



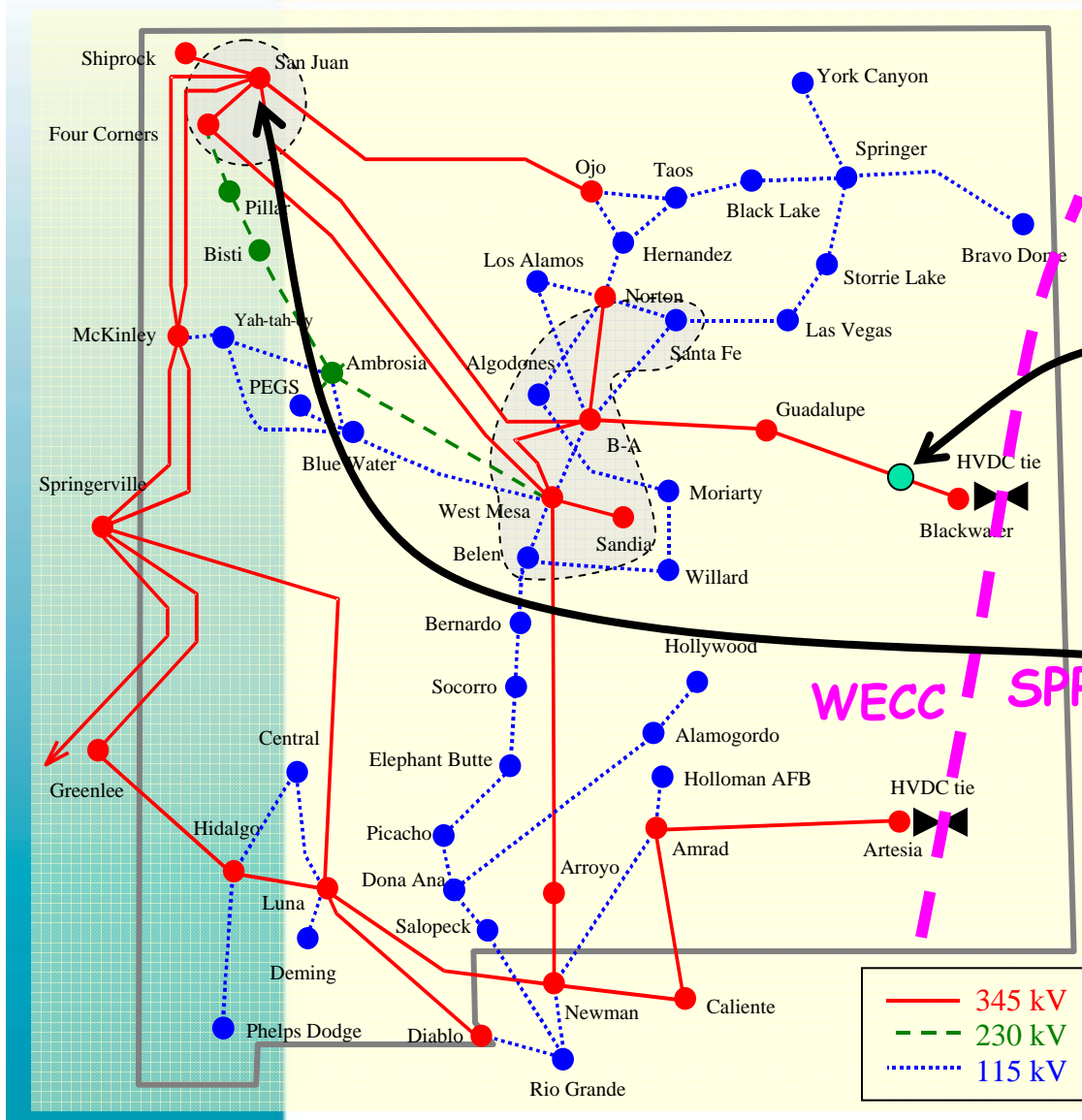
A personal commitment to New Mexico



Wind Forecast: Good, Bad, or Just Ugly?

Abraham Ellis - Public Service Company of New Mexico
UWIG Fall Technical Workshop - November 2005

PNM Control Area Summary



➤ 2300 MW peak load;
1200 MW off peak load
(2005)

➤ 204 MW wind
generation capacity at
the New Mexico Wind
Energy Center

➤ The majority of the
generation at San Juan
GS (coal-fired)

➤ Normally, regulating
reserves are carried on
coal units

New Mexico Wind Energy Center

- Located in eastern NM, approximately 160 miles from Albuquerque
- Installed in 2003, in record time!
- FPL Energy owns operates; PNM purchases and markets the output
- 204 MW of generation capacity
- 136 GE 1.5 MW generators
- Extends 15 miles along the edge of a plateau, oriented roughly North-South
- Injects output into a long radial 345 kV line terminated in an HVDC converter
- First installation in North America requiring LVRT for interconnection

NMWEC (Looking North-East)

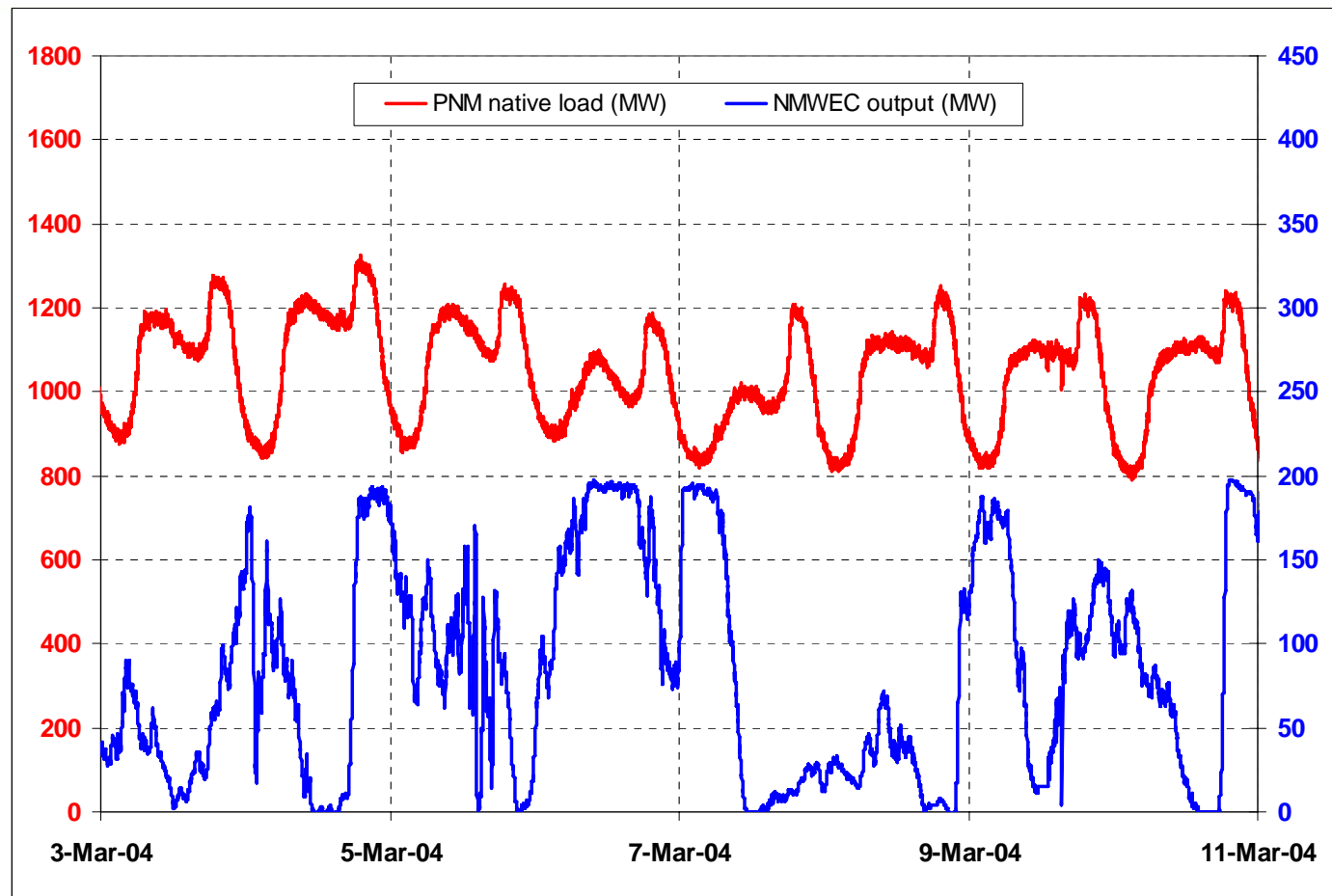


345 kV
Transmission
Station

NMWEC Wind Generation Pattern

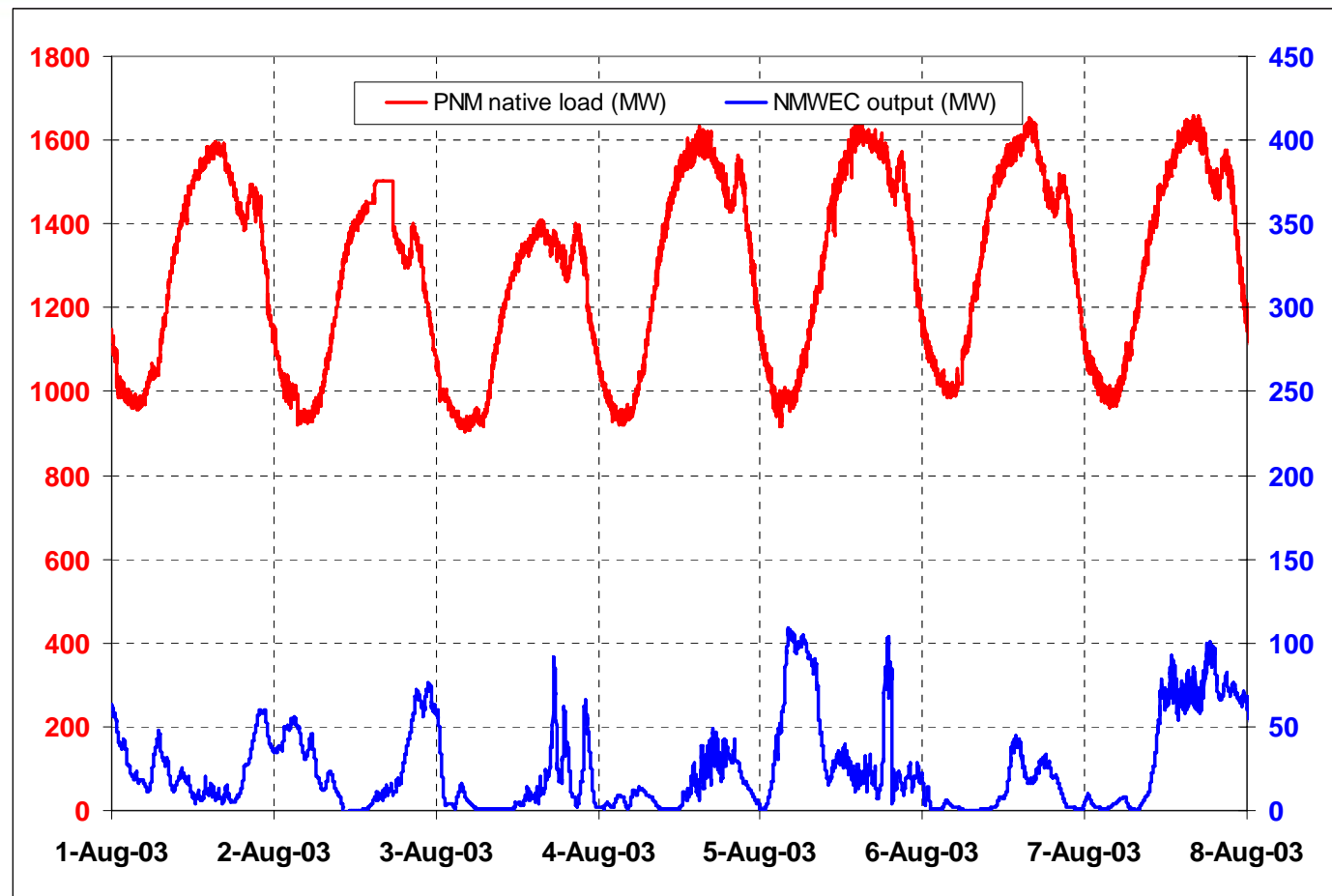
- **Seasonal & daily wind output patterns do not match load patterns very well**
 - More production in Spring; less in Summer
 - More production in the early evening; less during the middle of the day
- **Predictability changes with the season**
 - Somewhat predictable October-May (driven by storm fronts); don't bet on it the rest of the year
- **Variability changes with the season**
 - Stays at rated output for hours in Spring; does not stay above 50% of rated output for very long in Summer

Load and Wind Patterns - Spring 2004



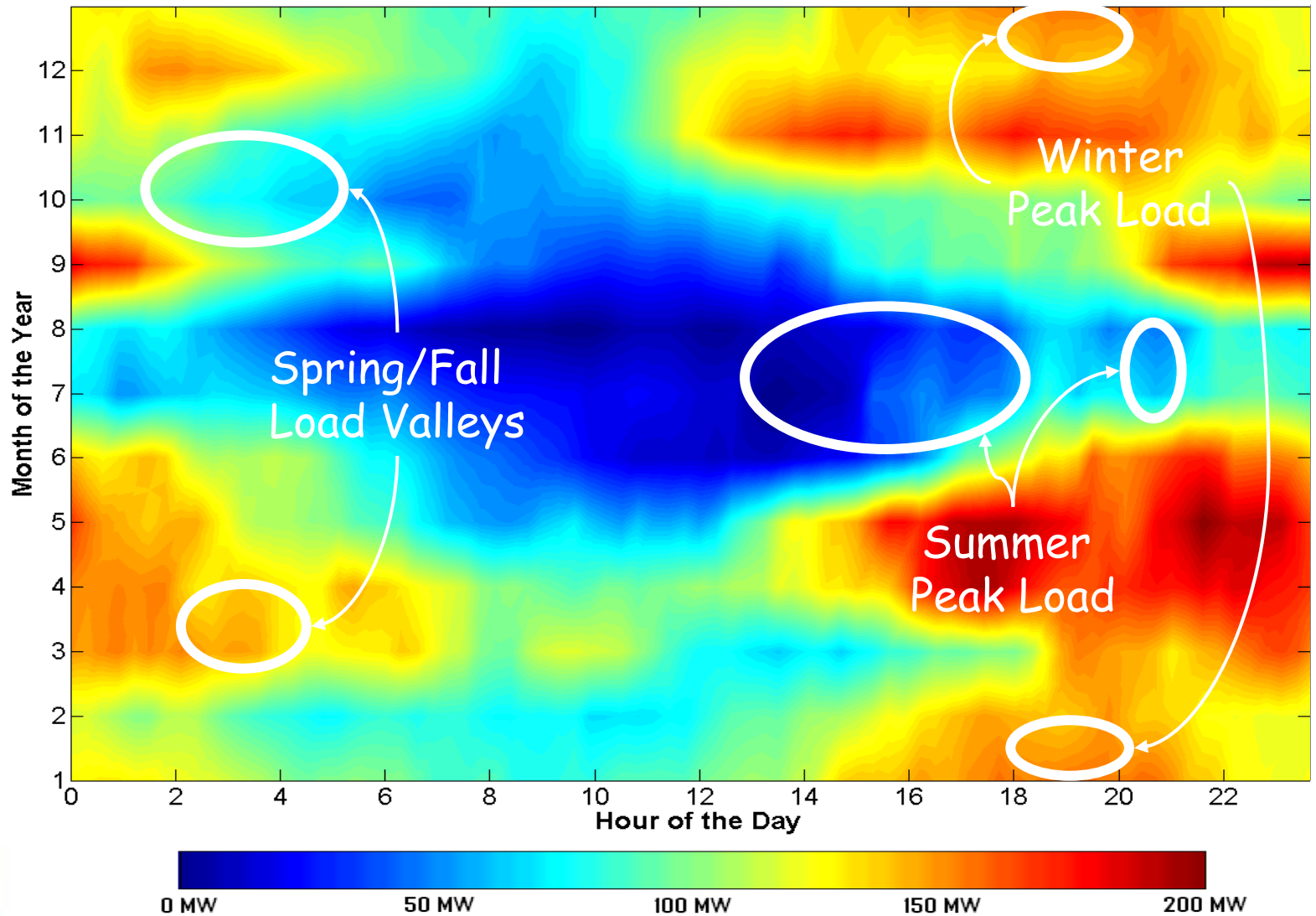
- Wind output at maximum capacity for long periods of time
- Wind output is generally higher during low load periods

Load and Wind Patterns - Summer 2003



- Wind output rarely reaches maximum capacity
- Wind output is generally higher during low-load periods

NMWEC Output Pattern (08/03-08/04)



Ramp Rates

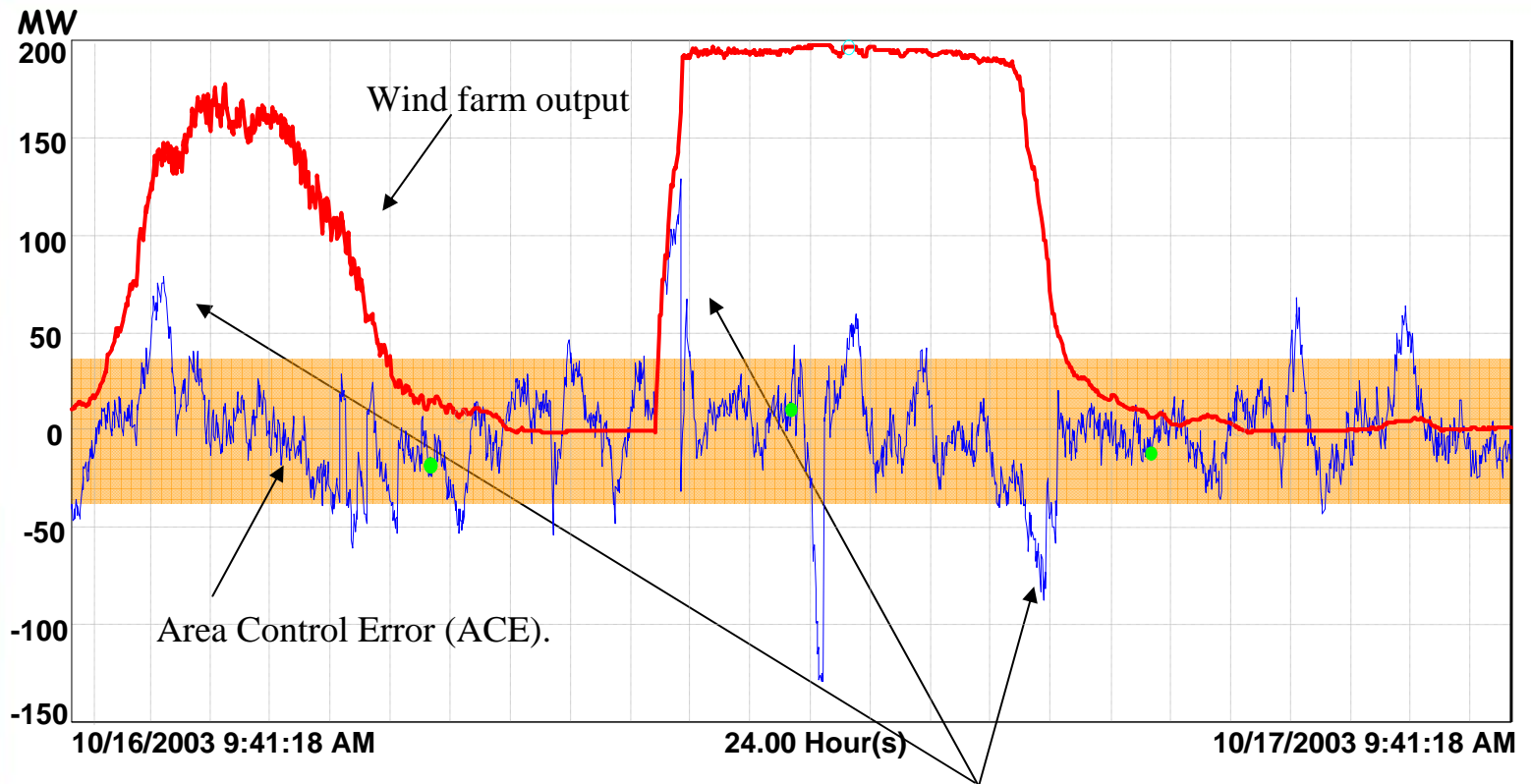
- **Control Area faces steep up and down ramps of wind generation**
 - Up to 50 MW in 1 minute
 - Up to 100 MW in 10 minutes
 - Up to 200 MW in 30 minutes
- **Control area has limited ramping capability for regulation**
 - 4 to 8 MW/min with coal units—wrong type!
 - 15 to 20 MW/min with gas units—too expensive!
 - Regulation capacity is a very scarce commodity in the market

NMWEC (Looking South)

← Prevailing Winds: East to West



Wind & Control Area Performance



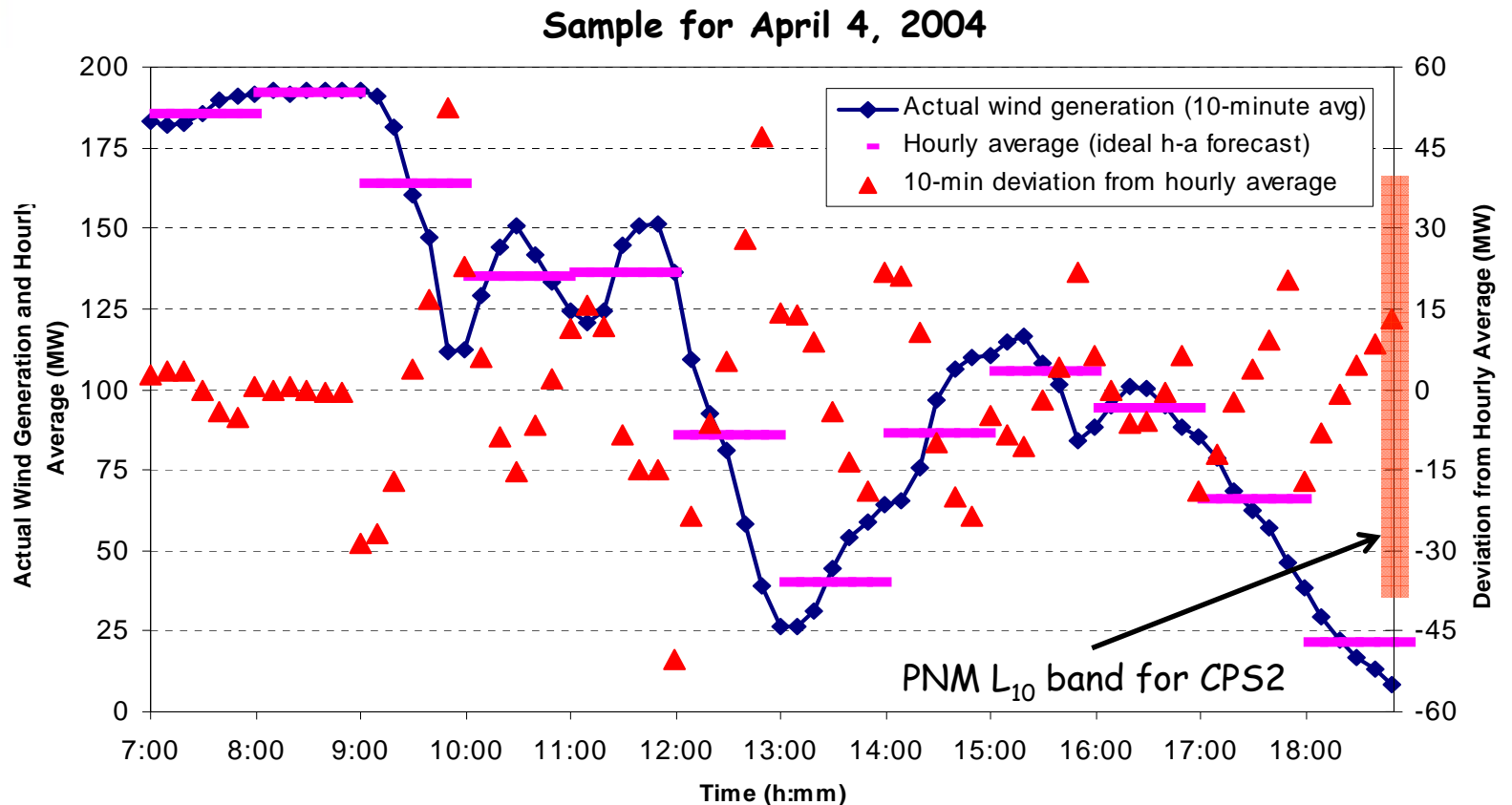
NERC CPS-2: *The average ACE for at least 90% of clock-ten-minute periods during a calendar month must be within a specific MW band (L_{10}).*

$L_{10} = 37$ MW for PNM.

ACE deviates by more than 37 MW as a result of rapid changes in wind power output. As a result, CPS-2 average is not within the L_{10} band for several clock-ten-minute periods.

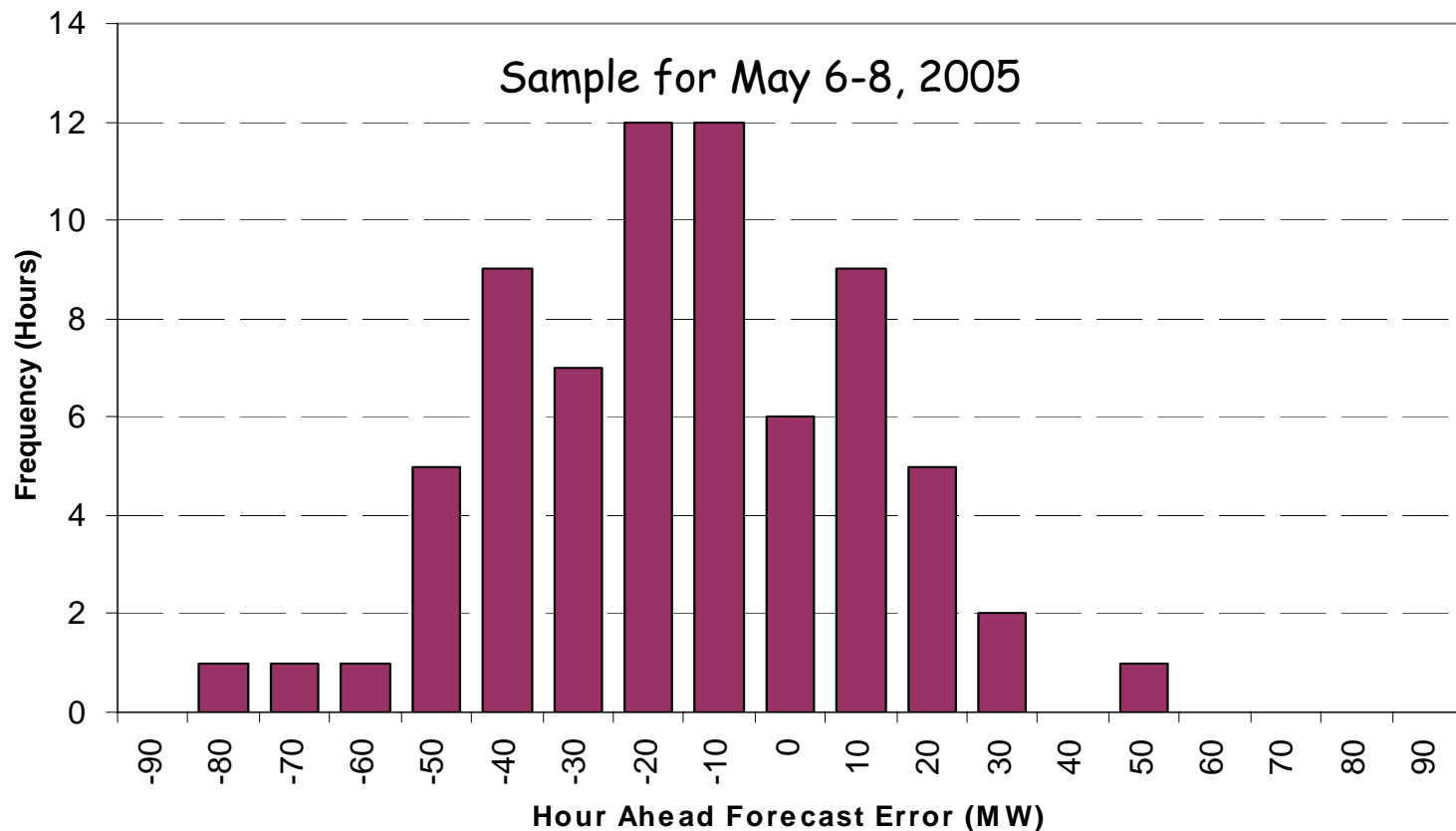
Wind & Control Area Performance

- Intra-hour variability of wind can be a challenge for a control area, even with a “perfect” forecast



Impact of Wind Forecast Error

- Large forecast errors make life even more difficult... and costly



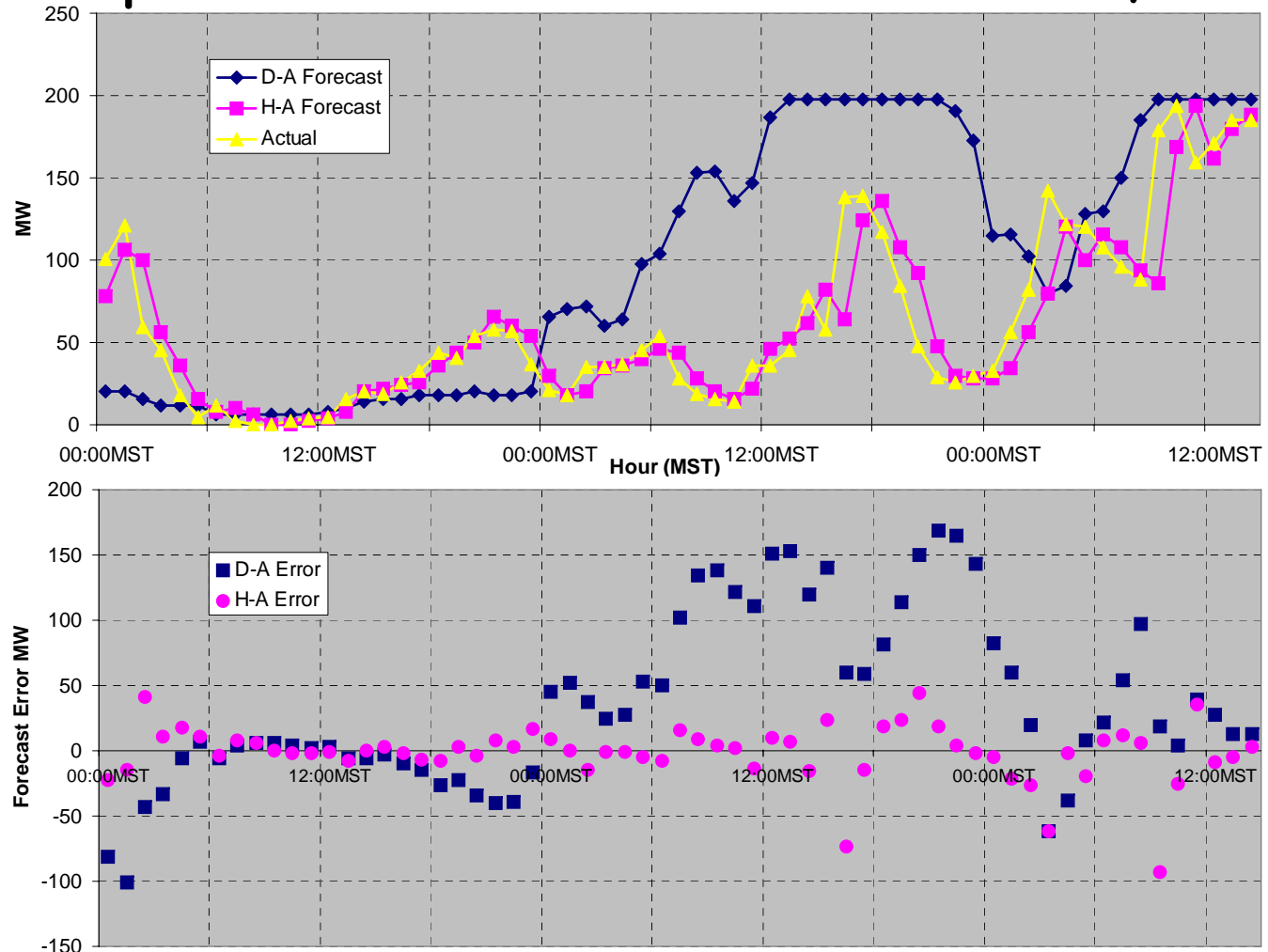
Note: This small sample does not characterize overall performance of the NMWEC forecast

How Good is The Forecast?

- **Day-ahead forecast error**
 - For 2004, the mean absolute error was 47 MW (23%) with standard deviation of 64 MW
 - Difficult to use to make decisions about the next operating day
 - Improved accuracy, at least based on total daily energy, would be beneficial
- **Hour-ahead forecast has value**
 - Useful to make decisions about the next operating hour—currently, application is art more than science
 - Large forecast errors are usually due to difficulty predicting the start of wind ramps

How Good is the Forecast?

➤ Sample D-A and H-A forecasts for Nov 1-3, 2005



Note: This small sample does not characterize overall performance of the NMWEC forecast

How Are We Doing?

- **Maintaining acceptable control area performance at a reasonable cost**
 - Closely managing regulation capacity
 - More frequent short-term energy transactions help
 - Some concern about effects of increased regulation duty on generators
- **Identifying areas that need improvement**
 - Accuracy and presentation of forecast
 - Better tools and strategies to deal with forecast error and wind volatility in the D-A, H-A and intra-hour time frames

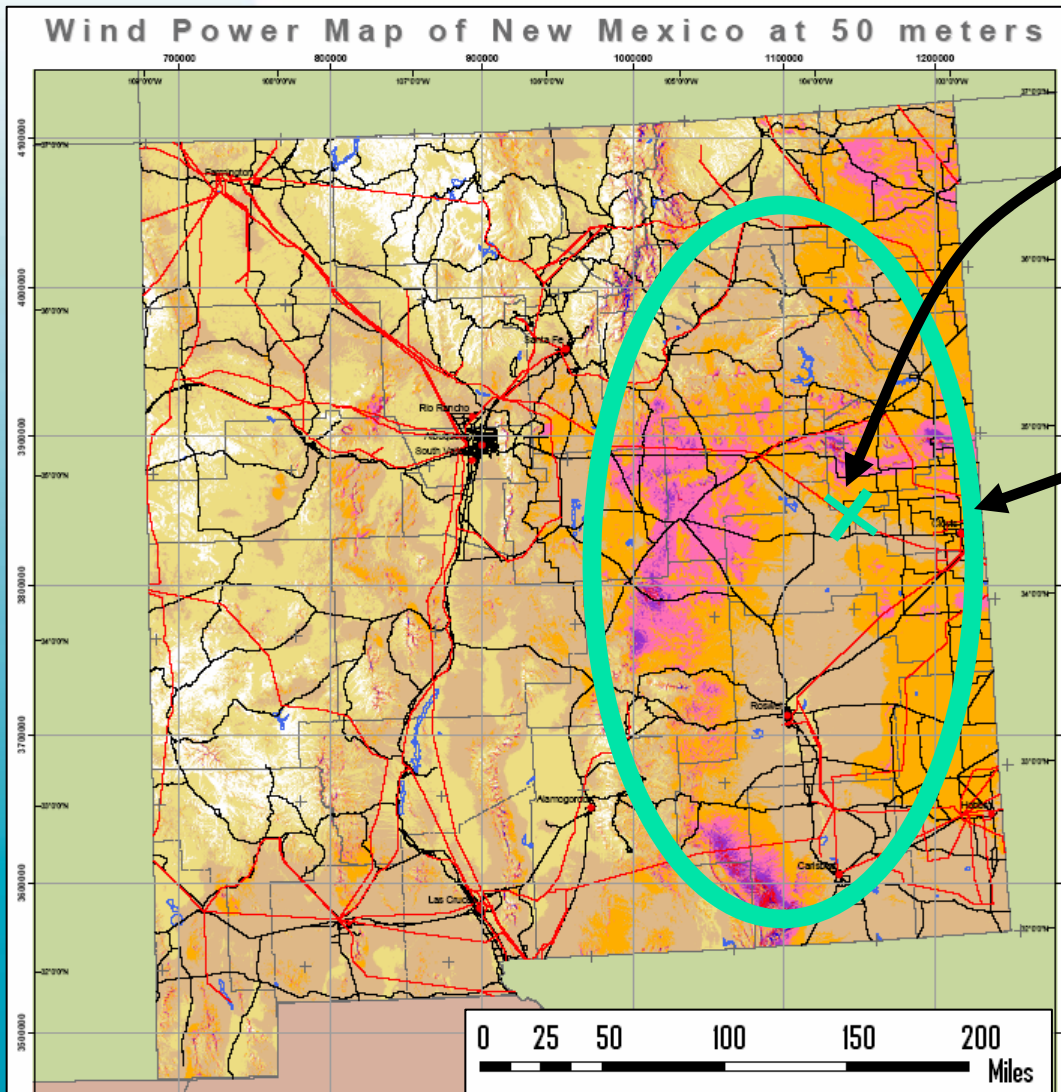
How Are We Doing?

- **Seeking expert help**
 - Recently commissioned a study to evaluate the impact of up to 500 MW of wind generation (25% wind penetration in PNM's control area)
- **Participating in related activities**
 - Transmission service and ancillary services
 - Regional transmission planning efforts
 - Wind plant modeling and interconnection requirements

Yes, It Matters to Us!

NMWEC (204 MW)

- Approximately 600 MW in PNM's interconnection study queue as of 11/05
- 1500 to 3000 MW being considered in regional study process



Class	W/m ²
1-	< 100
1+	100 - 200
2	200 - 300
3	300 - 400
4	400 - 500
5	500 - 600
6	600 - 800
7	> 800

•	Major City
—	Transmission Line
—	Major Road
—	Lake/Reservoir
—	County Boundary

Map By created by TrueWind Solutions from MesoMap system using historical weather data

Conclusion

- **Is the forecast Good, Bad, or Ugly?**
 - The wrong question
- **How do we make it better?**
 - A better question
- **How do we obtain fullest value of a good forecast**
 - An even better question!
- **Does it really matter?**
 - You bet! (especially for those on the fast wind lane)



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Thank You!

