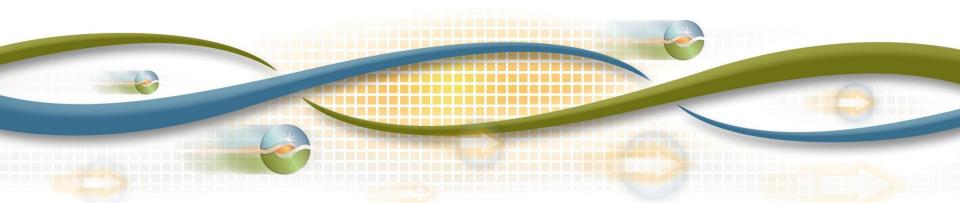# Flexible Ramping Product Technical Workshop
Integrated Day-Ahead Market

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Overview

- Benefits from Combining IFM and RUC
- Assumptions/Features
- Bid Cost Recovery
- iDAM Model
- Flexible Ramp Model
- Objective Function
- Power Balance Constraints
- Capacity Constraints
- Ramping Constraints

Benefits from Combining IFM and RUC

- **More efficient (lower cost) resource commitment decisions**
  - ◆ Single-step resource commitment satisfying IFM and RUC objectives simultaneously

- **More efficient Flexible Ramp procurement from all committed resources**
  - ◆ Otherwise Flexible Ramp will be procured only from resources committed in IFM

Assumptions/Features

- Single-step resource commitment
- Co-optimization among Energy, Reliability, Ancillary Services, and Flexible Ramp
- Two power balance constraints:
  - Physical/virtual Energy supply balance physical/virtual Energy demand and transmission losses (IFM objective)
  - Physical Reliability schedules balance the demand forecast including losses (RUC objective)
- All IFM and RUC features and constraints

Support for MPM and 72-hr RUC

- **MPM is a "trial" pass of iDAM where:**
  - the impact of physical resource Energy schedules on network constraints is quantified
  - constraints are classified as competitive or not
  - resources that provide congestion relief on non-competitive constraints are mitigated
- **iDAM Time Horizon: three Trading Days**
  - First Trading Day: all commodities
  - Second/Third Trading Day: all commodities except Energy schedules to determine binding start-ups
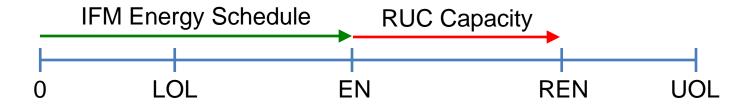
Bid Cost Recovery Allocation

- **Current IFM/RUC BCR Allocation**
  - ◆ IFM BCR Allocation:
    - Tier 1
      - ➢ Scheduled demand over self-scheduled generation and imports
    - Tier 2
      - ➢ Metered demand
  - ◆ RUC BCR Allocation:
    - Tier 1
      - ➢ Net negative demand deviation
    - Tier 2
      - ➢ Metered demand

- **iDAM BCR Allocation**
  - ◆ Tier 1
    - Scheduled demand over self-scheduled generation and imports
  - ◆ Tier 2
    - Net negative demand deviation
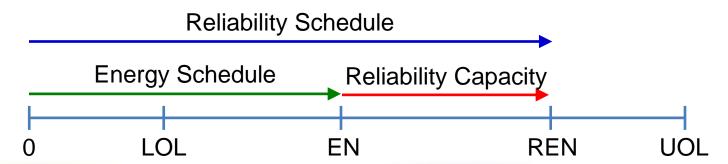 - ◆ Tier 3
    - Metered demand

Integrated Day-Ahead Market Model

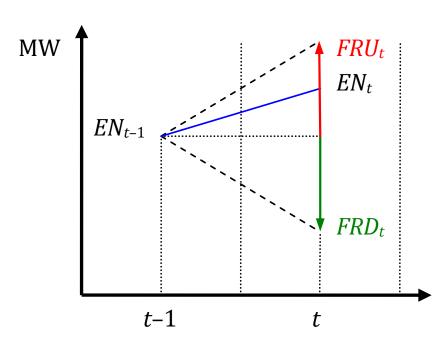- **Current DAM: IFM followed by RUC**

IFM Energy Schedule → RUC Capacity →

0　　　　LOL　　　　EN　　　　REN　　　　UOL

- **iDAM: Simultaneous Energy/Reliability**

Reliability Schedule →

Energy Schedule → Reliability Capacity →

0　　　　LOL　　　　EN　　　　REN　　　　UOL

Flexible Ramp Model

- **Capacity limits:**

$$\max(EN_{t-1} + FRU_t, EN_t) \leq UEL_t$$

$$\min(EN_{t-1} - FRD_t, EN_t) \geq LEL_t$$

- **Ramp limits:**

$$FRU_t \leq RRU(EN_{t-1})$$

$$FRD_t \leq -RRD(EN_{t-1})$$

$$RRD(EN_{t-1}) \leq EN_t - EN_{t-1}$$

$$\leq RRU(EN_{t-1})$$

Objective Function

- **Minimize cost and maximize benefit:**
  - ◆ Start-up, minimum load, state transition cost
  - ◆ Physical/virtual Energy supply schedules cost
  - ◆ Physical/virtual Energy demand schedules benefit
  - ◆ Ancillary Services awards cost
  - ◆ Reliability capacity awards cost
  - ◆ Flexible Ramp awards cost
  - ◆ Flexible Ramp demand benefit
  - ◆ Transmission capacity reservation awards benefit

Ancillary/Ramping Service Requirements

- **Cascaded Ancillary Services procurement**
  - ◆ Regulation Down ≥ Regulation Down Requirement
  - ◆ Regulation Up ≥ Regulation Up Requirement
  - ◆ Regulation Up + Spinning Reserve ≥ Regulation Up Requirement + Spinning Reserve Requirement
  - ◆ Regulation Up + Spinning Reserve + Non-Spinning Reserve ≥ Regulation Up Requirement + Spinning Reserve Requirement + Non-Spinning Reserve Requirement

- **Flexible Ramp elastic procurement**
  - ◆ Flexible Ramp Up/Down = Flexible Ramp Up/Down Demand ≤ Flexible Ramp Up/Down Requirement

Time Domain Constraints

- Regulation Down constrained by 10' ramp down
- (Regulation Up + Spinning Reserve + Non-Spinning Reserve) constrained by 10' ramp up
- Flexible Ramp Down constrained by 60' ramp down
- Flexible Ramp Up constrained by 60' ramp up
  - Flexible Ramp awards must be divided by 12 to convert them to a 5' ramp product.
- Ramp time domain is calculated from both Energy and Reliability schedules

Capacity Constraints

- **Energy and Reliability schedules, Ancillary Services awards, and Flexible Ramp awards are constrained by available resource capacity**
  - ◆ Regulation limits when on Regulation
  - ◆ Operating limits when not on Regulation
  - ◆ Economic limits for Energy/Reliability schedules and Flexible Ramp awards
  - ◆ Energy bid not required for Ancillary Services in DAM
  - ◆ Energy bid required for Flexible Ramp awards

Ramping Constraints

- Energy and Reliability schedules, and Regulation Down awards are constrained by 60' ramp down

- Energy and Reliability schedules, and Regulation Up, Spinning Reserve, and Non-Spinning Reserve awards are constrained by 60' ramp up

- Flexible Ramp is released for cross-interval ramping

Questions?