Community Wind

Wind Powering America Summit
June 8, 2006

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Topics I Will Cover

- Distributed Wind Generation Potential
- Community Wind Economics Using LLC Flip Model
- Community Wind Example

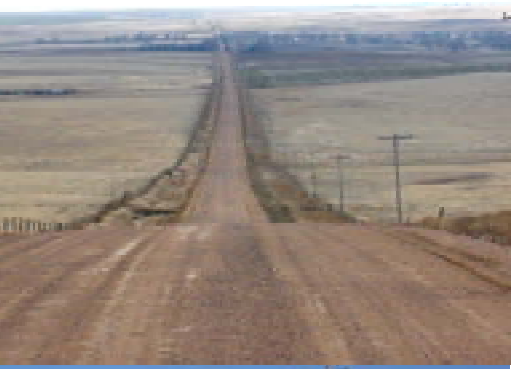
Single 900 kW Wind Turbine Owned
By Waverly Light & Power
Connected to 13.8 kV
Distribution Line

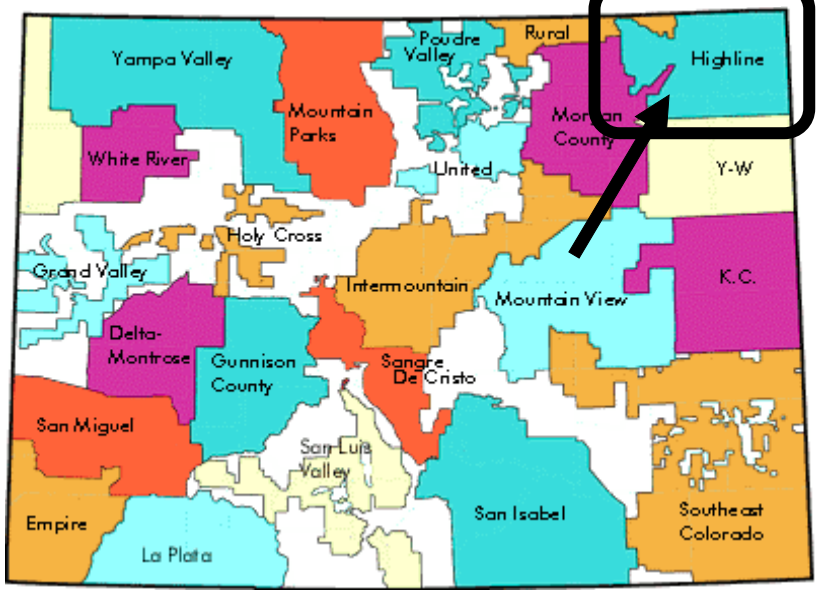

Distributed
Wind
Generation
Potential
Photo by GE Wind - Storm Lake, Iowa

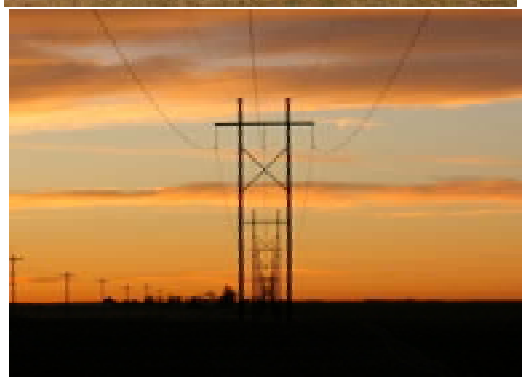
Distributed Wind Generation Study in Northeast Colorado

- Study in 2005 of the Highline Electric Association service territory in Northeastern Colorado
- The main purpose was to determine how many large 1.5 MW wind turbines could be connected to the existing 12.47 kV distribution system grid in the service territory
- Study considered:
  - Electrical characteristics of the distribution system
  - Relative wind speed in the immediate area
- Study did not consider the overall economics or economic feasibility of wind generation in this area.

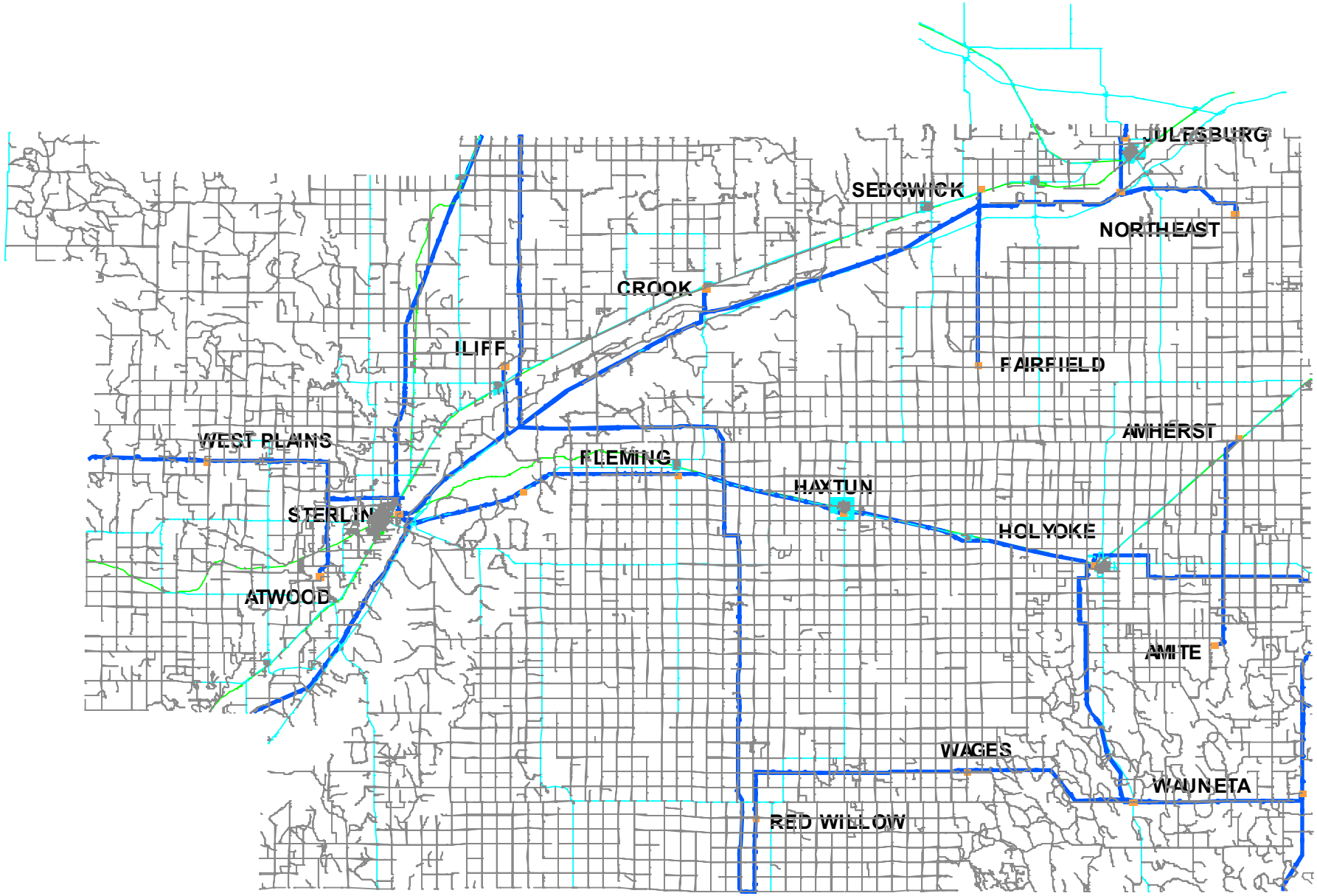
Study Area in Northeastern Colorado



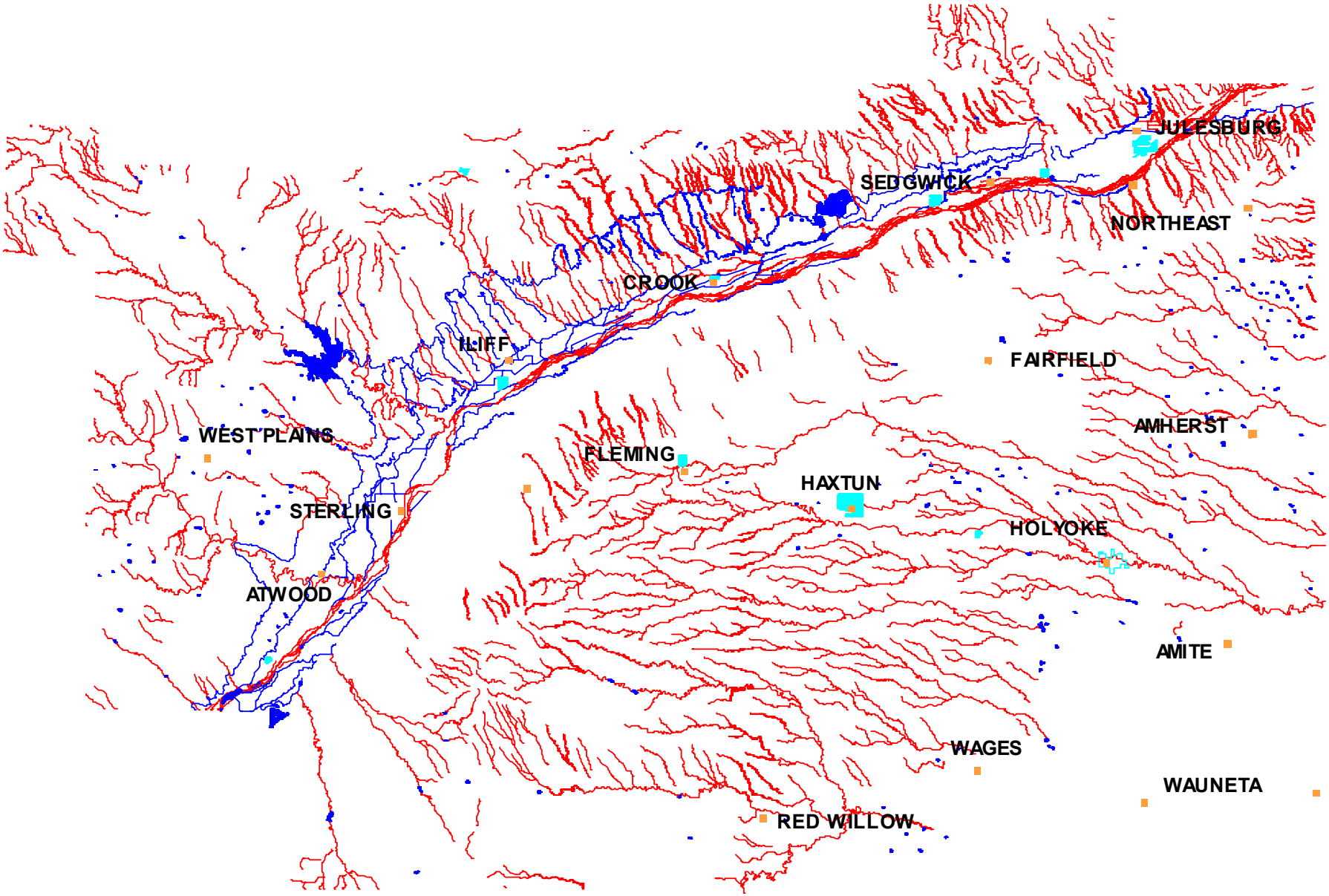




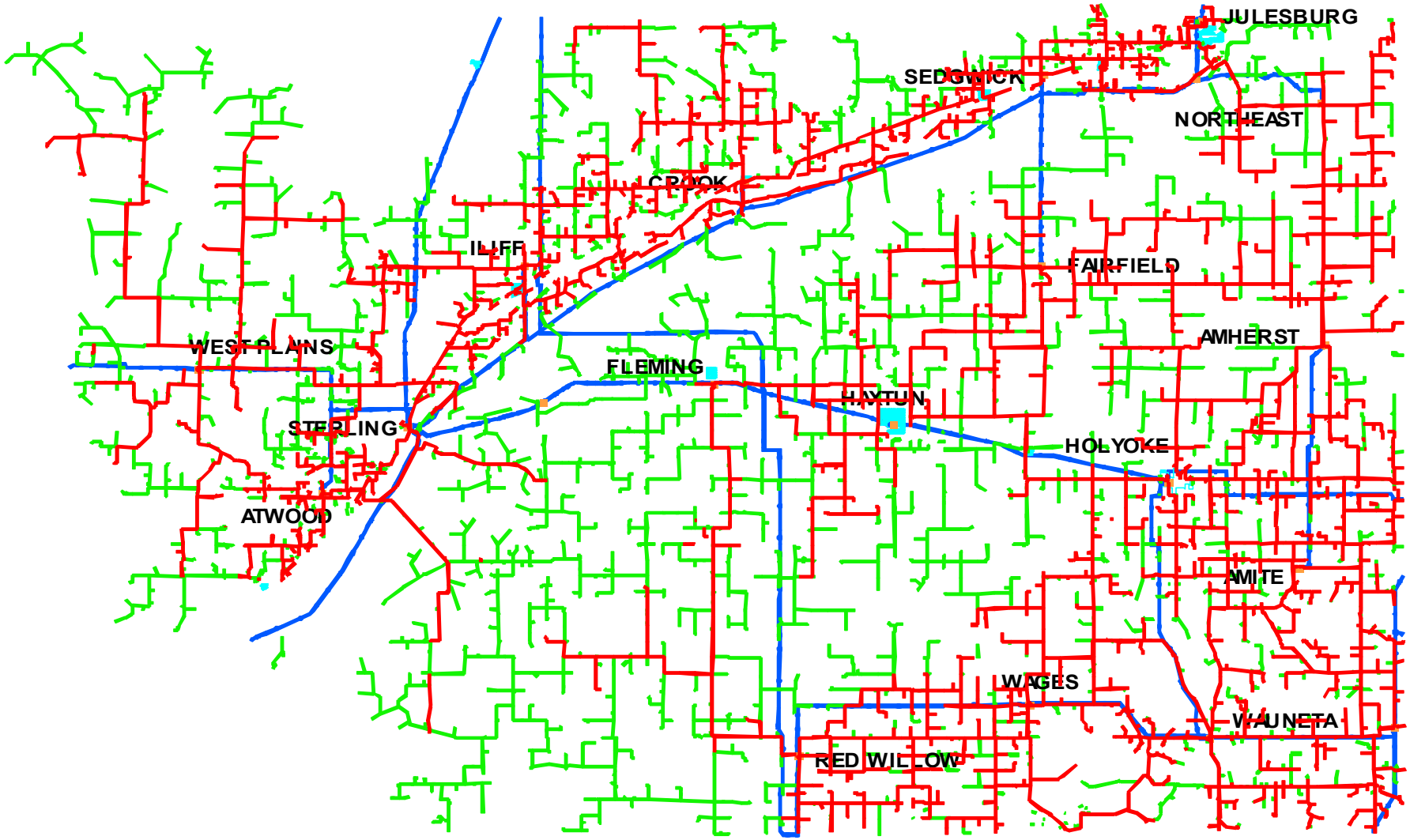
Study Area Major Towns, Highways, Roads, & Railroads



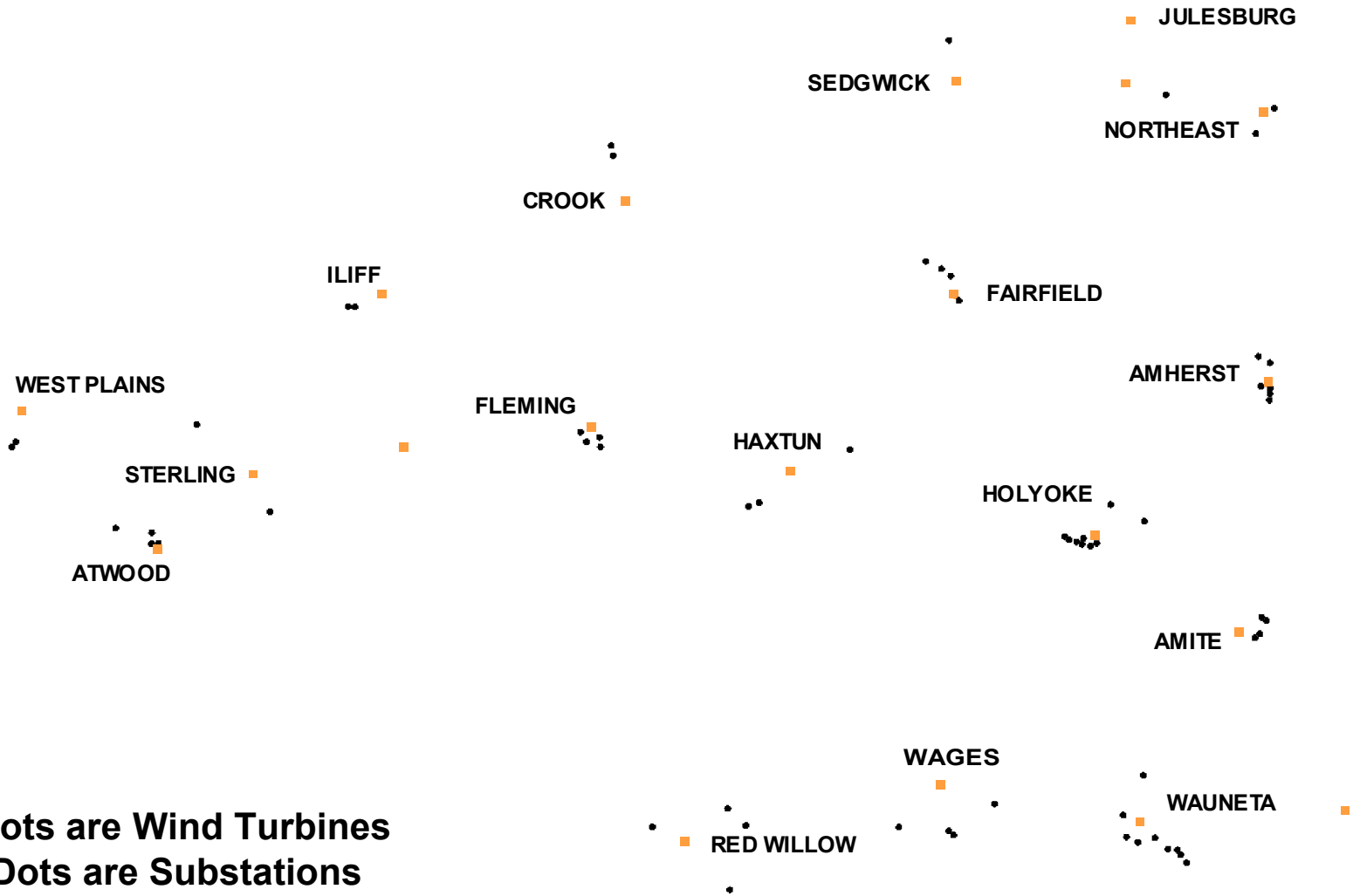
Lakes, Streams, & Irrigation Canals



Transmission Lines, 3-Phase, and & 1-Phase Distribution Lines

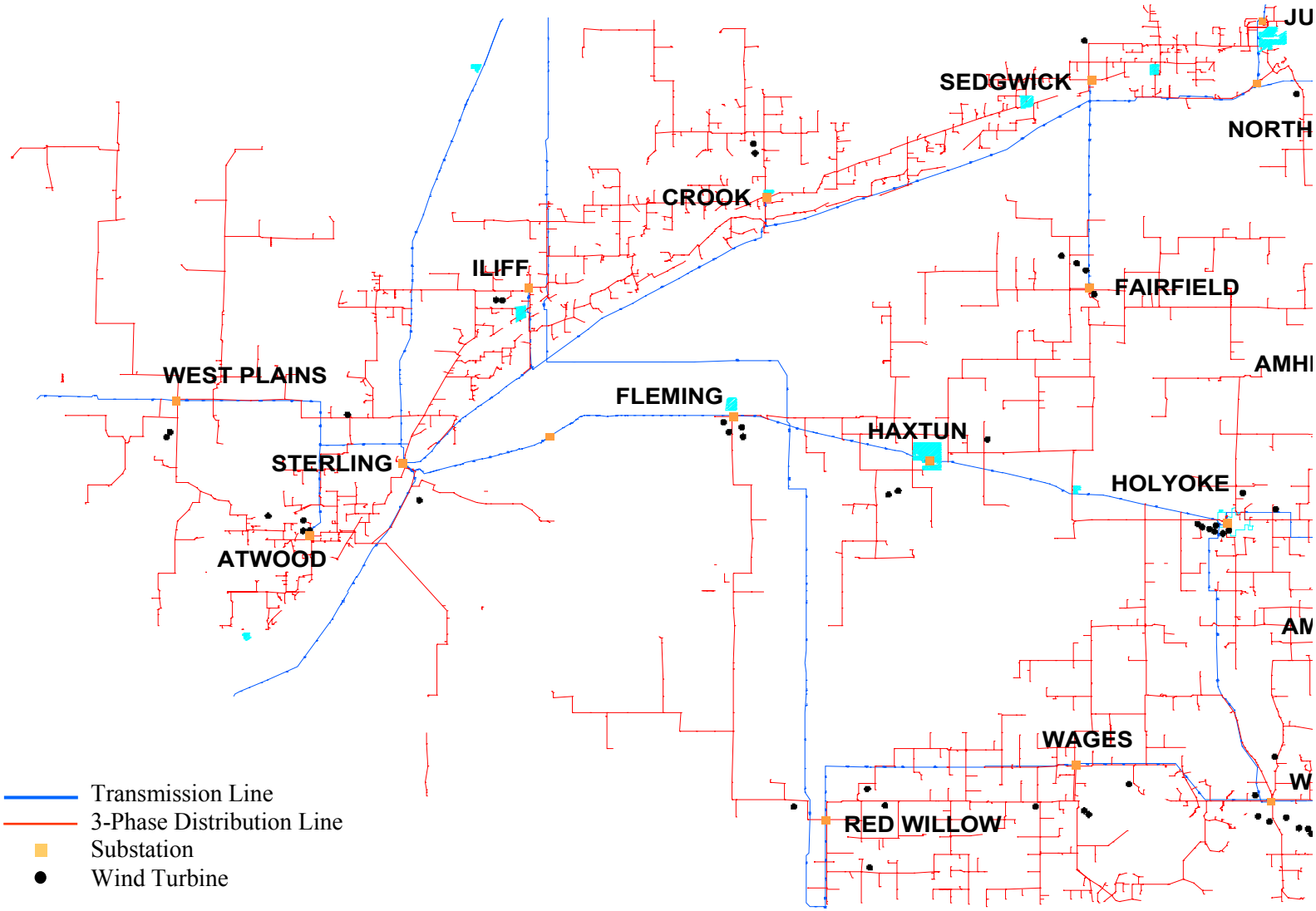


Wind Turbines Added to the Existing Distribution System



Black Dots are Wind Turbines
Brown Dots are Substations

Transmission & 3-Phase Distribution System With Wind Turbines



Summary of Results

Table 5-1 - Summary of Results

Substation Name	Substation Transformer MVA Rating	Scenario 1: Farthest Distance in Miles from Substation	Scenario 2: Most Number of Turbines	Scenario 2: Limiting Factor	Scenario 3: Potential Distribution System Reinf… Turbines to be Conne… Allow More …on System
Amherst	14.0	5.4	6	Flicker	Dedicated collect…
Amitie	14.0	5.5	4	Flicker	Dedicate…
Atwood	7.0	4.2	4	Transformer	L…
Crook	7.0	5.1	2	Poor Wi…	…ndier sites would allow 2 more turbines
Fairfield	14.0	5.0	4		…o a windy area
Fleming	7.0	4.0	4		
Haxtun	7.0	4.8			…collection line to a windy area
Holyoke	14.0	6.…			…rger transformer and dedicated collection line
Iliff	7.0			…d	Two 1-mile Line extensions to windier sites would allow 2 more turbines
Julesburg	10.…			…or Wind 1	A line extension would allow 2 turbines to be added.
Northeast				Flicker	Dedicated collection line to a windy area
Red Wi…			4	Flicker	Dedicated collection line to a windy area
Sedgwic…			1	Flicker	Dedicated collection line to a windy area
Sterling		6.5	2	Flicker	Dedicated collection line to a windy area
Wages		6.4	4	Flicker	Dedicated collection line to a windy area
Wauneta	22.4	7.0	9	Flicker	Dedicated collection line to a windy area
West Plains	3.8	3.3	2	Transformer	Larger transformer
Total Number of 1.5 Mw Turbines Added …..			63		

63 x 1.5 MW Wind Turbines Could Be Connected to the Existing 12.47 kV Distribution System

Notes: 1 - Since wind speeds are so much better on the higher ridges beyond the exsiting distribution lines, it was assumed no wind turbines would be connected to the existing distribution grid at Julesburg unless line extensions of at least one mile in length were constructed. This length exceeded the limit set in the study.


Community Wind
Economics Using
LLC Flip Model
Photo by GE Wind - Storm Lake, Iowa

Community Wind Economics Using LLC Flip Model

- Many Community Wind projects use the Minnesota Flip LLC structure
- This structure allows the project owners to take advantage of the federal income tax benefits provided to wind power
- A wind project proforma is a financial projection of the future shown in a financial format
- It provides a projection of the capital cost, sources of financing, revenue, the expenses, and the profit based on a specific set of assumptions
- By using a spreadsheet program like Excel, the assumptions can easily be changed to determine the impact on the profit.
  - This provides an easy tool to assess the financial impact of risks and uncertainties.

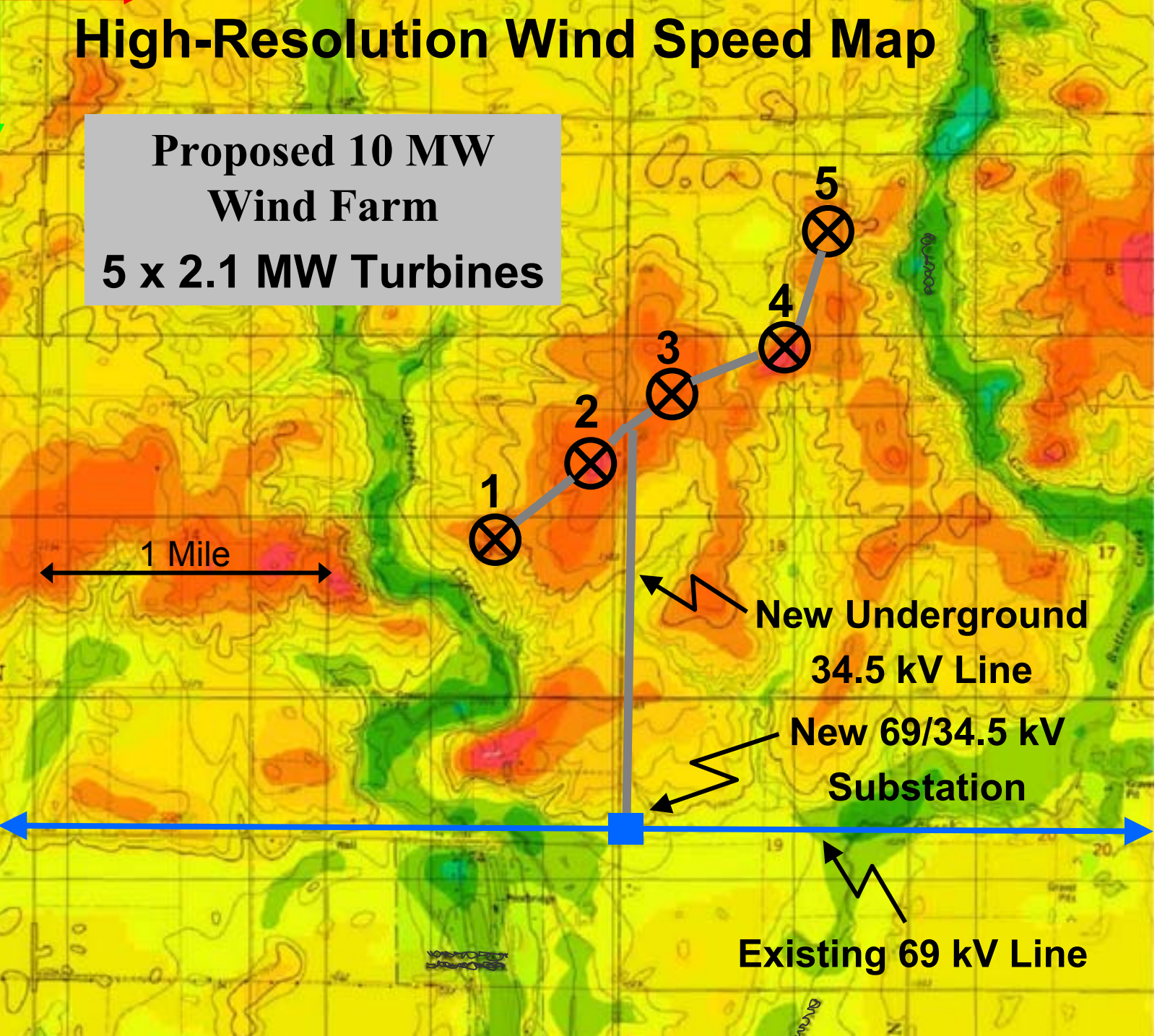
Factors Affecting Wind Project Economics

- The most important and influential factor is the wind speed
- The second most important factor is the Power Purchase Agreement ("PPA") selling price OR the power bill savings if the wind turbine is behind the meter
- The other factors affecting the project economics are:
  - State tax credits or incentives, wind turbine costs, interconnection cost, cost of financing, and grants.

Wind Project Example

- Ten Megawatt Wind Farm
  - Five x 2 MW wind turbines
  - Five Owners, each having one wind turbine
  - Minnesota Flip Model used
  - Long-term PPA with local utility
- Installed near an existing 69 kV line
- In a windy area of Iowa (windiest 15% of Iowa)

- The first thing we do is estimate the wind generation.



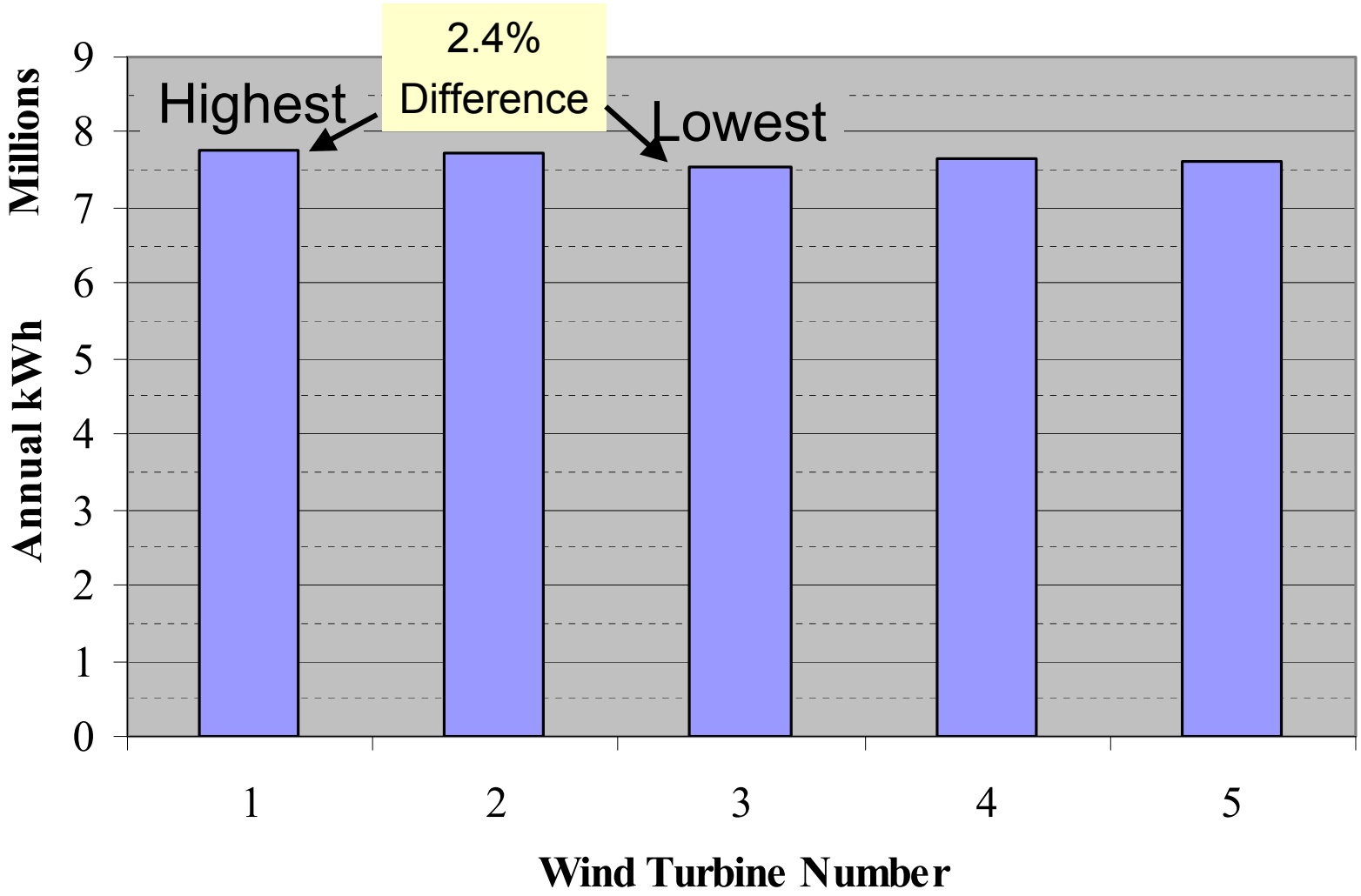
Mean Wind Speeds in Meters Per Second at 50 Meters

7.85
7.8
7.75
7.7
7.65
7.6
7.55
7.5
7.45
7.4
7.35
7.3
7.25
7.2
7.15
7.1
7.056
7

Wind Generation Production Estimates

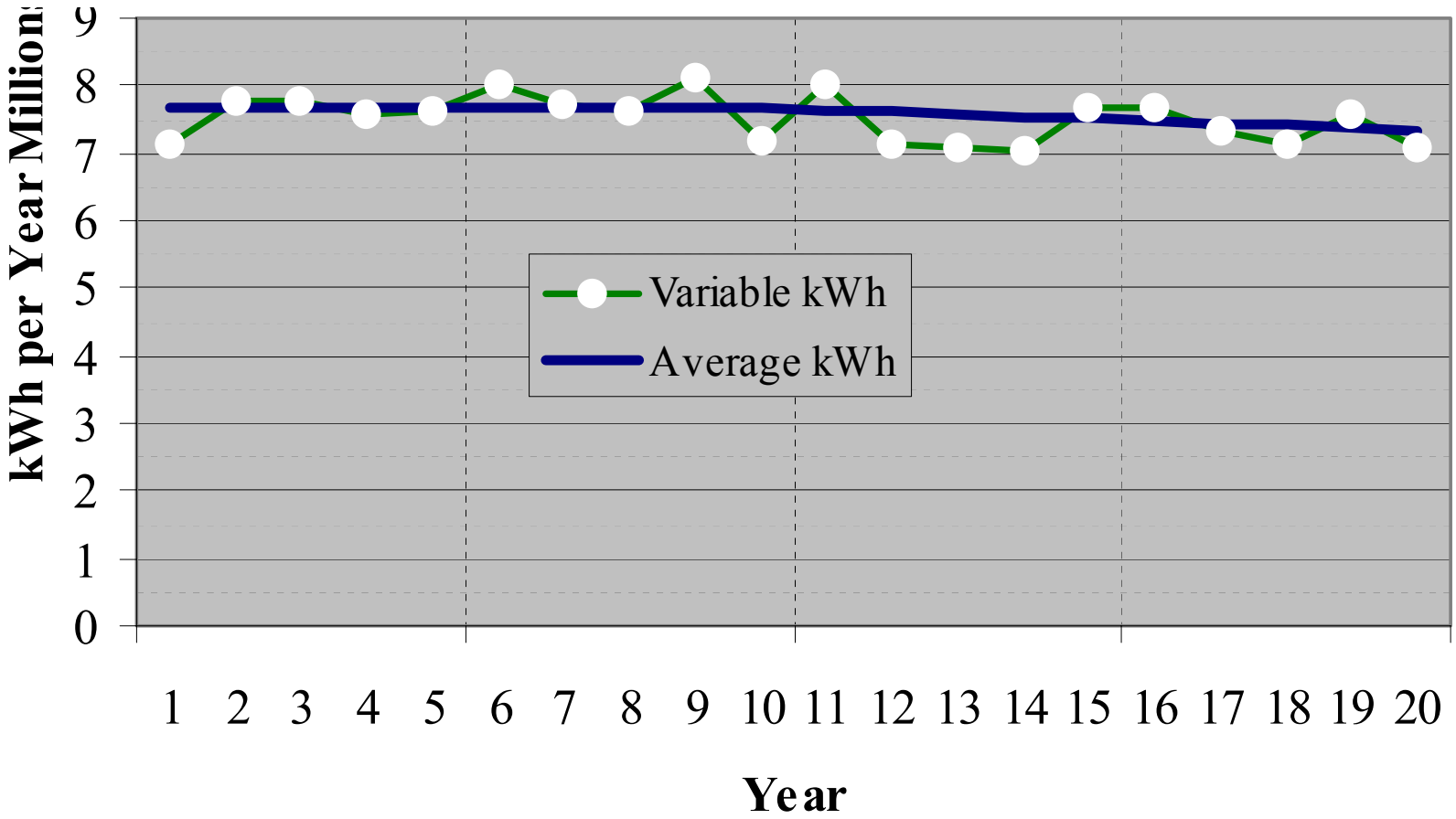
- Wind speed averages 7.7 meters per second ("mps") (or 17.2 mph) at 50 meters height, with a ± 0.05 mps difference between turbines.
  - At an 80 meter hub height, wind speeds are estimated to be average about 19.3 mph.
- Wake losses are different for each turbine, with the middle turbines having the highest wake losses (range is 0.7% to 2.9%)
  - Production differences between turbines will vary by about ±1.2% in this particular case
- Production will likely decline gradually in the later years of life, due to more maintenance and deterioration of blade surface.

Initial Annual Average kWh Generation by Wind Turbine Number



Actual Wind Generation Will Vary from Year to Year

Example of Variation in Wind Generation Versus Projected Average Annual Generation



Purpose of the Proforma Analysis

- The Proforma provides a succinct summary of all key financial assumptions about the project
- The financial assumptions cover all aspects of the project that can affect the return to the investors
- The Proforma answers the question…

Will the proposed project likely meet our return on investment objectives?

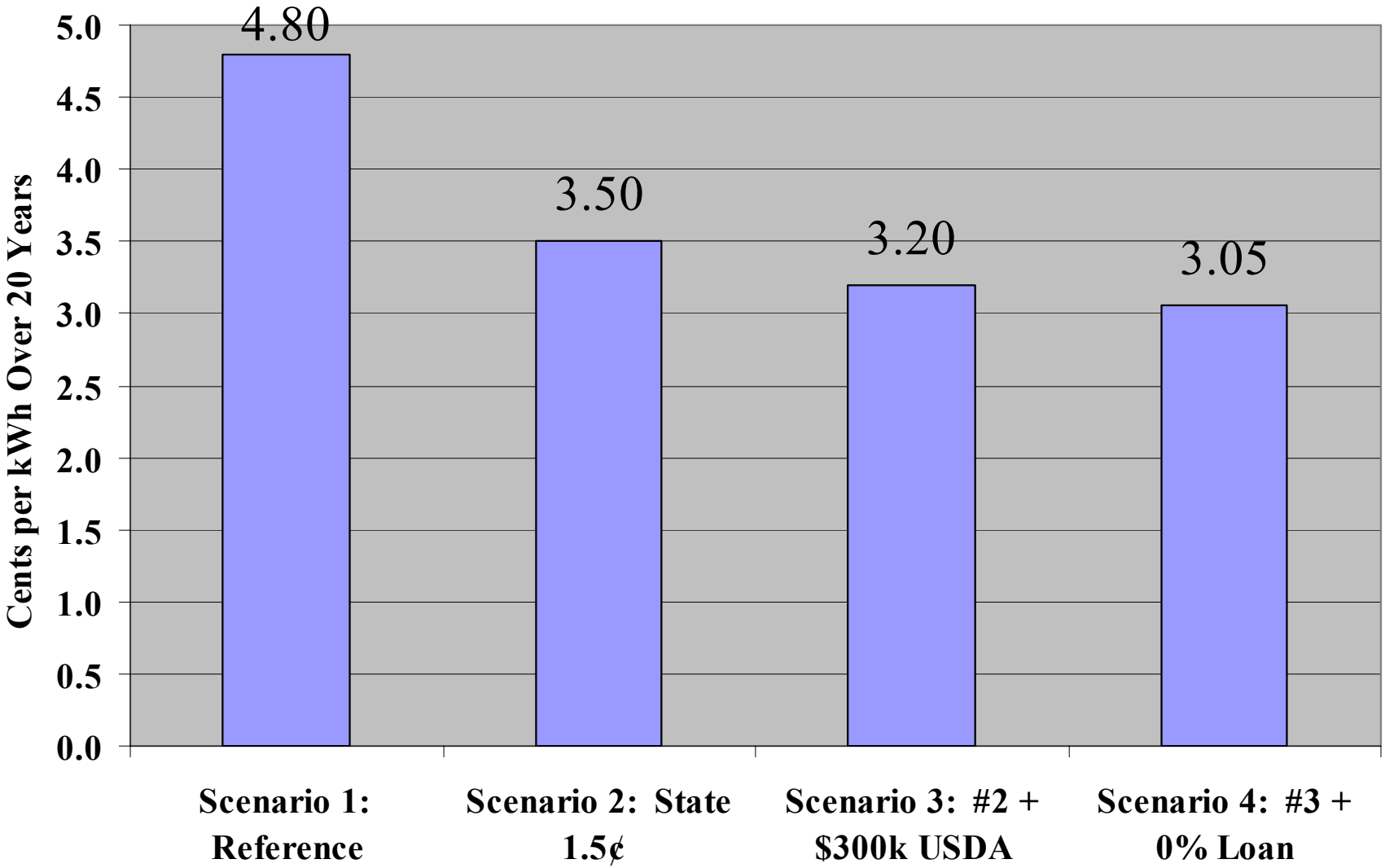
Assumptions for Reference Case Proforma

- Overall Capital Cost of Project is about $1,350 per kW (This is a little low in today's market)
- Minnesota Flip Model with outside investors owning 49% of the project
- Tax Investor provides 99% of Financing with a target return on investment of about 10%
- Ownership will flip to local owner when Tax Investor obtains a 10% return
- **Based on a number of assumptions for this scenario, it was determined that the PPA + Green Tag revenue of 4.8¢ per kWh was required to achieve a 10% return after 10 years for the tax investor**
- **Unfortunately, PPA rates in this area are not this high. Therefore, this project is NOT feasible. What can be done to help this out?**

State Production Tax Credit
(Iowa and Minnesota Have Had This in the Past)

- In Scenario 2 with the Iowa 1.5¢ per kWh Tradable State Tax Credit, the required revenue dropped from 4.8¢ per kWh to 3.5¢ per kWh
- This reduced the required revenue by 1.3¢ per kWh
- The required revenue is still a little higher than the typical amount for wind power in Iowa
- What else can be done to make the project economically feasible?

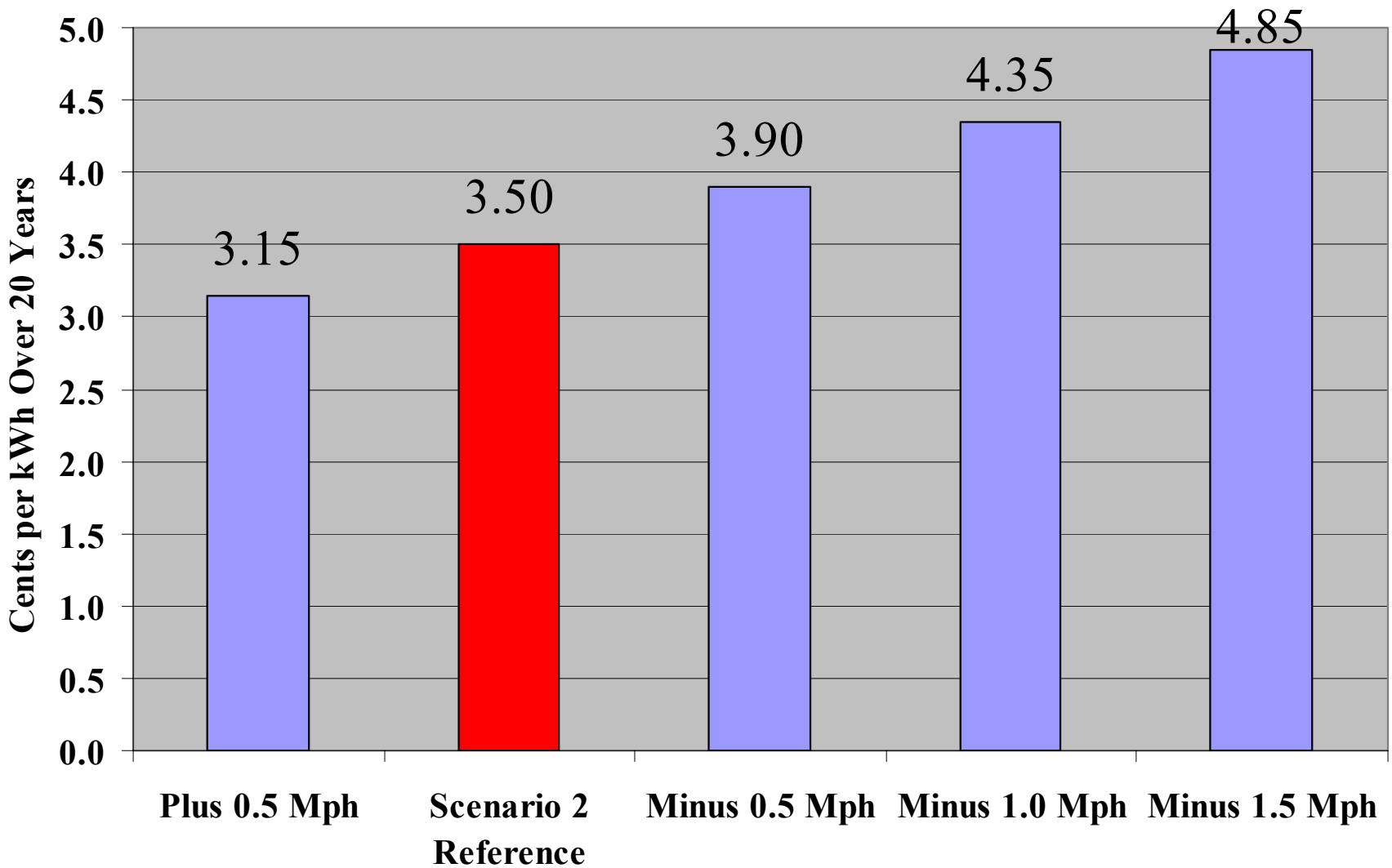
Required Revenue per kWh for Various Scenarios



Sensitivity to Input Assumptions

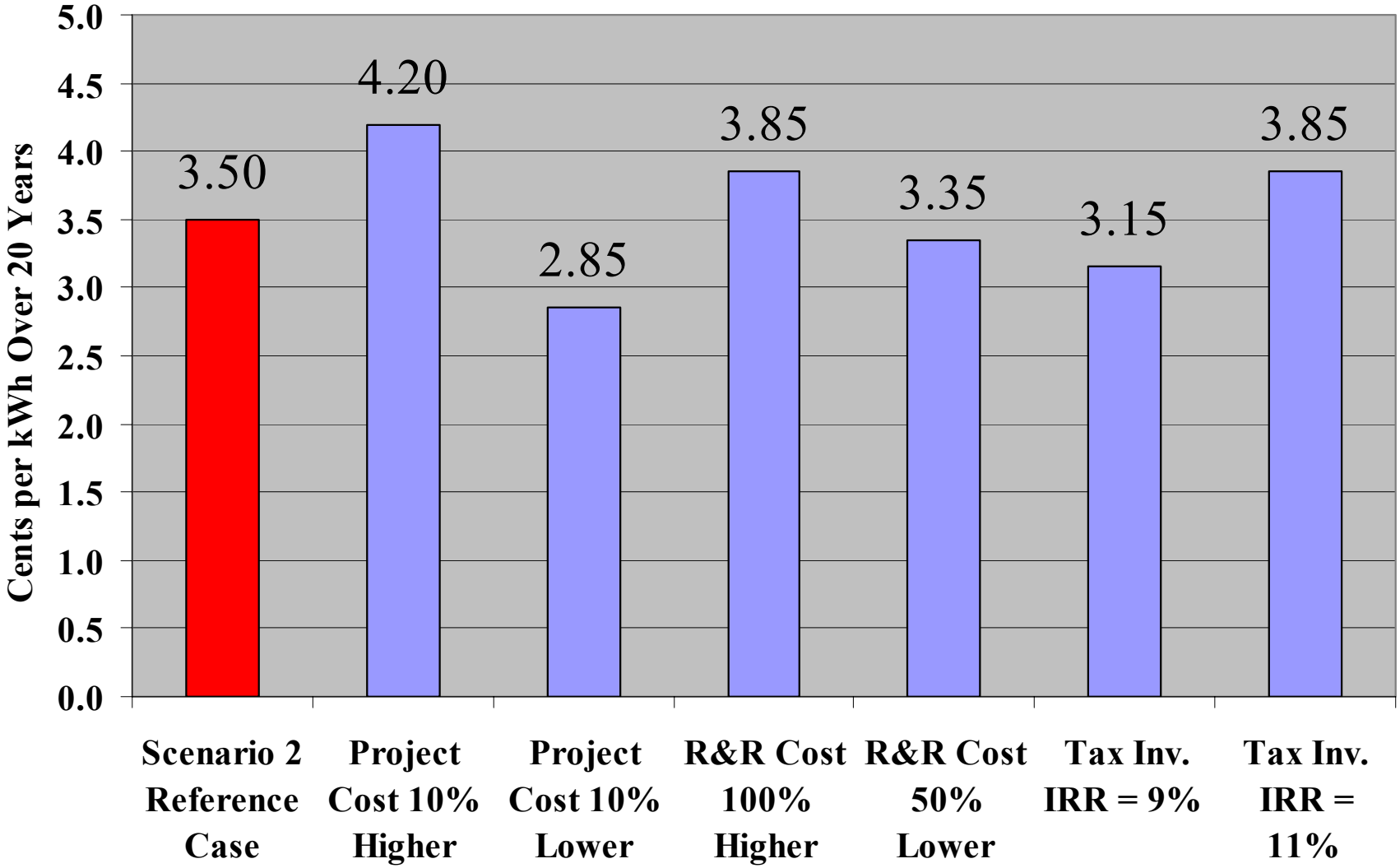
- Use Scenario 2 with the Iowa 1.5¢ per kWh Tradable State Tax Credit requiring revenue of 3.5¢ per kWh as the reference point
- How does the required revenue change for changes in:
  - Wind speed
  - Total project cost
  - Long-term R&R cost
  - Tax Investor required rate of return

Wind Speed Makes a Substantial Difference in the Required Revenue



Note: Changes in wind speed are based on 17.3 Mph at 50-meters for the Scenario 2.

Project Costs, Long-Term Repair and Replacement Costs and Investor Returns All Can Have a Significant Impact on the Revenue per kWh Needed



The Proforma Analysis Can Help Analyze Other Factors

- Adding another wind turbine to the project
- Moving a wind turbine to a different location with lower wake losses and longer electrical cables
- How the return to the local owner is affected by the subtleties of various contract terms
- How the flip date changes with various factors (for a guaranteed minimum return for the Tax Investor).

CREB Financing

- Clean Renewable Energy Bonds (“CREB”) provides an alternative to the old Renewable Energy Production Incentive (“REPI”) program for non-profit entities.
  - Congress budgets a small fraction of the full amount needed to make REPI equivalent to the federal PTC
- CREB provides zero percentage interest bond financing
- The term of the CREB bonds is based on interest rates and will typically be limited to about 15 years.

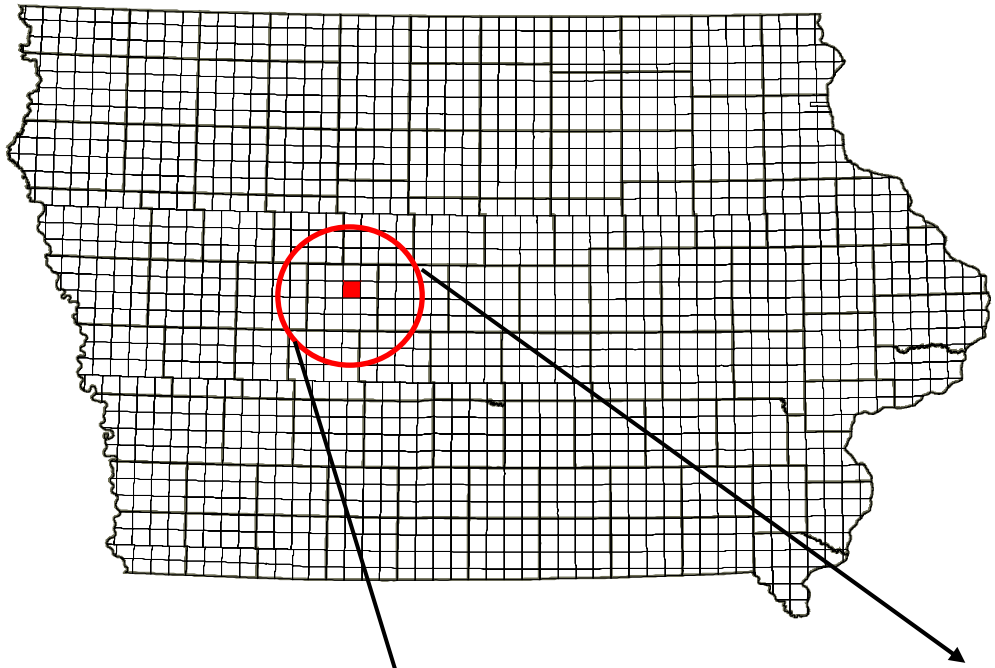
Comparison of Minnesota Flip Model Financing to CREB Financing

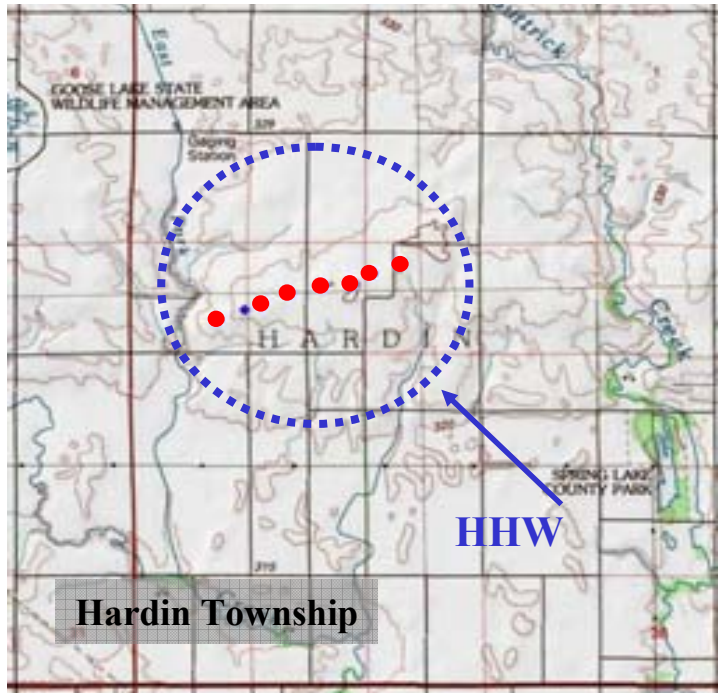
- Based on the Scenario 1 case, the minimum PPA needed for the project example was 4.80 ¢ per kWh
- For the same project owned by a non-profit entity and now financed with CREB bonds and no other grants or incentives, the 20-year levelized cost of wind power would be 3.6¢ per kWh, a savings of 1.2¢ per kWh
- Using CREB provides about the same benefit as the federal PTC and the Iowa 1.5¢ tax credit combined for this specific case
- CREB financing does not always provide the lowest delivered cost per kWh. It depends on several factors, such as wind speed.

Summary and Conclusions

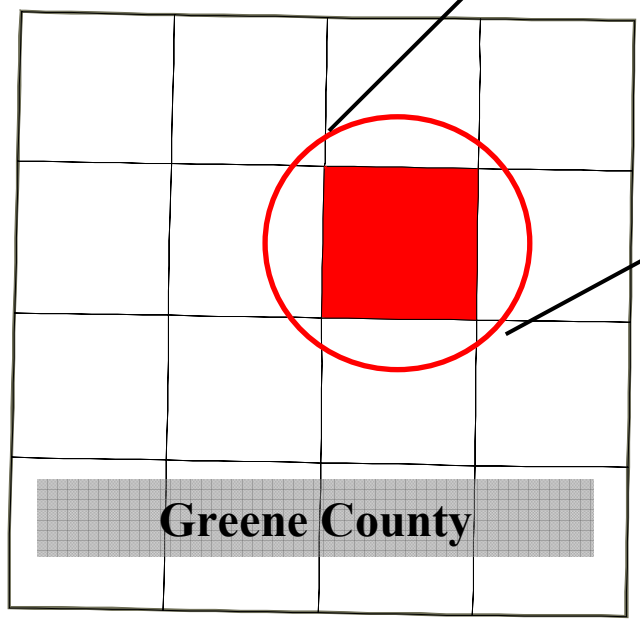
- A financial proforma is a very useful financial analysis tool for determining:
  - What minimum revenue per kWh is needed for a specific project
  - How changes in project layouts that affect costs and wind speeds affect project economics
  - How changes in financing assumptions affect the project economics
  - How uncertainties in wind speed will affect the returns to the investors
- CREB financing is an attractive alternative to replace the unreliable REPI program and can be competitive with the PTC in some cases.


Example of One Locally-Owned Wind Farm being Developed in Iowa
Photo by GE Wind - Storm Lake, Iowa





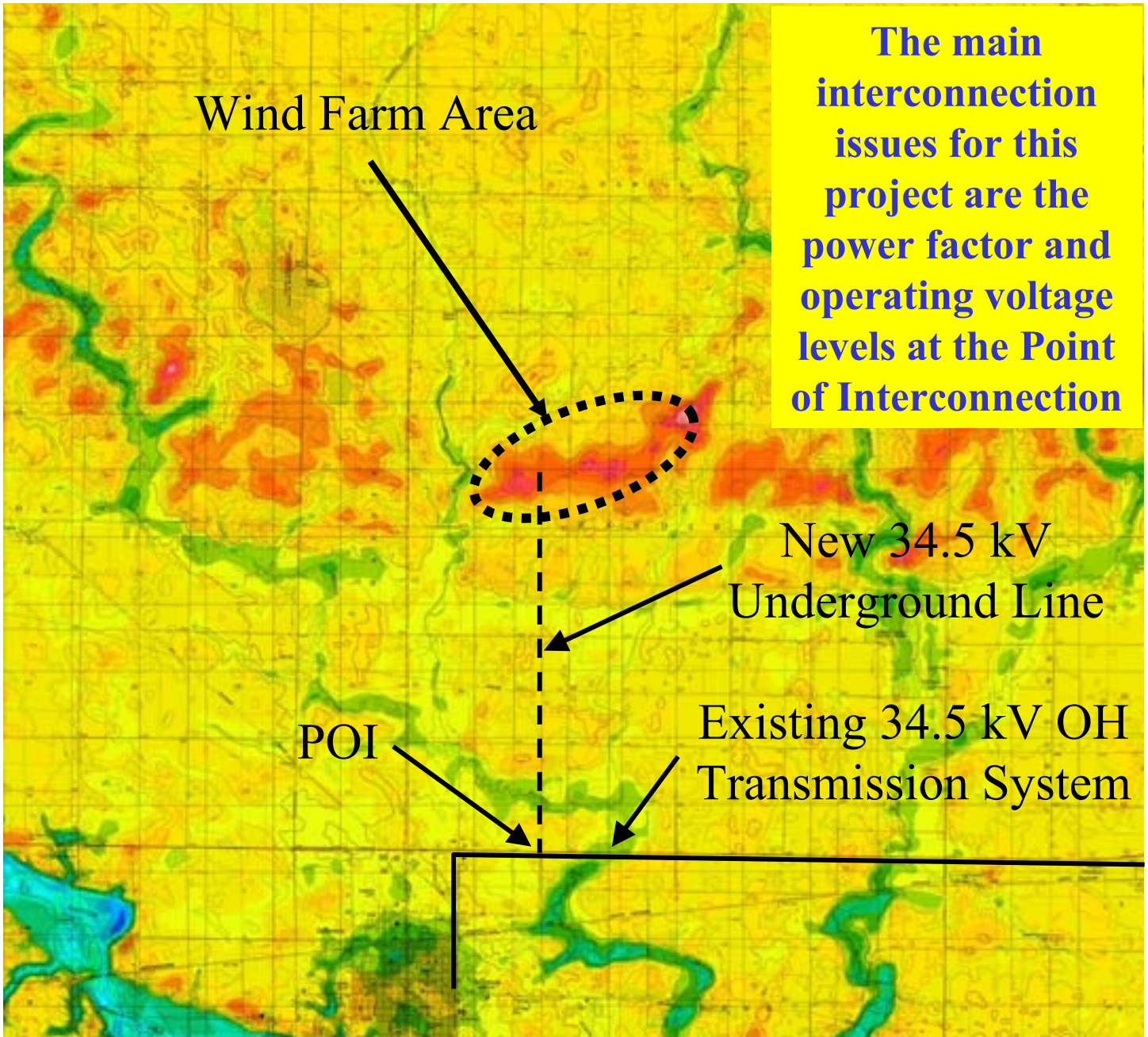
Locally-Owned Wind Farm being developed in Greene County, Iowa



Basic Information about Proposed Wind Farm

- Ownership structure based on Minnesota LLC Flip model
  - Ownership flips sometime after 10 years from Tax Investor to local owner when the Tax Investor achieves his target return
- Financing:
  - Tax Investor provides majority of capital
  - Local owners have received USDA Section 9006 grants averaging about $230,000 each
  - The LLC is borrowing $250,000 from a state revolving loan fund at zero % interest
  - The LLC will borrow some money from commercial banks
  - Local owners will have modest down payment
- Long-Term PPA is in 3.0-3.5¢ per kWh range with RECs
- Main challenge was finding wind turbines.

Wind Farm Interconnection

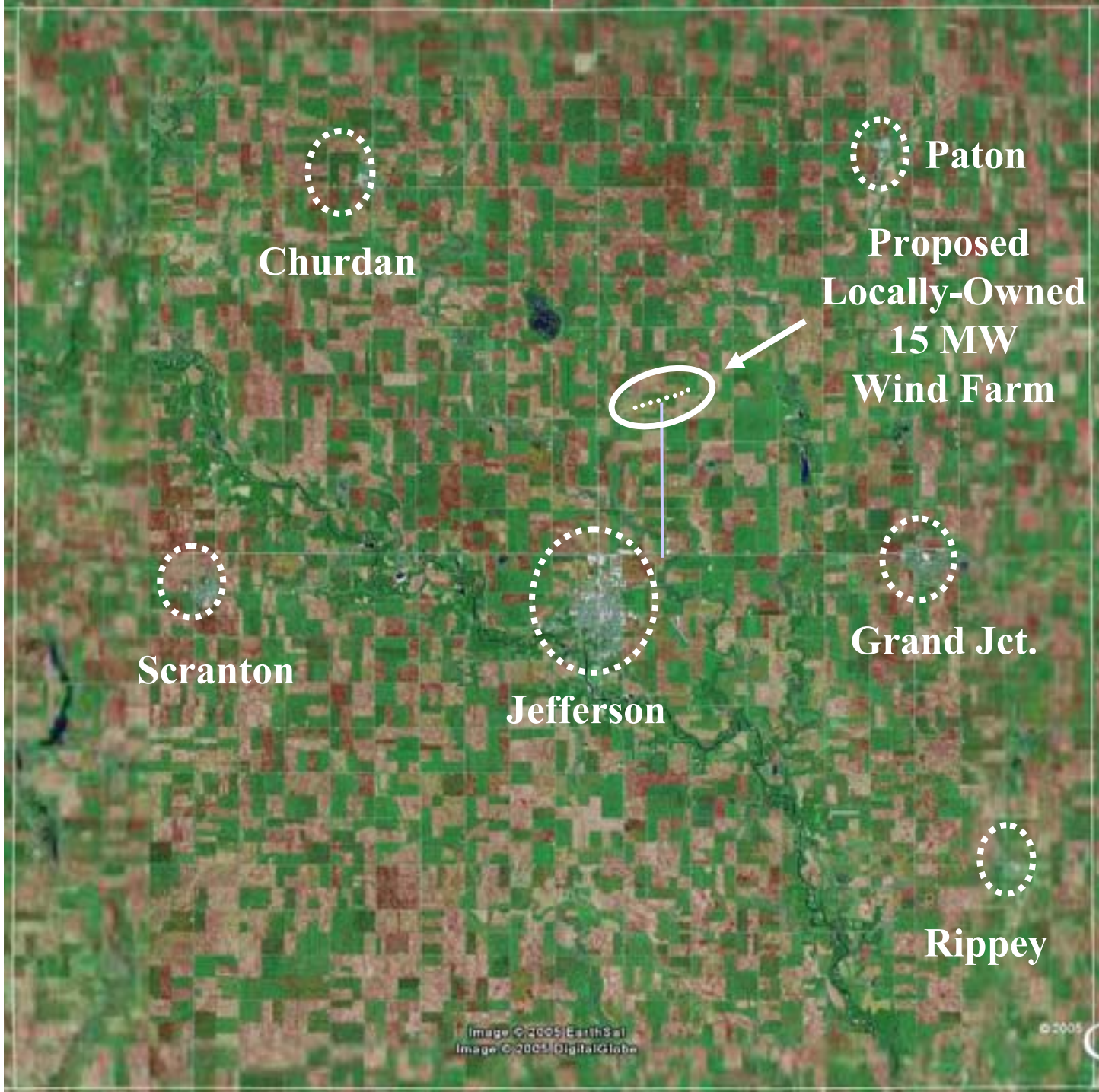


Mean Annual Wind Speed In Meters per Second at 50 Meters

Higher

Lower

- The proposed wind farm would generate about 47,000 megawatt-hours per year
- Jefferson uses about that same amount of energy per year
- The Proposed Wind Farm Will Be a Significant Supplier of Electricity to the County



- The 15 MW Locally-Owned Wind Farm Will Save the Equivalent of Enough Coal To Fill a Train 3 Miles Long <u>Every Year</u>