Transmission Topology Optimization

MISO CONGESTION COST RECONFIGURATION PROCESS

This process was announced by MISO in mid-2023. Requests for reconfiguration to alleviate regional congestion may be generated by internal analysis or by external requests from market participants. Once the request is submitted, MISO will conduct the appropriate analyses (technical and economic) to determine the suitability of the proposed reconfiguration, and if the result is positive, the reconfiguration may be implemented only if real-time operating conditions allow the maneuver to be executed in a safe manner. The proposed process falls within the operations planning timeframe but generalizes the use of the mechanism by formalizing requests from market participants.

INTRODUCTION

Transmission Topology Optimization (TTO) is a software technology that searches for lower cost, reliable configurations of the transmission grid by opening and closing circuit breakers in substations. These actions alleviate or reduce operational constraints through reduced transmission congestion on the grid that would otherwise require costly generation to be re-dispatched. In general, a reliable reconfiguration must not negatively impact reliability (overloads, instabilities, loss of reliability in generation or demand assets, short circuit limitations, etc.) and should have a significant positive impact on the net benefit of the system. On certain networks, the reconfiguration of the transmission system could lead to substantial cost savings for the entire region.

Regional Transmission Organizations (RTOs), Independent System Operators (ISOs), and Balancing Authorities (BAs) are responsible for congestion management in the areas in which they are established, and therefore, they emerge as one of the primary users of the technology. The reconfigurations will need to be coordinated with the transmission operators (TOs), who in turn could also benefit to make the operation of their assets more efficient. Finally, any market participant subject to an operational constraint could use the technology to analyze possible solutions based on the flexibility of the network to reduce the impact of congestion. This is precisely the case with the MISO Congestion Cost Reconfiguration Process, where reconfiguration requests can come from internal analysis or external requests from market participants.

TTO could help to improve operating conditions and market efficiency with a relatively low investment by optimizing the operation of existing assets. It is a complementary alternative to the current strategy of generation redispatch and can be appropriately complemented by other Grid-Enhancing Technologies (GETs). Recent research on this topic has prioritized the development of decision support tools for industry stakeholders to identify optimal reconfiguration alternatives, and its adequate implementation in planning and operational processes.

It is not intended to replace transmission expansion. Rather, it can complement transmission expansion by optimizing the use of existing assets.

STATE OF THE TECHNOLOGY

Today there is no clear distinction between transmission switching and TTO, and the terms may be used interchangeably.

Transmission switching has been used as an operational mechanism to facilitate the outage planning and scheduling process, or as a remedial action plan for a previously studied emergency condition. Typically, network reconfigurations are determined manually, based on the operational experience of the personnel, and are usually documented in operational guides. Under these conditions, transmission switching is more of a preventive or remedial action. For example, the PJM website describes a list of previously studied standard transmission switching procedures that can reduce or eliminate transmission system congestion under certain operating conditions.[1]

TTO allows for identification of single or multiple reconfigurations through advanced algorithms to take advantage of the flexibility of the network with certain objectives and criteria in mind. TTO can be utilized in different time frames from planning to operation with the set of elements available for decisions, and the objective for the reconfiguration dependent on the application. This includes the possible optimization of all practical monitored elements in a combined security-constrained unit commitment, economic dispatch, and transmission topology determination to minimize the overall production cost in a day-ahead or real-time hourly basis.

Commercial software providers, such as power system and market simulators, sometimes include transmission switching modules as a tool for evaluating topological reconfigurations. Some of them even include optimization functions that bring them closer to the concept of TTO. Separately, companies may provide standalone decision support tools for TTO that provide the reconfiguration to the electric companies, integrating it with Energy Management System (EMS) and Market Management System (MMS) tools. These tools may include, in addition to the least-cost optimization module, modules that allow technical validation of the proposed reconfigurations. Additional analyses may be required with existing tools available to utilities and ISOs/RTOs/BAs today to further confirm the feasibility of the reconfiguration, and therefore the integration interfaces with the software platforms (EMS, MMS, etc.) become critical.

TRANSMISSION SWITCHING

Reconfiguration of the transmission network through the opening/closing of one or a small number of pre-selected circuit breakers to implement a required corrective action in the system.

TRANSMISSION TOPOLOGY OPTIMIZATION

Optimize the topology of the transmission network to find reliable reconfigurations by opening/closing multiple circuit breakers to implement a beneficial action in the system.

IMPLEMENTING AND INTEGRATING THE TECHNOLOGY

Transmission switching has been a viable alternative for many years. In addition, TTO as an automated and systematic process has gained momentum as a viable alternative in recent years. Because this technology aims to increase the flexibility and efficiency of existing assets in the transmission system, it has the potential to impact several planning and operations processes from long-term planning to real-time operations.

Recent studies have shown the potential impact that TTO could have:[2]

- Potential congestion cost savings of 66% of a standing constraint in the MISO footprint over the summer of 2021.

1 Site accessed on May 03, 2024. https://www.pjm.com/markets-and-operations/etools/ oasis/system-information/switching-solutions.aspx.

2 Congestion & Overload Mitigation with Transmission Reconfigurations. Experience in MISO and SPP. FERC Tech. Conf. on Increasing Market and Planning Efficiency through Improved Software (Docket No. AD10-12-013). Washington, DC, June 23, 2022.

- An estimated 41% reduction in transmission congestion costs for Alliant Energy customers.
- Reliably increase throughput by 10% to 56% of the transmission capacity of three of the most binding MISO/SPP seam constraints, and 10% to 23% of the increased flow as mitigation solutions while transmission expansion projects can be completed.

For **operations planning**, a TTO tool:

- Optimizes the transmission grid through a technical and economic evaluation process based on scenarios that uses historical and forecasted data
- Collects and delivers information in coordination with the power system and market simulation tools
- Considers the development of an operational guideline to facilitate the implementation of the reconfiguration process in real time

For **real-time operation**, a TTO tool:

- Optimizes the transmission network through an agile technical and economic evaluation process according to the variable operating conditions of the system
- Collects and delivers information in coordination with the EMS/MMS platforms
- Considers the development of communication protocols with ISOs/RTOs/BAs, transmission owners, and market participants (and others identified).

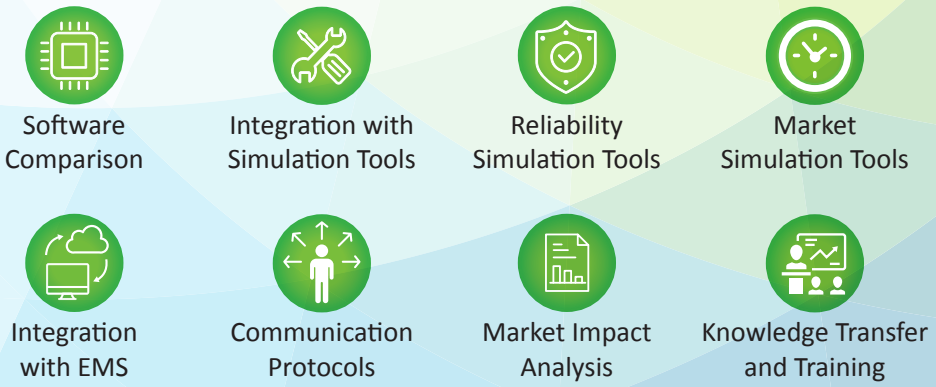
Other considerations are also important. For example, validating reliability and compliance is maintained when making reconfigurations are paramount. The aging of the infrastructure could also be a characteristic to consider in the analyses. TTO may also lead to unpredictable distributional effects on wholesale market prices and revenues of individual supply and loads; the process may need to consider this impact as part of the solution.

AREAS FOR ONGOING STUDY TO IMPROVE THE BODY OF KNOWLEDGE ON TTO

TTO is a technology that could benefit from building a broad understanding, especially around challenges related to its reliable implementation and its impact in the markets, so that confidence in its deployment can be increased, and its potential impact/benefits can be more confidently estimated. Because TTO can be integrated into multiple processes along the planning and operations continuum, mapping it to business processes can help ISOs/RTOs/BAs understand when and how to integrate. Furthermore, as ISOs/RTOs/BAs regularly improve or modify their business processes, they can also make incremental improvements to facilitate TTO framework including when and how it can be used.

The following activities can increase confidence and aid deployment of this technology:

- Develop and integrate decision support tools for identifying topological reconfigurations.
- Develop frameworks for when and how TTO can be used as examples considering the complex nature of transmission operations.
- Establish communication protocols (standardized procedures to facilitate coordination among TOs, ISOs, and market participants).
- Promote incentive mechanisms that encourage the development of low-capital-intensity projects and the efficient use of the technology for lowering operational costs.
- Conduct pilot tests and demonstrations.
- Transfer of knowledge and training.



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