

**Comments of the Large-scale Solar Association
on Proposed Additional Renewable-Resource Interconnection Requirements**

The Large-scale Solar Association (LSA) offers comments here on the following:

- **“Interconnection Standards Review Initiative – Draft Straw Proposal”** (“Proposal”) a March 26th document listing and describing CAISO-proposed additional interconnection standards that would apply to intermittent renewable generation (wind and solar plants), a.k.a. Variable Energy Resources (VERs); and
- **Discussions at an April 1st CAISO stakeholder meeting** to discuss the Proposal.

Summary of Proposal provisions: These are the CAISO’s proposals, as we understand them:

TECHNICAL AREA	CAISO PROPOSAL
Power Factor	<p>Establish required power factors for new plants (those without executed LGIAs) as:</p> <ul style="list-style-type: none"> • 0.95 lag/0.95 lead for asynchronous generators (asynchronous wind generators, solar PV), at the Point of Interconnection; and • 0.90 lag/0.95 lead for other generators, at the generator terminal.
Voltage Regulation	<p>“Clarify” the requirement in LGIA Section 9.6.2 that all generators “maintain Voltage Schedules” to require all plants (including existing plants) to:</p> <ul style="list-style-type: none"> • Install Automatic Voltage Regulation (AVR), which must control all reactive power devices used to vary generating facility’s reactive power output; and • Operate in voltage control mode as the default, with the ability to operate also in power factor control mode.
Frequency Ride-Through	<p>Require all plants (including existing plants) to comply with current WECC ONF rules, e.g., allow instantaneous trips only at/below 57 Hz or at/above 61.7 Hz, and require continuous operation between 59.4 and 60.6 Hz.</p>
Voltage ride-through	<p>Require plants with CODs after 6/1/2010 to comply with the latest version of NERC PRC-024-1 (standard still under development)</p>
Power management	<p>Require all variable/intermittent generation (including existing plants) to install “active power management,” including ability to limit ramp rates, respond to over-frequency conditions, and meet WECC 5% droop criteria.</p>
Interconnection studies modeling	<p>Use standard industry study models, if available, instead of applicant-provided models</p>
Power System Stabilizers (PSS)	<p>Clarify LGIA Section 5.4 to exempt all asynchronous generators from PSS requirement.</p>

General comments

We support the CAISO’s effort to review interconnection standards and assure adequate system performance as major changes occur in the composition of the generation fleet. However, we are very concerned about several aspects of the current CAISO effort, namely:

- **The speed at which the CAISO is moving.** This first real proposal was just issued in the last week in March, and the CAISO proposes to effectively finalize it by the end of April, for consideration at the May Board meeting. The CAISO itself set the schedule for Serial Group and Transition Cluster interconnection studies, and the imminence of LGIA execution for these projects is no excuse for adoption of incomplete and ill-considered rules.

Moreover, the rush to impose additional requirements is particularly unfair to relatively new generating technologies like solar. One reason that wind generators may be more readily able to meet the proposed requirements is that large-scale wind generation has been deployed for some time, so developers and manufacturers confronted many of these issues before and have had several years to reasonably address them. Solar developers should be afforded that same opportunity for natural and rational market and product evolution.

- **Inappropriate adoption of rules by only one Balancing Area Authority (BAA).** We repeat our earlier comments that the CAISO should not preempt the appropriately considered adoption of WECC/NERC standards, and that such action is likely to lead to confusion and lack of equipment standardization. At the very least, any CAISO Tariff revisions should specify that the requirements will be the lesser of the rules in the final Proposal and those eventually adopted by the NERC/WECC process, unless the CAISO can specifically show that its more-stringent requirements are needed for the CAISO Controlled Grid.
- **Imposition of requirements on only intermittent generators.** The Proposal would impose additional requirements on intermittent resources when:
 - **The resulting capability would support general system needs**, not just CAISO management of wind and solar resources. For example, the CAISO might order such resources to generate VARs to support operational needs that have nothing to do with intermittent generation.
 - **The required capability would benefit the system regardless of generating technology.** For example, increased ride-through capability that prevents generator tripping would increase system reliability if imposed on all generators, not just wind or solar generators.

There is no reason why only intermittent generation should be required to provide these services when others are not required to do so. Moreover, such requirements that benefit the entire system naturally raise the issue of compensation for the resulting services provided.

The CAISO has stated that it will not address market issues in this process, e.g., how the capability provided through these requirements would be used or compensated by the CAISO. However, these are clearly not just technical issues

Market compensation, economic signals, and last-resort use of command-and-control actions should be an integral feature of any CAISO framework. Even if the details are left until later (and the CAISO should specify when that would actually take place), the CAISO should state unequivocally that it will adhere to these principles in any exercise of this capability.

- **Lack of consideration of market mechanisms that would or could provide the same capability as the proposed requirements**, at potentially lower cost and/or greater efficiency. Even disregarding the inefficiencies of setting standards outside the NERC/WECC standard-setting process, the CAISO has not yet identified either the specific operational tools or processes it needs to manage higher levels of intermittent resources or the lowest-cost and most-efficient way to provide them.

The CAISO studies needed to identify those operational needs are now scheduled for an initial public release by around June of this year (after the final Proposal on this matter would be decided on by the CAISO Board), with a stakeholder vetting process to follow. Only after those needs have been determined in some final form should the CAISO consider how best to meet them; interconnection rule changes should only be considered as part of that later process.

Some of any identified operational needs can best be met through the current market (e.g., additional purchases of Regulation) or new Ancillary Services markets (e.g., voltage support), while others may best be met through increasing requirements on individual generators.

Because the CAISO is effectively skipping the above process and jumping right to additional requirements on individual generators, it has a strong responsibility to take particular care to only require additional capability that it is highly certain will be needed and that cannot be more cost-effectively provided in some other manner, e.g., through the market or using grid-level investments (see below). The CAISO has not met this burden of proof for many of the elements in the Proposal.

This responsibility is even stronger because generator developers have relied on the existing standards in good faith, and the new requirements could create undue economic or technical hardships. Most Serial Group and Transition Cluster projects:

- **Have little or no ability to recover any significant additional costs.** They have either already executed Power-Purchase Agreements (PPAs) or are in advanced stages of obtaining one (e.g., already submitted bids, been short-listed, and are likely wrapping up negotiations), and so they cannot reflect the increased cost in the prices they charge for their power.
- **Have largely completed their plant engineering and design,** and reflected those features in their Interconnection Requests, permitting, and other development activities. They are generally beyond the point where their systems can be designed to meet new standards.

Going forward, California end-users will ultimately pay the cost of any new standards imposed widely on generators. If grid-level and/or market solutions would be more efficient, those customers will be ill-served by ignoring or postponing that assessment and considering only more costly and/or less-effective plant-based solutions.

- **Lack of detail in key areas of the Proposal,** including details on how compliance will be measured. Some of the proposed rules are incomplete, as noted in comments below. Generators cannot realistically comment on the feasibility of complying with these requirements until specific compliance measures are proposed. Moreover, the lack of detail could potentially delay LGIA execution for projects that must complete those agreements quickly, e.g., those racing to begin construction by year-end to qualify for federal stimulus funding.
- **CAISO insistence that the new standards be incorporated into LGIAs now.** It is entirely unreasonable for the CAISO to insist on interconnection requirements beyond those in the pro forma LGIA before FERC has approved those new requirements.

While it is true, as the CAISO stated at the meeting, that these are “voluntary” agreements, the CAISO is holding generators who must have these agreements hostage to requirements that haven’t even been vetted through the stakeholder process, much less approved by the Board or FERC. We find ourselves in agreement with the stakeholder statement at the meeting that this behavior by the CAISO borders on “abuse of the process.”

Transition comments

Status exemptions: Generally speaking, significant requirements changes like those the CAISO is proposing should only be applied prospectively. Consistent with this principal, the CAISO should exempt the generators listed below from compliance with any new requirements, unless:

- Compliance costs are minimal;

- The CAISO or PTO compensates the developer; or
- The developer later re-powers or otherwise completely upgrades the plant equipment.
- **All currently operating plants**, regardless of their status.
- **All Serial Group projects**. Interconnection studies and LGIAs for these plants were supposed to be completed over a year ago, and their continued presence in the study process has confounded cluster studies for later-queued projects; moreover, delays and dropouts in this group due to uncertain or changing interconnection requirements are only likely to lead to more re-studies that will even further delay completion of the process for them.
- **All projects that can demonstrate that, by the effective date of any new requirements:**
 - **They have executed PPAs** that will not allow them to recover significant new costs; and/or
 - **They have purchased significant equipment** (e.g., inverters or turbines) that would be impacted significantly by the new requirements.

However, the above exemptions should not apply to any of the above projects that, after the effective date of any new requirements:

- ***Fails to provide written Authorization to Proceed*** with design and procurement by the date specified in their LGIA Appendix B Milestones; or
- ***Suspends work under its LGIA*** before procurement of generation equipment.

Small-project exemptions: Consider exempting small projects from these requirements, as the cost of compliance could be prohibitive, especially for power-factor and voltage/frequency ride-through requirements. The exemption threshold could be set at 10 MW, the size limit already adopted by WECC for voltage ride-through requirements and consistent with IEEE Standard 1547.

Distribution-level generators: These generators should be exempted from at least the proposed power-factor requirements, unless the distribution provider adopts the CAISO rules. These plants are/will be connected to systems not under CAISO control, and the distribution providers may have problems with CAISO-directed voltage and VAR movements through their systems.

Other transition comments: There are various transition periods proposed in the Proposal document, but the CAISO seemed to back away from several of them at the meeting. Thus, we are not sure what the CAISO's transition proposals are at this point.

We do not know when equipment that would meet the proposed requirements will be commercially available in the market, if such equipment is not available now. While we are interested to see whether CAISO discussions with equipment manufacturers elicits such information, any such feedback should be viewed as an estimate until compliant equipment is commercially available and sufficiently tested to support project financing.

If the CAISO proceeds with these new requirements, the transition period for each measure should not be set unless the equipment is available now through at least 3 vendors for the particular generating technology, i.e., the equipment can be competitively purchased. Instead, the transition period for each requirement (for non-exempt generators – see above) should be the later of two years after the effective date of any new requirements or one year after the equipment needed to comply with that interconnection requirement is available through at least 3 vendors.

Proposed power-factor requirements

CAISO-proposed requirement: Establish required power factors for new plants (those without executed LGIAs) as:

- 0.95 lag/0.95 lead for asynchronous generators (asynchronous wind generators, solar PV), at the Point of Interconnection; and
- 0.90 lag/0.95 lead for other generators, at the generator terminal.

Needs demonstration and cost-effectiveness: Power factor control and voltage regulation capability are built into synchronous generation machines and can be provided at relatively low cost, so may make sense to require it as a condition of interconnection. However, this is not the case for asynchronous machines, including PV generation and induction generators – providing the same dynamic regulation capabilities as synchronous generators could require more equipment, at considerable extra cost. For this reason, all induction and asynchronous generators should be subject to a standard no more stringent than +/- 0.95.

Moreover, it is particularly important, with respect to asynchronous generators, that the CAISO be required to demonstrate that:

- **Any new requirements are needed for compliance with Applicable Reliability Criteria (ARC)**, as required by FERC Order 661A.

Without a needs demonstration, for example, a concentration of renewable generators in particular locations could result in VAR oversupply and unnecessary expenditures by developers. (If the requirement is determined to be needed on a cluster basis, then the requirement and common costs should be spread among all generators in that cluster on a pro-rata basis, based on MW size; however, conventional generators can be treated separately where ARC imposes different requirements on them.)

Similarly, unless the interconnection study finds specifically that a continuous, dynamically controlled device is necessary to meet the ARC, developers should be allowed to meet this requirement using automatically switched shunt devices with mechanical switches.

- **Imposing these requirements on individual generators is more cost-effective than other alternatives**, such as utility-owned equipment at more optimal locations. If the studies find that this requirement is needed and that satisfying it through equipment at transmission substations would be more cost-effective, that equipment should be considered Network Upgrades and treated like any other such upgrades in the interconnection process.

Equipment location: Asynchronous generators may be disadvantaged by power-factor requirements at the POI, rather than at the generator site, if the POI is remote from the generator project site. Therefore generators should have the option to install (or fund) reactive controls equipment at the POI substation or in near proximity on the CAISO grid, for voltage or power factor control, if the equipment is required by ARC and the generator is connected to the POI through a tie-line (or a distribution line where the distribution provider has adopted the CAISO rules) that is:

- 115 kV or lower voltage and 1 mile or longer;
- 230 kV voltage and 2 miles or longer; or
- 500 kV voltage and 5 miles or longer.

Multiple generators with POIs in close proximity should be allowed to jointly fund such equipment. The cost of any reactive support equipment at transmission substations should be reimbursed by the PTO as Network Upgrades, like other such upgrades related to generator interconnection.

Incomplete definition: The requirements are incompletely specified, and the missing details can significantly impact compliance feasibility and cost. Specifically, the CAISO should clarify:

- ***The definition of “available” in the requirement that “reactive output shall be available at all active power levels.”*** We recommend that this be interpreted to mean that the power factor requirement should be constant over the active power range, rather than requiring the reactive power range measured at full load to be available at all load levels. Otherwise, if the capability is provided at the inverter level (for PV plants), removal of one or more inverters from operation would cause a violation of the requirement.
- ***Its proposal to condition a generator’s need to meet the power factor requirements on the plant equipment ratings.*** We recommend that “equipment ratings” be interpreted to mean the voltage ratings, and not the thermal capacity of the plant.
- ***The response-time requirement,*** i.e., how long the generator has to meet a specific power-factor or voltage set point.
- ***How the power factor requirement would be calculated,*** i.e., that the power factor requirement should be calculated at 1.0 per unit voltage.
- ***Relationship to Pmin.*** The definition of Pmin in the requirements is critical and should be clearly defined. The stakeholder meeting presentation stated that “reactive power range corresponding to 0.95 lag to 0.95 lead at rated power output shall be at all power production levels above Pmin.” If this means that full reactive power output must be provided at a real power output less than full load, it could require generators to install additional shunt capacitance or shunt reactance to meet the requirement, at significant additional cost.

Proposed voltage requirements

CAISO-proposed requirement: “Clarify” the requirement in LGIA Section 9.6.2 that all generators “maintain Voltage Schedules” to require all plants (including existing plants) to:

- Install Automatic Voltage Regulation (AVR), which must control all reactive power devices used to vary generating facility’s reactive power output; and
- Operate in voltage control mode as the default, with the ability to operate also in power factor control mode.

Needs demonstration, cost-effectiveness, and equipment location: See these sections above, which apply equally to power-factor and voltage requirements, as well as additional information below that is specifically related to voltage requirements.

Terminology: This requirement should be renamed “automatic voltage control,” since “AVR” typically refers to a specific piece of equipment associated with the excitation system of a synchronous machine.

Applicability

- ***The requirement should apply only to projects connecting to unregulated transmission voltage buses.***

- **The requirement should not apply to situations where voltage regulation may not be feasible or practical** – for example:
 - **Busses where there is already a regulation device** (i.e. either distribution interconnections or a device such as an SVC installed); or
 - **Situations where a project cannot effectively control the transmission voltage**, e.g., a small generator connected to a stiff high-voltage system (i.e., where the project is small compared to the short-circuit MVA of the system).
- **The requirement should be consistent with Good Utility Practice** for the type of device (e.g., switched shunt capacitors) that is used to control voltage.

Proposed frequency and voltage ride-through requirements

CAISO-proposed requirements

- **Frequency ride-through:** Require all plants (including existing plants) to comply with current WECC ONF rules, e.g., allow instantaneous trips only at/below 57 Hz or at/above 61.7 Hz, and require continuous operation between 59.4 and 60.6 Hz.
- **Voltage ride-through:** Require plants with Commercial Operation Dates (CODs) after 6/1/2010 to comply with the latest version of NERC PRC-024-1 (standard still under development).

General comment: Standards are still under development in this area and PV plants, at least, cannot comply with the proposed standards. Thus, if the CAISO plans to establish new requirements in this area, beyond the Low-Voltage Ride-Through wind-generation requirements currently in the tariff/LGIA and/or current equipment capabilities, it should follow the transition-period recommendations described in the Transition Comments section above, regarding:

- **Transition-period timeline**, i.e., this should be set based on commercial equipment availability on a competitive basis and a reasonable competitive-procurement timeline, and not on an arbitrary deadline; and
- **Eventual standards application**, i.e., the eventually adopted NERC/WECC standard should prevail, in the absence of CAISO demonstration why more stringent standards should apply.

Frequency Ride Through: The CAISO should simply follow the existing WECC requirement, with monitoring and enforcement through the NERC/WECC process.

Voltage Ride-Through: The proposed new voltage ride-through requirement would be more stringent (in terms of duration and voltage depression) than the current WECC standard, and it includes a new post-fault high-voltage ride-through requirement as well. This proposal could have a negative financial impact on projects under development, including those that have executed LGIAs. Thus, the exemptions in the Transition Comment section above should be applied.

- **High Voltage Ride-Through:** Power electronic devices used in PV inverters, and much of a plant's auxiliary equipment, can currently provide 10% over-voltage capability. Compliance with a 20% over-voltage, ride-through requirement could impact many systems, and over-voltage protection can be costly; thus, we recommend allowing a 10% maximum over-voltage until the issue is fully vetted in the NERC arena. If a 20% over-voltage requirement is maintained even by NERC, time (12-18 months) will be necessary to design protective systems and include them in the future project specifications.

- **Low-Voltage Ride-Through:** The solar inverter industry is currently moving in the direction of this capability. The proposed standard would also require review/re-design of the project balance-of-system. As this is a new requirement for solar PV, a transition period would be necessary – see our Transition Comments recommendations above.

Proposed power management requirements

CAISO-proposed requirement: Require all variable/intermittent generation (including existing plants) to install “active power management,” including ability to limit ramp rates, respond to over-frequency conditions, and meet WECC 5% droop criteria

Under-frequency droop: The exemptions recommended in the Transition Comments section above should be applied.

Lack of feasibility: The ability to control ramp rates is not generally available from PV inverter manufacturers and may require redesign of the internal controls within inverter. Thus, the recommendations under Transition Comments above would apply.

Incomplete standards: The CAISO should clarify:

- That ramp-rate limits would not apply where the ability to comply is limited by the lack of sufficient primary energy source (solar or wind);
- The ramp-rate limit (or range of limits) and the means of activation in sufficient detail to allow developers to develop equipment specifications and design the project.
- When and how the ramp-rate limits and rules for their activation would be established; and
- How ramp-rate limits and activation commands would be transmitted to generators.