OVERVIEW

- SPP's Operating Reserve Products Overview
  - Purpose
  - Response Time
  - Qualifications

- Products Co-optimization and Deliverability

- Requirements Methodology

PRODUCTS IN THE MARKET SINCE GO-LIVE

Regulation Up

- Must qualify by passing a Regulation Deployment test
- Participant submitted offer which includes a "capacity" offer and a "mileage" offer
- Cleared in both Day-Ahead Market (DAMKT) and the Real-Time Balancing Market (RTBM)
- In Real-Time cleared each 5-minute interval and deployable within the 5-minute interval

Regulation Down

- Must qualify by passing a Regulation Deployment test
- Participant submitted offer which includes a "capacity" offer and a "mileage" offer
- Cleared in both DAMKT and RTBM
- In Real-Time cleared each 5-minute interval and deployable within the 5-minute interval

Spinning Reserve

- Self-certified Qualification, but subject to random tests to ensure continued qualification
- Participant submitted offer
- Cleared in both DAMKT and RTBM
- In Real-Time cleared each 5-minute interval and deployable within the 5-minute interval, but the response time is 10 minutes
- Only cleared on "online" Resources

Supplemental Reserve

- Self-certified Qualification, but subject to random tests to ensure continued qualification
- Participant submitted offer
- Cleared in both DAMKT and RTBM
- In Real-Time cleared each 5-minute interval and deployable within the 5-minute interval, but the response time is 10 minutes
- Cleared on "online" and "offline" Resources

PRODUCTS ADDED TO THE MARKET SINCE GO-LIVE

Ramp Capability Up

- Qualified if Resource is dispatchable in Real-Time (Non-Dispatchable Variable Energy Resources and Block Demand Response Resources are not eligible)
- No offer is submitted, Market Clearing Price (MCP) is based on opportunity cost when co-optimized with all other products
- Cleared in both DAMKT and RTBM
- Is not directly deployed but is indirectly deployed through future RTBM dispatches
- Only cleared on Resource considered "online"

Ramp Capability Down

- Qualified if Resource is dispatchable in Real-Time (Non-Dispatchable Variable Energy Resources and Block Demand Response Resources are not eligible)
- No offer is submitted, Market Clearing Price (MCP) is based on opportunity cost when co-optimized with all other products
- Cleared in both DAMKT and RTBM
- Is not directly deployed but is indirectly deployed through future RTBM dispatches
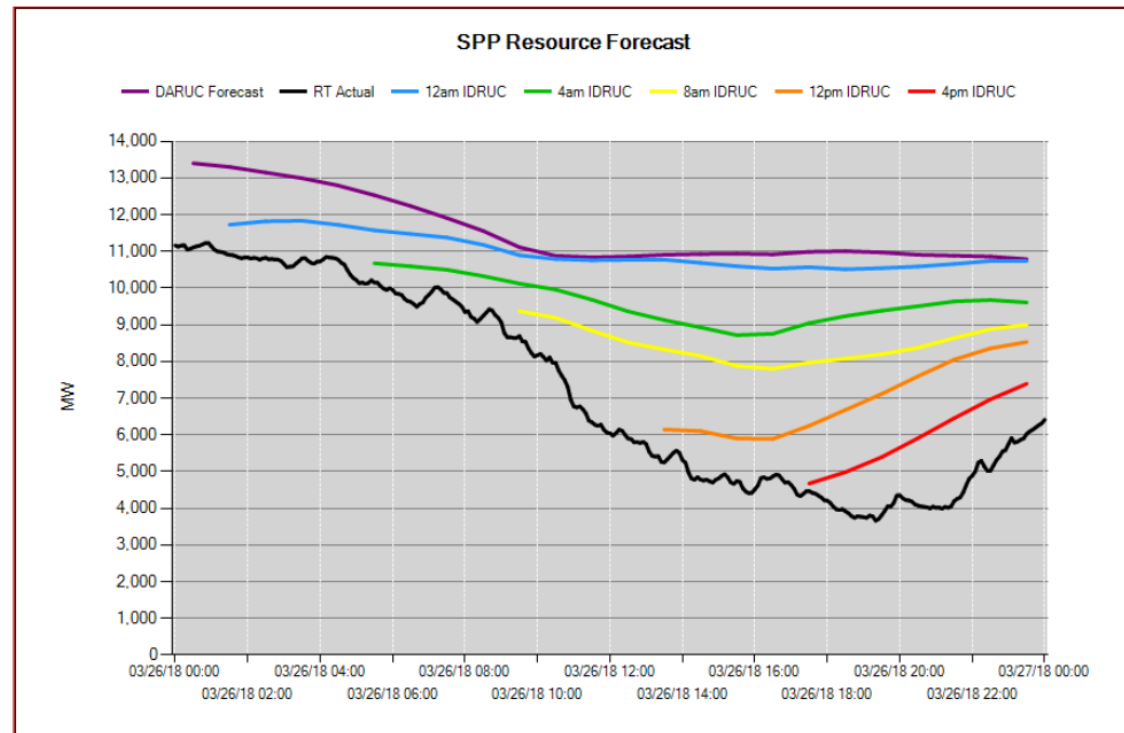- Only cleared on Resource considered "online"

Uncertainty Reserve

- Qualified if Resource is dispatchable in Real-Time (Non-Dispatchable Variable Energy Resources and Block Demand Response Resources are not eligible)
- When Resource is "online", no offer is submitted, Market Clearing Price (MCP) is based on opportunity cost when co-optimized with all other products
- When Resource is "offline", uses Participant submitted offer for clearing
- Cleared in both DAMKT and RTBM
- Is not directly deployed but is indirectly deployed through future RTBM dispatches
- Cleared on Resource considered "online" and offline
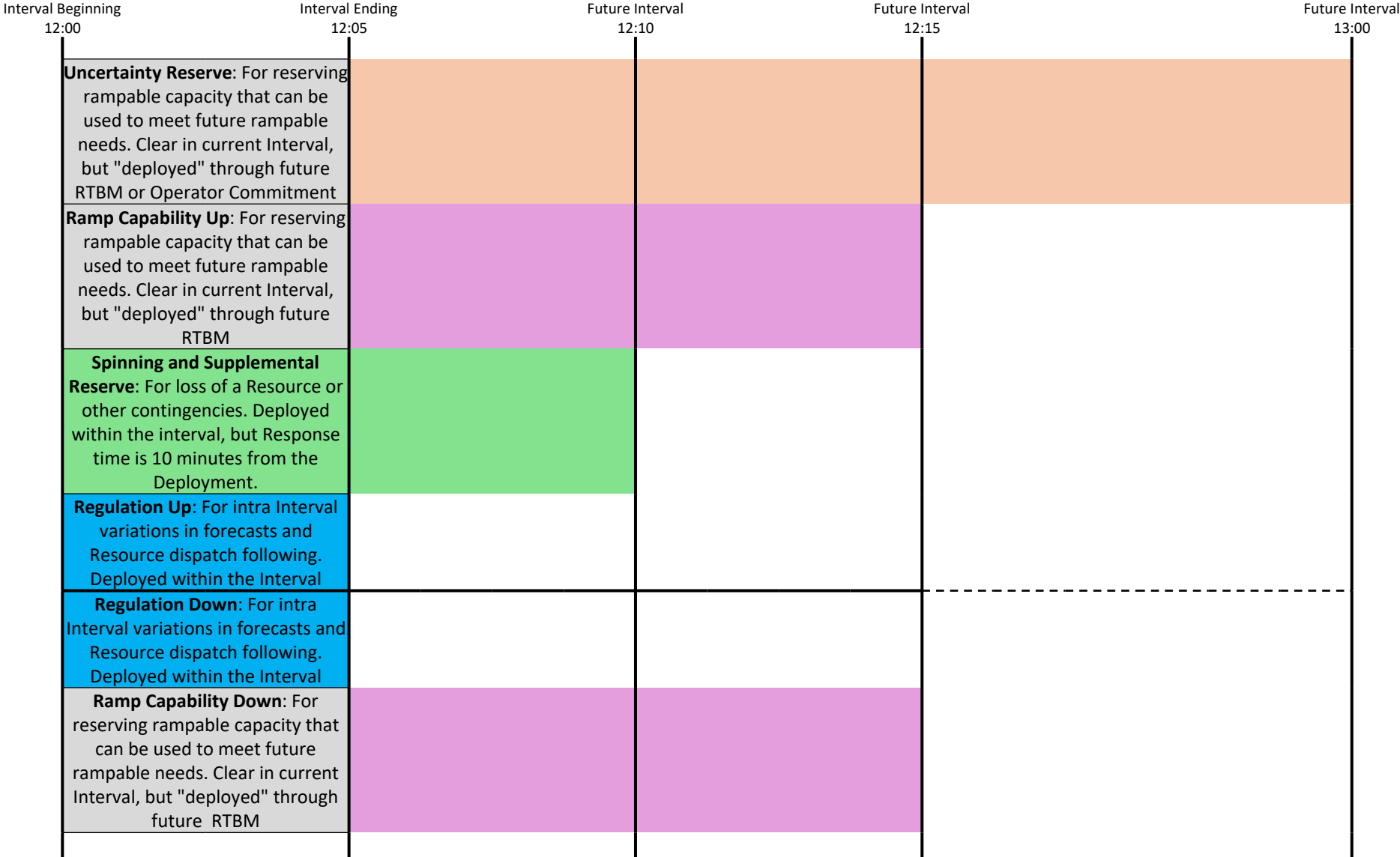
OFFLINE OFFER FOR UNCERTAINTY RESERVE

- Mitigated offer is comprised of the mitigated start-up offer, no-load offer, and Energy offer up to the resource's economic minimum; these costs are amortized over the resource's expected Uncertainty Reserve megawatts for the duration of the Uncertainty Reserve response time

- If a resource is committed within the response time (currently 60 minutes) after clearing offline Uncertainty Reserve, the Make-Whole Payment calculation for the resource will not include the Start-Up cost or the No-Load cost and Energy cost to economic minimum for the lesser of 60 minutes or the resource's minimum run time.

- **Example:**

  - Resource maximum = 20 MW

  - Resource minimum = 10 MW

  - Resource minimum run time = 1 hour

  - Quantity of offline Uncertainty Reserve offered = 20 MW

  - Start-Up Offer = $100

  - No-Load Offer = $50/h

  - Energy Offer = $25/MWh

  - Mitigated offline Uncertainty Reserve Offer =
    $$\$100/(20 \text{ MW} * 1 \text{ h}) \; + \; \$50/h * 1/(20 \text{ MW}) \; + \; \$25/MWh * 10 \text{ MW} * 1/(20 \text{ MW}) = \$20$$

REASON FOR NEW PRODUCTS

- The SPP generation mix includes a large percentage of Variable Energy Resource, and this will continue to grow

- Errors in load forecast could increase as distributed resources and demand side management increases

- These products are intended to reserve future rampable capacity to protect Energy, Regulation, and Contingency Reserves

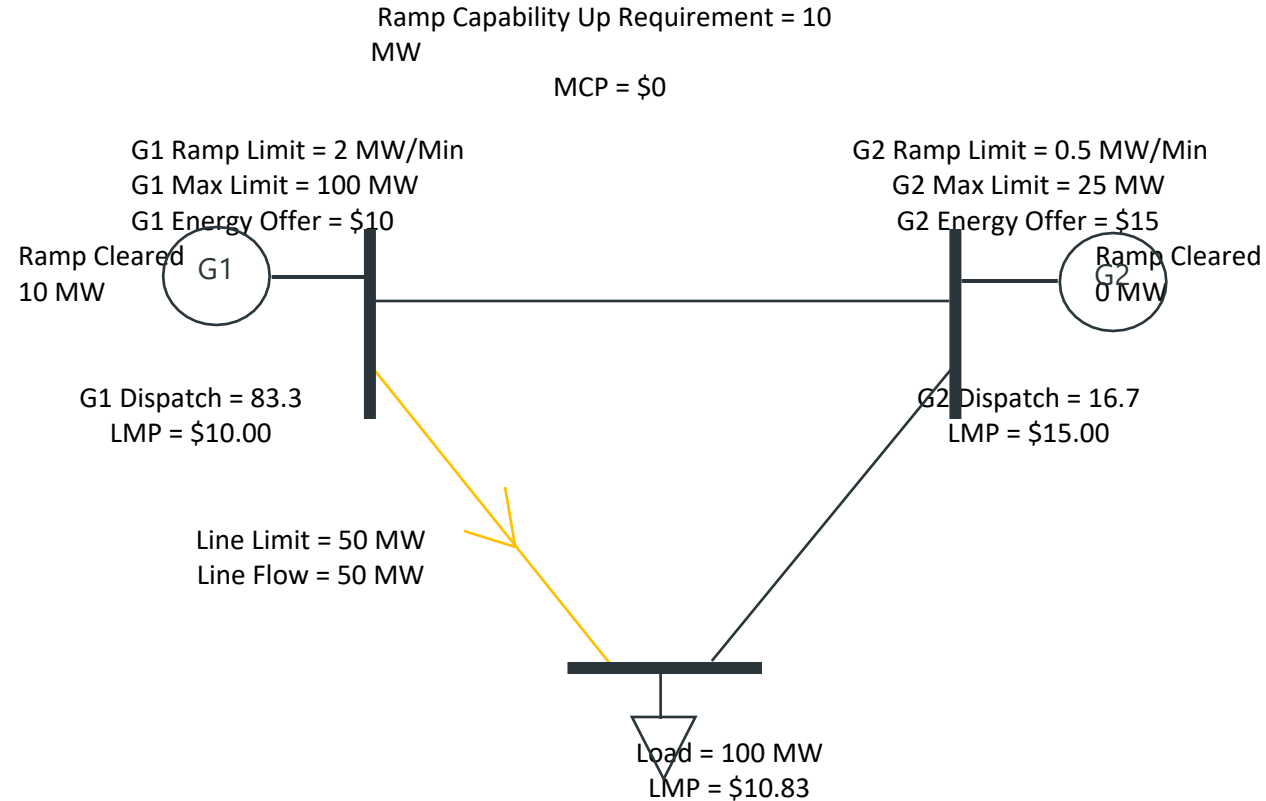- **Example large Resource Forecast Error:**

SPP Resource Forecast

PRODUCT RESPONSE TIMES

	Interval Beginning 12:00	Interval Ending 12:05	Future Interval 12:10	Future Interval 12:15	Future Interval 13:00
Uncertainty Reserve: For reserving rampable capacity that can be used to meet future rampable needs. Clear in current Interval, but "deployed" through future RTBM or Operator Commitment					
Ramp Capability Up: For reserving rampable capacity that can be used to meet future rampable needs. Clear in current Interval, but "deployed" through future RTBM					
Spinning and Supplemental Reserve: For loss of a Resource or other contingencies. Deployed within the interval, but Response time is 10 minutes from the Deployment.					
Regulation Up: For intra Interval variations in forecasts and Resource dispatch following. Deployed within the Interval					
Regulation Down: For intra Interval variations in forecasts and Resource dispatch following. Deployed within the Interval					
Ramp Capability Down: For reserving rampable capacity that can be used to meet future rampable needs. Clear in current Interval, but "deployed" through future RTBM					

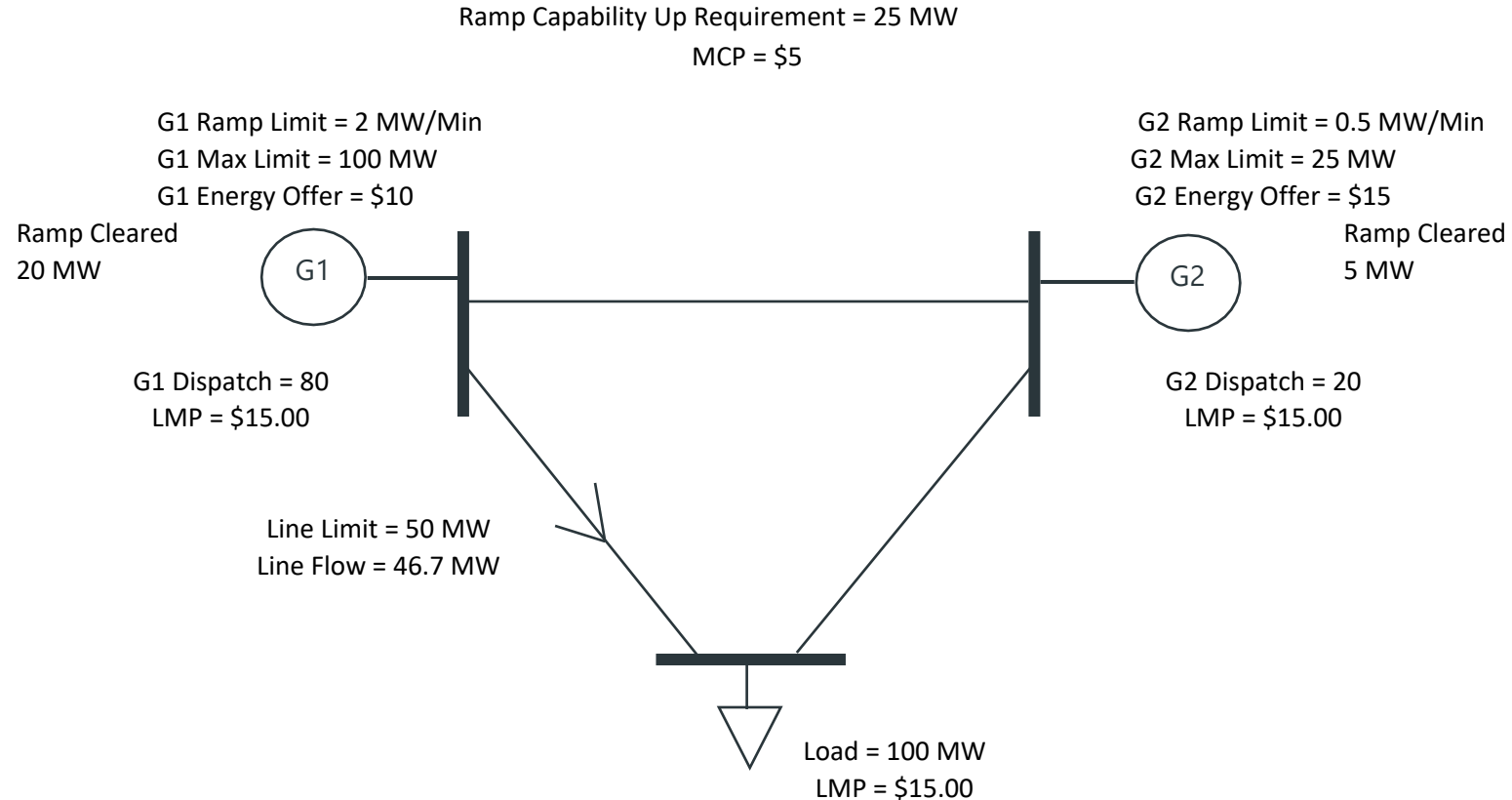# CO-OPTIMIZATION OF RAMP CAPABILITY AND UNCERTAINTY RESERVE PRODUCTS

- In the co-optimization Ramp Capability and online Uncertainty Reserve products clear based on opportunity cost between the product and Energy

- This leads to the clearing engine preferring to clear upward Operating Reserves on Resources that are economically dispatched down (and vice versa for downward products)

- Naturally, Resources dispatched down due to congestion become a prime target for clearing at a low opportunity cost

Ramp Capability Up Requirement = 10 MW

MCP = $0

G1 Ramp Limit = 2 MW/Min
G1 Max Limit = 100 MW
G1 Energy Offer = $10

G2 Ramp Limit = 0.5 MW/Min
G2 Max Limit = 25 MW
G2 Energy Offer = $15

Ramp Cleared 10 MW

G1

G2

Ramp Cleared 0 MW

G1 Dispatch = 83.3
LMP = $10.00

G2 Dispatch = 16.7
LMP = $15.00

Line Limit = 50 MW
Line Flow = 50 MW

Load = 100 MW
LMP = $10.83

- In this example, G1 is naturally dispatch down due to congestion and clearing the 10 MW of Ramp Capability Up on G1 comes at no cost to the Market, therefore the MCP = $0.

SMALL BUS EXAMPLE 2 OF RAMP CAPABILITY UP

Ramp Capability Up Requirement = 25 MW
MCP = $5

G1 Ramp Limit = 2 MW/Min
G1 Max Limit = 100 MW
G1 Energy Offer = $10

G2 Ramp Limit = 0.5 MW/Min
G2 Max Limit = 25 MW
G2 Energy Offer = $15

Ramp Cleared
20 MW

G1

Ramp Cleared
5 MW

G2

G1 Dispatch = 80
LMP = $15.00

G2 Dispatch = 20
LMP = $15.00

Line Limit = 50 MW
Line Flow = 46.7 MW

Load = 100 MW
LMP = $15.00

- In this example, we need both G1 and G2 to clear Ramp Capability Up to meet the requirement. We must dispatch G1 down even further and G2 up higher, therefore the MCP = $5 because G1 lost some opportunity to clear Energy.

DELIVERABILITY OF RAMP CAPABILITY FOR PREVIOUS EXAMPLES

- In both example 1 and 2, the question comes up, is this product deliverable?

- The answer is not straight forward

  - Future dispatch intervals (deployment of Ramp) can move a combination of G1 and G2 up to provide needed ramp

  - Is 100% of the Ramp Capability Up cleared deliverable? Probably not 100% but a large percentage is.

- This is a little easer to see in a small bus example, but in the full market it is hard to determine how much is deliverable

OTHER CONSIDERATIONS OF PRODUCT DELIVERABILITY

- The reason for deployment is a key factor in determining deliverability of products

  - Did wind drop? Did load go up?

- How far in the future is the deployment time?

  - Can we expect the congestion pattern to remain the same through the deployment period?

CURRENT WAYS OF HANDING DELIVERABILITY ISSUES IN SPP

- Regulation – Operators can "de-select" resources from clearing regulation if they are impacting congestion
  - There is a settlement credit to hold these resources harmless
- Spinning Reserve, Supplemental Reserve, Ramp Capability, and Uncertainty Reserve – Operators can give resources Operating Instructions to relieve congestion.
  - There is a settlement credit to hold these resources harmless
- SPP continues to monitor the deliverability question, but has no definite plans for changes

CALCULATION OF REQUIREMENTS FOR PRODUCTS

Regulation
- Based on Percentage of Load + percentage of wind + percentage of load variation + percentage of wind variation

Contingency Reserve
- Equal to the larges Most Severe Single Contingency (MSSC) times a fleet CR performance factor
- The requirement is split as half Spinning Reserve and half Supplemental Reserve

Ramp Capability
- Equal to planned ramp need over 15 minutes plus 95th percentile band forecast error (2.5th percentile for Ramp Capability Down and 97.5th percentile for Ramp Capability Up)
- There is a 200 MW minimum on the requirement
- Details are on SPP's portal under here (must have a certificate)

Uncertainty Reserve
- Equal to planned ramp need over 60 minutes plus 97.5th percentile forecast error
- Details are on SPP's portal under here (must have a certificate)

CALCULATION OF REQUIREMENTS FOR PRODUCTS

- Ramp Capability and Uncertainty Reserve requirements are calculated based on planned ramp plus historical net load forecast error based on 97.5 percentile

- Net load forecast = System Load Forecast – (Wind and Solar Forecast)

- Planned ramp is an interpolated value of the change in the hourly net load forecast

  - Planned ramp example:

Hour Beginning	Net Load Forecast	Ramp Capability Up Response Time	Ramp Capability Up Planned Ramp	Uncertainty Reserve Time	Uncertainty Reserve Planned Ramp
12:00	30,000 MW				
13:00	32,000MW	10 Minutes	333.3 MW	60 Minutes	2,000 MW

CALCULATION OF PRODUCTS REQUIREMENTS

- **Ramp Capability Example for net load forecast error:**

- Historical net load forecast error is based on the last 12 months of real-time data

- The error is calculated as 10 minute out forecasted MW – actual MW for each 5-minute interval in the hour

  - Example:

Interval 1	Interval 2	Interval 3	Interval 4	Interval 5	Interval 6	Interval 7	Interval 8	Interval 9	Interval 10	Interval 11	Interval 12
-150	-175	-160	-140	-135	-140	-150	-120	-130	-145	-155	-160

- All like hours in a month are combine and the 2.5th percentile is used for Ramp Capability Down while the 97.5th percentile is used for Ramp Capability Up:

  - Example:

Point #	#1	#2	#3	#4	...	#86	#87	#88	#89	#90
Value	500	495	485	475	...	-550	-575	-580	-590	-600
Percentile	0.0000	0.0112	0.0225	0.0337		0.9551	0.9663	0.9775	0.9888	1.0000

- Using this data set, we must interpolate between the two data points
  - Ramp Capability Up = -575 + (.975 - .9663)/(.9775 - .9663)*(-580 – -575) = -578.9 MW
  - Ramp Capability Down = 485 + (.025 - .0225)/(.0337 - .0225)*(475 – 485) = 482.8 MW

- Using data from previous slide and this on:

- Ramp Capability Up Requirement = 333.3 MW – -578.9 MW = **912.2 MW**

- Ramp Capability Down Requirement = 333.3 MW – 482.8 MW = -149.5 MW, however, it is floored to the **200 MW** minimum

Questions?