



Next Generation Markets Update

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Market Implementation Committee

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Multi-year partnership between PJM, MISO, ISO-NE and GE started in April 2017

Goals

- Create a substantial improvement in capability and performance
- Enable ISOs to share in costs and system functionality
- Reduce maintenance costs and time-to-market
- Improve system security and software quality
- Develop the next generation markets support team at GE and PJM



Product Development



Software product

- Advanced Storage Model

Whitepapers

- Aggregated Distributed Energy Resource
- Generator Start-Up/Shutdown Whitepapers

Proof of Concept

- Training and Test Simulator Environment

Day-Ahead Market Clearing Engine (DA MCE) Implementation

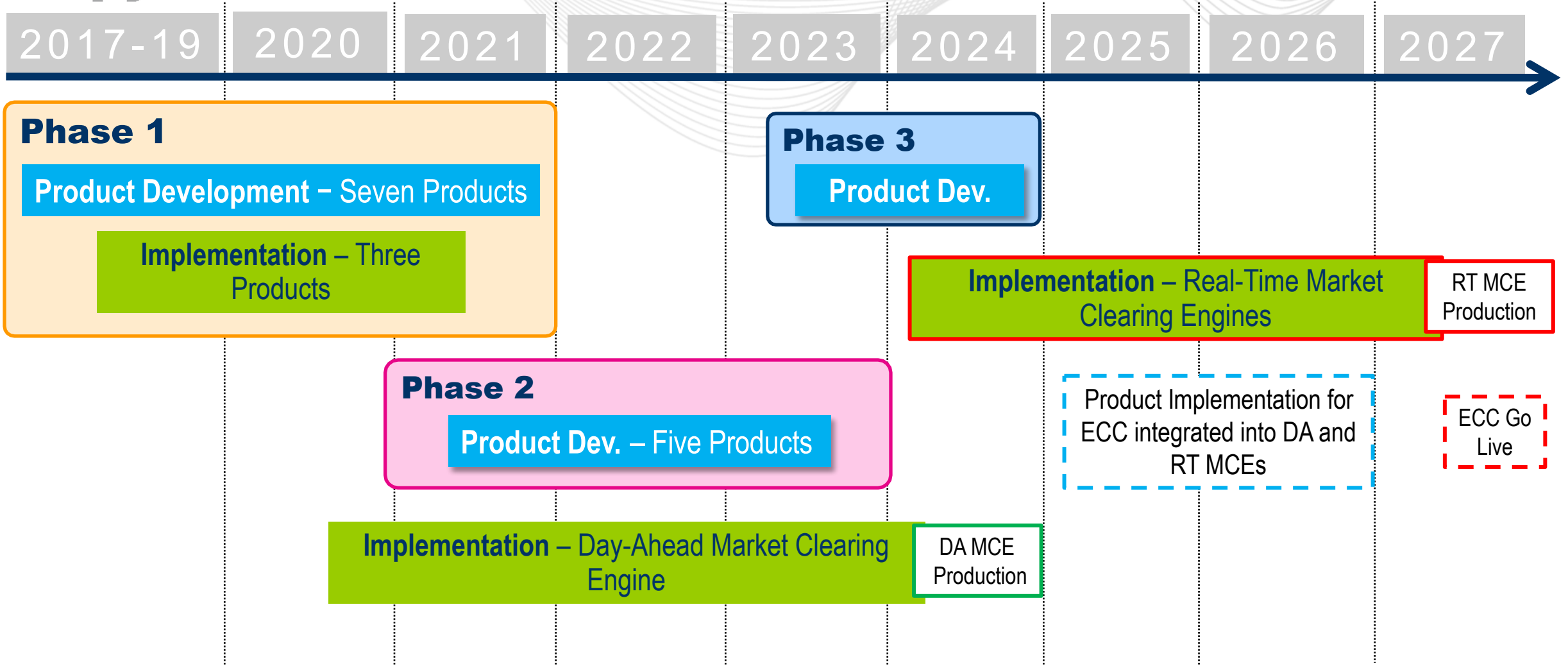
Project Increment #5, which consisted of Pre-Factory Acceptance Testing (FAT) and the DA MCE running in an integrated environment, was completed in February 2024. Project Increment #6, formal FAT, started in late February and completed in mid-April. Project Increment #7, Post-FAT Bug Fix, currently underway. Production Go Live is anticipated to occur in Q4 2024 and is dependent on the successful completion of Parallel Production Operations.

Phase 2 and Phase 3 Product Development

Phase 2 product development was completed in Q4 2023. Phase 3 development is underway with all components scheduled to be delivered by Q4 2024.

Real-Time Market Clearing Engine (RT MCE) Implementation

PJM signed the RT MCE Implementation Statement of Work in March 2024. GE began development of Project Increment #1, which is scheduled to be completed in October 2024. Multiple Project Increments are required in order to complete development and testing of the four RT Study Modes: IT SCED, RT SCED, ASO, and LPC.



- Drivers

- Higher complexity with 4 study modes
- GE resource limitations
- Continued changes to legacy system
 - Regulation Market Redesign
 - Reserve Certainty

- Ongoing Efforts

- Knowledge gained from DA MCE development and testing
- Expanded GE workforce
- PJM to prioritize changes; GE to leverage experience from legacy development and re-evaluate estimates

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Appendix

- nGEM products go through 2 development phases:
 - Product Development – Core product that is common across PJM, MISO, and ISO NE
 - Product Implementation – Customization of the core product to comply with PJM market rules

Product Development

Software products

- Data Transfer Enhancements
- Redesigned Network Applications
- Redesigned Market Clearing Engines
- Redesigned Markets Gateway
- Bidding Service

PJM Product Implementation

Customize and implement

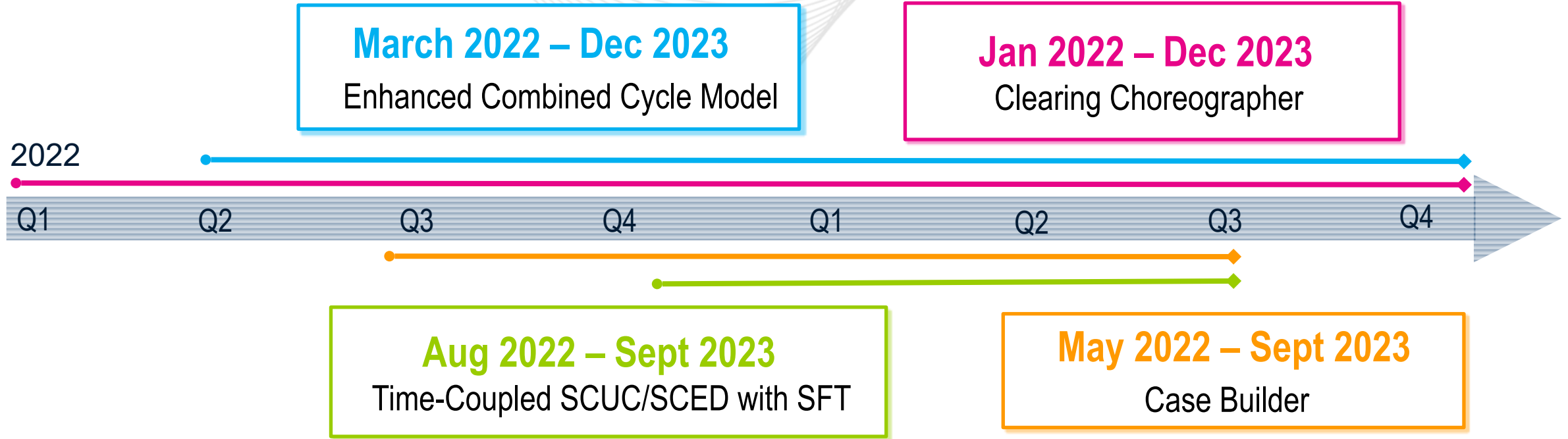
- Data Transfer Enhancements
- Redesigned Network Applications

Product Development



Software products

- Market Clearing Engine User Interface for Market Operators
- Enhanced Combined Cycle Model
- Time-Coupled Security Constrained Unit Commitment (SCUC) and Security Constrained Economic Dispatch (SCED) with Simultaneous Feasibility Test (SFT)
- Clearing Choreographer
- Case Builder



The Market Clearing Engine User Interface for Market Operators was delivered in April 2021.

Business Drivers

- Energy transition shifts from fewer high-megawatt units to a larger number of smaller intermittent units.
- An increase in units means more data and longer processing/clearing times.
- PJM will need to manage higher data volumes while maintaining or improving current processing/clearing performance, especially for real-time data in markets and EMS.
- IT applications and systems must be able to scale to sustain current baseline performance.

APPLICATIONS CHALLENGES

Mixed Integer Programming:
Parallelization effects are model-dependent.

- Addressing the Root Cause (Math Problem) Versus Faster CPU
- **Linear optimization may not benefit from additional threads.**
 - Unit commitment problem

Constraint on the software continues to be the formulation.

Intermediate and Long Term

Short Term

Performance improvements realized with **nGem engine implementation**.

Continued **investment in hardware** that has the fastest clock speed possible

Pilot converged infrastructure and baseline performance

Further engage with hardware vendors and research centers with a specific **focus on HPC application in optimization calculations**.

Further optimize the engine and look for research opportunities.

Maximize benefits of existing features.

Investigate light-weight simultaneous feasibility testing (SFT) suitable for hot-starting.

Research:

- Using non-linear programming
- Using machine learning for identifying non-binding constraints
- Using machine learning to improve orchestration
- On advanced optimization techniques, such as distributed optimization

Hardware approach – graphics processing unit (GPU) research