



# Grid West

## Module 3b Discussion Real-Time Energy Market

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Page 1

***The Real-Time Energy discussion will cover the following topics:***

- Objectives
- Assumptions
- Challenges & Considerations
- Service Descriptions
- Process Overview
- Timeline
- Key Concepts
- Capability Summary
- Open Issues

***The objectives of the Beginning State Real-Time Energy Market design are:***

- Develop a market based process for dispatching balancing energy in the consolidated control area (CCA)
- Allow entities outside of the CCA to voluntarily submit energy offers into the Real-Time Energy Market

## ***The Beginning State Real-Time Energy Market discussion assumes the following:***

- Grid West will operate a Real-Time Energy Market for the CCA
- The Real-Time Energy Market adjusts for any difference between total electricity requirements and the sum of energy schedules, and also performs a least-cost dispatch based on voluntary inc/dec bids
- The Real-Time Energy Market also manages transmission congestion and losses in Real-Time
- Real-Time Energy is arranged every N minutes (where N is between 5 and 15 minutes) by Grid West based on voluntary bids received from dispatchable resources
- Imbalance settlement for participants within the consolidated control area will utilize Real-Time Energy prices
- Control Areas (CAs) that do not consolidate will continue to perform the Balancing Authority functions as defined by the NERC functional model. Imbalance settlement for participants outside the consolidated control area will be performed by individual control areas using existing business rules
- Resources selected in the Real-Time Energy Market will be sent dispatch instructions and settled by Grid West
- Grid West will be responsible for issuing dispatch instructions to units that are selected as a part of the Real-Time Energy Market
- Dispatch Instructions will be sent to both the Control Area and the Resource (e.g., Generator)

## ***The Beginning State Real-Time Energy Market has the following challenges & considerations:***

- **NERC Functional Model** – The NERC functional model has enumerated a number of responsibilities (e.g., Balancing Authority, Interchange Authority, Reliability Authority, etc.). In a multi-control area configuration it is important to clearly identify who will perform each role.
- **Voluntary Supply Offer** – How will participants outside the CCA offer supply in the Real-Time Energy Market.
  - How will they be modeled (e.g., psuedo ties, etc.) in the EMS?
- **Cost Considerations** – How much existing infrastructure can be leveraged? (e.g., metering, etc.)
- **Operational Control** – The result of the Real-Time Energy Market will be a set of dispatch instructions. How will these dispatch instructions be implemented? (e.g., existing control areas, consolidated control areas, etc.)
  - How is the balancing done with multiple control area arrangements

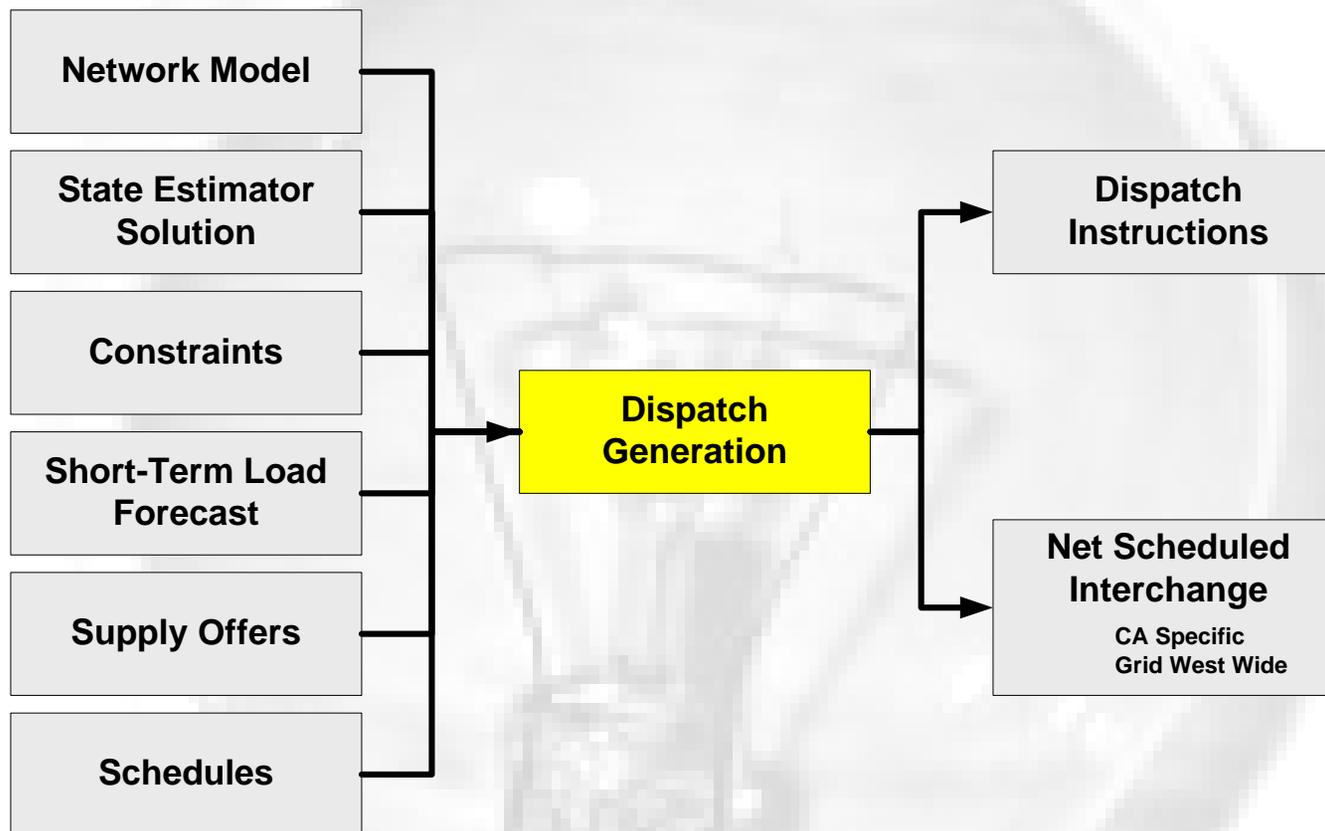
***The Beginning State Real-Time Energy Market design has the following basic characteristics:***

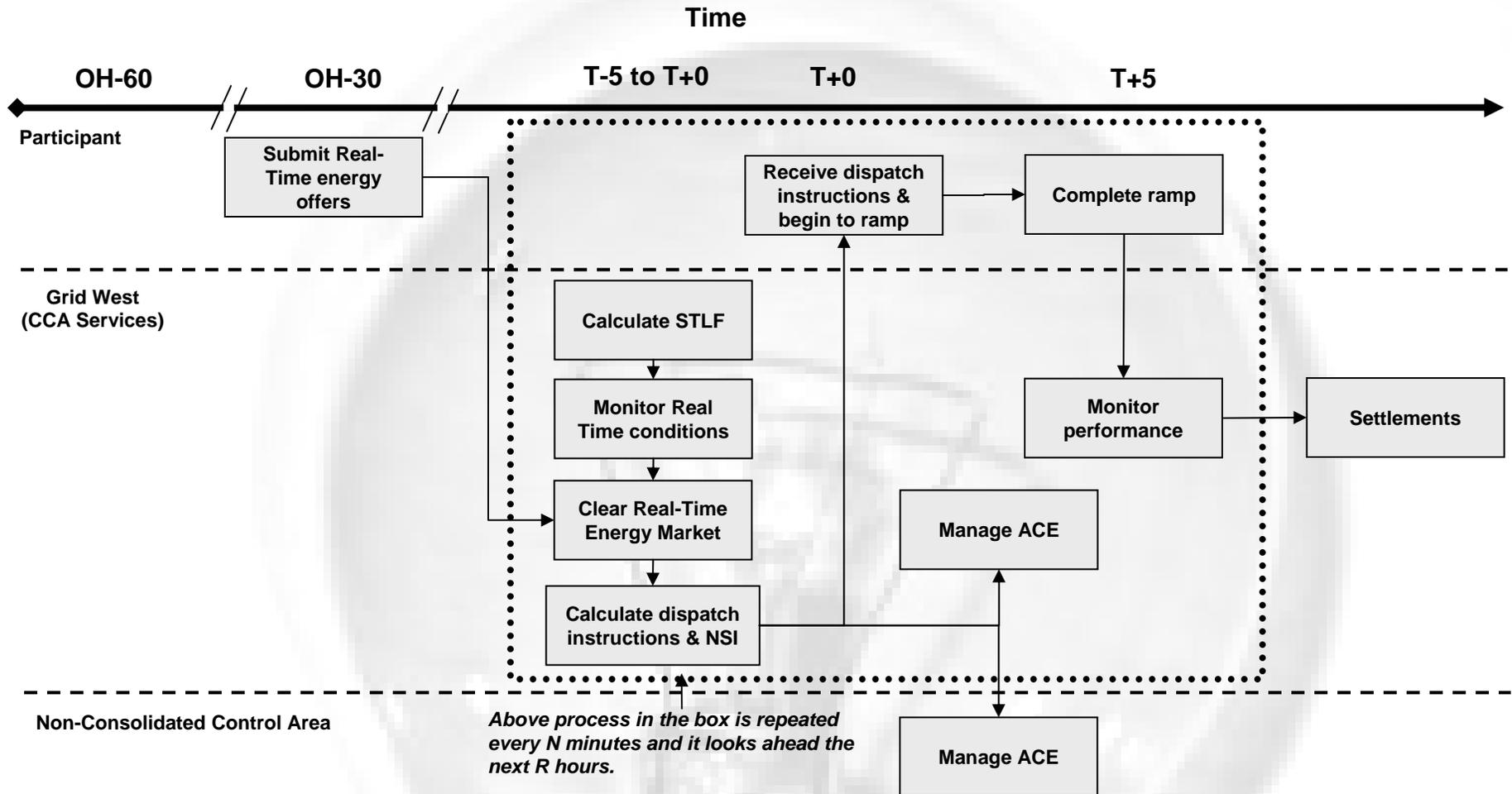
- Least cost dispatch will be based on available inc/dec offers.
- Dynamic transfers will be used, similar today, for jointly owned units, NWPP reserve response, etc.
- Control strategy may utilize existing control centers and metering to minimize cost of implementation.
- Grid West operates the Real-Time Energy Market for the CCA

**Grid West will provide the following Operating Hour Services:**

<p><b>Short-Term Load Forecasting</b></p>	<ul style="list-style-type: none"> <li>• Short-Term Load Forecasting (STLF) predicts system load by using historic load and weather data, plus forecasted weather conditions.</li> </ul>
<p><b>Real-Time Monitoring</b></p>	<ul style="list-style-type: none"> <li>• SCADA             <ul style="list-style-type: none"> <li>• Metered Generation, Load, &amp; Transmission</li> </ul> </li> <li>• State Estimator</li> </ul>
<p><b>Real-Time Energy Market</b></p>	<ul style="list-style-type: none"> <li>• Market where balancing energy is bought or sold every N minutes to accommodate energy use just moments before it occurs on a least-cost basis.</li> <li>• Market Participants can voluntarily submit offers to inc/dec resources for use in the CCA energy market, for use in managing congestion on transmission lines, or for use in executing least-cost dispatch.</li> </ul>
<p><b>Dispatch</b></p>	<ul style="list-style-type: none"> <li>• Dispatch of Real-Time Energy</li> <li>• Dispatch of Reserves</li> </ul>

**The Real-Time Energy Market includes the following inputs and outputs:**





Notes: 1. Times shown are illustrative only to provide context  
2. The exact timing of events (OH-30, etc.) needs to be further defined

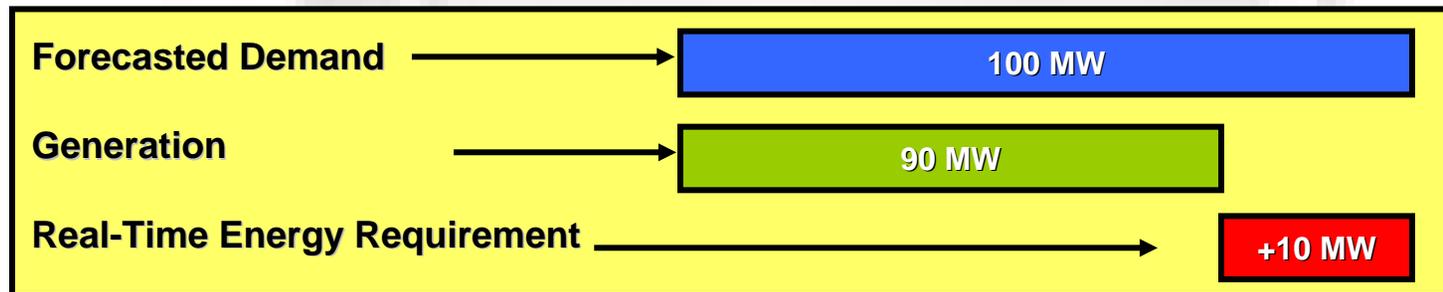
***The following scenarios will result in energy imbalance within the consolidated control area:***

- Generate more energy than scheduled
- Generate less energy than scheduled
- Consume less energy than scheduled
- Consume more energy than scheduled

***There may or may not be a financial consequence for this energy imbalance depending on the design of financial settlement (e.g., instructed vs. uninstructed deviation, dead bands, etc.)***

**Grid West will award Real-Time offers in response to energy imbalance...**

For any given 'n' Minute period:



**However, Grid West will ALSO use Real-Time Offers (Incs/Decs) to relieve congestion and produce a least-cost re-dispatch solution...**

**The following Real-Time Energy Market key concepts are explained in additional detail:**

Adjustment Period

Operating Hour

Real-Time Energy Market  
Module 3b

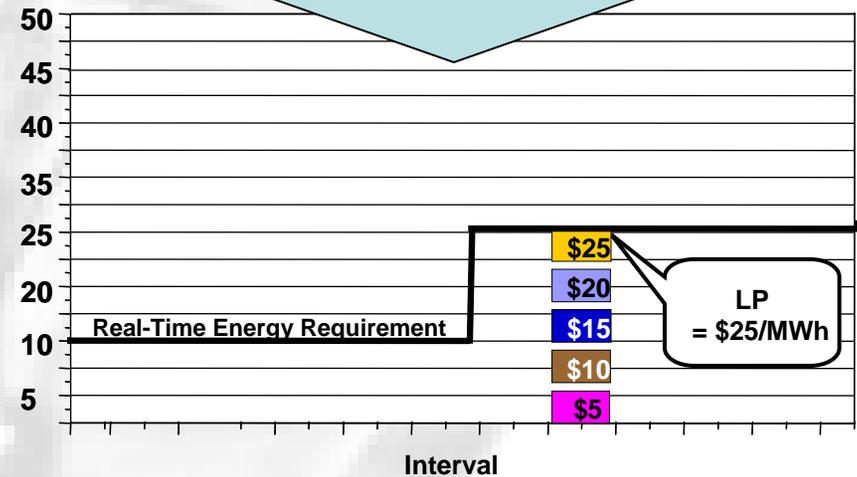
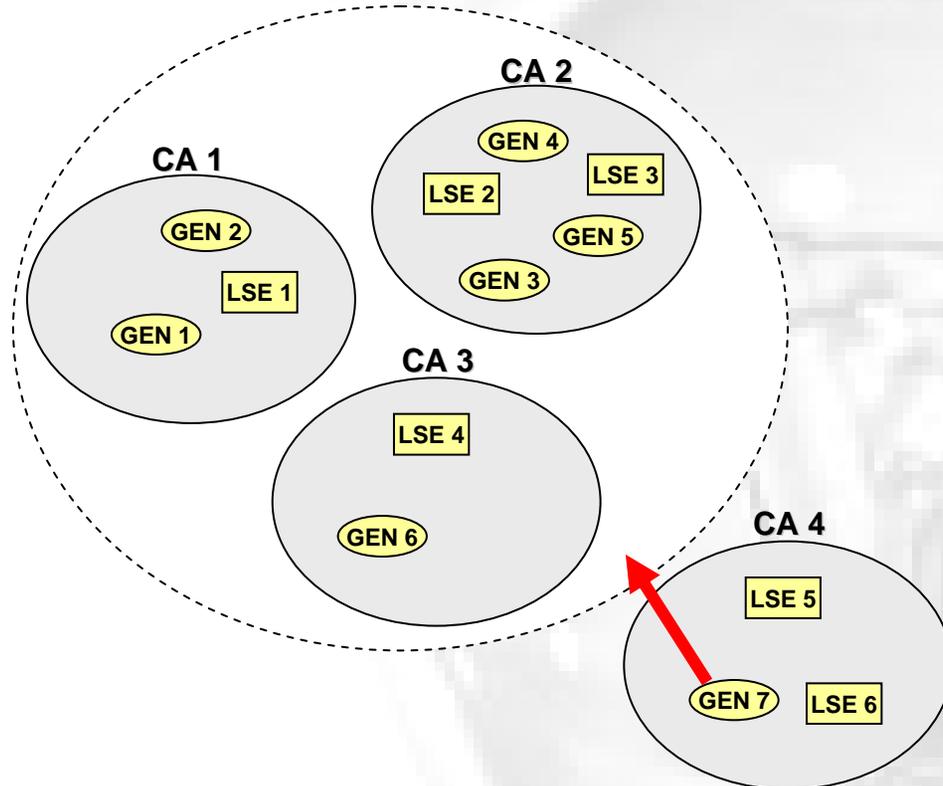
- Voluntary Supply Offer
- Operating-Hour Sequence
- Dispatch Model
- Market Power Considerations
- Uninstructed Deviation

***The following entities can submit offers into the Real-Time Energy Market:***

- Available Resources within the CCA
- Dispatchable Loads within the CCA
- Imports to the CCA

**Consolidated Control Area**  
Load = 1000, Generation = 900  
Real-Time Energy Requirement = 100 MW

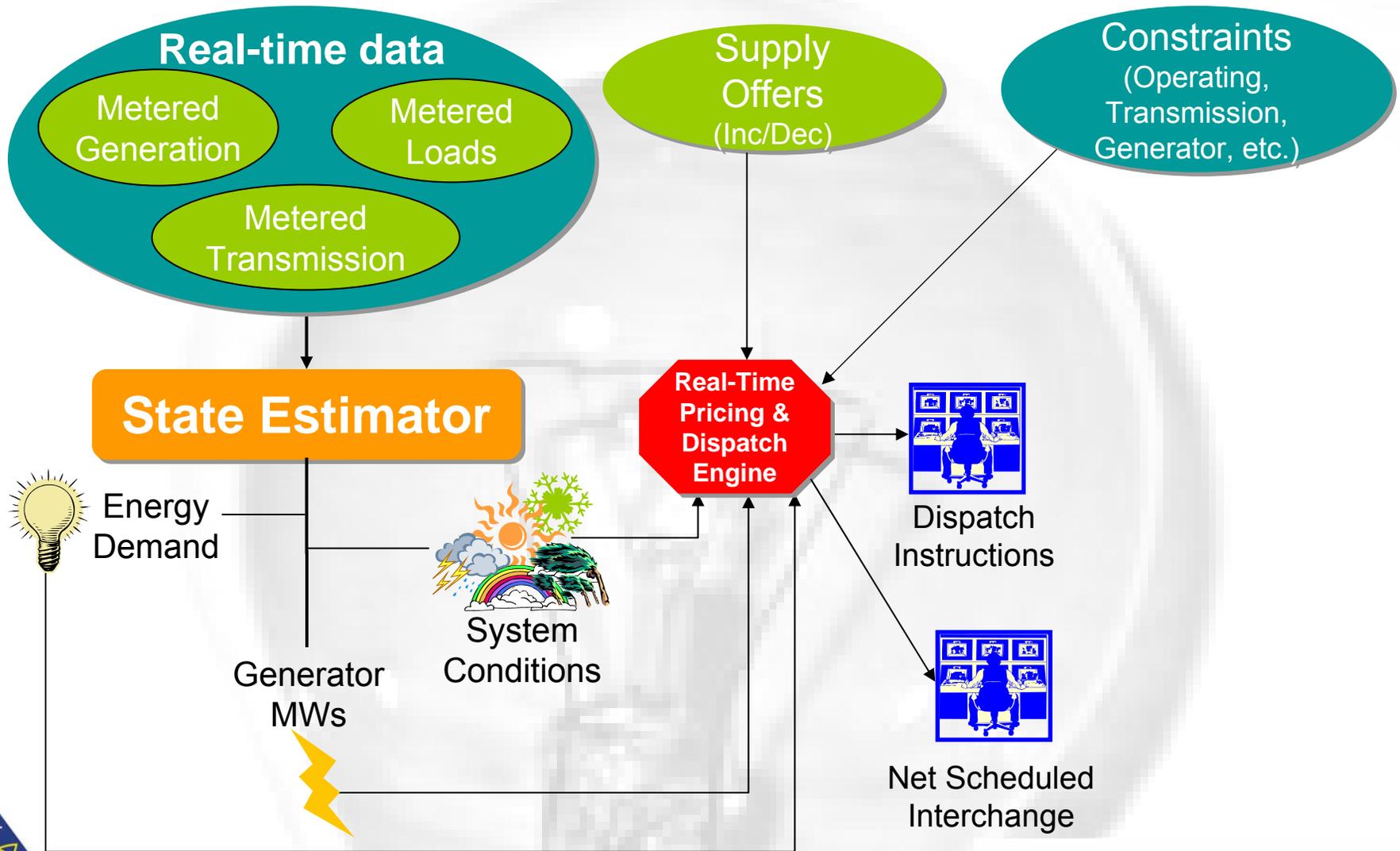
Entity	MW Offer	Price
GEN 1	20 MW	\$10/MW
GEN 3	5 MW	\$20/MW
GEN 4	15 MW	\$25/MW
GEN 5	40 MW	\$15/MW
GEN 7	25 MW	\$5

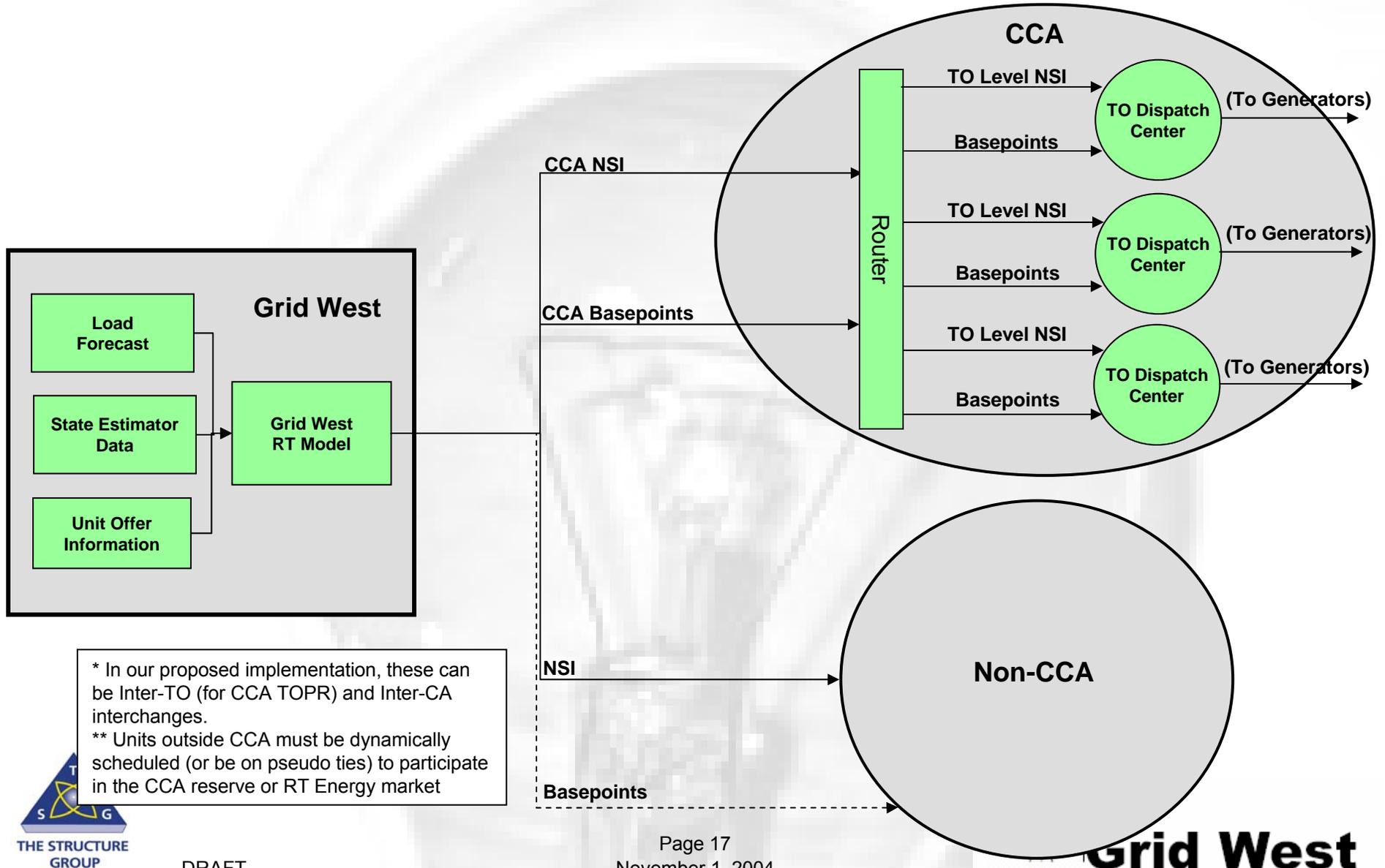


**The following activities are part of the Operating Hour sequence:**

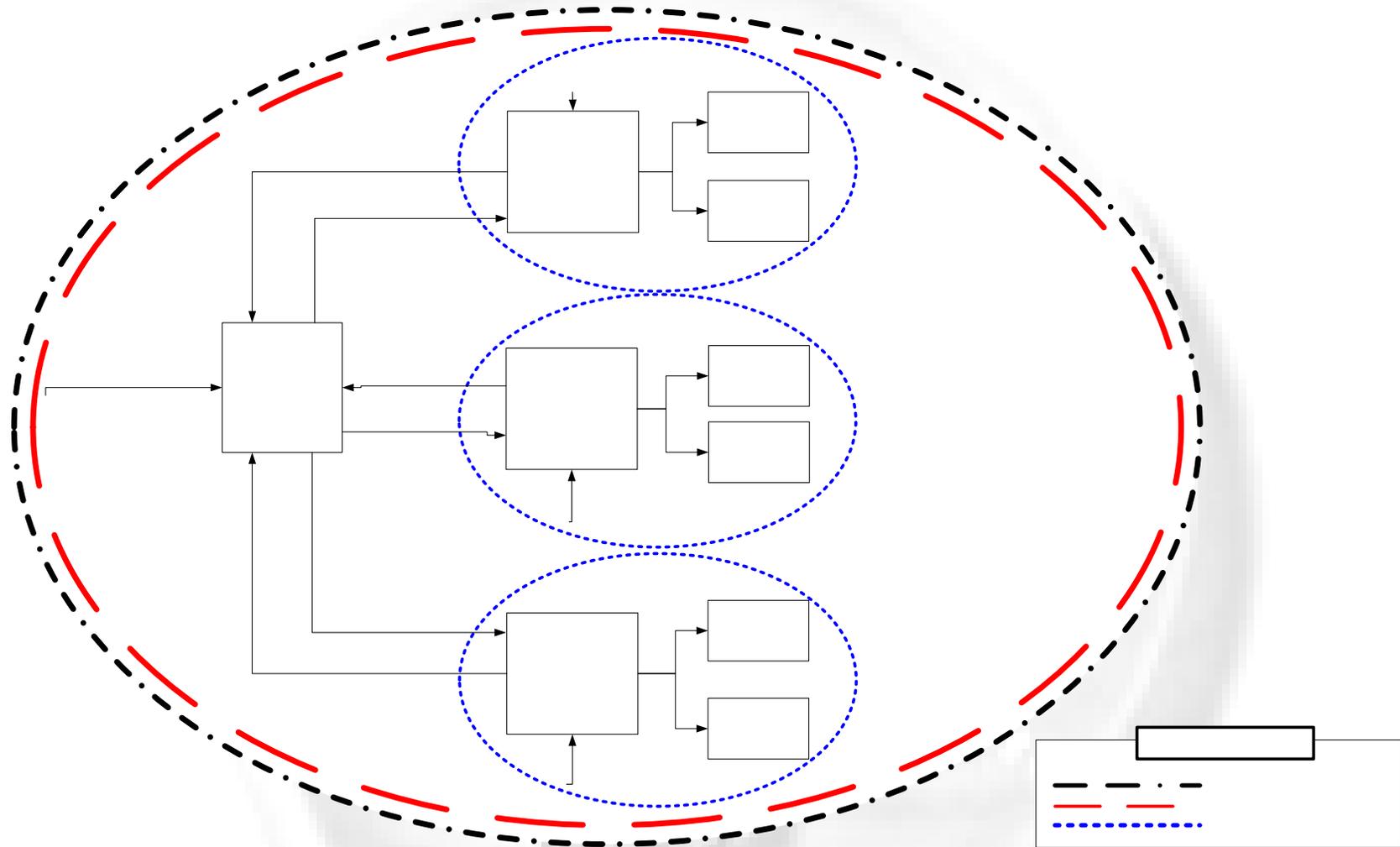
Time Ending	Participant Action	Grid West Action
<b>Adjustment Period</b>	<ul style="list-style-type: none"> <li>Submit updated schedules</li> </ul>	<ul style="list-style-type: none"> <li>Validate schedules</li> </ul>
<b>OH- 30</b>	<ul style="list-style-type: none"> <li>Complete the submission of Real-Time Energy Offers                             <ul style="list-style-type: none"> <li>•“A/S energy” or supplemental energy offers</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Validate Real-Time Energy Offers</li> </ul>
<b>T-5 to T+0</b>		<ul style="list-style-type: none"> <li>Clear the Real-Time Energy Market</li> <li>Publish Dispatch Instructions (Target: T+5 and later)</li> <li>Publish Net Scheduled Interchange by Control Area (Target: T+5)</li> </ul>
<b>T+0 to T+5</b>	<ul style="list-style-type: none"> <li>Operate Resource (Ramp)</li> </ul>	
<b>T+5</b>		<ul style="list-style-type: none"> <li>Monitor Performance</li> </ul>
<b>Settlement</b>		<ul style="list-style-type: none"> <li>Calculate &amp; Settle Real-Time Energy and Imbalance Energy</li> </ul>

*\* Steps T-5 through T+5 are performed for every interval in the Operating Hour.*





\* In our proposed implementation, these can be Inter-TO (for CCA TOPR) and Inter-CA interchanges.  
\*\* Units outside CCA must be dynamically scheduled (or be on pseudo ties) to participate in the CCA reserve or RT Energy market



***The previous configuration is an example of how consolidating parties can maintain their existing dispatch centers.***

- The “official” Grid West NSI can be subdivided into “Adjusted TO NSI” signals. The sum of these Adjusted NSIs must total the official Grid West NSI
- These Adjusted NSIs will be used to maintain individual Transmission Operators ACE. The sum of each TO ACE must total the ACE for the CCA.

***Control Areas outside the CCA will continue to perform the Balancing Authority functions, including:***

- Match the energy output of generation resources within their respective control areas to their load obligation (load + NSI)
- Maintain the frequency of their electric power system(s) within reasonable limits in accordance with WECC criteria
- Maintain energy flows on the Transmission Facilities in their respective Control Areas within appropriate limits to maintain reliability under the direction of Grid West, assuming Grid West is the Reliability Authority
- Provide sufficient capacity to maintain operating reserves in accordance with WECC criteria

***Local market power issues are common to all markets. There are several ways to mitigate this market power \*:***

- Price Caps
- Must Offer Obligations
- Reliability Must Run Contracts
- Reference Prices

***\*Note: A mitigation strategy applicable to the Region's hydro-electric nature will have to be developed.***

***Imbalance energy can be divided into uninstructed and instructed deviations. Examples of INSTRUCTED deviations include:***

- Energy provided outside of the target settlement interval as a result of the ramping specified
- Regulation instructions to a Participant providing regulation services
- Deployment of energy as a result of automatic governor control (AGC)
- Dispatch instructions from Real-Time awards

***UNISTRUCTED deviation occurs when the total metered resources of a participant for a settlement interval are different from the total of the scheduled resources plus any resource deployments instructed by Grid West. The following is an example:***

- Participant A schedules 100 MW from a 150 MW generator within the Grid West.
- If Participant A generates 95 MW:
  - Delivery will be 95 MW
  - Participant A assessed 5 MW charge at the MCP.
  - No additional deviation penalty will be assessed because deviation is within 5 MW dead-band.
- If Participant A generates 100 MW:
  - Delivery will be 100 MW
  - No Uninstructed Deviation
- If Participant A generates 102.6 MW:
  - Delivery will be 102.6 MW
  - Uninstructed deviation of 2.6 MW that will be paid using the MCP.
  - No deviation penalty will be assessed because deviation is within 5 MW dead-band
- If Participant A generates 110 MW:
  - Delivery will be 110 MW
  - Uninstructed deviation of 10 MW that will be paid using the MCP.
  - An additional deviation penalty will be assessed because the deviation of 10 MW is greater than 5 MW dead-band

**Note: Depending on the final design, there could be additional components added to the Uninstructed Deviation Charge**

Real-Time Energy Service	
Description of Function	Service where supplemental energy is bought or sold every N minutes to accommodate Real-Time Energy needs and least cost dispatch (where N to be determined later)
Timing & Frequency	Every N minutes of the operating hour.
Grid West Responsibilities	<ul style="list-style-type: none"> <li>• Calculate the Short-Term Load Forecast</li> <li>• Monitor Real-Time System Conditions</li> <li>• Receive/Validate Supplemental Energy (inc/dec) Offers</li> <li>• Clear Real-Time Energy Market</li> <li>• Publish Dispatch (Basepoint &amp; Price) Instructions</li> <li>• Initiate Emergency Operations, As Needed</li> <li>• Post Real-Time Energy Market Results</li> </ul>
Control Area Responsibilities	<ul style="list-style-type: none"> <li>• Match the energy output of generation resources within their respective control areas to their load obligation (load + NSI)</li> <li>• Implement Dispatch</li> <li>• Maintain the frequency of their electric power system(s)</li> <li>• Maintain energy flows on the Transmission Facilities in their respective Control Areas within appropriate limits to maintain reliability under the direction of Grid West, assuming Grid West is the Reliability Authority</li> <li>• Provide sufficient capacity to maintain operating reserves in accordance with WECC criteria</li> </ul>
Participant Responsibilities	<ul style="list-style-type: none"> <li>• Submit Real-Time Energy Bids/Offers</li> <li>• Ramp Unit According to Dispatch Instructions</li> </ul>
Methodology	<ul style="list-style-type: none"> <li>• Security Constrained Economic Dispatch</li> </ul>
ISO / RTO Benchmarks	All established ISO/RTOs have a Real-Time Energy Market

**The following matrix summarizes the Beginning State design for CCA Real-Time Energy Service:**

Description	Current Practice	Proposed Change	Opportunities/ Value
<b>NERC Functional Model</b>	<ul style="list-style-type: none"> <li>• Each CA acts as its own Balancing Authority.</li> <li>• To ensure reliability, there must be one balancing authority for consolidated parties.</li> </ul>	<ul style="list-style-type: none"> <li>• Each CA will continue to operate as the Balancing Authority.</li> <li>• CCA will operate as a single Balancing Authority.</li> </ul>	<ul style="list-style-type: none"> <li>• Potential cost savings for lowest cost energy.</li> </ul>
<b>Pricing</b>	<ul style="list-style-type: none"> <li>• Multiple prices for Imbalance Energy currently exist.</li> <li>• Price signals are not transparent to the market.</li> </ul>	<ul style="list-style-type: none"> <li>• Locational Real-Time energy prices for CCA will be known as a result of the Real-Time Energy Market.</li> </ul>	<ul style="list-style-type: none"> <li>• Central market efficiency afforded for Real-Time energy.</li> <li>• Quantitative value for congestion to guide expansion decisions.</li> </ul>
<b>Dispatch Instructions</b>	<ul style="list-style-type: none"> <li>• Performed on a CA basis.</li> </ul>	<ul style="list-style-type: none"> <li>• Grid West calculates NSI for each TO within CCA.</li> <li>• Grid West sends out dispatch instructions for the entire CCA.</li> </ul>	<ul style="list-style-type: none"> <li>• Regional coordination.</li> <li>• Advance response analysis to guide contingency response.</li> <li>• Alternative to curtailment.</li> </ul>
<b>Uninstructed/Instructed Deviations</b>	<ul style="list-style-type: none"> <li>• None.</li> </ul>	<ul style="list-style-type: none"> <li>• Instructions to participating units.</li> <li>• Incentives to follow dispatch instructions.</li> </ul>	<ul style="list-style-type: none"> <li>• Economic incentives for dispatch deviations.</li> </ul>
<b>Energy Imbalance</b>	<ul style="list-style-type: none"> <li>• Calculated and settled by each control area independently.</li> <li>• Pricing and standards vary across control areas.</li> <li>• Penalty provision for certain users.</li> </ul>	<ul style="list-style-type: none"> <li>• RTEM provides market-based imbalance energy</li> <li>• Grid West calculates imbalance for participants within the CCA.</li> </ul>	<ul style="list-style-type: none"> <li>• Standard, transparent and equitable solution and prices across the CCA.</li> <li>• Hourly value of congestion cost becomes quantitative</li> </ul>



***The following issues have been identified during the initial round of design:***

- **Bid Granularity** – What information needs to be provided in the Real-Time offer?
- **Emergency Conditions** – How will Grid West select resources from the bid stack during emergency operations?
- **Reserve Sharing Event** – What interactions need to occur during a reserve sharing event?
- **Market Power** – How will Grid West address market power situations?
- **Real-Time Energy Interval** – How often will the Real-Time energy market be cleared? (e.g., 5 minutes, 10 minutes, etc.)
- **Infrastructure** – What infrastructure can be leveraged as a part of the consolidated control area? (e.g., EMS, SCADA, State Estimator, etc.)
- **Dispatch Granularity** – Will dispatch instructions be unit specific or portfolio based?
- **Dispatch Medium** – How will NSI/Dispatch instructions be sent to control areas/participants (e.g., ICCP, XML, etc.)
- **Ex-Post vs. Ex Ante Pricing** – What prices (ex-ante or ex-post) will be used for dispatch? What prices will be used for Settlement?
- **Imbalance Trading** – Can participants trade imbalance the day after the operating day? (similar to MISO, SPP, etc.)
- **Non-Conforming Loads** – How will non-conforming loads be accounted for in the load forecast?
- **Real-Time Monitoring** – What information does GW require in order to operate a RT Energy Market? (e.g., Resource Status, Max Capacity, Load Forecast, etc.)

***Today we covered the following topics:***

- ✓ Objectives
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- ✓ Challenges & Considerations
- ✓ Service Descriptions
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- ✓ Open Issues