Market Design & Analysis

CAISO Contingency Modeling Alternative:

Regional Flexibility Markets

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Southern California Edison

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Outline

- Concerns with the CAISO's N-1-1 proposal
- Alternative approach: Regional Flexibility Markets
  - Concept
  - Key considerations
  - Formulation
  - Payment structure
  - Illustrative examples

Concerns with CAISO's N-1-1 Proposal

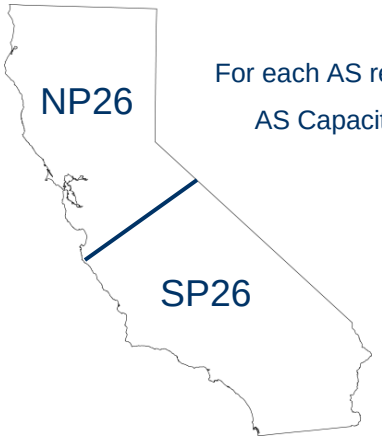
- The CAISO proposal may ultimately be the best approach, however
- Proposal is complex and results in largely incomprehensible/inexplicable price formation
  - Introduces a nodal capacity product and impacts energy LMPs based on the cost of temporal restoration
  - No other ISO's have a nodal capacity payment; now the CAISO wants **two** nodal capacity products (RUC and SOL-1 relief)
- No real-world demonstration of its merit/viability
  - Market power mitigation not addressed
- **False precision**: Relies on a host of assumptions in the DA market that *will not* materialize in real-time; thus DA "solution" may not solve the problems real-time
  - Too much uncertainty between DA and RT to attempt a single "optimal" solution in DA
  - Improper treatment of Virtual bids in the solution
  - Improper treatment of transmission emergency limits available for true N-1-1 restoration
- **Cost**: Spend money in DA with no guarantee that it works in real-time. Uses the DA market to "address" transmission problems that only require resolution in real-time
- Potential under-utilization of Transmission
- Unreasonably excludes Flexi-ramp and Regulation as part of the solution
  - Improper treatment of RA resources

➢ Given concerns, it is appropriate to explore alternatives

Regional Flexibility Markets: Concept

- Flexibility regions can be created to address regional and sub-regional capacity needs including Ancillary Services, flexi-ramp and N-1 SOL capacity
  - The CAISO does offline studies to determine regional flexibility needs

A/S Regions



For each AS region:

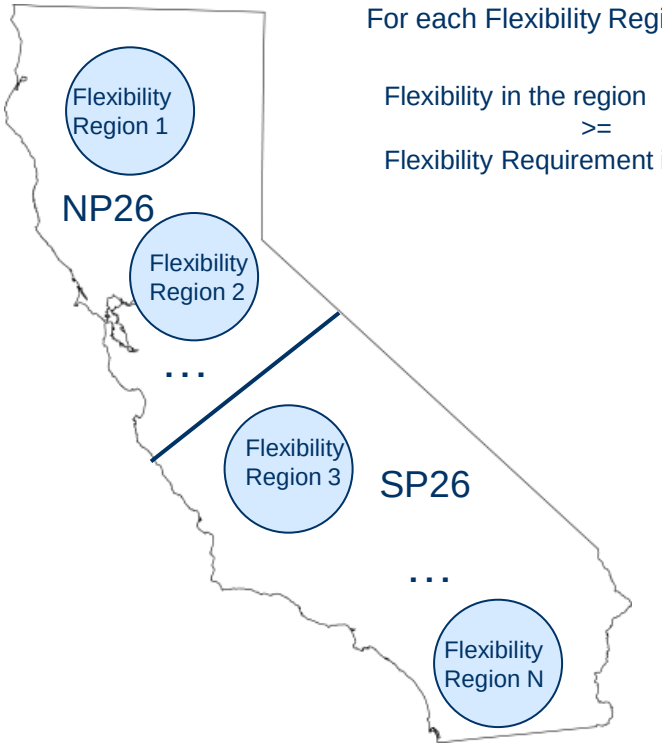
AS Capacity >= AS Req.

Flexi-Ramp Constraint Region

For CAISO System:

Flexi-Ramp Award >= FlexiRamp Req.

Regional Flexibility Markets



For each Flexibility Region:

Flexibility in the region >= Flexibility Requirement in the region

Regional Flexibility Markets

- **Proposed solution: Regional Flexibility Markets**
  - Create regions or sub-regions to provide more targeted and more locational Ancillary Services and Flexibility Capacity Procurement in the Day-ahead and Real-time markets
    - Without going to the nodal level
    - No new products (current Flexible Ramping proposal will require modifications)
    - A/S and Flexible Ramping will receive a Regional price "adder" when regional flexibility constraints bind
  - Use off-line studies to determine typical flexibility needs given expected conditions
    - More reasonable than "flow based" approach for Day-ahead market (e.g. no flows from Virtual Bids)
  - Energy and capacity are co-optimized as today, but procurement will have more regional targets
    - Relatively minor change from status quo (just more regions and price adders)
    - Robust solution to deal with uncertainty from VERs, load, and other sources
  - Similar to A/S, procure all needs in the DA market and only do additional procurement in RT if resources become unavailable or under material system condition changes
- **A regional approach will ensure**
  - Under an N-1 event, generation capacity will be used when they are needed
    - It will not restrict Operators in what capacity can be used to restore the flow
  - Addresses locational A/S needs and locational flexibility needs
  - Reduces unnecessary EDs on normal days
  - Address the failure of the CAISO "system-wide" Flexi Ramp Constraint design

Aside: Flexi Ramp Refinements to Integrate with SOL Issues

- The Flexi-Ramp Constraint was implemented in Dec 2011
- The current Flexi-Ramp design lacks regional procurement
  - Neither the flexi-ramp constraint or the flexi-ramp product considers regional procurement
- Without refinement, this design shortcoming will continue to cause problems such as those emphasized by stakeholders and FERC
  - FERC concluded the failure of the flexi-ramp in its 2012 State of the Markets Report:

    "… CAISO implemented the constraint for the ISO as a whole, rather than for specified locations. This failed to prevent insufficient ramp capability to meet load ramping needs around San Diego in summer 2012."
  - CAISO DMM also noted this problem in its 2012 Annual Report:

    "… around 56 percent of the capacity procured for the flexible ramping constraint was in the Pacific Gas and Electric area. Because flexible capacity is deployed during tight system-wide conditions, the majority of this capacity cannot be used when there is congestion in the southern part of the state, which occurred more frequently in 2012"
- Flexi-ramp should support N-1 SOL restoration
  - To align with operational reality of how the grid operators respond to N-1 events

Regional Flexibility Markets: Benefits

- Benefits of Regional Flexibility Markets*
  1. Provides a framework for regional Flexibility procurement
  2. Procurement based on “study conditions”, rather an “optimization” based on false precision/inaccurate DA forecasts
  3. Avoids co-mingling of financial (e.g. virtual bids) and physical flows to address a reliability requirement
  4. Allows Flexi-ramp and demand response to address N-1 SOL issues
  5. Regional price formation/better price transparency and mitigation of market power
  6. Avoid potential under-utilization of transmission under normal system conditions and better recognize transmission flexibility during N-1 conditions
  7. Potential to reduce both SOL-related EDs and other EDs (MOCs?)
  8. Resources selling “Flexibility” in a binding region will receive a locational premium

*: Compared to the current CAISO proposal which is Prevent-Corrective Constraint Approach

Formulation in IFM & RTM

Flexibility Constraint for Region α (15-min basis)*:

$$w_r \cdot Reg\alpha + w_{ns} \cdot NS\alpha + w_s \cdot S\alpha + w_{fr} \cdot FR\alpha >= 50\% \cdot T\alpha \quad \text{(Eq. 1)}$$

Where

- $T\alpha$ = $T\alpha 0$ - $DR\alpha$ – Other Allowable Non-Market Actions – Transf_Cap
- $T\alpha 0$ = Flexibility Requirement for Region α
- Transf_Cap = Transfer Capability from neighboring regions to $T\alpha$
- w's = Weights

Payment Structure:

Any existing ***product*** in Region α will be paid:

Existing product price + Flexibility Constraint shadow price in Region α

Example:

For Spinning and Non-Spinning, the existing product prices will be determined through:

- Reg Award >= Reg Target
- Reg + Spin >= Reg Target + Spin Target
- Reg + Spin + Non-Spin >= Reg Target + Spin Target + Non-Spin Target (Eq. 2-4)

Assume Eq. 2-4 set P_S (price for Spin) and P_NS (price for non-Spin) system-wide.

Assume the shadow price of Eq. 1 is P_α, then the prices for Region α will be

- P_S + P_α for Spin in Region α
- P_NS + P_α for Non-Spin in Region α

Same price adder P_α applies to FR in Region α.

Notation:

Reg: Regulation
NS: Non-spinning
S: Spinning
DR: Demand Response, including emergency programs
FR: Flexi Ramp Constraint/Product

*: Roughly 50% in 15 minutes. It can be more or less than 50% in reality

Formulation in RUC

Flexibility Constraint for Region α (30-min basis):

$$w_r \cdot Reg\alpha + w_{ns} \cdot NS\alpha + w_s \cdot S\alpha + w_{fr} \cdot FR\alpha + Avail\_Cap\ \alpha + Transf\_Cap >= T\alpha \quad \text{(Eq. 1)}$$

Where

- Avail_Cap α = $QS_{RA}\alpha + QS_{NRA}\alpha + ULC\alpha$
- Transf_Cap = Transfer Capability from neighboring regions to Tα
- Tα = Tα0 - DRα – Other Allowable Non-Market Actions
- Tα0 = Flexibility Requirement for Region α
- w's = Weights

Payment Structure:

- For RA resources, none
- For non-RA resources, paid at the RUC price

Notation:

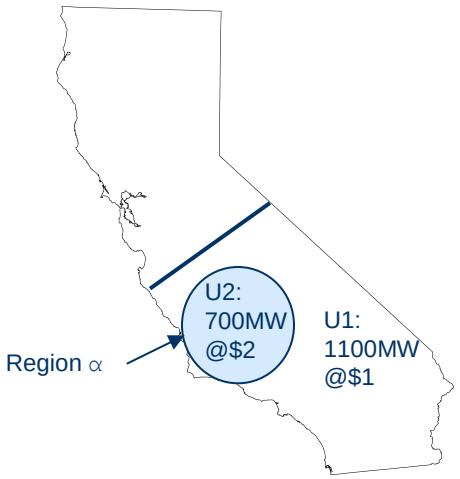
Reg: Regulation
NS: Non-spinning
S: Spinning
DR: Demand Response, including emergency programs
FR: Flexi Ramp Constraint/Product
Avail_Cap: available capacity in a region
QS: Quick Start resources
QS_{RA}: Quick Start RA resources
QS_{NRA}: Quick Start non-RA resources
ULC： Unloaded Capacity
Tα： Flexibility Target in Region α

Flexibility Modeling Example 1: Locational Flexibility can meet both Locational A/S and N-1 SOL needs

Setup

For simplicity, consider only Non-Spin(NS) is available to provide flexibility

Requirement	
NS in SP26	1100 MW
Flexibility in Region α	500 MW
Bids	
U1 (outside α)	NS: 1100MW @$1
U2 (inside α)	NS: 700MW @$2



Results

Without regional flexibility requirement

	Dispatch	Paid Price	Payment
U1 (outside α)	1100MW	$1/MW	$1100
U2 (inside α)	N/A	N/A	N/A

With regional flexibility requirement

	Dispatch	Paid Price	Payment
U1 (outside α)	600MW	$1/MW	$600
U2 (inside α)	500MW	$2/MW	$1000

- The 500MW U2 NS award can serve both locational A/S need and N-1 SOL need
- U2 is compensated for the service
- NS Price for U2 in Region α:

  *SP26 A/S price + Flexibility Constraint Price:$1/MW + $1/MW**

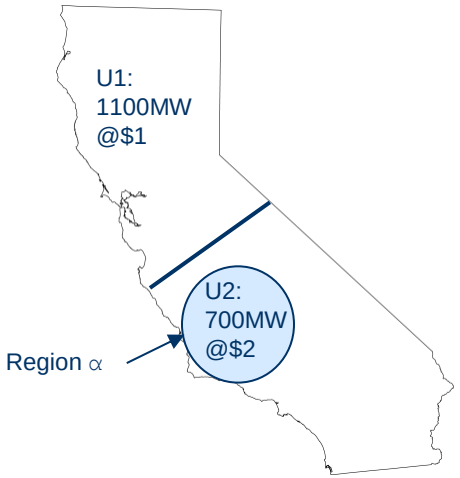
**: The optimization will calculate the shadow price as the marginal saving of reducing the flexibility constraint regional flexibility requirement by 1MW, which can be achieved by reducing U2 award by 1MW with increasing U1 award by 1MW. The saving is $2 - $1 = $1/MW*

Flexibility Modeling Example 2: locational flexibility can meet both locational flexi-ramp and N-1 SOL needs

Setup

For simplicity, assume only flexi-ramp is available to provide flexibility needed for N-1 SOL relief

Requirement	
Flexi-Ramp System-wide	1000 MW
Flexibility in Region α	500 MW
Flexi-Ramp cost	
U1 in NP26	1100MW @$1
U2 (SP26 inside α)	700MW @$2



Results

Without regional flexibility requirement

	Dispatch (Flexi-Ramp)	Paid Price	Payment
U1 (outside α)	1000MW	$1/MW	$1000
U2 (inside α)	N/A	N/A	N/A

- The 1000MW of ramp in NP26 can't address a problem in SP26 if there is congestion
  - This issues is noted by FERC and CAISO stakeholders
  - Load pays the main cost of having U1 Ramp for nothing

With regional flexibility requirement

	Dispatch (Flexi-Ramp)	Paid Price	Payment
U1 (outside α)	500MW	$1/MW	$500
U2 (inside α)	500MW	$2/MW	$1000

- The 500MW U2 flexi-ramp award can serve both locational Flexi-Ramp need and N-1 SOL need
- U2 is compensated for the service

Summary

- The Regional Flexibility approach has many potential benefits when compared to the CAISO approach
- The Regional Flexibility approach addresses one of the core problems with the current Flexi-ramp design – a locational component
- We feel strongly that alternatives, including the Regional Flexibility Markets, should be evaluated along with the CAISO proposal before deciding on a final design

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