Education: RTSCED and 5 Minute Dispatch

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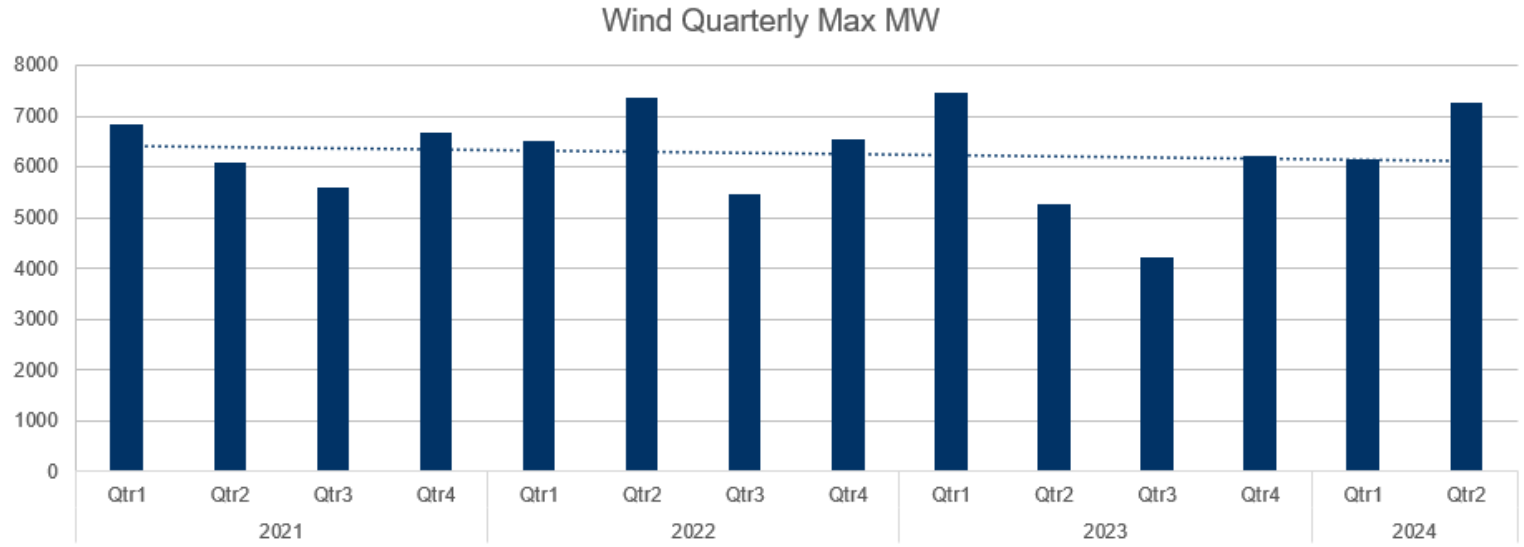
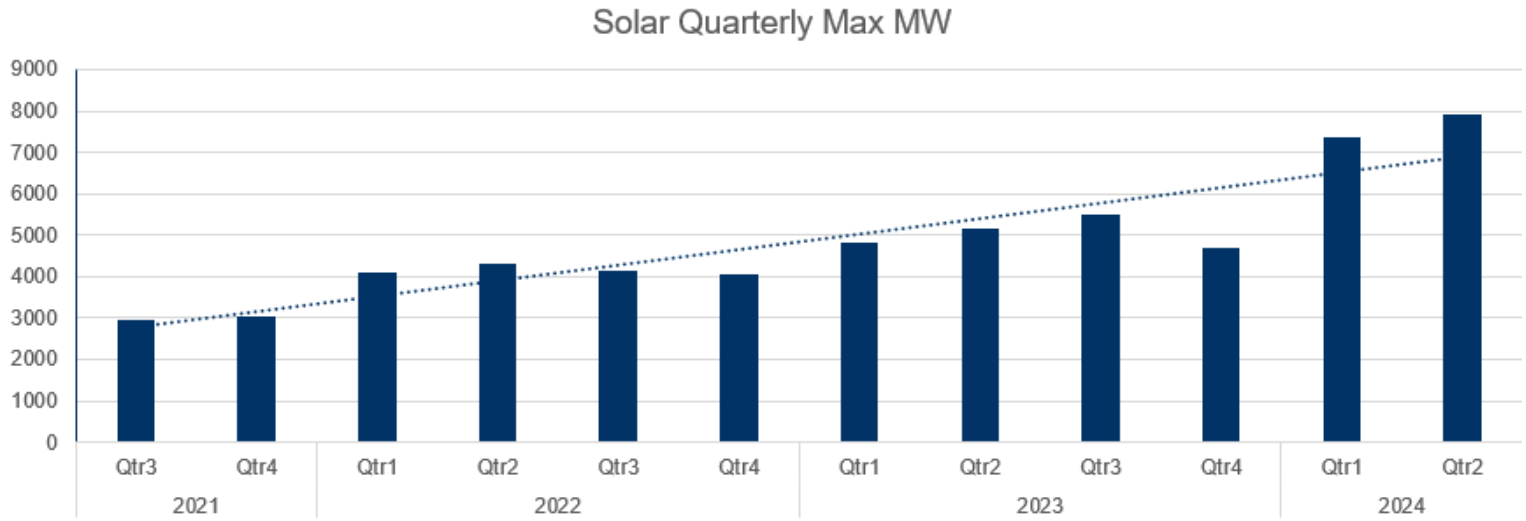
Overview

- 5-minute dispatch and pricing went live November 1, 2021
  - Focus on the basics of the dispatch run (RT SCED)
- Based on the current RT SCED engine logic, resources with a high (fast) ramp rate introduce two reliability issues System Operators must manage:
  - Power balance challenges that may contribute to ACE deviations
  - Increased volatility with constraint control
- These are reliability issues that have been exacerbated by the increased penetration of renewable resources with high or no submitted ramp rate
  - Reduce Manual Dispatch / Out of market actions

Wind and Solar Totals (2021-2024)

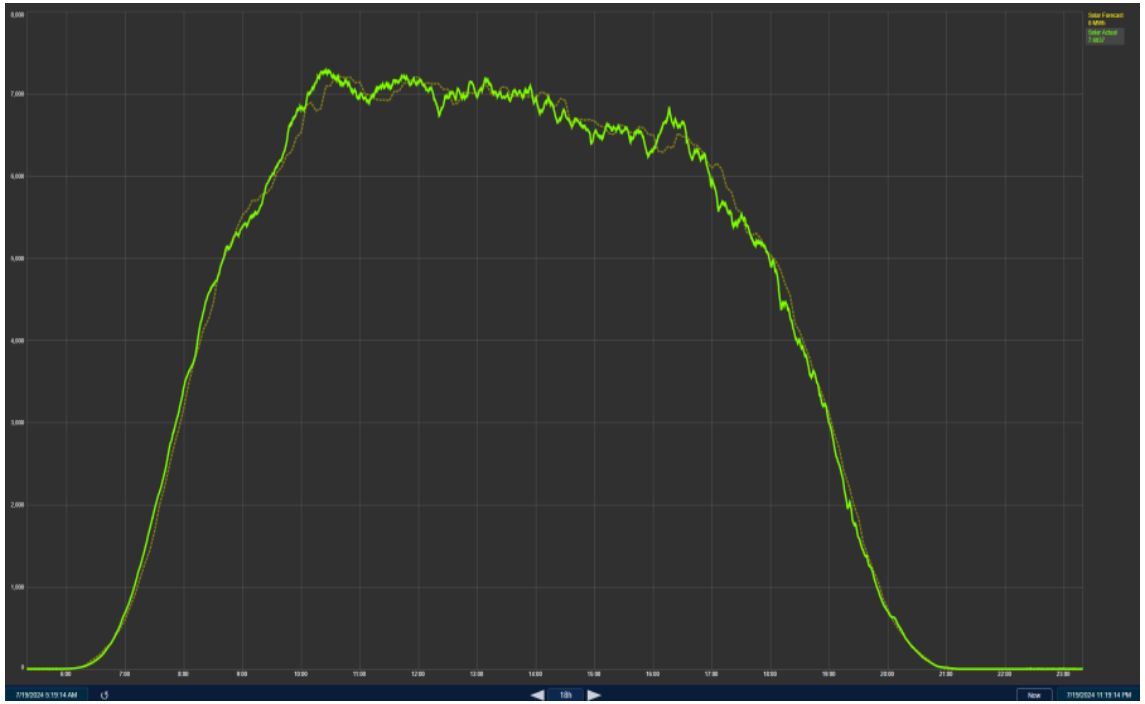




- Average total output from RTSCED (Not capacity)

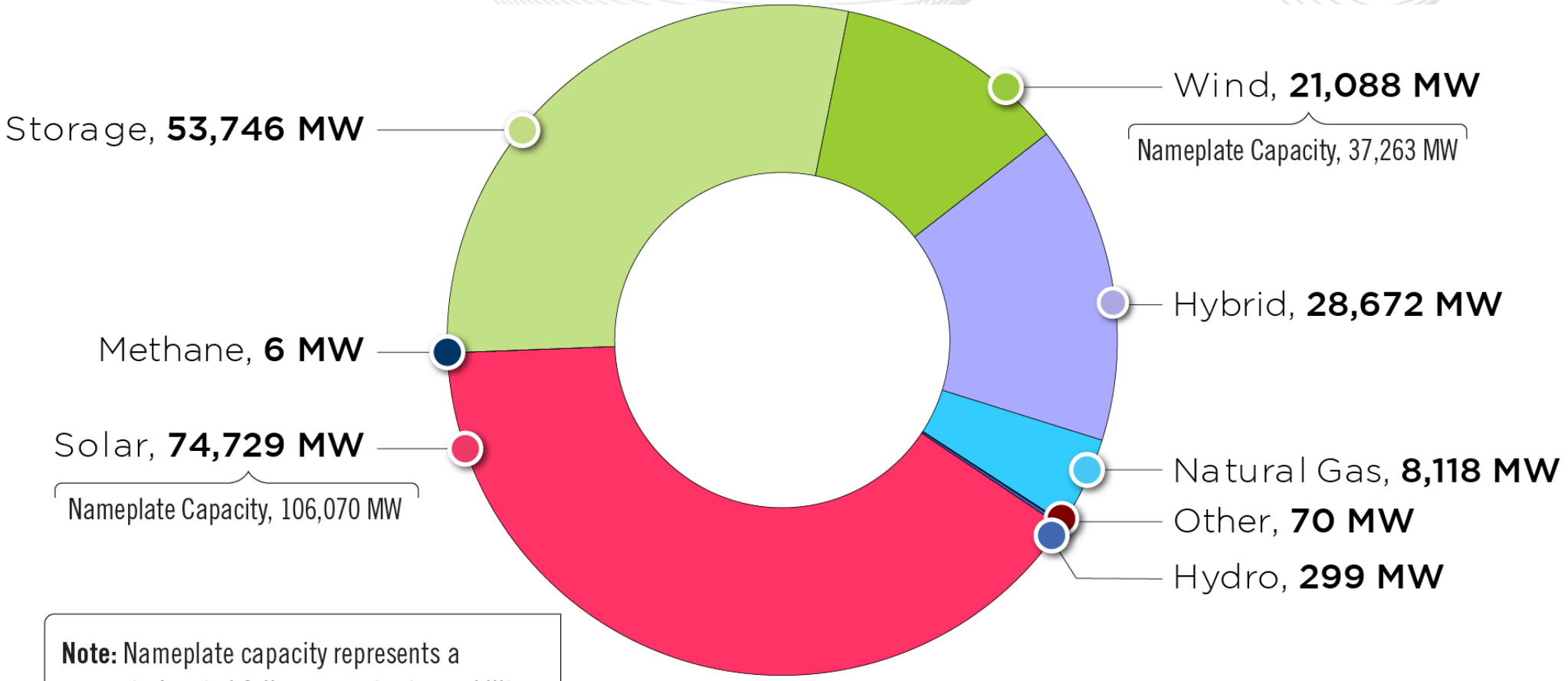
Actual Daily Generation Variations

Wind



Solar

Queued Generation Fuel Mix



Note: Nameplate capacity represents a generator's rated full power output capability.

As of Dec. 31, 2023

Understanding Key Terminologies

- Security Constraint Economic Dispatch (SCED)
- Look Ahead / Target Time
- Achievable Target MW
- Ramp Rates vs. Capability
- Bid-In Parameters
- Constraints Binding (Shadow Price / Marginal Value)
- Raise Help vs Lower Help (DFAX)

Real-Time Market Applications

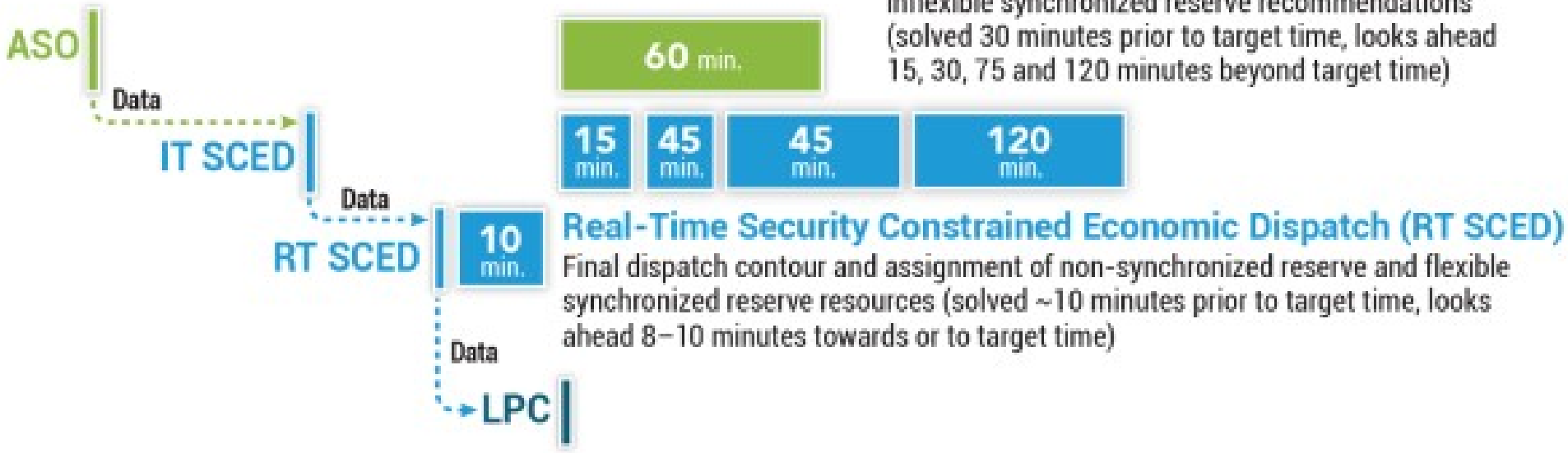
Manual 11, Section 2.5

Ancillary Services Optimizer (ASO)

Clearing and assignment of regulation and inflexible reserve resources (solved 60 minutes prior to target time, looks ahead 60 minutes beyond target time)

Intermediate-Term Security Constrained Economic Dispatch (IT SCED)

Demand Trajectory, generator loading strategy, Demand Response commitment for energy, CT commitment and inflexible synchronized reserve recommendations (solved 30 minutes prior to target time, looks ahead 15, 30, 75 and 120 minutes beyond target time)



Real-Time Security Constrained Economic Dispatch (RT SCED)

Final dispatch contour and assignment of non-synchronized reserve and flexible synchronized reserve resources (solved ~10 minutes prior to target time, looks ahead 8–10 minutes towards or to target time)

Locational Pricing Calculator (LPC)

5-minute energy and ancillary service prices
Based on latest approved RT SCED case

RT SCED Overview

Effective November 1, 2021

1 RT SCED cases execute every five minutes

- 5 cases execute
- Cases take approx. 1.5 min to solve
- Approx. 2 min to review
- Can be run on-demand by Dispatch

2 10-minute look ahead target time

- First five minutes determines ATM, or starting point
- Second five minutes resource expected to ramp to meet basepoint signal

3 Dispatches online resources for Energy & Regulation

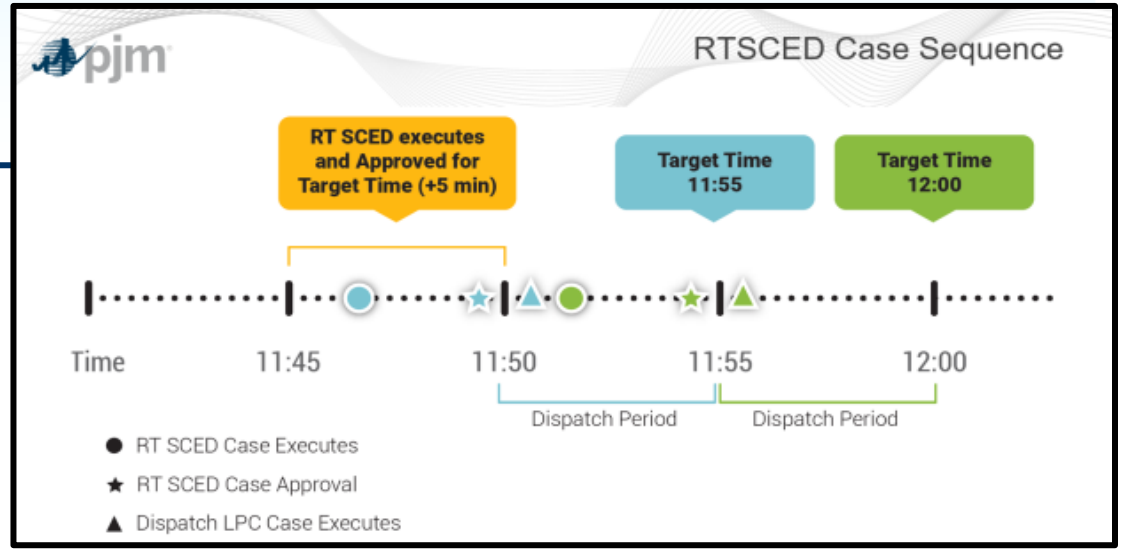
- Procures flexible reserve MWs to meet SR, PR, 30-min requirements

4 Performs constraint control for monitored constraints

- Re-dispatch out of merit resources to maintain transmission limits

Inputs:

- Resource bid-in data
- EMS data (SE, dfax, loss penalty factors)
- Load forecast
- Fixed AS assignments
- Wind Forecast
- Interchange schedules
- Operator inputs, e.g. load bias, hydro schedules, constraint control %, marginal value limit overrides



Achievable Target MW (ATM) Logic

Manual 11, Section 2.5.3.3

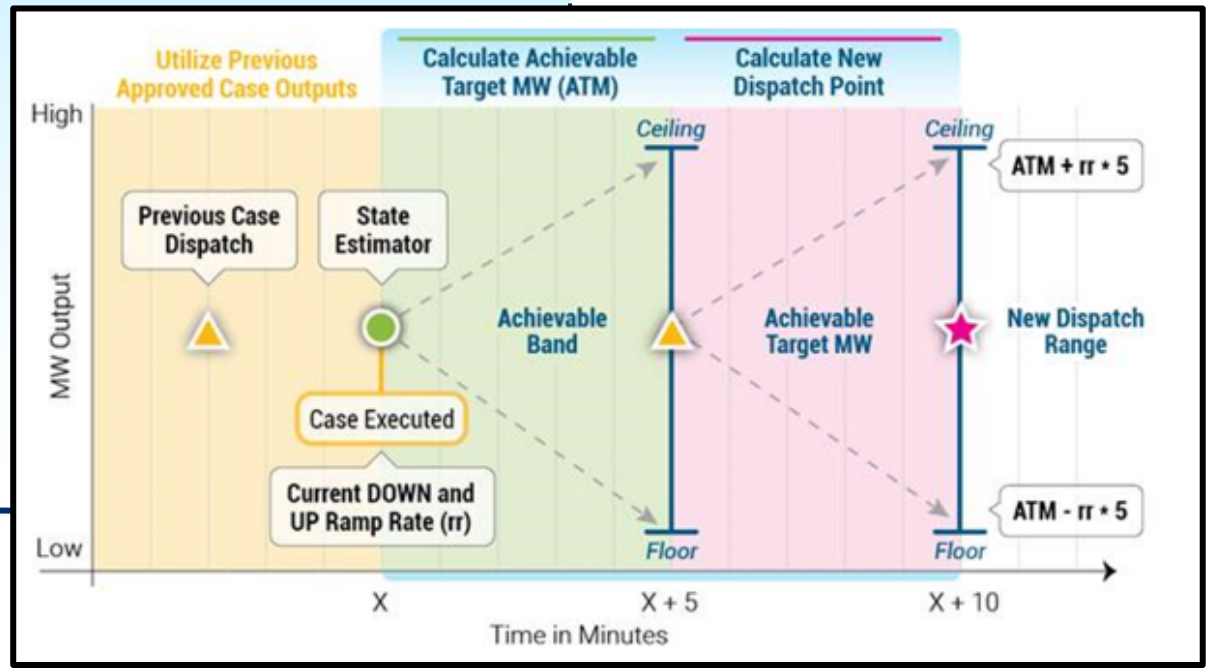
10 Minute Look Ahead with a 5 Minute Ramp

Uses the first 5 minutes of the look ahead period to recalculate an achievable previous target MW which is then used as the starting point to calculate the dispatch basepoint over the second five minutes of the 10 minute look ahead period. SE MW is used at the starting point in the calculation of achievable previous target MW

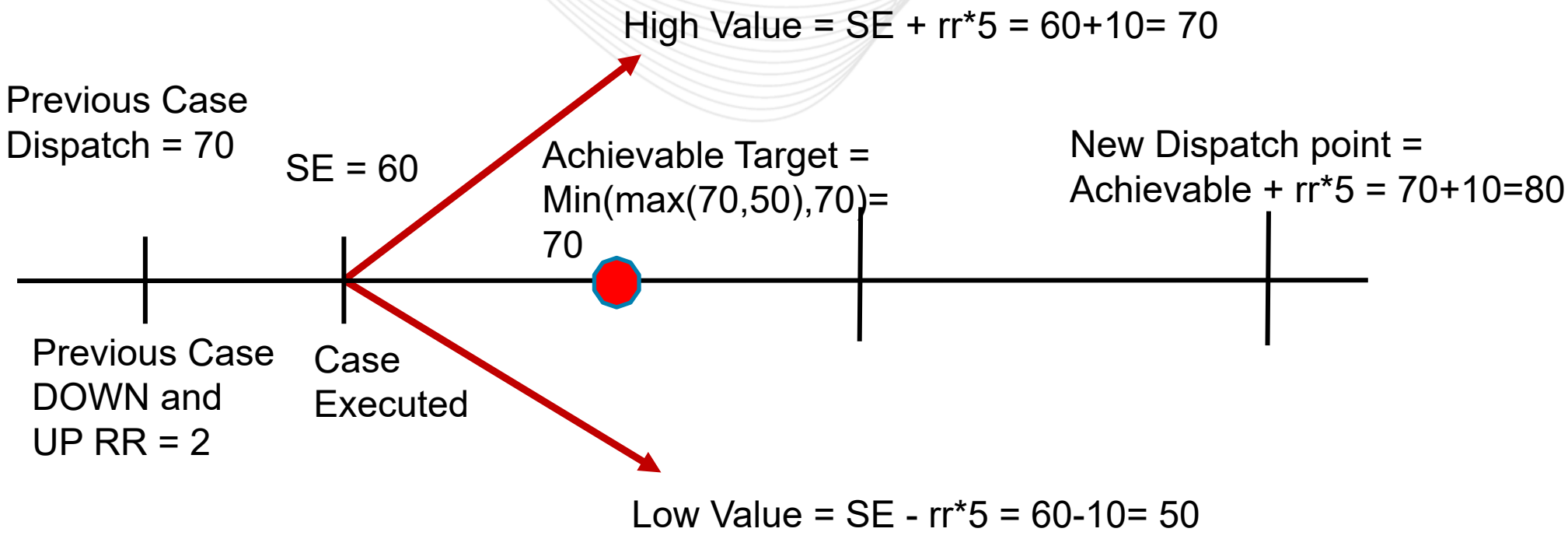
The unit will then be ramped over 5 minutes to it's next dispatch point

Direction of ramp (up/down) determined by forecasted system conditions

Each Segment builds upon each-other based on the projected output of the unit



Envelope Example (Numerical) Following



RTSCED - Today

- Bid-In Parameters – Resources can only be dispatched within the economic minimum and economic maximum bid-in parameters
  - Basepoint has to be within their bid-in parameters, even if SE Solution is outside of their range
- Ramp Rates – Utilize bid-in ramp rates for resources, however if resource does not submit a ramp rate, a default rate of 9999 is utilized
  - Resources can swing very fast from interval to interval
- At a high level, SCED is required to perform co-optimization while maintaining power balance, reserve requirement (s), constraint control

Challenges with Wind and Solar Dispatch

Resource Output	Unit Dispatch Direction	
	Lower Help (source, -lmp)	Raise Help (sink, +lmp)
Above eco max	SCED curtail, follow down or manual dispatch	Energy imbalance, SCED not accounting for extra MWs in basepoint signal
Below eco max		Off cost to control constraint, SCED thinks it has more MWs than reality

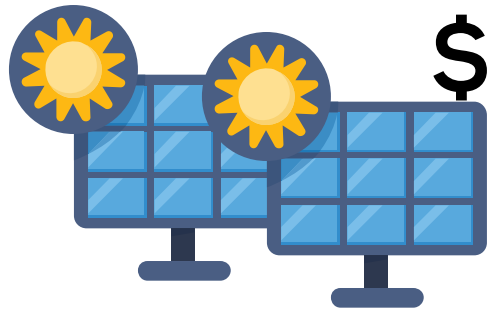
Price Curve		
Segment	MW	Offer Price
1	100	0.00

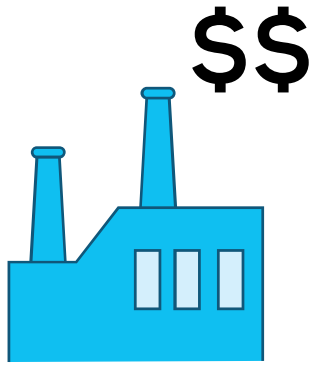
Parameters	
Eco Max	100
Eco Min	0
Ramp Rate	9999

Key takeaway: *SCED Basepoint is limited by economic parameters. Outdated values can lead to out of market, manual actions by PJM Dispatch.*

Resource Producing Below Eco Max

Rating = 100MVA





- 100% Raise Help
- SE = 50MW
- Interval 1: Constraint binding
- Interval 2: SCED dispatches solar up to 100MW for relief
- Interval 3: Constraint unbinds in SCED
- In reality, 50MW of relief does not materialize, EMS will continue to see the overload

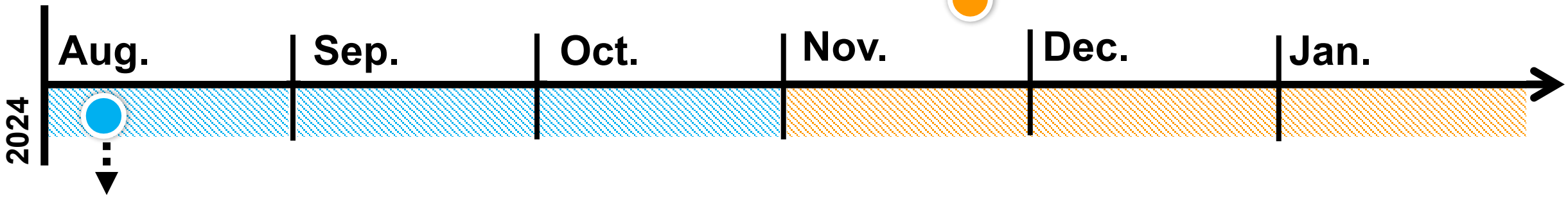
Dispatch must manually dispatch another effective resource to control the constraint

Future Agenda Topics

- Additional Examples
- RTO/ISO Comparison on treatment of Wind/Solar Dispatch
- Other Suggestions?

Timeline

Nov. – Jan.
Matrix Development



Aug. – Oct.
Education & Interest Identification

Monthly MIC Updates

Acronyms

Acronym	Term & Definition
RT SCED	**Real-Time Security Constrained Economic Dispatch** is the application responsible for dispatching resources in real-time for a target five minute interval as a result of a co-optimization of Energy and Reserves for the forecasted system conditions..
LPC	**Locational Pricing Calculator** performs a pricing run solution to determine the Real-time LMP values and Regulation and Reserve Clearing Prices on a five (5) minute basis.
ASO	**Ancillary Service Optimizer** performs the joint optimization function of Energy, Reserves and Regulation in the dispatch run. The main functions of ASO are the clearing and commitment of Regulation resources and inflexible Reserve resources for a one hour time period
IT SCED	**Intermediate Term Security Constrained Economic Dispatch** solves a multi-interval, time-coupled solution to perform functions that include but not limited to resource commitment recommendations for Energy and Reserves, resource commitment decisions for economic Demand Resources, execution of the Three Pivotal Supplier Test for Energy

PJM Glossary

Acronyms

Acronym	Term & Definition
LMP	**Locational Marginal Price** is defined as the marginal price for energy at the location where the energy is delivered or received. For accounting purposes, LMP is expressed in dollars per megawatt-hour ($/MWh). LMP is a pricing approach that addresses Transmission System congestion and loss costs, as well as energy costs.
AGC	**Automatic Generation Control** is equipment that automatically adjusts generation.
Basepoint	**Basepoint** is calculated output for a given resource from approved RTSCED based on co-optimization of Energy and Reserves. The basepoint is a MW value a resource should be able to achieve within 5 minute.
MW	A **Megawatt** is a unit of power equaling one million watts (1 MW = 1,000,000 watts) or one thousand kilowatts (1 MW = 1,000 KW). To put it in perspective, under non-severe weather conditions, one MW could power roughly 800 to 1,000 average-sized American homes.

PJM Glossary

Acronyms

Acronym	Term & Definition
ATM	**Achievable Target Megawatt** is range that is calculated within RTSCED that a given resource may be able to reach within a given timeframe (typically 5 minutes).
SE	**State Estimator** generates a network state estimation solution, every 1 minute within the PJM Energy Management System. The solution is used to determine the initial MW of a resource that RTSCED will use to dispatch for a look ahead timeframe.
DFAX	**Distribution Factor** is a calculated impact of a resource on a constraint by raising or lowering its output by 1 MW, commonly referred to as Raise help and Lower help.

PJM Glossary

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