



# Revisions: Qualifying Capacity and Effective Flexible Capacity for Storage & Supply-Side DR

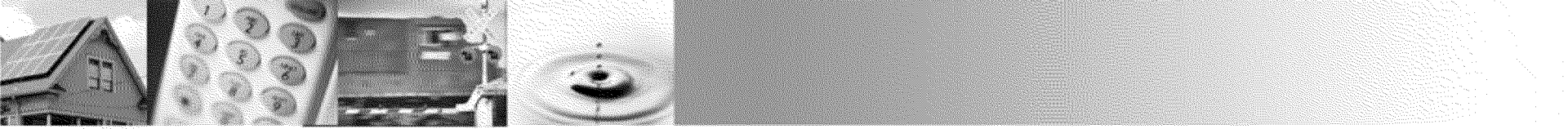


April 9, 2014

Resource Adequacy | Joanna Gubman

California Public Utilities Commission





Storage and DR resources may still be aggregated, but not with one another

- Several parties seemed concerned about the implementation of storage + DR aggregation and wanted more time to consider how this would work or what implications it might have
- Staff looks forward to revisiting this option in the future

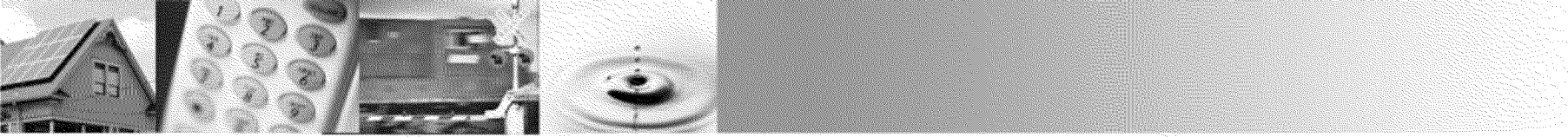




# DR Providers can pick a three-month testing window for Flexible RA

- Flexible RA DR Provider can pick which three month window
- CAISO can pick which date and time, as long as the time chosen falls into the resource's FRAC-MOO must-offer time window
  - System RA resource operators can self-schedule their test dates and times
- CAISO must provide advance warning in compliance with the resource's tariff
  - For example, a DR resource that is entitled to at least 30 minutes of notice in its tariff should receive at least 30 minutes notice of testing
- Resources offering both load curtailment and load increase must demonstrate both capabilities in testing

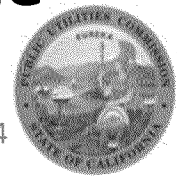




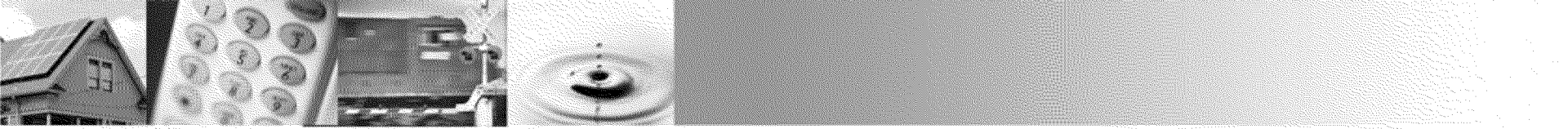
EFC: Yes, the methodology is complicated.

But...

- System and Flexible RA are bundled for all other resources, and we want to be consistent
- We don't want anyone to game the system
- For fast-ramping resources, a lot of the complexity goes away
- It is simpler in pictures
- Flexibility is in an interim stage; we anticipate revisiting the methodology in future years



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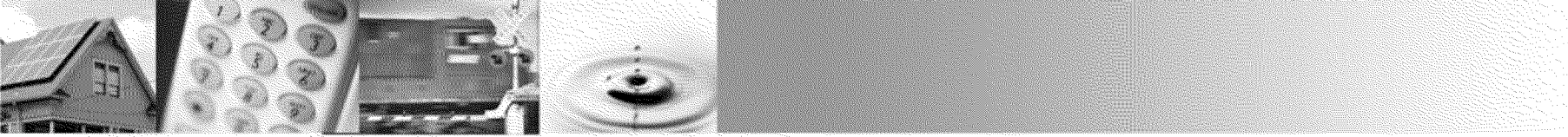


## Nomenclature:

### Positive and Negative Generation

- Positive generation means discharge or load curtailment
- Negative generation means charge or load increase
- Both types need to be dispatchable by the CAISO to count as RA

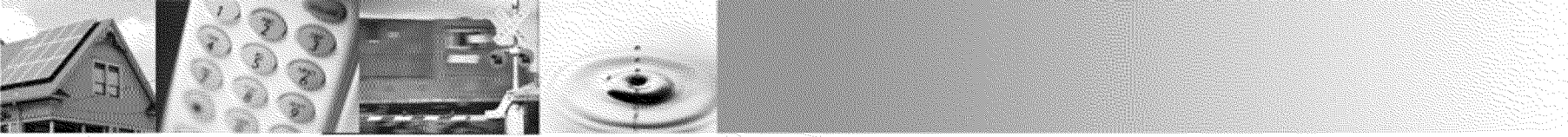




# Nomenclature: Power Output (in MW)

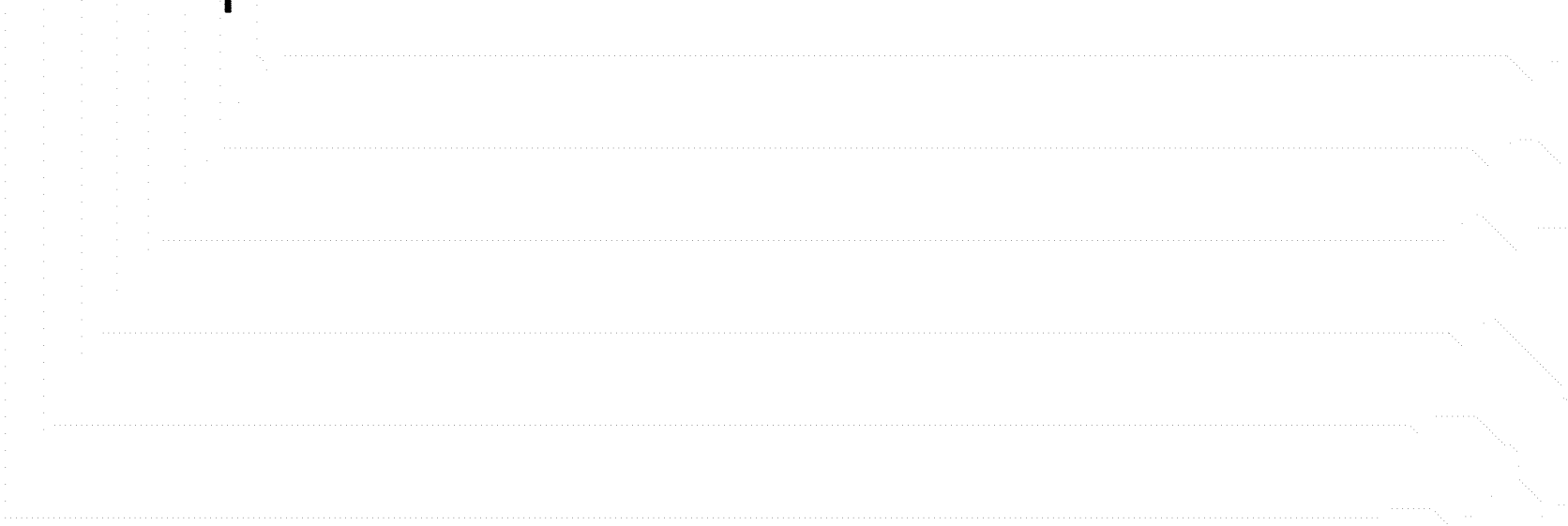
- **P<sub>max</sub>** – a resource’s maximum rated power output
- **P<sub>max,RA</sub>** – the maximum output sustainable for four hours; may be less than P<sub>max</sub>
- **P<sub>supply,min</sub>** – the minimum discharging or load curtailment sustainable for 3+ hours; only applicable to resources with positive generation
  - e.g., minimum dispatch level for a DR resource
- **P<sub>demand,min</sub>** – a negative number representing the smallest magnitude of charging or load increase that is sustainable for the duration required in calculating EFC; only applicable to resources with negative generation
  - e.g., minimum pumping loads
- **P<sub>min,RA</sub>** – either equal to P<sub>supply,min</sub> for resources with only positive operating ranges, or a negative number representing the largest magnitude of charging or load increase eligible for consideration in calculating EFC
- **P<sub>min</sub>** – a resource’s minimum rated output; may be a positive or negative number, and is less than or equal to P<sub>min,RA</sub>





EFC is how much a resource can ramp or sustain output over 3 hours, up to NQC

- Let's start by looking at resources with very fast ramp rates



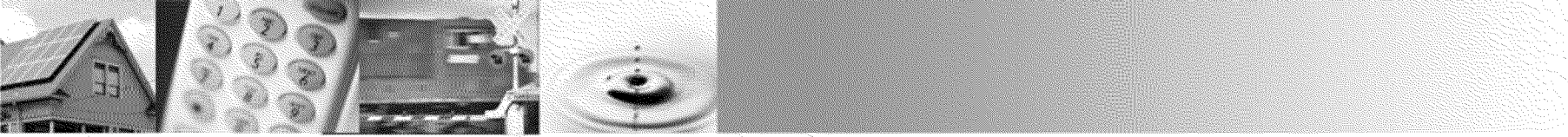


# EFC for Fast-Ramping Resources

- Positive-generation resources (treated the same as other resource types):
  - $EFC = NQC$ , if start-up time  $< 90$  minutes
  - $EFC = NQC - P_{min_{RA}}$ , if start-up time  $> 90$  minutes
- Negative-generation resources:
  - $EFC = -P_{min_{RA}}$
- Bi-directional resources:
  - $EFC = NQC - P_{min_{RA}}$





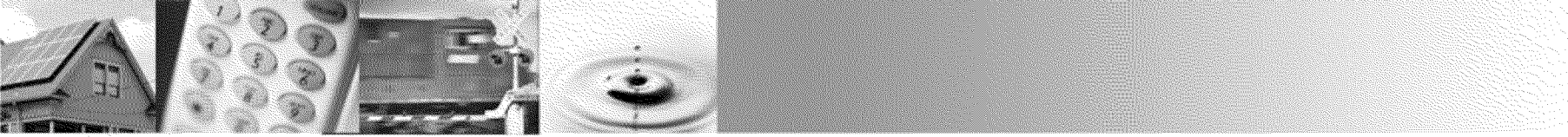


EFC is how much a resource can ramp or sustain output over 3 hours, up to NQC

- But what is the starting point? How is  $P_{min_{RA}}$  determined?

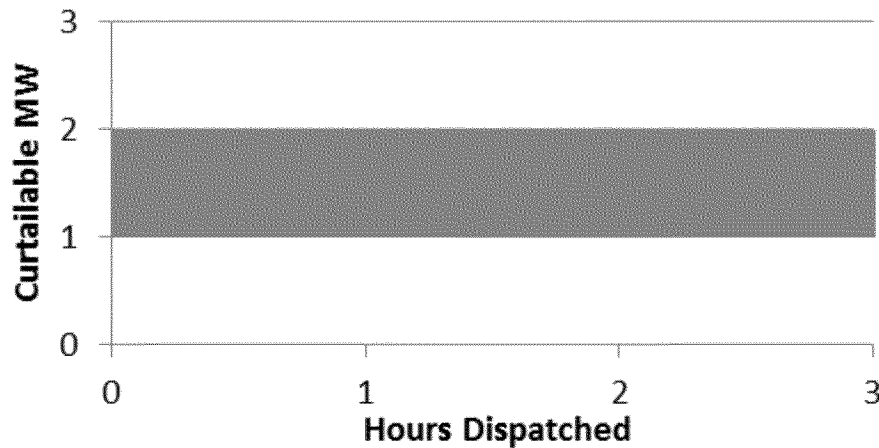
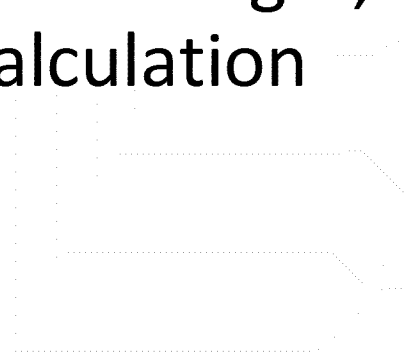
A large rectangular area with a dotted border, intended for handwritten notes or answers.





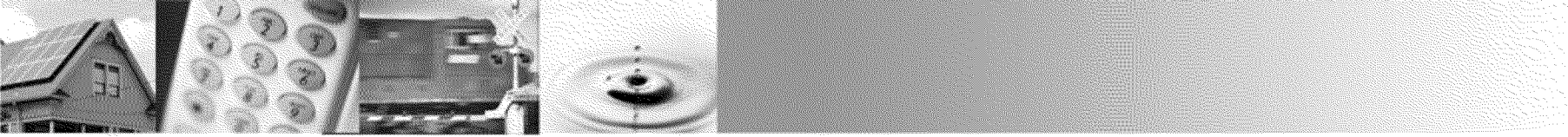
# Positive generation resources: $P_{\min_{RA}}$ is the minimum sustainable 3-hr output

- Equivalent to  $P_{\text{supply}_{\min}}$
- May be zero, if there is no minimum output constraint
- Don't forget,  $P_{\max_{RA}}$  is unchanged from the QC calculation



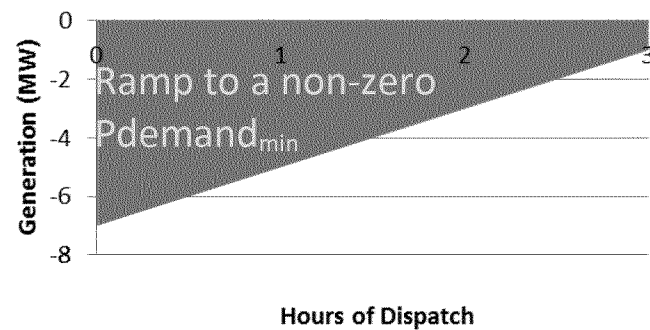
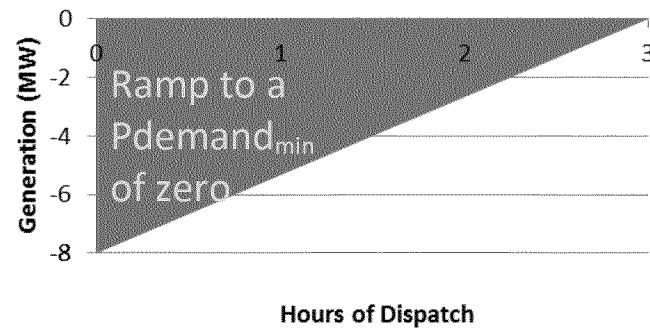
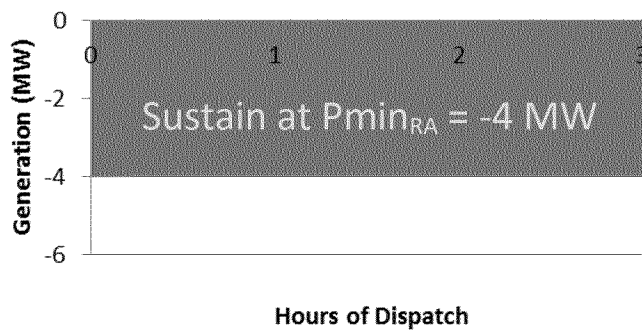
An example DR resource with  $P_{\min_{RA}} = P_{\text{supply}_{\min}} = 1$  MW





Negative gen:  $P_{min_{RA}}$  is the starting point to sustain output or ramp to  $P_{demand_{min}}$

- Limited by energy available to sustain or ramp at a constant rate for three hours
  - Examples: three resources, all with -12 MWh available

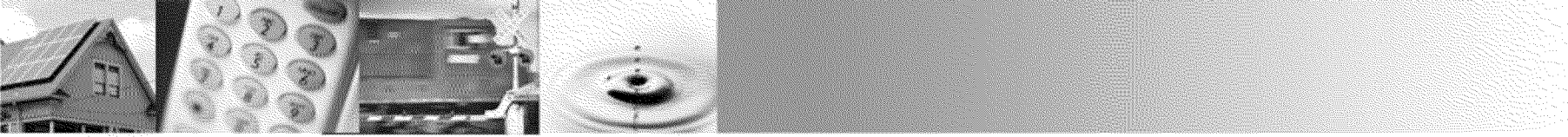




## Bi-directional resources: $P_{\min_{RA}}$ same as negative gen, except 1.5-hour basis

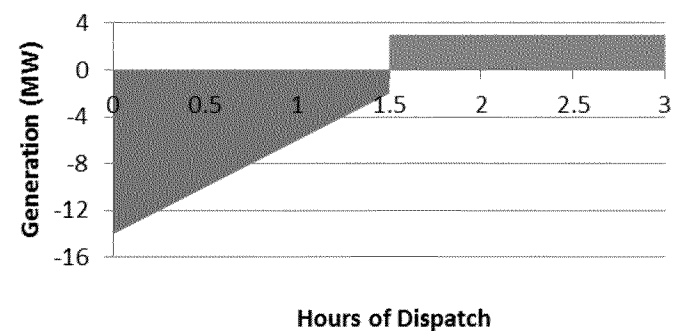
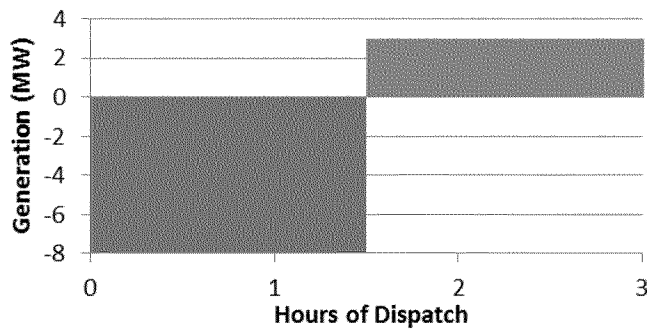
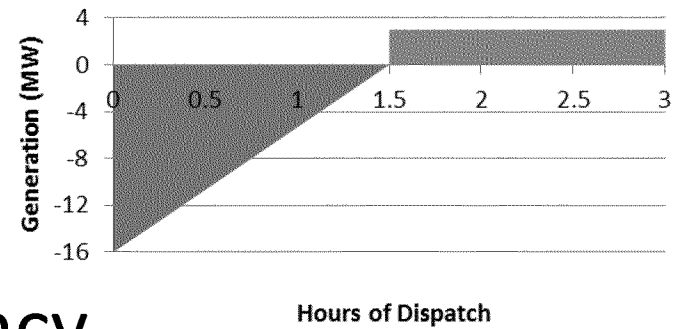
- $P_{\min_{RA}}$  is the starting point to sustain output or ramp to  $P_{\text{demand}_{\min}}$
- Limited by energy available to sustain or ramp at a constant rate for 1.5 hours
- The other 1.5 hours of flexible operation are fulfilled by the capability to output at  $P_{\max_{RA}}$  for 1.5 hours
  - $P_{\max_{RA}}$  remains unchanged; still based on constant 4-hour output

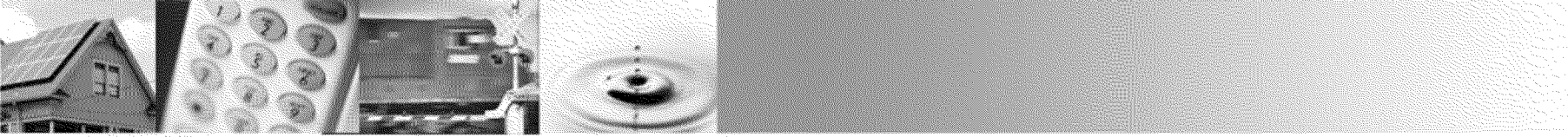




# Bi-directional resources: $P_{min_{RA}}$ same as negative gen, except 1.5-hour basis

- Examples: three resources, all with 12 MWh available and 100% round-trip efficiency

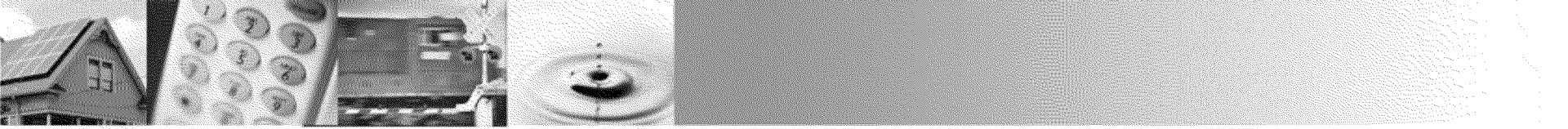




## Bi-directional resources: transition time and discontinuity at zero are OK

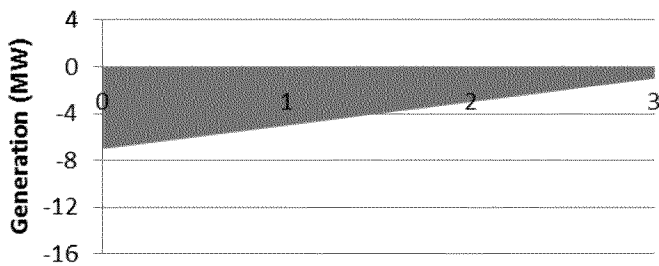
- Staff proposes up to 45 minutes as acceptable transition time. Please address in comments!
- Transition discontinuity means  $P_{demand_{min}}$  and  $P_{supply_{min}}$  can be non-zero
- The above characteristics are inconsistent with CAISO's NGR tariff as staff understands it
- Transition time does not count towards the three hours of operation – no gaming



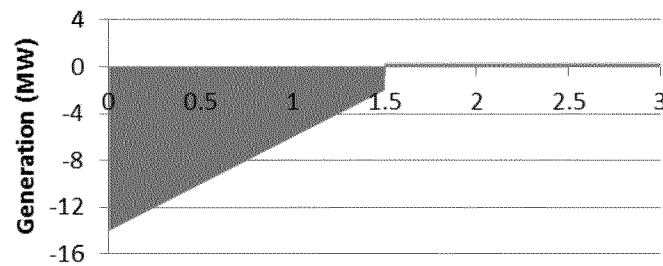


# Bi-directional resources: approximate symmetry proposed, to limit gaming

- Staff proposes that available negative energy not exceed twice the available positive energy (equivalent to a round-trip efficiency of 50%)
  - Feedback requested as to whether parties find this to be a reasonable percentage



Hours of Dispatch



Hours of Dispatch

Example: Absent a symmetry rule, an “aggregate” resource could inflate its EFC



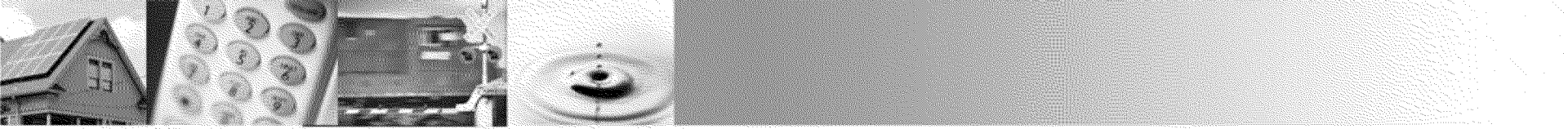


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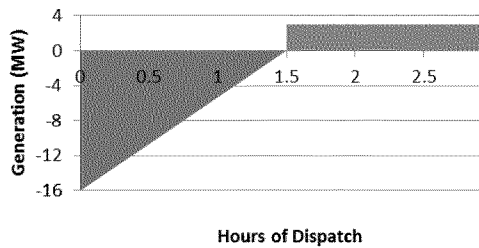
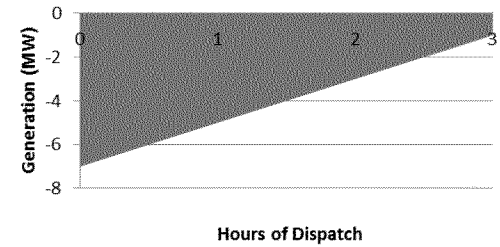
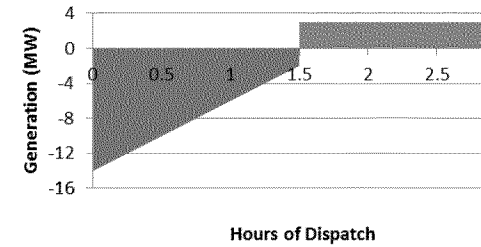
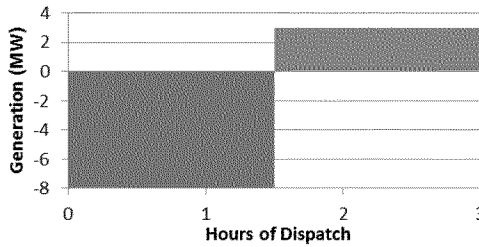
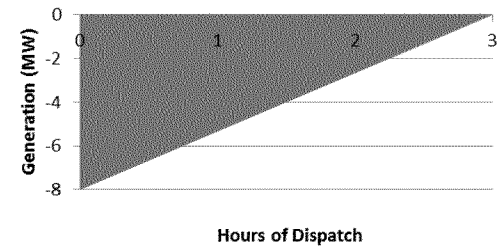
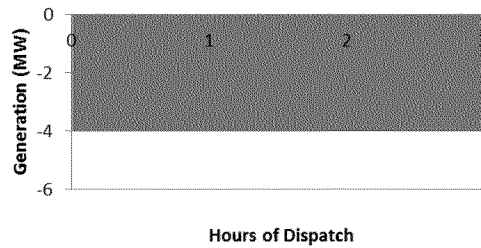
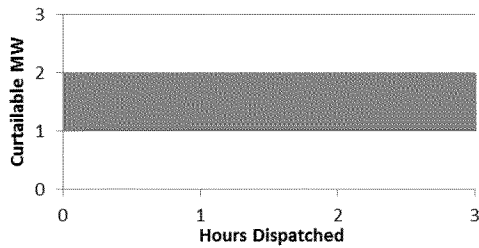






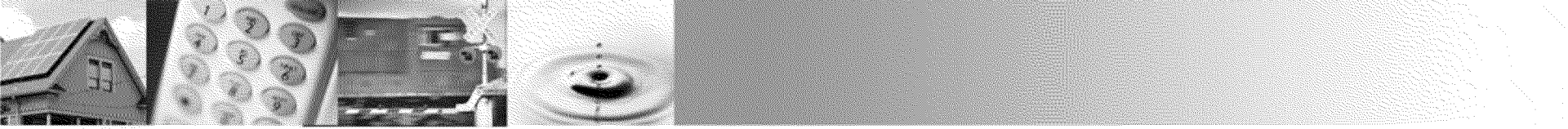
# EFC for Fast-Ramping Resources

- Top MW minus bottom MW in relevant chart\*



\*Except the positive generation resource, which may just be Top MW, if start-up time is under 90 minutes. And all top numbers are subject to deliverability limitation (NQC).





# Slower-ramping resources: EFC range is limited to what is physically possible

- Complicates the EFC formula, but conceptually similar to having a larger-magnitude  $P_{demand_{min}}$
- Use weighted average ramp rates (MW/min)

- $ARR_{pos} = \frac{P_{max_{RA}} - P_{supply_{min}}}{\text{Time to ramp up from } P_{supply_{min}} \text{ to } P_{max_{RA}}}$

- $ARR_{neg} = \frac{P_{demand_{min}} - P_{min_{RA}}}{\text{Time to ramp up from } P_{min_{RA}} \text{ to } P_{demand_{min}}}$





# EFC for Fast-Ramping Resources

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  - $EFC = NQC$ , if  $SUT < 90$  minutes
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- Negative-generation resources:
  - $EFC = -P_{min_{RA}}$
- Bi-directional resources:
  - $EFC = NQC - P_{min_{RA}}$





# EFC for All Storage & DR Resources

- Positive-generation resources:
  - EFC = Minimum of (NQC) and  $(P_{\min_{RA}} + (180 \text{ minutes} - \text{Start-up Time}) * ARR_{\text{pos}})$ , if SUT < 90 minutes
  - EFC = Minimum of  $(NQC - P_{\min_{RA}})$  and  $(180 \text{ minutes} * ARR_{\text{pos}})$ , if SUT > 90 minutes
- Negative-generation resources:
  - EFC = Minimum of  $(P_{\text{demand}_{\min}} - P_{\min_{RA}})$  and  $(180 \text{ minutes} * ARR_{\text{neg}})$ , plus the absolute value of  $P_{\text{demand}_{\min}}$  iff  $180 - (P_{\text{demand}_{\min}} - P_{\min_{RA}}) / ARR_{\text{neg}} \geq \text{shut-down time (SDT)}$
- Bi-directional resources:
  - EFC = Minimum of (NQC) and  $(P_{\text{supply}_{\min}} + 90 \text{ min} * ARR_{\text{pos}}) +$   
Minimum of  $(- P_{\min_{RA}})$  and  $(- P_{\text{demand}_{\min}} + 90 \text{ minutes} * ARR_{\text{neg}})$





# EFC for All Storage & DR Resources

- Positive-generation resources:
  - EFC = Minimum of (NQC) and  $(P_{\min_{RA}} + (180 \text{ minutes} - \text{Start-up Time}) * ARR_{\text{pos}})$ , if  $SUT < 90$  minutes
    - i.e., start up, get to  $P_{\min_{RA}}$ , and ramp up as much as possible in the remainder of the three hours
  - EFC = Minimum of  $(NQC - P_{\min_{RA}})$  and  $(180 \text{ minutes} * ARR_{\text{pos}})$ , if  $SUT > 90$  minutes
    - i.e., start at  $P_{\min_{RA}}$  and ramp up for three hours





# EFC for All Storage & DR Resources

- Negative-generation resources:
  - EFC = Minimum of  $(P_{\text{demand}_{\text{min}}} - P_{\text{min}_{\text{RA}}})$  and  $(180 \text{ minutes} * \text{ARR}_{\text{neg}})$ , plus the absolute value of  $P_{\text{demand}_{\text{min}}}$  iff  $180 - (P_{\text{demand}_{\text{min}}} - P_{\text{min}_{\text{RA}}}) / \text{ARR}_{\text{neg}} \geq \text{shut-down time (SDT)}$ 
    - i.e., ramp up as much as possible over three hours from  $P_{\text{min}_{\text{RA}}}$  towards  $P_{\text{demand}_{\text{min}}}$ ; if there's enough time remaining in the three hours, shut down and get to zero

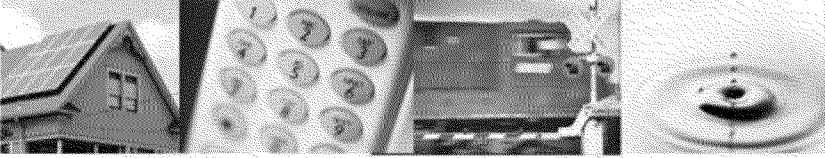




# EFC for All Storage & DR Resources

- Bi-directional resources:
  - $EFC = \text{Minimum of } (NQC) \text{ and } (P_{\text{supply}_{\text{min}}} + 90 \text{ min} * ARR_{\text{pos}}) + \text{Minimum of } (-P_{\text{min}_{\text{RA}}}) \text{ and } (-P_{\text{demand}_{\text{min}}} + 90 \text{ minutes} * ARR_{\text{neg}})$ 
    - i.e., ramp up for 1.5 hours to get to  $P_{\text{demand}_{\text{min}}}$ ; transition to  $P_{\text{supply}_{\text{min}}}$ , and ramp for another 1.5 hours





**Thank you!**  
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