginning with first cluster having an interconnection request window following the effective date of the tariff revisions.
- Exempts projects already in the interconnection process or already interconnected for the remaining life of the existing generating unit.
  - However, generating units replaced or repowered must meet these new requirements.

ISO's straw proposal consists of three elements

- Technical requirements for asynchronous generating facilities
- Operational requirements for asynchronous generating facilities
- Voltage regulation and reactive power control requirements for asynchronous generating facilities

Technical requirements for asynchronous generating facilities

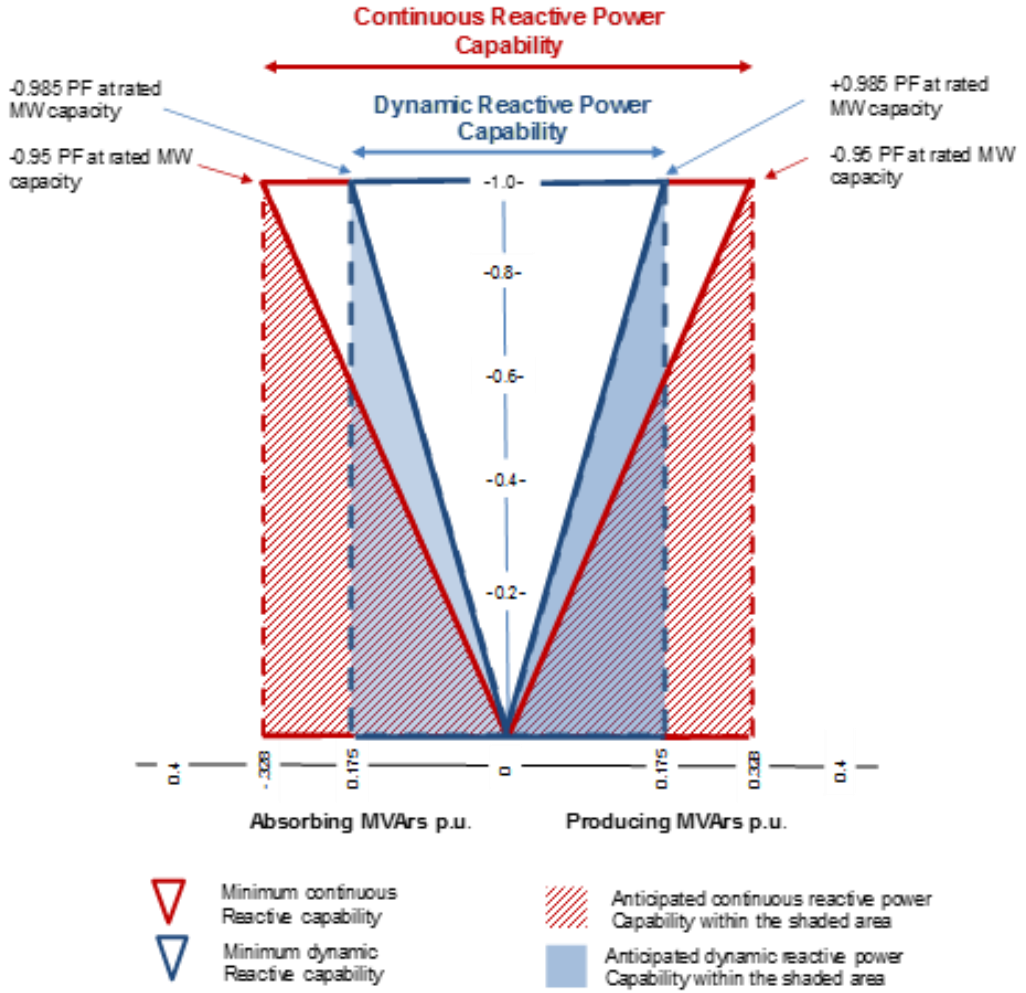
- An Asynchronous Generating Facility shall be designed to have an over-excited (lagging) reactive power producing capability to achieve a net power factor from 0.95 lagging up to unity power factor at the Point of Interconnection, at the Generating Facility's maximum real power capability.
- An Asynchronous Generating Facility shall be designed to have an under-excited (leading) reactive power absorbing capability to achieve a net power factor from 0.95 leading up to unity power factor at the Point of Interconnection, at the Generating Facility's maximum real power capability.
- Asynchronous Generating Facilities shall provide dynamic voltage response between 0.985 leading to .985 lagging at rated MW capacity at the Point of Interconnection.

Technical requirements (continued)

- Asynchronous Generating Facilities may meet the power factor range requirement at the Point of Interconnection by using controllable external dynamic and static reactive support equipment.
- Within the dynamic reactive capability range, Asynchronous Generating Facilities shall vary the reactive power output between the full sourcing and full absorption capabilities in a continuous manner.

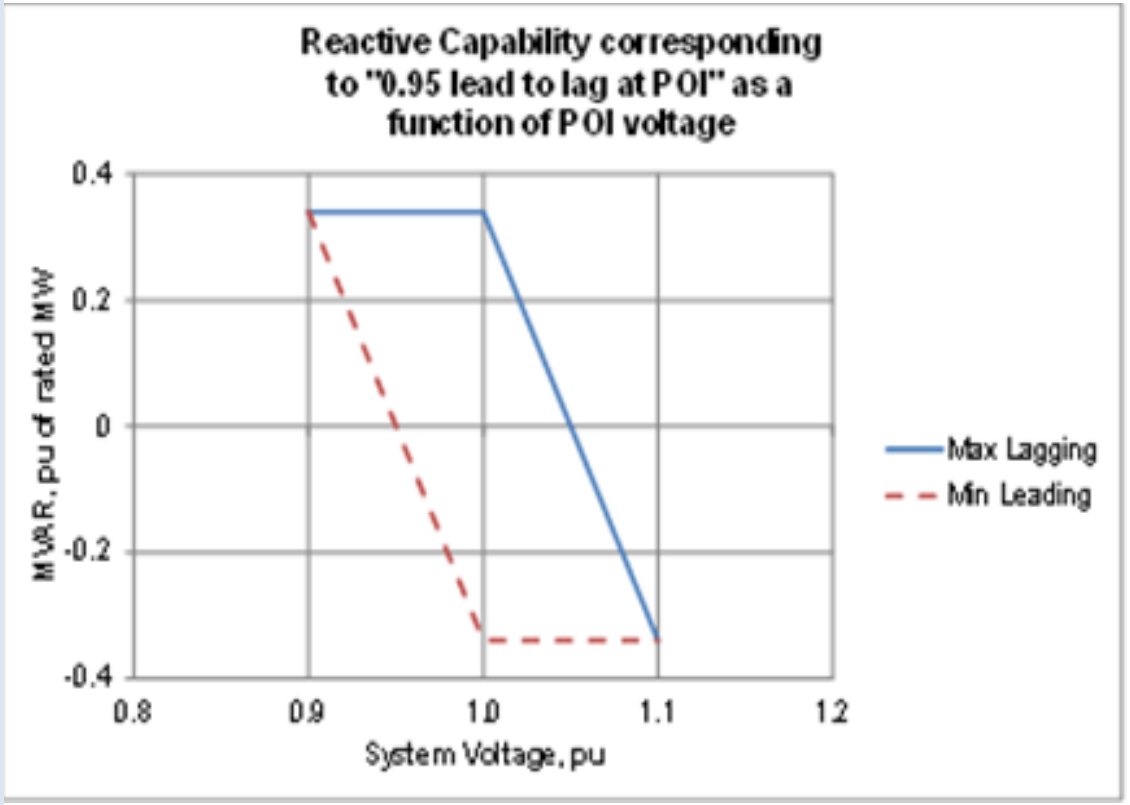
Technical requirements (continued)

Outside the dynamic range of .985 leading to .985 lagging, and within the overall reactive capability range of .95 leading and .95 lagging, the reactive power capability could be met at full real power capability with controllable external static or dynamic reactive support equipment.



Operational requirements for asynchronous generating facilities

The Asynchronous Generating Facility shall have the capability to provide reactive power at .95 lagging for voltage levels between .9 per unit and unity power at the Point of Interconnection. Likewise, the Asynchronous Generating Facility shall have the capability to absorb reactive power at .95 leading for voltage levels between unity power factor and 1.1 per unit at the Point of Interconnection.



Voltage regulation and reactive power control requirements for asynchronous generating facilities

- The Asynchronous Generation Facility's reactive power capability shall be controlled by an automatic voltage regulator (AVR) system having both voltage regulation and net power factor regulation operating modes. The default mode of operation will be voltage regulation.
- The voltage regulation function mode shall automatically control the net reactive power of the Asynchronous Generating Facility to regulate the Point of Interconnection scheduled voltage assigned by the Participating TO or ISO, within the constraints of the reactive power capacity of the Asynchronous Generation Facility.

Voltage regulation and reactive power control requirements (continued)

- The ISO, in coordination with the Participating TO, may permit the Interconnection Customer to regulate the voltage at a point on the PTO's side of the Point of Interconnection. Regulating voltage to a point other than the Point of Interconnection shall not change the Asynchronous Generating Facility's net power factor requirements set forth in Section A. iii of Appendix H.
- The Interconnection Customer shall not disable voltage regulation controls, without the specific permission of the ISO, while the Asynchronous Generating Facility is in operation.

Next steps

Next steps

- Please submit comments to InitiativeComments@caiso.com no later than 5pm on Friday, March 20.
- Following review and consideration of comments received, the ISO anticipates posting the next paper on April 8.
- All material related to this initiative is available on our website at: http://www.caiso.com/informed/Pages/StakeholderProcesses/ReactivePowerRequirements-AsynchronousResources.aspx.