2011-12 Winter Seasonal Assessment of Transmission System Performance

September 2011
Table of Contents

Introduction................................................................................................................................... 1

Executive Summary ...................................................................................................................... 3
  Summary of PJM 2011-12 Winter Operating Study ................................................................. 4
  Summary of MISO 2011-12 Winter Operating Study............................................................. 8
  Summary of Transmission Owner Experiences ...................................................................... 12
INTRODUCTION

On July 20, 2006, the North American Electric Reliability Corporation (NERC) was certified as the Electric Reliability Organization (ERO) in the United States, pursuant to Section 215 of the Federal Power Act of 2005. Included in this certification was a provision for the ERO to delegate authority for the purpose of proposing and enforcing reliability standards by entering into delegation agreements with regional entities. ReliabilityFirst is one of the eight approved Regional Entities in North America, under NERC. ReliabilityFirst's mission is to preserve and enhance electric service reliability and security for the interconnected electric systems within the ReliabilityFirst geographic area.

Exhibit 1: Location of ReliabilityFirst Area (ReliabilityFirst shown in blue)

The Bulk Power System (BPS) within the ReliabilityFirst footprint consists of an extensive 115 kV to 765 kV network. The 765 kV and 345 kV networks in ReliabilityFirst are located primarily in Wisconsin, Illinois, Indiana, Michigan, Ohio, Virginia, and West Virginia. The 500 kV and 230 kV ReliabilityFirst systems are located primarily in Pennsylvania, Delaware, Maryland, New Jersey, Virginia, and West Virginia. There are also 230 kV transmission systems in Indiana, Michigan, and Wisconsin. Systems within ReliabilityFirst interconnect with systems in the Midwest Reliability Organization (MRO), Northeast Power Coordinating Council (NPCC) and Southeastern Reliability Corporation (SERC) regions.

This assessment fulfills the requirements in NERC Reliability Standard TPL-005 and the Electric Reliability Organization (ERO) Rules of Procedure under Section 800 that ReliabilityFirst conduct a seasonal transmission assessment and provide a wide-area assessment of the projected performance of the system within the ReliabilityFirst footprint.

This ReliabilityFirst transmission assessment is based upon results from studies performed by the Midwest Independent System Operator (MISO) and PJM Interconnection LLC (PJM). The approach used by MISO and PJM, with Transmission Owner participation, is shown below.

- The PJM study by its Operations Assessment Task Force (OATF) assesses the PJM
Regional Transmission Organization (RTO) bulk power transmission system as it is expected to exist during the 2011-12 Winter peak load period. The purpose of the study is to determine the ability of the PJM system to be operated reliably according to the principles and guidelines contained within the PJM Manuals.

- The MISO Coordinated Seasonal Assessment (CSA) is performed in order to analyze and assess the MISO transmission system under projected peak load conditions for the winter of 2011-12. The coordination of this study across MISO’s area provides the benefit of reviewing the network over a much larger area than would normally be assessed by the individual participating transmission owners. This assessment has focused on the performance of large scale steady-state contingency analysis, critical interface analysis (PV) for selected areas where voltage stability margins are known to be small, and a wide area transfer analyses under NERC category B contingencies.

Interregional efforts and ReliabilityFirst efforts were focused on long-term reliability, based on collective assessments of study work that the BPS was not significantly different than that studied for 2010-11 winter, therefore it was determined that no additional study work for 2011-12 winter was needed.
EXECUTIVE SUMMARY

This report presents a seasonal assessment of the projected performance of the transmission system within ReliabilityFirst’s footprint for the 2011-12 Winter peak season.

Based on the study results, the PJM RTO bulk power transmission system can be operated reliably during the 2011-2012 winter peak load period in accordance with the operating principles and guidelines contained within the PJM Manuals.

Based on the study results, MISO’s Bulk Electric System can be operated reliably during the winter 2011-12 peak load period in accordance with the operating principles and guidelines contained within the MISO manuals. No significant transmission constraints are expected to cause a reliability concern for the upcoming season. No cascading/IROL (Interconnection Reliability Operating Limit) events are expected in the up-coming season.
Summary of PJM 2011-12 Winter Operating Study

The PJM Operations Assessment Task Force (OATF) study assesses the PJM RTO bulk power transmission system as it is expected to exist during the 2011-2012 winter peak load period. The purpose of the study is to determine the ability of the PJM system to be operated reliably according to the principles and guidelines contained within the PJM Manuals. This PJM section of the RFC report presents the significant findings of the PJM OATF study. The findings are based on the postulated system conditions, which will be different from actual operating conditions due to unplanned generation and transmission outages, the effects of unforeseen weather on load, transaction patterns, circulation and unit availability other than what was simulated in the study. To assess the system over a range of conditions, analysis was conducted at a higher than anticipated PJM RTO peak load and lower than anticipated generation availability in certain key areas. This winter, Duke Energy Ohio & Kentucky is integrating into PJM, and its load and generation are included in this winter's operating study.

Based on the study results, the PJM RTO bulk power transmission system can be operated reliably during the 2011-2012 winter peak load period in accordance with the operating principles and guidelines contained within the PJM Manuals.

Demand

The PJM RTO 2010-2011 winter peak was 115,535 MW, which occurred on December 14, 2010 at hour ending 19:00 EST. On a weather-normalized basis, the PJM RTO 2010-2011 winter peak forecast was 114,746 MW. The projection for the 2011-2012 PJM RTO winter peak is 130,711 MW. The significant increase in load forecast compared to the previous winter season reflects the integrations of ATSI, Cleveland Public Power, and Duke Energy Ohio & Kentucky. PJM forecasts the load of the entire RTO and the individual transmission zones on a coincident basis.

For the 2011-2012 delivery year, PJM has contractually interruptible demand side management of 11,826 MW. Demand response can reduce PJM's peak demand by 9.0 percent.

Energy Efficiency programs included in the 2011 load forecast are impacts approved for use in the PJM Reliability Pricing Model (RPM). At the time of the 2011 load forecast publication, 170 MW and 386 MW of Energy Efficiency programs have been approved as RPM resources in 2011 and 2012, respectively.

Generation

The total PJM capacity resources expected to be in service during the 2011-2012 winter peak period is 180,406 MW. Variable generation amounts to 5,200 MW nameplate and 682 MW expected on peak. Variable resources are only counted partially for PJM resource adequacy studies. Both wind and solar initially utilize class average capacity factors which are 13 percent for wind and 38 percent for solar. Performance over the peak period is tracked and the class average capacity factor.
is supplanted with historic information. After three years of operation, only historic performance over the peak period is used to determine the individual unit's capacity factor. PJM has additional renewable resources of 896 MW of biomass capacity counted fully in the capacity calculations.

Anticipated hydro conditions for the winter are normal. Reservoir levels are at maximum after two late summer post-hurricane rain events. Many dams had to spill significant amounts of water. Hydro conditions will be sufficient to meet both peak demand and the daily energy demand throughout the winter peak period. PJM is not experiencing or expecting conditions that would reduce capacity.

PJM does not anticipate any existing significant generating units that may affect reliability being out-of-service or retired during the winter season.

**Imports and Exports**

PJM has firm capacity imports of 3,858 MW. No additional firm capacity imports are planned at this time. All transactions are firm for both generation and transmission. No imports are based on partial path reservations.

PJM has firm capacity exports of 2,598 MW. No additional firm capacity exports are planned at this time. All transactions are firm for both generation and transmission. No exports are based on partial path reservations.

**Transmission**

Transmission Upgrades/Additions:

- Build TrAIL 500 kV transmission line: 502 Junction (Allegheny Power) to Mt. Storm (Dominion) to Meadow Brook (Allegheny Power) to Loudoun (Dominion)
- Build Carson-Suffolk 500 kV line, second Suffolk transformer and Suffolk-Thrasher 230kV line (Dominion)
- Replace Doubs 500/230 kV #2 and #3 transformers (Allegheny Power)
- Install fourth 500/138 kV transformer at Cabot (Allegheny Power)
- Replace Wylie Ridge 345/138 kV #2 transformer (Allegheny Power)
- Replace Waugh Chapel 500/230 kV #3 transformer (BGE)
- Add second 500/230 kV transformer at Burches Hill (PEPCO)
- Add a 345/138 kV transformer at Don Marquis (AEP)
- Install a third 345/138 kV transformer at Goodings Grove (ComEd)
- Install a new 500/230 kV substation (Center Point) and tap the high side to Elroy-Whitpain circuit and the low side to North Wales-Perkiomen circuit (PECO)

PJM does not anticipate any existing significant transmission lines or transformers being out-of-service through the winter season. No significant transmission constraints are anticipated.
Exhibit 1: Trend of PJM Reactive Interface Transfer Limits

Reactive interface transfer limits were calculated by simulating incrementally increasing power flow transfers across each interface by scaling available generation in the exporting subsystem and scaling load in the importing subsystem until non-convergence of the case solution was reached. At each incremental transfer level, violations on voltage criteria were monitored as well as the reactive interface megawatt power flow. A reactive interface transfer limit is determined by the lesser of:

- The interface megawatt power flow (minus an interface-specific megawatt backoff margin) at the incremental transfer level where a simulated contingency case non-convergence first occurs
- The interface megawatt power flow at the incremental transfer level where a post-contingency voltage criteria violation first occurs
Exhibit 2: Definitions of PJM Reactive Interfaces

<table>
<thead>
<tr>
<th>Eastern Interface</th>
<th>AEP-DOM Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wescosville-Alburtis 500 kV (5044 Line)</td>
<td>Kanawha River-Matt Funk 345 kV</td>
</tr>
<tr>
<td>Juniata-Alburtis 500 kV (5009 Line)</td>
<td>Baker-Broadford 765 kV</td>
</tr>
<tr>
<td>TMI-Hosensack 500 kV (5026 Line)</td>
<td>Wyoming-Jacksons Ferry 765 kV</td>
</tr>
<tr>
<td>Peach Bottom-Limerick 500 kV (5010 Line)</td>
<td></td>
</tr>
<tr>
<td>Rock Springs-Keeney 500 kV (5025 Line)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Interface</td>
<td></td>
</tr>
<tr>
<td>Keystone-Juniata 500 kV (5004 Line)</td>
<td></td>
</tr>
<tr>
<td>Conemaugh-Juniata 500 kV (5005 Line)</td>
<td></td>
</tr>
<tr>
<td>Conastone-Peach Bottom 500 kV (5012 Line)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Western Interface</td>
<td></td>
</tr>
<tr>
<td>Keystone-Juniata 500 kV (5004 Line)</td>
<td></td>
</tr>
<tr>
<td>Conemaugh-Juniata 500 kV (5005 Line)</td>
<td></td>
</tr>
<tr>
<td>Conemaugh-Hunterstown 500 kV (5006 Line)</td>
<td></td>
</tr>
<tr>
<td>Doubs-Brighton 500 kV (5055 Line)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Bed-Bla Interface</td>
<td></td>
</tr>
<tr>
<td>Black Oak-Bedington 500 kV (544 Line)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>AP South Interface</td>
<td></td>
</tr>
<tr>
<td>Mt Storm – Meadow Brook 500 kV (529 Line)</td>
<td></td>
</tr>
<tr>
<td>Mt. Storm-Doubs 500 kV (512 Line)</td>
<td></td>
</tr>
<tr>
<td>Greenland Gap-Meadow Brook 500 kV (540 Line)</td>
<td></td>
</tr>
<tr>
<td>Mt. Storm-Valley 500 kV (550A Line)</td>
<td></td>
</tr>
</tbody>
</table>
Study Scope

MISO’s winter peak 2011-12 Coordinated Seasonal Assessment (CSA) reviews the performance of the MISO Bulk Electric System (BES) and selected sub-transmission under anticipated winter peak loading conditions. This study is coordinated amongst those MISO members and neighboring systems that participate in the study.

The 2011-12 winter transmission assessment is produced in order to provide system operators with guidance as to possible system conditions that would warrant close observation in real-time in order to ensure security of the transmission system.

The 2011-12 winter CSA performed the following transmission system assessments:

- Steady State AC contingency analysis of MISO’s transmission system.
- Transfer analysis that identifies thermal limitations using First Contingency Incremental Transfer Capability (FCITC) analysis in Siemens/PTI’s MUST software. The list of inter/intra regional transfers considered in the study is shown below:
  - South to North into Manitoba Hydro (across Red River Valley)
  - MISO Central/East Regions to MISO West Region
  - PJM Northern Illinois to PJM Mid-Atlantic
  - PJM Mid-Atlantic to MISO West Region
  - MISO’s Missouri/Illinois to Entergy/TVA
  - South to North into IESO
  - North to South sourcing from IESO
  - TVA to Michigan (through MISO Indiana)
• Critical Interface voltage stability analysis of areas that are either known to experience voltage stability limitations under certain operating conditions or are suspected of having potential voltage stability limitations, using Powertech’s PSAT/VSAT software. The areas analyzed are:
  - Minnesota-Wisconsin Export Interface (MWEX)
  - Red River Valley Interface

**Overall Assessment**

Based on the study results, MISO’s Bulk Electric System can be operated reliably during the winter 2011-12 peak load period in accordance with the operating principles and guidelines contained within the MISO manuals.

No significant transmission constraints are expected to cause a reliability concern for the upcoming season. No cascading/IROL events are expected in the up-coming season.

**Demand**

MISO’s projected non-coincident winter peak demand in the 2011-12 power flow model used in the transmission assessment is 80,878 MW\(^1\). This is a decrease of 4,822 MW from the 2011-12 non-coincident winter peak demand of 85,700 MW. The peak demand from last year represent the non-coincident peak demand of all MISO member utilities (excluding First Energy and Duke OH/KY) and not just for ReliabilityFirst areas. A power flow model of MISO member utilities includes loads of other utilities that are not MISO members. Therefore, the demand in the power flow model is not directly comparable to the resource assessment demand forecast for MISO member utilities.

**Generation**

Total amount of generation available to serve MISO load from internally and externally designated network resources during the 2011-12 winter peak period is 107,145 MW. This excludes Duke OH/KY, as their exit from MISO is effective in January 1, 2012.

**Interchange**

The net scheduled interchange for MISO in the power flow model is a net import of 2,481 MW by the MISO member utilities in the 2011-12 winter peak.

**Steady State Analysis**

In general, the MISO BES is expected to perform adequately. Twenty six (26) potential loading or voltage issues in ReliabilityFirst areas for 2011-12 winter season. These 26 loading or voltage issues are due to 6 NERC Category B, and 20 Category C contingencies. All of these issues can be

---

\(^1\) This excludes Duke OH/KY, as their exit from MISO is effective in January 2012.
resolved either by system re-dispatch from the base case dispatch used, or by known operating guidelines or operator intervention. MISO operational personnel and other study participants have been advised of these conditions.

**Transfer Capabilities**

Transfer analysis identified thermal limitations using First Contingency Incremental Transfer Capability (FCITC) analysis. Overall, MISO’s transmission system is capable of substantial transfers between member systems and with external systems. The list of inter/intra regional transfers evaluated in the study and the thermal transfer limits observed (at 3% TDF threshold unless otherwise noted) are given below:

- South to North into Manitoba Hydro - Transfer limit is 3,830 MW
- MISO Central/East Region to MISO West Region - Transfer limit is 3,045 MW
- PJM Northern Illinois to PJM Mid-Atlantic - Transfer limit exceeds 5,000 MW
- PJM Mid-Atlantic to Midwest ISO West - Transfer limit exceeds 5,000 MW
- MISO’s Illinois/Missouri to Entergy/TVA - Transfer limit is 2,950 MW
- South to North into IESO - Transfer limit is 3,850 MW
- North to South sourcing from IESO - Transfer limit is 3,050 MW
- TVA to Michigan (through MISO Indiana) - Transfer limit exceeds 5,000 MW
ReliabilityFirst Trend of MISO FCITC Values

In each assessment, ReliabilityFirst trends the MISO calculated FCITC values. The following is a plot of that trending.

Exhibit 4: Trend of MISO FCITC Values
Summary of Transmission Owner Experiences

MISO WUMS Study Area

For the 2010-2011 winter season the following were the top 5 ATC real time constrained elements observed:

- [ATC] Pleasant Prairie-[CE] Zion 345 kV line
  This line has been uprated since last year. A 345 kV line from [ATC] Pleasant Prairie-[CE] Zion Energy Center proposed to be in service in 2014 will help mitigate this constraint.

- Minnesota to Wisconsin Exports Interface (MWEX)
  A 161 kV line from [XEL] Monroe County-[ATC] Council Creek proposed to be in service in 2014 will help mitigate this constraint.

- [ATC] Nordic-[ATC] Felch Tap 69 kV line
  A second [ATC] Chandler 138-69 kV transformer proposed to be in service in 2012 will help mitigate this constraint.

- Flow South, an interface consisting of the [ATC] Morgan-Plains 345 kV line, the [ATC] Stiles-Crivitz 138 kV line, the [ATC] Stiles-Amburg 138 kV line, the [ATC] Ingalls-Holmes 138 kV line, and the [ATC] Cranberry-Lakota 115 kV line.
  A back-to-back HVDC flow control device at [ATC] Straits, proposed to be in service in 2014, will help mitigate this constraint.

- [ATC] Lakeview-[CE] Zion 138 kV
  A 345 kV line from [ATC] Pleasant Prairie-[CE] Zion Energy Center proposed to be in service in 2014 will help mitigate this constraint.