

**Interconnection Initiative  
Fourth Replacement CAISO Tariff**

**May 26, 2010**

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**Changes recommended by the Large-scale Solar Association (LSA)  
and the California Wind Energy Association (CalWEA)**

## CAISO TARIFF APPENDIX Z

### Large Generator Interconnection Agreement for Interconnection Requests in a Queue Cluster Window

#### LARGE GENERATOR INTERCONNECTION AGREEMENT (LGIA)

[INTERCONNECTION CUSTOMER]

[PARTICIPATING TO]

CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION

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#### ARTICLE 1. DEFINITIONS

**Asynchronous Generating Facility** shall mean an Interconnection Customer's Generating Unit(s), other than a synchronous Generating Unit, identified in the Interconnection Request that produces 60 Hz (nominal) alternating current.

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#### ARTICLE 5. INTERCONNECTION FACILITIES ENGINEERING, PROCUREMENT, AND CONSTRUCTION

- 5.4 Power System Stabilizers.** The Interconnection Customer shall procure, install, maintain and operate Power System Stabilizers in accordance with Applicable Reliability Standards, the guidelines and procedures established by the Applicable Reliability Council, and the provisions of Section 4.6.5.1 of the CAISO Tariff. The CAISO reserves the right to establish reasonable minimum acceptable settings for any installed Power System Stabilizers, subject to the design and operating limitations of the Large Generating Facility. If the Large Generating Facility's Power System Stabilizers are removed from service or not capable of automatic operation, the Interconnection Customer shall immediately notify the CAISO and the Participating TO and restore the Power System Stabilizers to operation as soon as possible. The CAISO shall have the right to order the reduction in output or disconnection of the Large Generating Facility if the reliability of the CAISO Controlled Grid would be adversely affected as a result of improperly tuned Power System Stabilizers. The requirements of this Article 5.4 shall not apply to Asynchronous Generating Facilities.

#### ARTICLE 9. OPERATIONS

**9.6 Reactive Power.**

- 9.6.1 Power Factor Design Criteria.** For all Generating Facilities other than Asynchronous Generating Facilities, the Interconnection Customer shall design the Large Generating Facility to maintain a composite power delivery at continuous rated power output at the terminals of the Electric Generating Unit at a power factor within the range of 0.95 leading to 0.90 lagging, unless the CAISO has established different requirements that apply to all generators in the Balancing Authority Area on a comparable basis. For Asynchronous Generating Facilities, power factor design criteria are provided in Appendix H of this LGIA.

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**9.6.2.1 Governors and Regulators.** For all synchronous Generating Facilities, whenever an Electric Generating Unit is operated in parallel with the CAISO Controlled Grid and the speed governors (if installed on the Electric Generating Unit pursuant to Good Utility Practice) and voltage regulators are capable of operation, the Interconnection Customer shall operate the Electric Generating Unit with its speed governors and voltage regulators in automatic operation. If the Electric Generating Unit's speed governors and voltage regulators are not capable of such automatic operation, the Interconnection Customer shall immediately notify the CAISO and the Participating TO and ensure that the Electric Generating Unit operates as specified in Article 9.6.2 through manual operation and that such Electric Generating Unit's reactive power production or absorption (measured in MVARs) are within the design capability of the Electric Generating Unit(s) and steady state stability limits.

The Interconnection Customer shall restore the speed governors and voltage regulators to automatic operation as soon as possible. If the Large Generating Facility's speed governors and voltage regulators are improperly tuned or malfunctioning, the CAISO shall have the right to order the reduction in output or disconnection of the Large Generating Facility if the reliability of the CAISO Controlled Grid would be adversely affected. The Interconnection Customer shall not cause its Large Generating Facility to disconnect automatically or instantaneously from the CAISO Controlled Grid or trip any Electric Generating Unit comprising the Large Generating Facility for an under or over frequency condition unless the abnormal frequency condition persists for a time period beyond the limits set forth in ANSI/IEEE Standard C37.106, or such other standard as applied to other generators in the Balancing Authority Area on a comparable basis.

**9.6.2.2. Loss of Voltage Control and Governor Control for Asynchronous Generating Facilities.**

For Asynchronous Generating Facilities, Appendix H to this LGIA sets forth the requirements for the Large Generating Facility to respond to the loss of voltage control capability, governor response to over-frequency conditions, and ability not to disconnect automatically or instantaneously from the CAISO Controlled Grid or trip any Electric Generating Unit comprising the Large Generating Facility for an under or over frequency condition. Asynchronous Generating Facilities are not required to provide governor response to under-frequency conditions.

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**9.7.3 Under-Frequency and Over Frequency Conditions.** The CAISO Controlled Grid is designed to automatically activate a load-shed program as required by Applicable Reliability Standards and the Applicable Reliability Council in the event of an under-frequency system disturbance. The Interconnection Customer shall implement under-frequency and over-frequency protection set points for the Large Generating Facility as required by Applicable Reliability Standards and the Applicable Reliability Council to ensure "ride through" capability. Large Generating Facility response to frequency deviations of pre-determined magnitudes, both under-frequency and over-frequency deviations, shall be studied and coordinated with the Participating TO and CAISO in accordance with Good Utility Practice.

The term "ride through" as used herein shall mean the ability of a Generating Facility to stay connected to and synchronized with the CAISO Controlled Grid during system disturbances within a range of under-frequency and over-frequency conditions, in accordance with Good Utility Practice. Asynchronous Generating Facilities shall be subject to the over-frequency ride through capability requirements set forth in Appendix H to this LGIA.

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## Appendix H To LGIA

### INTERCONNECTION REQUIREMENTS FOR AN ASYNCHRONOUS GENERATING FACILITY

Appendix H sets forth the requirements and provisions specific to all Asynchronous Generating Facilities that have not executed an LGIA or been tendered an LGIA by the CAISO as of June 10, 2010. All other requirements of this LGIA continue to apply to Asynchronous Generating Facility interconnections.

#### A. Technical ~~Standards~~ Requirements Applicable to Asynchronous Generating Facilities

##### I. Low Voltage Ride-Through (LVRT) Capability

An Asynchronous Generating Facility shall be able to remain online during voltage disturbances up to the time periods and associated voltage levels set forth in the requirements below. The requirement set forth in this section A(I) to Appendix H shall not apply to any solar photovoltaic Asynchronous Generating Facility in the Interconnection Queue on June 10, 2010 that can demonstrate a binding commitment, as of May 18, 2010, to purchase inverters for thirty(30) percent or more of the Large Generating Facility's maximum Generating Facility Capacity that are incapable of complying with the low-voltage ride-through requirement. The Interconnection Customer must include a statement from the inverter manufacturer confirming the inability to comply with this requirement in addition to any information requested by the CAISO to determine the applicability of this exemption.

**{First version: incorporates minimal changes to the FERC 661a language.}**

1. Asynchronous Generating Facilities are required to remain in-service during three-phase faults with normal clearing ~~time~~ (which is a time period of approximately:
  - 9 cycles of zero voltage for low-voltage faults (115 kV and lower) (because primary protection relays operate after 6 cycles); and
  - 5 cycles of zero voltage for high-voltage faults (because primary protection relays operate at about 4 or fewer cycles).

Asynchronous generators shall also remain in-service during ~~4—9 cycles) and single- and two-~~ line to ground faults up to 20 cycles with delayed clearing, and subsequent post-fault voltage recovery to prefault voltage unless clearing the fault effectively disconnects the generator from the system.

The clearing time requirement for a three-phase fault will be specific to the Asynchronous Generating Facility substation location, as determined by and documented by the Participating TO. The maximum clearing time the ~~wind-Asynchronous G~~generating ~~plant~~ Facility shall be required to withstand for a three-phase fault shall be nine (9) cycles as specified above, after which, if the fault remains following the location-specific normal clearing time for three-phase faults, the Asynchronous Generating Facility ~~ies~~ may disconnect from the CAISO Controlled Grid. ~~A-The~~ Asynchronous Generating Facility

- shall remain interconnected during such a fault on the CAISO Controlled Grid for a voltage level as low as zero volts, as measured at the high voltage side of the Asynchronous Generating Facility GSU.
2. This requirement does not apply to faults that would occur between the Asynchronous Generator Unit terminals and the high side of the GSU.
  3. Asynchronous Generating Facilities may be tripped after the fault period if this action is intended as part of a special protection system.
  4. Asynchronous Generating Facilities may meet the LVRT requirements of this ~~standard requirement~~ by the performance of the generators or by installing additional equipment (e.g., Static VAr Compensator) within the Asynchronous Generating Facility or by a combination of generator performance and additional equipment.
  5. Existing individual Generator Units that are, or have been, interconnected to the CAISO Controlled Grid at the same location at the effective date of the Appendix H LVRT Standard are exempt from meeting the Appendix H LVRT Standard for the remaining life of the existing generation equipment. Existing individual Generator Units that are replaced are required to meet the Appendix H LVRT Standard.

***{Second version: incorporates additional modifications to the FERC 661a language.}***

An Asynchronous Generating Facility shall be able to remain online during voltage disturbances of durations and associated voltage levels set forth in the standard below.

1. An Asynchronous Generating Facility shall remain online for the voltage disturbance caused by any fault on the transmission grid, or within the asynchronous generating plant between the point of interconnection and the high voltage terminals of the plant step up transformer, having a duration equal to the lesser of the normal three-phase fault clearing time or 150 milliseconds, plus any subsequent post-fault voltage recovery to the final steady-state post-fault voltage. Clearing time shall be based on the maximum normal clearing time associated with any three-phase fault location that reduces the voltage at the asynchronous generating plant point of interconnection to 0.2 per-unit of nominal or less, independent of any fault current contribution from the asynchronous generating plant.
2. An Asynchronous Generating Facility shall remain online for any voltage disturbance caused by a single-phase fault on the transmission grid, or within the asynchronous generating plant between the point of interconnection and the high voltage terminals of the plant step up transformer, with delayed clearing, plus any subsequent post-fault voltage recovery to the final steady-state post-fault voltage. Clearing time shall be based on the maximum backup clearing time associated with a single point of failure (protection or breaker failure) for any single-phase fault location that reduces any phase-to-ground or phase-to-phase voltage at the asynchronous generating plant point of interconnection to 0.2 per-unit of nominal or less, independent of any fault current contribution from the asynchronous generating plant.
3. Remaining on-line shall be defined as continuous connection between the point of interconnection and the asynchronous generators, without any mechanical isolation. Asynchronous generators may cease to inject current into the transmission grid during a fault, and up to fifty (50) ms after fault clearing. Within fifty (50) ms of fault clearing, the asynchronous generators must resume operation with output commensurate with the voltage level present.

4. For single phase faults exceeding the duration described in (2), or multi-phase faults exceeding the duration described in (1), the asynchronous generating plant may disconnect from the CAISO Controlled Grid.
5. These requirements do not apply to faults that would occur between the asynchronous generator terminals and the high side of the GSU.
6. Asynchronous Generating Facilities may be tripped after the fault period if this action is intended as part of a special protection system.
7. Asynchronous Generating Facilities may meet the LVRT requirements of this standard by the performance of the generators or by installing additional equipment (e.g., Static VAR Compensator) within the asynchronous generating plant, or by a combination of generator performance and additional equipment.
8. Existing individual generator units that are, or have been, interconnected to the CAISO Controlled Grid at the same location at the effective date of the Appendix H LVRT Standard are exempt from meeting the Appendix H LVRT Standard for the remaining life of the existing generation equipment. Existing individual generator units that are replaced are required to meet the Appendix H LVRT Standard.
9. The provisions of this section shall not apply unless at least two seconds have passed since any prior LVRT event has ended.

## II. Frequency Disturbance Ride-Through Capability

An Asynchronous Generating Facility shall comply with the off nominal frequency requirements set forth in WECC Under Frequency Load Shedding Relay Application Guide or successor requirements as these may be amended from time to time.

## III. Power Factor Design and Operating Criteria (Reactive Power)

The reactive power capability design of an Asynchronous Generating Facility shall meet the following criteria:

1. An Asynchronous Generating Facility shall be designed to have sufficient reactive power sourcing capability to achieve a net power factor of 0.95 lagging or less at the Point of Interconnection (POI), at the Generating Facility's maximum Generating Facility Capacity. The generating facility may install less reactive power factor capability if its output is reduced to a point where it complies with this power factor capability if necessary to maintain the designated voltage schedule.

An Asynchronous Generating Plant shall be designed to have sufficient reactive power absorption to achieve a net power factor of 0.95 leading or less at the POI, at the Generating Facility's maximum Generating Facility Capacity. The generating facility may install less reactive power factor capability if its output is reduced to a point where it complies with this power factor capability if necessary to maintain the designated voltage schedule.

2. Net power factor shall be measured at the Point of Interconnection as defined in this LGIA.
3. Subject to Section A.III.1, Asynchronous Generating Facilities shall have sufficient meet the full reactive power capacity installed to meet power factor range requirement with the positive sequence voltage at the Point of Interconnection at any

value between 0.95 and 1.05 per unit of nominal voltage without exceeding the ratings of any equipment in the Asynchronous Generating Facility.

4. Asynchronous Generating Facilities may meet the power factor range requirement by using power electronics designed to supply the required level of reactive capability ~~(deleted language addressed in #3 above) (taking into account any limitations due to voltage level and real power output)~~ or fixed and switched capacitors, or a combination of the two, ~~if agreed to by the Participating TO and CAISO.~~

5. Asynchronous Generating Facilities shall also provide dynamic voltage support if the ~~Phase II Interconnection Interconnection System Impact Study finds that requires~~ dynamic voltage support is needed for system safety or reliability. The Phase II Interconnection Study shall consider whether any such requirement can be met more efficiently through installation of equipment at the plant site or at the POI, if installation of the necessary equipment at the POI is feasible. If the requirement can more efficiently be met through equipment installation at the POI, the required equipment shall be classified as Interconnection Facilities and be funded by the Interconnection Customer. If the reactive power equipment is installed at the POI, its output should count towards meeting the reactive power requirement of the Asynchronous Generating Facility.

5.6. Asynchronous Generating Facilities shall vary the reactive power output between the full sourcing and full absorption capabilities such that any step change in the reactive power output does not cause a step change in voltage at the Point of Interconnection greater than 0.02 per unit of the nominal voltage.

6.7. The maximum voltage change requirement shall apply when the transmission network is fully intact (no line or transformer outages), or during outage conditions which do not decrease the three-phase short circuit capacity at the Point of Interconnection to less than ninety (90) percent of the three-phase short-circuit capacity that would be present without the transmission network outage.

In operation, the reactive power capability of an Asynchronous Generating Facility shall meet the following criteria:

1. For plant output power greater than twenty (20) percent of the Asynchronous Generating Facility's maximum Generating Facility Capacity, the Asynchronous Generating Facility shall have a net reactive power range achieving 0.95 lagging to 0.95 leading at the Point of Interconnection, based on the actual real power output level delivered to the POI. At a minimum, reactive power output capability must be proportional to real power output. (If the plant is capable of full reactive power capability at reduced power levels, should not be required to disable some of that capability when it may benefit the system.)
2. If the reactive power capability of an Asynchronous Generating Facility is partially or totally unavailable, power output may be curtailed at the direction of CAISO to a value where the net power factor range is met, if operation beyond that level causes deviation of the voltage at the Point of Interconnection outside +/- 0.02 per unit of scheduled voltage level.
3. If the output power of the Asynchronous Generating Facility is less than twenty (20) percent of the Generating Facility's maximum Generating Facility Capacity, the net reactive power shall be anywhere within the range between -6.6% and +6.6% of the Asynchronous Generating Facility's real power rating. The Asynchronous Generating Facility reactive power output must remain within this range.

4. If the Point of Interconnection voltage exceeds 1.05 per unit, the Asynchronous Generating Facility shall provide reactive power absorption to the extent possible without violating the ratings of any the Asynchronous Generating Facility's equipment.
5. If the Point of Interconnection voltage is less than 0.95 per unit, the Asynchronous Generating Facility shall provide reactive power injection to the extent possible without violating the ratings of any equipment.
6. The Asynchronous Generating Facility shall not be required to incrementally produce or absorb VARs (reactive power) if that would require the Asynchronous Generating Facility to operate in a voltage range outside of its continuous operating limits. (This captures the concepts in Section 3.2.5 of the written Proposal document.)
- ~~6.7.~~ All reactive power devices used to vary the Asynchronous Generating Facility's reactive power output shall be under the control of an Automatic Voltage Control system.
- ~~7.8.~~ A solar photovoltaic Asynchronous Generating Facility with an executed LGIA or tendered LGIA as of June 10, 2010, can elect to comply with this Section A(III), rather than Sections 9.6.1 and 9.6.2 of the executed LGIA or tendered LGIA. Any solar photovoltaic Asynchronous Generating Facility that elects to comply with this Section A(III) shall also be deemed to have elected to comply with Section A(IV) below.

#### **IV. Voltage Regulation and Reactive Power Control Requirements**

The Asynchronous Generation Facility's reactive power capability shall be controlled by an automatic system having both a voltage regulation and a net power factor regulation operating mode. The default mode of operation will be voltage regulation.

The voltage regulation function shall automatically control the net reactive power of the Asynchronous Generating Facility to regulate the Point of Interconnection positive sequence component of voltage to within a tolerance of +/- 0.02 per unit of the voltage schedule assigned by the Participating TO or CAISO, within the constraints of the reactive power capacity of the Asynchronous Generation Facility. Deviations outside of this voltage band, except as caused by insufficient reactive capacity to maintain the voltage schedule tolerances, shall not exceed five minutes duration per incident.

The power factor mode will regulate the net power factor measured at the Point of Interconnection. If the Asynchronous Generating Facility uses discrete reactive banks to provide reactive capability, the tolerances of the power factor regulation shall be consistent with the reactive banks' sizes meeting the voltage regulation tolerances specified in the preceding paragraph.

The net reactive power flow into or out of the Asynchronous Generating Facility, in any mode of operation, shall not cause the positive sequence component of voltage at the Point of Interconnection to exceed 1.05 per unit, or fall below 0.95 per unit.

The CAISO, in coordination with the PTO, may permit the Interconnection Customer to regulate the voltage at a point on the Asynchronous Generating Facility'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 Article III of this Appendix H.

The Interconnection Customer shall not disable voltage regulation controls, without the specific permission of CAISO, while the Asynchronous Generating Facility is in operation at a power level



greater than twenty (20) percent of the Asynchronous Generating Facility's maximum Generating Facility Capacity.

## V. Plant Power Management

Asynchronous Generating Facilities must have the capability, as of January 1, 2012, to limit active power output in response to a Dispatch Instruction or operating order from CAISO. This capability shall extend from the Minimum Operating Limit to the Maximum Operating Limit of the Asynchronous Generating Facility in increments. The maximum size of the increment will be the lesser of five (5) MW or the highest amount that or less. Changes to the power management set point shall not causes a change in voltage at the Point of Interconnection of not more than exceeding 0.02 per unit of the nominal voltage.

For Asynchronous Generating Facilities that are also Eligible Intermittent Resources, the power management establishes only a maximum output limit. There is no requirement for the Eligible Intermittent Resource to maintain a level of power output beyond the capabilities of the available energy source.

Asynchronous Generating Facilities must have the installed capability to limit power change ramp rates automatically, except for downward ramps resulting from decrease of the available energy resource for Eligible Intermittent Resources. The power ramp control shall be capable of limiting rates of power change to a value ranging from five (5) percent to twenty (20) percent of the Asynchronous Generating Facility's maximum Generating Facility Capacity per minute, ~~with a default value of ten (10) percent per minute~~ (language deleted because the ramp limits should not be engaged except per CAISO instructions, i.e., there should be no "default" value). The set point for the maximum rate of power change shall be set by a CAISO Dispatch Instruction or operating order and shall remain in effect until a new Dispatch Instruction or operating order is issued. The Asynchronous Generating Facility may implement this ramping limit by using stepped increments if the individual step size is five (5) MW or less. Operation of the power-change ramp rate limits is only required pursuant to a CAISO Dispatch Instruction or operating order to engage the ramp rate limits.

Variable generation resources must have the installed capability to automatically reduce plant power output in response to an over-frequency condition. This frequency response control shall, when enabled at the direction of CAISO, continuously monitor the system frequency and automatically reduce the real power output of the Asynchronous Generating Facility with a droop equal to a one-hundred (100) percent decrease in plant output for a five (5) percent rise in frequency (five (5) percent droop) above an intentional dead band of 0.036 Hz. The application of this automatic plant output reduction should be limited to a ten-second period after the event that caused the frequency to rise above 0.036 Hz.

Asynchronous Generating Facilities shall be entitled to receive a waiver from the CAISO of any requirements in this section if, at the time that equipment needed to comply with those requirements must be ordered to meet the Commercial Operating Date, the required equipment was not available from at least three suppliers, in the quantities and on in the timeframe required for timely construction of the Asynchronous Generating Facility.

## VI. Supervisory Control and Data Acquisition (SCADA) Capability

~~An Asynchronous~~ Generating Facility shall provide SCADA capability to transmit data and receive instructions from the Participating TO and CAISO to protect system reliability. This provision should be moved to a tariff section applicable to all generators.

~~An Asynchronous~~ Generating Facility must be able to receive and respond to Automated Dispatch System (ADS) instructions and any other form of communication authorized by the

CAISO Tariff. The ~~Asynchronous~~ Generating Facility's response time should be capable of conforming to the periods prescribed by the CAISO Tariff. *This provision should be moved to a tariff section applicable to all generators.*

*The ~~d~~In the event that the Asynchronous Generating Facility's generation management is insufficient, the CAISO may, at its discretion, instruct the Participating TO to disconnect the Asynchronous Generating Facility. If an Asynchronous Generating Facility is ordered off-line, the Operator of the Asynchronous Generating Facility shall not reconnect the Asynchronous Generating Facility to the CAISO Controlled Grid without prior approval from the CAISO, and may be required to ramp its output in a controlled manner. ~~eted~~ provision should be considered in the later stakeholder process that will address market rules and procedures for the CAISO to use the installed capability, along with compliance issues. At a minimum, due-process elements such as warning notices and cure periods should be added.*

The Participating TO and CAISO and the Asynchronous Generating Facility Interconnection Customer shall determine what SCADA information is essential for the proposed ~~wind~~ plant, taking into account the size of the plant and its characteristics, location, and importance in maintaining generation resource adequacy and transmission system reliability in its area.

## **VII. Power System Stabilizers (PSS)**

Power system stabilizers are not required for Asynchronous Generating Facilities.