# SPP Integrated Marketplace- Unit Commitment

**FERC Technical Conference on Increasing Real-Time and Day-Ahead Market Efficiency through Improved Software**

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| | |
|---|---|
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GRID | ALSTOM

# Southwest Power Pool

- Independent, non-profit, Regional Transmission Organization

- ~550 employees

- Membership in 8 states
  - Arkansas, Kansas, Louisiana, Missouri, Nebraska, New Mexico, Oklahoma, and Texas

- Located in Little Rock, Arkansas

  - 24 x 7 operations

  - Reliability Coordination

  - Market Operations

  - Transmission Planning

  - Tariff Administration

  - Regional Scheduling
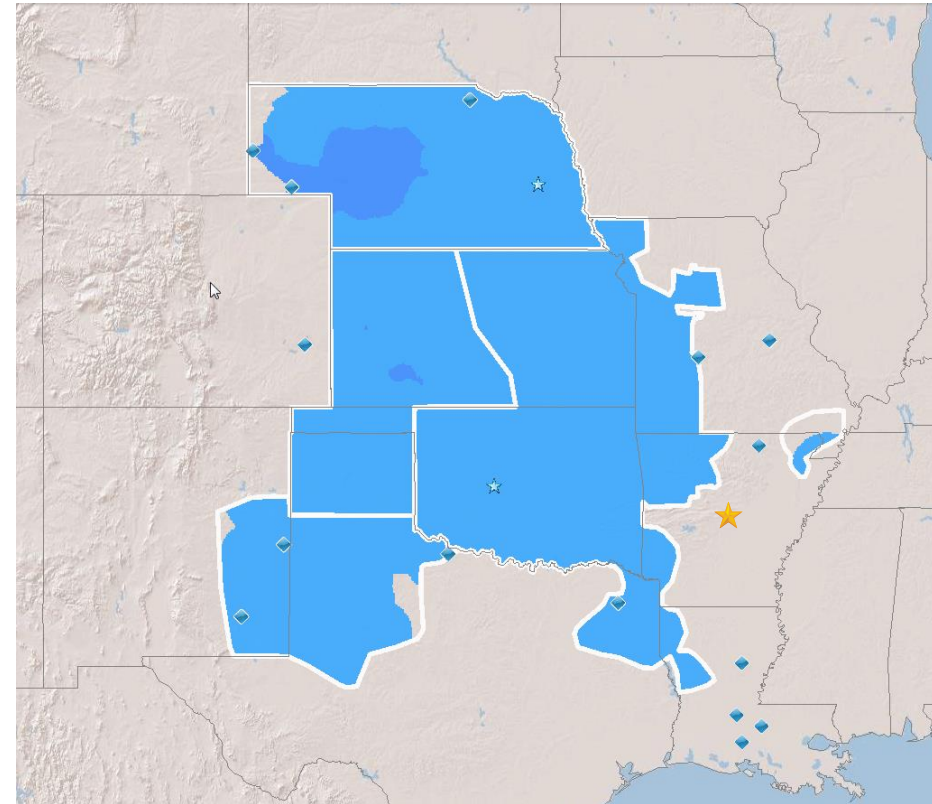
# What is Integrated Marketplace?

- **New "Day-2" Market Implemented March 1, 2014**

  - ➢ **Replaced Energy Imbalance Service (EIS) Market launched in 2007**

- **SPP consolidated all EIS member Balancing Authorities (BA) into one SPP BA**

- **Day-Ahead Market, Reliability Unit Commitment, Real-Time Balancing, and Transmission Congestion Rights (TCR)**

  - ➢ **Products: Energy, Regulation-Up, Regulation-Down, Spinning, Supplemental**

  - ➢ **Security Constrained Unit Commitment (SCUC), Security Constrained Economic Dispatch (SCED), Co-Optimization**

# Marketplace After 12 Months

- **122 Market Participants**

  - **Financial only and asset owning**

- **SPP BA has maintained control performance standards**

  - **Minimized inadvertent as much as possible**

- **System availability has exceeded expectations**

  - **Day-Ahead Market has posted on-time every day except once in early June (due to a modeling issue)**

  - **Real-Time Balancing Market has successfully solved 99.98% of all intervals**

    - **Considerably higher than during Market Trials**

# Marketplace Centralized Unit Commitment
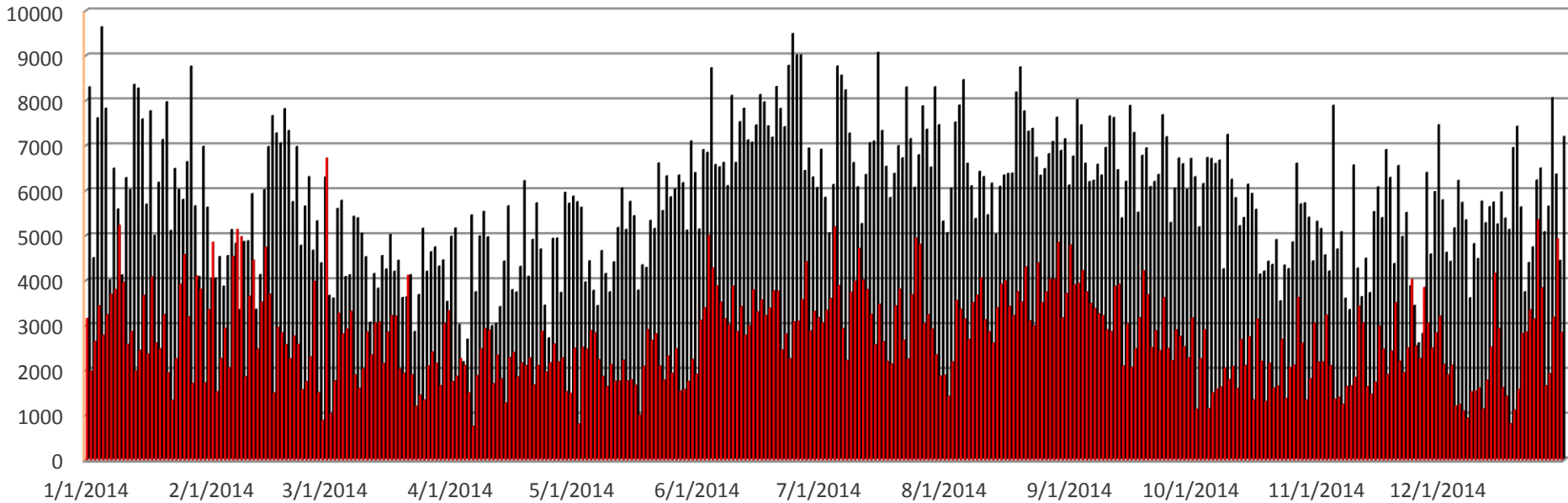


**Capacity Overage**

- ■ EIS (Year prior to Go-Live)
- ■ IM (Year after Go-Live)

*Overage=Economic Max - Load - NSI - (RegUp+SPIN+SUPP)
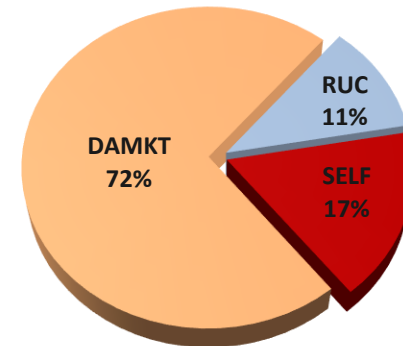
# Reliability Unit Commitments

**Unit Commitment Percentages (Number of Commitments)**

- 72% of commitments have come out of the DA Market

- 17% of commitments were self-commits after the DA Market
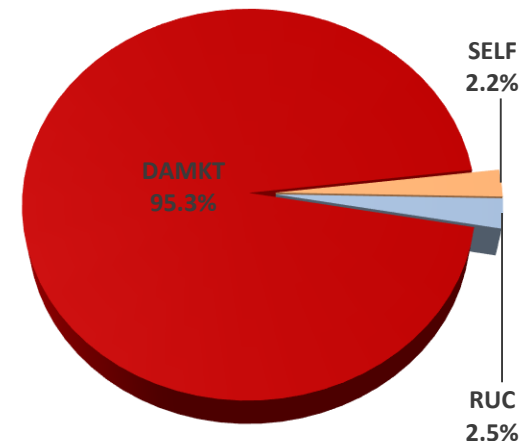
- 11% of commitments have come out of the RUC process

**Unit Commitment Percentages (MWh's of Commitments)**

- 95.3% of commitments have come out of the DA Market
- 2.2% of commitments were self-commits after the DA Market
- 2.5% of commitments have come out of the RUC process

**Centralized Unit Commitment (Number of Commitments)**



RUC 11%
SELF 17%
DAMKT 72%

**Centralized Unit Commitment (MWh's of Commitments)**



SELF 2.2%
DAMKT 95.3%
RUC 2.5%

# Average Hourly Load Participation in DA Market



Legend: ■ Cleared Demand as a Percent of Reported Load -OffPeak    ■ Cleared Demand as a Percent of Reported Load-On Peak
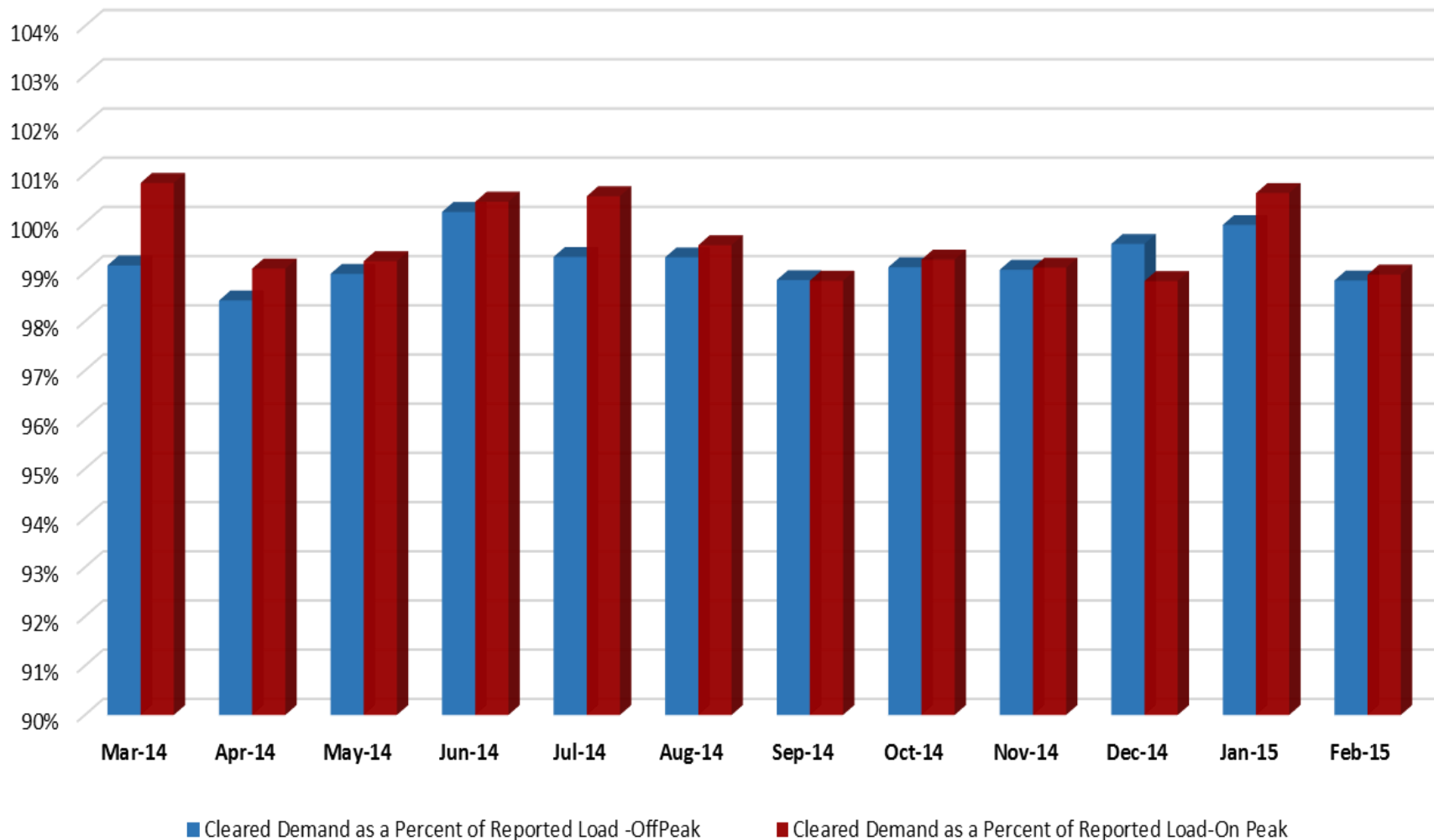
# Virtual Participation in Marketplace
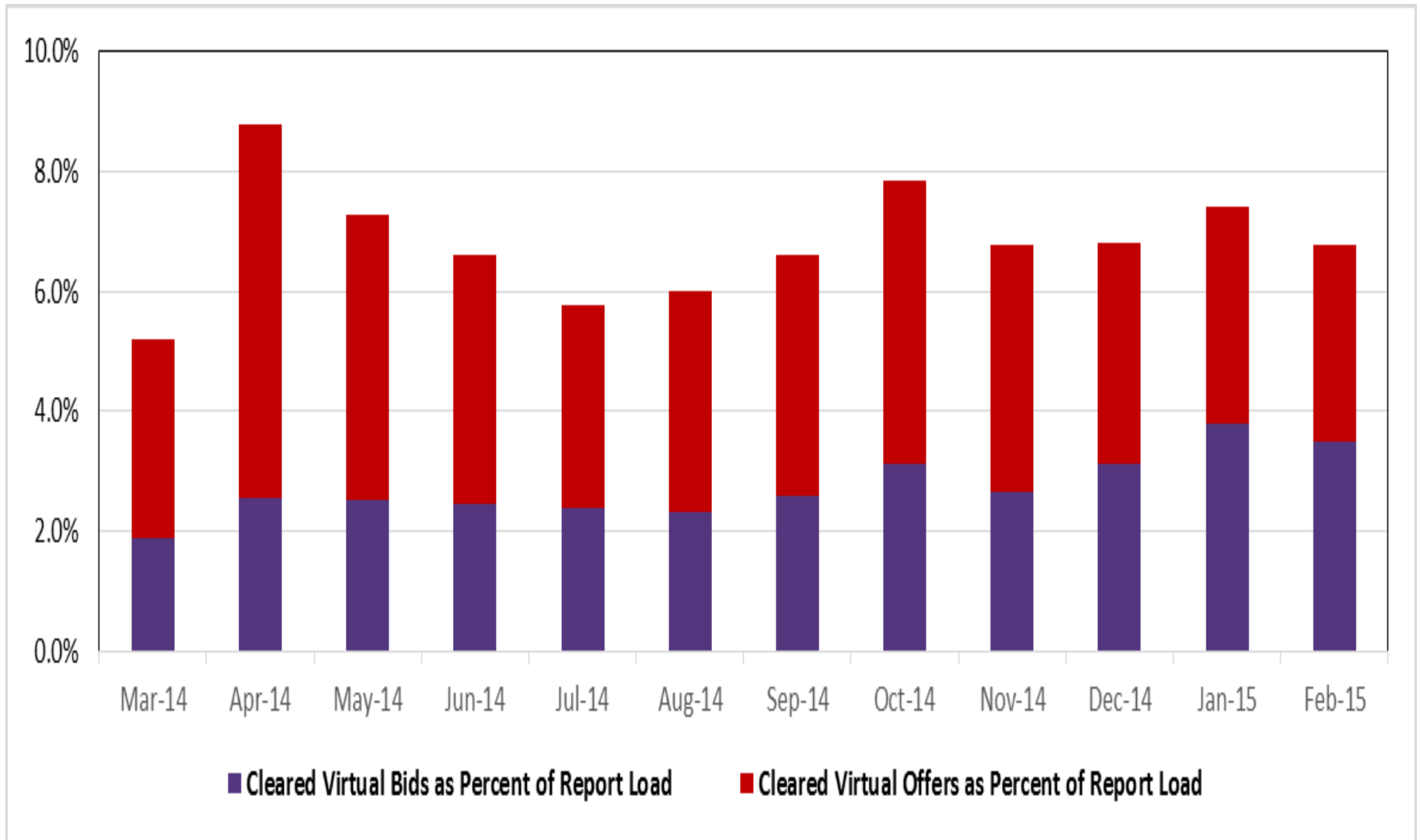
# Challenges

- **Involved extensively in IM market process :**

| Annual/ Monthly | OD-7 | OD-2 | OD-1 | | | OD | OD+1 | OD+7 |
|---|---|---|---|---|---|---|---|---|
| ARR/TCR Auction | 7 DayAhead-RUC | DBDA-RUC | RRC | DA SCUC/SCED with mitigaton | DA RUC SCUC/SCED With mitigation | IDRUC(SCUC/SCED) with Mitigatoin | PA-RUC | Settlement |
| | | | | | | RTBM(SCED) with mitigation | | |
| | | | | | | Pre-RTBM(Time coupled or non-Time Coupled SCED) | | |

Time Line →

Hour 20:00 OD-2
DBDA-RUC Done

Hour 07:00 OD-1
RRC Done

Hour 11:00 OD-1
DA starts

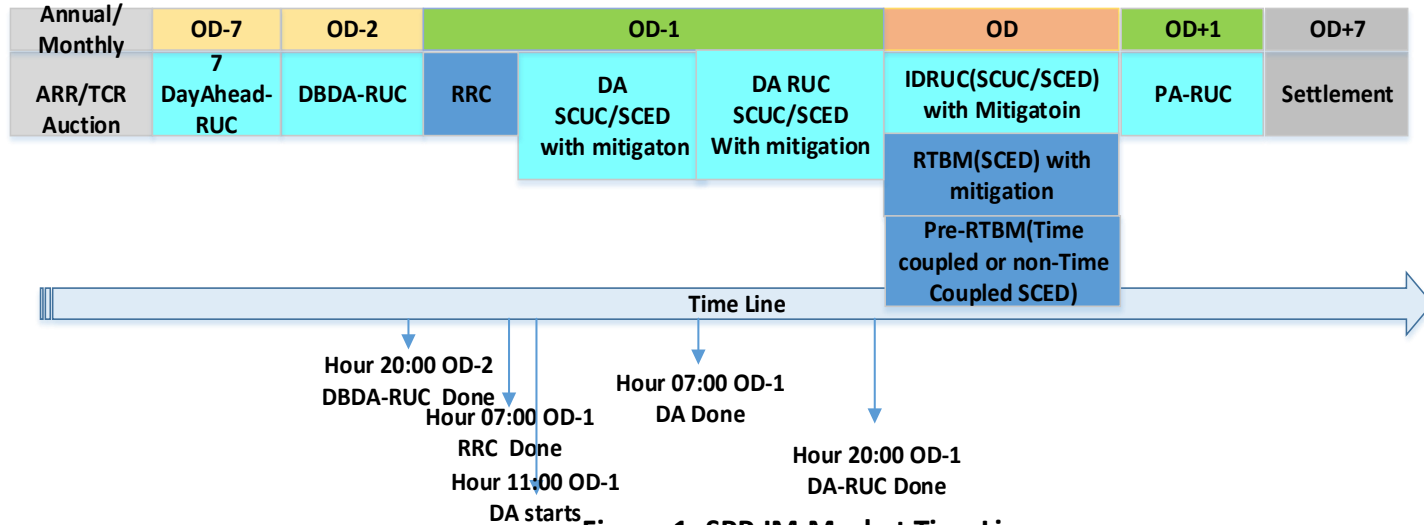Hour 07:00 OD-1
DA Done

Hour 20:00 OD-1
DA-RUC Done

**Figure 1. SPP IM Market TimeLine**

- **SCUC in DAMKT, DA-RUC, DBDA-RUC, ID-RUC, PA-RUC**

  - **One engine for all**

  - **Study window, input data, and objectives all vary by type**

  - **Flexible , robust and efficient**

# Challenges

- **Large complicated SCUC model:**

  - **Individual Regulation up and regulation down AS product**

  - **Recallable Transactions : supplemental reserve**

  - **Variable Energy Resources (VERs): regulation down only**

  - **External Dynamic Resources (EDRs):**

    - **AC-Ties : provide AS by deviating the scheduled energy output**

    - **DC-ties : bi-directional energy transfer**

  - **Demand Response Resources: dispatchable or block, unlocked for emergency**

  - **Linearize ALL the offers (resources, bids, virtual) :  more continuous variables**

  - **Large number of resources have maximum daily energy constraint**

# Challenges

- **Include Mitigation process :**

  – **Perform Market Impact test solve**

  – **Mitigated solve**

- **Complex Logic for scarcity and emergency conditions :**

  – **Scarcity and emergency condition detection with corrective actions**

  – **Different procedures in DA and RUC**

  – **AS Scarcity , Capacity Shortage and Excess Gen**

  – **Non-firm transactions curtailment**

  – **Emergency Range Release/Reliability resource commitment**

  – **De-commitment of Must Run resources under Excess Gen**

# Performance

- **Using Xeon E5-2690 (v1) processors**

- **CPLEX 12.5**

- **Single threaded performance of a CPU still tends to dominate the factors of MIP solve time.**

- **Utilizing CPLEX's parallel MIP methods have shown solve time improvement in some cases.**

# Performance

- **Observed  issues:**

    - **Expect to reach 0.1% MIP Relative Gap within  1200 seconds**

    - **Timed out case with unacceptable solution**

    - **Terminate prematurely termination with  large objective cost dominated by violation penalty cost**

    - **Numerical instability due to Scaling issue: large penalty price vs.  small offer price and sensitivities**

    - **Penalty price setting impact the performance and case dependent**

    - **Incorrect identify scarcity and emergency condition**

    - **Easily causing inconsistency between mitigation test solve and mitigated solve**

# Multi-stage SCUC Algorithm

- **Resource feasibility Stage:**

  - **Modeling**

    - **Ignore operating costs and system constraints**

    - **Minimize resource constraint violation**

  - **Goals and benefits**

    - **Handle input data/condition conflicts at resource level**

    - **Remove unnecessary violations**

    - **Improve robustness and solution quality**

    - **Decoupled model at resource level**

    - **Quick solve**

# Multi-stage SCUC algorithm

- **System feasibility stage:**

  - **Modeling**

    - **Ignore operating cost**

    - **Include system constraint and hard resource constraints with necessary relaxation**

    - **Minimize system constraint violation**

  - **Goals and benefits**

    - **Not solved for optimal SCUC solution**

    - **Quickly detect scarcity/emergency conditions**

    - **Avoid incorrect determination due to the penalty price setting vs large SU/noload cost**

# Multi-stage SCUC algorithm

- **Optimal solution stage:**

  – **Modeling**

    - **Full SCUC model including operating cost**

    - **Hard resource constraints with pre-determined relaxation**

  – **Goals and Benefits**

    - **Focus on optimal SCUC solution**

    - **Warm-start from system feasibility stage**

    - **Better solution qualify even when the solve times out**

# Future Challenges

- **Desire for ever increasing performance to shorten the time taken to solve.**

- **Enhanced Combined Cycle**

- **Grouped Resource constraint modeling (shared startup transformer or shared plant operators)**

- **Decrease mismatch in SCUC and SCED models**

**Helping our members work together to keep the lights on… today and in the future**