2018 Interconnection Process Enhancements (IPE)

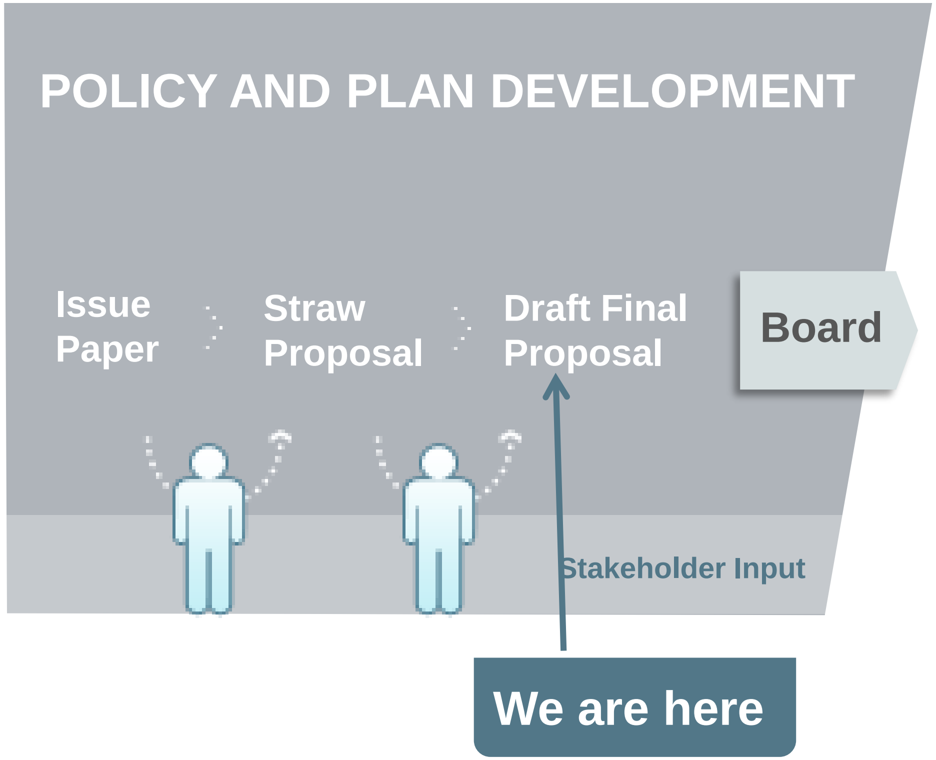
Meeting
September 17, 2018
10:00 a.m. – 4:00 p.m. (Pacific Time)

Agenda

Time	Item	Speaker
10:00 - 10:10	Stakeholder Process and Schedule	Jody Cross
10:10 - 10:15	Introductions and Background	Joanne Bradley
10:15 - 10:45	Affected Participating Transmission Owner	Daune Kirrene
10:45 – 11:15	Maximum Cost Responsibility for NUs and Potential NUs	Jason Foster
11:15 – 12:00	Reliability Network Upgrade Cost Cap	Jason Foster
12:00 – 1:00	Lunch	
1:00 – 3:50	Ride Through Requirements for Inverter-based Technology	Lou Fonte
3:50 - 4:00	Next Steps	Jody Cross

STAKEHOLDER PROCESS

CAISO Policy Initiative Stakeholder Process



Background/Scope

2018 IPE goal is to modify and clarify the generator interconnection process to reflect changes in the industry and in customer needs

- IPE was completed in 2014
- IPE 2015 was completed in 2016
- IPE 2017 was completed March 2018
- 2018 IPE
  - Initiative includes 25 topics
    - 8 topics were finalized in the straw proposal
    - 13 topics were finalized in the revised straw proposal
    - 4 topics included in the draft final proposal

Initiative topics and associated presenter

Topic	Presenter
Affected Participating Transmission Owner	Daune Kirrene
Maximum Cost Responsibility for NUs and potential NUs	Jason Foster
Reliability Network Upgrade Reimbursement Cap	Jason Foster
Ride-through Requirements for Inverter-based Generation	Lou Fonte

AFFECTED PARTICIPATING TRANSMISSION OWNER

Affected Participating Transmission Owner (6.2)

- Stakeholders suggested that CAISO consider a combined four (or more) party agreement, combining generator interconnection agreement and affected PTO upgrade facilities agreement
- Other stakeholders further suggested that the interconnecting PTO serve as a single point-of-contact for the interconnection customer
- The CAISO carefully considered these suggestions and will defer this issue to the next IPE process
- With respect to maximum cost responsibility, stakeholders support the Straw Proposal
  - The interconnecting and affected PTO cost estimates will sum to a single MCR for the interconnection customer's entire project

MAXIMUM COST RESPONSIBILITY FOR NETWORK UPGRADES AND POTENTIAL NETWORK UPGRADES

Maximum Cost Responsibility for Network Upgrades (7.1)

ISO reconsidered definitions and the structure of cost responsibility:

Proposed Definitions:

- Potential Network Upgrade
- Directly Assigned Network Upgrade
- Interconnection Service Upgrade (Plan of Service)
- Precursor Network Upgrade
- Current Cost Responsibility
- Maximum Cost Responsibility

Maximum Cost Responsibility for Network Upgrades (7.1) (cont'd)

Proposed Cost Responsibility Framework:

1. Interconnection Customer assigned upgrades:
   a. Directly Assigned Network Upgrades (DANU)
   b. Potential Network Upgrades

2. Cost Allocations
   a) **For DANUs** - cost allocations will follow current tariff provisions in Appendix DD, Sections 8.3 & 8.4, except
      – Interconnection Service Upgrades
         » 100% allocated to Maximum Cost Responsibility (MCR)
         » For Current Cost Responsibility (CCR) - share cost equally with other projects in same cluster

   b) **For Potential Network Upgrades** - cost allocations will follow current tariff provisions in Appendix DD, Sections 8.3 & 8.4, and
      – Interconnection Service Upgrades - 100% allocated to MCR

Maximum Cost Responsibility for Network Upgrades (7.1) (cont'd)

Framework proposal continued:

3. Maximum Cost Responsibility equals sum of:
   I. Directly Assigned Network Upgrades (2a above)

   AND

   II. Potential Network Upgrades (2b above)

4. IFS posted for Directly Assigned Network Upgrades
   - Not for Potential or Precursor Network Upgrades
     - Unless Interconnection Customer needs the upgrade before the assigned cluster and are willing to take on the cost responsibility for Potential or Precursor Network Upgrades

Maximum Cost Responsibility for Network Upgrades (7.1) (cont'd))

Potential Network Upgrades become:

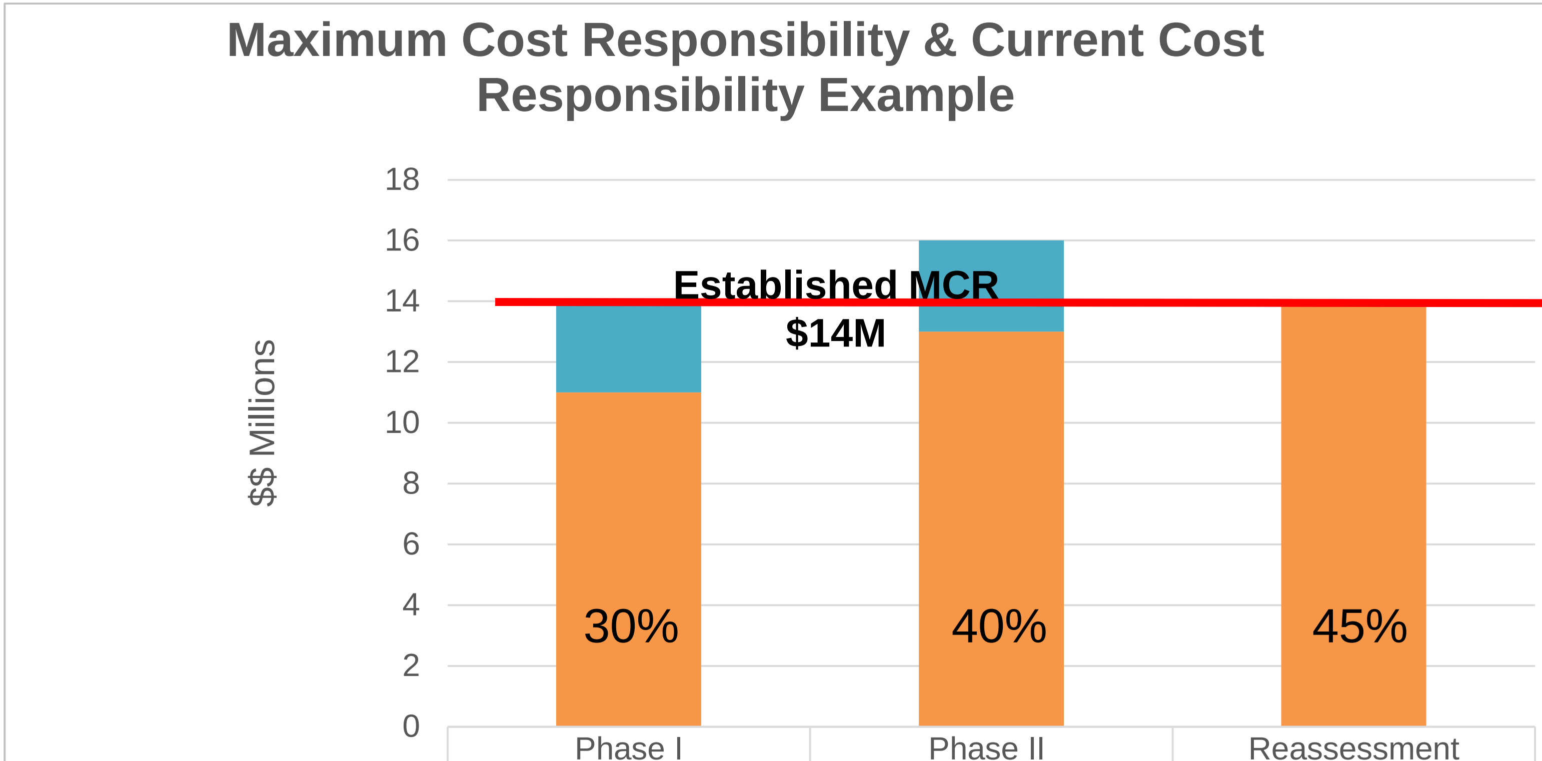
1. Directly Assigned Network Upgrades
   - When all prior clusters projects withdraw without executing a GIA

OR

2. Precursor Network Upgrade
   - When at least one prior cluster project, for which the potential network upgrade is directly assigned, executes a GIA for the Network Upgrade

- When a Potential Network Upgrade is removed from a project's responsibility, it may create headroom within MCR for increasing cost allocation percentage of a project's current DANU
- MCR adjustments will continue to be based on existing tariff guidelines in App. DD, Section 7.4

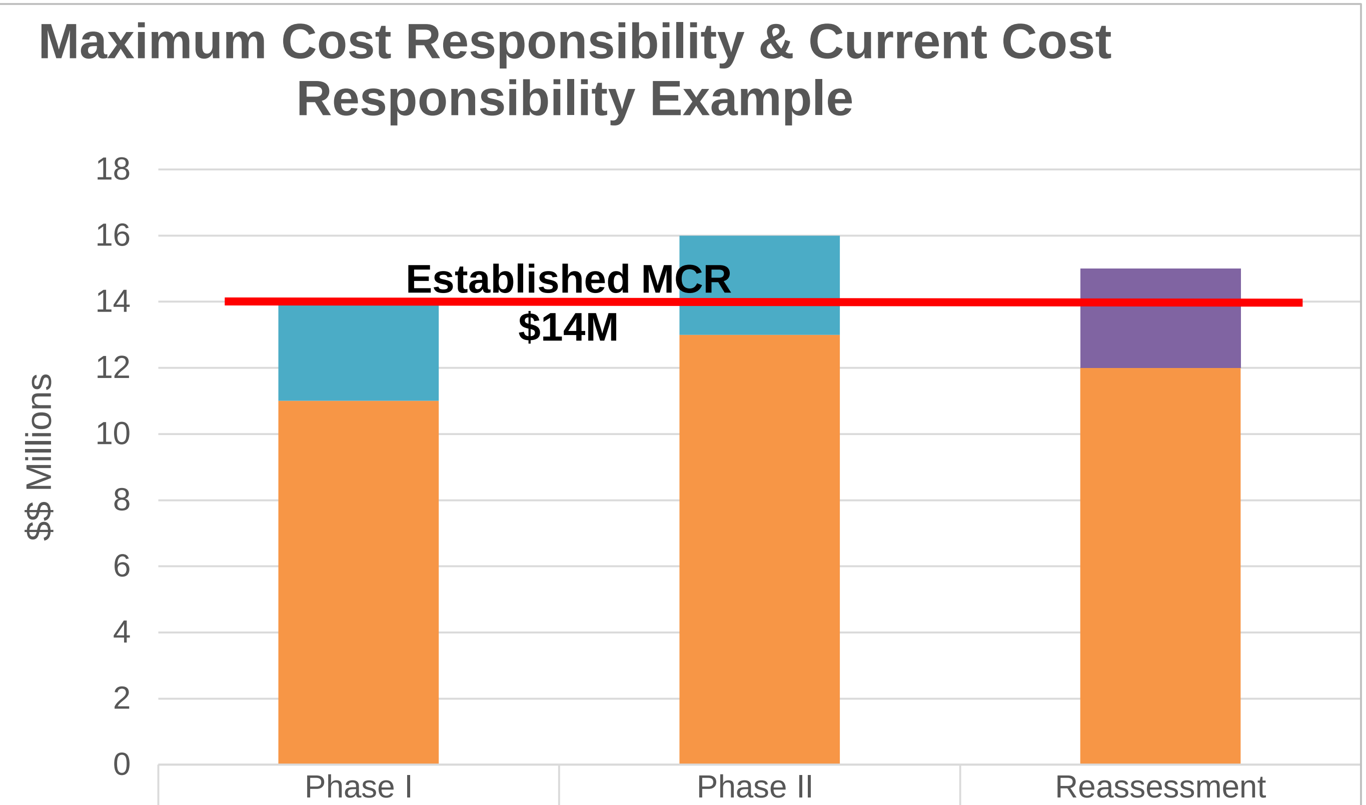
Maximum Cost Responsibility for Network Upgrades (7.1) (cont'd)



	Phase I	Phase II	Reassessment
Potential Converted			0
Potential Upgrades	3	3	
Direct Assigned Upgrades	11	13	14

Note: % above depicts the percent of a DANU assigned to project

Maximum Cost Responsibility for Network Upgrades (7.1) (cont'd)



	Phase I	Phase II	Reassessment
Potential Converted			3
Potential Upgrades	3	3	
Direct Assigned Upgrades	11	13	12

RELIABILITY NETWORK UPGRADE REIMBURSEMENT CAP

Reliability Network Upgrade Reimbursement Cap (7.7)

- Potential for current $60k/MW maximum reimbursement for an RNU to be circumvented when earlier-queued projects withdraw and the upgrade is still needed

- Based on stakeholder input and insufficient evidence that cap has actually been circumvented, CAISO is not proceeding with this topic
  - CAISO will continue to monitor to ensure no adverse impacts to ratepayers or PTOs from misuse of intent or spirit of the policy

- CAISO proposes applying escalation factor to $60,000 value
  - Adjusted annually as part of the per unit cost update stakeholder process

Year	2012	2013	2014	2015	2016	2017	2018
Actual Escalation Rates		1.20%	1.90%	1.80%	2.10%	2.10%	1.80%
Escalation Factors	1.0000	1.0120	1.0312	1.0498	1.0718	1.0943	1.1140
Escalated RNU Cost Cap	**$60,000**	**$60,720**	**$61,874**	**$62,987**	**$64,310**	**$65,661**	**$66,843**

RIDE THROUGH REQUIREMENTS FOR INVERTER-BASED GENERATION

Ride-through Requirements for Inverter-based Generation (6.4)

Summary of received comments:

1. SCE and SDG&E are generally supportive
2. First Solar: (a) requested a technical workshop (b) is not clear of the intent of section A(i)3 of Appendix H (return to pre-event condition) and (3) is not clear as to where to measure power factor as described in A(iii) of Appendix H
3. NextEra: (1) expressed concern on the recording capability of inverters and (2) need for the installation of a Phase Angle Measuring Unit (PMU)

Ride-through Requirements for Inverter-based Generation (6.4) (cont'd)

Summary of received comments:

4. PG&E proposed that the new requirements also apply to any projects going through repower or post COD modifications
5. SDG&E stated that the duration to inject reactive current into the grid was not clear
6. TMEIC recommended retention of inverter tripping for loss of the Phase Lock Loop (PLL), and proposed ride through requirements for the PLL

Summary - Proposed Ride-through Requirements for Inverter-based Generation (6.4)

Revise GIAs to incorporate NERC recommendations for inverter based generation

1. Eliminate momentary cessation for transient low voltages, and transient high voltages where V < 1.20 pu
2. Allow momentary cessation for V ≥ 1.20 pu
3. Eliminate inverter trip for **momentary** loss of the phase lock loop
4. Establish inverter TRIP return time range
5. Coordinate inverter controls with plant level controller
6. Identify minimum level of diagnostic equipment

Ride-through Requirements for Inverter-based Generation (6.4)

Diagnostic Equipment **(plants with net export > 20 MW)**

1. Plant level data: monitor plant voltage, current and power factor, and any plant protective relay trips.
2. Inverter level data: record ride through events and phase lock loop status
3. Time synchronization of data (1 mSec)
4. Data retention: retain data for 30 calendar days
5. Data reporting: provide data within 10 calendar days
6. Install a PMU **or equivalent** (minimum 30 samples per sec). **Real time telemetry is not required.**

Appendix H – A(i)3 Proposed final version

….Momentary cessation (i.e. ceasing to inject current) is no longer an acceptable mode of operation, with one exception as noted below. For transient low voltage conditions, the Asynchronous Generating Facility's units will inject reactive current. The level of this reactive current injection shall be directly proportional to the decrease in Per Unit voltage at the inverter AC terminals. The inverter shall produce full rating reactive current when the AC voltage as the inverter terminals drops to a level of 0.50 Per Unit. The Asynchronous Generating facility shall absorb reactive current for transient voltages between 1.10 and 1.20 Per Unit. The Asynchronous Generating facility's units may momentarily cease to inject current into the transmission grid for transient high voltage conditions $\geq$ 1.20 Per Unit.

Appendix H – A(i)3 Proposed final version – cont'd

Upon cessation of transient voltage conditions and the return of the grid to normal operating voltage (0.90 < V < 1.10 Per Unit), the Asynchronous Generating Facility's units shall automatically transition to normal active (real power) current injection. The Asynchronous Generating Facility's units shall ramp up to inject active (real power) current with a minimum ramp rate – from no output to full output – of at least 100% per second. A ramp rate of 200% per second is preferred. The entire time to complete the transition from reactive current injection or absorption (or momentary cessation if used for voltages ≥ 1.20 Per Unit) shall be one second or less.

Appendix H – A(i)4 Proposed final version

An Asynchronous Generating Facility unit trip is defined as the opening of the unit's AC circuit breaker or otherwise electrical isolation of the unit from the grid. Following the unit trip, the unit will make at least one attempt to resynchronize and connect back to the grid. The time delay to accomplish this will be adjustable to between 2 and 5 minutes. The default time shall be 2 ½ minutes. An attempt to resynchronize and connect back to the grid is not required if the unit trip was initiated due to a fatal fault code, as determined by the original equipment manufacturer.

Appendix H – A(i)10 Proposed final version

Asynchronous Generating Facility units shall not trip or cease to inject current for momentary loss of synchronism. As a minimum, the Asynchronous Generating Facility's unit controls may lock the PLL to the last synchronized point and continue to inject current into the grid at that last calculated phase until the PLL can regain synchronism. The current injection may be limited to protect the inverter. The inverter may trip if the PLL is unable to regain synchronism after 150 mSec.

Appendix H – A(i)11 Proposed final version

Inverter restoration following transient voltage conditions must not be impeded by plant level controllers. If the Asynchronous Generating Facility uses a plant level controller, it must be coordinated to allow the individual inverters to rapidly respond following transient voltage recovery, before resuming overall control of the individual plant inverters.

Appendix H – A(vi) Final Paragraph Proposed final version

The Asynchronous Generating Facility shall install and maintain a PMU (Phase angle Measuring Unit) or functional equivalent normally provided by protective relays at the service entrance to the facility. The PMU shall have a resolution of a least 30 samples per second. The Asynchronous Generating Facility, upon request from the CAISO or the PTO, shall make this data available within 10 calendar days. The CAISO does not require real time telemetry of the PMU data to the CAISO.

NEXT STEPS

Next Steps

Milestone	Date
Post draft final proposal	September 4, 2018
Stakeholder meeting	September 17, 2018
Stakeholder comments due	September 24, 2018

Written stakeholder comments on the draft final proposal are due by COB September 24th to InitiativeComments@caiso.com

Materials related to the 2018 IPE initiative are available on the ISO website at:

http://www.caiso.com/planning/Pages/GeneratorInterconnection/Default.aspx