Manual No. 025

Business Practices Manual

Operational Forecasting

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Revision History

Doc Number	Description	Revised by:	Effective Date
BPM-025-r12	Annual Review completed. No changes.	C. Wang B. Edwards	Oct-01-2024
BPM-025-r11	Annual review completed and added changes relevant to Hybrid Resource Filing	C. Saben C. Wang	Oct-01-2023
BPM-025—r10	Annual review for cleanup and to add new Section 3.1.2.3, clarify in Section 3.1.3 that a Load Forecasting Model will not be developed when the Load is zero, adjust language in Section 3.1.4, and add a paragraph to Section 4.2.	B. Edwards C. Saben C. Wang	Oct-01-2022
BPM-025-r9	Annual Review to update technical details and revise terminology with respect to renewable resources, Intermittent Resources, and Dispatchable Intermittent Resources.	C. Saben C. Wang	Nov-12-2021
BPM-025-r8	Update Sections 3 and 4 of the BPM.	C. Saben B. Borissov	Aug-10-2020
BPM-025-r7	Added Renewable model information to the BPM.	C. Saben B. Borissov	
BPM-025-r6	Annual Review completed to restructure the BPM; removed redundant information	B. Borissov D. Desai	NOV-05-2018
BPM-025-r5	Annual Review completed to rename the BPM to “Operational Forecasting”. Wind generation Forecasting section updated to Intermittent Resource Forecasting section, which now includes Solar Generation Forecasting. Updated reduced timing requirements for LBA submitted MTLF forecast to MISO to one submission per day.	D. Desai	NOV-05-2017
BPM-025-r4	Annual Review completed to update BPM language and remove redundancies. Additionally, updated the Day-Ahead Reliability Assessment and Commitment timeline change accordingly to reflect Tariff changes.	D. Desai Y. Potts	NOV-05-2016
BPM-025 r3	Annual Review completed to include details about the in house MISO generated Short-Term Load Forecast (STLF) backup system. Details regarding the submission of Medium-term load forecast (MTLF) by the Local Balancing Authorities (LBA) updated to include file format and additional information. Wind generation forecast section updated.	D. Desai Y. Potts	SEP-18-2015

BPM-025 r2	Annual review completed to include historical actual generation data request for newly registered wind units which had been generating for a while before joining the MISO market. Also updated wind forecast section to include the forecast process for units which share the same physical location Wind process flow diagram added MISO rebranding change.	D. Desai	SEP-18-2014
BPM-025 r1	Annual Review completed to include update about MTLF data submission time and about the monthly peak load forecast requirements. Also updated STLF to remove forecast approach.	D. Desai	SEP-18-2013
BPM-025	Original document	D. Desai	JUN-22-2012

Contents

List of Exhibits:

1. Introduction

This introduction to the Midcontinent Independent System Operator, Inc. (MISO) *Business Practices Manual (BPM) for Operational Forecasting* includes basic information about this BPM and the other MISO BPMs. Sub-section 1.1 of this Introduction provides information about MISO BPMs in general. Sub-section 1.2 is an introduction to this particular BPM. Sub-section 1.3 identifies other documents in addition to the BPM that can be used by the reader as references when reading this BPM.

1.1 Purpose of the MISO Business Practices Manuals

The BPMs developed by MISO provide background information, guidelines, business rules, and processes established by MISO for the operation and administration of the MISO markets, provision of transmission reliability services, and compliance with the MISO settlements, billing, and accounting requirements. A complete list of MISO BPMs is available for reference through MISO's website. All definitions in this document are as provided in the MISO Tariff, the NERC Glossary of Terms Used in Reliability Standards, or are as defined by this document.

1.2 Purpose of this Business Practices Manual

This BPM provides the necessary detail to aid MISO's stakeholders' understanding of their primary responsibilities and obligations to the reliable operation of MISO's footprint with respect to Operational Forecasting. This BPM only covers short-term (less than six hours), and medium-term (less than 7 days) load and renewable generation (wind and solar for purposes of this BPM) forecast processes in MISO.

Section 2 provides an overview for Operational Forecasting; Section 3 discusses short-term load and medium-term load forecast details; Section 4 covers renewable resource forecasting; and Section 5 discusses the uses of forecast data.

This BPM defines the different types of forecasts, the various inputs that are considered for producing a forecast, and the various assumptions that are made regarding the forecast wherever applicable.

This BPM benefits readers who want answers to the following questions:

- What are the forecast processes and who uses the forecasts?
- Where are the forecast data published and from where can they be accessed?
- What must the Market Participants (MPs) contribute for the load and wind generation forecasts?

- What are the Local Balancing Authorities' (LBA) and MPs' responsibilities and requirements?
- What are the particular requirements for the wind generation forecast to incorporate Dispatchable Intermittent Resources (DIR)?
- What are the values / contribution that Forecast Engineering provides to the success of MISO?

MISO prepares and maintains this *BPM for Operational Forecasting* as it relates to the reliable operation of MISO's region of authority. This BPM conforms and complies with MISO's Open Access Transmission, Energy and Operating Reserve Markets Tariff (Tariff), the North American Electric Reliability Corporation's (NERC, also known as the Electric Reliability Organization (ERO)) operating policies, and the applicable Regional Entity reliability principles, guidelines, and standards. This BPM is designed to facilitate administration of efficient Energy and Operating Reserve Markets.

1.3 References

Other reference information related to this BPM that are posted on the MISO public Website include:

- BPM-001, Market Registration;
- BPM-002, Energy and Operating Reserve Markets;
- BPM-010 Network and Commercial Models;
- BPM-011, Resource Adequacy;
- Open Access Transmission, Energy and Operating Reserve Markets Tariff;
- MISO ICCP Data Exchange Specification;
- North American Energy Standards Board (NAESB) Wholesale Electric Quadrant Standards (WEQ), Version 003, WEQ – 001, Open Access Same-Time Information System (OASIS); and
- NERC Reliability Standards.

2. Operational Forecasting Overview

MISO's Day-Ahead and Real-Time Market co-optimize the clearing of energy and operating reserves. A key input into market clearing process is the expected load forecast and renewable generation forecast. Both of these forecasts help MISO plan for the load and available generation resource needs for the next few hours or days. Load forecast is generally used in MISO to ensure adequate generation is available to meet the peak load needs, and to ensure that the transmission system can adequately meet the expected peak loads. Renewable forecasts represent the expected generation that is likely going to be produced given the expected meteorological conditions.

The remainder of this section provides a high-level description of the forecasts provided by the Operational Forecasting team. Section 2.1 provides a Load Data Overview. Section 2.2 provides a renewable resource overview. Section 2.3 provides an overview of forecast needs and frequency of forecasts.

2.1 Load Data Overview

The concept of electric load for the purposes of this BPM is related to the amount of energy that is withdrawn at any point in time. In order to meet the load needs, MISO needs to anticipate and attempt to forecast the needs of our stakeholders. To do this, MISO forecasts Load as the Load (including losses) within the physical boundary of its local balancing authority (LBA) members. In order to forecast load more accurately, MISO makes some assumptions about Load that is served "Behind-the-Meter" where the Load and Generation Resources are modeled in the Network Model. The host Load associated with any DRRs-Type II is also modelled for reliability purposes. MISO market Load is the summation of LBA market loads and includes transmission losses.

2.2 Renewable Resource Overview

Renewable resources will only generate if certain meteorological conditions apply. For example, wind and solar resources are limited by the availability of wind or sunlight to provide generation. So renewable resource output needs to be forecasted to ensure expected generation is accounted for in the market and in real time. In order to participate in the MISO market, a renewable resource must be registered as a MISO generator.

2.3 Forecast Needs and Frequency

Since Load and renewable resources can vary for differing reasons, the forecasting of these elements is a very important component to maintaining visibility and managing expectations for several areas in MISO's control room functions. Medium-term forecasts are updated every 15 minutes, at an hourly granularity, spanning to 168 hours into the future. MISO's forward and intraday commitment processes rely on the medium-term forecasts. Short-term forecasts are generated every 5 minutes, and span for 6 hours into the future. Short-term forecasts are used by the unit dispatch system to establish dispatch signals.

Forward looking processes that assess the transmission security planning, outage coordination, and available flowgate capacity leverage medium-term load forecasts that can span out to 31 days into the future and represent the daily peak.

MISO currently posts day-ahead renewable forecasts and real-time renewable generation information to the public website. The day-ahead information looks two days out and is updated once daily. The real-time actual is updated every hour. This information can be downloaded by the public in the form of a .CSV, .XML or .JSON. In addition, forecasts are shared with MISO's reliability partners, independent market monitoring. Other reports are made publicly available for general use.

The table below summarizes MISO generated forecasts horizon and the update frequency.

FORECAST	FORECAST HORIZON	UPDATE FREQUENCY
Short-Term Load Forecast (STLF)	6 Hours Out	Every 5 Minutes
Medium-Term Load Forecast (MTLF)	7 Days Out	Every 15 Minutes Update Shown Hourly
	Day Ahead (24 Hours)	Daily Snapshot Captured AT 14:30 (Eastern Prevailing Time)
	31 Days Out	Daily for Forward Operations
5-Minute Renewable Generation Forecast	6 Hours Out	Every 5 Minutes
Hourly Renewable Generation Forecast	7 Days Out	Every Hour
Day Ahead Renewable Generation Forecast	24 Hours Out	Snapshot Captured Once Every Day at 14:30 EPT

3. Load Forecasting

3.1.1 Introduction to Short-Term and Medium-Term Forecasting

Load Forecasting plays an important role in MISO's reliability and real time commitment processes. Forecasting is used to commit generation in order to meet system needs. MISO currently has two types of load forecasts which help with real-time market commitments, Short-Term Load Forecasting and Medium-Term Load Forecasting. While the two types of forecasts share some similarities, both have unique properties which contribute to MISO's needs. The Short-Term Load Forecast (STLF) is a 5-minute integrated forecast for each LBA in the MISO footprint. This forecast receives actual real time input load that is submitted at a 2 second frequency and extends 6 hours out into the future. The STLF for the market footprint is obtained by aggregating the sum of the LBA forecasts. The Medium-Term Load Forecast (MTLF) on the other hand is an hourly load forecast which is updated every 15 minutes. Because of this, it can be defined as the integrated forecast for each hour of the current day expanding 6 days out and the daily peak forecast expanding 31 days out. Like the STLF, the MTLF applies to both the individual LBA's and the aggregation represents the market footprint. The remainder of this section will look at forecasting within MISO from a more granular perspective. It will include areas such as data requirements for forecasting, forecast modeling, forecasting practices and collaboration between MISO and its customers.

3.1.2 Data Requirements for Load Forecasting

Load Forecasting requires two types of data in order to produce an accurate and updated forecast: real time and historical. These data requirements follow a standard forecasting industry practice for producing forecast values. MISO retrieves this data through the help of its customers.

3.1.2.1 Real Time Data

Real time data is required for both STLF and MTLF forecasting, however the type of data differs. For STLF, real time data consists of the AGC total load submitted to MISO at a 2 second frequency. This data is critical to the STLF as short-term forecasting relies more on the most recent actuals than it does on historical data. Because of this, each LBA is required to send valid data to MISO at a fixed interval. If there are any changes in the metered boundary of an LBA, then it is the LBA's responsibility to provide the new ICCP data and information to MISO. On the other hand, MTLF uses a wider array of real time data. This data consists of State Estimator (SE) values and weather information. SE values can be used as backup input data for the load forecasting application whenever the LBA ICCP values are not available or the LBA ICCP values are inaccurate. Weather information also plays a critical role in MTLF forecasting as slight changes in weather inputs can drastically impact load. Weather information is considered proprietary information and is provided to MISO by a weather service vendor at 30-minute intervals. Key weather parameters include dry bulb temperature, dew point temperature, wind speed, cloud cover, sunshine minutes and precipitation. MISO will also use additional historical weather data sources in order to prepare the load forecast. These sources include publicly accessible websites such as national weather service and weather sites on the internet.

3.1.2.2 Historical Data

MISO also relies on historical data in order to compute accurate forecasts. This data typically falls into 3 main categories: historical LBA data, calendar information and time changes. When an LBA joins MISO's footprint, the LBA is required to provide MISO with at least 5 years of historical load and weather data. This data is used to develop an accurate load forecast and adjust the forecasting models appropriately. If an LBA changes its metered boundary, then the LBA is required to provide MISO with new historical load data consistent with the new boundary. This data is defined at a 1-minute granularity. Calendar information such as days of the week, holidays and special events are also important in computing an accurate forecast.

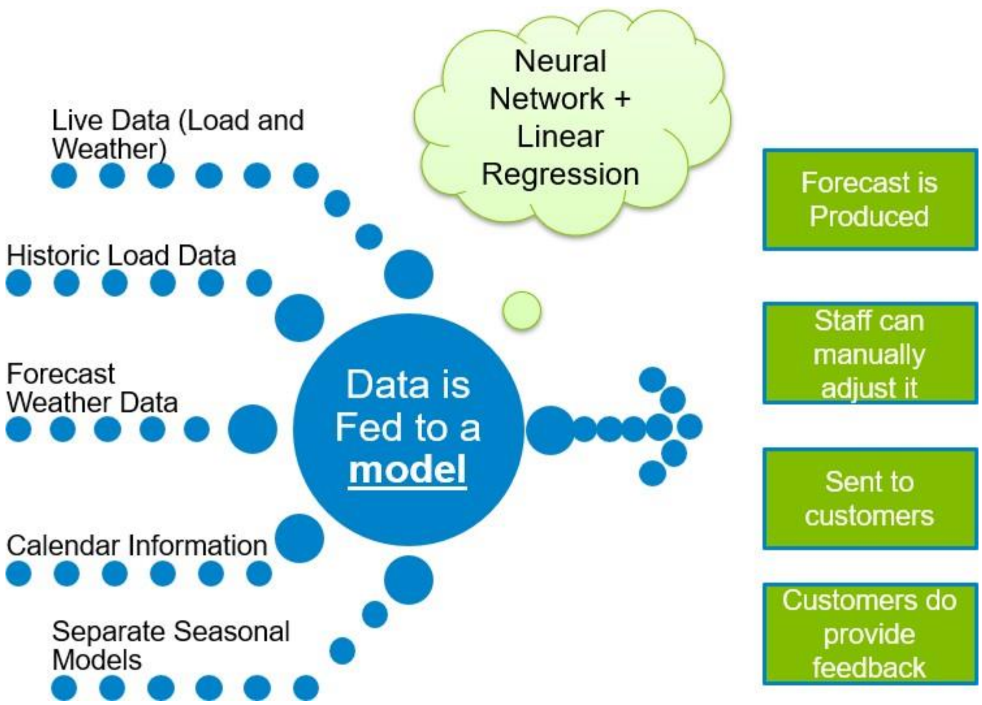
3.1.2.3 Weather Data

Weather data is a critical part of the load forecasting process. Weather forecasts are provided hourly by weather vendors and fed into both our MTLF and STLF. Although, the weather data input plays a larger factor in the MTLF as compared to the STLF. Weather variables that feed into the load forecast include temperature, dew point, cloud cover, and precipitation. The accuracy of the MTLF is heavily dependent on the accuracy of the weather forecast. Meteorologists will monitor the weather patterns and if risks are identified with the current vendor forecast that is fed into the MTLF, adjustments to the load forecast are made to account for those risks.

3.1.3 Load Forecast Modeling

The model building process for load forecasting is done in two parts (short-term models and long-term models). Although this process is done in two parts, the inputs are very similar. MISO begins the load model building process by examining the profiles for each of our individual Local Balancing Authorities (LBA's). This is because MISO creates a separate model for each LBA. These profiles often include historical load data and historical weather data. It also includes studying profiles of heating degree days and cooling degree days for the LBA's. After examining the different profiles, MISO creates a solid foundation for its models. In order to do this, a base model is created with regional awareness in mind. This base model is then used in each of the individual LBA load forecasting models. After the base model is created, MISO then begins to personalize the individual LBA models by leveraging the real time and historical data that it has collected. Historical data is used as a building block in the model building process allowing MISO to develop a great starting point. The real time data on the other hand is used to tune and adjust the models accordingly. MISO's models are created using Neural Network and Linear Regression software. This allows the models to continue to learn and adjust as they receive updated information. MISO's load forecast model building process can be seen in figure 3.1.3-1. The difference between a short-term and a long-term model lies in the information that it uses. A short-term load forecast model focuses more on the near term; therefore, it relies heavily on the most recent forecasts and actual load values. The long-term model on the other hand utilizes both load data and weather data in order to update the forecast accurately. If an LBA has zero load for a given period, a load forecast model will not be developed or utilized for that period and the load for that LBA will be reported as zero in the aggregate MISO market load.

Exhibit 3.1.3-1: Process Flow for Load Model Building



3.1.4 LBA Submission and Evaluation of Load Forecasts

LBA submitted load forecasts play an important role in MISO's reliability and commitment process. These forecasts are used as an independent source for quality assurance checks. They are also used when MISO's system is unable to generate an LBA forecast. Therefore, MISO requires each

LBA within the reliability footprint to send at least a seven (7) day hourly load forecast to MISO. This MTLF forecast should reflect the amount of Load in the LBA that is also modeled by MISO. The LBA will provide files to MISO for load forecasting by noon EST each day. The file must contain the forecast load for the LBA on an hourly basis for the current day and next seven (7) days. MISO accepts additional MTLF data submitted outside the standard times as well. MISO does a quality check of the forecast provided by the LBA and runs it through basic validations. If the forecast passes validations, MISO uses this forecast as a reference.

To the extent it is relevant, MISO recommends LBAs to provide pumping load schedules as this will ensure that pumping schedules are included in the MISO-generated load forecast.

When developing the LBA forecasts, MISO recommends that LBAs apply at minimum the following approach: use a load forecasting algorithm that is self-learning, use weather forecasting data, and have an awareness of the accuracy of load and weather forecasts.

MISO recommends that the medium-term load forecast evaluation criteria is for all 7 days. MISO also recommends a geographically relevant approach be considered by each LBA.

Specifically, LBAs should pay close attention to:

  - Significant weather systems (storms or tropical systems in the summer and snow/ice in the winter)
  - Significant temperatures deviations compared to normal.
  - Large temperature swings (7F or more) are expected from one day to the next
  - Daily forecasting performance

MISO applies the following evaluation of the load forecast for the next operating day.

- Current operating day MTLF performance is off, i.e., the last 2-3 hours MTLF has a Mean Absolute Percentage Error (MAPE) larger than 2% and it is impacting the afternoon or evening peak.
- MTLF/unadjusted MTLF performance was off by more than 2% MAPE for the last 2-3 consecutive days.
- Day-Ahead weather forecast performance was off by more than 2°F system-wide for the last 2-3 consecutive days.
- Special holidays for the next operating day: 4th of July, Christmas Eve, Christmas Day, the day after Christmas Day, New Year’s Eve, New Year’s Day and the day after New Year’s Day.
- The Day-Ahead MTLF produced by the software is unreasonable (i.e. significantly different from almost all indications from similar days and/or weather forecast). Even moderate differences in the Day-Ahead MTLF and similar days when the temperature

curves are close, warrants more investigation and a possible adjustment.

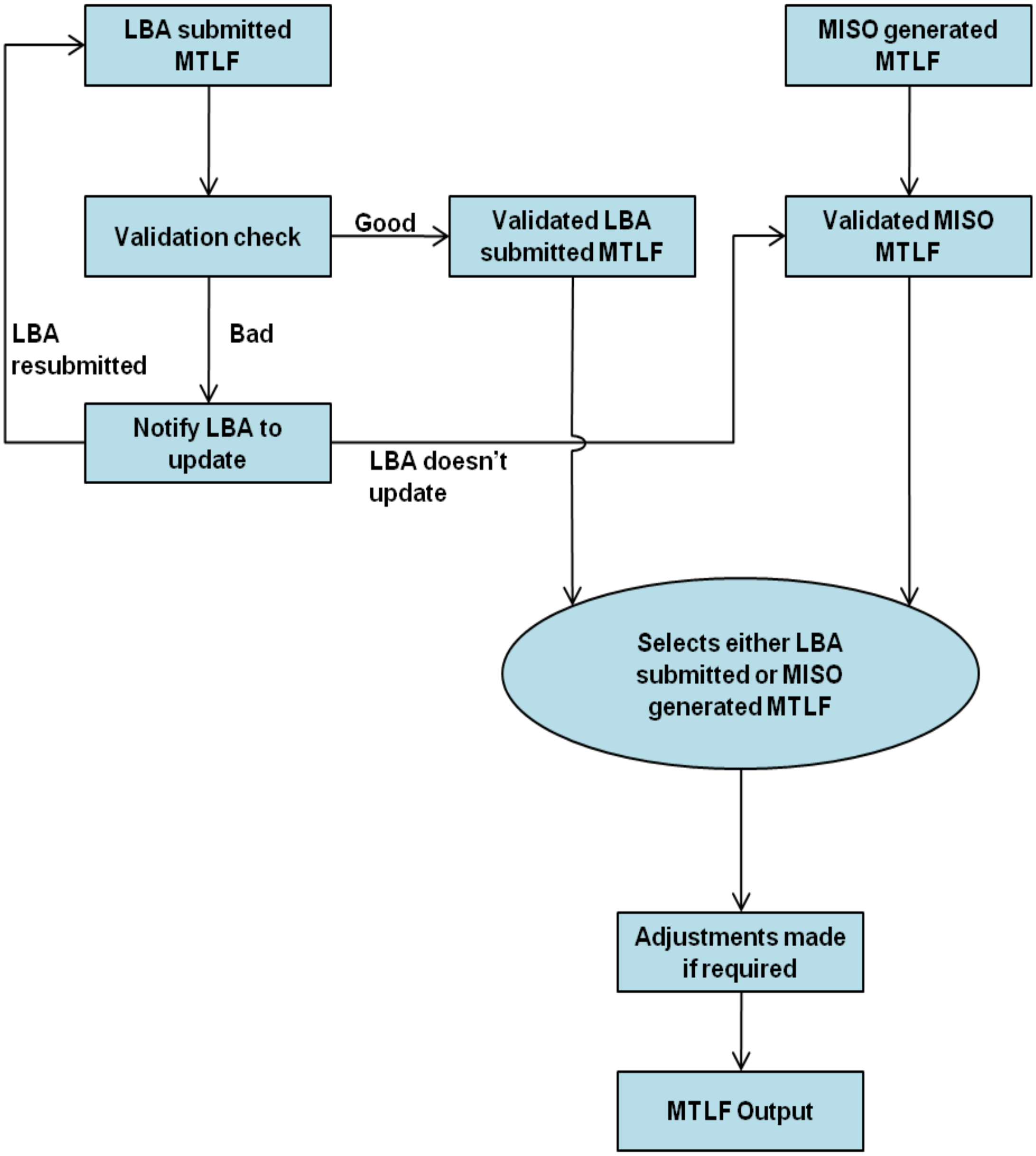
- Forecast temperature levels do not correspond well to the temperature-load sensitive study and or temperature forecast risk exists which warrants an adjustment to the load based on the sensitivity study.

As a result of the above evaluation, MISO may override the values associated with the load forecast.

Metrics are in place to help track how the load forecasting process performs. MISO has internal metrics on the Day Ahead hourly forecast accuracy, peak load forecast accuracy, and intraday load forecast accuracy. MISO recommends that each LBA tracks their forecast accuracy based on similar metrics.

The MTLF process which includes the use of LBA data can be seen in figure 3.1.4-1.

Exhibit 3.1.4-1: MTLF Process Flow Diagram



In order for MISO to use the LBA data mentioned above, the submitted forecast must pass a series of validations. These validations include:

- Forecast data should not exceed the defined load min/max limits for the LBA.
- Forecast data should not exceed the defined hourly rate-of-change for the LBA.
- Forecast data should not be older than 24 hours.
- Forecast data should not contain a zero value.
- Forecast data should not contain any blank value.

If any LBA-submitted load forecast violates any of the above-mentioned criteria, the seven (7) day hourly forecast of the impacted LBA will be replaced by the MISO-generated load forecast values.

3.1.5 Public Forecast Postings/Metrics

MISO believes in providing as much visibility and awareness to its customers as possible. Because of this, MISO currently posts real time load forecasts and forecasting accuracy metrics publicly. The real time load forecast can be found on MISO's website and is a snapshot of the current real time load, the cleared demand for the day and the current medium term load forecast for that day. In terms of forecasting metrics, MISO currently posts a monthly operations score for both day ahead and short term forecasting. MISO also posts detailed graphs for the day ahead MTLF and STLF. These graphs can be found in the slideshow for the Board of Director Market's Committee meetings.

4 Renewable Resource Forecasting

Renewable resource forecasting (currently wind and solar) is used in MISO's reliability commitment and dispatch processes. Renewable forecasts are used to estimate generation needs, predict availability, and provide balance between load and generation. MISO currently has two types of resources in its footprint for which renewable forecasts are developed, Dispatchable Intermittent Resources (DIRs) and Intermittent Resources (which are not capable of being committed or following set-point instructions). While the two have similarities, the methods for forecasting at a five-minute level are different. DIRs are forecasted on a five-minute level and these forecasts are used as the Economic Maximum to dispatch for the unit. On the other hand, Intermittent Resource units use the State Estimator value for the units' output. DIRs and Intermittent Resources use the same forecasting approach for the purpose of calculating the hourly renewable forecasts.

In order to forecast for the dispatch (five-minute) or reliability (hourly) processes, MISO must have accurate data for each unit. MISO collects physical and operational characteristics of a resource. Next, a forecast model is built for the unit using the collected data. Once the data is gathered and the model built, MISO utilizes the developed forecast in the dispatch or the reliability process. The remainder of this section describes in further detail the renewable forecast process. MISO does not forecast for Hybrid Resources registered as DIRs.

4.1 Physical and Operational Characteristics of Renewable Resources

Physical and Operational characteristics for renewable resources are provided by Market Participants as part of the unit registration process. All units must go through this process in order to become operational within MISO's footprint, including any renewable resource unit component of a Hybrid Resource. MISO needs two types of data from the Market Participants for renewable resources: static input data and real-time input data as further discussed below. Market Participants are required to update MISO with information regarding changes to static input data as it occurs.

4.1.1 Renewable Resource Static Input Data

MISO receives static data using a dedicated wind and solar template portion of the Attachment B. Required data fields must be completed prior to submitting the template to MISO. This data includes information such as geographical location of the resource (latitude and longitude), physical characteristics of the unit (hub height, number of turbines, installed capacity, and the number of photovoltaic cells), and operational characteristics (high wind speed cutoffs, high temperature cutoffs, low temperature cutoffs, tilt and azimuth positions of the solar panels, tracking capability, and the commercial operational date). To extend on this data, MISO requires all MPs to provide at least one year's worth of historic generation data for a wind or solar unit at one minute granularity. Please see section 4.2 for further information on the need for historical actual generation.

4.1.2 Renewable Resource Real-Time Input Data

MISO requires MPs to provide the actual generation data via ICCP for the renewable resource as soon as it becomes available. This information, along with the static information, provides insights as to how the resource can generate and be dispatched.

Market Participants have the responsibility to ensure that MISO has the most up to date generator capability information. This includes the resource's system information such as outage and derate information, unit testing dates, and the date of commercial operation for a unit. Lack of updates can result in inaccurate forecasts.

The above sections 4.1.1 and 4.1.2 only specify a sub-sample of the static data and the responsibility of Market Participants to inform MISO of unit related information. For more detailed registration requirements, please refer to the MISO DIR and Intermittent Resource registration process and MISOs Outage Coordination process.

4.2 Renewable Resource Forecast Modeling

MISO begins the model building process by using the static input data collected for each unit. This data provides the base for building the forecast models. Each resource has two forecast models, one used by the dispatch system and another for the reliability process.
Next, the process incorporates weather information specific to the physical location of the wind or solar farm. Weather conditions such as wind speed, cloud cover, rain, as well as ice and snow can heavily impact the ability of a resource to generate. For example, a wind unit would rely more on a variable such as wind speed; whereas, a solar unit would rely more on solar irradiance.

MISO's process leverages several weather forecasting models, which allows MISO to obtain a range of possible production scenarios based on forecasted weather conditions. The final step in building the renewable forecast is to employ an ensemble forecasting approach through the use of these different numerical weather predictions (NWP) models. The individual resources are forecasted using multiple NWP models and are then aggregated according to various weights (influenced by historic performance) in order to develop a deterministic wind or solar forecast that is best suited for each resource. Please see exhibit 4.2-2 to see an example of how the NWP create a consensus forecast.

As weather has a large impact on renewable generation, in addition to utilizing weather models, meteorologists monitor weather patterns as well. Watching for patterns that can lead to steep ramps in renewable generation is important. Meteorologists monitor all of these patterns to provide situational awareness and ensure accuracy.

Hourly renewable forecasts are developed by placing more emphasis on weather patterns and conditions. However, even after a forecast is produced, it needs to be updated to match real-time conditions. This is where MISO relies on the real-time data that units are required to provide. MISO's five-minute forecast gives more weight to a short-term correction based on the actual generation information that is received from the unit.

MISO develops hourly forecasts for all renewable resources. The unit level forecasts are aggregated to a MISO wide level and used in the reliability processes. Five-minute wind and solar

DIR forecasts are used at a unit level and used by the dispatch system. The MISO dispatch instruction is the value of the MISO generated forecast unless the resource submits its own forecast, as provided for in the Tariff and BPMs. For additional information about the forecast submission process and timing requirements, please refer to *Energy and Operating Reserve Markets BPM (BPM-002).* Section 4.3 below discusses the role that Dispatchable Intermittent Resources play in MISOs dispatch and reliability process.

Once the model is built, it is tuned daily by using the historical as well as the real-time actual generation of the unit that the Market Participant provides. Model tuning ensures the forecast model captures anomalies and helps in increasing accuracy of the forecasts produced.

Exhibit 4.2-1: Process Flow for Renewable Model Building

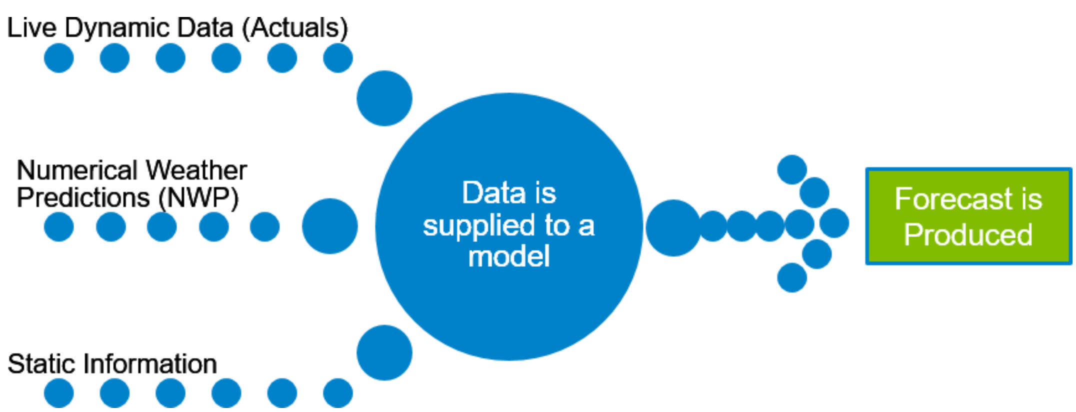
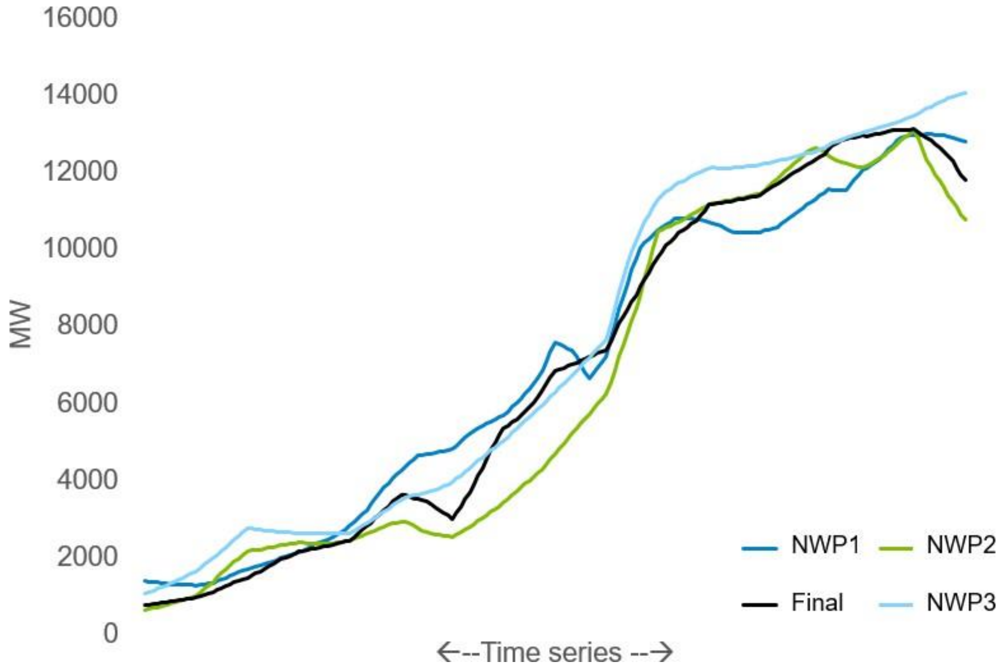


Exhibit 4.2-2: Example of NWP Model Forecasting



4.3 Market Participant Submission of DIR Forecasts

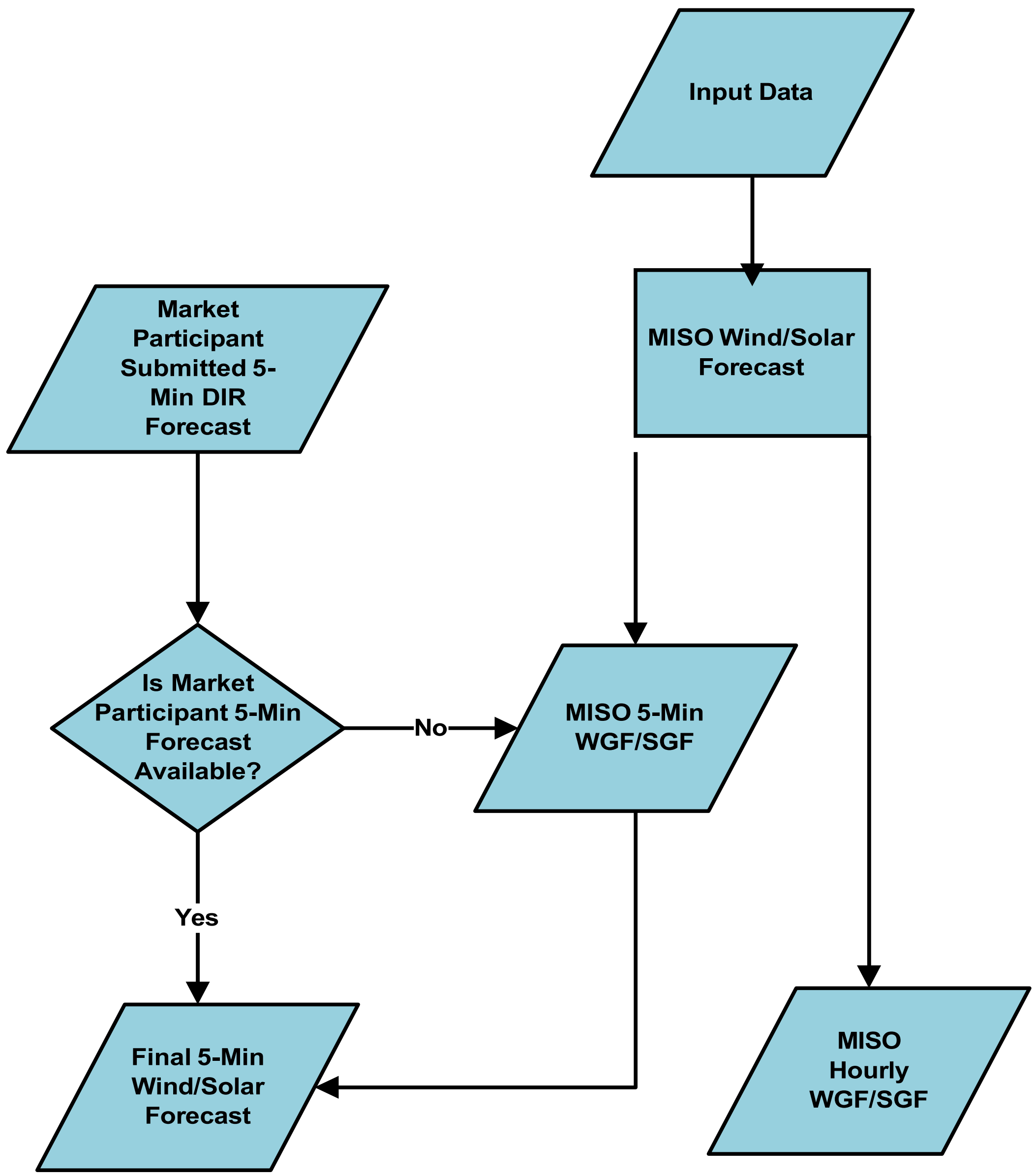
DIRs are unique because they participate very similarly to traditional resources. Currently when a wind unit joins MISOs market, the unit is required to register itself as a DIR with the ability to dispatch wind generation. Because of this, MISO expects these units to follow dispatch instructions. This greatly enhances congestion management and improves utilization of wind generation in the market.

Although these resources participate similarly to traditional resources, there are a few exceptions:

- DIR Asset Owners can submit a forecast for each 5-minute interval. This is because the Unit Dispatch System (UDS) will use the forecast as the Economic Maximum Limit offer for the given interval.
- DIR Asset Owners can update their forecast up to ten (10) minutes prior to each interval.
- Each registered DIR unit may provide a rolling forecast of twelve (12) 5-minute periods. If the rolling forecast is not provided in time by the DIR Asset Owner, the MISO-provided 5-minute renewable resource forecast will be used for the resource instead. If no MISO forecast is present, the State Estimator outputs will be used.
- Effective May 1, 2019, a DIR using MISO's generated DIR forecast can produce at its full potential unless it is being dispatched down.
- Hybrid Resources registered as DIRs must submit their own forecasts as MISO does not forecast for these Resources.

Please refer to Exhibit 4.3-1 for the process flow diagram regarding the usage of the 5 min DIR forecast.

Exhibit 4.3-1: Process flow diagram for DIR



4.4 Public Wind and Solar Forecasting Postings

MISO currently posts day-ahead wind and solar forecasting and real-time wind and solar generation information to the public website. The day-ahead information looks two days out and is updated once daily. The real-time actual is updated every hour. This information can be downloaded by the public in the form of a .CSV, .XML or .JSON.

5 Uses of Forecast Data

5.1 Reliability Assessment Commitment

The goal of the RAC processes is to ensure that enough generation capacity is scheduled on-line to meet the Load and Operating Reserve requirements in the MISO BA Area. It is very important that the Load, Wind Generation, and Solar Generation Forecasts be as accurate as possible. An incorrectly low Load Forecast or a high wind/solar forecast have the potential of resulting in a capacity insufficiency, resulting in the need for Emergency procedures. An incorrectly high Load Forecast or a low wind/solar forecast could result in too much generation being committed by MISO, with the potential for uplift of commitment costs.

5.2 Market Participant Estimation of Operating Reserve Obligations

The hourly mid-term MISO Balancing Authority Area Load Forecast developed for use in RAC is available to MPs through the MUI. Additionally, MISO provides a percent of Load values for each Reserve Zone that represent the percentage of MISO Balancing Authority Area Load Forecast that resides within each Reserve Zone (the sum of all Reserve Zone percentages will be 100%). MPs can use this Load Forecast and Reserve Zone percentage data to estimate their Operating Reserve obligation on both a market-wide and zonal basis. A MP will only need to estimate obligations on a zonal basis if the MP believes that a particular minimum Reserve Zone requirement will bind. For detailed illustration and explanation regarding this, please refer to Section 3.6.2.2 in the *Energy and Operating Reserve Markets BPM* (BPM-002).

5.3 Real-Time 5-Minute Dispatch

During the Real-Time 5-minute dispatch process, a MISO-developed load forecast is used on a 5-minute basis. The Security Constrained Economic Dispatch (SCED) uses the forecast load for a 5-minute target period and all Interchange Schedules into or out of MISO at the same point in time as an input. To the extent that the actual MISO BA Load in Real–Time is different than MISO’s 5- minute load forecast target, Regulation Capability in the MISO BA Area will make up for the difference, in response to Automatic Generation Control (AGC). The 5-minute wind are solar forecast are used to set the Hourly Economic Maximum Limits for wind resources in the Unit Dispatch System (UDS).

5.4 Look Ahead Commitment (LAC) Processes

Both load and wind forecasts are utilized in the LAC processes. For more information, please refer to the *Energy and Operating Reserve Markets BPM (BPM -002).*