




Wind Generation

How Wind Operates at PJM

- ❑ Describe wind generation offers
- ❑ Describe how Wind Generation is dispatched within PJM
- ❑ Describe procedures for curtailing wind energy and criteria for doing so.
- ❑ Describe how wind generation participates in emergency situations

- Wind Capacity Factor 13%** (PJM Manual 21, Appendix B)
 Capacity Factor does not mean the same thing as efficiency.

WIND FARM		PJM		FORECASTER
Power Data				Terrain
Unit Availability				Global Weather
Meteorological Data				Regional Weather
				Historical Data
Forecasts Produced (PJM Manual 14D Section 8.2.6)				
Title	Frequency	Interval	Duration	
Short	10 Mins	5 Mins	0 – 6 Hours	
Medium	1 Hour	1 Hour	6 – 48 Hours	
Long	1 Hour	1 Hour	48 – 168 Hours	
Ramp	10 Mins	5 Mins	0 – 6 Hours	

Generator Offer Submittal

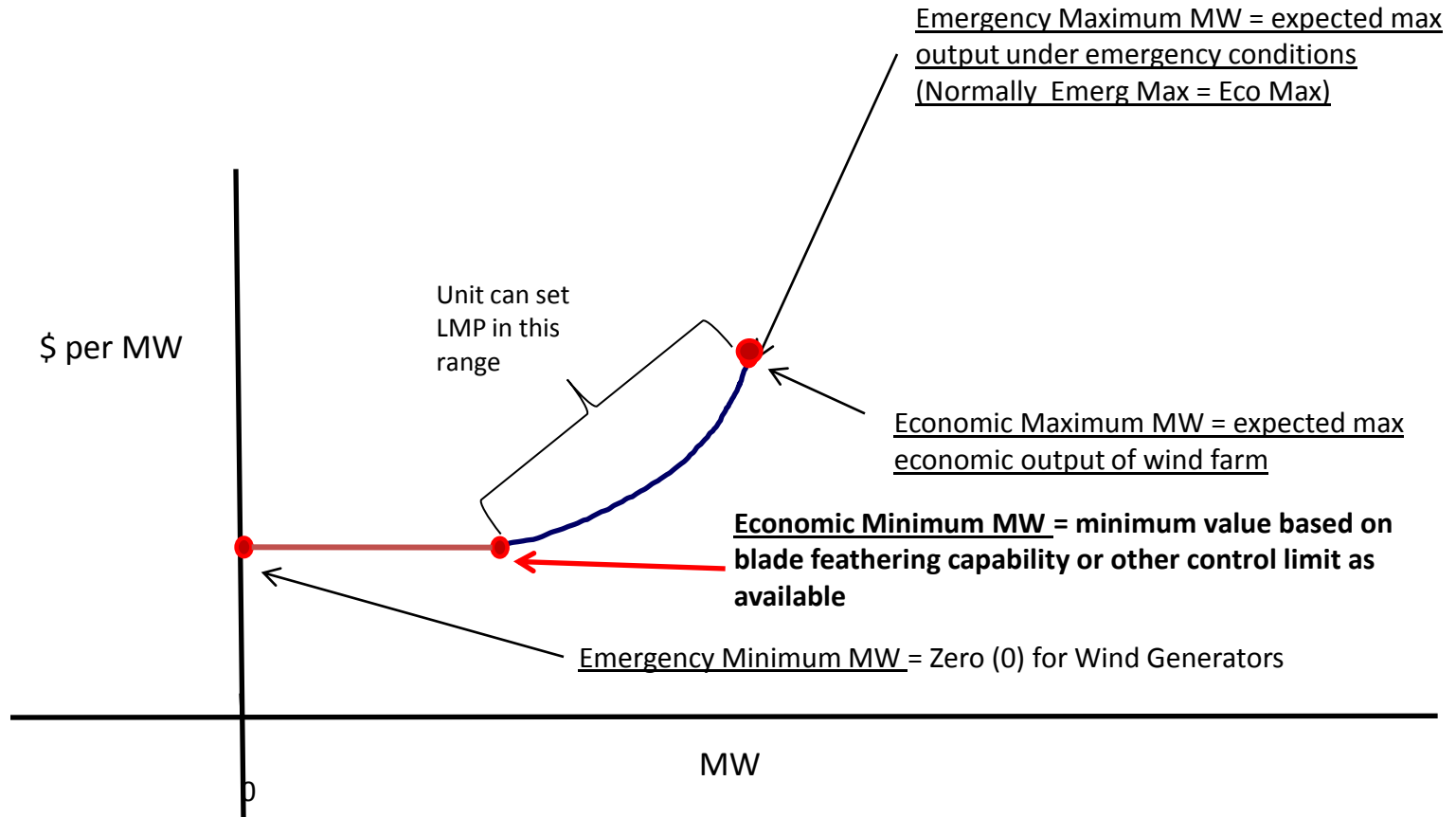
- **All generation offer** information is submitted **through** the **eMKT** tool (or uploaded via XML)
 - Offer will be for aggregate wind farm
- **eMKT** allows unit incremental price/cost curves to contain **negative prices**
- **Unit default cost/price offer** is assumed to be **\$0** if **not provided**
- **PJM will develop economic base-point** for wind farm based on incremental offer curve

Wind Offer into Day-Ahead Market

- 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 ~~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

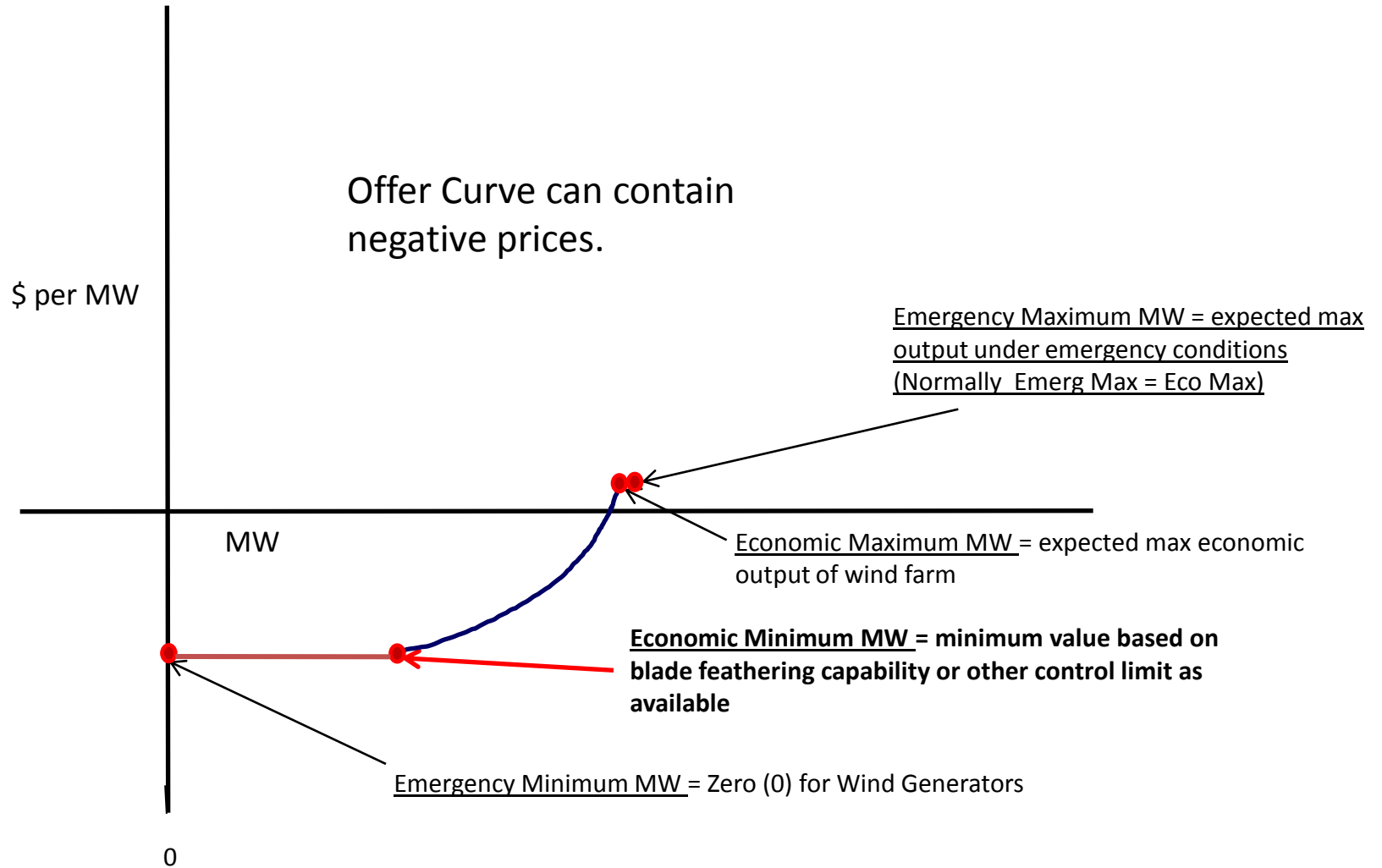


Wind Farm Offer Curve Example

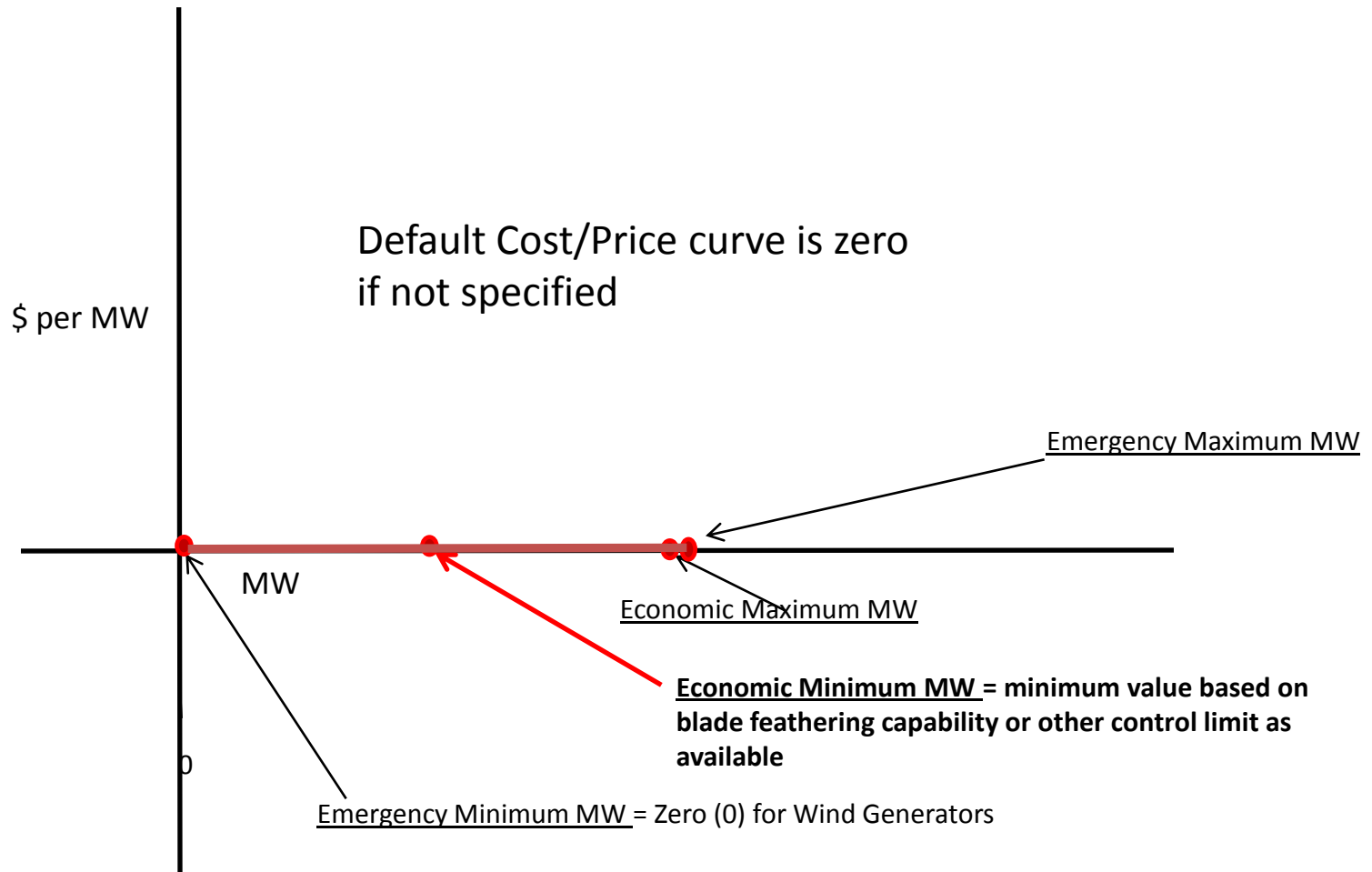


Wind Generator Operators will adjust Wind Turbine Control Systems or manually adjust turbine output to achieve the desired SCED basepoint

Wind Farm Offer Curve Example



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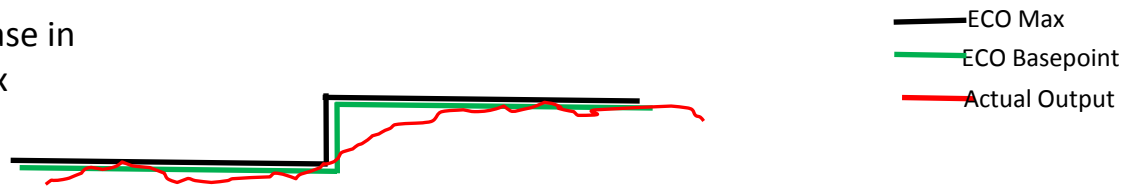
Wind Power – Real-time Coordination

- 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 SCED application 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

Real-time Dispatching of Wind Resources

- 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

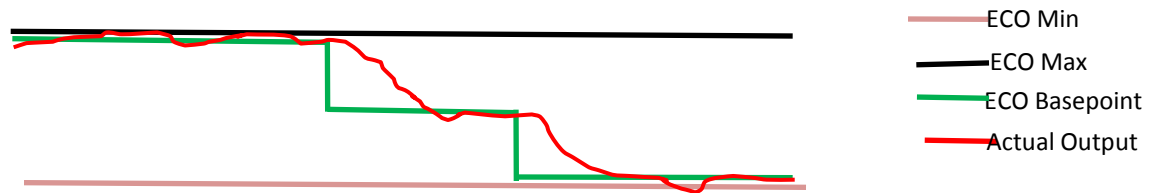
Wind owner forecasts increase in output and updates Eco Max



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



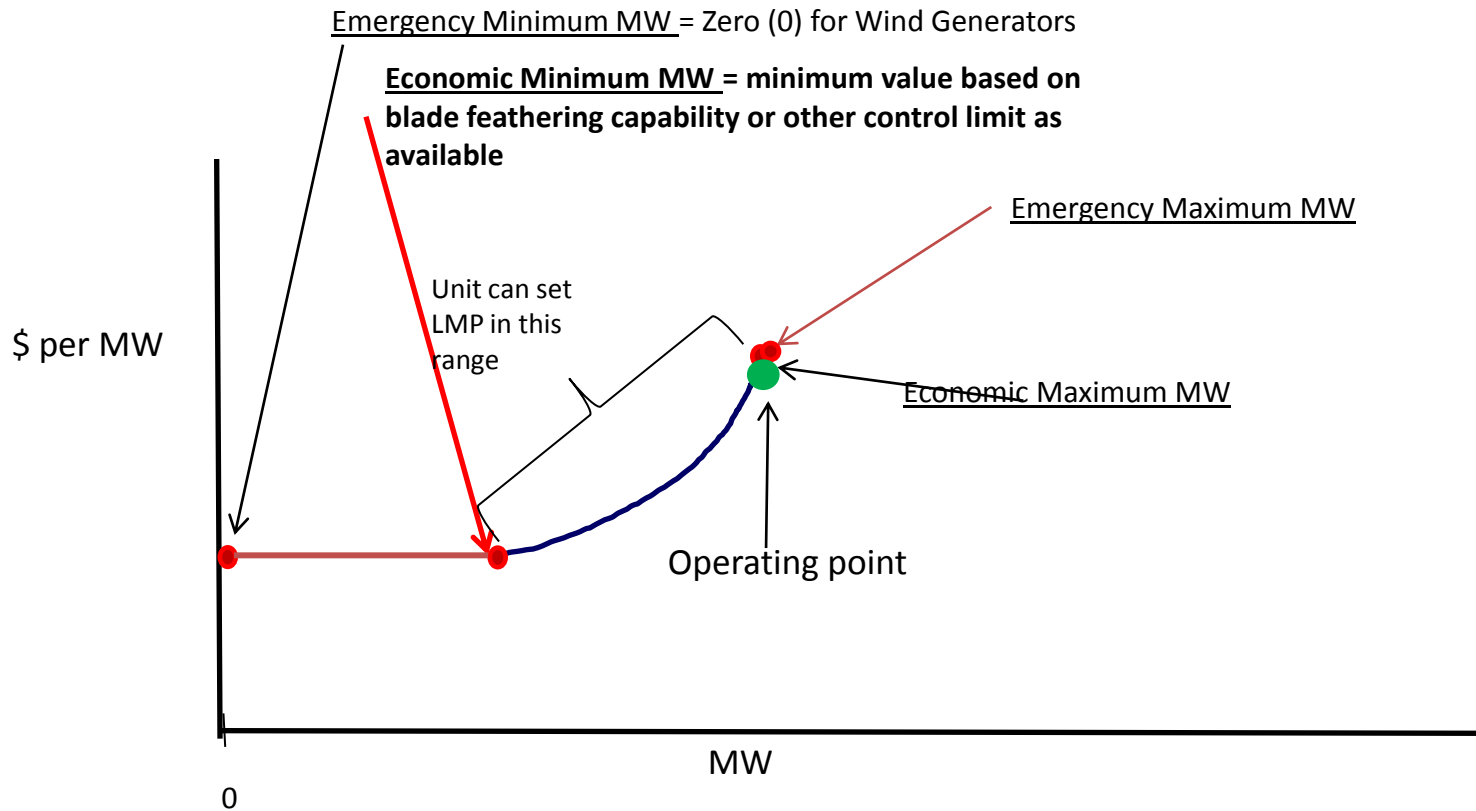
Eco Basepoint < Eco Max
Unit is being curtailed and should follow basepoint down



Curtailments for Transmission Constraints

- 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

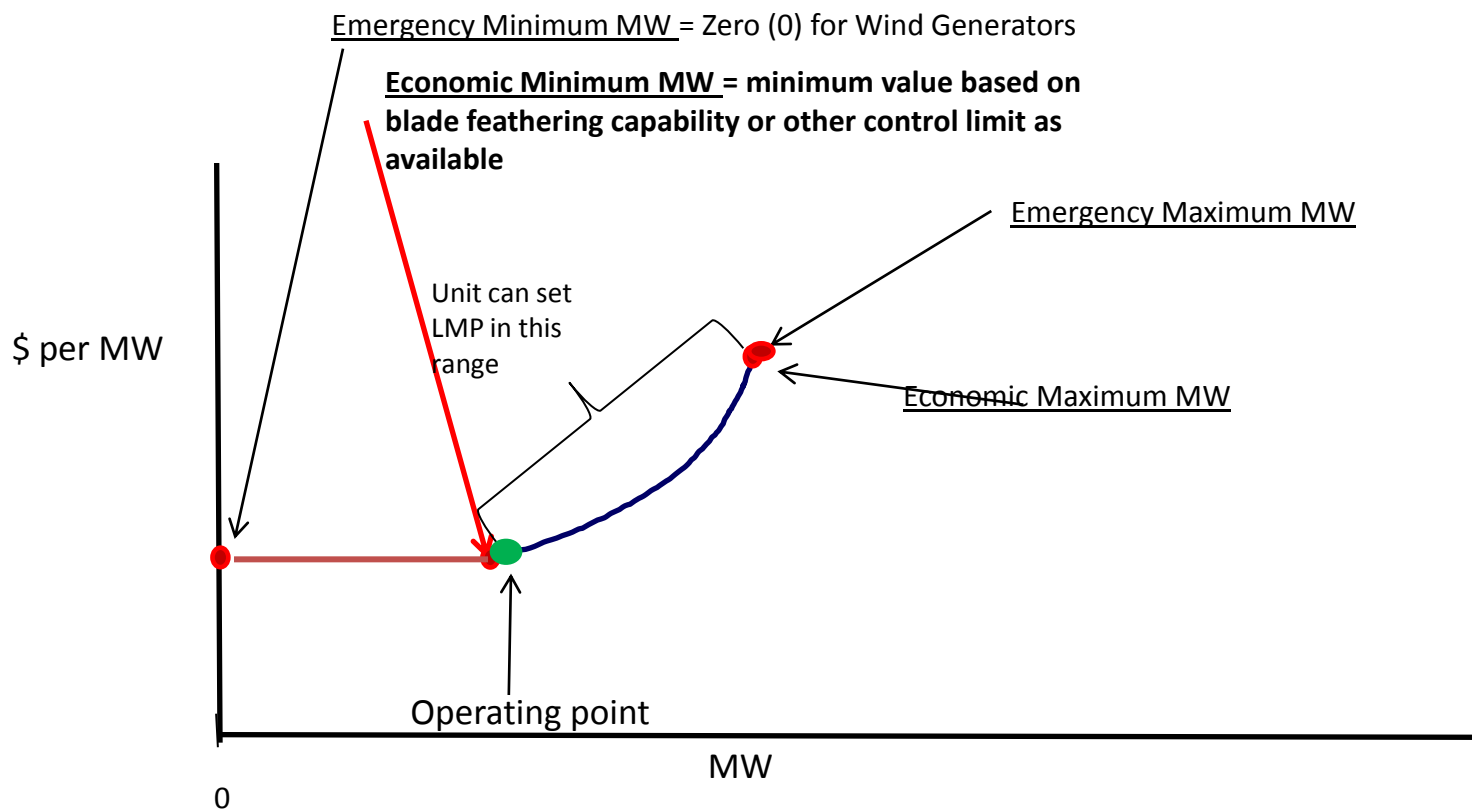
Constraint Curtailment Example



If wind is impacting constraint and it is the cost-effective solution, SCED 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 SCED basepoint

Constraint Curtailment Example



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.

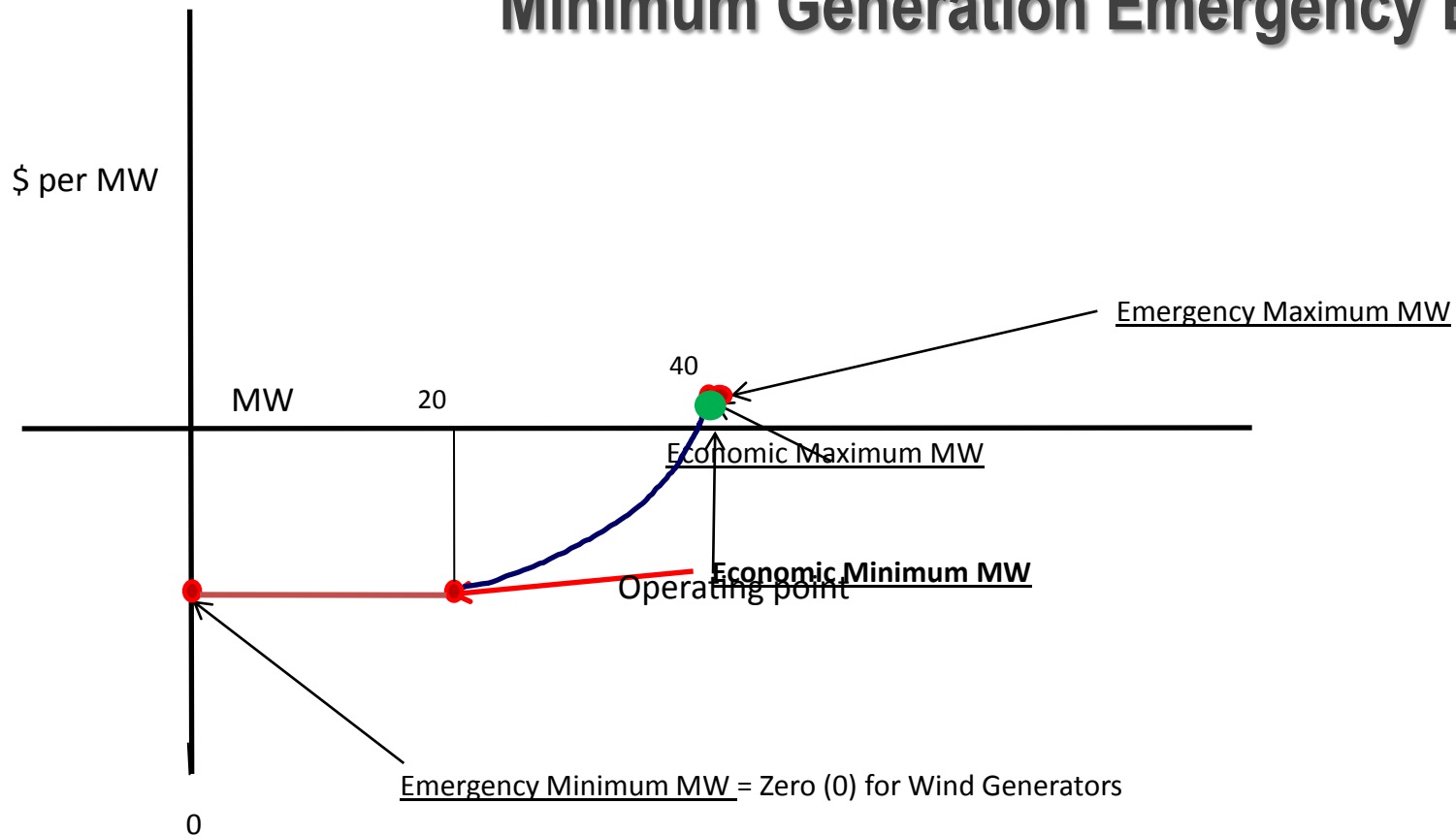
Wind Generator Operators will adjust Wind Turbine Control Systems or manually adjust turbine output to achieve the desired SCED basepoint

Light Load Procedures (Minimum Generation Event)

- ❑ PJM shall not differentiate between resource types during a Min Gen Emergency Event
- ❑ All resources are expected to reduce proportionally based on the percentage of 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

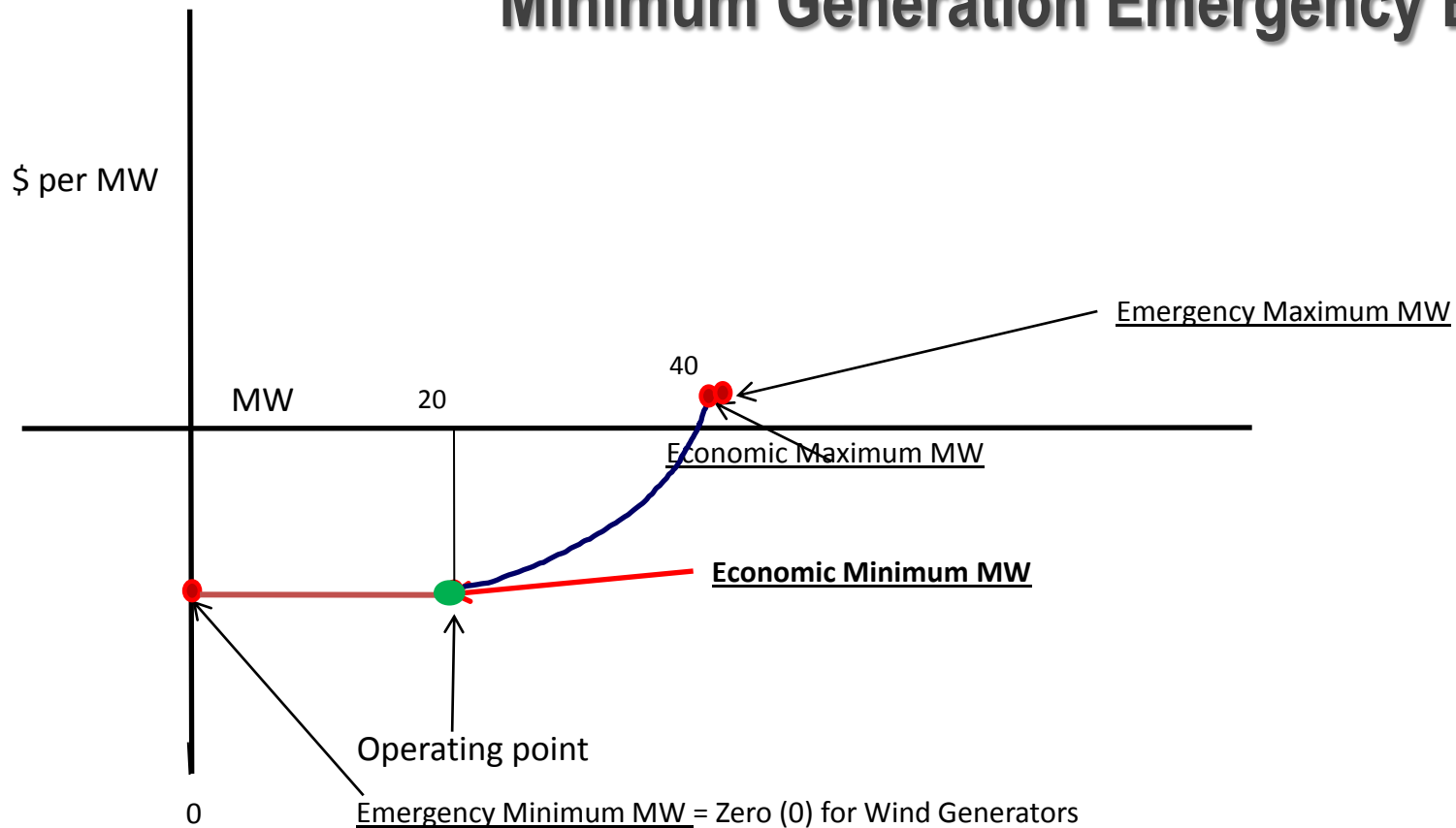


Minimum Generation Emergency Example



- 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

Minimum Generation Emergency Example



- 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

