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Wind Power and Electricity Markets

A living summary of markets and market rules for wind energy and capacity in North America

Prepared by the Utility Wind Interest Group

Market Operation and Transmission Policy Best Practices Users Group

Information compiled through December 1, 2004

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Based on information presented at the

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UWIG plans to update this information as regional electricity markets evolve

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The following table addresses market rules for wind power purchase in key regions of North America. Table entries are responses to the following questions:

- **Scheduling in Energy Markets:** How is wind energy scheduled and procured?
- **Imbalance Settlement:** How are wind energy imbalances settled – either through a balancing market or another settlement procedure?
- **Ancillary Services:** How are wind plants' ancillary service needs and costs recognized?
- **Wind Forecasting:** What role does wind forecasting play?
- **Capacity Calculation:** How is capacity value or capacity credit for wind plants calculated? Is there a distinction between capacity values for planning reserves (months and years time frame) and operating reserves (same-day to next-day)? If so, what is it?
- **Capacity Recognition:** How is capacity value recognized in capacity obligations and capacity markets?

As a baseline for the table, FERC Order 888's discussion of these questions is summarized here:

Scheduling in Energy Markets: No requirement for centralized energy markets.

Imbalance Settlement: Energy imbalance charges may apply if energy deliveries differ by more than +/- 1.5% from advance schedules. Actual penalties or payments for underdeliveries/overdeliveries left to discretion of transmission provider, but may be substantial.

Ancillary Services: Transmission provider required to offer scheduling and billing services and to act as purchasing agent for transmission customers that need ancillary services.

Wind Forecasting, and Capacity Calculation and Recognition are not discussed in Order 888.

	PJM	NYISO	ISO-NE	Ontario IMO
Scheduling in Energy Markets	Day-ahead scheduling; wind usually submits zero. Takes real-time LMP for energy provided.	Day-ahead scheduling available but not required. Up to 500 MW: takes real-time price for all energy produced beyond day-ahead amounts. Approach may be revised.	Day-ahead bid option; or self schedule day before. Settle at real-time nodal price.	Energy from renewable intermittent generation accepted as generated. Day ahead market under development.
Imbalance Settlement	Operating reserves deviations charges apply on differential between day-ahead and RT levels; (5 MW dead band; differentials less than this incur no deviation charges).	Up to 500 MW, no penalties. Buy out shortfalls at real-time LBMPs. Approach may be revised.	If deviations, notify ISO. No imbalance charges.	No penalties; payments settled at the hourly spot-market price.
Ancillary Services	Wind doesn't participate in A/S markets. No impact yet on the level of ancillary-services requirements in the market.	Wind doesn't participate in A/S markets, but is not precluded from doing so.	Currently no ancillary services markets. May have by late 2005. Considering products to mitigate variability.	No significant impacts expected, but will evaluate experience. System has some tolerance for wind variability (first 300 MW or so).
Wind Forecasting	No role so far.	No role so far, but will be considering development of wind forecasting in 2005.	No role so far. Likely to change with higher penetrations.	No role so far.

	PJM	NYISO	ISO-NE	Ontario IMO
Capacity Calculation	3-yr rolling average, 3-to-7 pm output, 6/1 through 8/31; default value: 20% of net plant rating until actual operating data become available. Wind must bid into day-ahead market to be a capacity resource and receive capacity market revenues.	Historic capacity factor, adjusted for maintenance. May be adjusted to reflect correlation with system peak hours. Intermittent resources not required to participate in day-ahead market to receive capacity revenues.	Historic capacity factor, adjusted for maintenance. May change to performance during the top 100 “critical hours.”	Yet to be developed. Probably based on assumptions at first, then on experience as it develops.
Capacity Recognition	LSEs may procure capacity bilaterally, self-supply, or purchase capacity credits from PJM capacity auctions. PJM proposing significant changes to capacity requirements to better incorporate locational values and demand response.	LSEs may self supply, purchase bilaterally, or purchase capacity in monthly auctions or biennial six-month capacity auctions.	LSEs may self supply or purchase bilaterally or purchase in monthly auctions.	No capacity markets in Ontario at this time.

	MISO	SPP	ERCOT	CAISO
Scheduling in Energy Markets	<p>If intermittent resource is designated as a 'capacity resource', then it has a must offer obligation in the day-ahead market and the reliability assessment commitment (RAC) process. Otherwise, the resource can – but has no obligation to – offer into the markets.</p> <p>No energy market currently, but day-ahead and real-time markets will launch in March 2005.</p>	<p>No centralized energy market; transactions done on bilateral basis.</p>	<p>Wind scheduled as all other resources, as part of a Qualified Scheduling Entity's (QSE) portfolio.</p> <p>No centralized energy market; transactions done on bilateral basis. Plans to adopt LBMP in the future.</p>	<p>Wind Energy is sold to Load Serving Entities via QF or Bi-Lateral contracts. The Scheduling Coordinator (SC) for the wind energy can either make its best forecast of energy production and schedule it in the Day-Ahead or Hour-Ahead Market, or it can participate in the CAISO PIRP Program. In the PIRP (Participating Intermittent Resource Program), the wind generation forecast is used as the energy schedule in the Hour-Ahead Market.</p>
Imbalance Settlement	<p>If resource designated by market participant as 'intermittent', then is price taker in the real-time market with no uninstructed deviation penalties. Wind generators subject to imbalance charges if participating in the day-ahead market.</p>	<p>Real-time balancing market to be launched by October 2005. The real-time balancing market will be an offer-based market, and nodal prices will be based on the resource offers submitted to SPP. Order 888 tariffs currently in effect.</p>	<p>Any imbalances are settled at zonal Market Clearing Price of Energy (MCPE). No take back of payment for over generation if within + or – 50% of scheduled capacity.</p>	<p>If the SC has opted to use the PIRP program, then hourly deviations are settled at market price and accumulated for monthly average of energy imbalances. If the forecast of wind energy production is unbiased, then the cumulative amount of imbalance energy charges at the end of the month is a relatively small amount of dollars. If the SC has not opted to use the PIRP program, then they are subject to the same hourly imbalance energy charges as any other SC.</p>

	MISO	SPP	ERCOT	CAISO
Ancillary Services	MISO does not offer ancillary services directly, since MISO is not a control area operator. Services and requirements are specific to each regional reliability organization in MISO (MAPP, ECAR, MAIN).	SPP does not offer ancillary services directly, since SPP is not a control area operator. As under Order 888, SPP can act as the transmission customer's agent to procure ancillary services.	All A/S are borne by loads, not generation.	Wind doesn't participate in A/S market. (But wind can result in an impact on the amount of regulation needed in the control area).
Wind Forecasting	Requirements under development. Likely to be similar to CAISO's.	No role so far.	No role so far.	Participants in the PIRP program pay small amount toward forecasts developed for CAISO on ongoing basis. Programs for forecasting ALL wind generation in the Control Area are in development.

	MISO	SPP	ERCOT	CAISO
Capacity Calculation	<p>Regional reliability organization (MAPP, MAIN, ECAR) determines criteria.</p> <p>MISO is in the process of defining a resource adequacy requirement, scheduled to be effective in early 2006.</p>	Output level that wind plant equals or exceeds during 85% of period defined by top 10% of load hours.	10% of installed wind-plant rating assumed when assessing regional capacity sufficiency	Working group currently studying the capacity value of wind generation and developing improved models for calculating the capacity value
Capacity Recognition	Payments received in bilateral market for capacity if designated as a Network Resource in MISO meeting Network Load. As a designated Network Resource, must offer capacity into the Day-Ahead Market.	No payments received for capacity—just credit toward overall system reliability through reserve margins	<p>Currently no capacity market.</p> <p>No payments received for capacity—just credit toward overall system reliability through reserve margins</p>	<p>No payments received for capacity—just credit toward overall system reliability through reserve margins.</p> <p>Resource-adequacy procurement program under development by CPUC, with implementation by 2006.</p>