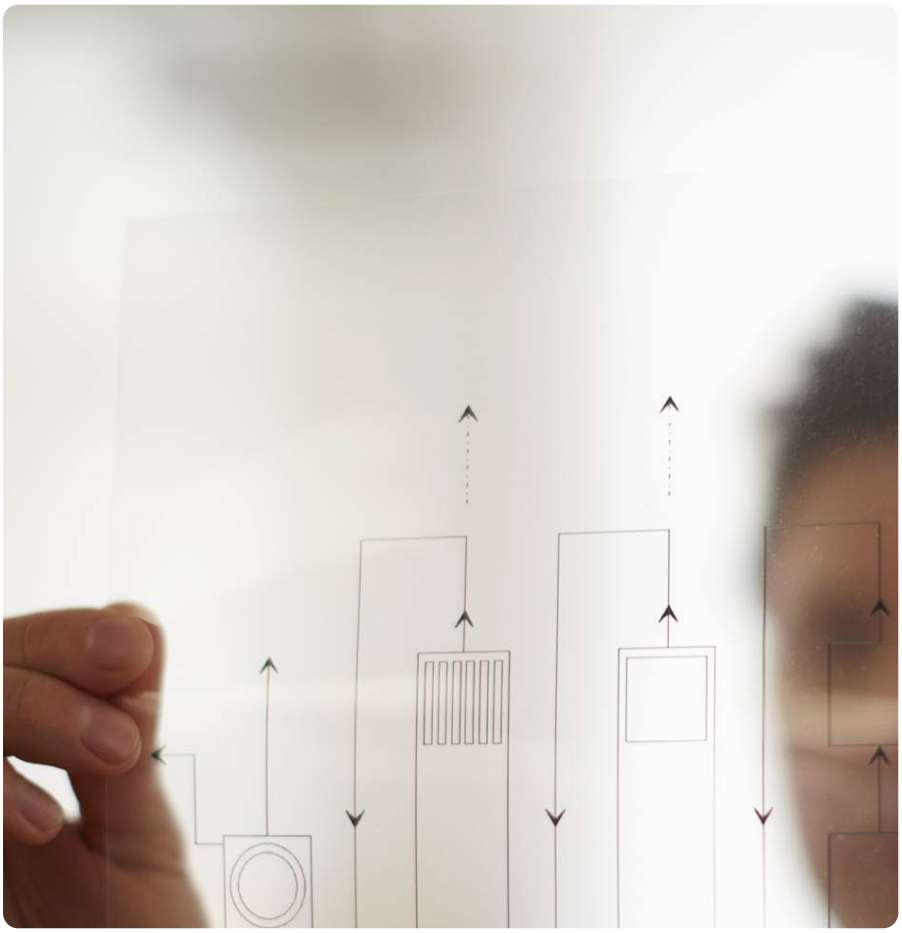

ISO Markets and Planning Data

Jurisdictional Review for IESO

23 June 2023

Bringing Ingenuity to Life.
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Contents

Disclaimer

The analysis and findings expressed in this report are based solely on publicly available information and are current as of December 2022. They were prepared by PA Consulting Group, Inc. (“PA”) at the request of the Ontario Independent Electricity System Operator (“IESO”). PA is not responsible for any loss or damage to any third party as a result of their use or reliance (direct or otherwise) on PA's analysis and this report.

Glossary

ACE – Area Control Areas

AESO – Alberta Electricity System Operator

AIL – Alberta Internal Load

API – Application Programming Interface

APNode – Aggregated Pricing Node

ATC – Available Transfer Capability

AUC – Alberta Utilities Commission

BAA – Balancing Authority Area

BC – British Columbia

BPTF – Bulk Power Transmission Facilities

BTF – Behind the Fence

BTM – Behind the Meter

CADD – Custom Automated Data Delivery

CAISO – California Independent System Operator

CAMS – Customer and Asset Management System

CARIS – Congestion Assessment and Resource Integration Study

CDR – Capacity, Demand and Reserves

CEC – California Energy Commission

CEII – Critical Energy Infrastructure Information

CELT – Capacity, Energy, Load and Transmission

CI – Confidential Information

CLCPA – Climate Leadership and Community Protection Act

COD – Commercial Operation Date

COPs – Current Operating Plans

CPNode – Commercial Pricing Node

CPUC – California Public Utility Commission

CRP – Comprehensive Reliability Plan

CRR – Congestion Revenue Right

CSA – Interconnection Construction Service agreement

CSO – Capacity Supply Obligations

CSPP – Comprehensive System Planning Process

CT – Connecticut

DA – Day Ahead

DAM – Day Ahead Market

DCR – Dispatched (and Accepted) Contingency Reserve

DCR – Demand Capacity Resource

DECs – Decrement Offers

DER – Distributed Energy Resources

DME – Decision Making Entity

DTS – Demand Transmission Service

E&S – Engineering & Supervision

ECEII – ERCOT Critical Energy Infrastructure Information

EEA1 – Energy Emergency Alert Level 1

EFORD – Equivalent Forced Outage Rates

EIM – Energy Imbalance Market

ELCC – Effective Load Carrying Capability

EMIL – ERCOT Market Information List

EMT – Electromagnetic transient

EOR – Energy Only Resources

EPNode – Elemental Pricing Node

EPP – Economic Planning Process

ERCOT – Electricity Reliability Council of Texas

ES – Engineering Study

ETPE – Economic Transmission Project Evaluation

ETS – Energy Trading System

ETU – Elective Transmission Upgrade

EV – Electric Vehicles

EWS – External Web Services

FAQs – Frequently Asked Questions

FCM – Forward Capacity Market

FERC – Federal Energy Regulatory Commission

FMM – Fifteen Minute Market

FOIP – Freedom of Information and Protection of Privacy Act

FPR – Forecast Pool Requirement

GHG – Greenhouse Gas

GIDAP – Generation Interconnection and Deliverability Allocation Procedures

GIM – Generator Interconnection or Modification

GIP – Generation Interconnection Process

GIQ – Generator Interconnection Queue

GIS – Geographic Information System

GIS – Generation Interconnection Status

HASP – Hour Ahead Scheduling Process

HVAC – Heating, Ventilation & Air Conditioning

IA – Interconnection Agreement

IEPR – Integrated Energy Policy Report

IHLF – Intra-Hour Load Forecast

IHPPF – Intra-Hour Photovoltaic Power Forecast

IMRE – Independent Market Information System Registered Entity

INCs – Increment Offers

IR – Interconnection Request

ISA – Interconnection Service agreement

ISD – Interconnection Service Date

ISO-NE – New England Independent System Operator

LAP – Load Aggregation Point

LBMP – Locational Based Marginal Price

LDA – Locational Deliverability Areas

LFL – Large Flexible Loads

LMP – Locational Marginal Prices

LOLE – Loss of Load Expectation

LRs – Load Resources

LRTP – Long Range Transmission Planning

LRZ – Local Resource Zone

LTA – Long-Term Adequacy

LTO – Long-Term Outlook

LTOPP – Local Transmission Owner Planning Process

LTP – Long-term Transmission Plan

LTSA – Long Term System Assessment

MAE – Mean Absolute Error

MAPE – Mean Absolute Percent Error

MATL – Montana Alberta Transmission Line

MC – Maximum Capacity

MCC – Marginal Congestion Cost

ME – Maine

MEC – Marginal Energy Cost

MIS – Market Information System

MISO – Midcontinent Independent System Operator

MLC – Marginal Loss Cost

MOM – Multiday Operating Margin

MP – Market Participant

MPP – Market Participant Portal

MTEP – MISO Transmission Expansion Plan

MTLF – Medium Term Load Forecast

MVP – Multi-Value Project

MW – Megawatt

NDA – Non-Disclosure Agreement

NEMA – Northeast Massachusetts

NERC – North American Electric Reliability Corporation

NH – New Hampshire

NRC – Network Resource Capability

NSI – Net Scheduled Interchange

NYCA – New York Control Area

NYISO – New York Independent System Operator

NYSERDA – New York State Energy Research and Development Authority

OASIS – Open Access Same Time Information System

OATT – Open Access Transmission Tariff

OBDs – Other Binding Documents

OEB – Ontario Energy Board

OTC – Once Through Cooled

PAC – Planning Advisory Committee

PAL – Public Access Link

PJM – Pennsylvania New Jersey Maryland Independent System Operator

PNode – Pricing Nodes

POE – Probability of Exceedance

POI – Point of Interconnection

PPTPP – Public Policy Transmission Planning Process

PTF – Pool Transmission Facility

PTP – Point-to-Point

PV – Photovoltaic

PVGRPP – Photovoltaic Generation Resource Production Potential

PVGRs – Photovoltaic Generation Resources

QSE – Qualified Scheduling Entities

RA – Resource Adequacy

RC – Reliability Committee

REC – Renewable Energy Credit

RI – Rhode Island

RIMS – Resource Interconnection Management System

RMR – Reliability Must Run

RNA – Reliability Needs Assessment

RPM – Reliability Pricing Model

RPP – Reliability Planning Process

RRA – Regional Resource Assessment

RRS – Reserve Requirement Studies

RSP – Regional System Plan

RT – Real Time

RTD – Real Time Dispatch

RTEP – Regional Transmission Expansion Plan

RTM – Real Time Market

RTO – Regional Transmission Owner

RTP – Regional Transmission Plan

RUC – Residual Unit Commitment

SA – Security Administrator

SARA – Seasonal Assessment of Resource Adequacy

SASR – System Access Service Request

SCC – Seasonal Claimed Capability

SCED – Security Constrained Economic Dispatch

SEMA – Southeast Massachusetts

SIS – System Impact Study

SK – Saskatchewan

SLDs – Single Line Diagrams

SMP – System Marginal Price

SSI – Sub-Synchronous Interaction

SSR – System Support Reserve

STAR – Short Term Assessment of Reliability

STRP – Short Term Reliability Process

SUFG – State Utility Forecasting Group

TEAC – Transmission Expansion Advisory Committee

TFO – Transmission Facility Owner

TNG – Total Net Generation

TOs – Transmission Owners

TP – Transmission Plan

TPP – Transmission Planning Process

TRP – Transmission Rate Projection

TWDB – Texas Water Development Board

UAA – User Access Administrators

UNDA – Universal Non-Disclosure Agreement

USA – User Security Administrator

USCA – Upgrade Construction Service Agreement

UTCs – Up to Congestion Transactions

VT – Vermont

WCMA – Western/Central Massachusetts

WECC – Western Electricity Coordinating Council

WMPA – Wholesale Market Participant Agreement

1 Introduction

In October 2022, PA and RBP ("we") were retained by the Ontario Independent Electricity System Operator (IESO) to conduct an independent jurisdictional review of other ISOs in North America to understand what types of data are made publicly available with respect to energy markets and planning and in what format such data is made available. This request was made in response to a settlement agreement, for proceeding EB-2022-0002, with the Ontario Energy Board (OEB) and intervenors laying out the specific requirements of this study.

As per the settlement agreement, the following jurisdictions are included in the scope of this study:

- Alberta Electricity System Operator (AESO),
- California Independent System Operator (CAISO),
- New York Independent System Operator (NYISO),
- New England Independent System Operator (ISO-NE),
- Midcontinent Independent System Operator (MISO),
- PJM Interconnection (PJM), and
- Electric Reliability Council of Texas (ERCOT).

The energy market data to be reviewed is:

- Real-time market clearing price
- Energy offers including price-quantity pairs for cleared and un-cleared entities
- Energy bids including price-quantity pairs for cleared and un-cleared entities
- Provincial, regional, and local demand for real-time energy dispatched (e.g., hourly data available by all planning regions and planning areas)
- Unit generation by real-time dispatch and schedule
- Forecast demand for different time periods including pre-dispatch, day-ahead, month-ahead and long-term
- Impact assessment for new loads and generators
- Impact assessment for retirement of loads and generators
- Summary of access and details of regional and bulk electricity system planning documents including scoping, need, costs, plans and construction schedule
- Process, timelines, and cost to request data from data owners
- Requirements to access confidential information including which entities are allowed to access, the process to retain confidential data access, the length of time confidential access is granted etc.

The following chapter discusses the findings for each jurisdiction in a separate section. To enhance the readability of this report, the sections follow the same structure, grouping similar pieces of information

laid out in the settlement agreement. Each section has six subsections and encompasses specific market aspects as follows:

1. Energy Market Clearing Prices
   - Real-time market clearing price.
2. Energy Offers and Bids
   - Energy offers including price-quantity pairs for cleared and un-cleared entities.
   - Energy bids including price-quantity pairs for cleared and un-cleared entities.
3. Historical Generation and Demand
   - Provincial, regional, and local demand for real-time energy dispatched (e.g., hourly data available by all planning regions and planning areas).
4. Forecast Generation and Demand
   - Forecast demand for different time periods including pre-dispatch, day-ahead, month-ahead and long-term.
5. Unit Generation and Dispatch
   - Unit generation by real-time dispatch and schedule.
6. System Impact Studies
   - Impact assessments for new loads and generators.
   - Impact assessment for retirement of loads and generators.
7. System Planning Documents
   - Summary of access and details of regional and bulk electricity system planning documents including scoping, need, costs, plans and construction schedule.
8. Requesting Data
   - Process, timelines, and cost to request data from data owners.
   - Requirements to access confidential information including which entities are allowed to access, the process to retain confidential data access, the length of time confidential access is granted etc.

Each ISO section begins with a brief introduction providing a high level overview of the key sources of data and (to the extent available) general time horizons for data availability, the general formats in which data are made available, as well as policies regarding confidential information and guidelines for what data can and cannot be made available.

The aforementioned sections describe the pertinent information that is made available in each jurisdiction, including associated documents and attachments. Links to relevant web pages are provided and, where multiple data sets or reports are available at the same URL, the various data set or report names are underlined to enhance readability. Specific nuances for certain types of data are discussed here as appropriate. Where the pertinent information is not available for an ISO, it is mentioned explicitly along with a brief explanation, if available, of the reason.

This report is based on:

- Publicly available information for each jurisdiction,
- Data and reports published by the ISOs themselves and not by third parties,
- Interviews with key members of each ISO, primarily in the data and regulatory teams, to seek clarifications as needed to ensure our interpretations were correct[1].

[1] Each System Operator was also given the opportunity to review its chapter in advance of the report being made public to ensure accuracy and completeness.

2 Jurisdictional Review

This chapter discusses the findings for each jurisdiction.

2.1 Alberta Electricity System Operator (AESO)

AESO publishes market data on the Market and System Reporting section of its website and also on a static dashboard which shows real-time data[2]. Standardised reports can be downloaded in CSV format by the general public, usually with a limit of 31- or 366-days at a time depending on the granularity of the data, hourly or daily. The information can also be viewed on the Current and Historical Market Reports webpage in HTML or graph format.

AESO data to can also be accessed programmatically via its Application Programming Interface (API). A detailed list of available data can be found at AESO API Homepage. The AESO APIs are made available in JSON format. An individual would need to register on AESO's website to get access to API.

The AESO's Confidentiality Information Document provides information with respect to how the AESO determines which records, in its opinion, are commercially sensitive. Records that are determined to be commercially sensitive are afforded confidential treatment under the AESO's rule of Confidentiality. The rules contained herein bind the AESO and all market participants concerning what information can be made publicly available, what is considered to be confidential information and how it must be treated.

Section 2 details what information is treated as confidential data and cannot be made public. Market participants and other stakeholders can request access to certain data not currently posted online or posted in a different format. AESO provides a detailed process for submitting and tracking information requests submitted to AESO. Non-Disclosure Agreements and Certification Forms are required for certain types of data requests.

2.1.1 Energy Market Clearing Prices

AESO publishes two-hour ahead and real time prices under the current section of Current and Historical Market Reports. It can also be accessed through Market and System Reporting website under Price, Supply and Demand Information. AESO does not have a nodal (Locational Marginal Price (LMP)) market, instead it has a single province wide clearing price which it publishes. With the help of the drop-down button on the current section page, the following energy price data can be viewed:

- Pool Price – It represents the settlement price of one MWh of electric energy exchanged through the power pool. Section 201.6 of the ISO rules, subsection 5, specifies that the AESO must set the pool price for each settlement interval as the time weighted average of the 1-minute system marginal price values for that settlement interval (i.e., an hour). The current Pool Price report on the AESO website displays pool price over the past 24-hour period while the historical Pool Price report displays pool

[2] Including information about overall summary, Alberta Internal Load, total net generation and maximum capability by type, pool price, energy transfer between Alberta and British Columbia (BC), Montana, & Saskatchewan, and System Marginal Price.

price over a user-specified period. This report provides information to participants about how the spot market price and system load is evolving over time. This report contains the pool price for the settlement period, the 30-day rolling average pool price, and Alberta Internal Load (AIL). The data is available in HTML, CSV format and updated on an hourly basis. The historical report can be downloaded for a maximum of 366 days at a time.

- System Marginal Price (SMP) – It represents the price of energy in each minute. During normal operating conditions, SMP is defined as the offer price of the most expensive offer block which would be dispatched to meet one additional MW of demand, excluding imports and exports, in each minute. A new SMP is only published when the value changes. This report provides the current SMP, as well as a 3-hour history. This report contains the time the SMP was published, the volume in the offer block that set price and the SMP. All Bid data is displayed in red text. All Offer data is displayed in black text. The currently dispatched block is highlighted in blue. This report is updated every 5 minutes. This data is available in HTML and CSV format and historical data can be retrieved for 31 days at a time.
- Daily Average Price – It represents the daily average pool price. This report provides information to participants about the daily average pool price for the last 7 days and the 30-day rolling average pool price including on and off-peak averages. The 30-day average is the average of the pool prices on the indicated date and the 29 previous days. This data is available in HTML, CSV format and is updated on a daily basis. Historic data can be retrieved for 31 days at a time.
- Actual Forecast – It provides information on the Forecast Pool Price and AIL two hours ahead of the specified hour and Actual Pool Prices and AIL, as well as the Forecast AIL & Actual AIL Difference. The data is available in HTML, CSV format and updated on demand and change of data basis. Historic data can be downloaded for 31 days at a time.

The data is available in HTML or CSV format and updated on hourly, daily, or event-basis depending on the price type. All historical data can be viewed or downloaded from the year 2000 onwards.

2.1.2 Energy Offers and Bids

AESO publishes energy market offers available for the system controller to dispatch based on the final state, including restatements of the energy market merit order for each settlement period. It can be viewed in the historical section of the Current and Historical Market Reports. It is named as Merit Order Snapshot – Energy in the drop-down list.

This hourly data is published daily with a 2-month lag period, as per the Alberta Fair, Efficient, and Open Competition regulation (Section 6), and can be downloaded in CSV format or viewed in HTML format. All non-anonymized offers are published whether dispatched or not. The Dispatched Flag indicates which offers were cleared.

The Merit Order Snapshot – Energy report includes import/export identifier, asset short name identifier, block number, price and quantity pair, prior and current block's cumulative MWs, dispatched MW information (available, dispatch indicator, dispatched value), flexible block indicator, and market participant name.

Loads are rarely bid into the market and the Merit Order Snapshot almost always reflects just generators offering into the market. It appears that loads that can respond to price prefer to simply reduce consumption when the price gets high-enough rather than bidding into the market.

The Energy Trading System (ETS) is used to participate in the wholesale energy market. Market participants use ETS to enter energy supply offers and demand bids. Offers can be made up of up to seven operating blocks. The Energy Offer and Bids Information Document provides background information on the requirements for offers. Section 203.1 requires pool participants to indicate whether each operating block is flexible or inflexible.

When an operating block is flexible, the AESO may issue a dispatch for all, or a portion of the energy contained in that operating block. When an operating block is inflexible, the AESO may only issue a dispatch for the total volume of the energy in the operating block. Operating constraints such as minimum on-time, minimum off-time and maximum run-up time are not mandatory as per Section 203.1 but the capability exists to enter them in the Energy Trading System. Historical data from September 2009 onwards is available for download.

2.1.3 Historical Generation and Demand

AESO publishes historical demand data under the historical section of the Current and Historical Market Reports. There are multiple ways in the drop-down list to view the actual historical and forecasted historical demand such as Actual Forecast or Pool Price as discussed in section 2.1.1 as well as Pool Weekly Summary and Pool Monthly Summary.

These reports are published at the system level only and available in HTML, CSV or graph format depending on the report type. Historical data is available from January 2000 or May 2010 onwards depending on the data type. All files can only be viewed or downloaded for a particular date, week, or month.

- Pool Weekly Summary – This report provides information on the weekly averaged pool price while comparing it to the prior week. It includes demand associated with the time of maximum pool price. It also publishes hourly pool price, forecasted pool price, actual demand and forecasted demand over the 7 days in a graph format and in a tabular format on a daily basis, it includes minimum, maximum, average in MWs and the total energy in MWhs. Historical data is available from January 2000 until July 2018.
- Pool Monthly Summary – This monthly report is similar to the pool weekly summary report except it provides information over a 30-day period. Historical information is available from January 2000 until one month prior to the current month. It also provides hourly information for the entire month in a tabular format.

AESO publishes historical generation data excluding behind-the-meter (BTM) generation, by masked Pool participant ID, under the historical section of the Current and Historical Market Reports via the Metered Volumes (All) report. This report reflects both supply and demand in the market and includes all assets that pay or receive the pool price including both large and small assets. It requires cross-referencing the pool participants list to know the asset name from the asset ID. This report is available in HTML or CSV format and data can be downloaded for a maximum duration of 31 days.

AESO also publishes market reports, also at the system level, on a daily and weekly basis.

- The Daily Market report provides a summary of the pool price, peak load & SMP while comparing the current day's values to the same day last week, 30-day rolling and year to data values. It also provides wind and solar capacity available for dispatch, imports & exports, and any outages by fuel type. Historic data is available dating back to May 2010 and can be downloaded in PDF format.
- The Weekly Market report provides information on the pool price, demand, day ahead load forecast and T-2 price forecast over a 7-day period. It publishes outages by fuel type, solar generation, wind generation and capacity, and import and export schedules. It also provides energy market price and demand statistics which include pool price on an average basis, weighted basis, on-peak, off-peak, maximum, and minimum values, followed by minimum and maximum SMP data, demand (average, minimum, maximum), availability factor by fuel type (coal, hydro, gas and other), and wind and solar generation and capacity factor data. The average of this current week is compared with last week value and year to date data. Historic data is available dating back to May 2010 and can be downloaded in PDF format.

Annual Market Statistics Report

AESO also makes available historical demand and generation by fuel type via their Annual Market Statistics Report. This report summarises key market information over the past year and describe historical market trends in a PDF format. Historical reports dating back to 2010 are available.

The report consists of comparison to previous year's pool price (on-peak, off-peak, monthly basis), spark spread daily averages, AIL over the last ten years (minimum, maximum, average load growth, load factor), system load (average, implied BTF load), seasonal peak load & regional load over the last five years. It also provides information by technology type on year over year installed generation capacity, annual generation & utilization availability factor and annual capacity factor.

The report evaluates generation availability and supply adequacy using supply cushion and reserve margin. It also includes historical flexibility parameters which helps AESO assess the ability of the electric system to adapt to dynamic and changing conditions. These parameters are explained in detail in the System Flexibility Assessment, discussed in section 2.1.7. The report also makes available wind & solar generation data as well as imports and exports data across three jurisdictions – British Columbia, Montana, and Saskatchewan.

The Annual Market Statistics report is accompanied by a data file, which is an interactive dashboard in tableau format, accessible from the Annual Market Statistics report page. The data file includes various dashboards with basic charts that contain information on key areas of the Alberta electricity market. It also includes different levels of time granularity, from hourly to annual, at season level (summer & winter), at hourly profile level (On-peak & Off-peak), and the ability to download the underlying data in a PNG, CSV, PDF, PowerPoint, Tableau Workbook, and Excel or CSV formats. The dashboard provides the following tabs:

- Price & AIL - AESO pool price, gas price, spark spread & AIL,
- System & Regional Load: System load and load from the six regions within AESO, also included are system wide losses. The regions are Calgary, Central, Edmonton, Northeast, Northwest, and South,
- Generation: capacity, availability, and utilization generation data, by fuel type (coal, cogeneration, combined cycle, dual fuel, gas fired steam, hydro, other, simple cycle, solar, storage, and wind).
- Intertie: limit and flow data for the three Alberta interties, aggregated by tie-line, and interface.
- Outages: volume of outages aggregated by fuel type.

2.1.4 Forecast Generation and Demand

Short Term Forecasts

The AESO's dashboard provides hourly forecast and real time actual AIL in a graph or a table format. AESO publishes forecast energy and demand under the current section of the Current and Historical Market Reports.

- Peak Load Forecast – This report presents the day-ahead forecast load (AIL) as a percentage of the month-to-date peak demand for each hour of the current day and following 6 days. This data is available in HTML format and is updated daily. The header row indicates the actual month to date peak demand and the date on which it was set. When forecasting into the next month the report presents the forecast peak AIL in the period and the date on which it is expected.
- 7 Days Hourly Available Capability Report – This report presents the aggregate available capability factor by fuel type (coal, gas, dual fuel, hydro, wind, solar, energy storage and other) for each hour over the upcoming seven days. The generation data for each fuel type is listed on the current supply and demand page. The availability percentage is calculated as the sum of the available capability divided by the total maximum capability of the fuel type. This report is available in HTML format and is updated on demand.
- Wind and Solar Power Forecast – The wind and solar forecasts are based on the currently installed wind and solar capacity listed on AESO's Current Supply and Demand page. AESO implemented a centralized power forecast for use in daily grid operations, allowing for better utilization of power from wind and solar generation which helps to improve dispatch efficiency and system reliability.
  - Monthly wind & solar power forecast vs. actual comparison report illustrates how the six-day (144 hour) ahead wind & solar power forecast supplied by Energy & Meteo systems GmbH, which is one of the processes in the centralized power forecast, correlates with actual wind & solar production. Historical monthly data is available in PDF format dating back to 2015.
  - A 12-hour & 7-day wind, and a 12-hour & 3-day solar forecast are available for download. A wind and solar combined 12-hour & 3-day forecast is also available. The 12-hour forecasts are updated every 10 minutes whereas the 7-day & 3-day forecasts are updated every hour. All files are made available in CSV format and provide minimum, maximum, and most likely energy produced in MWh.

Medium Term Forecasts

The 24-Month Supply and Demand Forecast depicts the Alberta Interconnected Electric System's ability to meet the demand for electricity over the next two years. This information is provided in graphical format with four 6-month graphs, the underlying data for which can be downloaded in CSV format. The components of this forecast are as follows:

- Total expected internal supply which indicates the expected availability of intra-Alberta generation after considering scheduled outages and derates as well as expected wind and solar output. The derates and wind and solar output are based on AESO assumptions.

- Import Capacity from British Columbia (BC), Saskatchewan (SK), and Montana (via the MATL) which indicates the expected maximum import Available Transfer Capability (ATC) of the interties with those provinces/states.
- AIL Load + Operating Reserves which indicates the peak forecast load (AIL) for each day (the peak hour), less load outages (as described in ISO Rule 306.3), less price responsive load (200 MW), less Demand Opportunity Service (20 MW), plus assumed Operating Reserve.
- Surplus, which, equals the Total Expected Internal Supply plus Import Capacity from BC, SK and MATL less AIL Load + Operating Reserves.

Long Term Forecasts

Long Term Adequacy Metrics Report

AESO publishes Long Term Adequacy Metrics reports on a quarterly basis which are developed with industry input and serve to help monitor the available supply of electricity in the province and ensure it is adequate to meet demand moving forward. The AESO posts a report each quarter in February, May, August, and November. The long-term adequacy metrics include:

- new generation projects and retirements - labelled by capacity and type,
- reserve margin forecast,
- supply cushion forecast, and
- two-year probability of supply adequacy shortfall.

Data for the current year and the last four years is available for download in PDF format. The report contains metrics that include tables on generation projects under development and generation retirements, an annual reserve margin with a 5-year forecast period at the time of system peak, a 2-year daily supply cushion, and a 2-year probabilistic assessment of the Alberta Internal Load (AIL). The Long-Term Adequacy (LTA) Metrics provide an assessment and information that can be used to facilitate further assessments of long-term adequacy.

Long Term Outlook

The AESO also publishes a Long Term Outlook (LTO) every 2 years. It reflects forecasted electricity demand and generation in the province over the next 20 years and is one of the many inputs used to guide transmission system planning, long term adequacy assessments, and market evaluations. With a variety of inputs including third-party forecasts and up-to-date data available, the LTO provides:

- Expected growth in electricity demand, and timing,
- Anticipated demand for generation capacity, and
- Potential types and locations of new generation.

AESO makes available various Long-Term Outlook supporting materials such as webinar, presentation, key highlights, agenda, report, and data file. It also provides annual charts and hourly load charts in a tableau format. The report provides forecasts for the next 20 years with multiple scenarios, system load cases and load categories as follows:

- Scenarios
  - Reference case
  - Clean Tech Scenario
  - Robust Scenario
  - Stagnant Scenario
- System Load Case
  - High System Load
  - Low System Load
- Categories
  - Average Alberta Internal Load
  - Average System Load
  - Average Behind the Fence (BTF) load
  - Average Demand Transmission Service (DTS)

The Excel data file provides:

- Forecast Load measured in megawatt (MW) for the different scenarios and system load cases

  - Annual average AIL,
  - Annual average BTF load,
  - Annual average system load,
  - Annual average DTS load for the reference case.
- Forecast maximum AIL, measured in MW for each year for the different scenarios,
- Forecast capacity and maximum output of the Distributed Energy Resources (DER), and Electric Vehicles (EV) load,
- All generating data including Output, Capacity, Capacity factors and emissions, by fuel type and scenario,
- Generation capacity by fuel type, scenario, and region, and
- Hourly AIL forecast for the reference case.

The key drivers and assumptions illustrated in the 2021 LTO include:

- Economic Drives & Assumptions
  - Oil Sands Production, as it correlates strongly with industrial load growth
  - Economic Recovery variables such as weighted average of real Alberta GDP, employment, and population estimates
  - Cogeneration growth as industrial and oil sands activity recovers
  - COVID-19 Pandemic, as it relates to lower energy demand and reduced oil prices
- Policy Drivers & Assumptions
  - Carbon Policy, as it influences the economics of thermal generating units
  - Corporate Power Purchase Agreements
- Technology Drivers & Assumptions
  - Distributed Energy Resources such as solar, wind and gas fired generation
  - Electric Vehicles as a load-only resource
  - Energy Storage
  - Risks and Uncertainties such as technological adoption and changing regulations impact electricity supply and demand, but also Alberta's economy.

The Annual Charts tableau dataset contains load and generation data used for figures in the LTO. The visualization provides the load and generation forecasts over the next 20 years. The visualization can be downloaded in various formats such as PNG, CSV, PDF, and PowerPoint. These dashboards also provide a crosstab function to download data in Excel or CSV format.

- Load Forecasts can be viewed via four charts with filters for different scenarios, categories, and load modifiers. The load modifiers included are: Average EV Load, Gas DER Capacity, Maximum EV Load, Maximum Gas DER Output, Max Solar DER output, max Wind DER output, Solar DER output, and Wind DER output. It also provides the average annual load data by scenarios in an Excel format. The crosstab data includes Electric Vehicles forecast, Peak AIL, category and load filter selected tables for download, one table at a time.
- Generation Forecasts provide trends on generation energy, generation capacity, carbon emissions and capacity factor with appropriate filters such as Capacity begin and end year, and various fuel type sources. The crosstab data includes the above stated trends for download.

The Hourly Load Charts tableau dataset contains the hourly 2021 LTO Reference Case Alberta Internal Load (AIL) forecast. It consists of Average AIL and Peak AIL forecasts for the reference case on a monthly basis in a tabular format. This dataset can be downloaded in PNG, PDF, PowerPoint, and crosstab (Excel or CSV) format. The crosstab data includes Average AIL, Peak AIL, Monthly AIL & Peak AIL for download, one table at a time. The average AIL is displayed in calendar years, whereas peak AIL is based on AESO's definition of seasonal years, where summer covers May through October of year X and winter includes November of X through April of year X+1.

2.1.5 Unit Generation Schedule and Dispatch

AESO provides real-time output (dispatch) across all generators of at least 5MW by viewing the Current Supply & Demand Report. It includes an overall summary, generation by fuel type, and interchange information. This report is updated every 2 minutes and available in a HTML format. It provides Maximum Capacity (MC), Total Net Generation (TNG), and Dispatched (and Accepted) Contingency

Reserve (DCR) for each asset. For units less than 5MW that are connected directly to the AESO grid, AESO only publishes historical data under the historical section of the Current and Historical Market Reports via the Metered Volumes (All) report, discussed in section 2.1.3.

AESO does not publish intertie schedules. However, if a data request is made, AESO publishes historical scheduled flows, Actual scheduled flow and total schedule flow for T-2 hours and T periods for the intertie regions are specified on an hourly basis in a CSV format. The information represents the volumes scheduled on each intertie when participant offers are due and when the volumes are expected to flow. The most recent request was for the British Columbia & Montana Intertie Scheduled Flows which can be found under Data Requests.

2.1.6 System Impact Studies

New generation and energy storage, and new loads, are required to facilitate various studies at the transmission level in collaboration with the AESO, Transmission Facility Owner (TFO), Market Participants (MPs) and Alberta Utilities Commission (AUC). The AESO responds to requests for system access service through the AESO Connection Process. The AESO is currently working on further refinements to streamline this process.

An Engineering Study (ES)/Engineering Connection Assessment needs to be completed to assess the impact of the project if it is above 5 MW. This study includes pre-project and post-project power flow analysis, voltage stability analysis, short circuit analysis, and transient stability analysis. It also includes, on an as needed basis, motor starting studies, sub-synchronous interaction (SSI) analysis and mitigation measure development and evaluation along with any project interdependencies.

Section 502.7 provides information on the minimum technical requirements for the design, construction and operation of any load facility that connects to the transmission system. The retirement of generators and large loads amounts to a change in contract wherein a request is made to the AESO to no longer have a supply or demand contract. This falls under the provision of system access service and the AESO connection process. Once a request is received, system & connection studies are conducted to assess the impact of the retirements.

AESO publishes the latest updates and detailed information about all Transmission Projects which include upgrades, reinforcements, system expansions or customer connections that involve the transmission system in the province. Interconnection studies are published once an application is filed with the Alberta Utilities Commission (AUC) for regulatory approval. It can include documents such as Engineering Connection Assessment, Single Line Diagrams (SLDs), and TFO Capital Cost Estimate depending on the type of project. AESO provides an option to filter projects by region and project type.

AESO also provides an interactive transmission map illustrating transmission capability, the estimated additional generation capacity that could be connected at different locations on the existing transmission system. It also provides a map user guide for using the map. These values are calculated based on existing transmission system with historical data. The locations with higher capabilities than the project size are favourable compared to locations with little or lower capabilities than the project size.

The interactive transmission map shows different voltage lines, AESO planning regions, substations, and AESO projects categorized into generation, load and recent energized. The most recent transmission capability data, an infographic summarizing the assumptions, methods, and key concepts for using this map, and FAQs can be found on the transmission capability map section of the website. Distribution level distributed energy resources (DER) hosting capacities in Alberta are also made available for the three utilities – Fortis Alberta, ATCO and Enmax.

AESO also publishes a connection project list (interconnection queue) and an interactive online map of connection projects in Alberta. It reports all in-progress connection projects with an accepted system access service request, as well as recently energized and cancelled projects. This includes all projects including the connection, behind the fence, or contract processes. The project list is updated monthly and contains project information including the project status, requested capacity for generation, energy storage and load, planned in-service date, and the current stage of the project.

A map user guide for using the interactive connection map and a downloadable GIS shapefile showing project location are available for download. Monthly historic project lists for the last 3 years can be access via connection project reporting. A list of new or revised templates are announced periodically and are available on AESO's connection process template.

2.1.7 System Planning Documents

Long Term Transmission Plan

AESO publishes proposed transmission development plans every two years via the Long Term Transmission Plan (LTP). The plan helps identify current and future needs for a range of possible demand and generation conditions. The transmission plans are flexible, allowing for potential generation developments and changes in the provincial economy.

The LPT is guided by Alberta's Electric Utilities Act and Transmission Regulation. It explains the general timing and location of transmission facilities required for the next 20 years to meet electricity needs, operate the electricity market, and support Alberta's economic development.

The long-term transmission plan associated documents include a webinar, presentation, agenda, single line diagrams (SLDs) and the telecommunication long-term plan. The AESO's long-term forecast is a key input into the long-term transmission plan. It assesses the system across the near and long term (within and beyond five years) and presents four scenarios to capture future states of Alberta's electricity supply and demand.

- Reference Case – Scenario that tests the impacts of current policy and regulatory landscape, technological advancements, and the most-predominant economic outlook for Alberta.
- Clean-Tech – Scenario that tests an upside trend in decarbonization, electrification and cost reduction in renewables.
- Robust Global Oil and Gas Demand – Scenario that tests the impact of an aggressive growth outlook for Alberta's energy sector
- Stagnant Global Oil and Gas Demand – Scenario that tests the impact of economic stagnation in Alberta due to muted investment in oil and gas sector.

System Flexibility Assessment

The AESO also publishes the System Flexibility Assessment report every two years. System flexibility refers to the ability of the electric system to adapt to dynamic and changing conditions. It includes scheduling and dispatching assets to balance supply and demand by the hour or minute and operating reliably following a system disturbance.

The AESO publishes periodic assessments of forecast system flexibility requirements, primarily addressing the impact of increasing renewable resource generation capacity on the Alberta electric system. The AESO currently relies on three primary approaches to provide system flexibility to balance supply and demand:

- Energy market dispatch up or down the merit order to address changes in demand, merit order, and interchange schedules with adjacent balancing authorities,
- Regulating reserve ramp up or down, via automatic generation control, to address minute-by minute changes in demand and variable generation, and
- Wind and solar power management that may be used in fast, large ramp-up events to limit wind and solar generation ramping.

The report is available in PDF format and is supported by an Excel data file and an interactive dashboard. The supporting Excel data files includes:

- Peak Alberta Internal Load and generation capacity,
- Distribution of 10-minute and 60-minute ramps of Alberta internal load, variable generation, and net demand,
- Ramping Capability Detail,
- Average Response Delay of dispatchable generation,
- System Flexibility Responses to net demand change,
- Distribution of the 10-minute-ahead wind generation forecast error,
- Cumulative absolute dispatch ramp over 10-minute intervals,
- Average number of on/off cycles per generation asset by technology,
- Available generation capacity in 1-hour intervals,
- Dispatched generation capacity that is offered above $0/MWh in 1-hour intervals,
- Duration and size of simulated area control errors (ACE),

- Indicative market impact of responding to net demand change, and
- Inertia of online synchronous generation in 10-minute intervals.

System Project Quarterly Report

All transmission applications to the Alberta Utilities Commission are made public via the System Project Quarterly Reports and includes upgrades, reinforcements, and system expansions. Once a project is fully energized, it is removed from the report. Historical data dating back to Q1 2020 are available for download in PDF format. It provides in a tabular format information regarding the project's submission & approval date, estimated cost, transmission facility owner (TFO), AESO approved authorized budget and forecast in-service date.

Transmission Costs and Rate Projections

AESO provides Transmission Costs information which include long-term transmission rate projections and cost benchmarking tools which helps forecast the cost of building transmission facilities. The Transmission Rate Projection (TRP) intends to provide transmission cost assumptions and estimates for the next 20 years which include:

- Updated costs and schedules for transmission projects in the AESO 2022 Long-term Transmission Plan,
- Recovery of transmission project costs over the life of the transmission equipment which generally can be between 30–60 years, as approved by the Alberta Utilities Commission,
- Forecast energy requirements and pool price, and
- Inflation factors based on indices provided by the Conference Board of Canada.

The TRP provides near and medium-term projections on connection spend, capital maintenance and replacement, total revenue requirement, demand transmission service energy forecast, average transmission rate and the average transmission portion of a 600kWh residential monthly bill. It also provides projections beyond 10 years with less certainty. A dashboard showing average transmission charges, DTS Revenue Requirement and Industrial Customer Average Transmission Charges over 20 years is also provided.

As part of the cost benchmarking tools, all transmission facility capital cost estimates and final project costs since 2005 are included in the AESO's cost benchmark database. The database consists of the following which can be downloaded in a PNG, PDF, or PowerPoint format:

- Project Scope Description – This tableau dashboard provides an overview of all projects connecting to different TFOs with filters on scope type (overhead line, substation, and telecom line) and detail level in AESO.
- Project Overall Cost Estimate Breakdown – This dashboard includes project overall costs broken down into component costs by dollars and also includes cost ratios. It provides an option to filter projects by project ID, region, TFOs, year of estimate, line ratio and project component costs.
- Transmission Line Facility Unit Cost Estimate – This dashboard includes line facility unit and non-facility component costs ($/km) for each transmission line facility over the years. It provides an option to filter by different voltage lines, year of estimate, circuit, conductor, and line distance.
- Substation Facility Unit Cost Estimate – Two different dashboards are provided for 138/144kV and 240kV voltage level substations facility unit cost estimates. These dashboards include facility and non-facility components costs with appropriate filters. For e.g., year of estimate, station type, VAR equipment, and location type.
- Substation Major Equipment Unit Cost Estimate – This dashboard has three tabs which includes unit cost estimates over the years based on transformer, circuit breaker, and capacitor bank. It provides filters based on the voltage type, transformer capacity, and equipment type.
- Engineering-Related Cost Estimates – These cost estimates include direct engineering costs, overhead for Engineering and Supervision (E&S), and the final cost report.
  - The Engineering Cost dashboard provides multiple tabs which include information on engineering cost related to facility cost (% Total), material cost (% Material), facility and material cost (% Both). It provides a statistical summary in weighted average of engineering cost ratio at the facility level by TFO, by facility type and work type (new or modify/upgrade). It also includes a statistical summary by average engineering cost, average E&S, and combined cost ratios to the total project cost by TFOs, date of estimate, and work type.

- Final Cost Report – This dashboard provides final cost summary report as well as a detail component costs report which include appropriate filters such as TFOs, Interconnection Service Date (ISD), and mapped ID (for e.g., owner, substation, engineering costs). Both reports contain variance for each project and each component cost. Based on subsection 10 of Section 504.5, the owner of transmission facility needs to provide AESO with the final cost report within 180 days after final energization.

2.1.8 Requesting Data

There are two ways to request data from AESO depending on the nature of data, Public or Critical Energy Infrastructure Information (CEII):

- Public Information – AESO provides a data request form to request public information or data not already provided posted online or posted in a different format. This form needs to be submitted to manalysis@aeso.ca. The turnaround time for such request is usually 10-15 business days (from approval). A charge of $100/hour applies to all data requests and final estimates depend on the complexity of the request. AESO also publishes approximate cost estimates on frequently requested data. Historical data requests are also made publicly available on AESO's data request page.
- Critical Energy Infrastructure Information (CEII) – CEII is treated as confidential information by the AESO and, at the discretion of the AESO, may be shared with individuals who have demonstrated a legitimate need, have executed a non-disclosure agreement (NDA), have accepted the Terms and Conditions when submitting a System Access Service Request (SASR) for a connection project. There are no specific timelines to grant access or publicly stated costs. There are two CEII request processes and steps associated with each as provided below:
  - CEII Request for Connection Projects Studies – Required to accept Terms and Conditions for use of the CEII request portal when submitting a SASR. Once the project is in progress, the AESO project manager will provide instructions to access CEII data for the specified project.
  - CEII Request for purposes other than Connection Project Studies – The following process needs to be followed to access CEII:
    - Complete the CEII request form which includes personal information, business organization information, type of data request which can be found in the base case catalogue, the purpose for CEII request with a brief description.
    - Submit the CEII request form - completed forms need to be submitted to PSMM@aeso.ca.
    - Non-Disclosure Agreement - if request is approved, an NDA needs to be signed with the AESO prior to any CEII data being shared.

There is another way to request information in the custody or under the control of the AESO. As AESO is subjected to the Freedom of Information and Protection of Privacy Act (FOIP), any individual can request access to records by submitting a formal access to information request which should be made in writing and accompanied by any applicable fee.

Individuals can draft their own request or use the access to information request form. Individuals can also submit their information requests using the online Public Access Link (PAL). Registration guide and submit a FOIP Request guide is available on AESO's contact us page under Freedom of Information and Protection of Privacy. Once the individual registers on PAL, they receive their username and password in separate emails. After signing into the account, one can submit an information request by completing the submit request form.

2.2 California Independent System Operator (CAISO)

CAISO publishes a current snapshot of market data on the Today's Outlook section of its website, which includes tabs for demand, supply, emissions, and prices. This information can be viewed in graph, map, or chart format and is updated every five minutes. Users can download the data that creates the graphs in CSV format dating back to April 2018.

The graphs are provided in different levels of granularity depending on the data. For example, graphs generally show hourly and 5-minute data for a given day together and some graphs only show monthly data. Standardized written reports can be viewed in PDF format. The data can only be downloaded for a single graph and is limited to the timeframe displayed on the graph, usually limited to a single day.

The ISO also makes all real-time data related to CAISO's transmission systems and its market publicly available on the CAISO Open Access Same-Time Information System (OASIS) website. The OASIS site provides more extensive information than the CAISO website because it has access to the entire

historical database. The OASIS site does not provide individual links for various data items and searches, rather it serves as a portal which then launches the user into a new window. Key data such as system demand forecasts, transmission outage and capacity status, market prices, and market result data are made available.

The OASIS website has a ribbon at the top of the page for different sections that lead to further sub headers, which allows users to narrow their search by selecting different categories. Once the category is selected the OASIS site will launch another window where the user will apply a series of filters to further define their data search; once the criteria are applied and data is identified, the user can then download the data in either XML or CSV format or view it directly on the OASIS site.

CAISO also provides direct access to its data to market participants that pertain to the day-to-day participation in ISO markets or for requesting different services from the ISO, through a variety of applications and their APIs. These include the Market Participant Portal (MPP) and the Resource Interconnection Management System (RIMS).

Market participants must designate one or more user access administrators (formerly points of contact) to manage the process of requesting user access to ISO applications. All technical specifications and artifacts of ISO applications are available on the password-protected ISO Developer site.

Section 6 – Communications and Section 20 – Confidentiality of the CAISO Tariff along with the CAISO Records Availability Policy governs what data can be made publicly available and what is considered confidential. Together provide the protocols which all market participants must adhere to and describe how various data will be treated and what data can be disclosed under what circumstances and procedures.

2.2.1 Energy Market Clearing Prices

CAISO publishes a current snapshot of today's market clearing prices on the Today's Outlook section under the Prices page, which includes an interactive price map that provides the day-ahead, fifteen-minute, and real-time data for the current day. This data cannot be downloaded and is only available within that price map format. For day-ahead, 15-minute, and real-time data the price map provides the Locational Marginal Price (LMP) and includes the detailed breakdown of its components: congestion, energy, and losses.

The ISO provides additional historical data regarding clearing prices via the OASIS site under the Prices header and Energy Prices sub header. The following energy price data is made available:

- Locational Marginal Prices (Day Ahead (DA) or Residual Unit Commitment (RUC)),
- Scheduling Point/Tie Combination LMPs (DA),
- Interval Locational Marginal Prices (Real Time (RT)),
- Interval Scheduling Point/Tie Combination LMPs (RT),
- Hour Ahead Scheduling Process (HASP) Locational Marginal Prices,
- Fifteen Minute Market (FMM) Locational Marginal Prices,
- FMM Scheduling Point/Tie Combination Locational Marginal Prices,
- Contingency Dispatch Locational Marginal Prices,
- Contingency Dispatch Scheduling Point/Tie Combination Location, and
- Hourly Real-Time Market (RTM) Load Aggregation Point (LAP) Prices.

Prices are available for a variety of scheduling horizons: real-time, 15-minute-ahead, and hour-ahead. In addition, prices in the event of contingency dispatch are posted separately. A scheduling point is a location or node at which Scheduling Coordinators may submit Intertie Bids in the CAISO Markets. An LAP is a representation of a load zone, and the price is the average of the prices of the nodes within the zone for all intervals within an hour.

Different filters are available for the above energy prices, but generally, for the LMP data the user can select a time range, market (DA / RT), either a specific node, all nodes, or all Aggregated Pricing nodes ("APnode"). Once the criteria are selected and the user clicks 'Apply' the data is shown directly on the OASIS site in hourly increments and gives the option for it to be downloaded in either XML or CSV format.

The LMP data on the OASIS site includes the breakdown of its components, namely the congestion, energy, loss, and greenhouse gas. The downloaded file provides additional detail regarding the interval start and end time, operational date, operational hour, node, market and LMP type.

For specific LMP markets, i.e., specified market time frames, like the FMM or the HASP, the OASIS site gives filters for time frame, node type, and operational hour. These specified time frames also provide the data components, i.e., congestion, energy, loss, and greenhouse gas directly on the OASIS site with the option to download an XML or CSV file with additional data like interval start and end time, operational date, operational hour, node, market, operational interval.

The pricing data are indexed by pricing nodes ("PNode") and aggregated nodes ("APNode"). A Pnode is defined as single network Node or subset of network Nodes where a physical injection or withdrawal is modelled for which a LMP is calculated and used for financial settlements. An APNode is defined as a Load Aggregation Point, Trading Hub or any group of Pnodes for which an averaged LMP is published. The Network and Resource Modelling page provides Excel files that describe the network model and pricing node mapping.

2.2.2 Energy Offers and Bids

CAISO publishes the RT and DA bids and offers on the OASIS website under the Public Bids header and Public Bids sub header. Bids and offers data for both markets are provided in the same XML or CSV file. Energy offer and bid data are published in accordance with the 90-day lag prescribed by FERC Order 719, based on the applicable Trading Day. There is no distinction between bids and offers that cleared or did not clear the market (were accepted or not accepted).

Both the RTM and DAM offer and bid data provide masked facility and participant names, with a numerical ID instead. Energy bids and offer records include operating limits (start time, stop time, resource type, and scheduling coordinator), and energy price-quantity pairs. The file lists the different resource types as generator, intertie, and load. A generator record is an offer, and a load record is a bid, and an intertie record can be either offer or bid. If the intertie has a positive price, it is an offer and if it has a negative price, it is a bid.

2.2.3 Historical Generation and Demand

On the Demand Section of the CAISO website it provides a current snapshot of the demand trend and net demand trend in graph format for a given day in five-minute and hourly intervals. The Demand graph shows the DA forecast, Hour-ahead forecast, and current demand. The Net Demand trend graph shows the hour-ahead, demand, DA and net demand. Both graphs allow the user to access historical data by changing the date of the graph dating back to April 2018 and can download the chart data in CSV format.

CAISO also publishes a Day Ahead Market Summary Report on the OASIS site under the Energy header and System sub header. On the Day Ahead Market Summary report page the user can filter the start and end date then click 'Apply' which then reveals data for the chosen time period directly on the page. This data is broken down by operational date, product type (demand, supply, exports, imports), self-schedule, energy bid, virtual bid, and total. The data can be downloaded in XML or CSV format which provide additional data showing the dollars cleared, dollars submitted, energy cleared, and energy submitted.

Under the System Demand header of the OASIS website, the CAISO Demand Forecast provides hourly actual demand information if historical dates are selected along with "actual" for the Market / Process type in the drop down menu. This provides the total actual hourly integrated load by zone and can be downloaded in XML or CSV format.

The California ISO Peak Load History 1998 through 2022 shows the MW at peak load associated with its specific date and time. Hourly real-time generation schedules (load plus losses) are available back to April 2009, on the OASIS site under the Energy header (Schedule | System Load and Resource Schedules).

2.2.4 Forecast Generation and Demand

Short Term Forecasts

As discussed in section 2.2.3, the Demand Section shows the Demand Trend and Net Demand Trend in graph format. The Demand Trend graph shows DA and hour-ahead demand forecasts as well as the demand in five-minute for the current day. The Net Demand Trend graph shows the hour-ahead forecast, demand, DA net forecast, and net demand in 5-minute intervals for the current day. Forecasts for the current and next three days can be viewed in the graphs and data downloaded in CSV format.

The Demand Section also provides the Seven-Day Resource Adequacy (RA) Capacity Trend in graphical format that shows the following data for the current and next seven days, which can also be downloaded in CSV format:

- RA Capacity + RA Credits
- Net RA Capacity + RA Credits
- DA Demand Forecast + Reserve Requirement
- DA Net Demand Forecast + Reserve Requirement

The OASIS site also provides a variety of forecasts under the System Demand header for various timeframes which can be downloaded in XML or CSV format. Forecasts include:

- The CAISO Demand Forecast provides various forecasts at differing time frames and levels of granularity, in addition to providing the actual data as discussed in section 2.2.3:
  - RT forecasts for the next twenty four hours at the 5- and 15-minute levels of granularity,
  - DA hourly forecast for the next 24-hours, and
  - DA hourly forecast for the next 2 and 7 days.
- The CAISO Peak Demand Forecast the forecast peak demand hour and associated MW for each zone for the next 7 days.
- The Wind and Solar Forecast provides various forecasts at differing time frames and levels of granularity for select trading hubs:
  - DA actual scheduled generation at the hourly level for the next 24 hours,
  - HASP hourly forecast for the current day,
  - RT forecast at the 5-minute granularity level for the next 24 hours,
  - RT pre-dispatch forecast at the 15-minute granularity level for the next 24 hours, and
  - DA hourly forecast for the next 7 days.
- The Advisory CAISO Demand Forecast provides various forecasts at differing time frames and levels of granularity for each zone:
  - RT forecast at the 5-minute granularity level for the next 24 hours, and
  - RT pre-dispatch forecast at the 15-minute granularity level for the next 24 hours.
- The Sufficiency Evaluation Demand Forecast is at the 15-minute and hourly granularity levels for each zone for the next 24 hours which are updated every 15-mintes / hourly respectively.

Annually, CAISO publishes the *Summer Loads and Resources Assessment*, in PDF format via the Reports and Bulletins page under the Seasonal Assessments section. The report analyses the expected supply and demand conditions for the upcoming summer for the CAISO BAA from both a probabilistic and deterministic point of view for the next year.

CAISO also conducts a comparative statistical analysis to the prior year to plan for operational preparedness which also incorporates forecasts from other entities such as, California Energy Commission (CEC), SoCalGas, California Public Utility Commission (CPUC), Moody's, and the Northwest River Forecast Centre.

The probabilistic analysis is conducted at the hourly level and assess many scenarios to evaluate system stability and resource adequacy by tweaking four key input parameters:

- Peak demand forecast,
- Hydro conditions, and
- System capacity.

The probabilistic analysis is also supported by a deterministic stack analysis that is based on a two-step analysis:

1. procuring adequate resources to meet the standards set under the California Public Utilities Commission (CPUC) Resource Adequacy program, and
2. assessing the ability of new and existing resources to meet system needs.

The report summarizes the findings from the probabilistic and deterministic analyses and the associated impacts on system stability and resource adequacy. The report is made available in PDF format, with historical reports dating back 2 years, and also includes a series of appendices:

- Review of the previous year's summer,

- Details of the current year's assessment including assumptions and results:
  - Load forecast,
  - Hydro generation,
  - System capacity,
  - Generation additions and retirements,
  - Unit commitment,
  - Demand response,
  - Interchange,
  - Stochastic analyses methodology, and
  - Deterministic and stochastic study results.

Medium and Long Term Forecasts

As per a Memorandum of Understanding between the CAISO, California Public Utilities Commission (CPUC) and the California Energy Commission (CEC), longer term load forecasting is the responsibility of the California Energy Commission, generally as part of the Integrated Energy Policy Report (IEPR) proceeding.

2.2.5 Unit Generation Schedule and Dispatch

This information is considered confidential and is not made available to any other entity, except the scheduling coordinator for each resource, not even under an NDA. However, some information on intertie schedules, transfer limits and losses is available via OASIS:

- Energy Imbalance Market (EIM) Transfer & Transfer Limits by Tie – provides Western EIM effective transfer & transfer limit MWs of energy transfer across the tie, resulting from real-time market runs.
- EIM BAA Dynamic Net Scheduled Interchange – provides the NSI results based on real-time market runs per Balancing Authority Area on an hourly basis
- EIM BAA Hourly Base NSI & losses – provides hourly base net scheduled interchange & losses for each balancing authority areas at T-40, T-55, and T-75 timeframes on an hourly basis.

2.2.6 System Impact Studies

New generating units wishing to interconnect to the CAISO Controlled Grid are required to facilitate studies, which are carried out by CAISO in coordination with the pertinent Transmission Operators (TO(s)). According to Appendix Y – Generator Interconnection Requests, of the CAISO Tariff, there are three study groupings: i). Queue Cluster, ii). Independent Study Process, and iii). Fast Track Study Process. A generating facility will by default be assigned to the Queue Cluster process unless it requests one of the other two processes and meets the eligibility requirements. The studies required depend on the process.

FERC Orders 2003 and 2006 required CAISO to distinguish between large and small generators in its interconnection procedures, and to have separate interconnection agreements for each. Large and small generators are defined as one whose capacity is above or below 20 MW, and their procedures are governed by Appendix U and S respectively.

However, as of September 2022, the Generation Interconnection and Deliverability Allocation Procedures (GIDAP) in Appendix DD define the new process which maintains the aforementioned study groupings. It is further elaborated upon in CAISO Business Practice Manual for Generator Interconnection and Deliverability Allocation Procedures. The GIDAP outlines the new requirements for both large and small generators. Load interconnections are subject to the Transmission Owner's tariff and not CAISO's.

The studies required depend on the process but can include System Interconnection Study, Facilities Study and Deliverability Assessment. Interconnection studies are provided to the requesting party only and the individual studies are neither published nor available under an NDA. However, the area reports for the cluster studies are posted on the CAISO transmission planning section of the market participant portal requiring an NDA, the Regional Transmission Planning NDA, to access.

Generators desiring to retire must submit a formal withdrawal notice along with an affidavit as outlined in Section 41 of the tariff. Section 12 of the Generator Management Business Practice Manual outlines the various retirement scenarios along with their process. The list of retirement notices is made public and posted via the Reliability Requirements portal and includes details such as the facility name and id,

location, current status, capacity, date notification received, proposed offline date, request status, minimum retention date, proposed replacement plan and its status.

CAISO will perform a Local Capacity Technical Study to determine the reliability impact of the generator's retirement and ensure compliance with reliability criteria. Other studies may be performed as needed. If it is deemed that the retirement would adversely affect system reliability, CAISO can designate it as Reliability Must Run (RMR) unit and provide an RMR contract.

CAISO publishes the ISO Generator Queue, which includes energy storage units, through the Resource Interconnection Management System (RIMS). This interconnection queue report is published in Excel and PDF format via the RIMS portal under the Reporting Tab. It includes details on the project name, queue position, date of initial request, queue date, application status, study process, fuel type, MW, net MWs to Grid, full capacity, partial or energy only, off-peak deliverability and economic only, county, state, utility, station or transmission line, proposed on-line date, current on-line date, and the status of various reports (e.g., phase 1 and 2, feasibility, facilities studies etc.).

2.2.7 System Planning Documents

As per Section 24 of the CAISO Tariff, the Transmission Planning Process (TPP) is carried out annually and also described in the Business Practice Manual for Transmission Planning Process. The role of the TPP is to identify and plan the development of solutions to meet the future needs over a minimum ten year planning horizon. CAISO follows FERC decisions (e.g., Order 1000) and standards established by the North American Electric Reliability Corporation (NERC) and the Western Electricity Coordinating Council (WECC) in addition to the CAISO Planning Standards.

The Transmission Plan (TP) represents the CAISO Board-approved roadmap for infrastructure requirements and must solicit input and priorities from the California Public Utilities Commission (CPUC) and the California Energy Commission (CEC) as well as various Local Regulatory Authorities (other government agencies that oversee utilities, e.g., the City Councils of cities with municipal utilities in CAISO). The CEC leads the forecasting of customer load requirements.

The TPP consists of three phases:

- Phase 1 consists of developing the unified planning assumptions and study plan,
- Phase 2 consists of the technical studies, stakeholder engagement and the development of the TP, and
- Phase 3 consists of the identification of projects in the Plan that are eligible for competitive procurement, and the solicitation of entities to build and own such projects.

The TP describes:

- Key Inputs and Influences such as the load forecast, as developed by the CEC, and distributed generation scenarios, generation supply, resource planning and portfolio development based of other studies, as well as other influences such as non-transmission alternatives, e.g., storage, potential future transmission offerings and renewable integration challenges.
- The Reliability Assessment which aims to identify weak spots in the grid that may potentially fail to meet applicable reliability performance requirements and identifies solutions that complies with all appropriate NERC and WECC standards.
- The Policy-Driven Need Assessment, which identifies grid upgrades needed to address California's mandate for meeting renewable energy and greenhouse gas (GHG) reduction targets. For the transmission planning process, it is broken into two objectives:
  - Support Resource Adequacy (RA) deliverability status for the renewable generation and energy storage resources identified in the portfolio as requiring that status.
  - Support the economic delivery of renewable energy over the course of all hours of the year.
- The Economic Planning Study which examines economic-driven transmission solutions with the potential to reduce ratepayer costs within the ISO.
- Planning to support Interregional Coordination, i.e., cooperative operation with regions outside CAISO.
- Various Other Studies and Special Reliability Studies.
- The Transmission Project List, which details the TP in which it was approved for prior projects and the expected in-service date.

The TP report is published in PDF format and is accompanied by several appendices, each of which are provided in a separate PDF document:

- Various data tables describing the CAISO system including existing and retired generation, Once-Through Cooled (OTC) generation, planned generation, reactive resources and special protection schemes,
- The Reliability Assessment,
- Detailed results of the Reliability Assessment, identifying specific facilities facing reliability challenges and solutions identified to mitigate those issues,
- List of projects submitted by various parties as potential mitigations,
- Descriptions of the need and nature of projects in the TP along with estimated costs and in-service dates,
- List of contingencies (potentially significant equipment failures within the CAISO grid) that could affect adjacent systems, and
- Detailed descriptions of the transmission facilities eligible for competitive solicitation.

In 2022, CAISO published the first ever 20-year Transmission Outlook, a process that was conducted in parallel with the 2021-2022 TPP and in collaboration with the CEC and the CPUC. It is not enshrined in the tariff, to facilitate more informal stakeholder engagement, and is focused on helping the state achieve the SB-100 target of 100% zero carbon resources by 2045. There is no fixed schedule for updates which will be done on an as needed basis.

The report is published in PDF format and describes:

- Coordination process with other agencies,
- Key Inputs and how assumptions are built of the starting SB-100 scenario such as the load forecast and distributed generation scenarios, resource planning and portfolio development based on other studies including natural gas plants, BESS, LDES, utility scale solar, in-state, out-of-state and offshore wind and geothermal generation resources.
- Integration of renewable resources, in-state, out-of-state and offshore, and the tie into the starting SB-100 scenario.
- High level assessment that details for each study case:
  - demand, generation and transmission assumptions,
  - methodology and results, and
  - transmission development alternatives.

2.2.8 Requesting Data

As per the Records Availability Policy, CAISO will notify the requestor within ten business days of whether it is able to comply with the request or provide the basis for which the request is being denied, e.g., data considered confidential. If the data is readily compiled, the data is provided within ten business days of confirmation that CAISO will comply with the request, otherwise an estimated date will be provided to the requestor.

There is no charge for CAISO staff time to review and process requests. Should the request entail more than thirty pages that need to be photocopied or printed, the requestor will be notified of the charge, including postage if applicable. Electronic copies are provided at no charge.

For data requests that require the creation of a new data set / document, the requests are reviewed by CAISO's Data Review Committee to assess whether the requested data can be made publicly available. If yes, CAISO will balance the amount of work required to produce the data versus the requestor's business need for the data to determine whether CAISO can comply with the immediate request.

To access certain secure planning and market systems data an entity must designate one or more User Access Administrators (UAA) the manage the organizations access to CAISO's systems. To access certain secure planning and market systems data an entity must also have an approved WECC Confidentiality Agreement and signed non-disclosure agreement (NDA) prior to requesting access to this data.

Depending on the nature of data being requested, an entity must also demonstrate a legitimate need for the data and enter into additional NDAs:

- Regional Transmission Planning NDA

- Congestion Revenue Rights Full Network Model NDA
- Protected Data NDA which includes the following as per Section 6.5.10.1 of the tariff:
  - Pre- and post-Day-Ahead Market Transmission Constraints Enforcement Lists, which are the daily lists of information for the Transmission Constraints, including Contingencies and Nomograms, the CAISO plans to enforce or not enforce, or which were or were not enforced, in the daily Day-Ahead Market,
  - Load Distribution Factors actually used in the Integrated Forward Market,
  - Power Transfer Distribution Factors for each binding Transmission Constraint in the Integrated Forward Market, HASP and Real-Time Dispatch,
  - Limits associated with all Transmission Constraints that were enforced in the Integrated Forward Market, FMM and Real-Time Dispatch, and that based on the flows in the respective market runs are near binding, and
  - Hourly unscheduled flow at each Intertie considered in the Day-Ahead and Real-Time Markets, a summary of whether the CAISO enforced physical flow constraints on the Interties, and the accuracy metric by Intertie.

Once the additional NDAs are in place, the UAAs must submit the appropriate access forms for the particular applications. Once the individual users have conformed to CAISO's Information Security Standards, they will receive a digital certificate which they can install to gain access to the specific data via the appropriate application.

2.3 New York Independent System Operator (NYISO)

The New York Independent System Operator (NYISO) maintains publicly accessible data portals for most market data, including a Real-Time Dashboard updated in near real time. Data is generally available as CSV files and some data is also available in PDF or HTM format. The NYISO does not have a specific API. However, users can create Custom Automated Data Delivery (CADD) reports/processes via a query tool, which can be downloaded in either CSV or XML format.

CADD requests are limited to 150,000 records at a time which generally rules out bulk data access. Data for the ten most recent days is usually available directly on the portal download page, with historical data available on a designated archive web page in monthly CSV zip files containing a file for each day of the month, with the archive time frames varying depending on the data item.

Most data are accessible directly from the NYISO website which links to various databases as needed to provide the user with a single source of information. Some data can also be accessed via the NYISO Open Access Same-Time Information System (OASIS) website, which is also one of the sources that the NYISO website connects to for certain data and is part of the NYISO's Management Information System (MIS).

2.3.1 Energy Market Clearing Prices

The NYISO publishes market clearing prices for the last ten days in the Energy Market & Operational Data portal of the NYISO website. The following Locational Based Marginal Price (LBMP) data is made available:

- Day-Ahead LBMP, and
- Real-Time LBMP.

The DA and RT LBMP data are organized by zone as well as by generators. All LBMP data includes the breakdown of its components, namely the Marginal Cost of Losses and the Marginal Cost of Congestion.

The DA LBMP file provides the data in hourly increments while the RT data is available in 5-minute increments. Both DA and RT data is available in either CSV, PDF, or HTM format and contains a days' worth of data, and archived data is available by either clicking the 'Archive' button at the bottom of the section. The historical data provides individual files for the last 10 days in csv, html, and pdf format and archived files in monthly CSV zip files with one file for one day for each day of the month. Archived data is available back to market start on November 1999.

On the Real-Time Dashboard, real-time market zonal LBMPs and day ahead market zonal LBMPs are shown in interactive maps that update with the latest data ever five minutes. On both graphs the user can hover over the various zones which then brings up the breakdown of the LBMP to the right of the map, namely, marginal cost of energy, losses, congestion, and the LBMP. Also, the user can click on a zone box, and it will pull the designated data and show it in graph format for 5-minute increments.

Custom Day-Ahead Market LBMP reports can also be created for select zones. To do so the user must navigate to the Custom Reports page and select the desired zone, start date, end date, version (latest, versioned, all), and format (CSV, HTML, PDF). Once the criteria are selected click 'Generate Report' which will create a file derived from the NYISO database.

2.3.2 Energy Offers and Bids

NYISO publishes Offer and Bid data with a 3-month lag, as per Section 6.3 of the NYISO Market Services Tariff that requires NYISO to make bid information public three months after it has been submitted by Market Participants. Bids and offers are published for energy (generators, loads, and transmission interconnects), ancillary services, transmission congestion contracts, and the installed capacity market.

The 'Gen Bids' column on the dedicated web page lists the offers to sell and the 'Load Bids' are the bids to buy. For both offers and bid data, participant and facility names are masked, with an ID provided rather than a name, along with operating limits (upper, emergency), start-up and mange parameters (cost and quantity), self-commitment (cost and quantity) and price-quantity pairs for both energy and ancillary services. Historical data is available dating back to November 1999.

2.3.3 Historical Generation and Demand

NYISO publishes historical real-time actual load and integrated real-time load via the Load Data portal and the real-time fuel mix and BTM solar data via the Reports & Info portal. The real-time load is the actual telemetered load for each real time dispatch interval while the integrated load is a time weighted average hourly load value and considers the duration of all intervals in a given hour.

- Historical Real-Time Actual Load – provides the historical 5-minute interval load by zone in a separate CSV file for each day for the last 10 days. The archived files are provided in monthly CSV zip files with one file for each day of the month dating back to May 2001.
- Integrated Real-Time Actual Load – provides the historical hourly load by zone in a separate CSV file for each day for the last 10 days. The archived files are provided in monthly CSV zip files with one file for each day of the month dating back to June 2001.
- Real-Time Fuel Mix – provides the historical 5-minute interval for the generation by fuel type types (dual fuel, natural gas, nuclear, other fossil fuels, other renewables, wind and hydro) in a separate CSV file for each day for the last 10 days. The archived files are provided in monthly CSV zip files with one file for each day of the month dating back to December 2015.
- BTM Solar Estimated Actuals - MW data is provided for each NYISO zone in hourly increments in a separate CSV file for each historical day for the last 9 days. The archived files dating back to November 2020 are provided in monthly CSV zip files with one file for each day of the month.

2.3.4 Forecast Generation and Demand

Short Term Forecasts

Short term load forecast data is available via the Load Data portal under the Load Forecast section and via the Reports & Info portal under BTM Solar Information. The NYISO publishes the following forecasts which are effectively daily compilations:

- NY Load Forecast – MW data is provided for each NYISO zone as well as the NYISO BAA in hourly increments in a separate CSV, HTML or PDF file for each day for the last 9 days. Each forecast file includes a forecast for the current and next 5 days. The archived files dating back to November 1999 are provided in monthly CSV/HTML/PDF zip files with one file for each day of the month.
- Load Forecast Weather Data – Daily weather data, min/max dry and wet bulb temperature, is provided for each station for the current day and the next day in a separate CSV file for each day for the last 10 days. The archived files dating back to September 2008 are provided in monthly CSV zip files with one file for each day of the month.
- Behind-the-Meter Day Ahead Zonal Forecast – for BTM solar, MW data is provided for each NYISO zone in hourly increments in a separate CSV file for each day for the last 11 days. Each forecast file includes a forecast for the next day. The archived files dating back to November 2020 are provided in monthly CSV zip files with one file for each day of the month.

Long Term Forecasts

Annually, the NYISO publishes the Load & Capacity Data Report, a.k.a., the Gold Book, as part of its long-term planning process via the Gold Book Resources portal. Through this process, the NYISO provides 30-year forecasts for energy usage, seasonal peak demand, energy efficiency, and electrification for different zones and localities in addition to historical data and existing and proposed generation and transmission facilities.

The Gold Book is comprised of seven parts, most notably:

- The "annual energy and peak demand - historical and forecast" section is the largest section providing several forecasts. Baseline, Low and High Load scenarios are forecast with assumptions for each scenario provided:
  - System wide energy as well as coincident peak demand forecast by season (summer / winter) with breakdown of various components such as:
    - energy,
    - BTM generation,
    - EVs and
    - building,
  - Baseline annual energy as well as coincident and non-coincident peak demand historical (last 10 years) and forecast data by zone and season,
  - Annual seasonal 90th and 10th Percentile forecasts of baseline energy as well as coincident and non-coincident peak demand by zone,
  - Annual Impacts of energy efficiency and codes and standards on historical (last 18 years) and forecast energy and seasonal coincident peak demand by zone,
  - Annual BTM solar photovoltaic (PV) nameplate capacity by zone and the associated annual reductions on historical (last 10 years) and forecast energy and seasonal coincident peak demand,
  - Annual BTM non-solar distributed generation nameplate capacity by zone and the associated annual reductions on historical (last 10 years) and forecast energy and seasonal coincident peak demand by zone,
  - Annual historical (last 10 years) and forecast EV stock by light, medium and heavy duty, and busses at the New York Control Area (NYCA) level,
  - Annual historical (last ten years) and forecast impact of EVs on energy and seasonal coincident peak demand by zone,
  - Annual forecast energy storage nameplate capacity in MW and the associated impacts on energy and seasonal coincident peak demand by zone,
  - Annual forecast of building electrification impacts on energy and seasonal coincident peak demand by zone,
  - Annual forecast of EV and building electrification impacts on energy by scenario at the NYCA level,
  - Annual forecast, for the next 10 years, of large interconnecting loads by zone and the associated impacts on energy and seasonal peak demand at the NYCA level, and
  - Historical (last 10 years) seasonal coincident peak demand datetimes and MW at the NYCA level.
- Changes in generation from the prior year's Gold Book by fuel type and the associated impacts on seasonal capacity. Fuel types include gas, oil, gas and oil, nuclear, pumped storage, hydro, wind, solar and other.
- List of existing generation facilities and associated information such as plant name, owner, location in-service date, fuel type and seasonal capacity ratings. Summary tables of the existing capacity and prior year's energy production by fuel type and zone for each season are also provided.
- Changes in generating capacity based on proposed projects in the interconnection queue as well as re-ratings and retirements along with associated information such as plant name, owner, zone, proposed date, fuel type, seasonal capacity ratings and queue position.
- Summary of NYCA load and capacity for the next ten years by season and fuel type, in the load and capacity schedule section.
- List of existing transmission facilities operating in NYCA at various voltage levels: 115, 138, 230, 345, 500 and 765 kV as well as 150 and 500 kV DC.

- List of proposed transmission facilities which includes both firm and non-firm proposals and merchant transmission projects along with associated information such as the transmission owner, terminals, line length, voltage, thermal ratings and expected in-service date.

In addition to the report, which is provided in PDF format, the corresponding graphs and tables are made available in XLSX and PDF format via the same portal:

- Baseline, Low and High Load Scenario Forecast Tables in Excel format with multiple tabs corresponding to a specific table or graph mentioned in the report,
- Forecast Graphs in PDF format, and
- NYCA Existing Generating Facilities in Excel format.

2.3.5 Unit Generation Schedule and Dispatch

This information is neither made publicly available nor via an NDA as unit specific information is considered confidential. However, some information on intertie flows is published under Power Grid Data.

- Interface Limits & Flows – provides net flow for each interface line and also provides positive and negative flow time on five-minute basis. Historical data is available dating back to July 2002.
- Long Term & Real-time Transfer Capability – provides prescheduled and real-time total & available transfer capability for the interface on an hourly and 15-minute interval basis in a CSV, PDF, and HTML file for the last 10 days. The archived files are provided in monthly CSV zip files with one file for each day of the month dating back to June 2001.

2.3.6 System Impact Studies

NYISO's *Open Access Transmission Tariff* (OATT) describes the interconnection rules and is available via the NYISO website. Section 3.9 outline the overall study procedures for new load and generators while Section 3.7 and Attachment P – Transmission Interconnection Procedures provides more details with regards to the transmission studies that need to be conducted, key among them being the System Impact Study and Facilities Study.

There is a distinction between a large and a small generator and they have different interconnection agreements and procedures. According to OATT Attachment X – Standard Large Facility Interconnection Procedures, facilities that exceed 20 MWs or are a Class Year Transmission project qualify as large generators. According to Attachment Z – Small Generator Interconnection Procedures, facilities that are 20 MW or less qualify as small generators.

As per Section 3.9 of the OATT, new loads must also perform technical studies to evaluate their reliability impact on the system and identify necessary network upgrades in order for the load projects to be reliably interconnected to the system.

As per Attachment FF – Generator Deactivation Process of the OATT, retiring generators must perform a generator deactivation assessment, which is performed by the NYSIO as part of the quarterly Short-Term Reliability Process (STRP) (although the NYISO may elect to conduct studies separately) in coordination of the Transmission Owner to assess the reliability impacts of a proposed retirement on system reliability. Should the NYISO determine that the retirement would adversely impact system reliability, the request for retirement can be denied and the unit may be classified as a Reliability Must Run (RMR) unit and the NYSIO would enter into a special RMR agreement to provide appropriate compensation.

NYISO publishes the interconnection queue via the Interconnection Process portal on the NYISO website. The interconnection queue is provided in Excel format and gives detail on the proposed generation facilities including energy storage. This includes the owner/developer, project name, date of initial request, fuel type, location, interconnection point, utility, last updated, availability of studies, proposed in-service date, proposed initial-sync date, and proposed commercial online date.

The interconnection studies for all projects, as listed under the availability of studies column in the interconnection queue, are available on the NYISO secured website. The secure website is only accessible to those who have a My NYISO account and also requires Critical Energy Infrastructure Information (CEII) access.

The NYISO established the Short-Term Reliability Process (STRP), in accordance with Attachments Y and FF of the OATT, in 2019 to prepare for the impact of expected changes in supply and demand of energy for the transmission system. The NYISO publishes the quarterly Short-Term Assessment of

Reliability (STAR) reports in PDF format for a five-year forecast horizon, with greater focus on needs arising within the first three years. Historical reports for the last two years are also available.

The report details three key sets of assumptions:

- Generation
  - Additions,
  - Deactivations,
  - Peaker Rule, and
  - Return-to-service.
- Load
- Transmission
  - Existing, and
  - Proposed transmission.

The analysis results in three sets of assessments, based on which a final assessment is made with regards to the status of the Bulk Power Transmission Facilities (BPTF) meeting the reliability criteria. Any solutions along with their status are made public via the Short-Term Reliability Process Solutions List.

- Resource Adequacy
- Transmission Security
  - Steady State,
  - Dynamics,
  - Short Circuit, and
  - Transmission Security Margin.
- Additional Transmission Owner Local Criteria

2.3.7 System Planning Documents

In accordance with Attachment Y of the OATT, the NYISO's Comprehensive System Planning Process (CSPP) is used to plan for the impact of expected changes in energy supply and demand on the NYISO transmission system over a ten year forecast horizon on a biennial basis. The CSPP Flowchart illustrates the three key processes and how they build off one another to identify and establish needs.

- Reliability Planning Process (RPP) – focused on what the reliability needs are by conducting a reliability needs assessment and then solicit solutions that are commercially viable. This also includes a Local Transmission Owner Planning Process (LTOPP) wherein each TO produces their planning documents and posts them on their website. The LTOPP reports include a description of the needs addressed by the LTPP as well as the assumptions, applicable planning criteria and methodology utilized, and the policy requirements considered. Reports produced by the NYISO include:
  - STAR report as discussed in section 2.3.6,
  - Reliability Needs Assessment (RNA) report, and
  - Comprehensive Reliability Plan (CRP) report.
- Economic Planning Process (EPP) –focused on developing a system and resource outlook and then identifying potential transmission expansion opportunities by engaging with interested developers and conduct analyses to determine viability. Reports produced by the NYISO include:
  - System & Resource Outlook (Outlook) report, and
  - Economic Transmission Project Evaluation (ETPE) to process specific transmission projects for which developers seek to allocate and recover their projects' costs through the NYISO OATT as Regulated Economic Transmission Projects
- Public Policy Transmission Planning Process (PPTPP) – this segment involves meetings with stakeholders to solicit solutions to meet the public policy transmission need and ultimately select a transmission project. Reports produced by the NYISO include:
  - New York Public Policy Transmission Planning Reports.

Stakeholders may also request confidential additional reliability and economic planning studies utilizing NYISO's databases, CEII access is required.

Reliability Needs Assessment

The RNA is the first step in the RPP and evaluates the NYISO transaction system reliability over the next decade that begins four years from the current year, i.e., years four thorough ten, and is made available in PDF format. The study factors in the current state of the grid and key policy decisions as well as multiple assumptions that are described in the report:

- Load Forecast,
- Changes in Generation, and
- Bulk and Local transmission projects.

The report also describes the methodology used the assess system needs. The study is conducted over multiple scenarios that factor in various policy and economic factors such as:

- Base Case,
- High / Low Load Forecast,
- Weather,
- Status Quo, i.e., ignores major generation and transmission projects form the base case, and
- Climate Leadership and Community Protection Act (CLCPA) policy based scenarios.

Historical RNA reports dating back to 2007 are available. The report is supported by a datasheet, in PDF format, as well as a list of appendices which are bundled into a single PDF document:

- Glossary of terms,
- Overview of the reliability planning process,
- Load and Energy forecast for the next decade,
- Resource Adequacy and Transmission System Security Base Case Assessments,
- Scenario assumptions and results
- Transmission Security Margins, and
- Historical Congestion.

Comprehensive Reliability Plan

The CRP follows the RNA and also factors in findings from the STAR reports as it evaluates system reliability over the next decade by forecasting demand and generation as well as transmission capabilities. Like the CRP, scenarios surrounding generation load and transmission are also evaluated but a notable difference is that the base case incudes conservative inclusion rules.

Historical CRP reports dating back to 2005 are available. The report is made available via PDF format, as are the appendices which are bundled into a single PDF document:

- Glossary of terms,
- List of planned projects and assumptions,
- Description of Resource Adequacy Models and analyses,
- Transmission Security Margins,
- Scenario assumptions and results,
- Overview of the reliability planning process,
- List of reliability compliance obligation activities, and
- List of Bulk Power Transmission Facilities (BTPF).

System and Resource Outlook

For the first time in 2021, the NYISO published the System & Resource Outlook (Outlook) report that provides a twenty year forecast of system resources and transitions constraints whilst highlighting potential economic and policy driven opportunities for transmission investment. Scenario analysis is conducted to evaluate the system under various economic and policy conditions:

- Baseline Case – business as usual scenario with conservative inclusion rules for new projects and uses the energy and demand forecasts form the latest Gold Book.
- Contract Case – builds upon the Baseline Case by inducing renewable projects that are recipients of the New York State Energy Research and Development Authority (NYSERDA) Renewable Energy Credit (REC) contracts and thus have a higher probability of completion but do not yet meet Baseline inclusion criteria.

- Policy Case – incorporates various federal, state and local policies that impact the NYISO transmission system such as 70 x 30 renewable mandate, i.e., 70% renewables by 2030, and the 2040 zero-emissions directive.

This report replaced the now-retired Congestion Assessment and Resource Integration Study (CARIS). It provides assumptions for each scenario regarding the generation and load resources included as well as transmission congestion assumptions. The report also discusses various Renewable Generation Pockets, how they are defined, what energy they can deliver and the key takeaways from a system reliability and planning perspective.

The report is provided in PDF format and is accompanied by several appendices, each of which are provided in a separate PDF document:

- Glossary of terms,
- Other Economic Planning Studies that stakeholders can request the NYISO conduct at their cost, namely:
  - Requested Economic Planning Study, and
  - Economic Transmission Project Evaluation.
- Production Cost Assumptions,
- Capacity Expansion Assumptions,
- Modelling Assumptions and Methodology by scenario,
- Results and Summary Charts by scenario,
- Capacity Expansion Scenarios,
- Detailed Baseline and Contract Case Results,
- Transmission Congestion Analysis by scenario, and
- Renewable Generation Pockets by scenario.

The Outlook report is also accompanied by a series of supporting documents in Excel format which also include an information tab that describes the file and the data provided on each tab:

- Outlook Policy Case Additions – final capacity expansion modelling results by zone for select forecast years.
- Renewable Profiles – generic hourly capacity factors for utility scale solar, wind and offshore wind by zone.
- Hourly Zonal LMPs – hourly DA LBMP forecasts for select years by zone.
- Monthly Average Zonal LBMPs – monthly average LBMP and number of negative price hours by peak and off-peak periods for select forecast years by zone.
- Hourly Load Forecast – hourly load data forecast by zone for each scenario.
- Policy Case Zonal Capacity Expansion Preliminary Results – preliminary capacity expansion results for select forecast years for aggregated zones.
- Fuel Price Forecast – annual and weekly price forecasts for uranium and coal, and natural gas and fuel oil respectively.
- Emissions Price Forecast – annual emission allowance forecast pries for SO_2, NO_2 and CO_2.
- Contract Case Renewable Projects – list of renewable projects with flags for which are included in the base case along with various project details such as eligibility, solicitation name, REC price, technology, counterparty, developer, capacity, location and zone, interconnection queue number, project status, start date, and contract quantity (MW).

Public Policy Transmission Planning Process

The New York Public Policy Transmission Planning Process consists of three phases: i). identification of public policy related transmission needs, ii). Requests for projects to address needs, and iii) Selection of the most efficient and cost effective projects. The reports detail the specific public policy related needs, the methodology used to evaluate the various proposals along with associated assumptions as well as key evaluation metrics such as:

- Capital Cost Estimates
- Cost / MW ratio,
- Expandability,
- Operability,

- Performance,
- Production Cost,
- Property Rights and associated challenges,
- Potential Construction Delays.

The report ranks various projects and makes recommendations based on which projects would have the most impact in the most cost effective manner. The reports and supporting appendices are made available in PDF format. Recent reports include the Western New York Public Policy Transmission Planning Report (2017) and the AC Transmission Public Policy Transmission Planning Report (2019).

2.3.8 Requesting Data

There are two ways to request data from the NYISO depending on the nature of data: Public or Critical Energy Infrastructure Information (CEII):

- Public Information – For general data requests an email can be sent to stakeholderservices@nyiso.com, and the requests are handled on a case-by-case basis with no strict time frame in place. There are no costs to request the data. If the NYISO determines that the data can be made available, it is posted to the appropriate section of the website for all to access.
- Critical Energy Infrastructure Information (CEII) – To access the NYISO's CEII data, the requestor must demonstrate a clear need for that information and in accordance with the process, fill out the NYISO CEII Request Form and the NDA specific to the requested information. Once submitted, the individual will receive an email requiring a signature and notification that an inquiry has been started due to the request. After the review it will be determined if the request has been approved, denied, or if more information is required. There are no specific timelines to grant access or publicly stated costs. If the request is approved, the user is required to create a digital MyNYISO account which enables access to CEII data such as:
  - Operating Committee documents,
  - Planning documents, and
  - Reliability Analysis databases.

2.4 New England Independent System Operator (ISO-NE)

ISO-NE publishes market data on the ISO Express section of its website, which includes a dashboard of real time data.[3] Standardised reports can be downloaded in CSV format by the general public, usually with a limit of seven or fifteen days of data at a time depending on the granularity of the data, e.g., 5-minute interval vs. hourly data. Hourly data is provided in a separate file for each day and five-minute data is provided in a separate file for each four-hour period of a given day. When multiple days are queried at a time, a zip folder with multiple files for the appropriate time intervals is provided.

The ISO also makes all public data available via a web services API, where there are no limits on the amount of data that can be downloaded at a time. A detailed list of REST API Endpoints allows users to download various data programmatically by connecting to the appropriate Endpoint. This section focuses on the report's portal, i.e., the ISO Express as well as other sections of the website as appropriate, but all the same data is also available via the web services API.

The ISO-NE Information Policy, Attachment D in the tariff[4], details the rules and guidelines with respect to the collection and disclosure of all information related to the participation and operation of all markets administered by ISO-NE. The rules contained herein bind the ISO and all market participants with regards to what information can be made publicly available, what is considered to be confidential information and how it must be treated. Section 3 details what information can and cannot be made public. All data requests submitted to ISO-NE are tracked. Non-Disclosure Agreements and Certification Forms required for certain types of data are also provided in the appendices.

2.4.1 Energy Market Clearing Prices

ISO-NE publishes RT and DA locational marginal prices (LMPs) in the Energy Pricing Reports section of ISO Express. The following energy price data is made available:

[3] Including system load, short term load forecast, hourly and five-minute prices, resource mix, emissions, and interconnect transfers.
[4] Complete ISO-NE Tariff.

- Hourly Day Ahead LMPs,
- Preliminary Real Time 5-minute LMPs,
- Preliminary Real-Time Hourly LMPs,
- Final Real-Time 5-minute LMPs,
- Final Real-Time Hourly LMPs,
- Weekly LMP indices, and
- Monthly LMP indices.

The LMP data includes the detailed breakdown of its components, namely the Energy, Congestion and Marginal Loss components. Queries are limited to fifteen days at a time for hourly data and six days at a time for 5-minute data. Custom LMP reports can also be created for select nodes for hourly day ahead, 5-minute real time and hourly real time data wherein 45 days' worth of data can be downloaded at a time going back 7 years.

The price data are indexed by pricing nodes ("PNode"). Pricing nodes include network nodes and several types of aggregated nodes: zones, interfaces and the Hub node representing the entire control area. PNodes are numbered, although the Day Ahead Hourly LMP data include node names. Node names may also be obtained from the contemporaneous PNode list. The PNode list separately identifies network nodes and aggregated nodes (for which average prices are supplied). Aggregated nodes include zones (the PNode list shows the zone for each network node), interfaces, DRR Aggregation zones, and the New England control area hub. The PNode list identifies the zone and DRR Aggregation zone to which each network node belongs.

Annual compilations of Zonal Data are also available in Excel format at hourly, daily and monthly levels of granularity which include LMPs along with the breakdown of its components for each of the eight zones, Maine (ME), New Hampshire (NH), Vermont (VT), Connecticut (CT), Rhode Island (RI), Southeast Massachusetts (SEMA), Western/Central Massachusetts (WCMA), and Northeast Massachusetts (NEMA). The regulation service and capacity prices are also provided but only at the aggregate ISO-NE level. LMP price statistics, namely the 5-minute minimum, maximum and standard deviation for the total LMP and the congestion component are also provided for twenty Price Responsive Demand (PRD) Aggregation Zones. A notes tab at the start of the file clearly describes each column.

The ISO also publishes a series of reports to illustrate the average costs associated with serving a real-time load obligation in the New England Wholesale Markets. These reports are intended to emphasize and underscore the locational aspects of the component costs of electricity in each location. This includes hourly wholesale load costs for each of the eight load areas, monthly average wholesale load costs, and yearly average wholesale load costs. These reports break out almost all components of service costs, including LMPs, capacity costs, ancillary service costs, transmission auction revenue rights costs, demand response resource costs, PRD costs, and market fees. These components are broken for each zone but not for the aggregate ISO control area as a whole, i.e., the Hub.

2.4.2 Energy Offers and Bids

ISO-NE publishes RT and DA bids and offers in the Offers, Bids & Threshold Prices section of ISO Express. Energy offer and bid data are published monthly on the first day of the fourth month following the operation month, as per the FERC ordered 4-month lag period. All bids and offers used by the DA and RT markets are published, whether cleared or not.

Facility and participant names are masked, with a numerical ID provided instead. Energy bids and offer records include operating limits (must take energy, maximum daily energy, economic minimum, and maximum quantities), three part offers (cold/intermediate/hot start-up prices, no load prices, and up to ten marginal energy price-quantity pairs), and other operating parameters (CLAIM10, CLAIM30, which relate to the MW that can be online within 10 and 30 minutes respectively of receiving a dispatch instruction).

2.4.3 Historical Generation and Demand

ISO-NE publishes historical demand data in the Demand and Energy and Peak Load sections of ISO Express. The data published includes:

- Five-Minute System Demand – Total recorded MW load broken down into native load and asset related load for the New England Balancing Authority Area (BAA) in a separate CSV file for each day.

- Hourly Day-Ahead Cleared Demand – Total recorded systemwide demand cleared in the Day Ahead Energy Market.
- Hourly Real-Time System Demand – Total recorded systemwide demand for each hour of the day. Current data are made available in approximate real-time.
- Zonal Information – Annual compilations of hourly, daily and monthly load, demand, and weather data for each of the eight load zones and the BAA. This data includes day ahead cleared demand, real time demand, weather data (dry bulb, CDD, HDD), as well as pricing data as discussed in section 2.5.1.

Hourly reports are available for the last seven years and 5-minute reports are available for the past year. Custom queries for specific hubs or zones can also be written allowing the user to pull up to 45 days' worth of data at a time. Alternatively, users can download hourly load for an entire year in a single file in Edison Electric Institute format.

The ISO also publishes, at the level of the New England control area, aggregated generation output data:

- Daily Generation by fuel type – Total metered generation (in MWh) from each fuel source.
- Solar Generation – Total metered hourly solar generation (in MWh), and the number of solar units with non-zero output.
- Wind Generation – Total metered hourly wind generation (in MWh), and the number of wind units with non-zero output.

These data are published in Excel format, with a year of data in each report, available from 2011 up to a few days prior to the current day. The reports only include wholesale market registered generators, not distributed behind the meter facilities. When fewer than four wind or solar units had output in a given hour, the total output value is not provided, to protect data confidentiality. Solar data is cleaned to remove anomalous overnight generation readings.

The ISO publishes various summarised monthly or annual data:

- Net Energy and Peak Load – annual compilations of monthly supply and peak loads.
  - MW Data is provided for the peak day, the peak FCM supply day, and for telemetered data.
  - GWh energy data is provided for supply, pumping/charging load, and net interchange. It is also split out by each of 14 different fuel sources[5], and import/export for each of the six interconnections to neighbouring control areas[6].
- Historical Hourly Flows and Limits – Annual compilations of hourly and monthly flows and limits on each interconnector in Excel format, accompanied by a pdf format report describing the methodology and file formats.
- Summer and Winter Normalised Peaks – PDF format reports detailing methods and results of adjusting actual peak data for the prevailing weather, to determine a weather neutral peak demand for more accurate comparison across years.
- Network and Nodal data:
  - Nodal Load weights – Monthly csv files containing hourly load and price data for each pricing node in one of the eight load areas. The ISO also publishes a summary file giving mean, maximum, minimum, and standard deviations of load participation percentage of the eight load zones. Data is available for the previous calendar month, and earlier data can be queried via a separate dialog up to two months at a time, though some are available via the Nodal load weights archive.
  - Regional Network Load – monthly csv files containing contact details and monthly MW load values for 161 offtake customers.

As part of the long term Capacity, Energy, Load and Transmission (CELT) planning process, discussed further in section 2.5.4, the ISO also publishes the following via the Load Forecast section:

[5] Coal, gas, hydro, nuclear, oil, landfill gas, methane, refuse, solar, steam, wind, wood, other, price responsive demand.
[6] New Brunswick, New York-Northern AC Ties, Hydro-Quebec Phase II, Hydro-Quebec Highgate, New York-Cross Sound Cable, and New York-Norwalk/Northport.

- Historical BTM PV data - Estimates of total hourly installed capacity and normalised production from behind-the-meter photovoltaic installations in each of the eight wholesale load zones for the current year and the previous eight years.
- Historical Energy and Demand Data - Net and gross energy, coincident and non-coincident peak, load factor, and following peak for New England and each constituent state.

2.4.4 Forecast Generation and Demand

Short Term forecasts

The Morning Report is published daily, with the best estimate of expected capacity available to meet peak-hour electricity demand and reserve requirements. The report can be viewed on the webpage wherein users can hover over various sections to get a more detailed description of each line item or can also be downloaded in CSV format. The report details the expected weather forecast and load for the peak hour along with the breakdowns of the various energy, reserves and import capacity available to meet demand and what, if any, special actions are planned to ensure system reliability.

The ISO publishes Three Day Forecasts at two levels of locational granularity:

- The Three-Day System Demand Forecast gives ISO-NE's hourly systemwide demand forecast for the current day and the next two days. It shows the expected amount of electricity to be used in the New England BAA: CT, RI, MA, VT, NH, most of Maine. The forecast is updated twice daily at 6am and 10am ET.
- The Three Day Reliability Region Demand Forecast gives ISO-NE's hourly demand forecast for each day (as forecasted in-day and the two preceding days) for each of the eight reliability regions[7]. Demand is given in MW, and as a percentage of the total balancing area demand[8]. The report is updated daily, usually in the morning ET.

The ISO publishes Seven Day Forecasts for demand and for wind generation. The Seven-Day Capacity Forecast is a daily summary of factors affecting the power system from two to seven days out:

- Weather: forecast highs and dew point temperatures for each of Boston and Hartford
- Generating capacity for the balancing area (all in MW): anticipated cold weather outage, other anticipated outages, anticipated de-list capacity, anticipated import at time of peak
- Load: projected peak load, required reserve, required reserve including replacement, available demand side resources, available real-time emergency generation
- Overall projected surplus or deficiency (in MW).
- Whether the ISO has made load relief notifications[9] for each day in the forecast horizon. This provides enough time for market participants to respond to capacity deficiencies and trigger the commitment of generators with start times greater than 24 hours.

The Seven Day Wind Forecast is published daily before 10am ET and includes a forecast of total wind generation in the New England balancing area for each hour of the next seven days, starting from the hour the report is published. Users can download reports for up to 15 days at a time, back to April 2016. Forecasts are available back to May 2013, though the period before April 2016 are published in a different format via an archive page.

All reports are published in CSV format.

Medium Term forecasts

The ISO's 21-Day Energy Assessment Forecast and Report is published fortnightly in PDF form. It shows the current system condition (Normal, FEEA1, FEEA2, or FEEA3) and the oil and distillate consumption over the previous fortnight (in Gallons) in tabular form. It also shows, in chart form, at the hourly level of granularity, the energy surplus forecast for the next five and twenty-one days, temperature and load forecast for the next 21 days.

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[7] Northeast Massachusetts (including Boston), Southeast Massachusetts, Western/Central Massachusetts, Connecticut, Maine, New Hampshire, Rhode Island, and Vermont.
[8] Forecasts before 25 May 2017 are available from the Three-Day Reliability Region Demand Forecast Archive. These reports are in a different format and include the current day and the next two days.
[9] The ISO has two levels of alert for energy shortfall events (power watch and power warning), and three levels of alert for cold weather (watch, warning, and event).

The report also contains forecasts of fuel availability and MW capacity of oil-fired units, accounting for available fuel supplies. In addition to publishing this data, the ISO also provides infographics and press releases calling attention to issues that may cause problems in the months ahead.

Long Term forecasts

ISO-NE prepares Long Term Load Forecasts as part of long term planning processes and publishes them in its annual 'Forecast Report of Capacity, Energy, Loads and Transmission' (the CELT report). Through this process, the ISO provides 10-year projections of electric energy usage and seasonal peak demand for the region, states, and load zones. Data is available for download in Excel format. Specifically:

- Projections of summer and winter peak demand for each of the next ten years which includes gross and net forecasts, both net of BTM solar, and net of BTM solar and load reductions from energy efficiency.
- Monthly projections of peak load (MW) and energy usage (GWh) for the next two years (as well as actuals for the previous year) which includes the gross and net of behind the meter solar for the 50% probability of exceedance (POE) forecasts.
- POE forecasts for summer and winter peak load for each of the next ten years, for the 5% POE and the 10% through 90% POE in 10% POE increments.
- Forecasts of annual energy as well as summer and winter peak demand impacts of heating and transportation electrification by state for each of the next ten years.

The CELT report is supported by a detailed set of forecasts for load, energy efficiency and distributed generation that are provided in separate files and can be easily downloaded from the main CELT page.

- Load Forecast including 10-year hourly forecast for the region as a whole, for each of the eight load zones, and for each of the thirteen sub areas, in Edison Electric Institute format as well as 10-year summer peak, winter peak, and energy forecast for ISO-NE and each state in Excel format, broken down into gross load, heating electrification, transport electrification, PV and EE forecasts.
  - Transport electrification forecast and assumptions in pdf format, including
    - EV uptake by year by state broken into personal vehicles and fleet vehicles, with fleets broken further into light duty, medium duty, school buses and transit buses,
    - Vehicle miles travelled,
    - Vehicle efficiency by temperature,
    - Daily charging profiles in each month for each vehicle category,
    - Annual, monthly, and hourly energy usage for each vehicle category,
    - Monthly EV demand by state,
    - Summer and winter peak EV demand by state,
    - Comparison of changes since the previous forecast, and
    - Interaction of EV demand and BTM PV.
    - Heating electrification forecast and assumptions in pdf format, including: incremental air source heat pump adoption by year by state for the 10-year forecasting horizon, share of installations which are full- or part-heating installations, location and weighting of weather stations used to determine temperature assumptions for each state, 10-year monthly heating energy and peak demand forecasts for each state, and check of model outputs by using AMI meter data samples to compare equivalent households with and without electric heating.
  - A compendium of forecasting inputs, including:
    - 10-year annual forecast of summer peak and winter peak demand, BTM PV, total annual energy and energy efficiency for ISO-NE and each of the six states, thirteen sub areas, and eight load zones, for both the 95th percentile (50/50) and 99th percentile (90/10) peak weather cases along with 90% confidence intervals for each forecast,
    - 10-year monthly forecast of total energy and peak demand (gross and net of BTM PV and energy efficiency) for the 50% POE case, and gross summer and winter peaks for the 10% through 90% POE cases, for ISO-NE and each of the six states,
    - Economic and demographic variables from the past 30 years, including Net Energy for Load, Energy Efficiency Resources, Price Responsive Demand Resources, Behind-the-Meter Solar PV generation, Price of Electricity, Population, Income, Total Gross State Product, Cooling Degree Days, and Heating Degree Days. Data is provided for ISO-NE and each of the six states,

    - Comparison of the change in forecasts from the previous year,
    - Projected proportions of load served by distribution operating companies that falls into each of the thirteen sub areas for the first and last years of the ten-year study horizon,
    - 10-year weekly forecast of peak load, mean load, standard deviation, and skewness for the ISO-NE area, and
    - Annual summer and winter passive demand (as participating in capacity market) in each state (16 years historical, 4 years forecast).
  - Monthly variables and diagnostic parameters (one for each month of the year, not for each month of each year in the study horizon) for the peak and energy forecasts for New England and each of the states
  - A forecasting procedure setting out the methodology used to generate the forecasts and statistical checks undertaken on the results.
- Energy Efficiency data in PDF format, with various data in tables and charts, covering:
  - Forecast process and methodology,
  - Residential and low-income end-use shares by state, divided into HVAC, process, hot water, lighting, and refrigeration,
  - Commercial and industrial end use shares by state, divided into compressed air, customer measures, hot water, HVAC, lighting, motors/drives, lighting, process, and refrigeration,
  - Incentive rates for each end-use,
  - Summer and winter coincidence factors for each end use,
  - State energy efficiency budgets for each year in the 10-year forecast horizon,
  - Total energy efficiency production costs by year for each customer segment (residential/low income, commercial/industrial),
  - Forecast reductions in total energy and summer and winter peak demand by year, by state. Data is provided gross and net of expiring measures, and
  - A comparison between the current forecast and the previous forecast.
- Distributed Generation forecast in PDF format. While ISO-NE considers three categories of solar resources[10], this report focuses only on behind the meter PV, because it appears to the ISO as a part of system load, while the other two categories generally participate in wholesale markets. The report includes:
  - Comparison between forecast and reported growth for the previous year,
  - Existing BTM PV installations and capacity by state and utility, based on surveys of distribution owners in the ISO-NE control area. Data is provided in tabular form as well as in heat map form for each state,
  - Forecast assumptions for each state, including state tax credits, investment incentives, and discount factors,
  - 10-year annual forecast BTM PV nameplate capacity by state, both as incremental and absolute MW, in tabular and graphical form,
  - Assumed capacity factors by state (annual in tabular form, and monthly in graphical form),
  - 10-year forecast by state of annual panel age and degradation factors energy forecast from BTM PV (grossed up for avoided network losses), market participating PV nameplate capacity, summer peak load reductions from BTM PV, and
  - Assumed geographic distribution of BTM PV within each of the eight sub areas.

2.4.5 Unit Generation Schedule and Dispatch

This information is neither made publicly available nor via an NDA as unit specific information is considered confidential. However, ISO-NE publishes Real-Time Actual Scheduled Interchange Data by interface for the exchange of energy between New England and neighbouring balancing authority areas, as scheduled the previous day on an hourly basis. Historical hourly data is available for the past 7 years.

2.4.6 System Impact Studies

New and retiring generators and new loads are required to facilitate various studies, carried out either by ISO-NE or by the relevant utility responsible for the local connection prior to connecting or disconnecting

[10] PV as a capacity resource in the Forward Capacity Market; Non-FCM Energy Only Resources (EOR) and Generators; Behind-the-meter PV

from the system. The results of these studies are classified as CEII, and while not publicly available, can be requested under the process referenced in section 2.5.8.

In accordance with provisions of the *Open Access Transmission Tariff* (OATT), interconnection studies include proposals for generator and elective transmission upgrade[11] interconnections and supplemental transmission service for New England's grid. The projects listed in the ISO's Interconnection Request Queue are typically studied serially, according to the order in which the requests are received. Studies are performed to ensure that system reliability criteria and standards for no adverse impact are met. They typically consist of thermal, voltage, stability, and short-circuit analyses, with electromagnetic transient (EMT) analysis also performed for inverter-based resources.

ISO-NE publishes the transmission interconnection queue, giving detail on proposed generation, storage, and transmission projects signalled by developers and market participants. This includes the name, location, description, fuel type, summer and winter capacity, date of the initial request, expected commissioning date, project status, and links to completed studies. New generators complete up to three Interconnection Request Studies as set out in the ISO's interconnection process guide:

- Feasibility Study,
- System Impact Study (SIS), and
- Facility Study.

All interconnections require a System Impact Study, which assesses how the new facility will impact the power system. A feasibility study selects certain areas of the SIS to focus on but can be skipped in favour of going direct to the SIS. The Facilities Study focuses on the specific infrastructure required to connect the new facility, along with cost and time estimation for the interconnection project. The studies are classified as CEII, but they can be requested by following the instructions listed in section 2.4.8.

System studies for new loads are complicated and depend significantly on the interconnection point. If the load is connecting directly to the Pool Transmission Facility (PTF), these CEII classified studies can be found here: Interconnection Request Studies.

Retiring generators must first shed all their Capacity Supply Obligations (CSO) and are not eligible to retire until they have done so. The market participant must initiate the retirement in the Customer and Asset Management System (CAMS). All the parties involved with the asset need to approve the retirement request by the action deadline date. A Retirement Questionnaire is required to be completed to ensure all necessary actions are taken to successfully retire generator asset that is mapped to a FCM resource.

Detailed Asset Retirement Instructions and Asset Retirement Video are provided on ISO-NE's website. Studies relating to an ISO decision to deny or delay a retirement request are CEII, however the outcome of the study is made publicly available via Historical Nonprice Retirement Requests and Determinations. Nonprice retirement requests were allowed from the fourth through the tenth Forward Capacity Auction (FCA), with the last retirements of this type effective on or by May 31, 2019.

2.4.7 System Planning Documents

Every three years, ISO-NE prepares a Regional System Plan (RSP) as required under Section K of its tariff. This plan forecasts the region's electricity needs, and the plans for resources and transmission facilities to meet those needs over a 10-year horizon, while also accounting for market efficiencies and economic and environmental considerations. The plan summarises assumptions and outputs for the 10-year planning horizon including:

- Load forecasts including annual energy and peak load, heating and transportation electrification, energy efficiency (energy and demand savings from EE initiatives that participate in the capacity

[11] As per Schedule 25, Elective Transmission Upgrade Interconnection Procedures pdf page 10, Elective Transmission Upgrade (ETU) is defined as "a new Pool Transmission Facility, Merchant Transmission Facility or Other Transmission Facility that is interconnecting to the Administered Transmission System, or an upgrade to an existing Pool Transmission Facility, Merchant Transmission Facility or Other Transmission Facility that is part of or interconnected to the Administered Transmission System for which the Interconnection Customer has agreed to pay all of the costs of said Elective Transmission Upgrade and of any additions or modifications to the Administered Transmission System that are required to accommodate the Elective Transmission Upgrade. An Elective Transmission Upgrade is not a Generator Interconnection Related Upgrade, a Regional Transmission Upgrade, or a Market Efficiency Transmission Upgrade."

market); and distributed solar PV. Data is generally presented annually by state and is a summary of the data published in the CELT (see section 2.5.4 for the detailed load forecast information available).

- Resource adequacy forecasts, covering:
  - Expected procurement of capacity in the capacity market including installed capacity requirements, local resource requirements and limits, import capabilities, capacity supply obligations already in place through the Forward Capacity Auction, and the expected capacity surpluses or shortfalls,
  - Ancillary services forecasts including operating reserves and regulation. These parameters are not represented as absolute numbers. The report instead gives the basis on which they are to be calculated in real time, restating the NERC criteria that define the dynamic contingency measures that are the basis for the real-time requirement, along with limits that must be respected and the required response time. Expected values are given as ranges for system-wide and locational requirements for major import areas, along with qualitative commentary on expected future trends,
  - Generation and other resource development covering the existing generating capacity by state and load zone, a qualitative assessment of fuel markets and infrastructure, high level data on the generation interconnection queue by state and resource type, assessment of historical withdrawal and commitment rates, and discussion of the study results indicating what network investment will be required to connect these new resources, and a discussion of underlying trends (including state and federal policies) that are affecting the makeup of the future power system,
  - Discussion of the results of any economic studies conducted. These studies are performed on request by external parties, and generate estimates of production costs, transmission congestion, electric-energy costs for New England consumers. These metrics suggest the most economical locations for resource development and the least economical locations for resource retirements. While the RSP does not include the detailed results, they are available elsewhere on the ISO website (more discussion below), and
  - Discussion of and links to any interregional studies conducted with neighbouring jurisdictions.
- Transmission outlook, summarising and linking to past and current transmission planning studies (see Key Study Areas below) and providing status and cost data for specific transmission projects (separately updated three times a year in the RSP Project List, discussed further below), and historic costs of market congestion and locational services provided by generators.
- Environmental considerations, including discussion of the impacts of recent legislation on system operations, a summary of state level environmental plans and policies, and overall trends in greenhouse gas emissions.
- Other state and federal policy initiatives that are likely to affect the power system.

The Regional System Plan is supplemented by a number of other publications, including:

- The RSP Project List, updated three times per year, providing detail of existing, planned, and cancelled transmission projects in each state. The list is provided in Excel format, and for each project it shows: project name and description, the primary reason for the project (reliability, elective, or generator interconnection), the tariff part under which the project is conducted, equipment owners, current status (concept, proposed, planned, under construction, or in service), in-service dates (projected and actual), approval dates, and estimated costs where available (including a comparison with the previous costs where they have changed). Changes since the previous version are highlighted for easy visibility.
- The Asset Condition List, updated three times per year, providing detail of existing, planned, and cancelled projects to maintain or upgrade existing transmission equipment. It contains the same information as the RSP project plan, but the primary driver is Asset Condition for all projects.

ISO-NE also publishes planning information for:

- Key Study Areas, for which there is at least one in each state. These are organised around specific projects, and most information is confidential, requiring a CEII request through the process discussed in section 2.5.8.
- Market Efficiency Transmission Upgrades, which are upgrades which aim to reduce total production cost to supply system load. Material is provided in PDF form, and some is classified as CEII. Publicly available material includes high level study results, options considered, estimated production cost

savings, estimated effects on LMP, changes to interface flows, emissions changes, status, and next steps.

- Public Policy Transmission Upgrades, which are improvements of or additions to the regional transmission system designed to meet state, federal, and local public policy requirements identified as driving transmission needs. These materials are similar to the other upgrade types (with some material classified CEII) but have a greater focus on stakeholder consultation processes.

CELT Reports, discussed earlier in section 2.5.4, provide a detailed 10-year forecast of electricity demand in New England. The CELT reports also reflect demographic, economic and market information including scheduled and proposed transmission changes, project listings and summaries of future resources. These data are used as assumptions in power system planning and operations reliability studies. The report is in Excel format, and provides:

- Summer and winter capacity supply obligations (CSOs) by fuel/unit classification and load zone for new and existing generating capacity resources, demand capacity resources, and imports,
- Generator data for all in service assets including name, ID, location, fuel type, responsible participant, nameplate capacity, seasonal claimed capability (SCC) for both winter and summer of the current year, and gas pipeline connections for gas fired resources,
- Net summer and winter import and export capacity to each neighbouring balancing authority,
- Forecasts of PV resource nameplate capacity by category (i.e., in market and BTM) and state for each year of the planning horizon,
- Annual BTM PV energy production by state,
- Qualified and cleared capacity for all resources that participated in the most recent forward capacity auction,
- Summer and winter network resource capability (NRC) and capacity network resource capability (CNRC) for the current year,
- Qualified capacity of each existing demand capacity resource (DCR), and cleared CSO for each new DCR, by state, dispatch zone, whether active or passive, for each summer and winter in the next four capacity commitment periods, and
- Peak load, energy efficiency, and BTM PV forecast data the ISO uses for transmission planning, for each year of the planning horizon.

2.4.8 Requesting Data

Attachment D of the ISO-NE tariff (the ISO New England Information Policy) defines how ISO-NE classifies data and what can and cannot be made public. There are two ways to request data from ISO-NE depending on the nature of data: Public or Critical Energy Infrastructure Information (CEII).

- Public Information – ISO-NE provides a form to request public information or data not already provided by the ISO. Data requests are published in the ISO's Data & Information Request Tracker which is updated quarterly. This form requires the individual wishing the information to provide detailed description and purpose of the request as well as the date range, location (system, zone, region or other), periodicity of data (five-minute, hourly, daily, weekly, monthly, quarterly, yearly, or other), publishing frequency and the preferred delivery format. The data format can be CSV/PDF/DOC depending on the nature of the request. There is no cost to request data and ISO-NE works to respond as soon as possible.
- Critical Energy Infrastructure Information (CEII) – the process to request CEII data depends on whether one is a market participant or not.
  - For Market participants, their organization's Security Administrator (SA) for ISO's Customer and Asset Management System (CAMS) must register him/her into the CAMS database and grant the necessary roles and permissions to view CEII data. Once the necessary roles and permissions have been granted by the SA, an individual can view CEII data published on ISO-NE's website.
  - For Non-market participants, access is provided through the CEII Access Request form via Ask ISO. The individual will need to specify the request category along with the requested materials for ISO-NE to process the request. If data for multiple categories is needed, one must submit a separate request for each category.
    A list of categories and materials are provided via the Request Categories & CEII Materials portal and include Reliability Committee (RC), Planning Advisory Committee (PAC), Interconnection Request (IR) CEII Materials and Discrete Request of CEII Materials. An Online CEII Access

Request Form must be submitted via Ask ISO for the requisite categories.
ISO-NE will review the request, which may take up to two weeks and there are no publicly stated costs associated with the review, and if the request is granted instructions on how to access the data are received:

- For a RC, PAC, or IR request, how to retrieve and install the digital certificate, and
- For a discrete request, how to access the requested materials.

2.5 Midcontinent Independent System Operator (MISO)

Most MISO market data is available via the Market Reports webpage. The webpage also provides a Market Report Directory in Excel format which provides a list of all available datasets and their locations. The directory contains three tabs:

- Market Reports – describes the various datasets available via the Market Reports webpage wherein the folder column corresponds to the navigation pane. The reports available under each folder are described and includes details related to the update frequency, history, download path and download file format.
- Market Reports Data Elements – follows the same folder and report name structure as above and then proceeds to list all the data elements available within each report.
- Real Time Data URLs – provides a list of the various APIs that can be used to access various real time data along with the appropriate URLs that can be used to set up automated tools to extract the needed data. Most APIs have multiple links to allow the user to access the data in various formats, e.g., CSV, XML, JSON.

Each market report section has a reader's guide at the top of the page that describes the data. Should a user encounter challenges, such as missing data, a contact number is provided, and the user is requested to provide details regarding the specific report and file for MISO to investigate further. Data is generally provided in a separate file for each day, including via the API. In addition to the reports, MISO also publishes:

- a snapshot of high level market data on the Markets and Operations page which includes the current peak load forecast, total load, aggregated LMP for all of MISO, and net scheduled interchange,
- real-time Markets Displays, LMPs and constraint information, in map and tabular format which can be downloaded in Excel, CSV or JSON format, and
- real time Operational Displays showing fuel mix, system wide load, wind and solar generation as well as the day ahead forecast, intertie schedules and generator outages in graph format wherein the underlying data can be downloaded in Excel, CSV or JSON format.

MISO has a general retention policy of two years though some reports may be available further back in time under an archive section.

2.5.1 Energy Market Clearing Prices

MISO publishes DA and RT locational marginal prices (LMPs) in the Historical LMP section of the Market Reports webpage . The following energy price data is made available:

- Day-Ahead EPNode LMPs,
- Day-Ahead Market ExAnte and ExPost LMPs, wherein ExAnte LMPs are produced by the scheduling and dispatch software, based only on energy bids, and ExPost LMPs include allocated costs of committing Fast-Start generators,
- Historical Annual Day-Ahead LMPs,
- Historical Annual Real-Time LMPs,
- Real-Time 5-Min ExAnte LMPs,
- Real-Time EPNode LMP,
- Real-Time Final Market LMPs,
- Real-Time Preliminary Market LMPs, and
- Weekly Real-Time 5-min LMP.

MISO publishes data for two types of nodes: Elemental Pricing Nodes, EPNodes, and Commercial Pricing Nodes, CPNodes. EPNodes correspond to the individual physical nodes of the MISO Network Model and CPNodes represent the nodes of the MISO energy market, i.e., generators, hubs, interfaces

and load zones. The Day-Ahead and Real-Time EPNode files provide pricing data by EPNode whereas all the reports include pricing for only the CPNodes.

All data is in hourly format except for the specified 5-minute RT reports. Most of the LMP reports include the LMP as well as the Marginal Congestion Cost (MCC) and Marginal Loss Cost (MLC) components except for the DA ExAnte and ExPost and the RT Prelim and Final reports. The Real-Time 5-Min ExAnte report also includes the Marginal Energy Cost (MEC).

Each day's results are also summarized in the Real-Time Pricing Report which contains LMPs for the entire MISO system and each individual hub in hourly increments. The hubs include Illinois, Michigan, Minnesota, Indiana, Arkansas, Louisiana, Texas and Missouri. This report also includes other key data such as energy and demand cleared in MWh and dollars as well as the peak hour.

The Historical DA and RT Annual reports are available dating back to Jan 2016. Most other aforementioned reports are available dating back to January 2020 from the most recent full day, except for the Real-Time Preliminary Market LMPs available on a rolling four day basis and the Real-Time 5-Min ExAnte LMPs dating back to November 2020.

It takes three to five days for MISO to finalize preliminary LMPs, and only days for which prices have not been finalized, i.e., not available in the Real-Time Final Market LMP report, are represented by Real-Time Preliminary Market LMP reports.

MISO's Market Report Archives provides older historical pricing data in zip format. The reports vary with regards to how far back the data goes. Note that these archived reports are listed here the sequence in which they appear on the Market Report Archives page, which differs from the sequence of the recent reports on the Historical LMP page.

- Archived Day-Ahead Market LMPs – available from April 2005 through February 2015 in monthly zip files with one CSV file for each day of the month.
- Archived Annual Real-Time LMP 5-Min – available from January 2012 through May 2014 in monthly zip files containing one large CSV file for the entire month.
- Archived Day-Ahead EPNode LMP – available from February 2014 through December 2019 in monthly zip files with one zipped CSV file for each day of the month.
- Archived Day-Ahead Market ExAnte LMPs – available from January 2015 through December 2019 in monthly zip files with one CSV file for each day of the month.
- Archived Day-Ahead Market ExPost LMPs – available from February 2015 through December 2019 in monthly zip files with one CSV file for each day of the month.
- Archived Day-Ahead and Real-Time EPNode LMP – available for only January 2014 in single zip file which contains a CSV zip file for each day of that month.
- Archived Historical Annual Day-Ahead LMPs – available from 2011 through 2015 in annual zip files with four zipped CSV files, one for each quarter.
- Archived Historical Real-Time LMPs – available from 2011 through 2015 in annual zip files with four zipped CSV files, one for each quarter.
- Archived Real-Time 5-Min ExAnte LMPs – is available from January 2016 through December 2019 in monthly zip files with one CSV file for each day of the month.
- Archived Real-Time EPNode LMP – available from April 2014 through December 2019 in monthly zip files with one zipped CSV file for every day of the month.
- Archived Real-Time Final Market LMPs – available from April 2005 through December 2019 in monthly zip files with one CSV file for every day of the month.
- Archived Weekly Real-Time 5-Min LMP – available from June 2014 through December 2019 in monthly zip files with one CSV file for each week of the month.

MISO also publishes the current LMPs via the Markets Displays section of its website. The data is sourced from the Market User Interface and should be considered preliminary. The table is automatically refreshed every five minutes and allows the user to search for a particular node name or character sequence. Four types of pricing data are displayed:

- Hourly Day-Ahead Ex-Ante (current hour),
- Hourly Day-Ahead Ex Post (current hour),
- Five Minute Real-Time (current interval), and
- Last Hour Estimated.

The table displays the LMP as well as the MLC and MCC components. The data in this table can be filtered to show MISO North, Central, or South and can be exported into CSV, XML, and JSON format. It also includes an LMP Contour Map, which shows the hub price points in the MISO market and by hovering over a point user can display a pop-up containing the LMP, MLC and MCC for that point.

2.5.2 Energy Offers and Bids

MISO publishes anonymized Offers from generators, energy storage and some demand response resources with a three month lag. MISO publishes cleared energy offers for both Day-Ahead and Real-Time markets.

Generation units are reported by code, along with their region, which are consistent over time rather than by name to anonymise the data. Full details of each offer and some output parameters are provided for each hour of the day, including:

- economic and emergency maximum/minimum MW,
- flags for whether the unit is cleared in economic or emergency range,
- flags for whether the unit is available, or must run,
- self-scheduled MW quantity,
- ten price quantity pairs,
- the cleared MW for each of the twelve 5-minute intervals in an hour the RT report,
- curtailment offer price and target MW reduction in the RT report, and
- for storage resources: min/max energy storage level and minimum/maximum emergency energy storage level.

MISO also publishes anonymised, cleared, Bid data with a three-month lag. Market participants are similarly identified a code, along with their region to anonymise the data. Full details of each offer are provided for each bid, denoted by a bid id, for each hour of the day, including:

- nine price quantity pairs,
- LMP and MW values for which the bid applies, and
- type of bid, i.e., decrease, increase, fixed and price sensitive with the first / last two being virtual / physical bids respectively.

There is no distinction made for cleared vs. uncleared bids. Historical data dating back to January 2020 is available for both offers and bids data.

2.5.3 Historical Generation and Demand

MISO publishes actual hourly load for the previous day via two Summary reports:

- Daily Forecast and Actual Load by Local Resource Zone (LRZ),[12] – reporting on each zone either on its own or grouped with another LRZ as well as at the system level.
- Daily Regional Forecast and Actual Load – covering each of the three regions[13] as well as at the system level.

Each file contains the actual load data for the previous day based on submitted meter data as well as medium term load forecast (MTLF) for the current and next 5 days for the LRZ report and the current day for the regional report. Both reports are available dating back to January 2020.

Annual summaries of the aforementioned reports, i.e., by LRZ and by region, are also available dating back to January 2020. Both annual summaries provide historical actuals and MTLF data though the exact vintage of the MTLF for each historical hour is not known. The data is spread across one or two summary Excel files for each year.

MISO maintains a historical archive of the daily and annual summary reports which follow the same structure as the outline above. The daily archives are available in monthly zip files which contain a CSV file for each day of the month.

[12] A map of the LRZs may be found in MISO Tariff Attachment VV. This report groups zones 2 and 7; zones 3 and 5; and zones 8,9 and 10.
[13] Zones 1 and 3 make up the MISO North region; zones 2, and 4-7 make up the MISO Central region; and zones 8-10 make up the MISO South region.

- Archived Daily Forecast and Actual Load by Local Resource Zone – available from January 2015 through December 2019.
- Archived Daily Regional Forecast and Actual Load – available from July 2009 through December 2019.
- Archived Historical Daily Forecast and Actual Load by Local Resource Zone – available from June 2013 through December 2019.
- Archived Historical Regional Forecast and Actual Load – available from January 2010 through December 2019.

MISO publishes real-time load and energy data in chart format in the Real-Time Displays section of its website, showing cleared demand, actual load, and the medium-term load forecast for the current day by five-minute interval; power being supplied in the current interval by fuel type; and Net Scheduled Interchange for the current day by five-minute interval. Data is updated every 5 minutes, and can be downloaded in CSV, XML, and JSON format.

MISO also publishes information about the makeup of its energy supply:

- Generation Fuel Mix – provides the prior days generation by fuel type by region as well as at the system level in Excel format dating back to January 2020. Each file contains two sheets, one with the DA cleared and the other with the actual RT mix. Fuel types include coal, gas, nuclear, hydro, solar, other generation, and storage resources.
  - Archived Generation Fuel Mix – available in the same format as mentioned above from July 2015 through December 2019 in zip file format for each month containing the daily Excel files for each day of the month.
- Historical Generation Fuel Mix – provides the annual summary of the DA & RT generation by fuel type for each region dating back to January 2020 via an Excel file for each year.
  - Archived Historical Generation Fuel Mix – available in the same format as mentioned above from January 2013 through December 2019 in a zipped Excel file for each year.
- Historical Hourly Wind Data – total MISO wind energy production for each hour in the year in an Excel file for each year dating back to January 2020.
  - Archived Historical Hourly Wind Data – available in the same format as mentioned above from January 2010 through December 2019 in a zipped Excel file for each year

MISO also publishes the historical hourly Net Scheduled Interchange (NSI) in MW for each of the neighbouring balancing authorities. A CSV file containing a year's worth of data is made available dating back to January 2020. Archived Historical NSI data is available in the same format from January 2010 through December 2019.

Negative / positive values represent imports / exports into / from MISO to neighbouring jurisdictions. Additionally, MISO publishes real-time generation and intertie flow data in chart format via the Real-Time Displays webpage and can be downloaded in CSV, XML and JSON format. The following data is made available:

- Fuel Mix – presented in pie chart format and shows the breakdown of fuel type for the current interval. It shows the percentage of total MW supplied by the following resources: coal, natural gas, nuclear, wind, other, and solar. The 'other' resource consists of hydro, pumped storage hydro, diesel, and demand response resource.
- NSI – MISO Footprint – presented by a line graph that shows the total amount of energy flowing into or out of MISO.

2.5.4 Forecast Generation and Demand

Short Term Forecasting

The Daily Forecast and Actual Load by Local Resource Zone and Daily Regional Forecast and Actual Load as discussed in section 2.5.3 provide hourly forecasts for the current and next five days and the current day respectively. Additional forecasts include:

- Look Ahead by Region – forecasts the peak hour and the associated load and generation capacity on outage in GW for the current and next six days by region dating back to January 2020.

  - Archived Look Ahead by Region – available in the same format as mentioned above from July 2015 through December 2019 in zip file format for each month containing the daily CSV files for each day of the month.
  - Archived Look Ahead – structured similarly to the Look Ahead by Region report but do not provide a regional breakdown and are available from July 2006 through September 2016 in zip file format for each month containing the daily CSV files for each day of the month.
- Next Day Net Scheduled Interchange (NSI) – provides a system wide forecast of the hourly NSI MW in the DA market for each intertie for the next day dating back to January 2020.
  - Archived Next Day NSI – available in the same format as mentioned above from April 2011 through December 2019 in zip file format for each month containing the daily Excel files for each day of the month.
- Multiday Operating Margin (MOM) Forecast – forecasts for the next five days committed, uncommitted, emergency and renewable (wind and solar) resources, NSI, projected loads, and reserves to forecast near future generation requirements. The report is provided in Excel format, dating back to January 2020, and contains multiple tabs:
  - MOM forecast for each region as well as the MISO system,
  - Hourly forecast of solar and wind by region,
  - Uncertainty statistics for wind output and load such as Mean Absolute Percent Error (MAPE), Mean Absolute Error (MAE) in MW and standard deviations, and
  - Outage forecast for the next seven days, as well as a one month lookback, by region and outage type – derated, forced, planned and unplanned.

Medium Term Forecasting

The Long-Term Outage Schedule report forecasts the planned generation outages in GW for the next year and includes the minimum, average and maximum daily amount of capacity that is scheduled and approved at the system level for a given week. Archived Long Term Outage Schedule data is available in the same format from April 2011 through December 2019 in zip file format for each month containing Excel files for each week of the month.

Long term forecasting

Long-term load forecasts are not conducted in-house by MISO. They are obtained from the State Utility Forecasting Group (SUFG), housed at Purdue University, and the reports are available via the System Forecasting for Energy Planning section of the Policy Study Page.

2.5.5 Unit Generation Schedule and Dispatch

This information is neither made publicly available nor via an NDA as unit specific information is considered confidential. However, MISO does publish system wide forecast for the Next Day Net Schedule Interchange as described in Section 2.5.4.

2.5.6 System Impact Studies

MISO's Generation Interconnection and Retirement Procedures are described in Tariff Attachment X. The evaluation of interconnection requests is a multi-step process. Each step involves one or more studies. The Generator Interconnection Studies and Procedures webpage provides a process flow diagram that summarizes the overall process and timelines, describes the various studies required at each step as well as various interconnection documents and study reports by cycle and region.

MISO publishes and tracks the status of interconnection requests in via the Generator Interconnection Queue (GIQ), which includes energy storage, in an interactive tabular format which can be downloaded in CSV format, as well as in map format. A Points of Interconnection (POI) Map is also provided to aid ICs in screening potential POIs. The interactive queue provides detail on proposed generation facility the project ID, proposed in-service date, transmission owner, State, study cycle/group/phase, service type, summer and winter capacity ratings, and fuel type.

Fuel types include BESS, biomass, coal, cogeneration, combined cycle, diesel, gas, high voltage dc, hybrid, landfill gas, nuclear, solar, stream, waste heat recovery, wind and wood. The GIQ includes live links to download various public reports such as System Impact studies (SIS) across all three Definitive Planning Phases described above as well as public reports from other studies such as Affected Systems Studies. The Facility Studies are considered CEII and can be requested as described in 2.5.8.

MISO also performs various studies for requests for long-term firm transmission service through the Open Access Transmission Tariff and are available via the MISO OASIS webpage . Available studies include:

- System Impact Studies,
- Facilities Studies,
- Special Studies,
- Quarterly Operating Limits, and
- Pre-Certified Point to Point Drive Out Paths.

Generators seeking to retire or suspend operations are required to notify MISO at least twenty-six weeks in advance along with the requisite details in accordance with Attachment Y. MISO will evaluate the reliability impact of the retirement / suspension by performing steady-state voltage and thermal analysis, and voltage stability analysis if required .[14] If reliability issues are identified, the unit is deemed as a System Support Reserve (SSR) and is provided with a 1-year contract and the SSR destinations are reviewed annually. Additional details on the studies can be found in in Business Practice Manual 20 – Transmission Planning which also governs the process for the interconnection of new loads which mainly fall to the Transmission Owner (TO).

2.5.7 System Planning Documents

MISO Transmission Expansion Plan

MISO publishes the annual MISO Transmission Expansion Plan (MTEP) that is developed in collaboration with stakeholders to identify reliability needs and solutions over a 20 year horizon. The process is described in detail in Business Practice Manual 20 – Transmission Planning. Historical reports dating back to 2017 are available.

The MTEP report as a whole is made available in PDF format as well as via an intuitive webpage document that breaks out the sections of the report and links to additional resources as appropriate as well as detailed appendices:

- Overview – provides an overview of MISO, the transmission planning process and a summary of projects identified for investment by project type, e.g., baseline reliability, generator interconnection etc., and region.
- Portfolio Evolution – reviews retirement trends, the current state of the interconnection queue and the resource outlook to plan for the future and summarizes the key concerns and actions required.
- Regional and Inter Regional Studies – discusses the studies and results conducted by MISO alone to ensure system reliability, e.g., Long Range Transmission Planning (LRTP) initiative and associated studies, as well as in collaboration other ISOs, e.g., MISO-SPP Joint Targeted Interconnection Queue (JTIQ) Study, Coordinated System Planning studies with SPP and PJM.
  - As part of the value-based transmission planning process, regional solutions or Multi-Value Projects that meet specific criteria became a focus area. Additional supporting information available via the Multi-Value Projects webpage include:
    - Business case description in PDF format.
    - Business case analysis in Excel format detailing on separate tabs the assumptions, waterfall cost benefit analysis, congestion fuel savings, gas price sensitivities, avoided capital cost analysis, regional capacity costs and MW enabled, expansion capacities, upgrade cost financial analyses, resource adequacy benefits, avoided load loss analyses and decarbonization analyses.
- Reliability Studies – studies to determine the needed transmission infrastructure upgrades to maintain system reliability in accordance with various standards and a detailed list of project recommendations and justifications by region and transmission owner with breakdowns by project type.
- Appendices:
  - List of new projects and facilities recommended for approval in Excel format provided on separate tabs with details such as name, description, location, need addressed, expected in-service date and cost.

[14] Additional details on the studies can be found in Business Practice Manual 20.

  - New project and facility cost allocation by transmission zone in Excel format.
  - List of prior approved projects not yet in service in Excel format with project details such as name, description, location, type, status, e.g., approved, pre-construction, under construction etc., expected in-service date and cost.
  - List of needed projects and facilities not yet ready to be deployed in Excel format provided on separate tabs with details such as name, description, location, need addressed, status, expected in-service date and cost.
  - Future scenarios in PDF format.
  - Substantive stakeholder comments in PDF format.

Additional details on projects are made available via the Project Lists and Status Reports webpage which provides project specific reports, indexed by MTEP year / cycle as well as additional reports, mostly quarterly:

- Status reports with comparisons to the previous quarter in Excel format,
- Status report dashboard in PDF format with graphical summaries of active projects by year, type and region.
- Multi-Value Project (MVP) dashboard in PDF format with the latest regulatory and construction status as well as cost information.
- List of projects under evaluation in Excel format with details such as name, description, location, need addressed, type, expected in-service date and cost.
- List of in-service projects with details such as name, description, location, type, actual in-service date and estimated cost.

As projects are approved as part of the MTEP, various circumstances may significantly influence the cost, schedule and or ability to deliver the project. As needed, MISO performs Variance Analyses to better understand the drivers for such circumstances and evaluate the potential impacts on successful project completion as well as on the transmission system. Reports are indexed by project and are available in PDF format.

Resource Adequacy

MISO also conducts seasonal, spring, summer, fall and winter, resource assessments to identify and evaluate potential resource adequacy risks for the upcoming season. These reports, published in PDF format, evaluate projected near-term available capacity under probable and extreme peak load forecasts and historical generator outage conditions for each season. The analysis flags potential issues to aid the ISO, market participants and stakeholders prepare for potential strained system conditions and take appropriate preventative measures. The reports are published via the Resource Adequacy webpage, under the documents section, dating back to 2008 with reports beyond the last eight years in the archive section.

Regional Resource Assessment

The Regional Resource Assessment (RRA) uses publicly shared plans and goals of the MISO's electric utilities to develop a twenty-year view of the evolving resource mix across each of the ten Load Resource Zones (LRZs) in collaboration with various stakeholders including member states. The report, published in PDF format and available dating back to 2021, describes the various inputs, resource additions, emissions and capacity factor trends as well as various modelling caveats. The report also analyses the impacts of emerging technologies such as SMR, CCUS and hydrogen.

The RRA facilitates two types of analyses:

- Resource Adequacy Analysis – focuses on whether generation resources are sufficient to meet demand.
  - Analyse potential seasonal risk drivers and understand capacity value trends over time.
  - Perform a Loss of Load Expectation (LOLE) assessment.
  - MISO-wide effective load carrying capability (ELCC) analysis of solar, wind, solar-plus-storage, and stand-alone storage.
- Flexibility Assessment – focuses on how net load variability and uncertainty evolves over time and the associated impacts on reserve products to meet future needs.
  - Analyse net load variability to identify periods of increased risk and conduct simulations to assess the sufficiency reserve.

  - Assess impact of growth in renewable generation as well as hybrid and battery storage resources.
  - Identify stressed system trends.

The report is accompanied by a series of supporting tools and data:

- Generation Resources Portal (Juicebox) – an interactive tool to visualise the study results.
- Emissions Dashboard – an interactive tool to visualise historical emissions and electricity generation.
- Technical Appendix – detailed discussion of assumptions and methodology in PDF format.
- Supplementary Flexibility Assessment Results – additional charts in PDF format.
- Resource Adequacy Model Data – model data for select years in CSV format.
- LRZ-level Assumptions and Results – breakdown of modelling assumptions and results by LRZ in PDF format.

2.5.8 Requesting Data

For information that is believed to be public but is not readily available in any of the existing market reports, a New Market Reports request can be submitted via email to the Client Services and Readiness team who reviews the request to ensure the data is not already available via another report as well as to ensure any confidential information is protected. The request is then sent to the Steering Committee for approval.

In general, all requests, including data requests, must go through the MISO Help Centre wherein the requests can be tracked and monitored by MISO staff. A login is required to submit a case, and anyone can request a login via the Request Help Centre Access webpage.

Any requests for restricted content, i.e., non-public data such as Critical Energy Infrastructure Information (CEII), must be submitted via the aforementioned process and access will be granted to only qualified parties, namely:

- Generator Interconnection Customer,
- MISO Market Participant,
- MISO Non-Market Participant,
  - MISO Local Balancing Authority,
  - MISO Transmission Owner, and
  - MISO Transmission Operator.
- MISO Member,
- Neighbouring Reliability Coordinator,
- Neighbouring Transmission Operator,
- Neighbouring Transmission Planner, and
- Sector Member.

Any access requests for restricted content require a Universal Non-Disclosure Agreement (UNDA) which must be executed by an authorised representative of the requesting entity. Appendix A should list all the employees and/or consultants who need access to MISO confidential information. Non-CEII data is provided to the requestor, if approved, via a Sharefile. CEII requests require an additional CEII NDA which must be executed by each individual seeing access and the data is provided via the secure MISO Extranet portal.

For any data request, there are no costs or set timelines as it depends on the complexity and SME resources availability as different business units' own data. MISO works to review and process all requests as quickly as possible.

2.6 PJM Interconnection (PJM)

PJM maintains most of its tabular data in its market data portal Data Miner 2. This portal allows datasets to be updated in near-real time and lets users view data in the browser as well as download in CSV format. Data queries in the browser are limited to 366 days of data and no more than one million rows at a time. For each dataset, the portal displays a detailed description of the table's data fields including units of measurement and data encoding types, as well as a description format for each dataset including posting frequency, update availability, retention time, last updated time and first available date.

Direct access to the Data Miner 2 database is available using PJM's API portal, which allows for direct queries of larger data quantities. PJM Members are limited to 600 data connections per minute while non-members are limited to six data connections per minute. Each connection is limited to 50,000 rows, meaning that users must split large queries into multiple smaller queries.

PJM also provides a Data Viewer which provides real-time dashboards of useful market information such as locational marginal pricing, intertie flows, load, weather and renewable output. Registered users may customize their dashboards while guests, i.e., no login required, are limited to the standard interface.

Non-tabular information is published via the Reports & Notices portal. A Data Directory portal with a searchable interface linking to all published data items. This covers the sources listed above, as well as other publications on the website, such as network augmentation and generator retirement information.

The Data Availability portal also provides a list of data that is not made public along with a brief rationale for why it is not made public. PJM Manual 33, Section 6.1 provides guidelines for public data postings. To maintain confidentiality, PJM posts only aggregated data if there are more than three market participants' data and is over at least a PJM transmission zone.

2.6.1 Energy Market Clearing Prices

PJM publishes RT and DA locational marginal prices (LMPs) in the Locational Marginal Prices section of the Data Miner 2 portal. The following energy price data is made available:

- Day-Ahead Hourly LMPs,
- Five Minute IT SCED LMPs, i.e., intertie prices,
- Real-Time Five Minute LMPs,
- Real-Time Hourly LMPs,
- Real-Time Unverified Five Minute LMPs,
- Real-Time Unverified Hourly LMPs,
- Settlements Verified Five Minute LMPs,
- Settlements Verified Hourly LMPs,
- Unverified Five Minute LMPs for a subset of PNodes namely zonal, aggregate, interface, hub and 500 kV bus.

Day ahead data is published the day before dispatch. Hourly and 5-minute LMPs are available back to the year 2000 and 2018 respectively, though queries on data more than two years old are not as flexible as later data. Real-time energy LMP data is available at five-minute and hourly granularity for all buses.

Most datasets provide the total LMP price as well as a breakdown of its components, namely energy, congestion, and marginal loss components. Price data is indexed by pricing node (PNode), which can be individual nodes or node aggregations, including hubs, zones, loads, generators, extra high voltage lines, and interfaces with other markets. Nodes are numbered and named. The datasets also include node information such as voltage and equipment.

Unverified prices are published shortly after real-time. Final prices are published daily after they have been verified for settlement. Settlement verified prices are published at five-minute (real-time market) and hourly (day-ahead market) resolution.

2.6.2 Energy Offers and Bids

Energy offers and bids are available through the Data Miner 2 database. Due to confidentiality reasons, PJM publishes masked non-aggregated or aggregate data with a four-month lag as required by FERC. Masking codes are changed annually. Data availability through Data Miner 2 includes:

- Energy Market Generation Offers – anonymized hourly energy offer data for the day ahead market, dating back to November 2017 including:
  - Unit commitment parameters such as no load cost, cold/intermediate/hot start costs, max daily starts, min runtime,
  - Operational parameters such as economic maxima and minima, and
  - Up to 20 price-quantity pairs.
- Hourly Day-Ahead Demand Bids – aggregated demand bids submitted to the Day-Ahead Market. For each hour, the total MW amount of demand bids is shown, aggregated by price point. This data is published with a six-month lag and available dating back to June 2006.

- Hourly Demand Bid Data – total MW quantity of hourly day-ahead bids for each market day for the PJM, Mid Atlantic and Western regions. Data is available dating back to June 2000.
- Hourly Day-Ahead Increment Offer and Decrement Bid Data – bid and offer data for virtual transactions, i.e., traders taking a financial position in the day ahead market in order to arbitrage expected differences between day-ahead and real time prices. Bids and offers are aggregated by pricing point, bid type, hour, and day. This data is available dating back to June 2006.
- Daily Cleared INCs, DECs and UTCs – total cleared quantities in the DA market for virtual transactions dating back to October 2011:
  - Increment Offers (INCs) – offers to sell energy in the day ahead market,
  - Decrement Offers (DECs) – offers to buy energy in the day ahead market, and
  - Up to Congestion Transactions (UTCs) – bids to purchase congestion and losses between two points.

PJM also publishes anonymised Demand Response Bid Data at the hourly level with a 4-month lag in a single CSV file containing a months' worth of data and includes information related to:

- Commitment parameters such as shutdown cost, notification time, and minimum downtime,
- Up to ten price-quantity pairs, and
- Economic minima and maxima.

2.6.3 Historical Generation and Demand

PJM publishes aggregated historical load data for annual peaks, hourly, and instantaneous timeframes. Load at an individual node is considered confidential, so load data is aggregated to service territory level[15]. The following datasets are made available via Data Miner 2:

- Hourly Load - Preliminary – provides average hourly MW load and is calculated daily from raw telemetry data. It is considered an approximation for informational purposes only. Load values are aggregated by service territory and are available dating back to August 2011.
- Hourly Load - Estimated – provides estimated MWh of load from meter information which has not yet been verified by the electric distribution companies and are subject to further adjustment. Load values are aggregated by service territory and the dataset is available dating back to April 1998.
- Hourly Load - Metered – provides MW-hour net energy for load as consumed by the service territories, namely the market region, transmission zone and load area. There is also a flag that indicates whether the data has been verified by the distribution company. Historical data is available dating back to January 1993.
- Instantaneous Load – contains 5-minute MW by load zones. Load values are approximations from raw telemetry data and are not official PJM loads. Historical data is available on a rolling one month basis.
- Annual Zonal Network Service Peak Loads – represent the highest MW load experienced in the previous year from November through October for each transmission zone. Preliminary data is published in October, and final data in November. Historical data is available dating back to January 2022.

Historical summer peak, winter peak, net energy, and weather-normalised seasonal peaks for each zone and region are also published in the annual load forecast report. The following historical generation data is also made available via Data Miner 2:

- Equivalent Forced Outage Rates (EFORD) – Monthly – provides the EFORD on a monthly basis, including the number of units, by fuel type – coal, combined cycle, combustion turbine, diesel, gas, hydro, nuclear, oil, pumped hydro and other. Data is available dating back to January 2006.
- Five Minute Solar Generation – provides historical 5-minute system wide solar generation on a rolling 1-month basis.
- Generation by Fuel Type – provides the system wide hourly generation by fuel type, including the percent contributed by each fuel type in an hour dating back to January 2016. Fuel types include coal, gas, hydro, multiple fuels, nuclear, oil, wind, solar, storage such as batteries, flywheels, compressed air, as well as other renewables such as geothermal, biofuels and municipal waste.

[15] There are currently 21 service territories: AECO, AEP, APS, ATSI, BGE, COMED, DAY, DEOK, DOM, DPL, DUQ, EKPC, JCPL, METED, OVEC, PECO, PENELEC, PEPCO, PPL, PSEG, and RECO.

- Instantaneous Wind Generation – system wide wind generation provided on a fifteen second basis for a rolling 1-month period.
- Solar Generation – provides the hourly solar generation dating back to January 2019 by area – MIDATL, RFC, RTO, South, West and Other.
- Wind Generation – provides the hourly solar generation dating back to January 2011 by area – MIDATL, RFC, RTO, South, West and Other.

2.6.4 Forecast Generation and Demand

Short Term Forecasts

PJM publishes short term forecasts of load and generation outages via Data Miner 2:

- Seven Day Load Forecast – provides an hourly forecast of load for the same twenty-five individual regions forecasted for in the 5-minute Load Forecast, as well as the PJM system as a whole.
- Forecasted Generation Outages – provides a forecast of generation outages for the next three months by three regions – RTO, West and Other, with historical data dating back to January 2013.

PJM also publishes forecasts for load and wind output via Data Miner 2:

- Five Minute Load Forecast – forecasts load for a rolling 2-hour window for twenty-five regions including the PJM area as a whole with historical data available on a rolling one month basis.
- Five Minute Wind Power Forecast – forecasts system wide wind output for a rolling 2-hour window for twenty-five regions including the PJM area as a whole with historical data available on a rolling one month basis.
- Hourly Wind Power Forecast – provides an hourly forecast of total wind output at the system level for the next 46 hours with historical data available on a rolling one month basis.

PJM also retains some Historical Load Forecasts at the hourly level dating back to January 2011 by forecast area – AEP, APS, ATSI, COMED, DAY, DEOK, DOM, DUQ, EKPC, MIDATL, RTO and OVEC. Eight forecasts for each operating day are available, four made the day before and four made on the day so stakeholders can see how the forecasts have evolved over time.

Long Term Forecasts

Annually, PJM publishes the Load Forecast Report via the Reports & Notices portal. The report has a planning horizon of fifteen years at a monthly granularity level for each PJM zone, region, locational deliverability area (LDA), and the total RTO as a whole. It also contains a comparison to prior forecasts at the zonal, regional and system wide level.

The report is provided in PDF format which gives an overview of the forecasts including charts for each individual region:

- Seasonal (spring, summer, fall and winter) peak demand forecasts including growth rates by zone, region and the PJM RTO,
- Monthly peak demand forecasts by zone, region and the PJM RTO,
- Distributed solar, BESS, EV and other adjustments to summer peak forecasts
- Summer coincident peak load forecasts by zone, region and the PJM RTO,
- Locational Deliverability Area Seasonal Peaks,
- Extreme weather, i.e., 90/10, summer peak forecast,
- Annual and monthly net energy forecast with annual growth rates by zone, region and the PJM RTO, and
- Load management under PJM coordination.

The PDF report also includes some historical energy and peak demand information and is accompanied by a data file in Excel format which provides separate tabs for each zone / region that contain the monthly energy and peak demand forecast. Historical reports dating back to 2012 are available.

The Load Forecast Development Process describes in detail how the forecast was developed and is made available in PDF format via Manual 19: Load Forecasting and Analysis. In addition to the report, the process portal also makes available a series of supplemental data and assumptions:

- Historical, dating back to 2013, weather normalized summer and winter peaks by zone in Excel format,

- Load Forecast Supplement in PDF format which serves as a reference guide with respect to the details of the methodology, data and assumptions used,
- Sector Models and End Use Indices in Excel format for the five sectors: residential, commercial, industrial, heating, cooling, and other,
- Forecast Economic Assumptions in PDF format for households, population, working age population, real goods output, real services output, real personal income and service employment.
- End Use Variable assumptions in PDF format,
- Historical and forecast Electric Vehicle assumptions by zone in Excel format,
- Calendar Variables in Excel format,
- BTM Capacity Forecast Assumptions in Excel format for distributed solar and BESS,
- Model statistics such as Coefficients in Excel format and Residuals in PDF format,
- Seasonal Daily and Hourly Peak plots in PDF format,
- Zonal Weather Standards for Demand Response Certification in PDF format, and
- Summary of Historical Load Management Events in Excel format dating back to 1991.

2.6.5 Unit Generation Schedule and Dispatch

PJM does not publish scheduling and dispatch values for individual generators as it is considered confidential information as described on the Data Availability portal. However, some aggregated information, including information on intertie schedules, is available via Data Miner 2:

- Daily Generation Capacity – provides the total system wide generation capacity at an hourly level of granularity dating back to January 2012:
  - Economic Max – total economic MW offered into the market excluding system outages.
  - Emergency Max – total emergency MW offered into the market excluding system outages.
  - Total Committed – total committed capacity including Fixed Resource Requirement units.
- Scheduled Generation – provides the hourly economic load and reserve MW, i.e., units called on in real time to meet load and/or reserve requirements as well as the hourly economic maximum MW capacity of self-scheduling generators, and of units called on in real-time to meet load or reserve requirements. To maintain confidentiality, the called unit figure is not published unless the total MW called is above a threshold, namely data of at least four different market participants and must cover a geographic area of at least a transmission zone as per Manual 33, Section 3.6. Historical data is available dating back to October 2017.
- Actual / Schedule Summary Report – provides the hourly scheduled, actual and inadvertent flows on each intertie wherein positive values denote imports into PJM and negative values imply exports from PJM. Historical data is available dating back to Jan 2014.
- Real-Time Scheduled Interchange – provides the hourly net tie schedule for each tie line wherein positive values denote imports into PJM and negative values imply exports from PJM. Historical data is available dating back to August 2011.
- Five Minute Tie Flows – provides the scheduled and actual flows for each intertie at the 5-minute granularity level wherein positive values denote imports into PJM and negative values imply exports from PJM.
- Off-Cost Operations – provides data on the location, time and reason for off-cost operations or reactive operations to maintain system voltage. It gives the region, facility, datetime, and the network contingency requiring each call. Facilities referenced are usually network elements, i.e., transmission facilities. Historical data is available dating back to January 2006.
- Operator Initiated Commitments – provides the total economic maximum commitment and reason by zone each time PJM commits a generation facility to deal with non-market factors. Examples include elevated system risk, physical or cyber threats, extreme weather, supporting local area voltage (pre- or post-contingent) and constraint management. Individual facilities are not identified. Historical data is available dating back to October 2019.

2.6.6 System Impact Studies

In accordance with PJM's Open Access Transmission Tariff (OATT), new generation, energy storage and transmission, move through the interconnection queue process and are required to conduct a series

of studies in conjunction with PJM and the local transmission owner. Once an interconnection request is accepted, various information about the request is made available via the New Services Queue.

Small generation facilities, i.e., under 20 MW, are also required to go through the interconnection queue process though they may be eligible for certain procedures to be fast tracked in accordance with Part IV, Subpart G of the OATT. The interconnection of new loads falls under the purview of the local Transmission Owners (TO).

Three studies are required for all new interconnections, which includes energy storage, and are accessible via the New Services Queue portal under the Phases and Agreements tab. The contents of each of these three studies is discussed briefly below:

1. Feasibility Study,
2. System Impact Study (SIS), and
3. Facilities Study.

The Phases & Agreements tab also includes links to a project's Interconnection Service agreement (ISA) or Wholesale Market Participant Agreement (WMPA)[16] and Interconnection Construction Service agreement (CSA) or Upgrade Construction Service Agreement (UCSA). ISAs grant rights to interconnect and generate, define project milestones, describes the point of interconnection, describes system upgrades and costs, outlines metering requirements, and sets security requirements. An ISA persists after construction. Construction service agreements outline responsibility, schedules, and insurance for the construction process, it is terminated after construction. These are signed after the aforementioned studies are completed.

The new services also queue provides for each interconnection:

- Descriptive data: queue id, name, state, status, maximum facility output, MW of energy, MW of capacity, MW in service, project and fuel type.
- Transmission Rights data: transmission owner, transmission type and transmission rights.
- Project Schedule Data: projected and actual in service dates, queue date as well as start, end and withdrawn dates.

All datasets on the interconnection queue page are available for download in Excel and XML formats. Studies and agreements are available in PDF format.

In addition to the interconnection queue, PJM's Regional Transmission Expansion Plan (RTEP) provides a high level overview on the amount of queued generation in each state. The RTEP provides a timeline of queued generation, giving MW values for:

- Generation applications,
- Feasibility studies issued,
- Impact studies issued,
- Facilities studies issued,
- Facilities that have signed Interconnection Service and Wholesale Market Participation Agreements,
- Facilities that have been constructed, and
- Facilities in service.

For any generation retirements, PJM must be notified at least two quarters prior to the proposed deactivation date. In collaboration with TOs, PJM completes a reliability analysis in the second quarter after receiving the retirement notification.

Transmission upgrades may be required to accommodate the generation loss and while PJM does not have authority to order plants to continue operating, they are permitted to formally request continued operations to maintain system reliability, subject to FERC-authorized rates, while transmission upgrades are completed.

Historical, planned and withdrawn generator deactivation requests are available via the Generation Deactivations portal which includes summary data such as unit name, fuel type, capacity, state, age, transmission owner zone, owner withdrawal notification date and requested deactivation date. The reliability analysis reports are not publicly available.

[16] Facilities over 20MW require ISAs while those under 20MW may use a WMPA in the correct circumstances.

If generator retirement could cause issues for power system security or reliability, its impact is assessed by the Transmission Expansion Advisory Committee (TEAC). The reports come in the form of a PowerPoint presentation which details the effects of the retirement, and the necessary action required to mitigate any ill effect. Special reports may also be published where the retirement of generators is highly consequential.

Feasibility Study

A feasibility study assesses practicality and cost of the potential connection. The study covers short-circuit and power flow analysis against NERC reliability standards. Feasibility studies are published without the name of the entity facilitating the study for confidentiality reasons. Study results provide:

- Description of project size and location,
- Preliminary estimates of
  - Cost
  - Construction lead time.
- Network impacts of:
  - Generator deliverability,
  - Multiple facility contingency,
  - Short circuit, and
  - Stability.
- Light load analysis,
- Required system reinforcements.

System Impact Study (SIS)

An SIS is a detailed system analysis testing deliverability under peak load conditions, impact on system stability, and identifying and solving any system constraints resulting from the proposed connection. Study results can include:

- Point of interconnection and associated details,
- Project cost summary,
- Analysis of the facility's effects on system protection requirements,
- Interconnection schedule,
- Network impacts such as:
  - Contribution to Previously Identified Overloads,
  - Steady-State Voltage Requirements,
  - New System Reinforcements,
  - Contribution to Previously Identified System Reinforcements, and
  - Potential Congestion due to Local Energy Deliverability,
- Map of project location,
- Line diagrams,
- Refined, comprehensive cost responsibility and construction lead time estimates for required upgrades, and
- Revenue metering and SCADA requirements.

Facilities Study

A Facilities Study carries out the requisite engineering design work to build out the grid upgrades needed to accommodate the proposed facility. It provides a good-faith cost estimate for attachment facilities, local upgrades and network upgrades, as well as an estimate of the time required to complete the detailed design and construction of the facility along with the requisite system upgrades. Study results can include:

- Scope of required work for transmission owner and interconnection customer,
- Facility inverter requirements,
- Milestone of schedules for work completion,
- New or upgraded transmission lines,
- New or upgraded substation or switchyard facilities,

- Metering details,
- Environmental, real-estate, and permitting issues, and
- Summary of cost estimates.

2.6.7 System Planning Documents

Regional Transmission Expansion Plan

Annually, PJM develops the Regional Transmission Expansion Plan (RTEP) to identify transmission system enhancements required to maintain system reliability over a fifteen year planning horizon. The RTEP Development Process is carried out in accordance with Schedule 6 of the Operating Agreement and PJM Manuals 14A – 14G. The plan identifies transmission constraints and other system reliability concerns and works to identify enhancements to address them factoring in feasibility, system impact and cost.

The report is published in PDF format and is also accompanied by a Key Graphics and Information presentation that provides some details regarding key maps, tables and figures. The RTEP report describes:

- Review of the current year for which the report has been published which includes:
  - Changes in generation mix,
  - Key drivers for baseline projects,
  - Future trends such as offshore wind, state level RPS targets, grid enhancing technologies, probabilistic planning etc., and
  - Measurements against the RTEP process milestones.
- Resource Adequacy Modelling including:
  - Power flow model[17] and forecast,
  - Demand resources and peak shaving, and
  - Effective Load Carrying Capacity (ELCC) model and forecast values by fuel type.
- Transmission Enhancements which also considers of generation retirements and interregional planning,
- Market Efficiency analysis which includes production cost modelling under various scenarios to determine which solutions provide maximum impact at the lowest possible cost,
- Interconnection Summary including process reforms and stakeholder initiatives,
- State Summaries for each of the thirteen states which covers:
  - State specific RTEP context,
  - Load growth,
  - Existing generation,
  - Interconnection requests,
  - Generation deactivation,
  - Baseline projects,
  - Network projects,
  - Supplemental projects, and
  - Merchant transmission projects.

The report also includes appendices that describe the various TO zones and Locational Deliverability Areas (LDA) as well as provide summary statistics, primarily focused on costs, for the various RTEP projects by transmission zone.

Baseline Reliability Assessment

As part of the RTEP process, the Baseline Reliability Assessment, i.e., Baseline, reports are also published which are focused on identifying the needed transmission system enhancements given various anticipated system conditions and determine appropriate cost allocation. The analysis effectively provides a starting point, i.e., a baseline, from which system needs and responsibility for enhancements to accommodate various interconnection requests can be identified.

[17] The detailed Power Flow Model and associated electrical system data is considered CEII as per PJM Manual 14B, section 1A.

The Baseline studies also have a fifteen year planning horizon but have a greater focus on the next five years. The reports are published in PDF format and describes the scope of the study, details the analysis methodology and associated assumptions and provides a detailed list of the results, i.e., the list of baseline upgrades needed to maintain system reliability.

Transmission Expansion Advisory Committee (TEAC)

The TEAC provides advice and recommendations to aid in the development of the Regional Transmission Expansion Plan (RTEP). The TEAC meets on a monthly basis with detailed agenda which includes market efficiency update, utility specific supplemental projects update, interregional planning update & generation deactivation notification updates. All updates can be downloaded in PDF format dating back to May 2007.

The market efficiency update deals with base case and sensitivity scenarios as well as congestion impacts on the new PJM load forecasts. Generation deactivation updates deal with unit deactivation status with details on transmission zone, requested deactivation date, and PJM reliability status. It also includes each utility's baseline upgrade cancelation information. The utility specific supplemental project update provides data on the project number, process stage, project driver, specific assumption reference, and problem statement.

Additional Studies

- The Planning portal provides an up-to-date overview of transmission planning projects. This allows participants to access more recent information as it is updated hourly and includes various dashboards related to system planning, examples include recent RTEP updates, project cost summary, queued generation by fuel mix, queue timelines, number of active studies.
- PJM also publishes on an annual basis Effective Load Carrying Capability (ELCC) studies in PDF format. The report details the assumptions and methodology used to determine the ELCC values for each resource class for the next decade, e.g., wind, solar, storage, which are then used in the capacity auction, i.e., the Base Residual Auction (BRA). The report is also supported by a series of CSV files provided in ZIP folders for thermal, load and Loss of Load Event (LOLE) scenarios.
- Annually, the Reserve Requirement Studies (RRS) are also published as part of the Reserve Requirement Development Process. The study works to determine the Forecast Pool Requirement (FPR) for the next decade which forms a key input into the Reliability Pricing Model (RPM). The report also details the assumptions and approach including load, generation, transmission, modelling and other operational related considerations. Historical reports dating back to 2017 are available.
- The Competitive Planning Process is aimed at maintaining compliance with FERC Order 1000 by providing non-incumbent transmission developers an opportunity to participate in the RTEP process whilst encouraging innovative, cost-effective and timely solutions benefiting ratepayers. There are three planning cycles with different criteria:
  - Immediate Need – needs are driven by reliability criteria violations with a required in-service date within the next three years.
  - Short Term – needs are driven by reliability criteria violations with a required in-service date between three to five years.
  - Long Term – needs are driven by reliability criteria violations, economic constraints, system conditions and public policy requirements with a required in-service date beyond five years.
- Redacted Proposal Data for current and closed windows are publicly available. The purpose of the redactions is to protect Critical Electrical Infrastructure Information (CEII) as per PJM Manual 14F, section 6.2.
- The Project Status & Cost Allocation portal provides project status and cost allocation information for baseline, network and supplemental projects in the RTEP. This page includes tabular data about upgrades, which can be downloaded in Excel or XML format, and which includes upgrade id and description, voltage, state, status, transmission owner, project cost, cost allocation details, required date, projected and actual in-service dates and related materials if applicable.
  - Immediate Need reliability projects are exempt from planning cycle related proposal windows, details for which are provided separately. Tabular data includes the upgrade id, information about what specific challenge the project is meant to address, project description, designated entity for construction, Transmission Owner (TO) zone, anticipated in-service date, need-by date, board approval date and associated materials which can include Transmission Expansion Advisory Committee (TEAC) reports and regulatory filings.

State Specific Reports

Annually, PJM also publishes State Specific Reports in PDF format primarily comprising of various charts that include:

- Generation capacity data, including existing and queued capacity by fuel type, historical progression of interconnection requests (including percentage of planned capacity that has reached commercial operation) and generation retirement notifications (name, date, and capacity),
- Transmission data, including name, cost, and timing of planned grid projects by existing and merchant transmission operators,
- Load data, including current and historical forecasts, summer and winter peaks for the next year and ten years ahead,
- Capacity market data, covering offered and cleared capacity in each category (generation, demand response, energy efficiency) in the state, as well as the clearing price, and
- Energy market summary data, covering prices, imports and exports, production (by fuel, and emissions (CO_2, NOx, SO_2).

2.6.8 Requesting Data

There are three ways to request data from PJM depending on the nature of data information: Non Confidential Markets Data, Critical Energy Infrastructure Information (CEII) and Other Information Requests:

- Non Confidential Markets Data – a PJM member request certain data be made available via the Member Data Request portal. The request will be reviewed against confidentially rules and if it is determined that the data can be made available and does not impose an undue burden on PJM staff, the data will be made publicly available via the One-Time Data Requests portal for all to access at the same time.
- Critical Energy Infrastructure Information (CEII) – a PJM CEII Request Form must be submitted via the My PJM account, for which anyone can sign up. The information provided in the request form will used to determine whether there is a legitimate need and weigh the need against the potential adverse effects of releasing the data. The authenticity of the requestor is also verified as is whether the request is consistent with the business interest. Additional information, beyond the CEII Request Form, may be requested as needed.
- Other Information Requests – for information that is not publicly available and is not CEII, an Information Request Form must be filled out. PJM will review the request to ensure the information is not confidential or proprietary and that it is permitted to disclose such information under the Operating Agreement.

There are no costs or set timelines for any data requests. PJM works to review all requests within a few days and process approved requests within a few weeks depending on the size and complexity of the data request.

2.7 Electricity Reliability Council of Texas (ERCOT)

ERCOT publishes public, secure, and certified market information via various avenues, namely the ERCOT website for public information and API, External Web Services (EWS), Applications and the Market Information System (MIS) which require some form of authentication. Protocols require that ERCOT ensure all Market Participants have access to the ERCOT MIS on a non-discriminatory basis as outlined in the Nodal Protocols, Section 12 – Market Information System.

Section 1.3 of the Nodal Protocols provide guidance on what information is considered confidential. The Planning Guide, Section 7 – Market Data Transparency, provides information on the data list categorizing it into public, secure or certified classification. Digital ERCOT also provides a searchable listing of all ERCOT Market Information List (EMIL) items required to be supplied by Protocols or Other Binding Documents (OBDs).

- Public data can be accessed by any individual and can be downloaded in an Excel or CSV format via the ERCOT website.
- Secure data can be accessed by registering as a Market Participant or Independent Market Information System Registered Entity (IMRE). Certificates are required to view data classified as secure.

- Certified data is company specific data, masked by a unique identifier, and is available on the secure portal which requires authentication by registered Market Participants. This classification is only available to users mapped to the unique identifier.

The IMRE classification was created as workaround for lack of access to public data and the desire to obtain certain protocol specified secure data sets. ERCOT is currently in the process of reclassifying all secure data that is not covered under the realm of CEII as public and creating a public API for easy access thereby eliminating the need for IMRE. The current intent is to seed the public API with seven years of historical data.

Information is also provided via dashboards / displays. ERCOT does not provide an option to download multiple files at a time. Standardised reports can be downloaded in CSV or Excel format one file at a time. Historical information for the last three or five days is made available for a 5-minute interval data, whereas for seven, thirty or 365 days, if it is provided on an hourly or daily basis.

2.7.1 Energy Market Clearing Prices

ERCOT publishes Day-Ahead and Real-Time displays as well as Real-Time Prices and Day Ahead Market (DAM) Results Reports on its Market Information website. The following energy price data is made available:

- Day-Ahead and Real-Time Displays
  - DAM Settlement Point Prices Display
  - Real-Time Locational Prices
  - Real Time Dispatch (RTD) Indicative LMPs by Load Zones or Hubs Display
  - Real-Time LMPS for Load Zones and Trading Hubs Display
  - Real-Time Settlement Point Prices Display
- DAM Results Reports
  - DAM hourly LMPs
  - DAM Settlement Point Prices
- Real-Time Prices Reports
  - LMPs by Electrical Bus
  - LMPs by Resource Nodes, Load Zones, and Trading Hubs
  - Settlement Point Prices at Resource Nodes, Hubs, and Load Zones

The RT and DA data are provided in 5-minute and hourly intervals respectively. The DA Hourly prices are indexed by the bus name. The DA LMPs are provided in a single file for each day while the RT LMPs are provided in a single file for each 5-minute interval. The Reports are available in a zip file and can be downloaded in CSV or XML format. Historical data for DAM is available for the last 31 days whereas RT data is available for the last 5 days due to the granularity of the data.

The displays do not allow for data to be downloaded. The DAM and Real Settlement Point Prices Display provide data in a tabular format allowing the user to select from the last seven and six days respectively. The Real Time Locational Prices Display shows the RT prices on a map of ERCOT via colour gradient. The Real-Time LMPs for Load Zones and Trading Hubs Display shows the current 5-minute RT price in a tabular format.

2.7.2 Energy Offers and Bids

ERCOT publishes Energy Offers and Bids data following a 60-day lag period for the DA market only and is indexed by the masked Qualified Scheduling Entities (QSE) and Settlement Point. ERCOT Nodal Protocols, Section 3.2.5 - Publication of Resource and Load Information, provides disclosure guidelines. Historical data for 30 days is available for download in a zip file which contains multiple Excel files for a single day. All bids and offers used by DAM are published. The zip file contains the following energy related CSV files:

- Energy Bids – includes masked QSE, 10 price-quantity pairs, settlement points, and energy only bid ID.
- Energy Bid Awards – includes masked QSE, settlement point, energy only award bid in MW, settlement point price and bid ID.
- Energy Only Offers – includes masked QSE, 10 price-quantity pairs, settlement points and energy only bid ID.

- Energy Only Offer Awards – includes masked QSE, settlement point, energy only award bid in MW, settlement point price and bid ID.
- Generation Resource Data – includes masked QSE, Decision Making Entity (DME), generation resource name and type, ten price quantity curve pairs, settlement point price and name, and three part offers (hot/intermediate/cold start up prices, no load prices).
- Point-to-Point Obligation Options (PTP) – includes QSE name, settlement point source and sink, price, quantity, Offer ID and Congestion Revenue Right (CRR) ID.
- PTP Obligation Options Awards – includes QSE name, settlement point source and sink, price, quantity, Offer ID and Congestion Revenue Right (CRR) ID.
- PTP Obligation Bids - includes QSE name, settlement point source and sink, PTP bid price and quantity, and Bid ID
- PTP Obligation Bids Awards – includes QSE name, settlement point source and sink, PTP bid price and quantity, and Bid ID.

2.7.3 Historical Generation and Demand

ERCOT publishes historical energy and demand via the Actual Loads of Weather Zones Display and Actual Loads of Forecast Zones Display. These displays are updated hourly at 20 minutes after the hour and provide access to the current and previous five days. The Forecast Zones include North, South, West and Houston. The Weather Zones or Weather Control Areas include Coast, East, Far East, North, North Central, Southern, Southern Central, and West.

This data is also available in a report format via EMIL - Actual System Load by Forecast Zone, Actual System Load by Weather Zone. ERCOT also provides the Actual Hourly Load Data by Study Area which contains one study area, the Valley. A CSV or XML file can be downloaded which contains data for a single day at the hourly level.

The System-Wide Demand report shows the total ERCOT system wide demand in 15-minute intervals. Data can be downloaded in CSV or XML format wherein each file contains the four 15-minute interval data for a specific day and hour.

The Hourly Load Data Archives provide historical data by control area dating back to 1995, except for 2001. A years' worth of data is available for download in a single Excel file. Since 2003, ERCOT has reported load data in eight weather control areas as well the ERCOT BAA. Prior to 2003, ERCOT was divided in to eleven control areas and the load data is reported accordingly.

ERCOT also provides system wide historical Hourly Aggregated Wind and Solar Output for the last 3 years. Prior to 2021, the report included only wind data and simply provided the hourly wind output without any accompanying charts and summary statistics. The data includes the hourly ERCOT load, wind / solar generation, installed MW capacity, output as a percentage of load, output as a percentage of installed MW capacity, and the one hour output change in MW and percentage terms.

ERCOT also publishes fuel mix reports, on the generation website which contains actual generation by fuel type for each 15-minute interval, as well as totals by month and year-to-date. The last two years' worth of data are available in separate files on the website while historical data from 2007 to 2020 are available in a zip file which contains an Excel file for each calendar year.

Each fuel mix Excel report file contains a summary tab followed by a tab for each month. The summary tab shows the total monthly generation in GWh for each fuel type along with a pie chart breaking down the percentage generation by each fuel type as well as a more detailed breakdown of the fuel types that provided less than two percent. The monthly tabs provide the 15-minute interval generation by each fuel type – Biomass, Coal, Gas, Gas-CC, Hydro, Nuclear, Other, Solar and Wind.

2.7.4 Forecast Generation and Demand

Short Term Forecasts

ERCOT provides multiple short- term forecasts with at least 3 days of historical information, most of which are updated on an hourly basis:

- Intra-Hour Load Forecast (IHLF) by Weather Zone – A rolling two-hour forecast at the 5-minute granularity level for each weather zone as well as the ERCOT BAA. An updated CSV or XML file is available for download every five minutes.
- Seven-Day Load Forecast by Forecast Zone – Hourly demands for each forecast zone as well as the system total, for the current and next seven days.

- Seven-Day Load Forecast by Weather Zone - Hourly demands for each weather zone as well as the system total, for the current and next seven days.
- Seven-Day Load Forecast by Model and Weather Zone – Hourly system-wide forecast as well as for each weather zones for all forecast models for the current day and next seven days.
- Seven-Day Load Forecast by Model and Study Area – Hourly demand forecast by the study areas, for the current day and next seven days for one study area, the Valley.
- Short-Term System Adequacy Report – This report provides the available capacity for generation resources and load resources by zone. It also includes off-line available capacity by zone and ERCOT BAA, available reserve capacity and total system wide generation and load resources capacity, for each hour of the current day and six days forward. Historic data is made available for the last month.

ERCOT does not publish an acronyms and definitions list. Models are generically named E, E1, E2 and E3 with the E's indicating ERCOT developed models. Models A3 & A6 are from the vendor system. "DSTflag" is a flag for Daylight savings time to account for the repeated hour.

ERCOT also publishes solar and wind forecasts with at least 3 days of historical data which is updated on a 5-minute or hourly basis depending on the report type:

- Hourly System-Wide and Regional Solar Forecasts by Model - This report provides hourly regional and system-wide Photovoltaic Generation Resource Production Potential (PVGRPP) values produced by each forecast model for On-Line PVGRs for the rolling future 168-hour period as well as for the past 48-hour period. It indicates which forecast model is used for each region to populate Current Operating Plans (COPs). The different regions are Centre East, Centre West, Far East, Far West, Northwest, Southeast. Historical data is available for the last 7 days.
- Intra-Hour Solar Power Forecast by Geographical Region - This report provides a rolling two-hour forecast on a five-minute IHPF granularity level of system-wide and solar region aggregations.
- Intra-Hour Wind Power Forecast by Geographical Region – This report provides a rolling two-hour forecast on a five-minute IHPF granularity level of ERCOT-wide wind production potential. It includes system wide and wind regions aggregations of the Intra-Hour Wind Power forecast. The different regions are Coastal, North, Panhandle, South & West.

Medium Term Forecasts

ERCOT provides two 36-month forecasts, with historical data dating back to one year, are available in Excel format. Both reports are classified as Secure meaning that it is not available to the general public and an individual or organization seeking to access the reports must be registered as an IMRE to access this information.

- Long-Term Daily Load Forecast – daily minimum and maximum peak for each of the weather zones and forecast zones.
- Long-Term Weekly Peak Demand Forecast – weekly minimum and maximum peak demand by forecast zones.

Long Term Forecasts

ERCOT publishes, on an annual basis, the Long-Term Hourly Peak Demand and Energy Forecast report which has a ten-year horizon. This hourly forecast is based on forecast economic data and historical weather from 2006 – 2020. Graphs depicting the historical and forecast values for the Summer Peak Demand & Annual Energy are also available on the portal. Historical reports dating back to 2013, except 2015, are available.

The report is in PDF format and describes the forecast methodology, highlighting its major conceptual and statistical underpinnings and presents the forecast results in the form of a comparison to the previous year's forecast. The report includes a summary of the annual summer peak demand and energy forecast as well as forecast uncertainties as the volatility of these factors have a major impact on the forecast accuracy:

- Weather
- Economics
- Energy Efficiency
- Price Responsive Loads
- Electric Vehicles

- Large Industrial Loads, and
- Change in ERCOT's Service Territory

ERCOT makes available various supporting documents in Excel format:

- Long-Term Monthly Peak Demand and Energy Forecast – Monthly forecast with expected monthly peak demand in MWs and energy in MWhs.
- ERCOT Hourly Forecast – Hourly values of load forecasts, PV forecasts and net load forecasts by weather zone.
- 90th Percentile Summer Non-Coincident Peak by Weather Zone – gross and net summer peak demand 90th percentile forecast by weather zone.
- ERCOT Peak Demand Scenarios – gross and net summer peak demand for each forecast year based on historical weather years (2006-2020).
- Weather Zone Coincident Peak Forecast – gross summer coincident peak demand forecast by weather zone.
- Weather Zone Non-Coincident Peak Forecast – gross summer non-coincident peak demand forecast by weather zone.

2.7.5 Unit Generation and Dispatch

ERCOT publishes base points, i.e., instructed output/consumption levels, in their 60 Day Security-Constrained Economic Dispatch (SCED) Disclosure reports. This report is at the fifteen-minute level and includes generation, storage (dispatchable batteries) and controllable load Resources (dispatchable loads). Similar to Energy Offers & Bids, this data is published following a 60-day lag period. Historical data for 30 days is available for download. Each day's data provided in a zip file which contains multiple Excel for:

- Manual Override – flags what manual overrides were implemented for what timestamp for a resource along with a reason code.
- Load Resource Data – includes Qualified Scheduling Entity (QSE), Decision Making Entity (DME), load resource name, maximum, minimum & real power consumption, ten price quantity SCED curve pairs, high and low dispatch limit.
- Generation Resource Data – includes QSE, DME, generation resource name and type, thirty-five incremental and decremental SCED price quantity curve pairs, three part offers (hot/intermediate/cold start up prices, minimum generation cost), ten submitted price quantity pairs, high and low dispatch limit, and high and low sustained limit.
- Settlement Metered Net Energy for Generation Resources – includes interval number, resource code and interval value.
- Dynamically Scheduled Resource (DSR) and Loads – includes QSE name and total telemetered DSR loads.

Operator Dispatch Instructions are communicated directly to the QSE but not posted in any report. According to NP 1.3.1.4(6) Information of Protected Information Status, information that is no longer Protected Information, but not posted, including Dispatch Instructions, is available on request under the ERCOT Request for Records and Information Policy. For Dispatch Instructions, the information may be requested with respect to a specific Resource, where applicable, and by service type and Settlement Interval or as integrated over each Settlement Interval for Dispatch Instructions with sub-Settlement Interval frequency.

2.7.6 System Impact Studies

ERCOT publishes, on a monthly basis, the Generation Interconnection Status (GIS) report in Excel format with multiple tabs that are clearly defined on a Table of Contents tab which include a References and Acronym tab to aid the user. The Summary tab provides the total number of requests by large and small generators, inactive and cancelled requests as well as the number of projects along the various milestones by fuel type.

The Large and Small Generators' Project Detail tabs provide project specific detail such as project name, Generator Interconnection or Modification request (GIM) study phase, Capacity, Demand and Reserves (CDR) reporting zone, interconnecting entity, point of interconnection (POI), fuel type, system size, start and end dates for various studies and construction, permit status (air, GHG, water), interconnection agreement (IA) and projected Commercial Operation Date (COD). The GIM Trends tab provides various

trends over a 13-month rolling basis such as GIM monthly capacity by milestone and fuel type and capacity by COD date and CDR forecast zone.

The Commissioning Update and Cancellation Update tabs list the various projects that received approval / were cancelled in the current month. The Inactive Projects tab lists the projects that are inactive. These tabs also include a few key project details such as fuel type, MW capacity, size category and county.

Along with the GIS report, ERCOT also publishes a Battery Identification report on a monthly basis with multiple tabs which includes a Definitions and Acronym tab to aid the user. The Summary tab summarises the total number and MW capacity of projects by type, i.e., standalone and co-located. There are separate tabs for standalone and projects co-located with solar, wind and thermal resources which provide project specific information similar to the GIM report.

The Historical Trends summarizes the battery projects by type, i.e., standalone vs. co-located, over the past year. The Battery RFI Charts tab summarises the number of batteries that are operational and fully approved, operational but not fully approved, or planned. The Co-located Operation tab provides a list of operational projects that are co-located with details on the fuel type, CDR reporting zone, in-service date, and capacity.

ERCOT publishes the Resource Interconnection Handbook which details the process that must be followed to enter the Generation Interconnection or Modification (GIM) Process either to connect new generation or modify existing generation facilities already connected to the ERCOT System as described in Planning Guide, Section 5. The guidelines differ for large vs. small generators, i.e., over or under 10 MW, but the interconnection process is the same. Interconnection studies are classified as CEII and are not publicly available. Studies can include a Security Screening Study, Full Interconnection Study and Reactive Study.

ERCOT Nodal Protocols, Section 3.14 - Contracts for Reliability Resources and Emergency Response Service Resources governs suspension of operations and Reliability Must Run (RMR). A unit must notify ERCOT of any retirements or suspension of operations. ERCOT will evaluate the request and assess whether the unit is needed for reliability. If ERCOT deems the units are required for reliability purposes, certain provisions are triggered under which the generation unit becomes a Reliability Must Run (RMR) unit.

Retirement studies, some of which may not be classified as CEII, are not publicly available but accessible via the Secure MIS. ERCOT does not conduct studies for retirements of Load Resources (LRs) and there are no defined or required processes for LR retirement.

2.7.7 System Planning Documents

Planning Portal Reports

As part of ERCOT's Planning portal three key reports are made available:

- Regional Transmission Plan (RTP)
- Long Term System Assessment (LTSA)
- Electric System Constraints and Needs

Regional Transmission Plan (RTP)

Annually, ERCOT publishes the Regional Transmission Plan (RTP) which is the result of a coordinated planning process with extensive review and input by NERC-registered Transmission Planners (TPs), Transmission Owners (TOs), and other stakeholders. The RTP addresses system-wide transmission needs over a 6-year planning horizon, wherein years one through five and six represent the near and long-term horizons.

Results of this plan include recommendations for upgrading and improving the existing system and proposals for new transmission projects that ensure transmission system reliability and relieve significant anticipated transmission system congestion. Noteworthy reliability projects are also identified in the RTP. It also includes an economic assessment of the transmission system wherein projected transmission constraints are identified and lines recommended for dynamic rating.

The RTP study scope is limited to the steady state and short circuit portion of the reliability standards. The Input Assumptions include the transmission topology, generation and demand. The RTP can be downloaded in a ZIP file that contains the main PDF report as well as the following supporting documents:

- Scope and Process in PDF format that also highlights the deliverables of the process,

- Reliability Input Assumptions in Excel format,
- Economic Input Assumptions in Excel format,
- Reliability Projects List in Excel format, and
- Reliability Project Locations on a map in PDF format.

Long Term System Assessment (LTSA)

Bi-annually, ERCOT also conducts the Long-Term System Assessment (LTSA) to determine the needed transmission infrastructure and make appropriate recommendations. The planning horizon is notably longer than the RTP extending 10-15 years and are both important pieces of the overall puzzle as the one of the goals of the LTSA is to guide the near term planning, namely the RTP, via an assessment of multiple probable scenarios.

The LTSA is a composite study comprising multiple processes such as scenario development, demand forecasting, capacity-expansion and retirement analysis, and transmission expansion analysis. The scenarios are developed in collaboration with stakeholders which are then converted into a series of scenario specific modelling assumptions.

The specific scenarios can vary from one study to another, but recent examples include:

- Current Trends – economic, fuel, demand.
- Expanded System Outlook – new resources in the interconnection queue.
- Demand Side Evolution – Large Flexible Loads (LFL), Electric Vehicle (EV) penetration, rooftop solar adoption.
- Renewable Mandate – favourable regulatory environment, reduced hurdles.
- High Battery Energy Storage
- High Industrial Load
- Existing Transmission Constraints – impacts on resource mix by geography.

Supporting appendices, in PDF format, include:

- LTSA Process,
- Resource Siting Methodology (provided as a separate document),
- Generation Retirements, and
- Scenario Results Summary.

The resource siting methodology documents the process used to site new generation and energy storage resources for the LTSA. Capacity expansion and retirement analyses are performed to determine the capacity, type, and commission dates for new resources for each scenario. The goal is to locate probable generation sites based on key drivers such as resource availability, transmission infrastructure accessibility and economic factors.

Electric System Constraints and Needs

The Annual Report on System Constraints and Needs report summarises the following:

- Recent System Constraints,
- Projected Constraints,
- Planned Improvements,
- Transmission Cost Trends over the past decade,
- Grid Changes related to generation, distributed generation and demand,
- Recent PUC Rule Changes and Initiatives, and
- Other Regional Updates as appropriate.

Resource Adequacy Portal Reports

As part of ERCOT's Resource Adequacy portal, four key reports are made available:

- Capacity, Demand and Reserves (CDR) Report,
- Seasonal Assessment of Resource Adequacy (SARA),
- Drought Risk Analysis Report, and
- Resource Capacity Trends.

Capacity, Demand and Reserves (CDR) Report

The Capacity, Demand and Reserve Report (CDR), published bi-annually, forecast the Planning Reserve Margins for the ERCOT summer and winter Peak Load Seasons (June through September, and December through February, respectively) over a ten year horizon. The Planning Reserve Margin is percentage of generation capacity in excess of firm demand that is expected to be available to cover future uncertainty. This report is available in Excel or PDF format and includes:

- Significant changes as compared to the last CDR,
- Load forecast, resource capacity in MW and the associated reserve margin by season,
- List of registered resources and their MW capabilities used in determining the capacity contribution for each season,
- Condensed versions of the summary forecast for the next five years under different sets of planned project inclusion criteria,
- Generation capacity in MW by fuel type along with their associated capacity contribution values by season,
- Unconfirmed retirement capacity, i.e., a public retirement announcement has been made but a formal notice of suspension has not been submitted to ERCOT, over the next six years and the associated impacts on the reserve margins, and
- List of decommissioned generating resources.

Seasonal Assessment of Resource Adequacy (SARA)

The Seasonal Assessment of Resource Adequacy (SARA) serves as an early indicator for the need to call an Energy Emergency Alert Level 1 (EEA1) due to insufficient operating reserves during peak periods. A range of resource adequacy outcomes based on extreme weather conditions are illustrated. The report details the installed and winter peak capacity in MW for all generation resources and provides assessments of the capacity available for operating reserves for two groups of scenarios:

- Base & Moderate Risk
  - Forecasted Peak Load / Typical Unplanned Outages / Typical Renewable Output
  - High Peak Load / Typical Unplanned Outages / Typical Renewable Output
  - Forecasted Peak Load / High Unplanned Outages / Typical Renewable Output
  - Forecasted Peak Load / Typical Unplanned Outages / Low Renewable Output
- Extreme Risk
  - Extreme Peak Load / Typical Unplanned Outages / Typical Renewable Output
  - High Peak Load / High Unplanned Outages / Typical Renewable Output
  - High Peak Load / Extreme Unplanned Outages / Extreme Low Wind Output

Scenario assumptions are detailed in the reports which are updated quarterly and available in Excel of PDF format.

Drought Risk Analysis Report

The Drought Risk Analysis Report which summarises the potential drought related impacts on generation resources over the next 18-months. The analysis is based on weather forecasts, recent levels from the Texas Water Development Board (TWDB) and historical usage trends. The report presents all information in a graphical manner, which includes a map of current reservoir levels, and is available in PDF format. The publishing frequency of the report depends on the amount of capacity deemed at risk. When there is no risk, it is published bi-annually.

Resource Capacity Trends

Resource Capacity Trends are published, in Excel format, on a monthly basis on separate tabs for solar, wind, battery storage and natural gas which is divided into combined cycle and other gas. Two reports are available, one that provides an 18-month forecast on a monthly basis and another that provides a two to three year forecast along with historical data dating back to 2000.

A chart displaying the generation capacity broken down by facilities that are operational, have a signed IA and have posted financial security and have a signed IA but not posted financial security. The accompanying data table with various project specific details such as project ID, project name, projected COD, IA signed date, approved for synchronization date, fuel, technology, capacity, and if financial security is posted or not are also included.

2.7.8 Requesting Data

There are three ways to request data from ERCOT depending on the nature of data information: Public, Secure and Critical Energy Infrastructure Information (CEII):

- Public Information – Information not required to be publicly posted, in accordance with protocols, can be requested via the information request portal. For substantive requests, a cost estimate is provided, which includes a labour cost of USD 15/hour, and payment must be received for the request to be processed. Historical Information Requests are also made publicly available.
  - ERCOT will send notice of receipt of the request and will endeavour to respond to requests within ten (10) business days of receipt of the request. If a response requires more than ten business days, ERCOT will notify the requestor of the expected delay and the anticipated date that the documents may be available.
  - ERCOT may seek clarification or ask other questions regarding a request and the response time may be extended pending resolution of such inquiries. If a requestor does not respond to a request for clarification or follow up question after 60 days, then the request will be deemed withdrawn. Information will be provided in electronic format via email unless the requestor is reasonably unable to receive information in such format.
- Secure Classified Information – Access to the MIS Secure Area requires registration as an Independent Market Information System Registered Entity (IMRE). A Registration Form, a USD 500 fee, and a Standard Form Market Participant Agreement are required. The turnaround time is typically two weeks depending on the number of IMRE applications under review.
- Critical Energy Infrastructure Information (CEII) – One needs to be registered as an IMRE to in order to view ERCOT Critical Energy Infrastructure Information (ECEII). The User Security Administrator (USA) of the organization can request ECEII-eligible Digital Certificates for individuals within the organization which are usually addressed in a month.

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We believe in the power of ingenuity to build a positive human future.

As strategies, technologies, and innovation collide, we create opportunity from complexity.

Our diverse teams of experts combine innovative thinking and breakthrough technologies to progress further, faster. Our clients adapt and transform, and together we achieve enduring results.

We are over 4,000 strategists, innovators, designers, consultants, digital experts, scientists, engineers, and technologists. And we have deep expertise in consumer and manufacturing, defence and security, energy and utilities, financial services, government and public services, health and life sciences, and transport.

Our teams operate globally from offices across the UK, Ireland, US, Nordics, and Netherlands.

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