

Wind Generation Operational Considerations

June 2009

- **Data Requirements**
- **Outage Reporting**
- **Wind Power Forecasting**
- **Submitting generation offers**
- **Responding to Economic Basepoint**
- **Curtailments for Transmission Constraints**
- **Curtailments for Economics/Emergencies**



Wind generators are responsible for supplying specific data (during interconnection process and also in real time) to PJM for input into a forecasting tool

Demographic information and MW Output aids forecasting efforts

Specific requirements found in Section 8 - Manual 14d

Each wind farm must install at least one meteorological tower in the farm and provide real time meteorological (or mutually agreed upon alternative source) data to PJM through ICCP link

Real-time weather data aids forecasting efforts

Specific requirements found in Section 8 - Manual 14d

eDART submittals required for reporting outages of turbine, reactive capability curves (D-curves), and status of Automatic Voltage Regulator (AVR)

Information bridged to forecasting tool

Information on generation outage reporting found in Manual 10 (Pre-Scheduling Operations)

Generator operational requirements and responsibilities are located in *Manual 14d*:

<http://www.pjm.com/documents/manuals/rtep-process-manuals.aspx>



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PJM Regional Transmission Planning Process Manuals

PJM's *Regional Transmission Expansion Plan (RTEP)* identifies transmission system upgrades and enhancements to preserve the reliability of the electricity grid, the foundation for thriving competitive wholesale energy markets.

PJM Manual 14 Series

M-14A Generation and Transmission Interconnection Process guides the generation and/or transmission developers through the planning processes to interconnect to and operate in PJM markets. Current Version Previous Version

M-14B PJM Region Transmission Planning Process focuses on the PJM's open and participatory process for planning baseline expansion facilities. Current Version Previous Version

M-14C Generation and Transmission Interconnection Facility Construction provides PJM process guidelines for the construction and integration of all RTEP projects, including generation and merchant transmission interconnections and Transmission Owner upgrades. Current Version Redline Version

M-14D Generator Operational Requirements focuses on generator responsibilities as signatories to the Operating Agreement of the PJM Interconnection and related market and operational requirements for connecting to the PJM system. Current Version Redline Version

RELATED INFORMATION

- Planning
- Compliance

RECENT DOCUMENTS

- NOV 13 M-2: Transmission Service Requests 2008 Posted 73 days ago PDF
- NOV 13 M-2: Transmission Service Requests - Redline 2008 Posted 73 days ago PDF
- NOV 13 M-1: Control Center and Data Exchange Requirements 2008 Posted 73 days ago PDF
- NOV 13 M-1: Control Center and Data Exchange Requirements - Redline 2008 Posted 73 days ago PDF

CONTACT INFORMATION

Specific information on Wind Farm Requirements are located in Section 8

- **General Turbine Information**
 - Class of turbine
 - Capacity of turbine
 - Power Generation Threshold Rates (min/max wind speed)
- **Manufacturer Power Curves of individual turbines**
- **Longitude/Latitude of wind farm site or each turbine if available**
- **Hub height of wind power facility**
- **Aggregate historical data**
 - MW output
 - Outage information
 - Wind speed at hub height
- **Ambient temperature operating limits**
 - “Cold weather package” information if installed

Possible metering installation guidelines, which applies to the aggregate wind farm connected at a collector point or interconnection point, are in Manual 14d, Exhibit 4 (Guidelines for Metering Installations)



The Generator shall communicate the outage of any data communication equipment connecting the facility to the PJM system

- **Aggregate Real Time Output of Wind Farm**
 - Low-side net MW/MVAR
 - High-side net MW/MVAR
 - 10 seconds or less frequency
 - DNP 3.0, Level 2
 - ICCP
 - See Manual M-01 for details
- **Meteorological Tower Information**
 - At least one meteorological tower per farm is required (or mutually agreed upon alternative source)

Parameter	Units	
Wind Speed	meters/second	Required
Wind Direction	Degree from True North	Required
Temperature	Fahrenheit	Preferred
Pressure	Hectopascals	Preferred
Humidity	percent	Accepted

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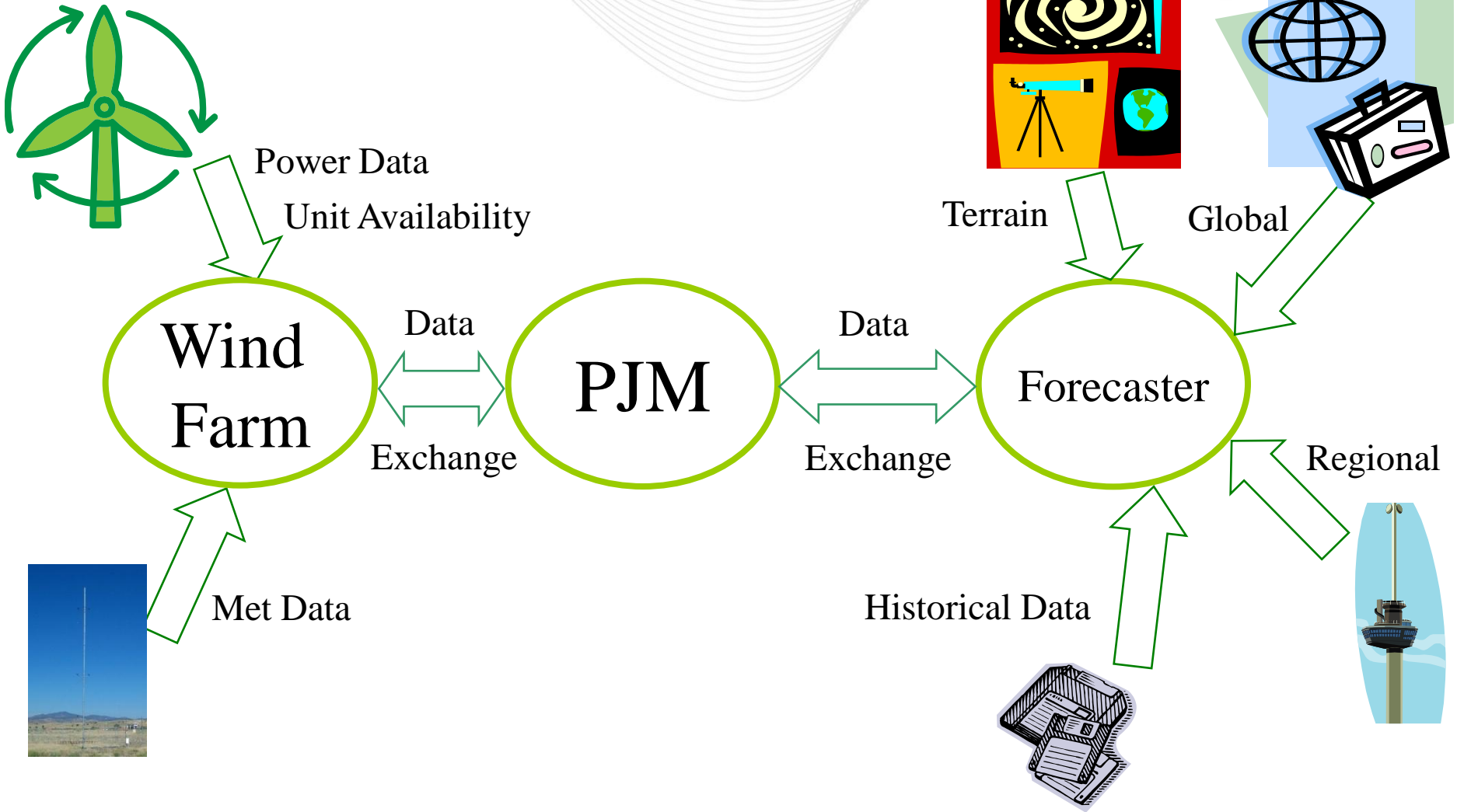


- eDART used for
 - Generation outage reporting
 - 1 MW or more outage for 1 hour or more
 - Changes to Reactive Capability(D-curve)
 - AVR status changes
 - Reserve Reporting
 - See http://www.pjm.com/sitecore/content/Globals/Training/Courses/ol-gen-outage.aspx?sc_lang=en for detailed eDART Training
- Wind farm modeled as single unit with capability equal to the sum of all turbines at full output
- Do not submit outage tickets related to wind speed
 - Forecast tool will model this

- Wind Farm has 50 turbines and has an installed capacity of 50 MW at full load
 - Each turbine has an installed capacity of 1 MW
 - Capacity value for RPM is 7 MW
- If 10 turbines are out for maintenance, Wind Farm will submit an outage ticket for 10 MW
- Wind forecasting tool will now assume that Wind Farm is at 4/5 of it's capability and adjust forecast based on this and expected wind speed
- Correct outage data is critical to providing an accurate wind power forecast!

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Relying on information from wind resources, PJM will forecast wind conditions. The goal of this forecasting effort is to:

- 1) Augment real-time reliability decisions by PJM operators
- 2) Accurately schedule generation in the Day-Ahead and Reliability Analysis unit commitment

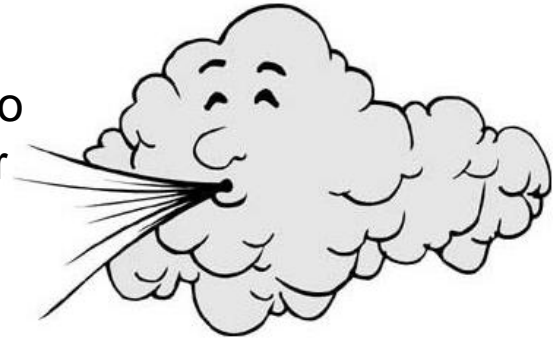


Met Mast

Real-time Reliability Assessment

PJM will use the Short-Term Wind Power Forecast to

- evaluate current day congestion
- ensure that sufficient generation resources are available to respond to real-time or projected fluctuations in Wind Power Output



Day-ahead Reliability Assessment

PJM will use the Medium-Term Wind Power Forecast to

- predict day-ahead congestion and mitigating strategies
- to ensure that sufficient generation resources are scheduled within PJM to meet forecast load, transaction schedules and PJM reserve requirements

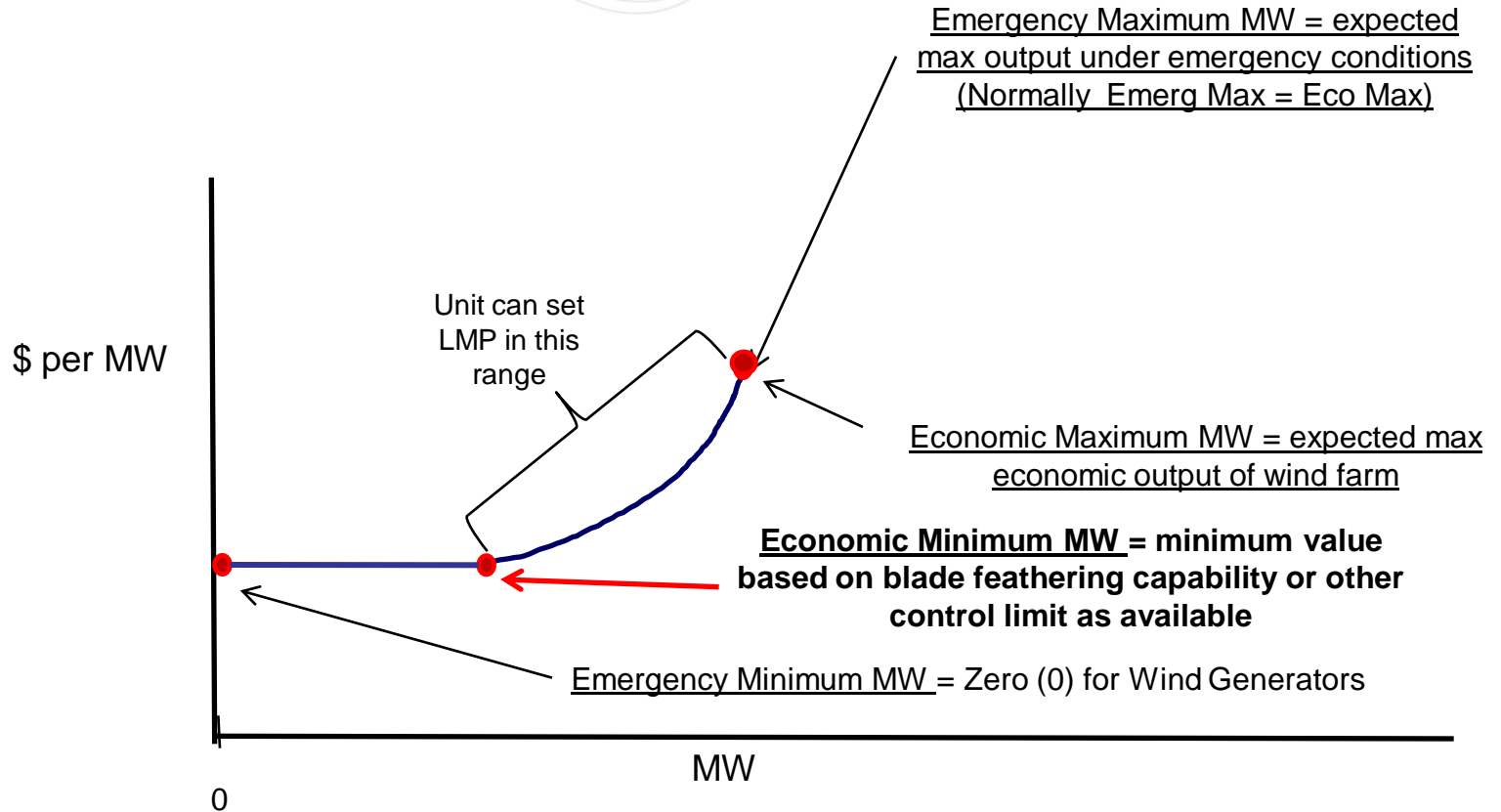
Forecast	Frequency	Interval	Duration
Short Term	10 minutes	5 minutes	0 – 6 hours
Medium Term	1 hour	1 hour	6 – 48 hours
Long Term	1 hour	1 hour	48 – 168 hours
Ramp	10 minutes	5 minutes	0 – 6 hours

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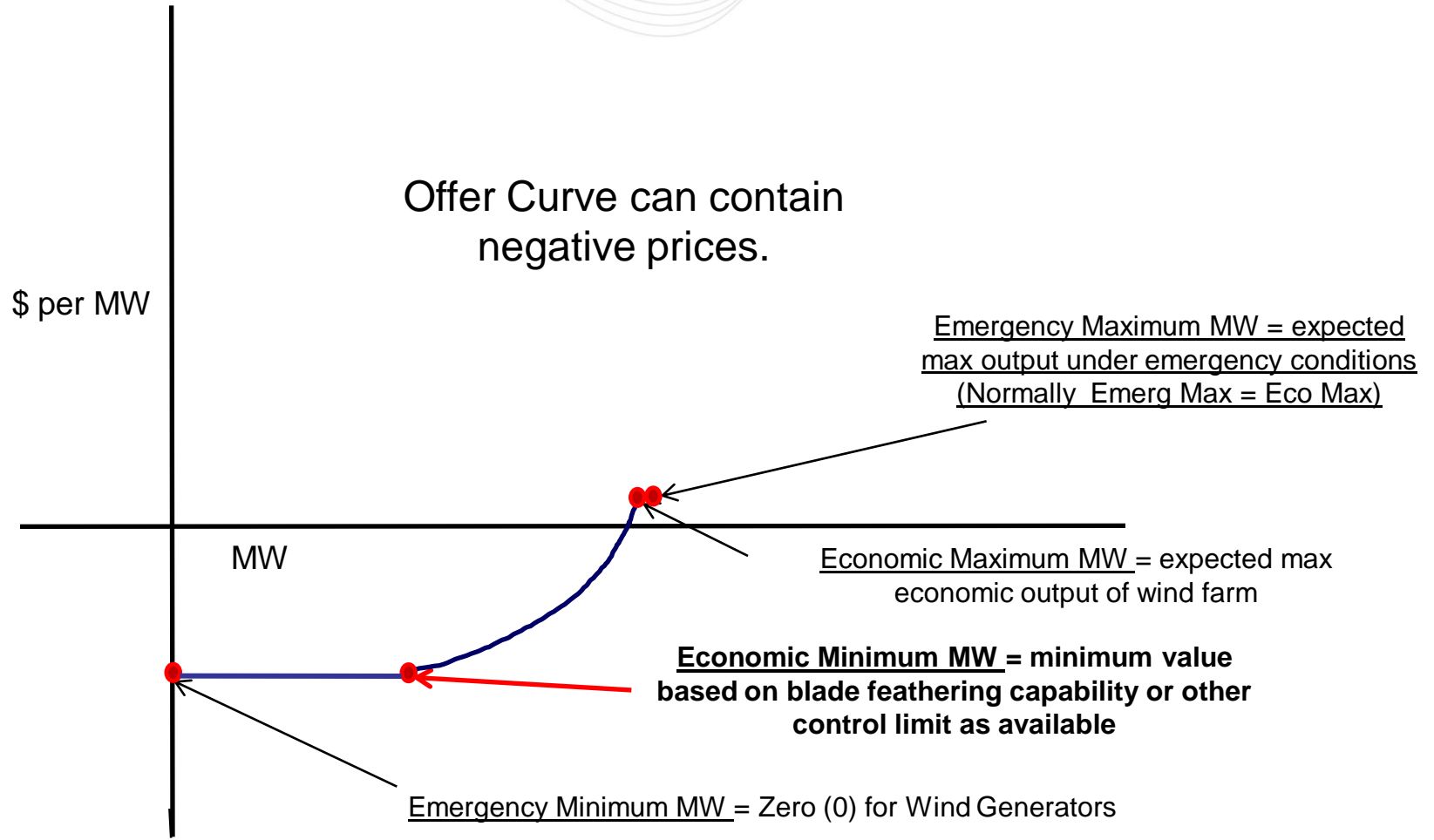


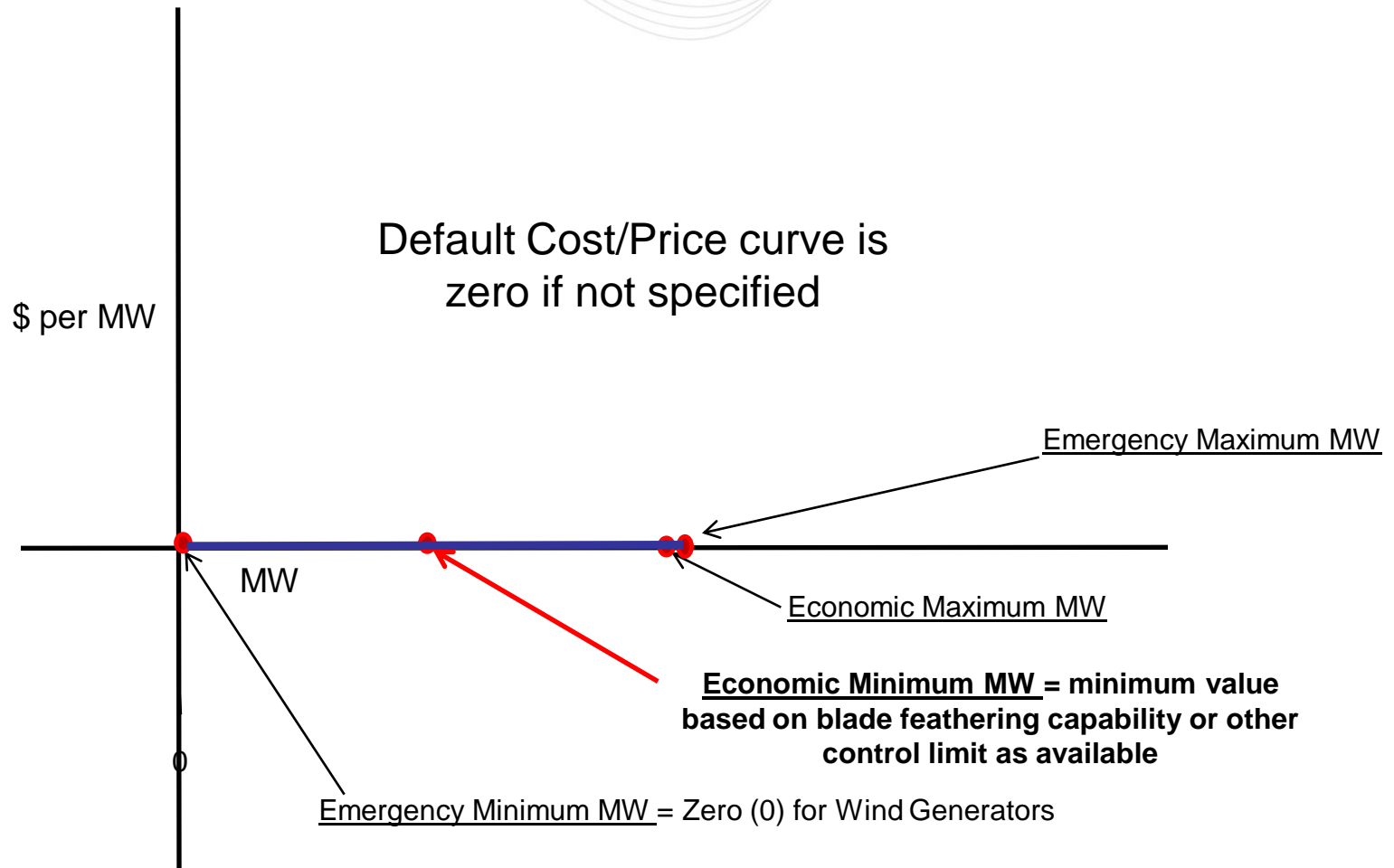
- All generation offer information is submitted through the eMKT tool (or uploaded via XML)
 - See http://www.pjm.com/sitecore/content/Globals/Training/Courses/ol-da-sched.aspx?sc_lang=en for detailed training on the PJM Day-ahead scheduling process and offer submittal using eMKT
 - Offer will be for aggregate wind farm
- eMKT has been modified to allow unit incremental price/cost curves to contain negative prices
- Unit default cost/price offer is assumed to be **\$0** if not provided
 - If other than a zero cost curve is desired, must be approved by PJM Cost Development Task Force (CDTF)
- PJM will develop economic base-point for wind farm based on incremental offer curve

- Capacity Wind Generation should offer what they expect to generate into Day-Ahead market
 - Energy-only units have the option to offer into DA market – not required
- Example
 - 100 MW ICAP unit; 13 MW cleared RPM Capacity
 - Based on expected wind next day, wind owner believes they can produce 7 MW
 - Unit should set limits as **EMERG MAX = ECO MAX = 7 MW**
 - Unit is NOT required to submit outage ticket for 6 MW reduction
 - This is because it is due to lack of wind and not a unit outage.
 - Unit will not be scheduled above 7 MW in Day-ahead market or dispatched above 7 MW in real-time operations
 - The maximum limits may be changed on an hourly basis for the DA offer and Real-time through the eMKT Unit Hourly Updates page
- Note: Wind unit capacity value is determined by actual historical production



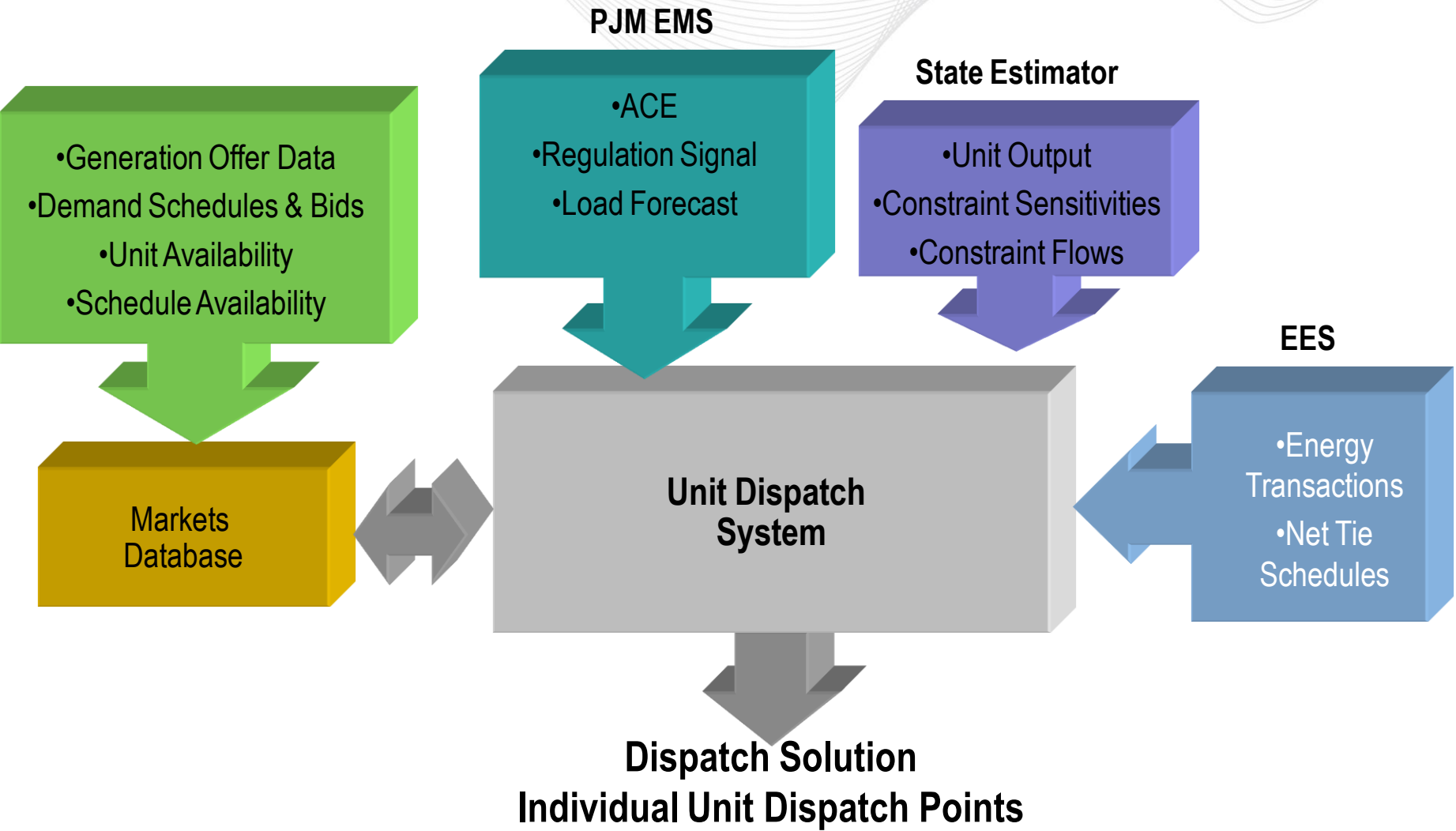
Wind Generator Operators will adjust Wind Turbine Control Systems or manually adjust turbine output to achieve the desired UDS basepoint

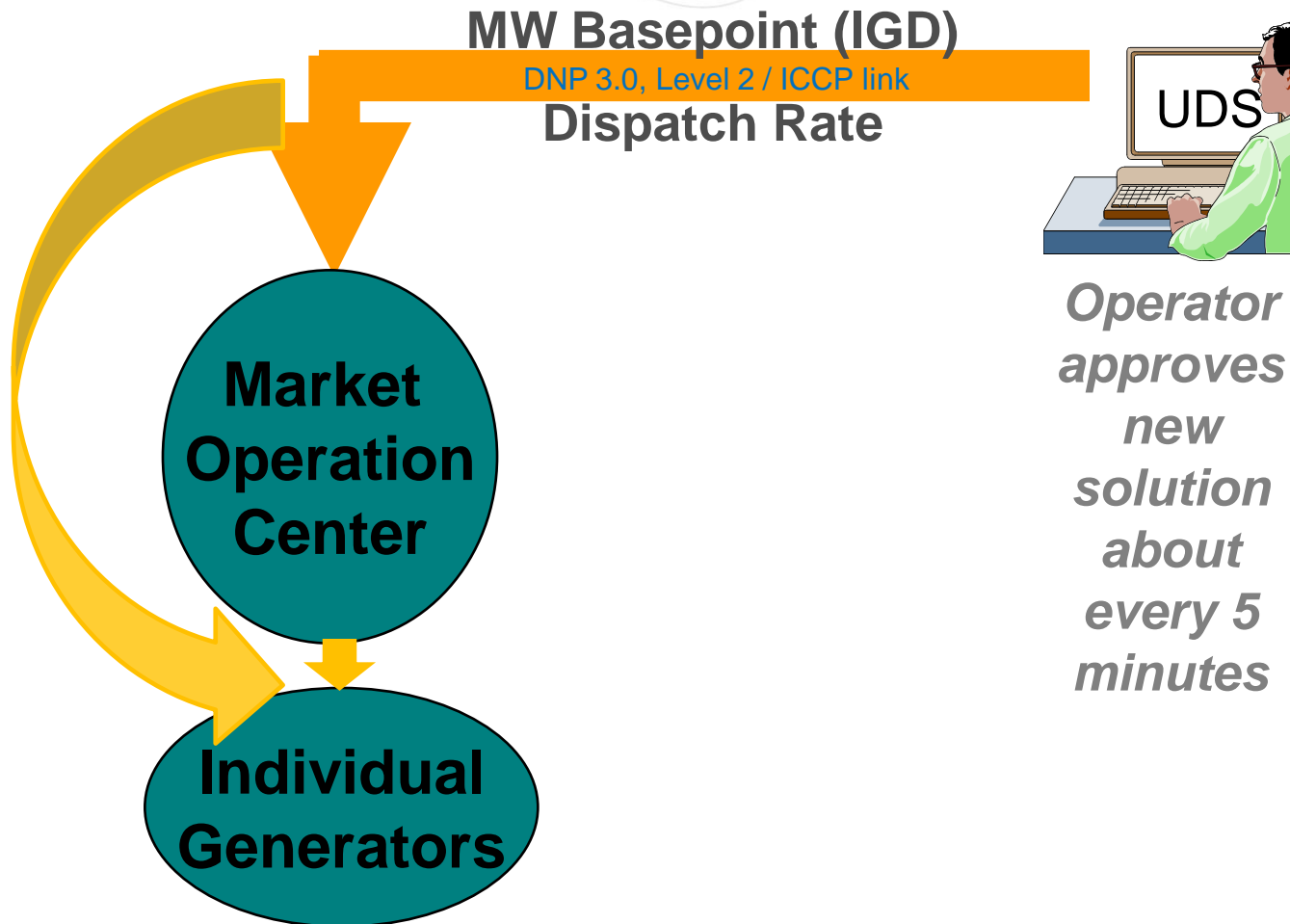




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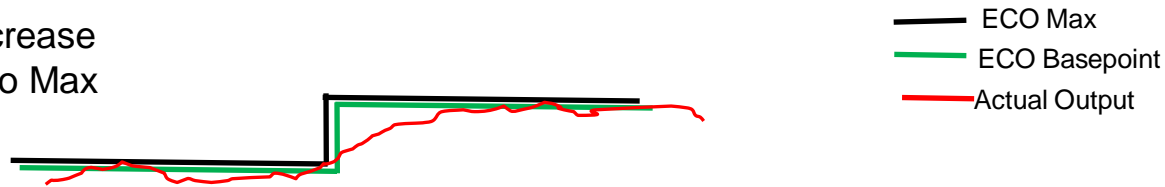




- PJM may request wind generator to **reduce** output if causing transmission constraint
 - System planned for deliverability up to capacity value
- Based on the intermittent nature of wind, the PJM Unit Dispatch System will only curtail (not increase) Wind Resources to control transmission based on their bid parameters
 - Wind may return to normal operating point once constraint is no longer being controlled
- Wind farm Individual Generation Dispatch (IGD) base-point is calculated based on bid-in ramp rate, Eco Min and Eco Max limits
 - Base-point may reflect an increase in output based on bid-in parameters;
 - However, it is assumed that generator will be at Eco Max unless lowered due to constraints/emergencies
- Communication requirements to PJM dispatcher for significant known changes in output
- All-call messages assumed to go to generation Market Operation Center
 - Recipient of All-call messages has PJM Certification requirements

- In general: Eco Max = Emerg Max = Expected output
 - Can be changed hourly in eMKT
 - If Actual Output > Eco Max; Limits should be adjusted in eMKT
- If Eco Basepoint < Eco Max
 - Unit is being reduced for economics or a constraint

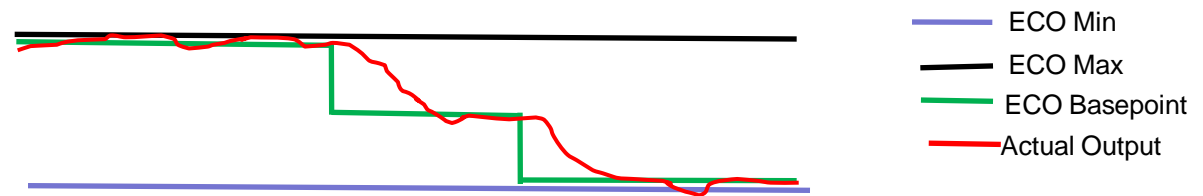
Wind owner forecasts increase in output and updates Eco Max



Wind owner notices Actual Output > Eco Max and updates Eco Max limit



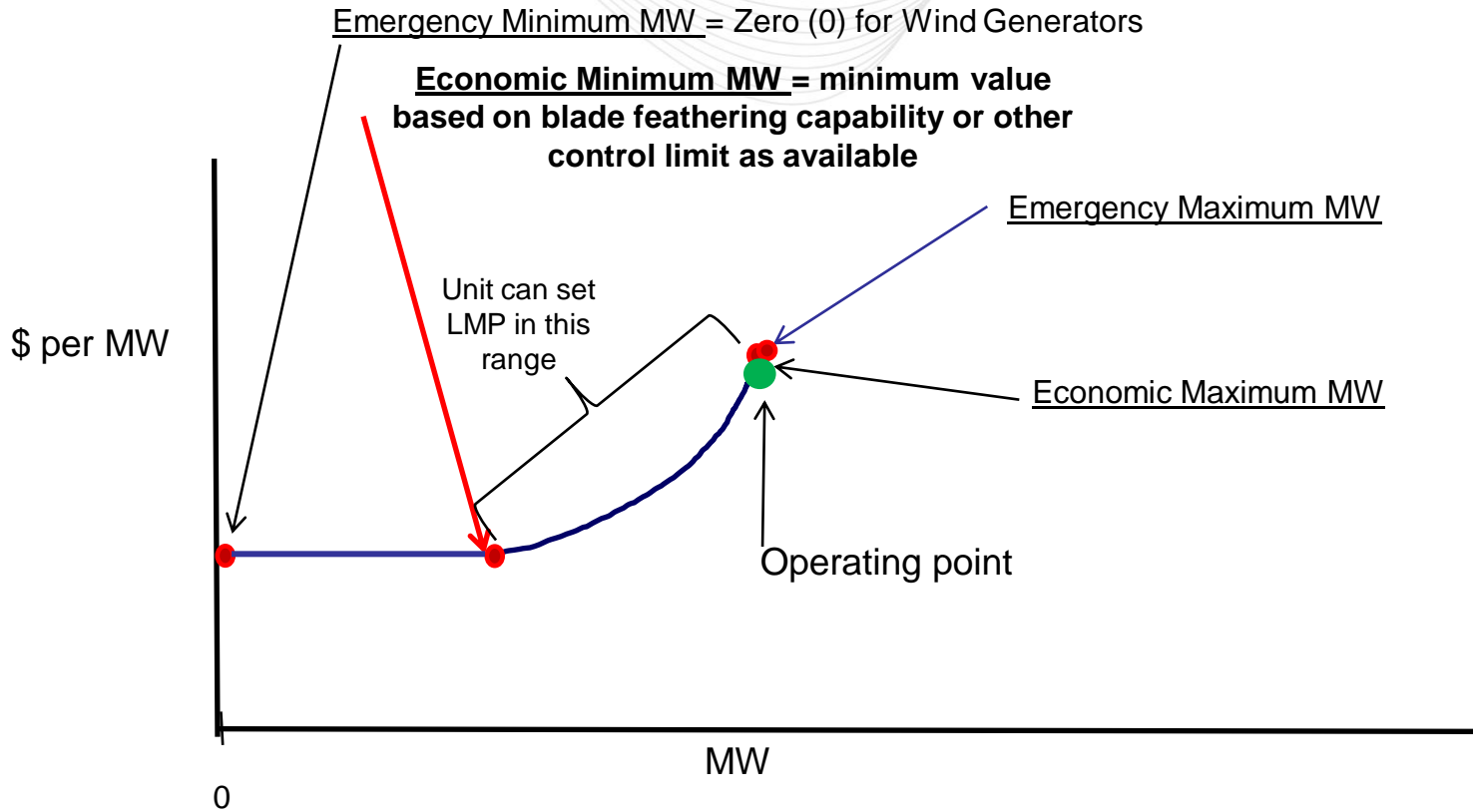
Eco Basepoint < Eco Max
Unit is being curtailed and should follow basepoint down



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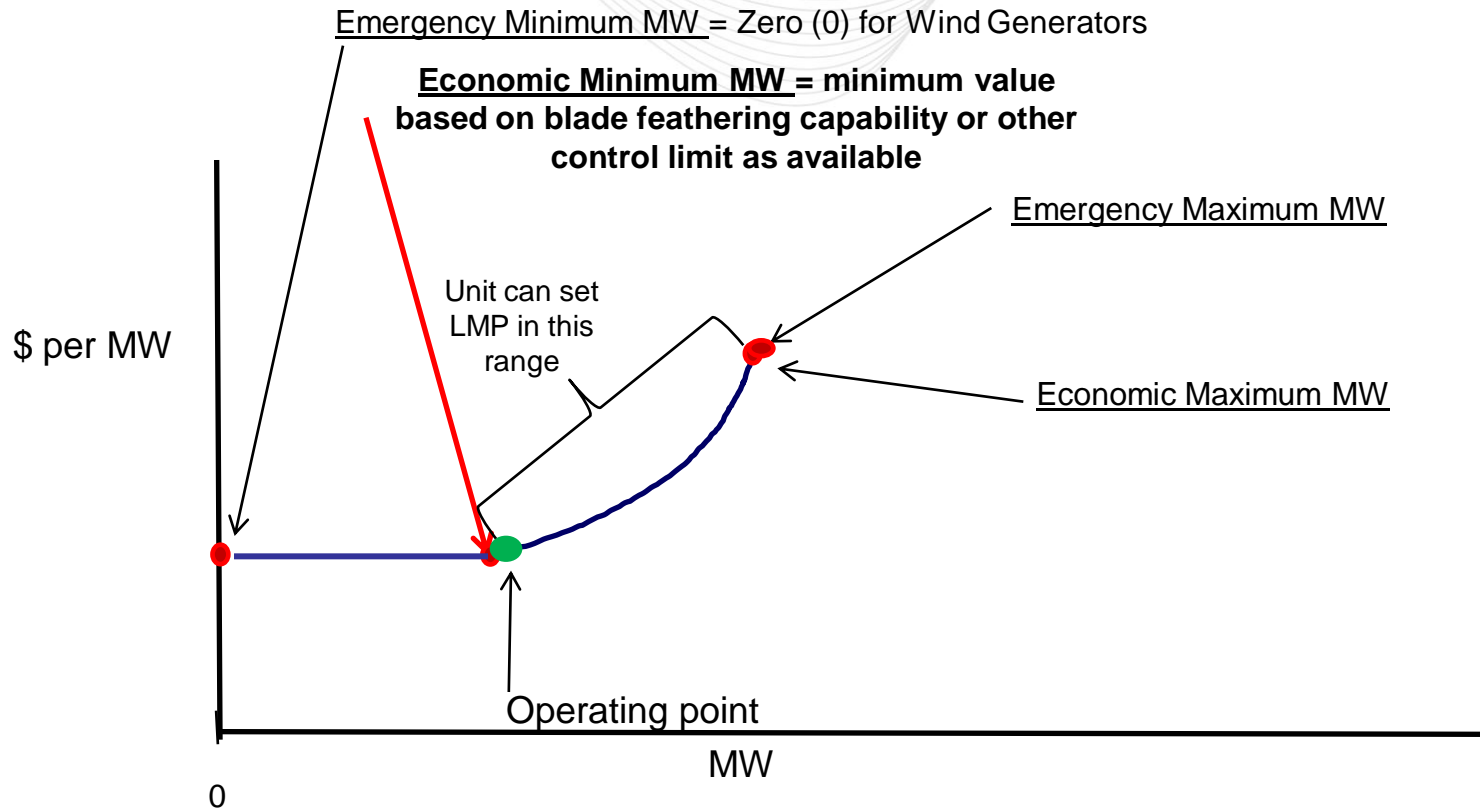


- For constraints where Wind Generation has an impact of greater than 5% for contingency overloads and 3% for actual overloads, PJM will curtail wind down toward their Economic Minimum on a cost-effectiveness basis
- Curtailments will be based on unit offer and lowest \$/MW relief on constraint
- Wind generation being lowered for a constraint may contribute to setting LMP
- Wind Farm curtailment should be achieved within 15 minutes or within a timeframe that the wind farm technology permits
 - PJM should be notified if curtailment is expected to exceed 15 minutes
- Once economic re-dispatch is exhausted, PJM may request further curtailment of wind generation toward Emerg Min if constraint still exists



If wind is impacting constraint and it is the cost-effective solution, UDS will lower wind basepoint towards Eco Min.

Wind Generator Operators will adjust Wind Turbine Control Systems or manually adjust turbine output to achieve the desired UDS basepoint



If unit is at EcoMin, all redispatch options are exhausted and constraint still exists, PJM will direct Wind unit to reduce down toward Emerg Min (0) as required.

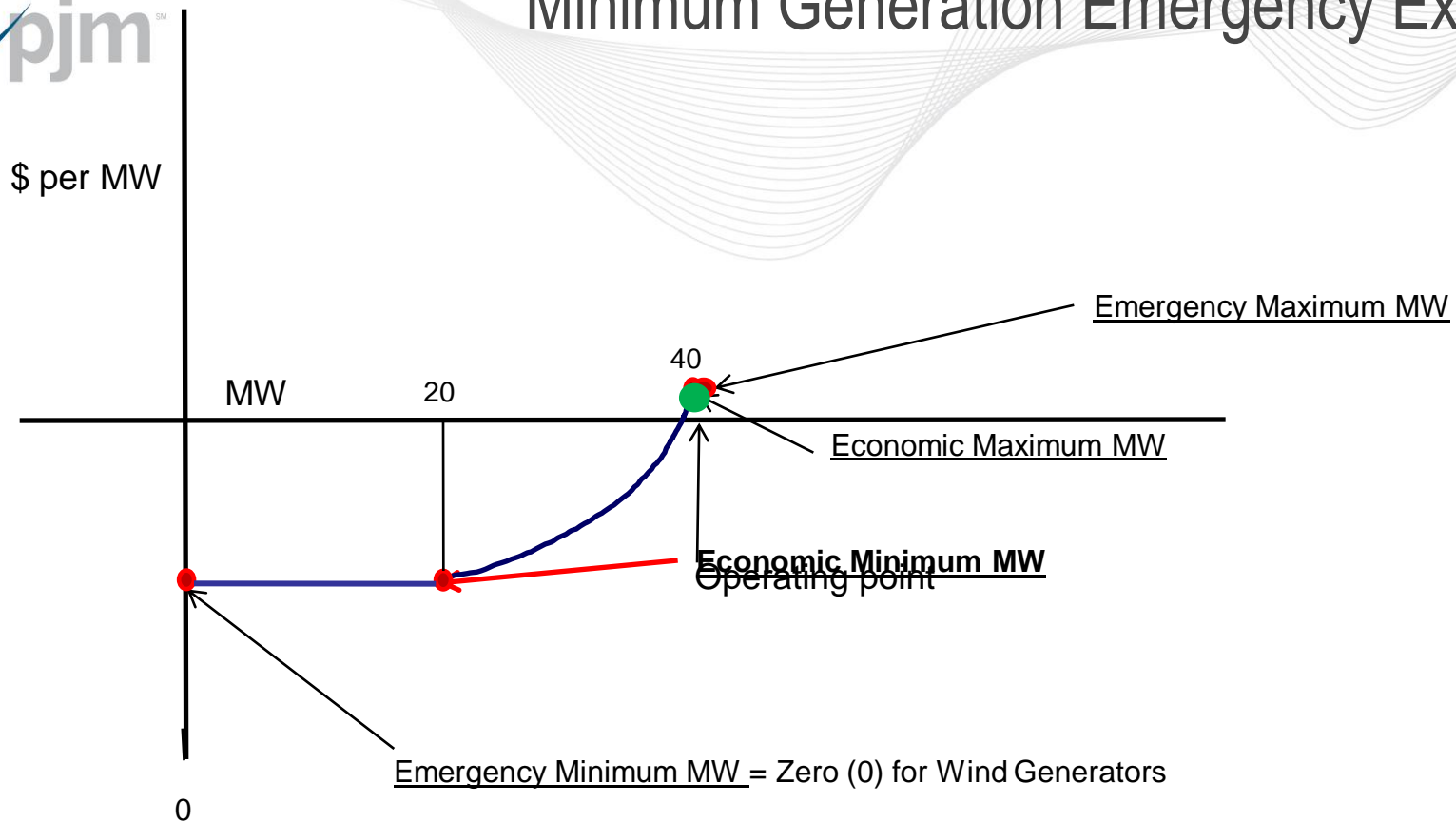
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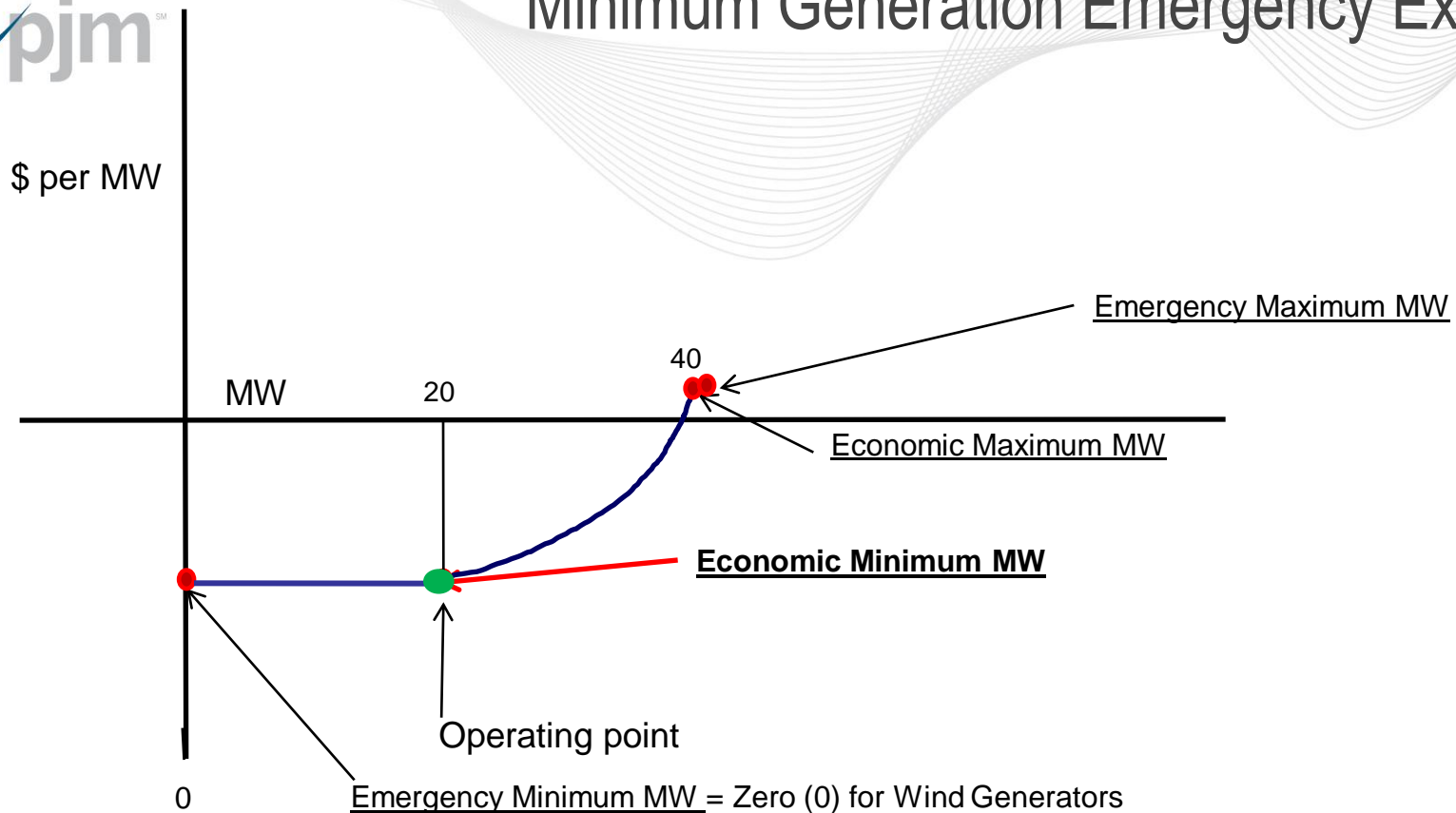


- PJM shall not differentiate between resource types during a Min Gen Emergency Event
- All resources are expected to reduce proportionally based on the percentage Emergency Reducible Generation declared
- The available Emergency Reducible Generation is (Eco Min – Emg Min)
- See Manual M-13 Section 2 for details on Light Load Procedures
- See http://www.pjm.com/sitecore/content/Globals/Training/Courses/ol-II-proc.aspx?sc_lang=en for training on Light Load Procedures

Minimum Generation Emergency Example



- During a light load condition, PJM will dispatch all units toward their Economic Minimum
- LMP may be negative, if marginal unit has negative offer curve



- Emergency Reducible Generation = Eco Min MW – Emerg Min MW = 20 – 0 = 20 MW
- When all units are at Economic Min, Minimum Generation Emergency/Events are initiated if additional generation reduction is required
- During a Minimum Generation Event, all Emergency Reducible Generation is reduced by an equal percentage (i.e. 20%, 30%, etc)
- Wind units will be taken offline as required to meet Emergency Reducible Generation as needed
- LMP will be set at the lower of zero or the lowest offer of all online generation

- Committees
- User Groups
- Working Groups**
- Black Start Service Working Group
- Credit Working Group
- Data Management Working Group
- Demand Side Response Working Group
- Governance Working Group
- Intermittent Resources Working Group**
- Long-Term FTR Working Group
- Market Data Working Group
- Market Settlements

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Intermittent Resources Working Group

Roster (PDF)

Overview

At its meeting on August 6, 2008, the [Markets and Reliability Committee \(MRC\)](#) directed PJM to form a new Intermittent Resources Working Group (IRWG) to address market and/or operational issues specific to intermittent resources. Intermittent resources are characterized by 1) a dependence on natural factors beyond the control of the resource operator for their energy production and 2) having little or no energy storage capability. Intermittent resources include, but are not limited to, wind and solar facilities. The IRWG shall address intermittent resource related issues as are assigned to it by the MRC and/or MIC.

Postings

Charter (PDF)

Posting Date

12.16.2008

Current and Upcoming Meetings

Past Meeting Material

RELATED INFORMATION

- PDF PJM Members Handbook
- + Committee Member Enrollment/Change Form
- + Facilitator Feedback Form
- + WebEx

RECENT DOCUMENTS

- NOV 17 2008 Posted 71 days ago PDF Agenda
- NOV 13 2008 Posted 74 days ago PDF Item 02 - IRWG Items
- NOV 13 2008 Posted 74 days ago PDF Item 03 - Transmission Rights
- NOV 13 2008 Posted 74 days ago PDF Item 02 - Draft Charter

This Working Group gives wind generators an opportunity to address specific operational and market issues that impact wind resources

- Data requirements for wind generation include demographic information, real-time power and metrological information and outage reporting via eDART
- PJM requires accurate wind farm outage data for accurate wind power forecasting
- Wind generation will be dispatched via UDS according to the unit's economic offer data
- Wind generation will be dispatched down to economic minimum for constraint control and emergency minimum if constraint can't be controlled by other methods
- Wind generation will be dispatched down to economic minimum during light load conditions economically and toward emergency minimum during Minimum Generation Events