Continued from page 1A

Engineer Pat Wrase said all the PUC seeks to do at the meeting ask for a permit for an anemometer tower to measure wind speed (at the project sites).

"We've struggled with high (electrical) rates in the past few years and believe there is wind there, enough for a good project for our customers," said Wrase.

He added that Nicollet County is the best site for wind turbines within 30-40 miles of New Ulm.

"It's a close second to southwestern Brown County but only three miles from our substation, so the economics are much better (than western Brown County)," said Wrase.

Ridgley

He added that he initially worked on the wind project favorably with some of the what he called "disgruntled" land owners.

"They changed their tune somewhere in the process, asking for (land lease) numbers four to five times the going rates," said Wrase.

He added that the New Ulm PUC used a wind resource map from Wind Logic, which he said researched the entire state.

Wrase said the resource map is available from the PUC and Minnesota Department of Commerce.

Fritz Busch can be e-mailed at fbusch@nujournal.com.

13 SEPT 08
THE JOURNAL

Minnesota Wind Resource Maps

Minnesota Wind Resource Maps

In 2005, the Minnesota Department of Commerce contracted WindLogics to develop average annual wind speed maps at 30, 80 and 100 meters above ground surface, along with maps for capacity factors and energy production for a typical 1.65 MW wind turbine.

To achieve this accuracy and resolution, WindLogics employed hourly and six-hourly gridded data sets from the National Weather Service (including the WindLogics "Rapid Update Cycle" Archive and the 40-year NCEP/NCAR Reanalysis data), prepared the data with a mesoscale numeric weather model and then further refined it with a diagnostic windfield modeling process. The final results were then validated using a variety of field data including MN DOC tall tower measurements, NWS stations and other available public domain study results.

This finer resolution employed by the WindLogics process provided greater detail and accuracy. Using these techniques validated the extent of the superb wind resources found along the Buffalo Ridge area in the southwestern corner of the state, and also revealed additional areas of excellent wind potential, including south-central and northwest areas of the state.

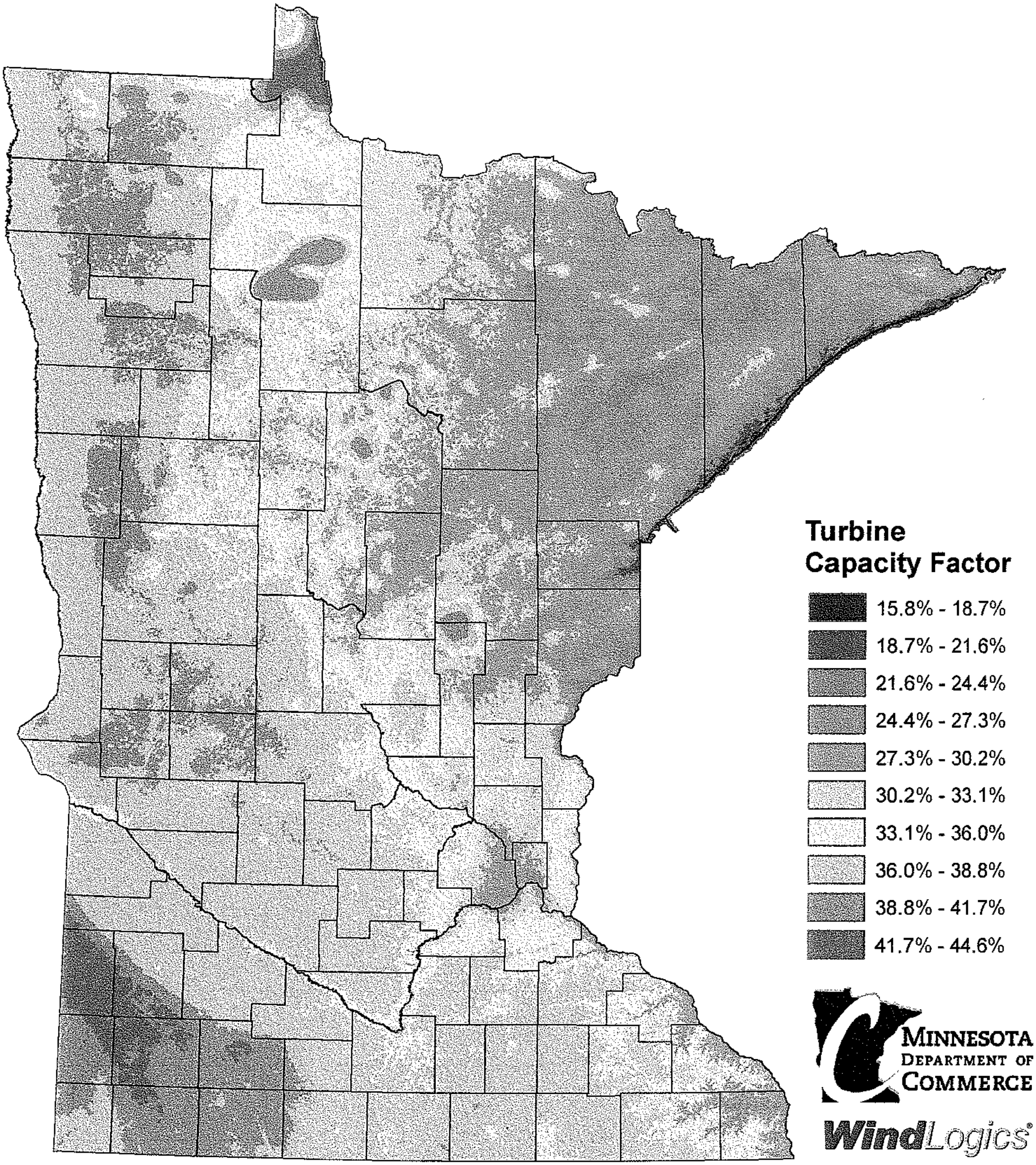
As expected, average wind speeds at 80 meters exceeded 8.8 meters per second (m/s) in some areas of southwestern Minnesota, translating to Class 6 and 7 wind resources at the windiest locations. In other areas of the state, in particular the south-central and northwest, locations of average wind speeds in the Class 5 range were identified, with some pockets of Class 6 wind resources.

These wind resources make Minnesota a natural place for wind energy deployment. In fact, the American Wind Energy Association's Wind Power Outlook 2008 reports 1,299 MW of installed wind energy capacity for Minnesota, placing the state third among the 32 states reporting utility-scale wind energy installations.

The Minnesota Department of Commerce offers these maps to the public as PDF files at no charge. The wind speed files can also be imported into a GIS program, such as ArcMap, for further analysis and review by external parties.

For more information, visit the Department of Commerce website, e-mail energy.info@state.mn.us or contact the Energy Information Center at 85 7th Place East, Suite 500, St. Paul, MN 55101.

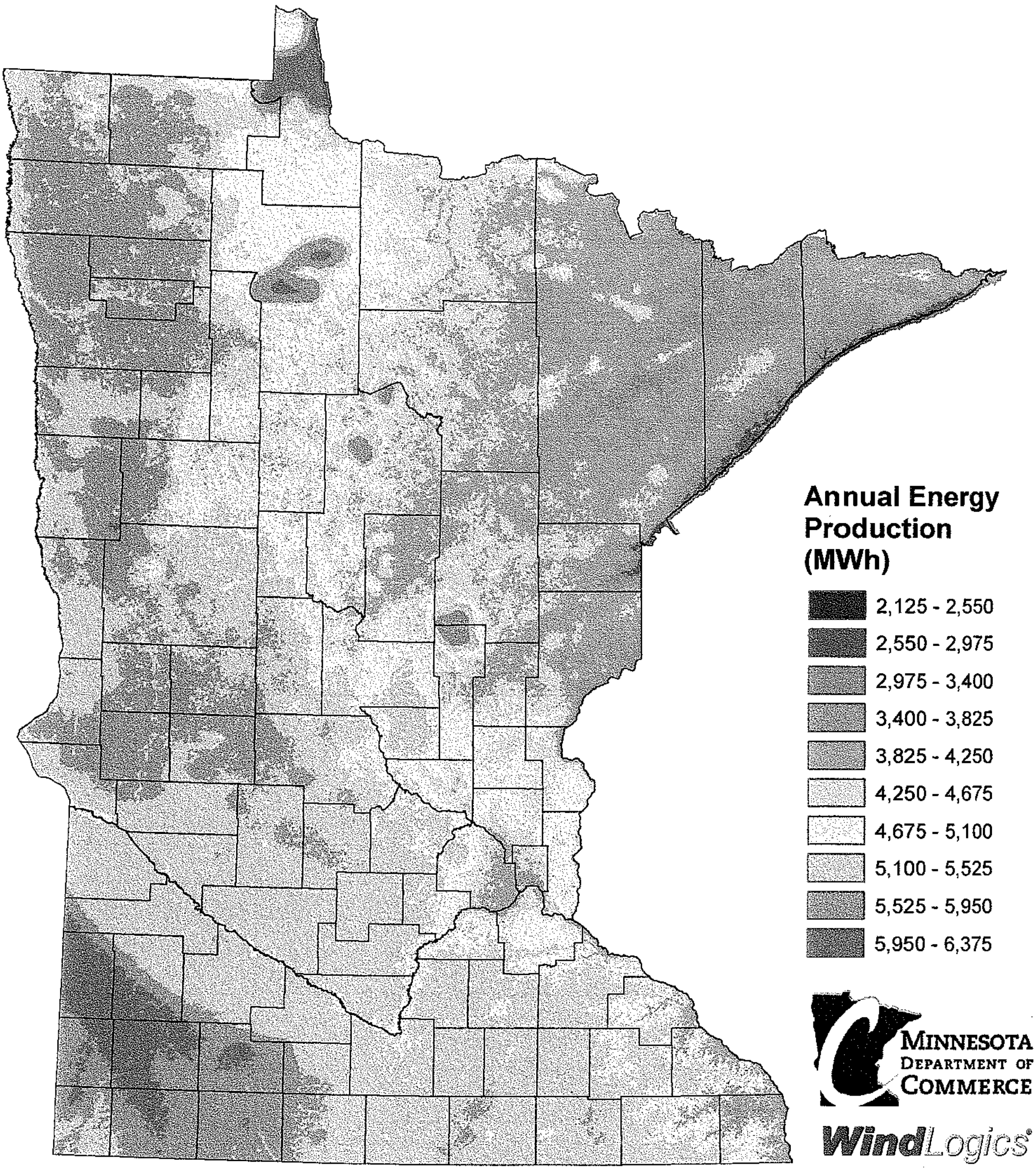
Minnesota's Wind Resource by Capacity Factor at 80 Meters



This map has been prepared under contract by WindLogics for the Department of Commerce using the best available weather data sources and the latest physics-based weather modeling technology and statistical techniques. The data that were used to develop the map have been statistically adjusted to accurately represent long-term (40 year) wind speeds over the state. Capacity factors are based on a 1.65 MW turbine, and production has been discounted 15% to represent real world conditions. Data has been averaged over a cell area 500 meters square, and within any one cell there could be features that increase or decrease the values shown on this map. This map shows the general variation of Minnesota's wind resource and should not be used to determine the performance of specific projects.

January 2006

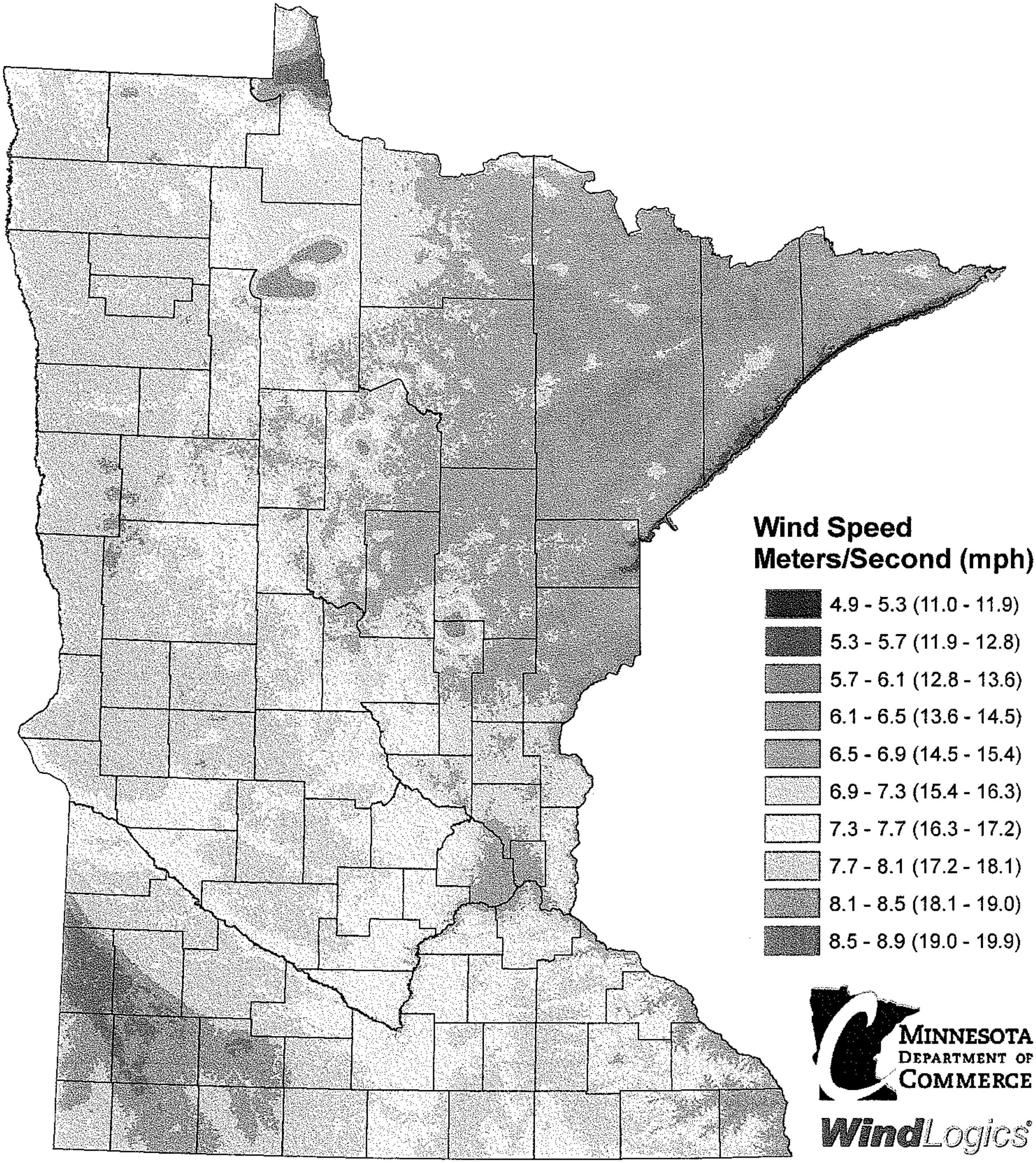
Minnesota's Wind Resource by Estimated Annual Energy Production at 80 Meters



This map has been prepared under contract by WindLogics for the Department of Commerce using the best available weather data sources and the latest physics-based weather modeling technology and statistical techniques. The data that were used to develop the map have been statistically adjusted to accurately represent long-term (40 year) wind speeds over the state. Energy production is based on a 1.65 MW turbine. Production has been discounted 15% to represent real world conditions. Data has been averaged over a cell area 500 meters square, and within any one cell there could be features that increase or decrease the values shown on this map. This map shows the general variation of Minnesota's wind resource and should not be used to determine the performance of specific projects.

January 2006

Minnesota's Wind Resource by Wind Speed at 80 Meters



MINNESOTA DEPARTMENT OF COMMERCE

WindLogics®

This map has been prepared under contract by WindLogics for the Department of Commerce using the best available weather data sources and the latest physics-based weather modeling technology and statistical techniques. The data that were used to develop the map have been statistically adjusted to accurately represent long-term (40 year) wind speeds over the state, thereby incorporating important decadal weather trends and cycles. Data has been averaged over a cell area 500 meters square, and within any one cell there could be features that increase or decrease the values shown on this map. This map shows the general variation of Minnesota's wind resource and should not be used to determine the performance of specific projects.

January 2006

WindLogics®

Final Report - 2006 Minnesota Wind Integration Study
Volume II - Characterizing the Minnesota Wind Resource

Prepared for:
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November 30, 2006

(135 pages)

Description

In this study three levels of wind penetration were modeled, characterized and then analyzed at 15%, 20%, and 25% of projected Minnesota retail electric energy sales (ranging up to 6,000 MW of wind generation in the year 2020).

A review and characterization of current and projected wind turbine technology including cost of energy (as a function of wind resource quality), maintenance costs, reliability, and interconnection and power system impacts (capabilities and requirements; e.g. reactive power control, and low voltage ride through) was conducted. The technical characteristics of distributed / dispersed / distribution connected utility scale wind generation including technical benefits and technical challenges were also reviewed and described.

The wind generation resource and resulting relative economics of wind generation for each County in Minnesota were assessed, and the wind speeds at hub height were quantified using GIS techniques. The input data used was the October 2005 Minnesota Department of Commerce high resolution (500 meters) state-wide wind maps and associated GIS files.

The regional wind generation resources were identified (representing community, corporate, and utility developed projects) in the amounts outlined above based on: existing projects, contracted projects, wind resource quality, interconnection queues, proposed projects, and proximity to load.

The appropriate time series wind plant output profiles were developed and validated for use in the 5-minute and hourly time frames for the wind generation in the study, including 80 and 100-meter hub heights. Modeling was performed at 4 km and 5- minute resolution for 3 years. The extent of wind generation variability that the power system should experience was analyzed, including the effects of projected wind turbine technology. The effects of geographic diversity were also quantified.

The diurnal, monthly, and inter-annual Midwest wind patterns and resulting wind generation patterns and variability were characterized.

The wind generation forecast accuracy on an hour and day-ahead basis was quantified, and the implications on the degree of certainty that is included in the forecast were assessed.

Introduction and Modeling Overview

Recent studies have shown that a high-fidelity, chronological representation of wind generation is perhaps the most critical element of this type of study. For large wind generation development scenarios, it is very important that the effects of spatial and geographic diversity be neither under- or over-estimated. The approach for this task has been used by EnerNex and WindLogics in at least six wind integration studies, including the southern Minnesota study completed in 2004 for the Minnesota Department of Commerce with funding from the Xcel Renewable Development Fund. The base data for both the wind resource characterization and the production of wind speed and power time series were generated from the MM5 mesoscale model (Grell et al. 1995). This prognostic regional atmospheric model is capable of resolving mesoscale meteorological features that are not well represented in coarser-grid simulations from the standard weather prediction models run by the National Centers for Environmental Prediction (NCEP). The MM5 was run in a configuration utilizing two grids as shown in Figure 1. This "telescoping" two-way nested grid configuration allowed for the greatest resolution in the area of interest with coarser grid spacing employed where the resolution of small mesoscale meteorological phenomena were not as important. This methodology was computationally efficient while still providing the necessary resolution for accurate representation of the meteorological scales of interest within the inner grid.

More specifically, the 4 km innermost grid spacing was deemed necessary to capture topographic influences on boundary layer flow and to resolve mesoscale meteorological phenomena such as thunderstorm outflows. The 12 and 4 km grid spacing utilized in grids 1 and 2, respectively, yield the physical grid sizes of 2400 x 2400 km for grid 1, and 760 x 760 km for grid 2.

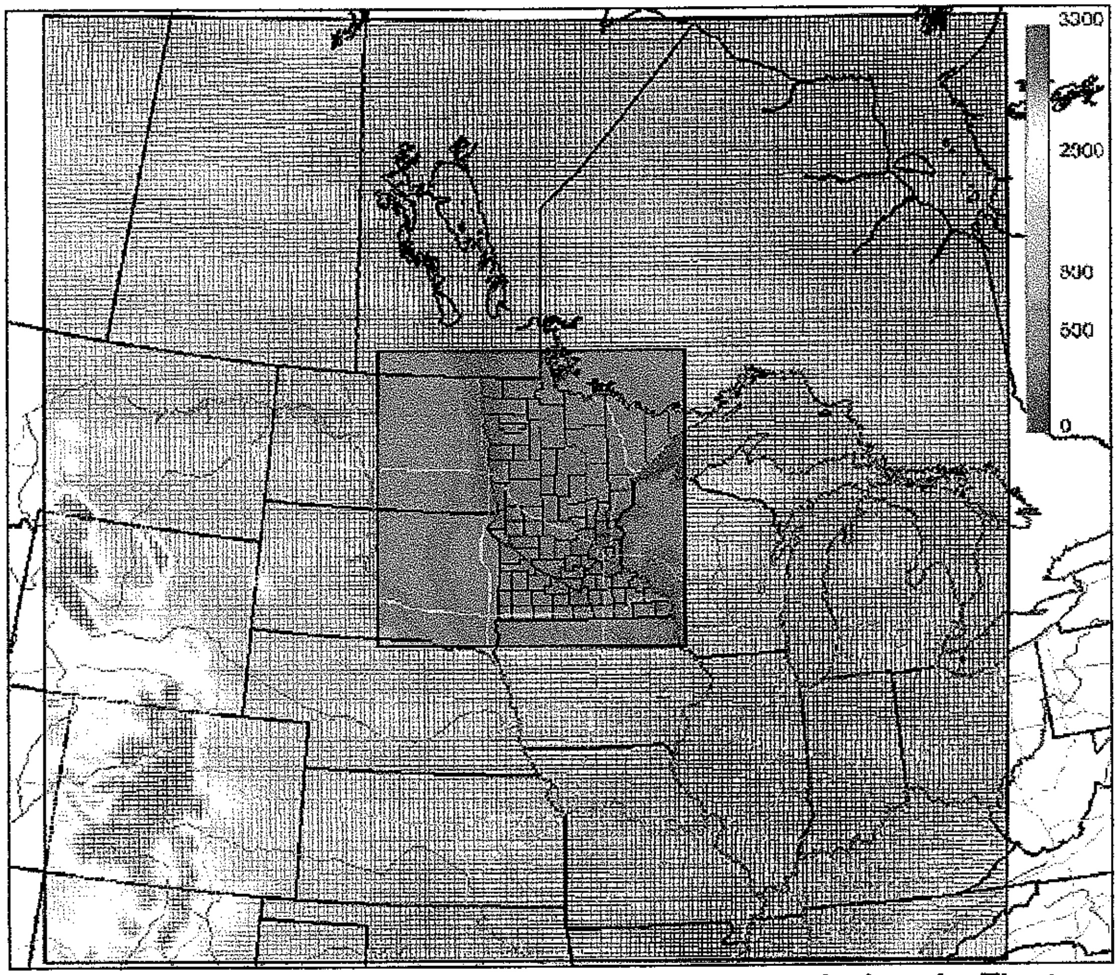


Figure 1: MM5 nested grid configuration utilized for study domain. The two-grid run includes an inner nested grid to optimize the simulation resolution in the area of greatest interest. The grid spacing is 12 and 4 km for the outer and inner grids, respectively. The colors represent the surface elevation.

To provide an accurate assessment of the character and variability of the wind resource for Minnesota and the eastern Dakotas, three full years of MM5 simulations were completed. To initialize the model, the WindLogics archive of NCEP Rapid Update Cycle (RUC) model analysis data was utilized. The years selected for simulation were 2003, 2004 and 2005. The RUC analysis data were used both for model initialization and for updating the model boundary conditions every 3 hours. This RUC data had a horizontal grid spacing of 20 km for all three years.

Wind Generation Technology Assessment

Commercial wind turbine technology has been evolving rapidly over the past decade, and this trend will almost certainly continue. As the wind energy industry matures, lessons learned from existing wind generation facilities are driving improvements to successive generations of wind turbine equipment and wind

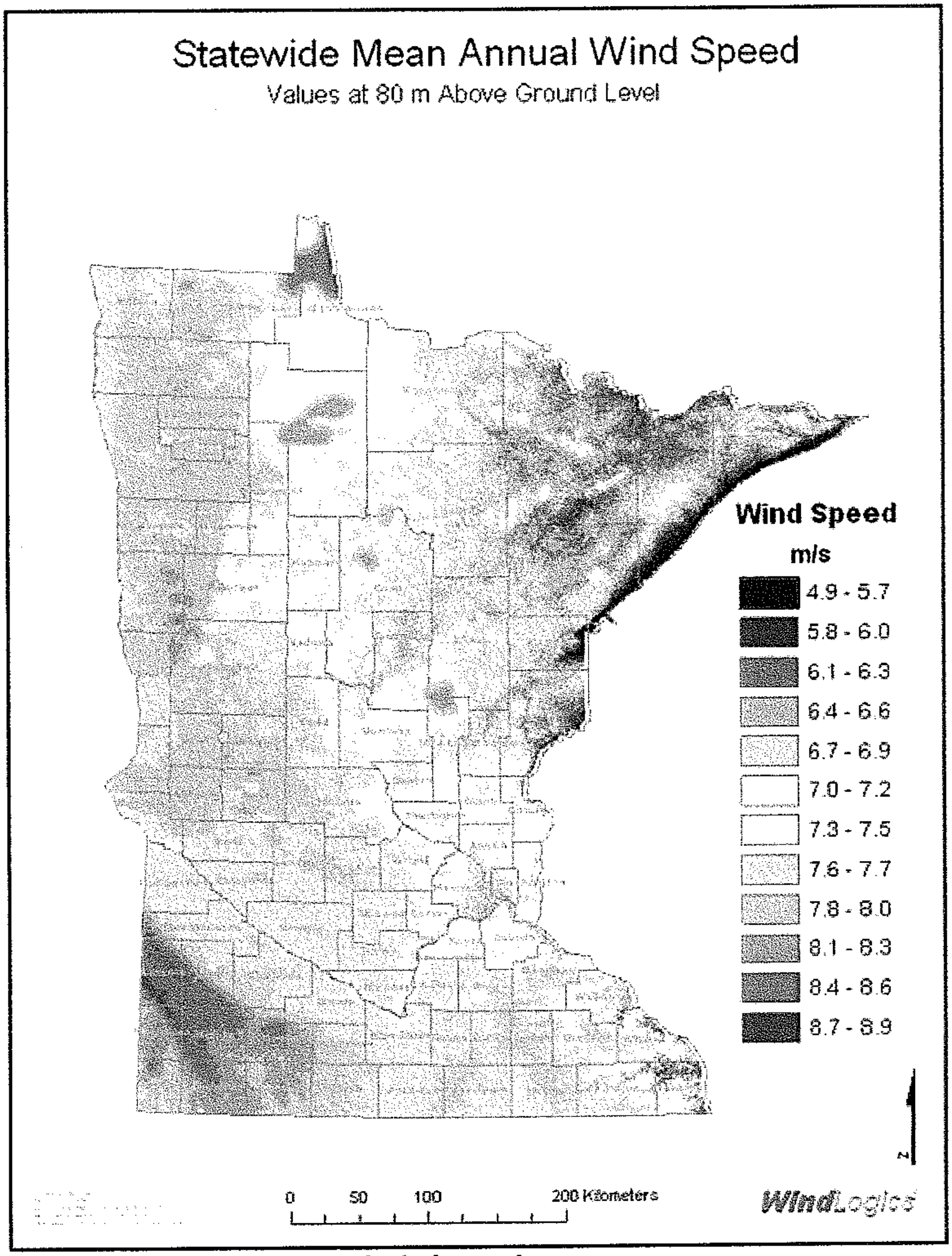


Figure 16: State mean annual wind speeds.

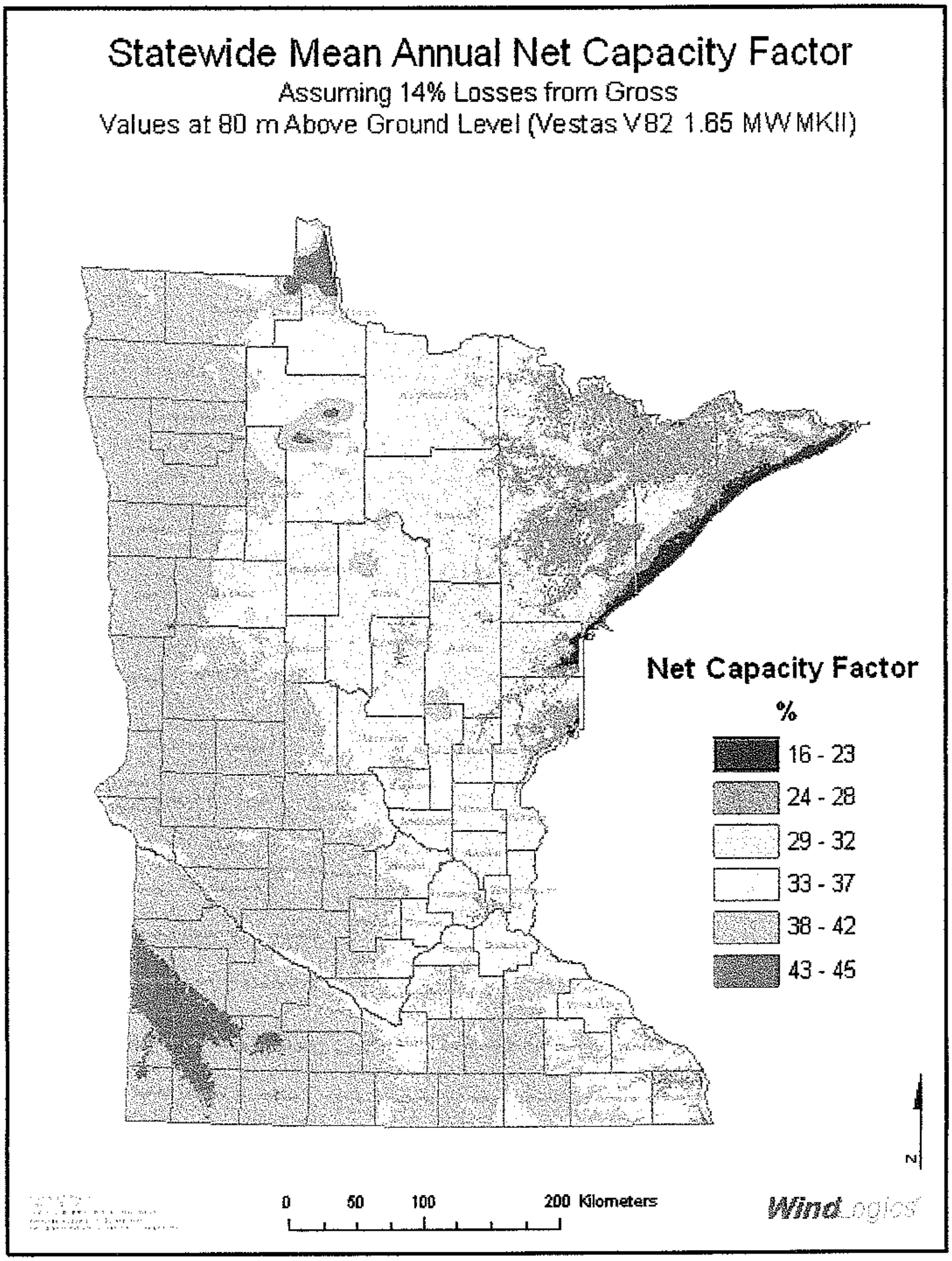


Figure 17: State mean annual capacity factors.

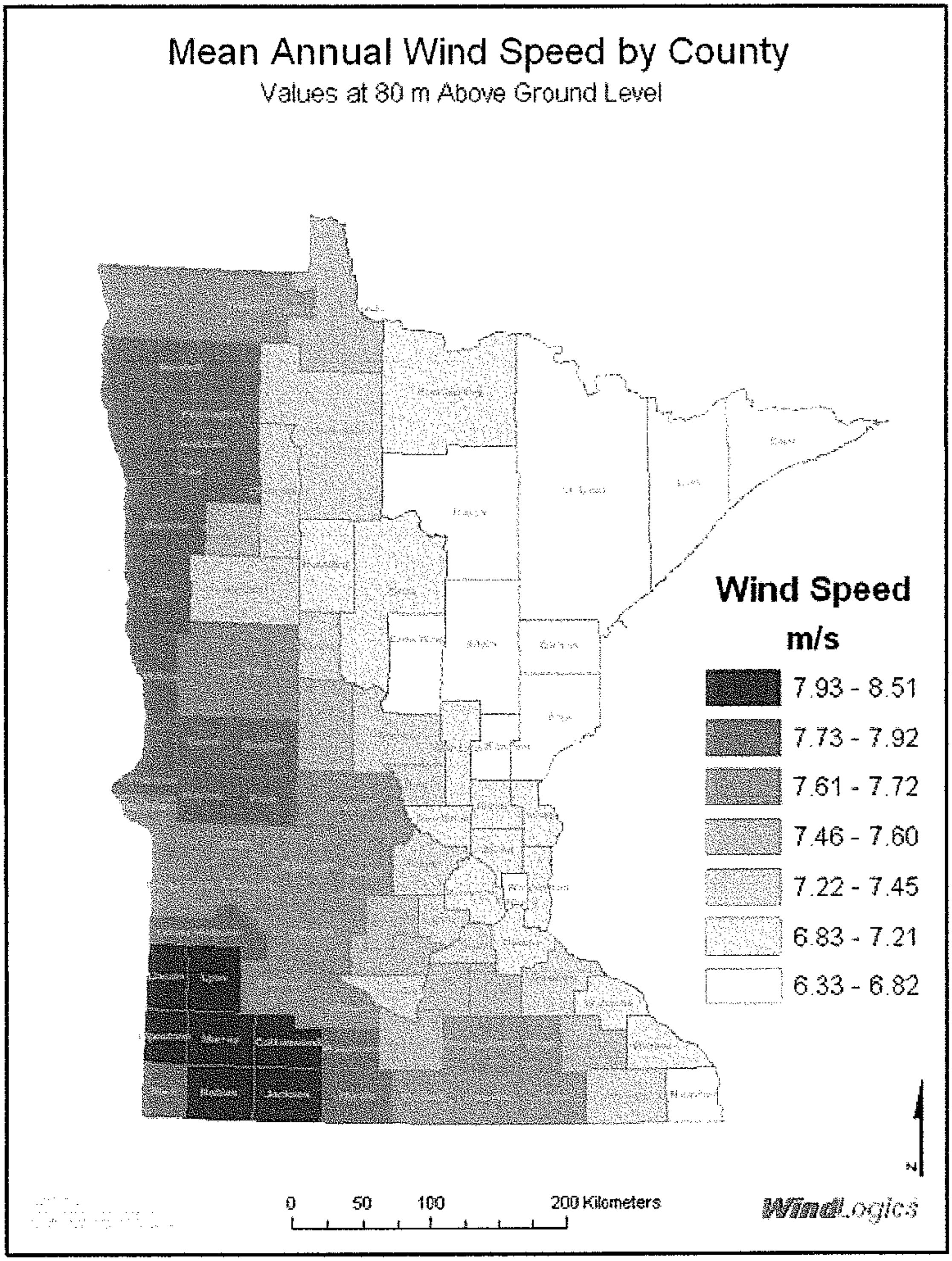


Figure 18: State mean annual wind speeds by county.

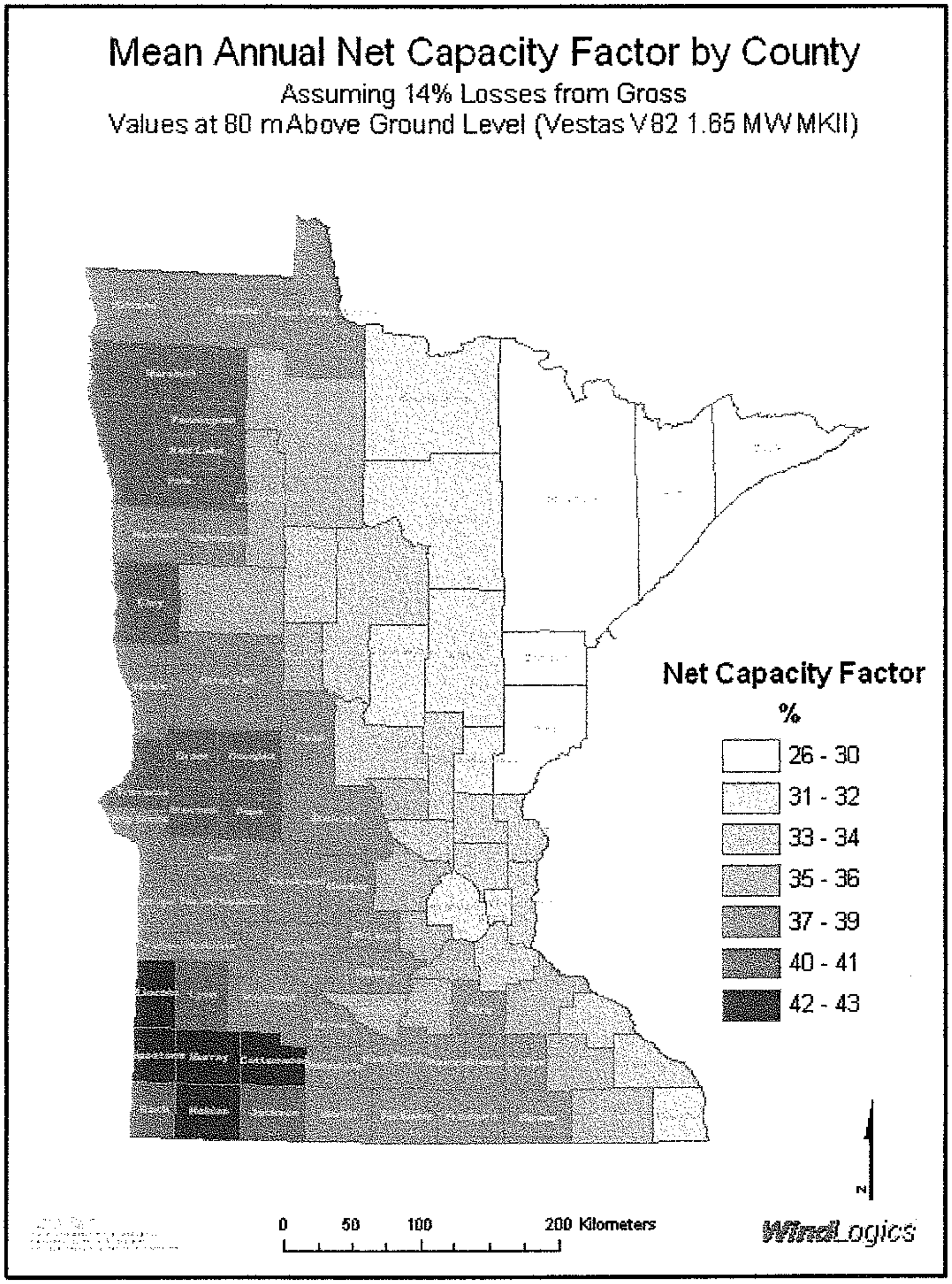


Figure 19: State mean annual net capacity factors by county.

Regional Wind Generation Resource

Based on existing projects, contracted projects, wind resource quality, interconnection queues, proposed projects, and proximity to load, WindLogics and EnerNex created wind generation scenarios consistent with the RFP cited 15%, 20%, and 25% penetration levels. In collaboration with participating utility and other technical review partners, 152 wind generation proxy locations were selected throughout the study area in Minnesota, North Dakota, and South Dakota. See figure 20 for the Proxy Tower locations.

Wind Generation Time Series

Develop Wind Speed and Power Time Series

To support the development of the system integration wind model, data at 152 grid points (proxy towers) in the inner model nest were extracted every 5 min as the simulation progressed. This process ensured that an analysis of the character and variability of the wind resource over several time scales could be performed at geographically dispersed locations. Figure 20 depicts the MM5 innermost grid with selected locations for high time-resolution data extraction. The sites were selected in coordination with the utility and government stakeholders represented on the Technical Review Committee to correspond to 1) existing wind plant locations such as those along the Buffalo Ridge and other regions of southern Minnesota, 2) proposed locations for near-future wind plant development or 3) favorable locations for future wind production with emphasis given to a distribution of wind energy plants that would provide beneficial geographic dispersion. The 2005 Minnesota Department of Commerce high-resolution state wind map was used, in part, for guidance in assessing favorable development areas. Overall, 152 sites were located in 62 counties in the three state domain at locations within the county with an expected favorable county-relative wind resource. Consideration was also given to the existence of nearby transmission and substations. Model data extracted at each site included wind direction and speed, temperature and pressure at 80 and 100 m hub heights. The non-wind variables were extracted to calculate air density that is used along with the wind speed in turbine power calculations. With this data, WindLogics developed time series of 80 and 100 m wind speed and power at 5 minute and 1 hour time increments for use by EnerNex in system modeling efforts described in Tasks 2 and 3.

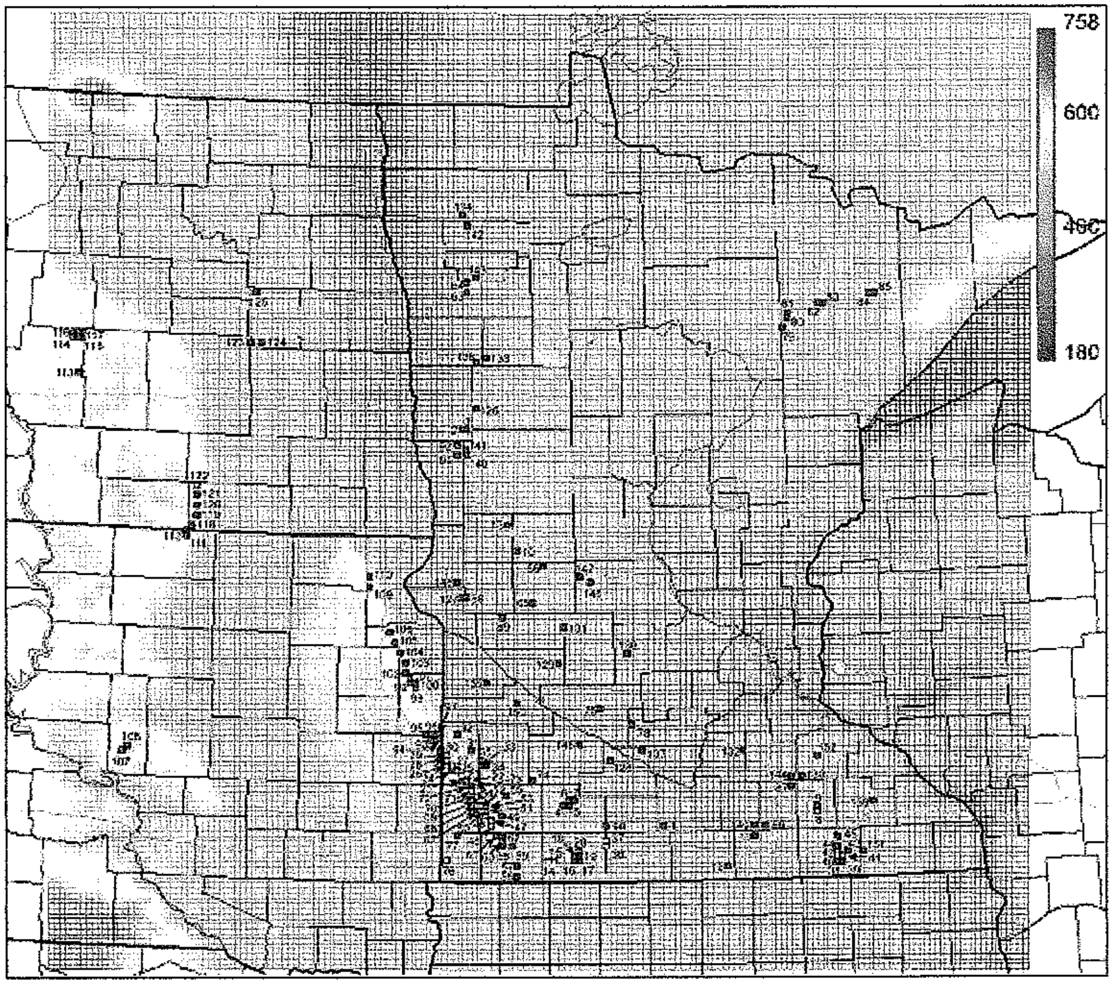


Figure 20: Inner model grid with 152 proxy MM5 tower (data extraction) locations. The color spectrum represents surface elevation. Yellow boxes indicate MM5 extraction sites that are collocated with existing wind production.

Proxy Tower # 137? Nicollet Co Why? #2 of 3 selection

Model Validation

To ensure that the MM5 simulations were accurately representing the wind resource, WindLogics conducted a validation test using the Minnesota Department of Commerce administered meteorological tower at Breckenridge in Wilkin County of western Minnesota. This tower was selected due to its height (70 m) and due to its favorable design that featured sufficient sensor boom lengths that mitigate detrimental tower shadowing and over-speeding effects. The results from this validation analysis are presented in Table 1. Annual wind speeds from the model were compared to the tower for the year 2004 at three levels (50, 60, and 70 m AGL). The model compared very favorably with the tower, with only small biases in the annual wind speeds of ≤ 5.3% and mean monthly absolute errors (MAE) of 4.1 to 5.7 percent. At the critical near-hub

Mean Annual and Monthly Wind Speed – Normalized to 40-Year Climatic Mean

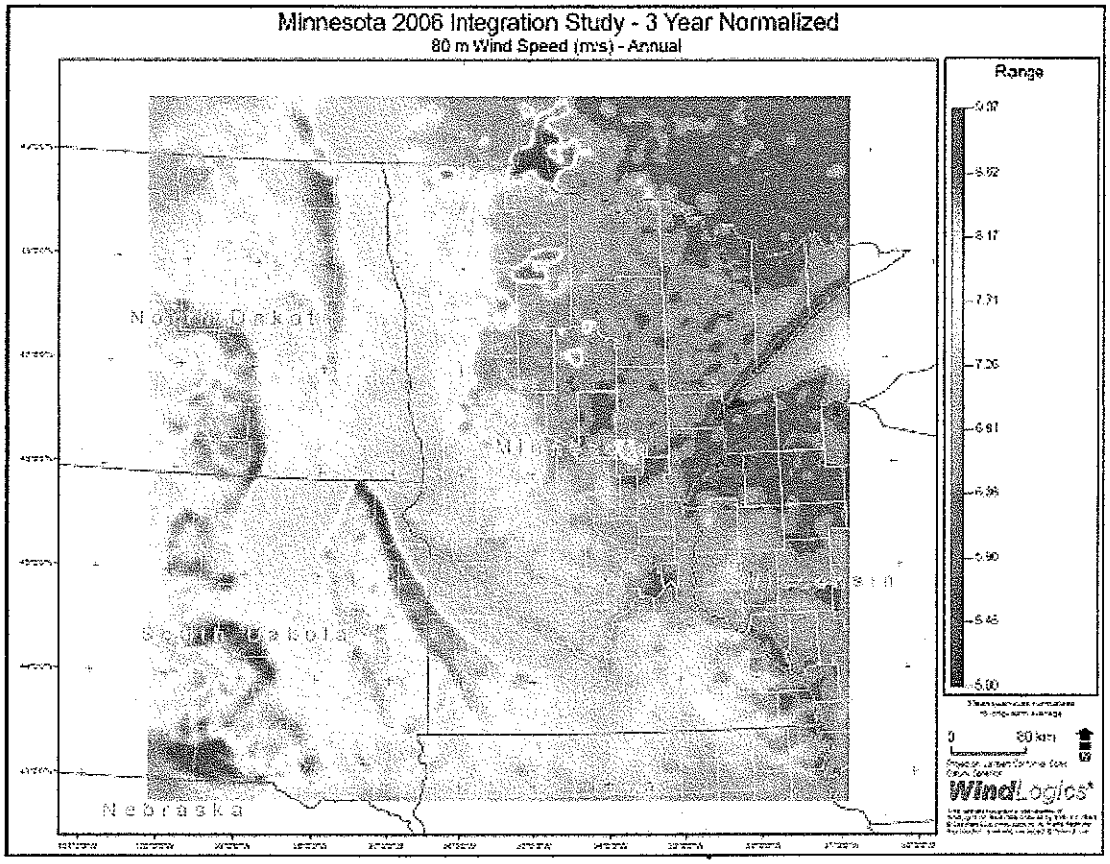


Figure 31: Mean annual 80 m wind speed in m/s.

scale, low-level wind speed variability is highly influenced by the vertical transport of momentum that is dictated by thermal stability and boundary layer evolution.

In addition to the mesoscale meteorological phenomena noted above, there are region-specific mesoscale influences on the wind resource and its variability that are tied to topographic characteristics. For example, the Buffalo Ridge which extends from southwest Minnesota through northeast South Dakota appears to excite buoyancy waves (gravity waves) under stable thermodynamic conditions when the ridge-relative flow has a large orthogonal component to the ridge axis. Model evidence indicates this flow regime extends the excellent wind resource northeast of the top of the ridge. As another example, Lake Superior exerts a marked effect on the climate of northeast Minnesota by the inland penetration of air possessing characteristics of Superior's marine boundary layer.

Mapping of Mean Quantities

WindLogics conducted a quantitative wind resource analysis characterizing annual and mean monthly patterns using atmospheric data at 80 m from the three years of modeling. These mean quantities were normalized to represent the long-term wind resource. Further, diurnal wind patterns are presented below for several geographic locations within Minnesota and North Dakota. Proxy tower locations 41, 71, 82, and 115 were chosen for diurnal wind analysis. Each parameter map series is followed by a summary analysis.

Normalization of Model Wind Data with Long-Term Reanalysis Database

To more accurately characterize the historic wind resource over the project domain, the MM5 wind speed data was normalized with the WindLogics archive of the National Center for Atmospheric Research/NCEP Reanalysis Database (RNL). This RNL database represents 40 years of atmospheric data that has been processed through a modeling assimilation cycle to ensure dynamic consistency. This RNL database is the best objective long-term atmospheric dataset available and was created for purposes such as climate research investigations. By comparing applicable RNL grid points for a given month and year to the long-term average at those points, ratios are created that are applied to the MM5 wind data. This process normalizes the model data to better represent the historic character of the wind resource.

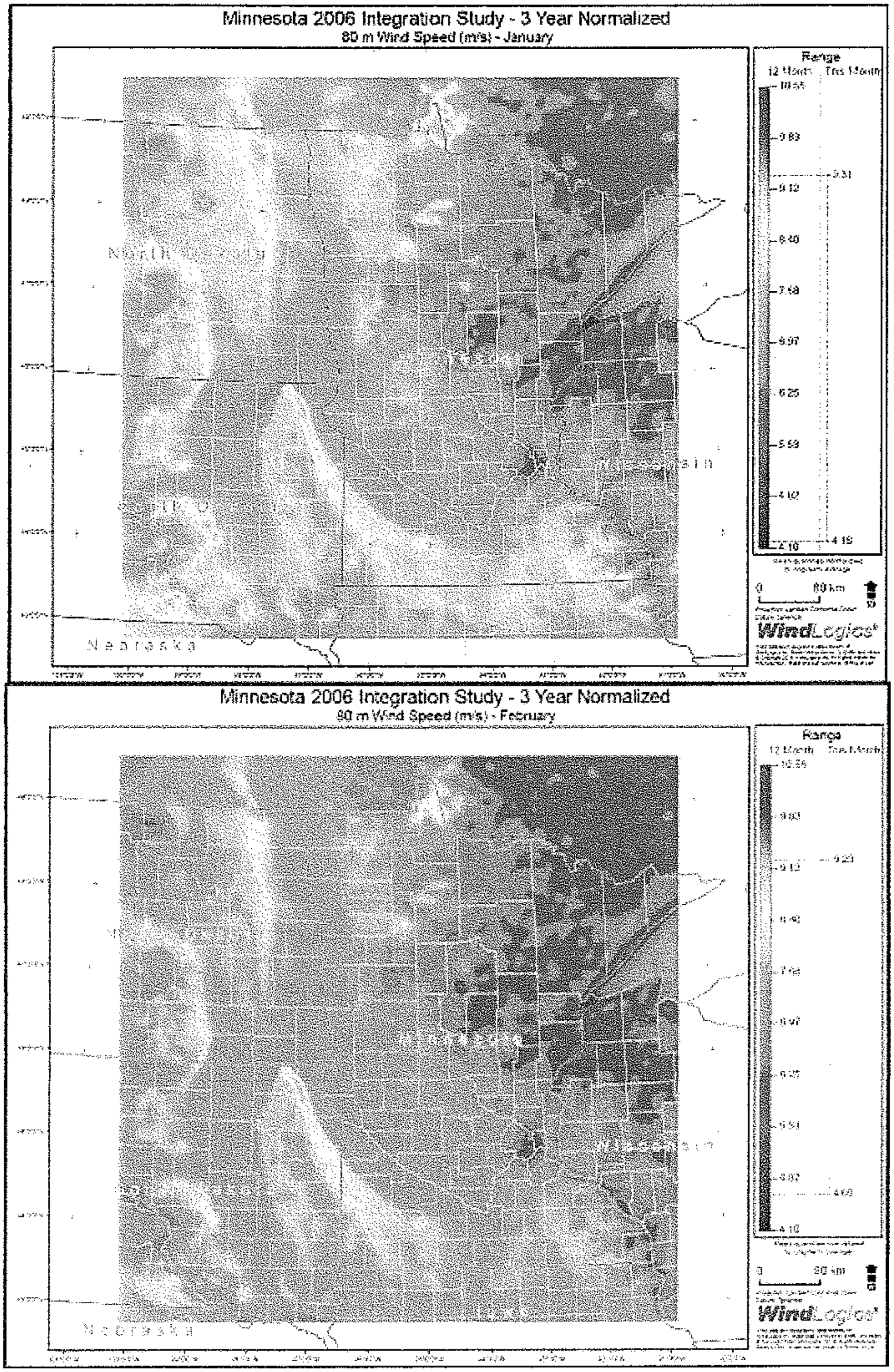
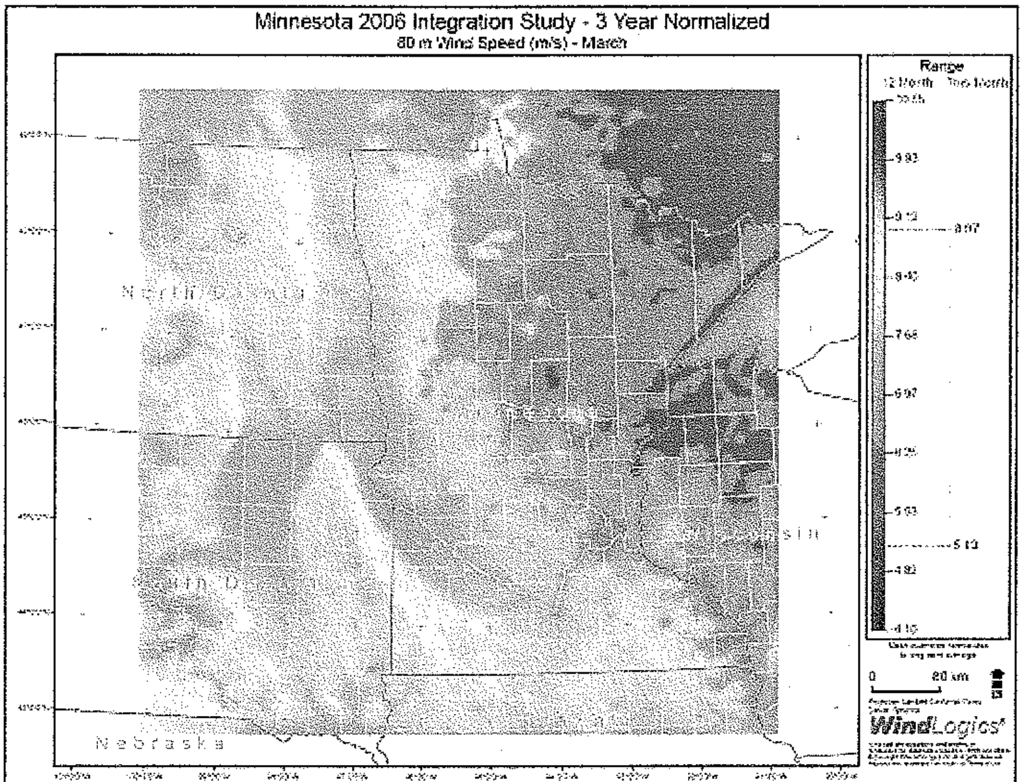


Figure 32: Mean January and February 80 m wind speed in m/s.



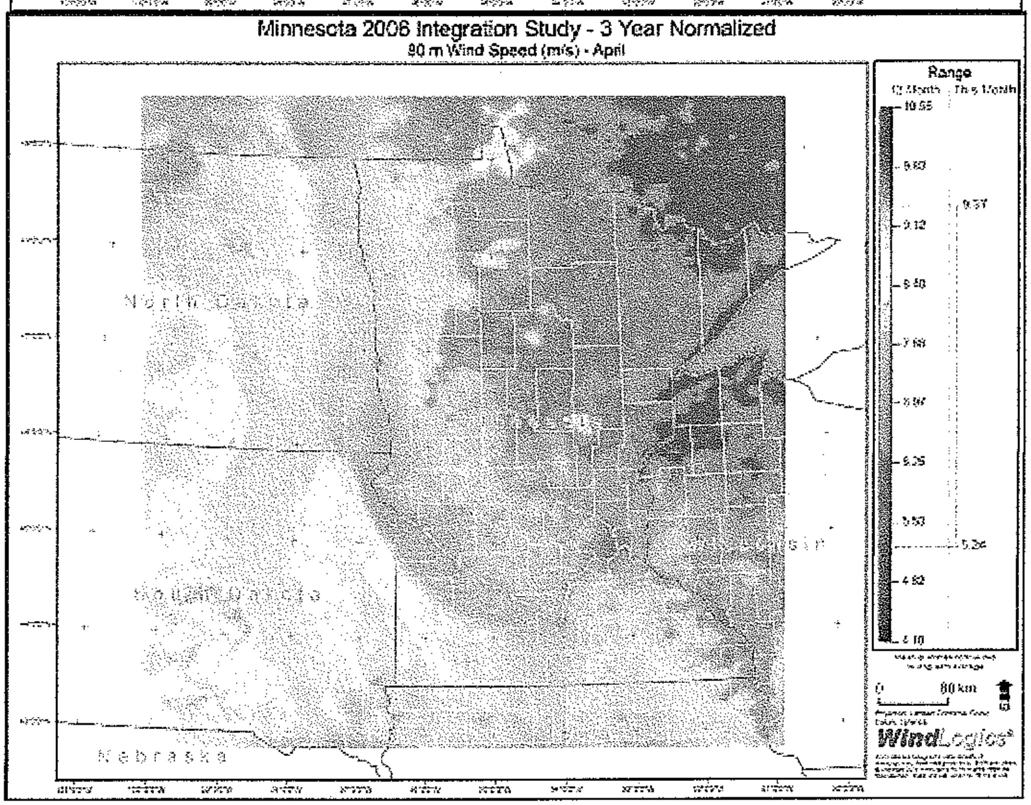


Figure 33: Mean March and April 80 m wind speed in m/s.

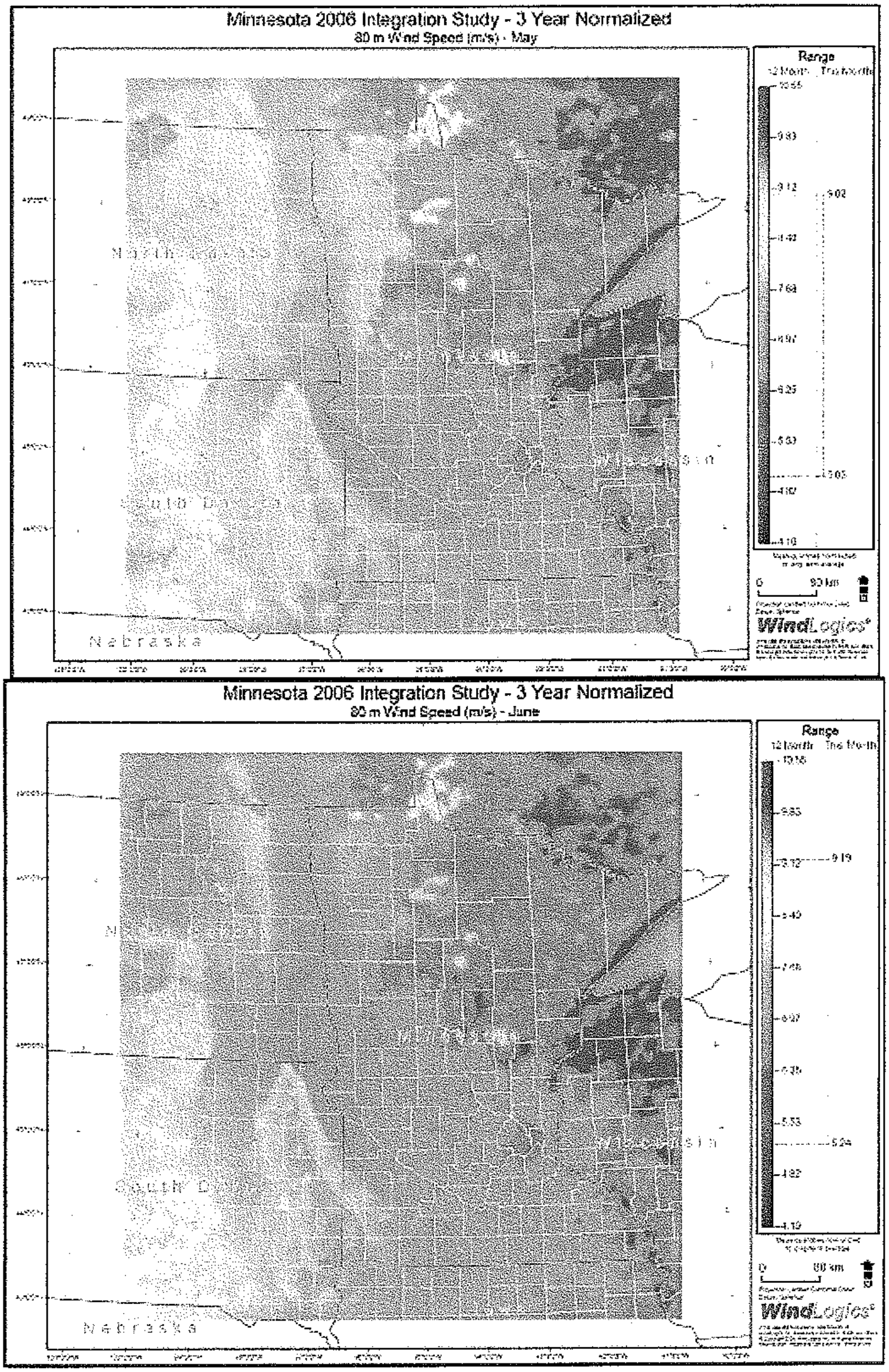


Figure 34: Mean May and June 80 m wind speed in m/s.

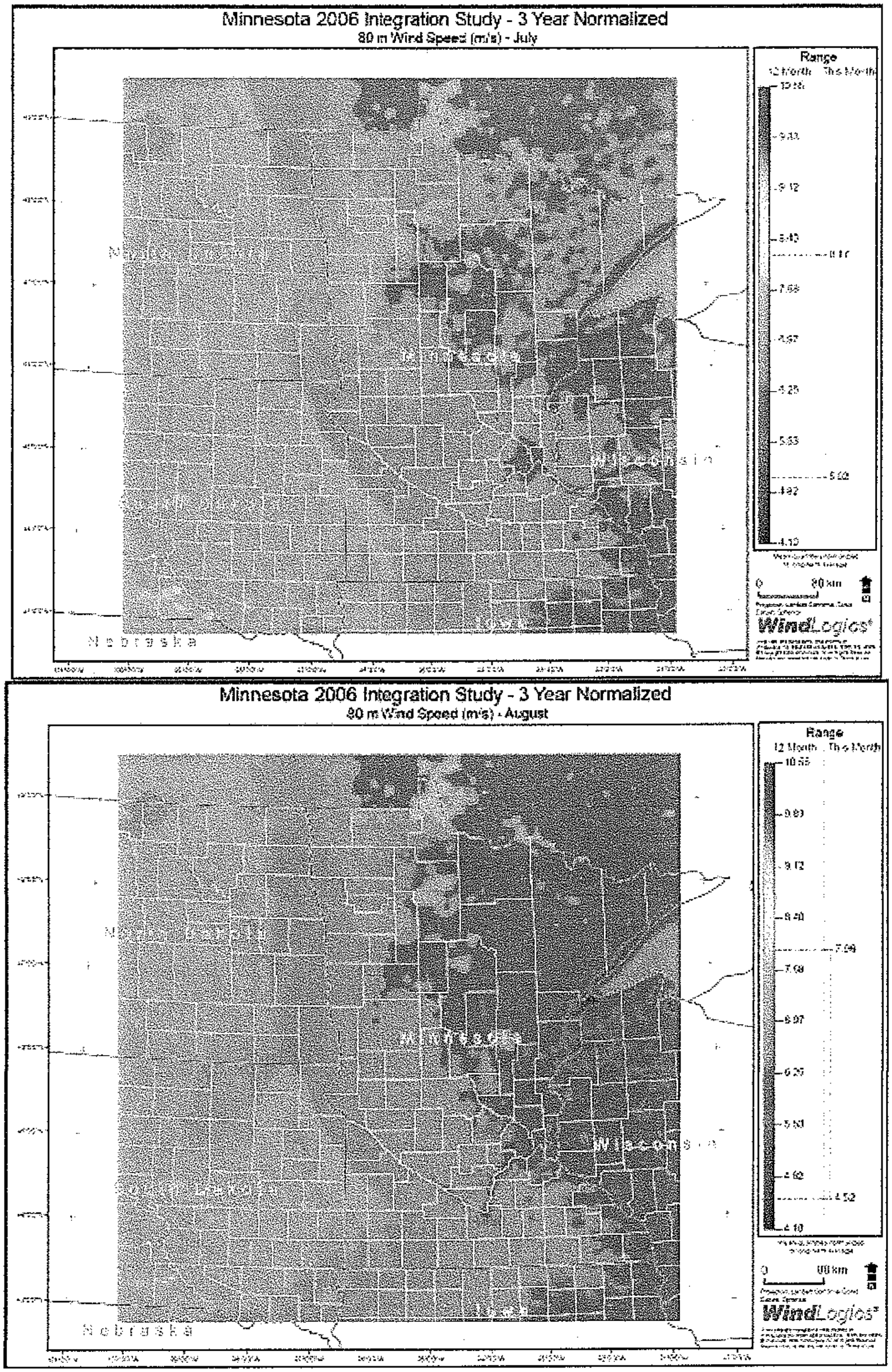


Figure 35: Mean July and August 80 m wind speed in m/s.

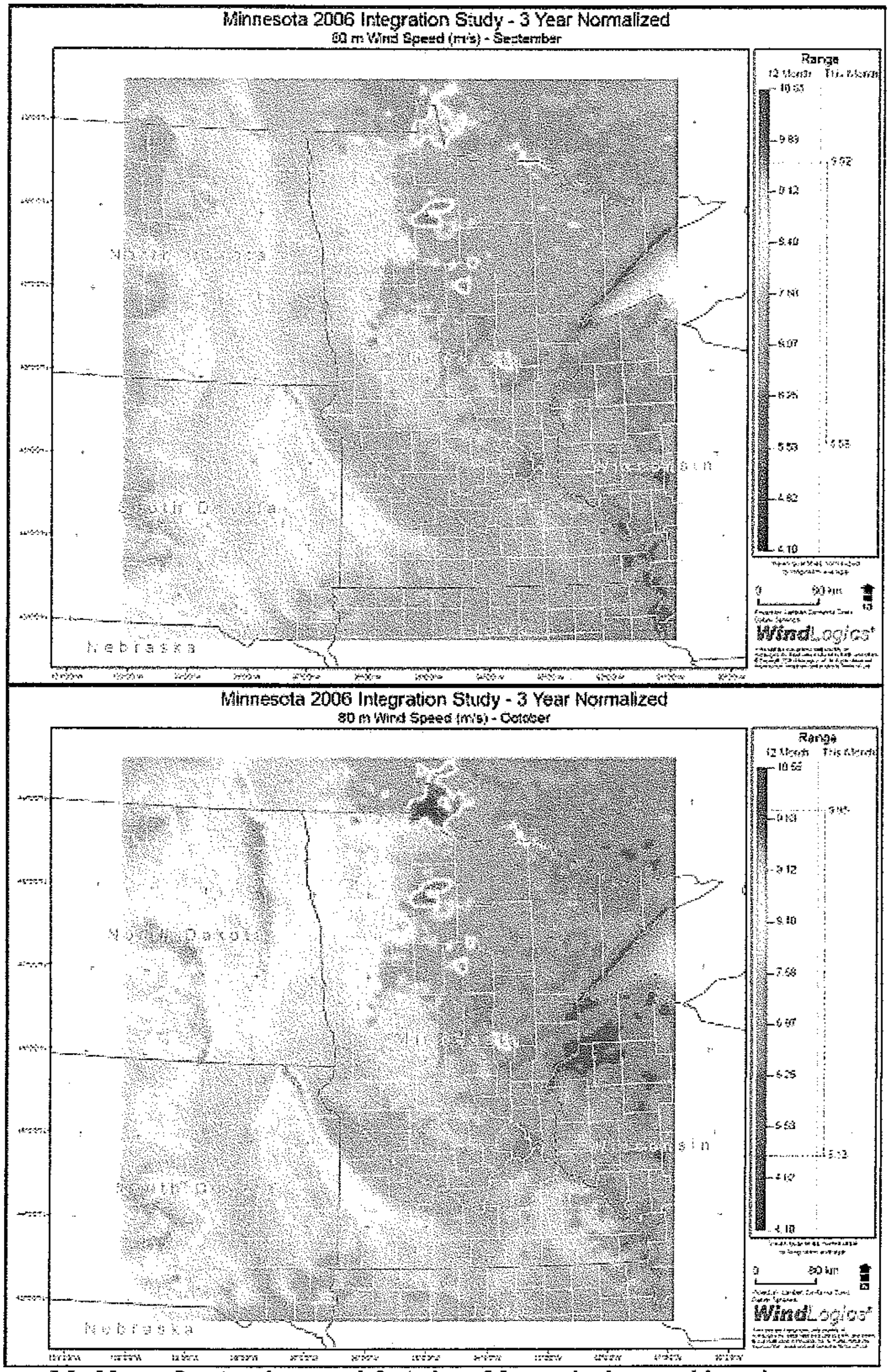
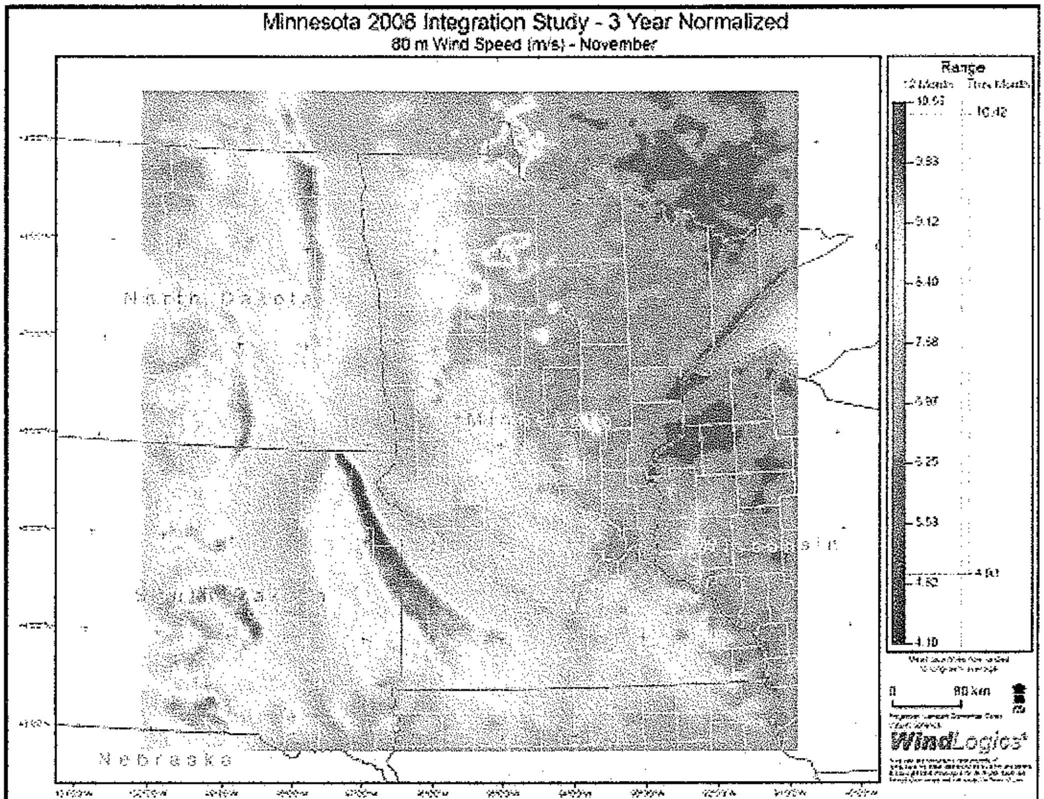


Figure 36: Mean September and October 80 m wind speed in m/s.



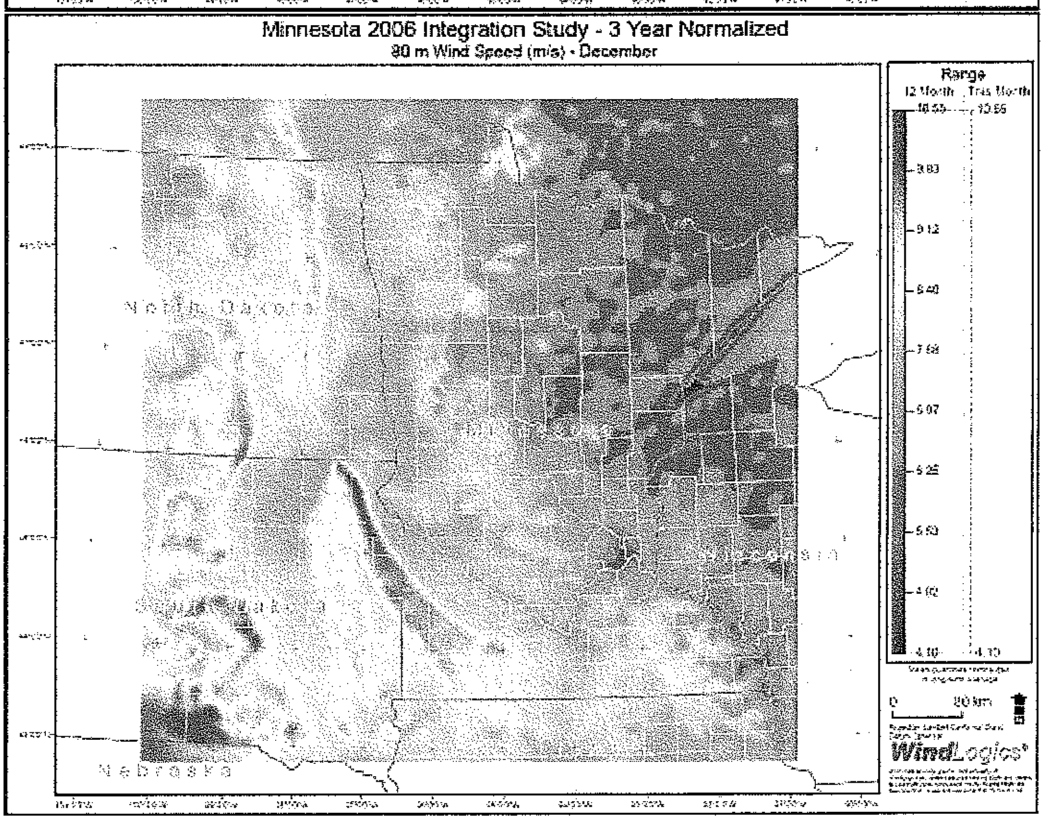


Figure 37: Mean November and December 80 m wind speed in m/s.

EnerNex
CORPORATION

Final Report - 2006 Minnesota Wind Integration Study
Volume I

Prepared for:

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In Collaboration with:

The Midwest Independent System Operator

November 30, 2006

committed and dispatched in an optimal fashion, the size of the effective system into which the wind generation for the study is integrated grows to almost 1200 individual generating units. The aggregate flexibility of the units on line during any hour is adequate for compensating most of the changes in wind generation.

The magnitude of this impact can be gauged by comparing results from recent integration studies for smaller systems. In the 2004 study for Xcel Energy, for example, integration costs were determined to be no higher than $4.60/MWH for a wind generation penetration by capacity of 15%, which would be closer to 10% penetration on an energy basis.

7. The contribution of wind generation to power system reliability is subject to substantial inter-annual variability. Annual Effective Load Carrying Capability (ELCC) values for the three wind generation scenarios from rigorous Loss of Load Probability (LOLP) analysis ranged from a low of 5% of installed capacity to over 20%. These results were consistent with those derived through approximate methods.

PROJECT AND REPORT OVERVIEW

EnerNex Corporation, of Knoxville, Tennessee was selected to be the prime contractor for the study. WindLogics, of St. Paul, Minnesota was subcontracted by EnerNex to perform the wind resource characterization and develop the long-term chronological wind speed data sets upon which the analyses of the Minnesota power system were based.

The study was conducted through an open and transparent process that involved the Commission, technical representatives from the Minnesota utility companies, the Midwest Independent System Operator, and stakeholder groups, along with technical experts in wind generation from across the country. The approach, data, assumptions, and analytical methodology were reviewed and extensively discussed at review meetings over the course of the project. Interim results were presented and evaluated, with recommendations from this Technical Review Committee (TRC) guiding subsequent analyses.

The technical scope for the project was based on the original Request-for-Proposal from the Minnesota Public Utilities Commission. As the project progressed, some revisions to this original scope were necessary as a result of assumptions and decisions made in conjunction with the TRC. This report documents the project as conducted.

The contribution of the Midwest Independent System Operator to this effort was very significant. Analysis of an electric power system of the geographic extent and operation complexity considered in this study would have been extremely difficult if not impossible without the support and collaboration of the MISO engineering staff. The project team thanks MISO staff for their efforts and significant contribution.

This report is comprised of four main sections. In Section 2, the approach used to develop the chronological wind generation data so critical to the analytical methodology is described. Characterizations of the wind resource in the state of Minnesota are also presented, and are documented in detail in the companion volume to this report.

Section 3 details the assumptions made in conjunction with the project Technical Review Committee to govern the analysis. Data comprising the models of the electric power system in Minnesota to be used in the analysis are also described. Analysis and assumptions regarding the impact of wind generation on system reserve requirements is presented.

In Section 4 the analytical approach to determining the contribution of the wind generation model to system reliability is documented, along with results of the analytical procedures and conclusions.

Finally, Section 5 details how wind generation affects the operation of the Minnesota power system, as determined from annual hour-by-hour simulations of generation unit commitment and dispatch.

National Wind Watch

July 25, 2007
Minnesota

PUC sells bonds

The New Ulm Public Utilities Commission Tuesday authorized the issuance of $2,375,000 in general obligation revenue bonds that will fund various projects including construction of the Cottonwood booster station and design work on the proposed New Ulm Wind Farm.

The bonding issue now goes to the City Council for ratification. It also would provide about $700,000 for the Boiler No. 4 conversion project. The commission acted after discussing the utility's bonding capabilities with the city's bonding consultant during an informational meeting that preceded the PUC's regular meeting.

Maintaining a satisfactory level of unrestricted reserve cash has greatly enhanced the utility's ability to the best possible interest rate on its bonds, bonding consultant Jon Burmeister of Des Moines said.

"New Ulm is in the enviable position of maintaining an A1 bond rating while giving New Ulm almost triple-A rates," Burmeister said.

The commission took another step in securing less expensive electrical power by voting to apply for at least a portion of the 20 megawatts of Pick Sloan federal hydroelectric power being offered to new customers by the Western Area Power Administration.

New Ulm Public Utilities would be in line for the cheaper power because Heartland Consumer Power District, which becomes NUPU's primary power supplier in 2009, will act as the conduit for obtaining the power, commissioners were told.

While he couldn't give specifics yet, Director Gary Gleisner said obtaining the cheaper hydroelectric power should cut the utility's product costs "quite a bit."

Although Sargent & Lundy's estimate of NUPU's wind farm project costs, at $12.5 million, was considerably higher than the utility's own estimate of around $10 million, "Sargent & Lundy's estimate includes $3.8 million for a new substation [for transmission of power generated on the wind farm] which may or may not be necessary," NUPU's Planning and Development Engineer Patrick Wrase told the commission.

Wrase said the utility's estimate was based on sending its generated power through the substation owned and operated by Xcel Energy near New Ulm.

"We will have to depend on Xcel's substation to get the wind generation power into New Ulm. [To get more independence] we would have to put in a new transformer, but it would have to be built next to the present substation on Xcel land so we'd still have to work through Xcel," Wrase said.

Otherwise, the prognosis for a wind energy farm just gets better and better, Wrase reported.

According to Wrase, WindLogics Inc. has completed the wind resource assessment of sites for the utility's local wind project, and "the wind resource assessment has indicated an average gross capacity factor of 44 percent is likely for the site." ← VIRTUAL - PERCENT - DOESN'T MATCH WINDSPD TO HIGH

That's about 10 percent higher than the assessment calculations used by NUPU staff for the preliminary assessment for the project, Wrase said. FOR NET — DISCOUNT 15% TO REPRESENT REAL WORLD CONDITIONS

"The project continues to be economically attractive, especially if we're successful at obtaining Clean Renewable Energy Bonds for a portion of the project costs," Wrase said. The utility is applying for $2.975 million in CREB funding 'which would be zero percent interest," Wrase said.

The reason that the utility's net margin of $309,880 after the first six months is only 28 percent of the utility's budgeted annual net margin of $1,093,165 is that the utility's customers are getting really serious about conserving on energy and water, Gleisner told the commission.

"Our sales are flat in almost every department," Gleisner said.

"Even though we have more homes now, the number of people in each house is smaller. We're not seeing four or five kids in a house any more," City Manager Brian Gramentz added.

By Ron Larsen
Journal Staff Writer

The Journal [1]

25 July 2007

URLs in this post:
[1] The Journal: **http://www.nujournal.com/News/articles.asp?articleID=8210**
