



Mayo
29

Colombia

1^{ER} SEMINARIO IBEROAMERICANO CIGRÉ - SIAC 2018

Nuevos horizontes del sector eléctrico
y retos para Colombia

Mayo
28

Medellín

Invita:



Organiza:



Miembros CIGRÉ





Electricity Markets

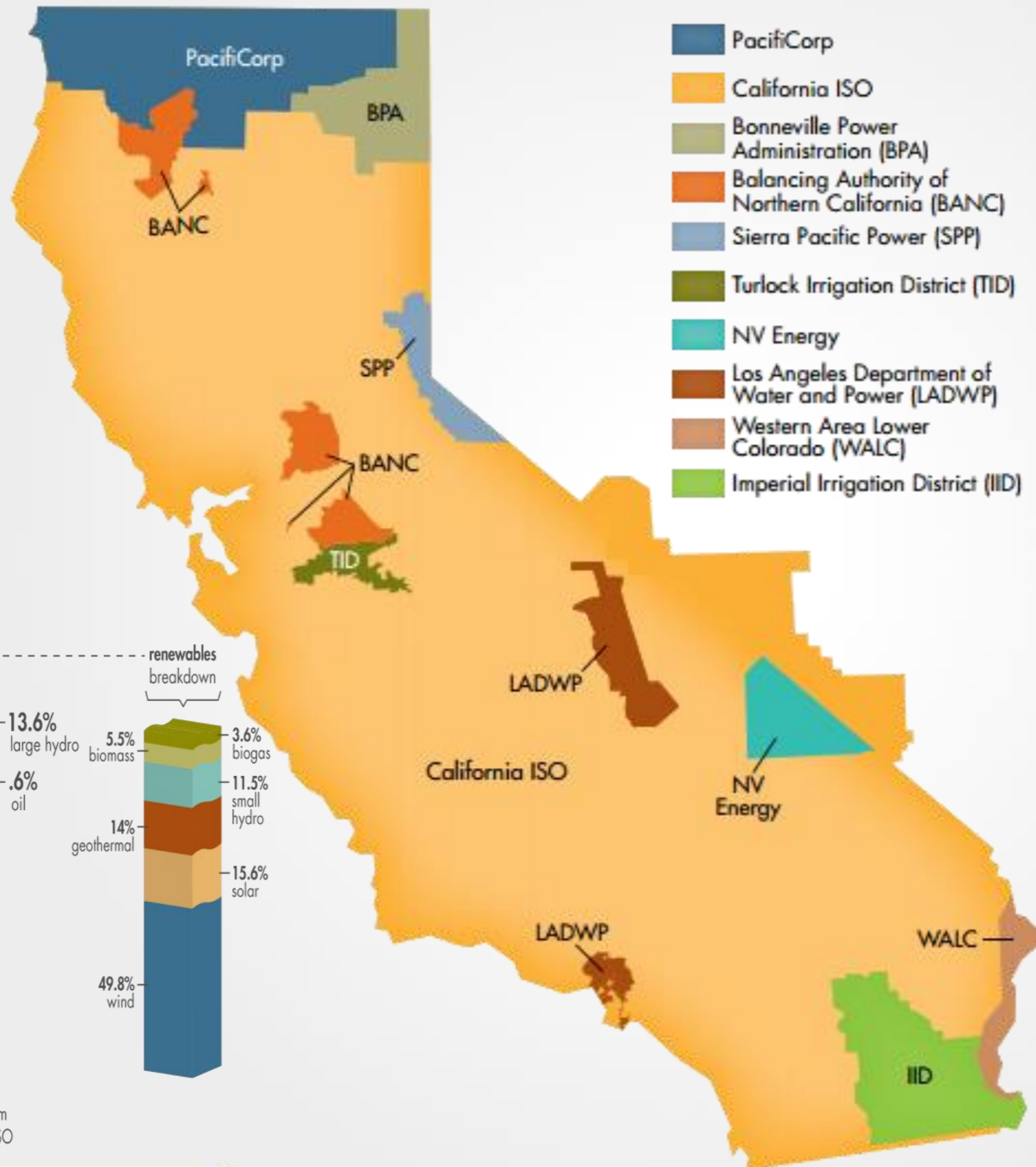
Design for Short-Term Flexibility

Dr. Guillermo Bautista Alderete
Director, Market Analysis and Forecasting
California ISO, CA USA

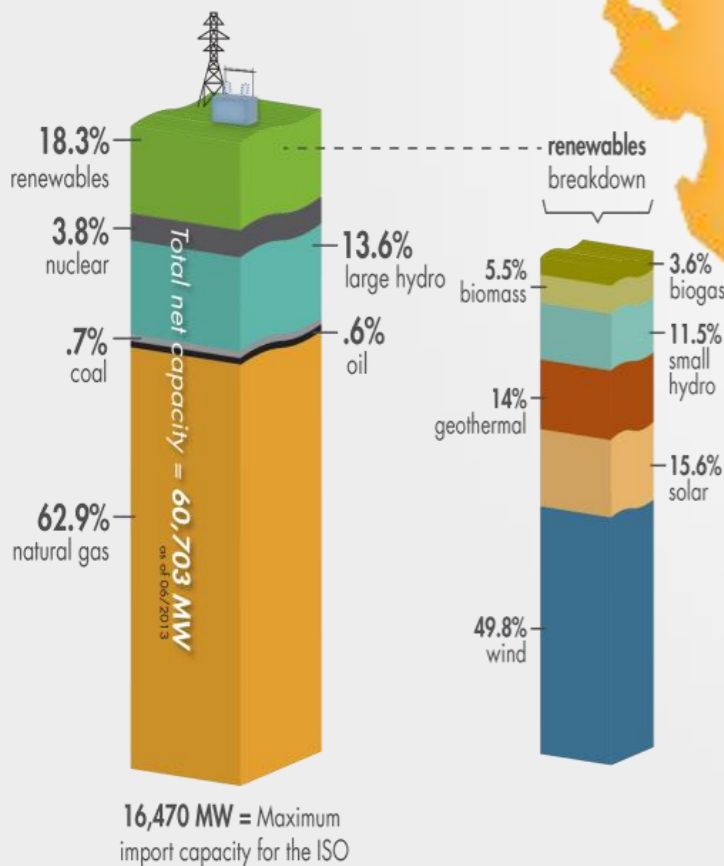
The new reality in the operation of Power Systems is the convergence of multiple disciplines, bridging Power Systems, Economics, Finances, Optimization and is fueled by Innovation and Technology



California ISO is the largest of ten BAs in CA



- **65,226 MW of power plant capacity (net dependable capacity)**
- **50,270 MW record peak demand (July 24, 2006)**
- **30 million people served**
- **80% of the load served in California**



California ISO

Increasing renewable resources coming on-line –

33% by 2020

50% by 2030

Once-through-Cooling policy affect 12,000MW of steam resources located in or near load centers

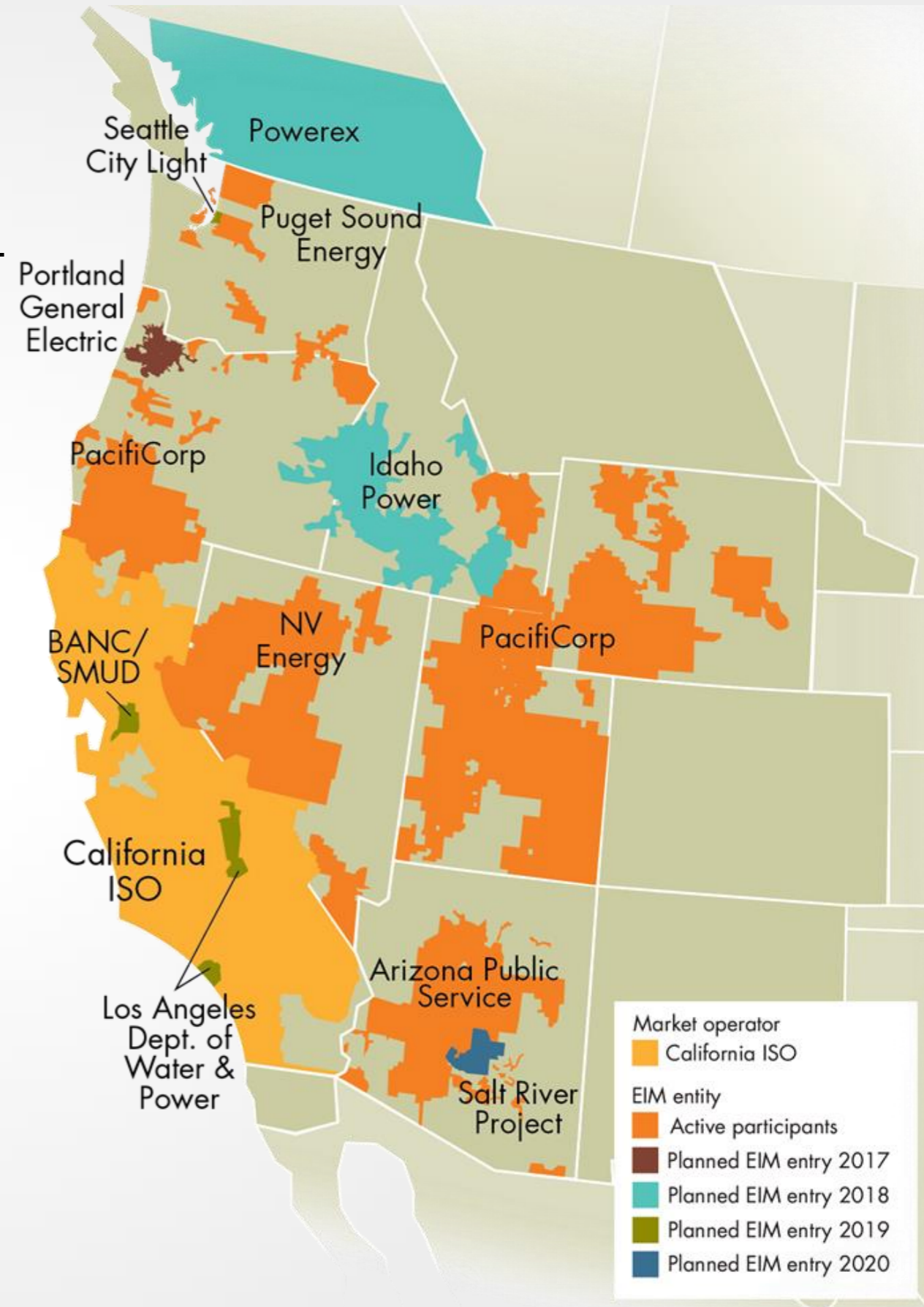
Drought conditions affecting both hydro and conventional resources

CA Delta Plan – required flows may affect hydro availability

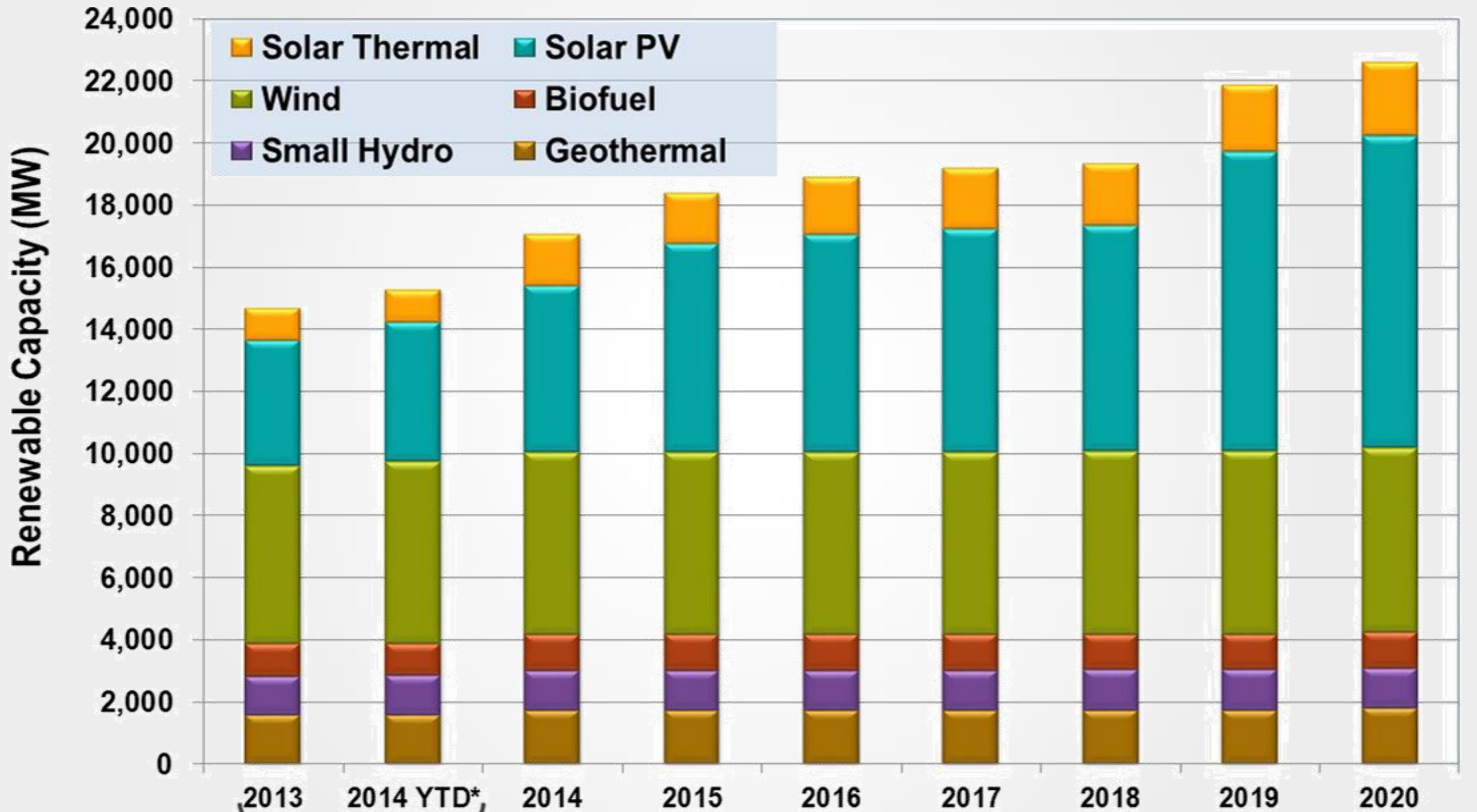
EPA Clean Air Plan

Nuclear relicensing: Diablo Canyon 2024

Decarbonizing transportation sector and buildings may increase demand



In next few years solar generation doubles



(Existing generation)

*All online resources are included in the 2014 YTD amounts, including those yet to achieve full commercial operation.

Power industry transformation



Wind

- Unpredictable Output
- Over 4000 MW of production



Solar Thermal / Photo Voltaic

- Semi – Predictable Output
- Reaching now 10,000 of production



Roof Top Solar

- Semi – Predictable Output
- Behind the meter – Residential
- 5000-6000 MW Estimated Capacity

Main Drivers:

- ✓ California RPS
- ✓ GHG reduction
- ✓ Once-through-Cooled plants retirement

Goals:

- ✓ Higher expectation of reliability
- ✓ Higher expectation of security
- ✓ Smart Grid
- ✓ Situational awareness through Visualization

Summary operational changes to balancing supply and demand

1. Downward ramping capability

Thermal resources operating to serve loads at night must be ramped downward and potentially shut down to make room for a significant influx of solar energy after the sun rises.

2. Minimum generation flexibility

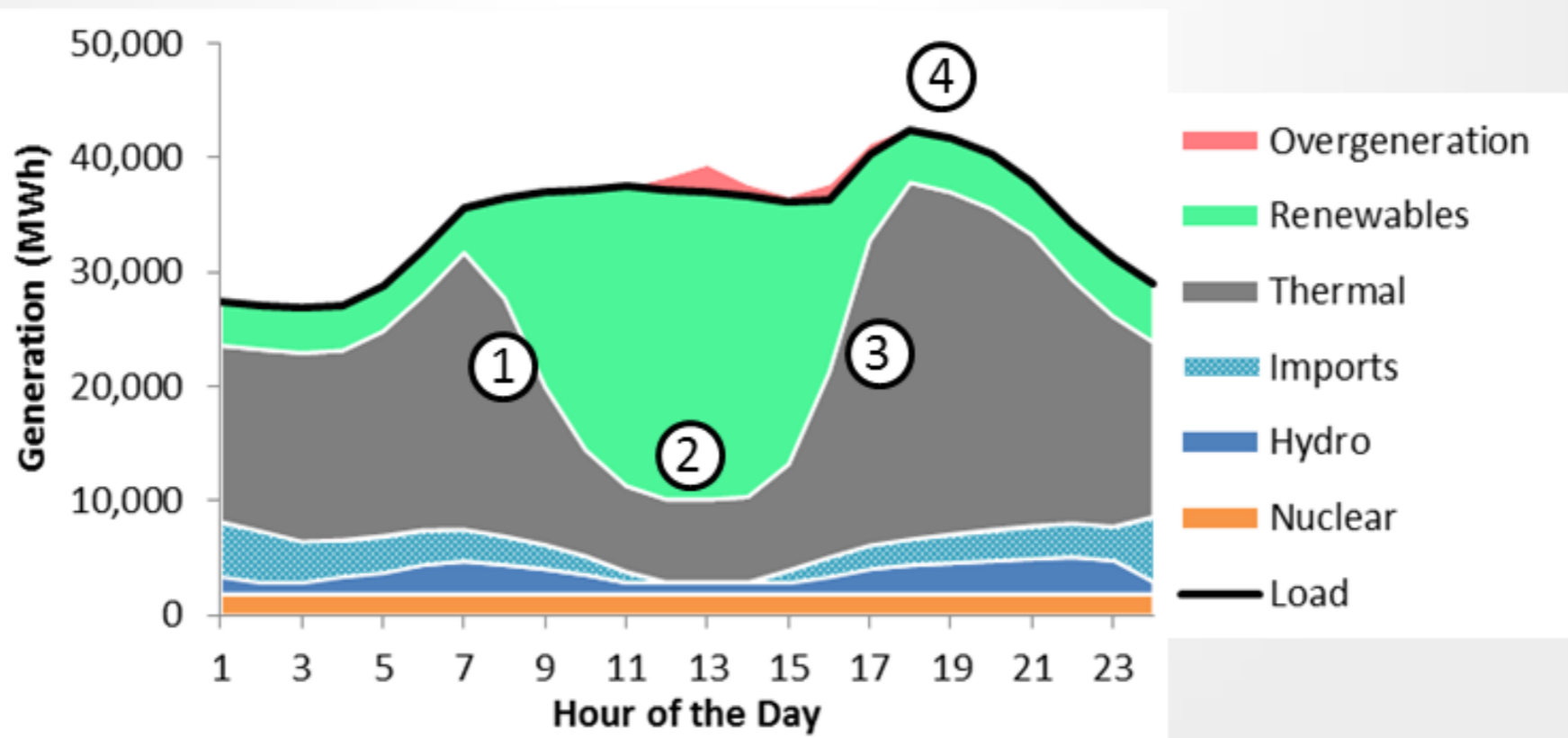
Overgeneration may occur during hours with high renewable production even if thermal resources and imports are reduced to their minimum levels. A system with more flexibility to reduce thermal generation will incur less overgeneration.

3. Upward ramping capability

Thermal resources must ramp quickly from minimum levels during daytime hours and new units may be required to start to meet high net peak demand occurring shortly after sundown.

4. Peaking capability

The system will need enough resources to meet the highest net-loads with sufficient reliability



Market Products

CRRs (obligations)

- seasonal or monthly,
- peak and off-peak

Energy

- 60, 15 y 5 minutes

Virtual energy

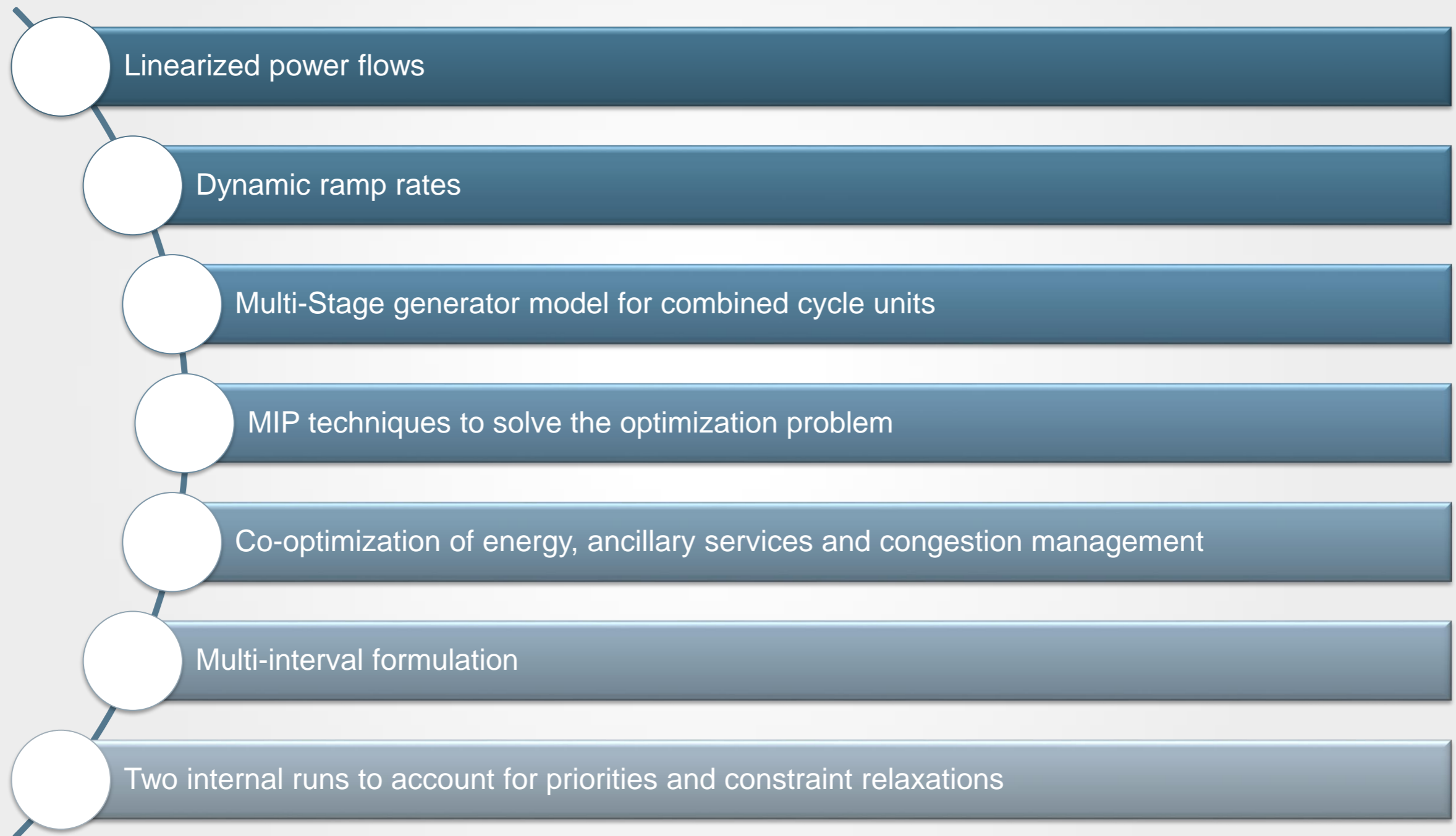
Operating reserves (spinning and non-spinning)

Regulation (Upward and Downward) and Mileage

RUC Capacity

...Corrective capacity, Imbalance Reserves

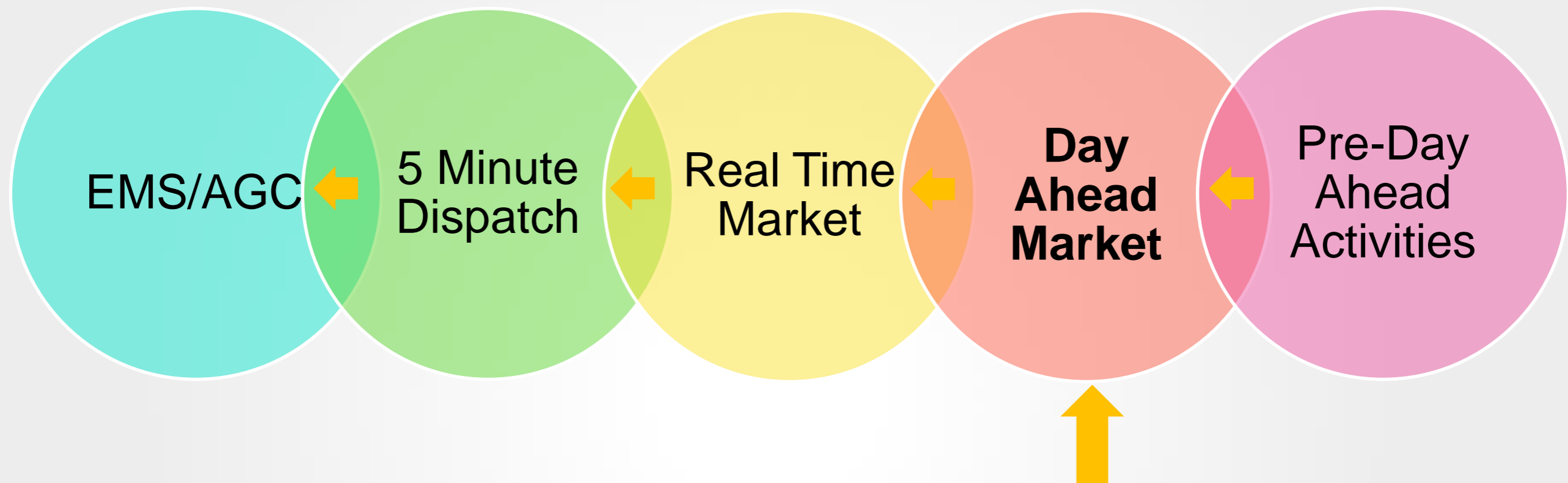
Flexible markets capture the complexities of the actual system -CAISO energy market



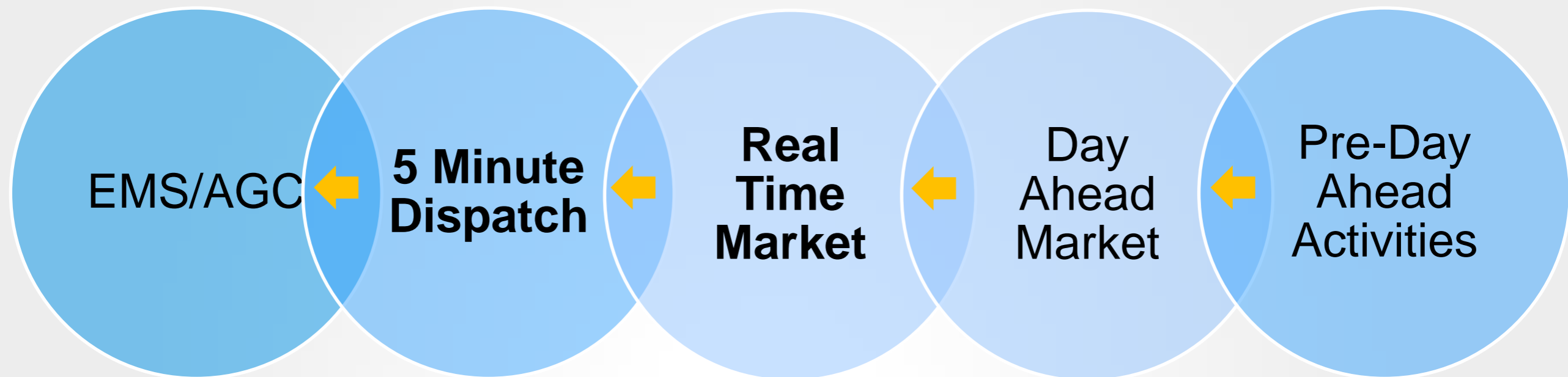
Flexible Markets are an efficient mechanism to cope with the industry transformation



- **System planning**
- **Operation Planning**
 - Procedure development
 - Resource adequacy
 - Outage Coordination
 - 3 and 2 day ahead run
 - Forecasting
 - Long start commitment
- **Congestion Revenue Rights (CRR) allocation to LSE / auction**



- **Market set-up bid collection**
- **Market Power Mitigation**
- **Integrated Forward Market**
- **Residual Unit Commitment**



EMS/AGC

5 Minute Dispatch

Real Time Market

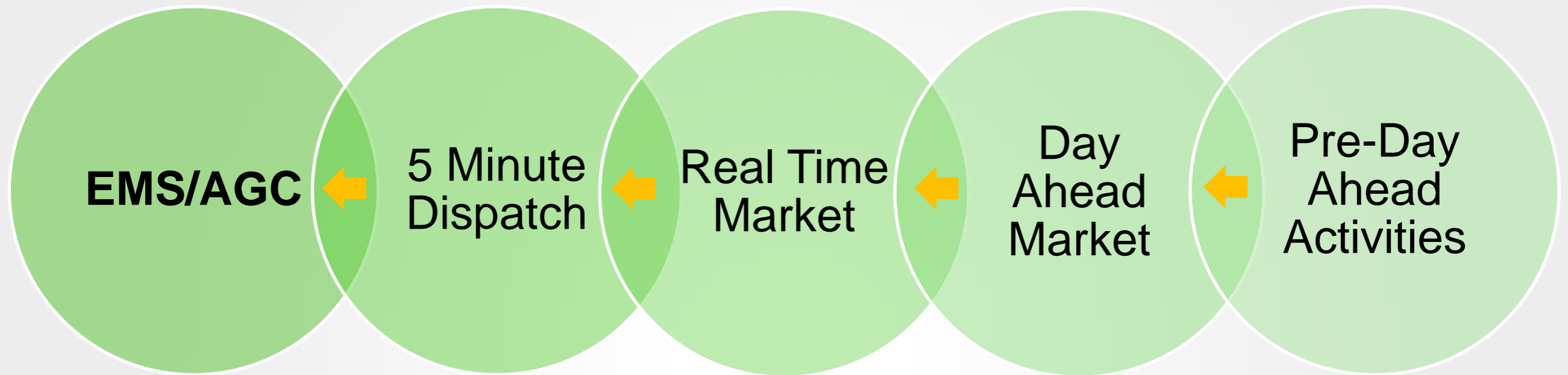
Day Ahead Market

Pre-Day Ahead Activities

- **Create 5-minute demand and supply forecast**
- **Issue dispatch instructions**
– for generators and participating load
- **Set and issue 5-minute prices**
- **Issue exceptional dispatches, if needed**

- **15 minute optimization for 2-5 hours**
- **Receive and process bids**
- **Mitigate market power**
- **Procure additional ancillary services**
- **Commit short start resources**
- **Schedule interchange with adjacent areas**

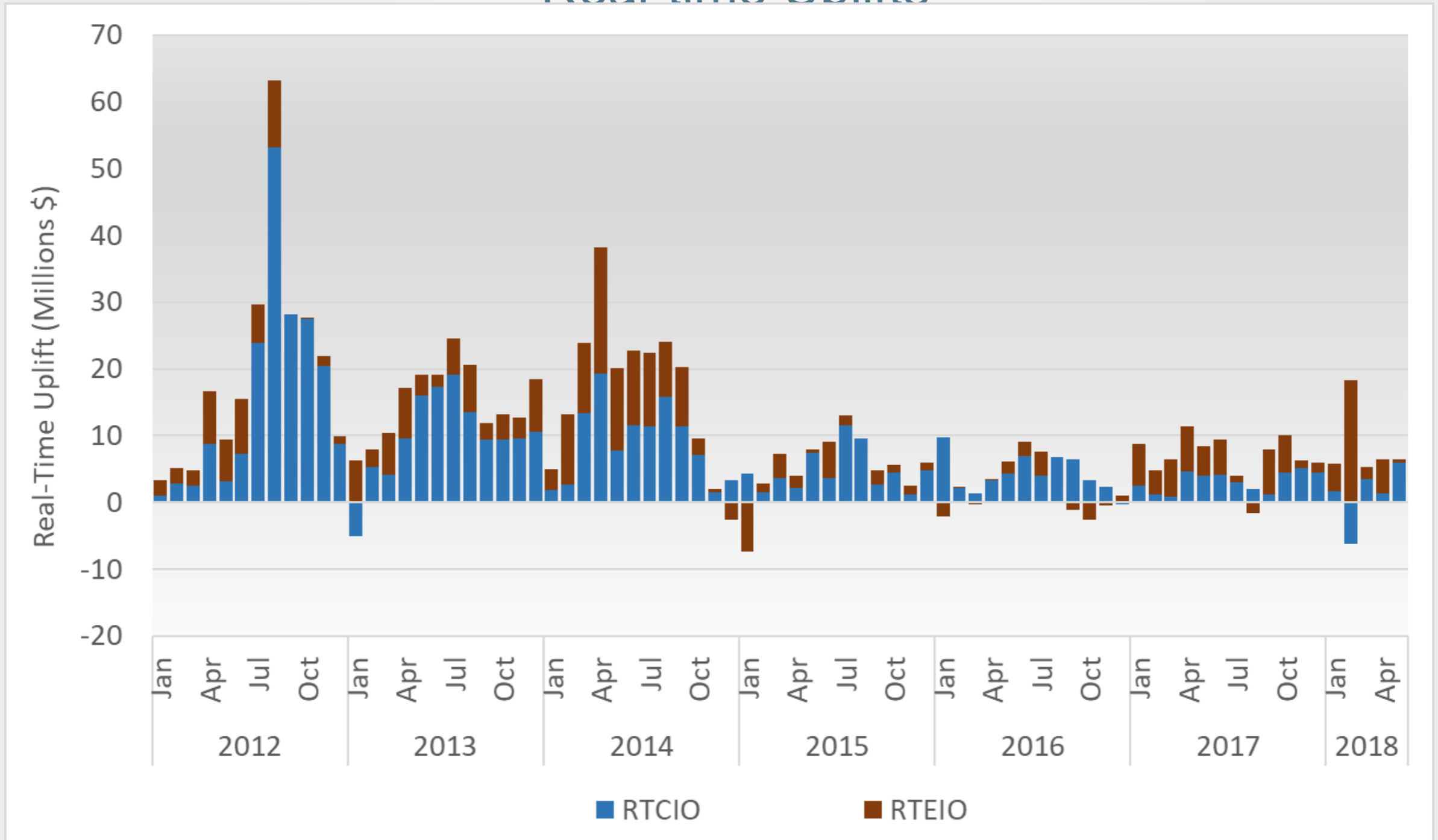
**Real Time
Market
Operations**



- **Resources respond to dispatch instructions**
- **Monitor minute-to-minute conditions**
 - Instantaneous demand and supply changes
 - Contingencies and grid constraints
- **Operators intervene where needed**

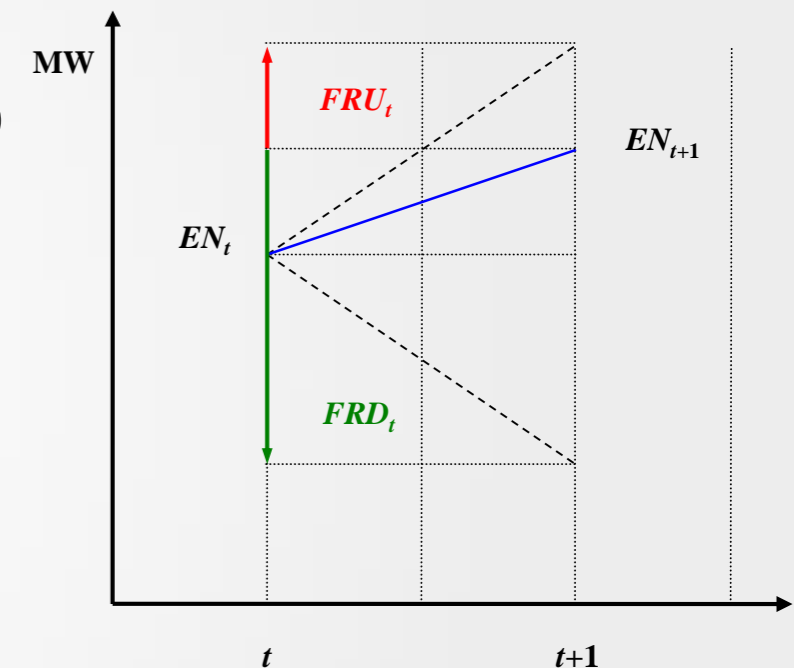
Flexible Markets see to minimize overall costs

Real-time Uplifts



Dispatch Flexibility is a must for the integration of renewable resources

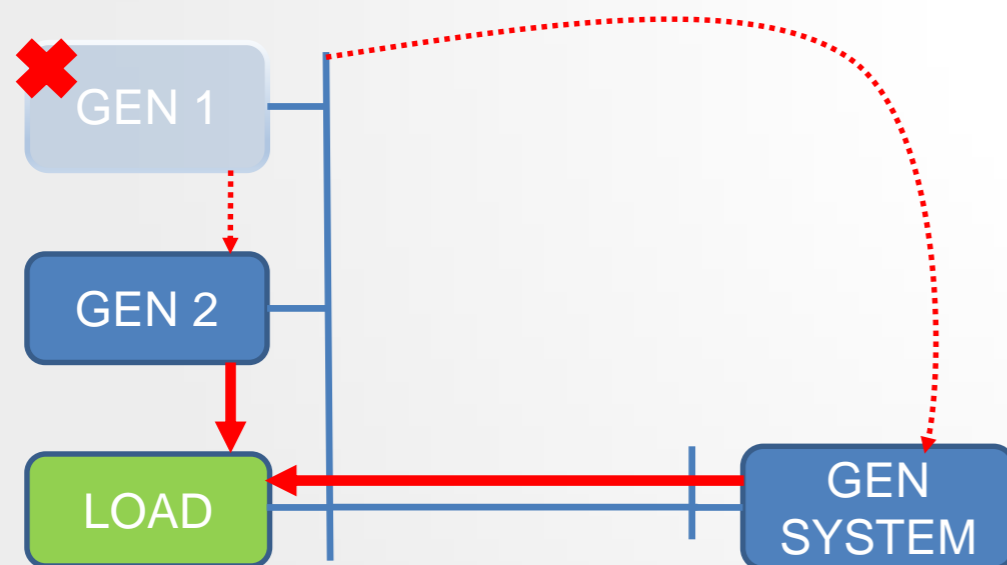
- Flexible Ramping Up/Down Uncertainty Awards
 - No bids, priced at opportunity cost
 - Paid FRU/FRD marginal price (shadow price of requirement constraint)
 - Allocated to those that cause uncertainty
- Forecasted Movement Up/Down
 - From binding to advisory dispatch
 - Paid FRU/FRD marginal price
 - Charged FRD/FRU marginal price
 - FMU/FMD settlement supplements energy settlement
 - Addresses price formation issue of opportunity cost for out-of-merit dispatch in t being reflected in advisory LMP of $t+1$



Flexible Markets address Operational conditions through market mechanisms

Model the “pick-up” effect of the system for a generator loss

- Consistent with reliability studies for generator loss
- Consistent with operator’s real-time contingency analysis tool
- Incorporate the potential change in electrical flows into locational marginal prices



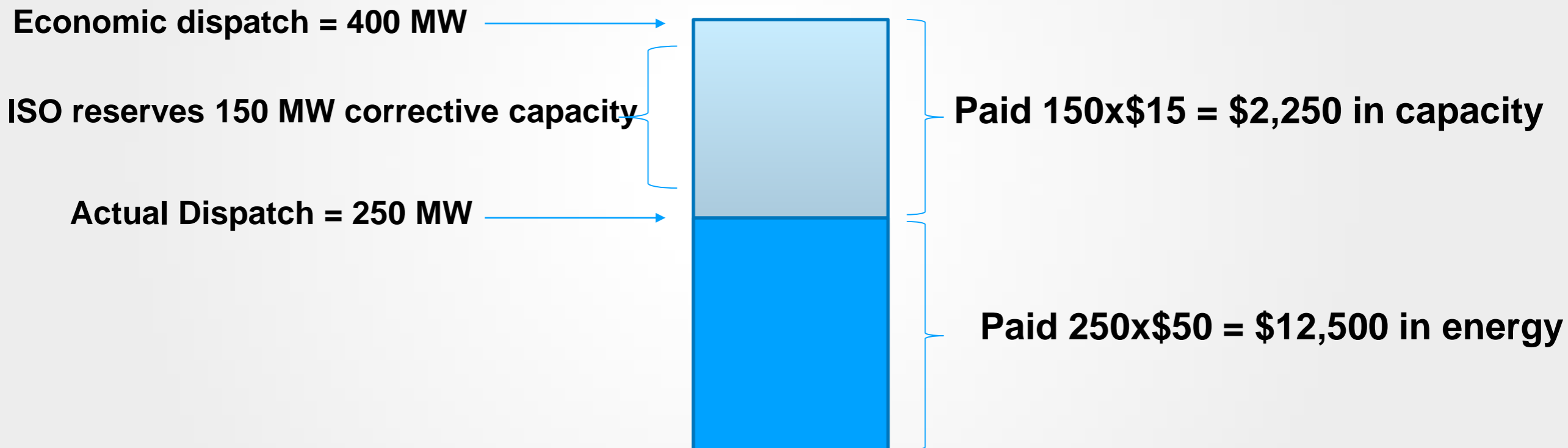
Loss of generation spread to other online resources to model transmission line flows.

Most GEN 1 output picked up by GEN SYSTEM.

GEN 1 locational marginal price considers flows on LINE 1 due to pick-up by GEN SYSTEM.

Enhanced Pricing formulation to provide market price signals for reliability conditions

LMP = \$50
Bid = 400 MW for \$35



**Resource paid for out-of-merit dispatch to reserve corrective capacity.
Since paid for out-of-merit dispatch no incentive to deviate from dispatch.**



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