Speeding Up Interconnection Studies

ESIG Webinar

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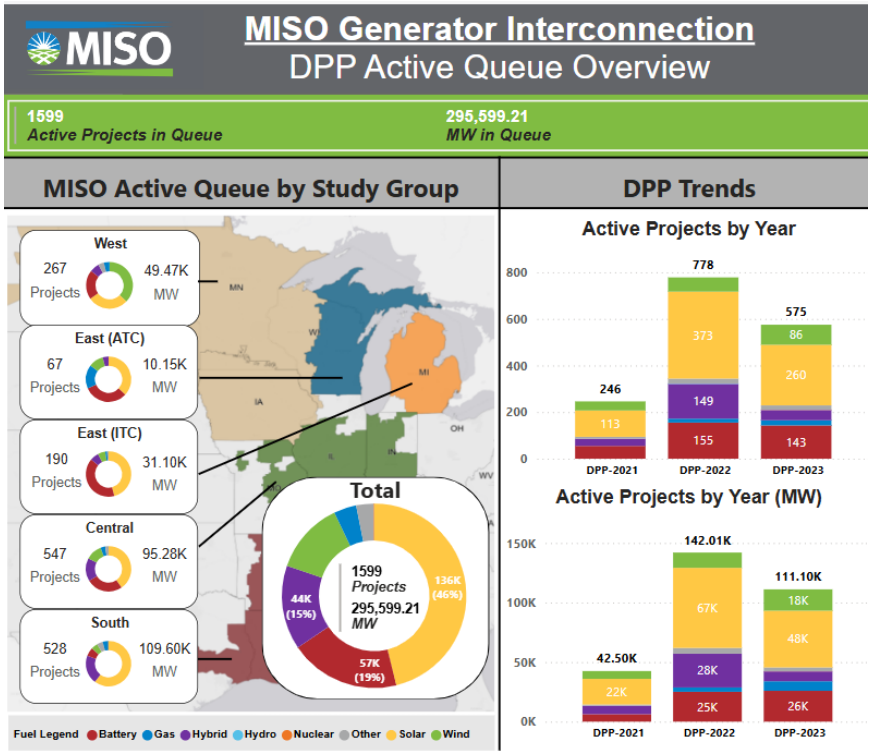
MISO's large Queue volume and a backlog of applications are contributing to the delay of resource additions



CURRENT QUEUE

- Tariff time is 1-year
- Cycles are taking 3-4 years
  - Late-stage dropouts from 2020-2022 require restudies and prevent processing of later cycles
- Generator Interconnection Agreements are required now for projects aimed at meeting resource adequacy needs in the next 3-5 years

Queue data as of 3/21/2025

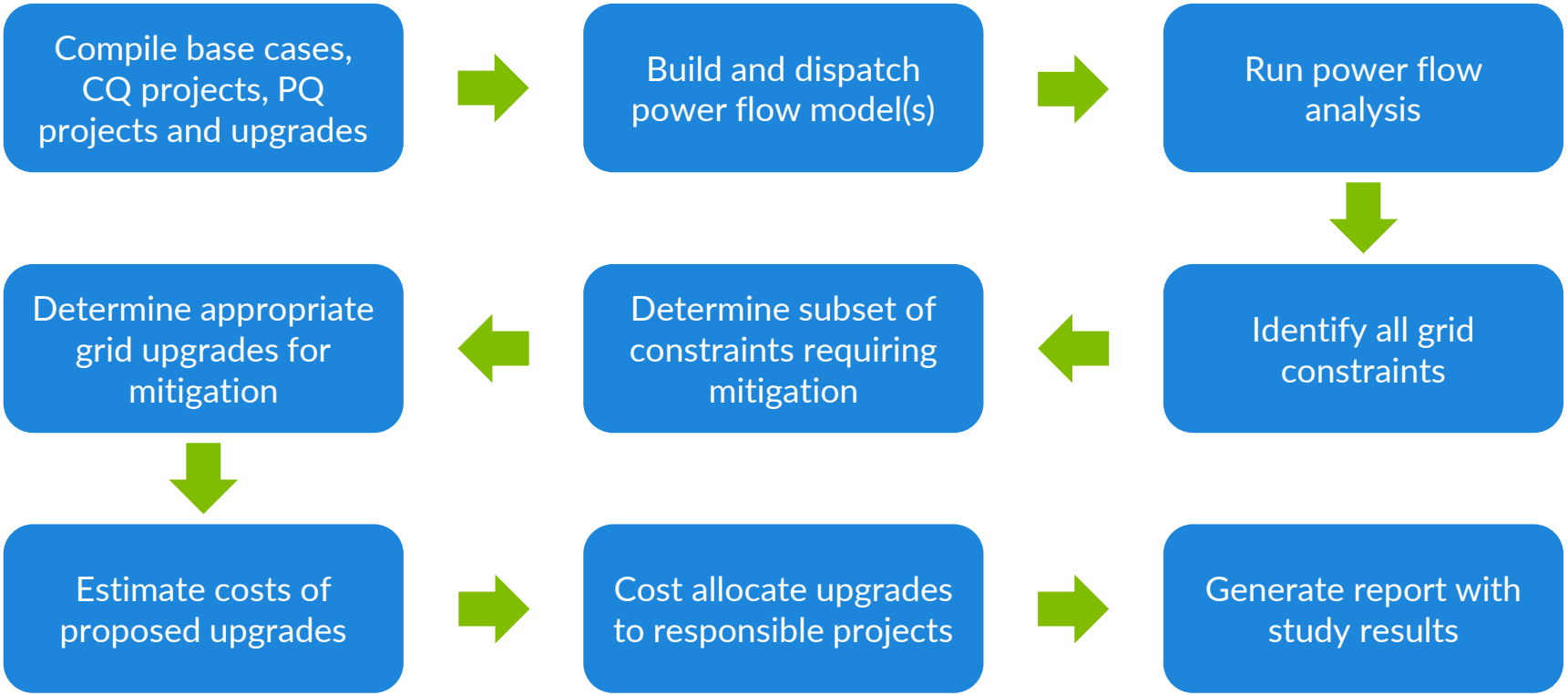
MISO has been actively improving the manageability of its Queue to provide a critical path to timely resource approvals, but it may take several years to reduce Queue processing to a one-year timeframe

2024 Accomplishments	2025 Plans	
	Queue Improvements	Support for Timely Resource Additions
• Implemented FERC-approved reforms • Filed compliance with FERC Order 2023 • Received FERC approval of JTIQ framework	• Implement Queue Cap upon receiving FERC approval • Begin using innovative software for automation of early Queue phases	• Commercial Operation Date tracker tool and web postings • Launch Expedited Resource Adequacy Study (ERAS) process

Improvements are addressing the Queue backlog, improving certainty of projects and addressing resource adequacy needs

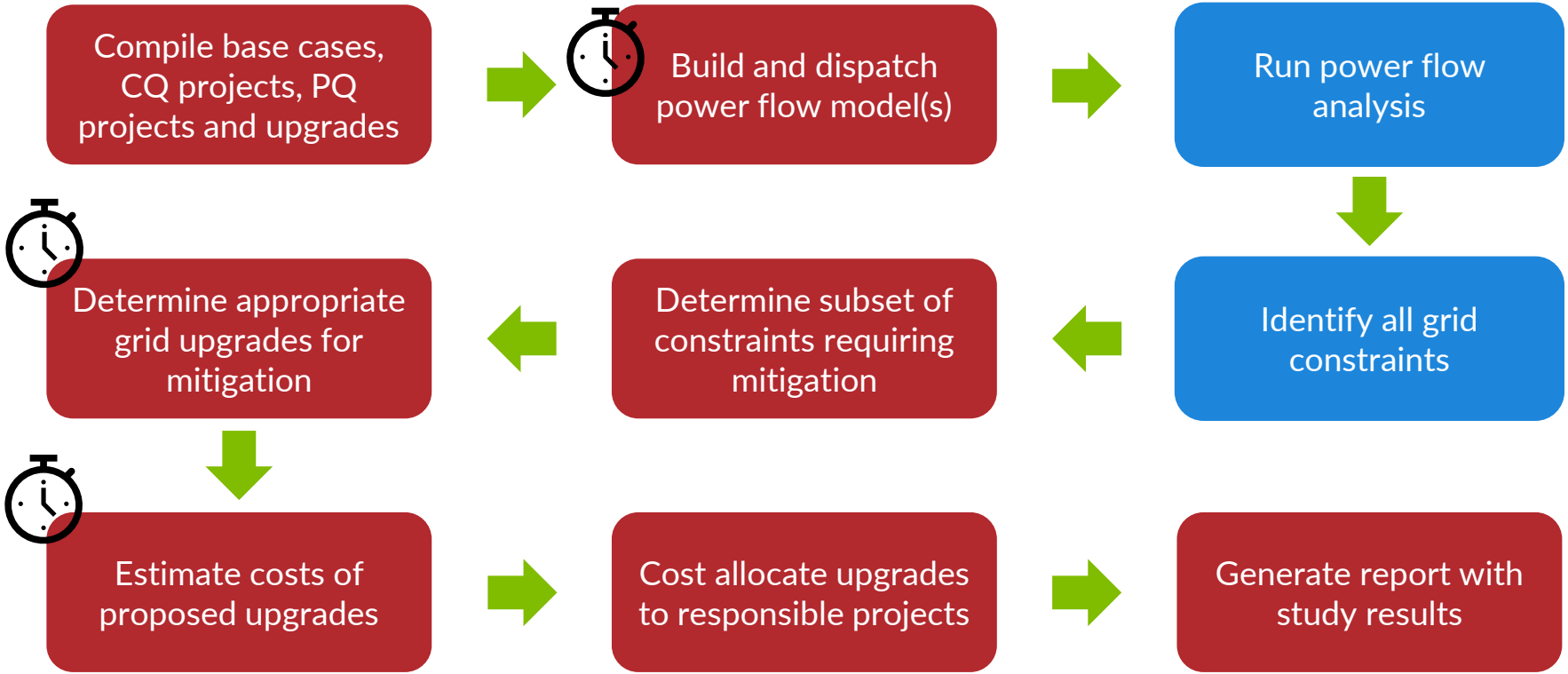
Automating Interconnection Studies

Under the Hood of a Steady State Cluster Study



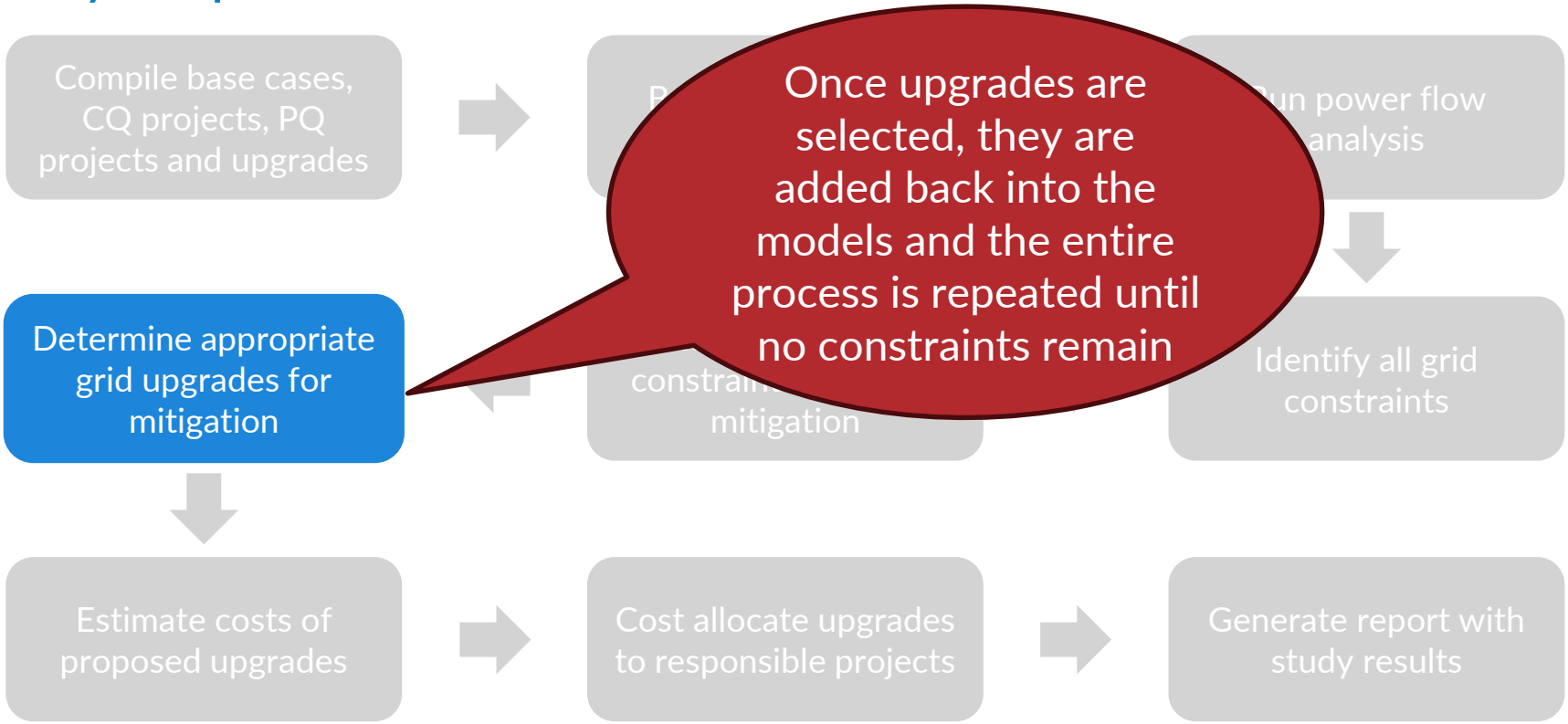
CQ – Current Queue projects
PQ – Prior Queued projects

Study steps are often manual, with model building and selecting network upgrades being the most time-consuming activities



CQ – Current Queue projects
PQ – Prior Queued projects

Study Steps are **Iterative**



CQ – Current Queue projects
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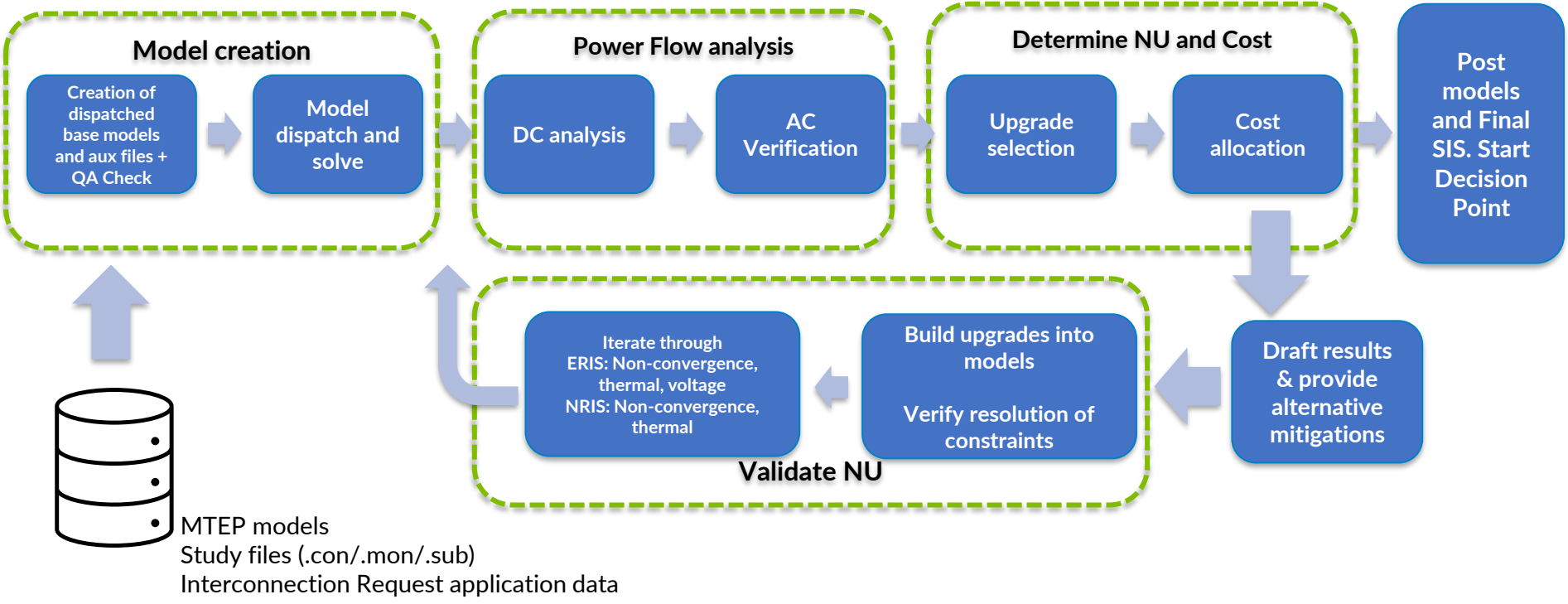
SUGAR Deployment

SUGAR software feature implementation summary for DPP Phase 1 studies

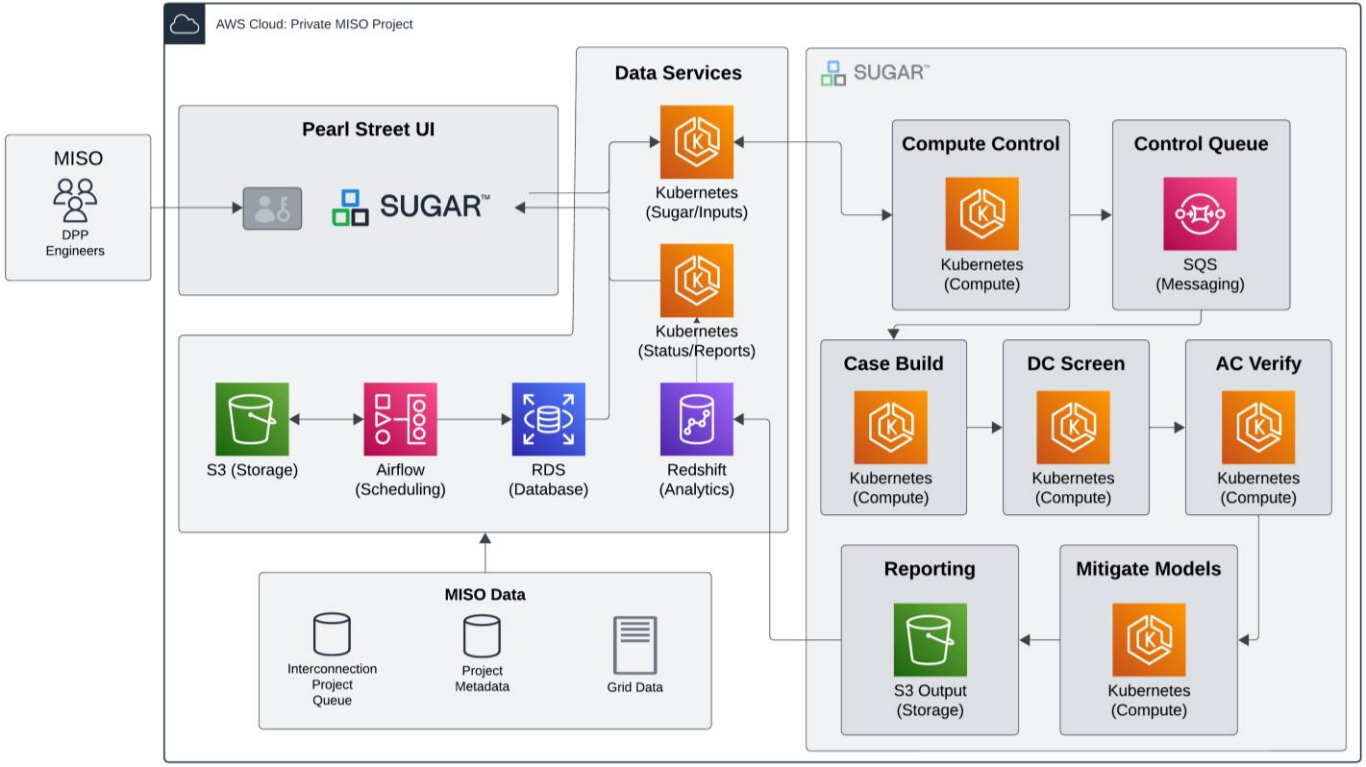
SUGAR Software Feature	2022 Cycle	2023 Cycle	2025 Cycle
Model Building and Solving		✓	✓
Perform Power flow analysis	✓	✓	✓
Determine Network Upgrades (NU) and cost allocate using MISO Transmission Cost Estimation Guide	✓	✓	✓
Validate if Network Upgrades mitigate the constraint(s)	✓	✓	✓
Live data Quality Assurance for Pre-Queue application phase			✓*

✓ Indicates that the feature will be implemented
✓* Dependent on finalizing new application tool expected by end of summer 2025

SUGAR Deployment at MISO

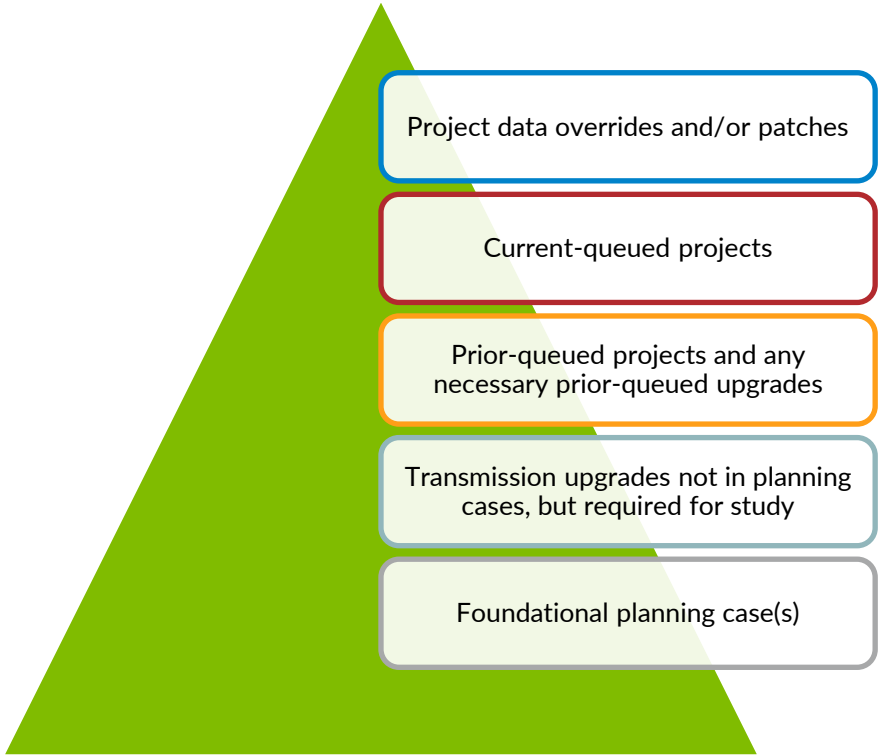


System Architecture



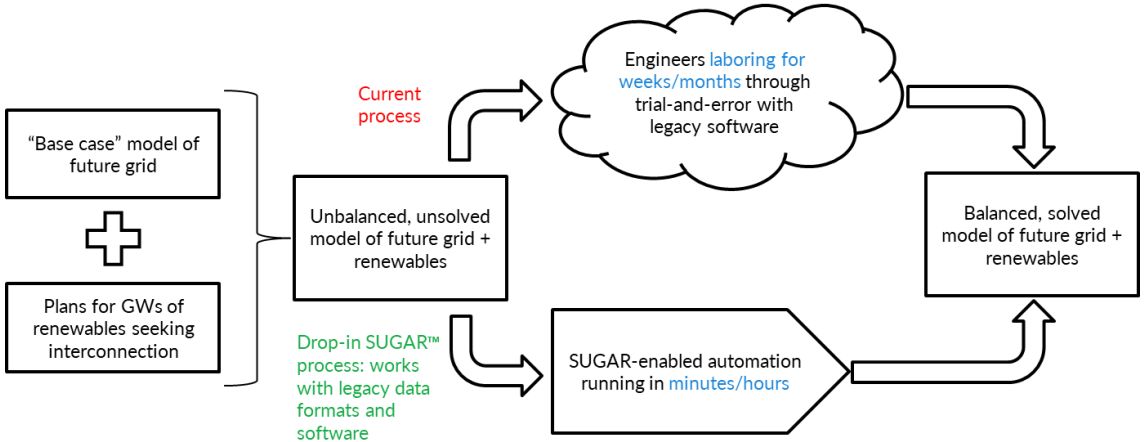
Automating Model Building

- Project data is exported from intake database and layered on top of MTEP
  - Individual project overrides can be supplied on an as-needed basis
  - Voltage schedules can be optionally provided to ensure units regulate their bus (or POI) voltage following local TO practice
- Study files are updated automatically to adjust for model changes (e.g., line taps)
- Built power flow cases are then available for download, or fed directly into analysis



Automating Model Dispatch and Solving

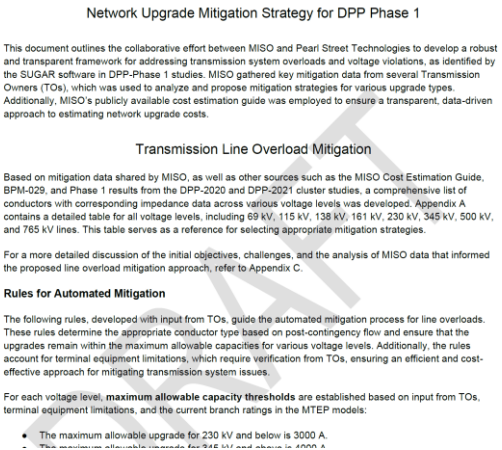
- MISO's recent clusters contain enough capacity to displace nearly the entire existing generation fleet
  - A dispatch change this large is often a time-consuming, labor-intensive task to solve in power flow
- SUGAR automates model dispatch, sinking, and solving for quick creation of cluster study models



Transparent Network Upgrade Selection

MISO + Pearl Street developed a series of rules to automate the selection and validation of reasonable network upgrades based on sound engineering principles, and documented the process for full transparency

Read More: Automated Network Upgrade Selection Strategy



Network Upgrade Mitigation Strategy for DPP Phase 1

This document outlines the collaborative effort between MISO and Pearl Street Technologies to develop a robust and transparent framework for addressing transmission system overloads and voltage violations, as identified by the SUGAR software in DPP-Phase 1 studies. MISO gathered key mitigation data from several Transmission Owners (TOs), which was used to analyze and propose mitigation strategies for various upgrade types. Additionally, MISO's publicly available cost estimation guide was employed to ensure a transparent, data-driven approach to estimating network upgrade costs.

Transmission Line Overload Mitigation

Based on mitigation data shared by MISO, as well as other sources such as the MISO Cost Estimation Guide, BPM-029, and Phase 1 results from the DPP-2020 and DPP-2021 cluster studies, a comprehensive list of conductors with corresponding impedance data across various voltage levels was developed. Appendix A contains a detailed table for all voltage levels, including 69 kV, 115 kV, 138 kV, 161 kV, 230 kV, 345 kV, 500 kV, and 765 kV lines. This table serves as a reference for selecting appropriate mitigation strategies.

For a more detailed discussion of the initial objectives, challenges, and the analysis of MISO data that informed the proposed line overload mitigation approach, refer to Appendix C.

Rules for Automated Mitigation

The following rules, developed with input from TOs, guide the automated mitigation process for line overloads. These rules determine the appropriate conductor type based on post-contingency flow and ensure that the upgrades remain within the maximum allowable capacities for various voltage levels. Additionally, the rules account for terminal equipment limitations, which require verification from TOs, ensuring an efficient and cost-effective approach for mitigating transmission system issues.

For each voltage level, **maximum allowable capacity thresholds** are established based on input from TOs, terminal equipment limitations, and the current branch ratings in the MTEP models:

- The maximum allowable upgrade for 230 kV and below is 3000 A.

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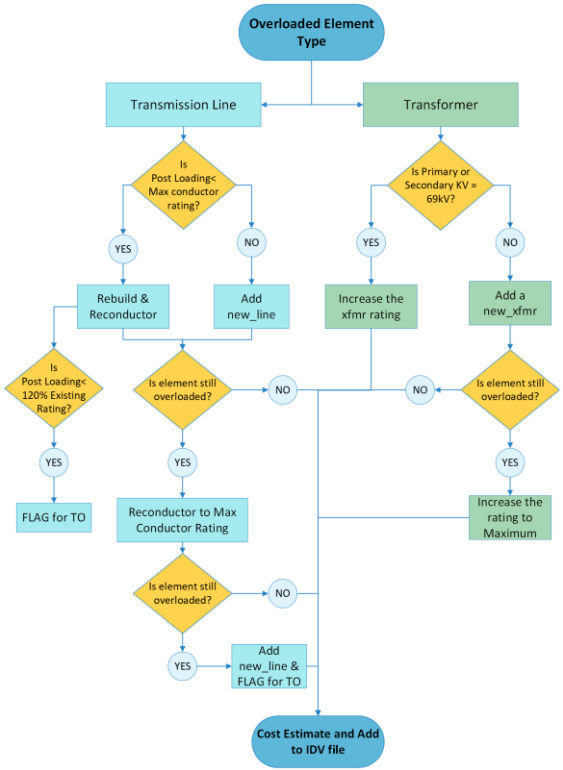
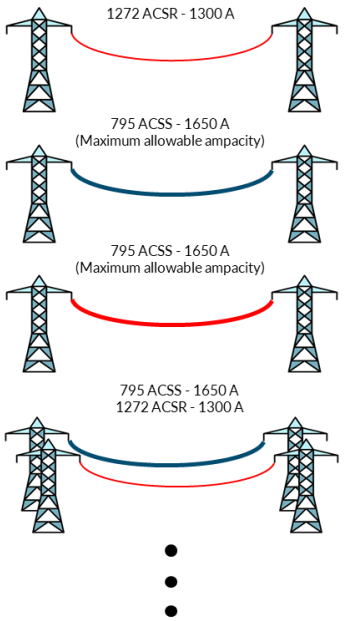


Mitigation Example

Post Contingency Analysis

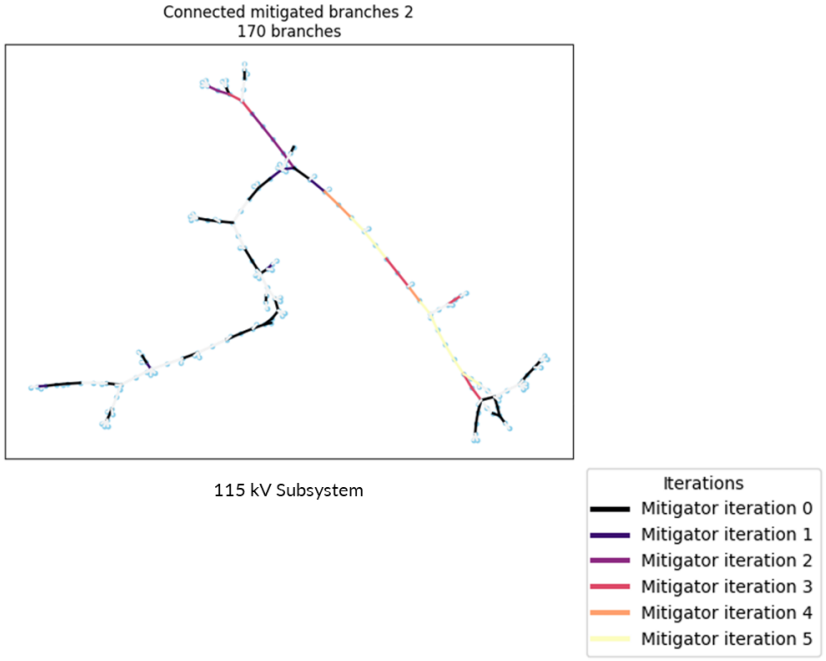


AC Loading % > 100%

Iteration 1
Rebuild and Reconductor

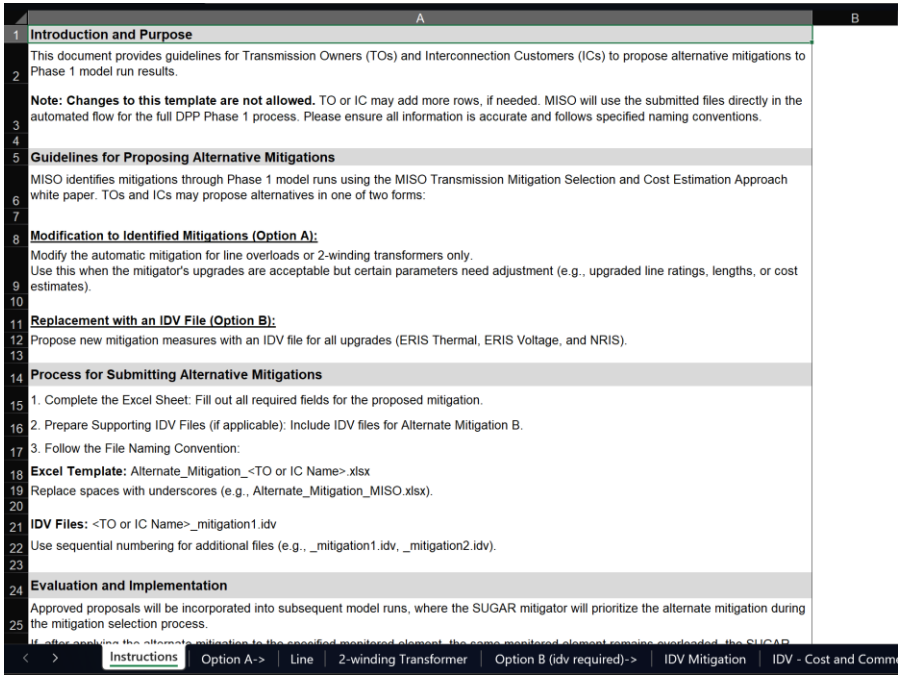
AC Loading % > 100%

Iteration 2
Add new line, evaluate new overloads and mitigate as above



Study Engineers Have Final Say

SUGAR has built-in capabilities to take in and evaluate alternative upgrades, including some GETs/ATTs, and cost overrides

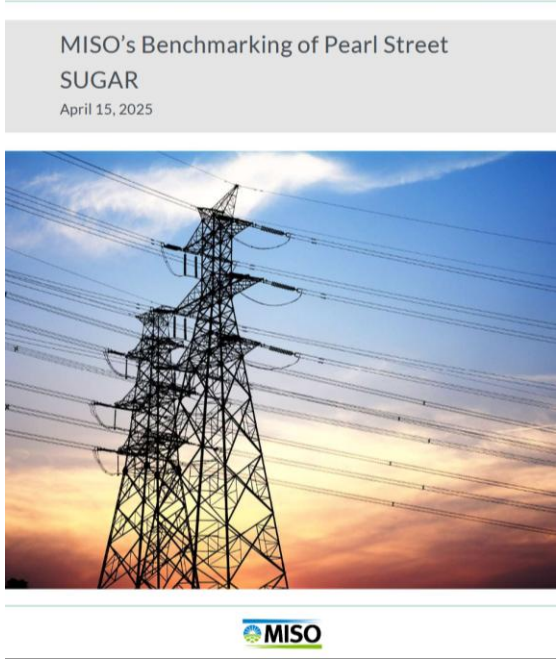


	A	B
1	**Introduction and Purpose**	
2	This document provides guidelines for Transmission Owners (TOs) and Interconnection Customers (ICs) to propose alternative mitigations to Phase 1 model run results.	
3	**Note: Changes to this template are not allowed.** TO or IC may add more rows, if needed. MISO will use the submitted files directly in the automated flow for the full DPP Phase 1 process. Please ensure all information is accurate and follows specified naming conventions.	
4		
5	**Guidelines for Proposing Alternative Mitigations**	
6	MISO identifies mitigations through Phase 1 model runs using the MISO Transmission Mitigation Selection and Cost Estimation Approach white paper. TOs and ICs may propose alternatives in one of two forms:	
7		
8	**Modification to Identified Mitigations (Option A):**	
9	Modify the automatic mitigation for line overloads or 2-winding transformers only. Use this when the mitigator's upgrades are acceptable but certain parameters need adjustment (e.g., upgraded line ratings, lengths, or cost estimates).	
10		
11	**Replacement with an IDV File (Option B):**	
12	Propose new mitigation measures with an IDV file for all upgrades (ERIS Thermal, ERIS Voltage, and NRIS).	
13		
14	**Process for Submitting Alternative Mitigations**	
15	1. Complete the Excel Sheet: Fill out all required fields for the proposed mitigation.	
16	2. Prepare Supporting IDV Files (if applicable): Include IDV files for Alternate Mitigation B.	
17	3. Follow the File Naming Convention:	
18	**Excel Template:** Alternate_Mitigation_<TO or IC Name>.xlsx	
19	Replace spaces with underscores (e.g., Alternate_Mitigation_MISO.xlsx).	
20		
21	**IDV Files:** <TO or IC Name>_mitigation1.idv	
22	Use sequential numbering for additional files (e.g., _mitigation1.idv, _mitigation2.idv).	
23		
24	**Evaluation and Implementation**	
25	Approved proposals will be incorporated into subsequent model runs, where the SUGAR mitigator will prioritize the alternate mitigation during the mitigation selection process.	

Instructions | Option A-> | Line | 2-winding Transformer | Option B (idv required)-> | IDV Mitigation | IDV - Cost and Comm

Benchmarking of SUGAR

Benchmarking of Flows and Constraints



Read More: Benchmarking of Contingency Analysis, Voltage Analysis, and Deliverability Analysis

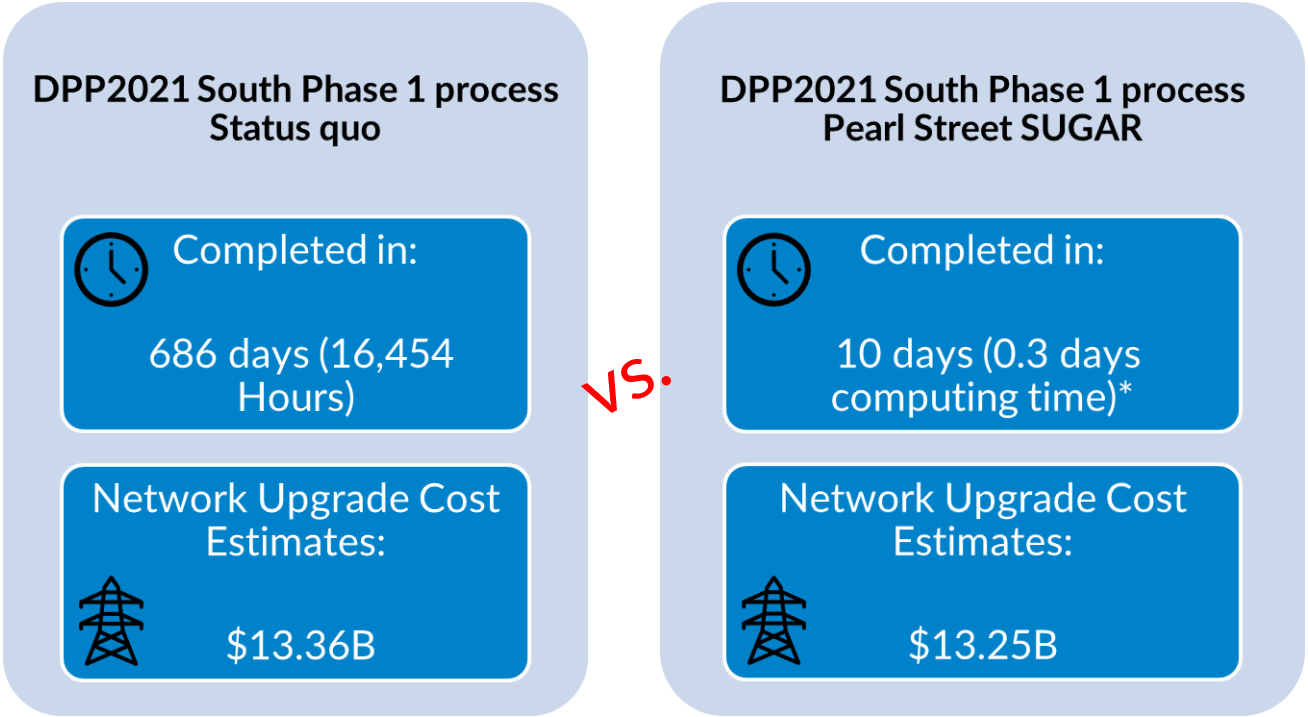
"The benchmarking study demonstrates that SUGAR is a reliable tool for power flow simulation, matching more than 99% of constraints identified by MISO's current software.

Key highlights include:

- Thermal Analysis (ERIS): 99.23% match rate with minimal deviations
- Flowgate Analysis (NRIS): 100% match rate with additional constraints identified and accepted as valid
- Voltage Analysis: 99.03% match rate with minor variations, all justified

These results confirm that SUGAR can be utilized…with minimal impact to stakeholders while also providing significantly increased speed in conducting MISO DPP Phase 1 studies."

Automation of MISO's entire system impact study process enabled a 99%+ reduction in runtime and comes within 1% of total cost in DPP 2021 Cycle benchmark



*Full end-to-end time was 10 days including debugging time and input file setup
Benchmarking is not a final production. Further tuning and enhancements are continuing to be developed.

Summary

- MISO's implementation of Pearl Street's SUGAR software is part of a broad effort to improve queue processing timelines
- The deployment of SUGAR enables a dramatic reduction in time from kickoff to results, and brings additional transparency to the process
- New capabilities and enhancements will continue to be rolled out over future cycles

Questions?