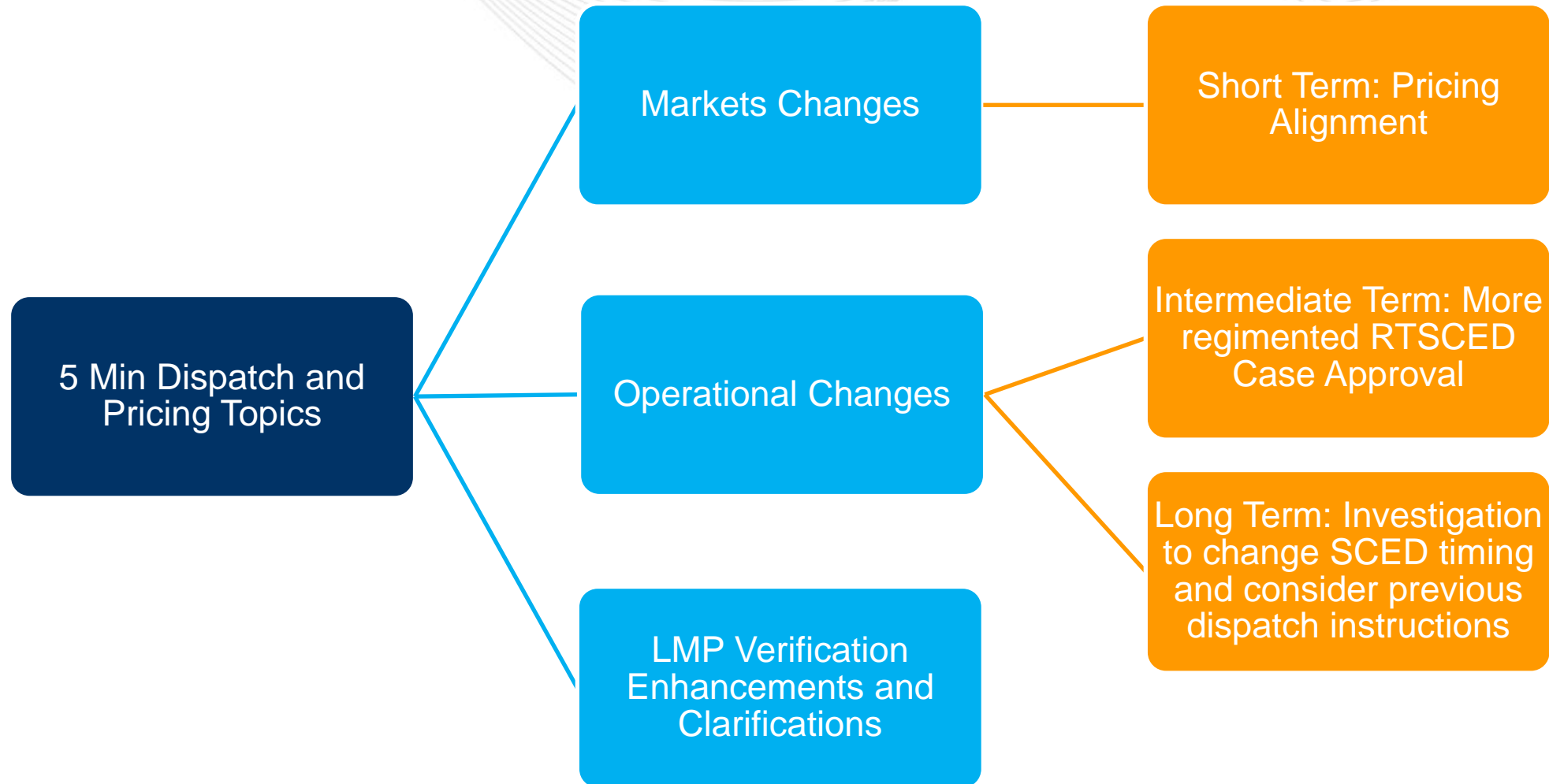




PJM Package Highlights: 5 Minute Dispatch and Pricing

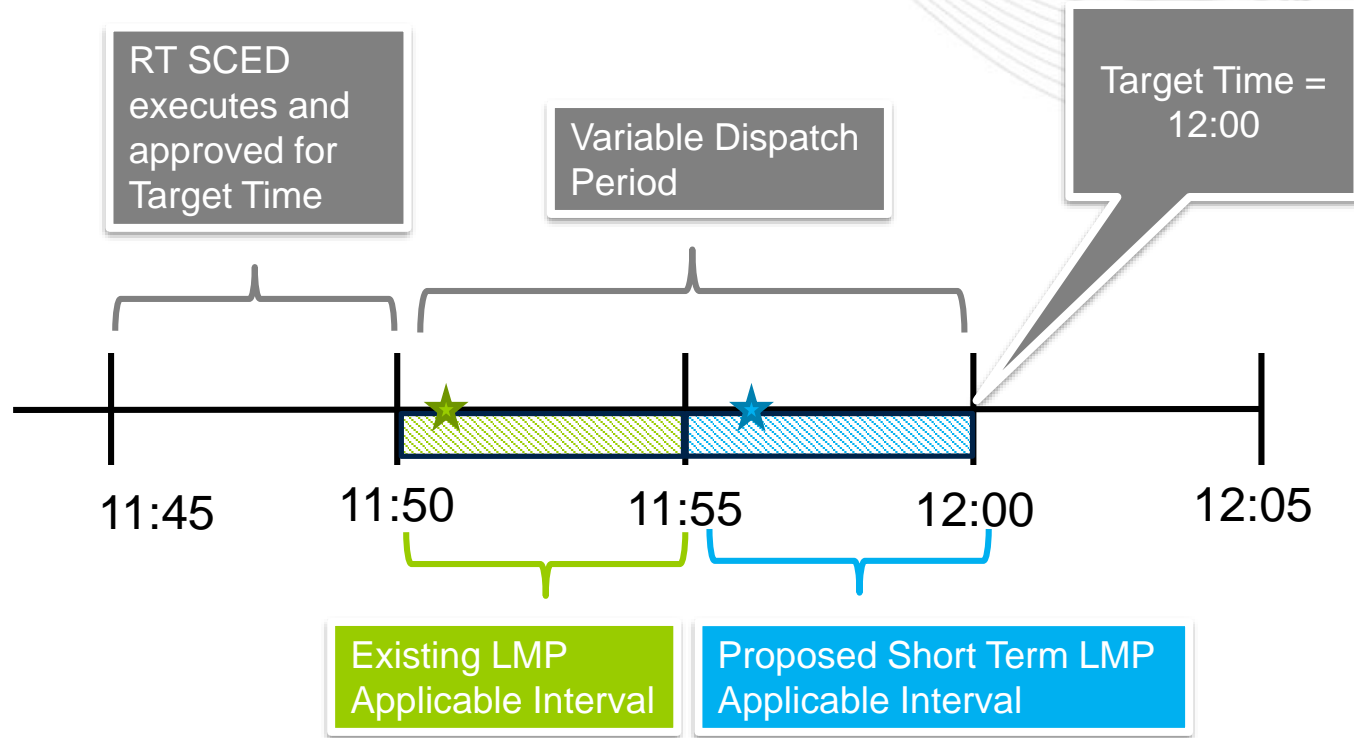
Market Implementation Committee
June 3, 2020



- Vote is only for benefit of filing and implementing of short-term changes to the PJM market
- Vote is not with regard to whether the short-term change addresses the issues raised by the IMM in the Fast-Start pricing docket
 - FERC will ultimately decide in Fast-Start docket
 - Vote indicates your support for the short-term change
 - While PJM believes this change would satisfy the concerns raised in the Fast-Start proceeding, stakeholders will have the opportunity to state their position on this issue in the Fast-Start docket when PJM makes its informational filing
- If short-term changes are approved, PJM will file with FERC and also indicate the current state of the intermediate term changes

- PJM is pursuing the intermediate term changes:
 - First test of 5-minute auto case execution was successful
 - The next test is for the week of June 22
 - If everything is successful PJM will keep this intermediate term design component in place permanently
 - If that occurs, PJM will bring forward conforming manual changes for member endorsement memorializing these changes to its operational business practices
- PJM has not, at this point, identified any Tariff/OA changes necessary to implement the intermediate term changes

- Align LPC to use the reference RTSCED case for the same target time
 - Example: LPC calculates prices for interval from 11:55 to 12:00 using RT SCED solution with target time 12:00
 - Execute LPC cases every five minutes after the start of dispatch interval. Therefore, a delay of approx. 5-6 minutes will occur between when the RTSCED case is approved and priced
- Resource Offers, Parameters and Ancillary Service assignments corresponding to the interval ending at the target dispatch time are used as input to the RTSCED Case
 - Example: Offers for 11:00 to 12:00 will be effective up to and including the 12:00 target time, Offers 12:00 to 13:00 will be applied to dispatch target time of 12:05
- LPC will use the most recently approved RTSCED case prior to target time if no approved RTSCED case exists for the same target time



- ★ Existing LPC case execution time
- ★ Proposed LPC case execution time

SCED Changes:

- Hourly Offer Curves for 11:00 hour used instead of 12:00 hour
- Inflexible Sync Reserve and Regulation awards determined by ASO for 11:00 hour instead of 12:00 hour

LPC Changes:

- Align LPC to use the latest approved RT SCED case for the same target time (interval ending)
- LPC case executed at a predefined time, shortly after the start of dispatch interval
 - I.e. the LMP for 11:55 - 12:00 is calculated at 11:56:30

Short Term Timeline

Committee	Action
May MIC	1 st Read
June MIC	Vote
June MRC	1 st Read
July MRC/MC	Vote
October 2020	Tentative implementation pending FERC approval

- Vote on Short term changes
- Updates on Intermediate changes and progress
- Continue to pursue LMP Verification Enhancements
- Continue to evaluate Long Term changes

Appendix A

PJM and IMM Design Component Comparison



Comparison Between PJM and IMM proposals

Design Components	Status Quo	PJM Option	IMM Option	PJM Timing
LPC Execution Frequency	Every 5 minutes, 90 seconds after the start of dispatch interval	Execute cases every five minutes as soon as feasible after the start of dispatch interval		Short term
Applied Energy and Reserve Offers for RTSCED	RTSCED uses offers effective at the start of Target Time. Example: Offers from the 11 hour will be effective until 11:59 target time. Offers for hour 12 will be applied to RTSCED for target time 12:00	Use offers that end at the target time, Interval Ending Method. Example: Offers from the 11:00 to 12:00 hour will be effective until 12:00 target time. Offers for the 12:00 to 13:00 hour will be applied to RTSCED for target time 12:05 onwards.		Short term
Synchronized reserve (SR) and regulation assignments used as inputs to RT SCED from ASO	ASO uses offers effective at the start of Target Time. Example: Offers from the 11 hour will be effective until 11:59 target time. Offers for hour 12 will be applied to RTSCED for target time 12:00	Use SR and regulation assignments until the end of the applicable hour in RT SCED. Example: Assignments from the 11:00 to 12:00 hour will be effective until 12:00 target time. Assignments for the 12:00 to 13:00 hour will be applied to RTSCED for target time 12:05 onwards.		Short term
LPC Applicable Time for Settlements	Prices are applied to the five minute interval during which the LPC case completes its solution, regardless of the RT SCED case target time.	Five minute interval that ends at the target time for SCED and LPC		Short term
No Approved RTSCED Case for Target Time for LPC	latest approved RTSCED case is effective until a new RTSCED case is approved (regardless of target interval)	Use the most recently approved RTSCED case prior to the Target Time (Status Quo) Post information as a repricing interval		Short term
RTSCED case used for starting point of LPC case	Most recently approved RT SCED case at the time LPC executes, regardless of the RT SCED case target time.	The latest approved RT SCED case, for the same target time.		Short term
RT SCED Approval / Dispatch Signal Frequency - Default Scenario	Manual: Varies Average: 3.5 - 4 minutes per case approval for 2019	One RTSCED case every 5 minutes manually approved for a target time. Dispatch signals are sent upon case approval.		Intermediate
RT SCED Case Execution Frequency	Auto- execute every 4 minutes or upon demand by dispatch	Auto-execute cases every 5 minutes		Intermediate

Design Components	Status Quo	PJM Option	IMM Option	PJM Timing
RT SCED Approval / Dispatch Signal Frequency - Default Scenario	RTSCED cases are approved 10-14 minutes prior to target interval.	Approve at least one solution from the SCED case solved for the target time. If a case is not manually approved for each target time, a case will be auto-approved for the target time.		Long Term - Under Evaluation
RT SCED Case Execution Frequency	RTSCED cases are executed 10-14 minutes prior to target time.	RTSCED cases are executed 8 to 10 minutes prior to target time or manually executed by dispatch		Long Term - Under Evaluation
Exceptions to RT SCED Approval/Dispatch signal frequency	No defined schedule or approval frequency.	<p>A RTSCED case may not be approved for a target interval at dispatcher discretion.</p> <p>Additional cases may be approved for the target time and dispatchers will log the need for additional cases based on predefined reasons.</p> <p>Additional transparency may be provided when multiple cases are approved for a target time.</p>	<p>A case may not be approved if there was a data or software failure, or other similar reason, such that no valid case was solved by the beginning of the dispatch interval.</p> <p>An additional case may be approved after the dispatch interval begins for defined circumstances. The applicable target time for such a case will be moved forward by 5 minutes (this is for LPC to continue to use the latest approved SCED case at a defined time)</p> <p>Under both scenarios, publicly post information explaining the reasons for deviation from default.</p>	Long Term - Under Evaluation
RT SCED Assumed Ramp Time	10 minutes	First 5 minutes assume previous SCED dispatch, next 5 minutes ramp to optimize in SCED		Long Term - Under Evaluation
RT SCED Resource Initial MW	Most recent state estimator value at the time of RT SCED case execution	Previous approved SCED dispatch MW, adjusted for feasibility based on unit's SE MW and ability to meet previous dispatch target. No DGP adjustments		Long Term - Under Evaluation
Dispatch MW used in Settlements for Operating Reserve, Credits and Deviation charges	Time-Weight all approved RTSCED cases to calculate ramp limited desired MW and UDS base point based on approved RTSCED case time	The latest RT SCED case approved prior to the start of the dispatch interval applied for the five minute interval ending at the SCED target time		Long Term - Under Evaluation
Synch and Non-Synch Reserves for Settlement	Last approved RT SCED case with an RT SCED forecast target time at the beginning of the five minute interval. If there is not one, settlements uses the most recent previous approved case. The majority of the time this will not match the RT SCED case id from which prices are derived.	The latest RT SCED case approved prior to the start of the dispatch interval applied for the five minute interval ending at the SCED target time		Long Term - Under Evaluation

Appendix B

Intermediate term, LMP Verification Enhancements and Clarifications, and Long term changes

- The objective is to execute and approve one RTSCED case for each 5 minute dispatch target time subject to minimal deviations
 - Auto execution of RTSCED cases changes from every 4 minutes to every 5 minutes
 - Additional cases may be manually executed and approved as needed by dispatch
 - PJM will transition to this state through operator training and software changes
- May include changes to ancillary service requirements or other items necessary to accommodate less frequent dispatch cases

LMP Verification Enhancements and Clarifications

- Changes to be pursued separately
- Clarify Operating Agreement language regarding LMP and Clearing Price reposting
- Conforming manual language changes
 - Align with the current Verification process
 - Updated Dead Bus Replacement Logic

PJM will continue to evaluate the impact and benefits of these long term changes

- RTSCED cases will auto execute every 5 minutes with a target time of 10 minutes into the future
 - The initial MW for the new case will be adjusted for feasibility using the previous dispatch MW as an input
- RTSCED Case Approval
 - If a case is not manually approved by dispatch for a target time, a case will be automatically approved at a specified time or deadline prior to the start of the dispatch interval
 - A case may not be approved for target time at dispatcher discretion
 - Additional transparency provided when RTSCED cases are not approved for a target time
- Additional changes to Ancillary Service products may be required to support these long term changes

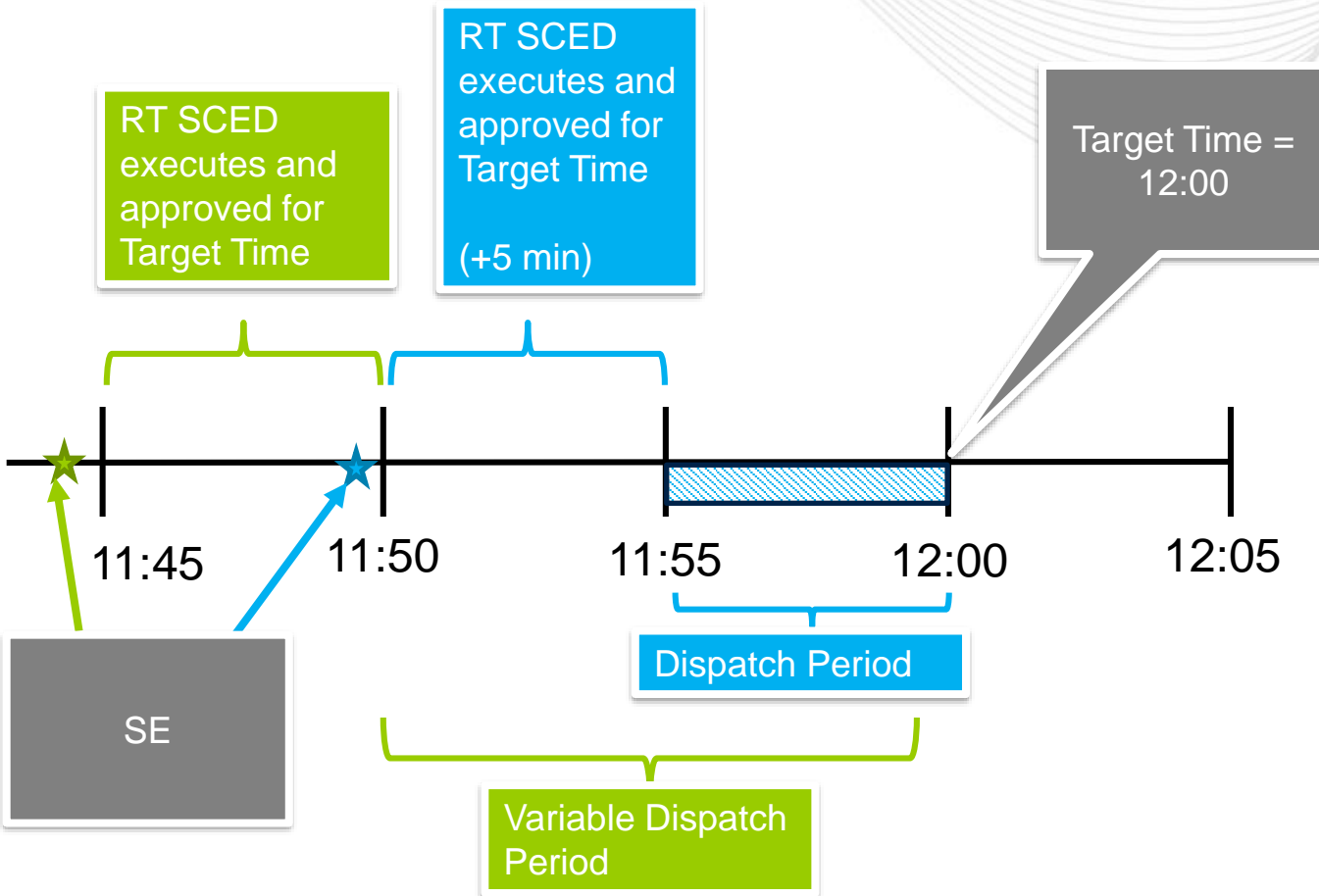
Current SCED vs. Proposed Long Term SCED Implementation

Current SCED Execution

- RTSCED cases auto-execute every 4 minutes, 10 to 14 minutes prior to target time
 - RTSCED cases are manually approved at dispatcher discretion
- The most recent SE MW is used for initial MW and adjusted by unit's ramp rate to determine 10 min dispatch value

Long Term SCED Execution Under Investigation

- RTSCED cases will auto execute every 5 minutes, 8 to 10 minutes prior to target time or manually executed by dispatch
 - If RTSCED case is not approved for a target dispatch interval, will be automatically approved at a specified time or deadline prior to the start of the dispatch interval
- The initial MW for the 11:55 case will be adjusted for feasibility using the previous dispatch MW, 11:50 approved case, as an input



- Benefits and impacts to Operations require further evaluation
 - Changes impact Operator actions
 - Consider parallel or incremental implementation approach
 - Prioritization with other on going efforts
- Updates to be provided as appropriate to Stakeholders and IMM