

Small Wind Farm Research at

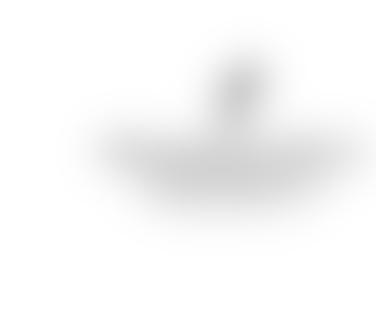
MSU

22 Nov 11

Dr. Vincent Winstead

Graduate Student: Ms. Priti Sood

Topics



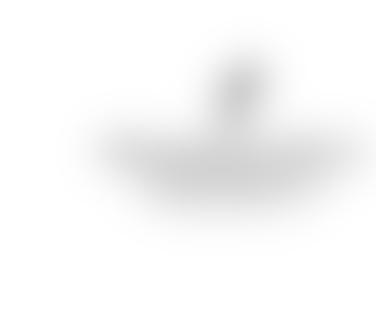
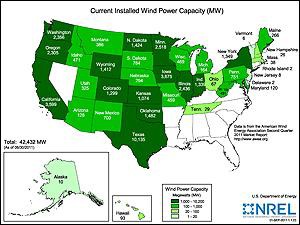
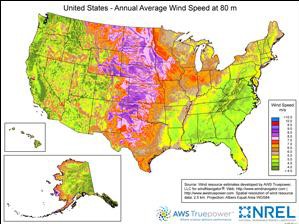
• Applied Small Wind Project

• Wind Farm Modeling

• Simulation Efforts

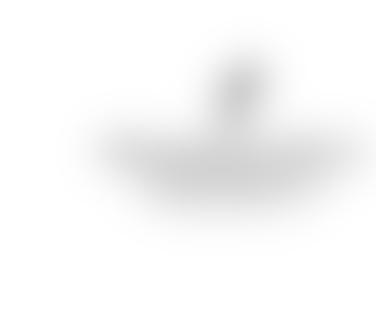
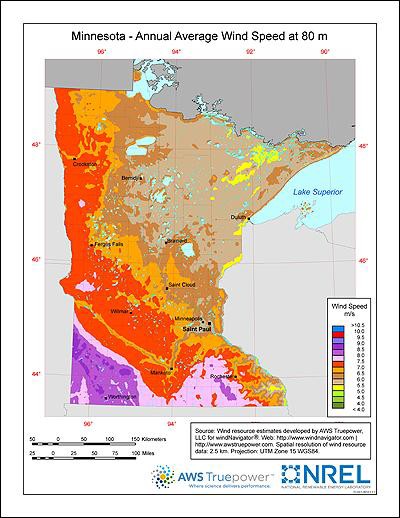
• On-going Studies

Motivation



From: [www.windpoweringamerica.gov](http://www.windpoweringamerica.gov/)

Motivation



• 2025 Energy Initiative

– 25% electrical energy via

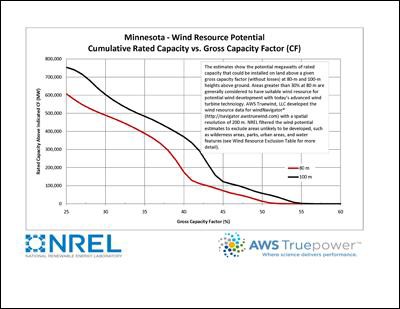
renewables by 2025

– How to get there?

• Minnesota is number 4 in installed wind in the U.S.

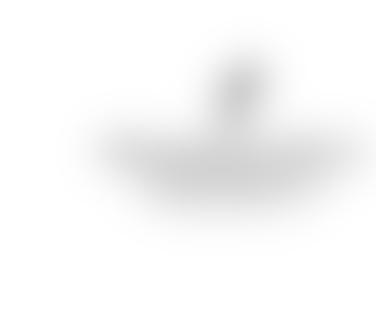
• What about residential

installations?



From: [www.windpoweringamerica.gov](http://www.windpoweringamerica.gov/) From: [www.windpoweringamerica.gov](http://www.windpoweringamerica.gov/)

Project Scope



• Small (Residential Scale) Wind Installations

using commercially available systems

• Questions to answer: What are…

– Costs associated with purchase, installation

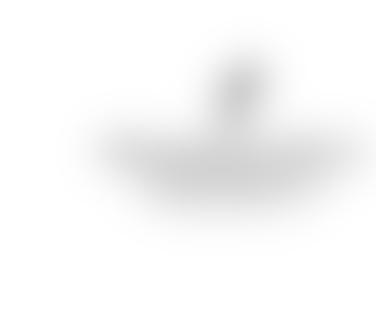
– Electrical code issues

– Maintenance requirements

– Performance capability vs. manufacturer data

• *Can the typically consumer benefit?*

Self-Imposed Constraints



• Roughly 2-3kW rated output

• U.S. manufacturer or distributor

• Some VAWTs (Vertical Axis) and some HAWTs

(Horizontal Axis)

PacWind – Delta I

Decision Process

Southwest Windpower – Skystream 3.7

Urban Green Energy - SAWT 3kW

Southwest Windpower – Whisper 500

WindMax 2kW (similar)

Southwest Windpower – Skystream 3.7

Urban Green Energy - SAWT 3kW

Abundant Renewable Energy – ARE 110

- PacWind becomes WePOWER

- WePOWER also markets SAWT turbines

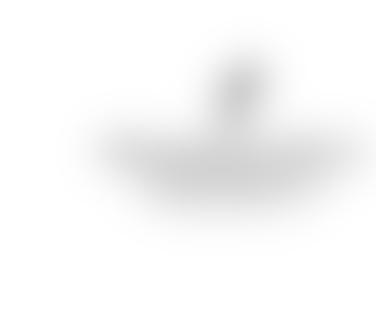
Helixwind S322

Southwest Windpower – Skystream 3.7

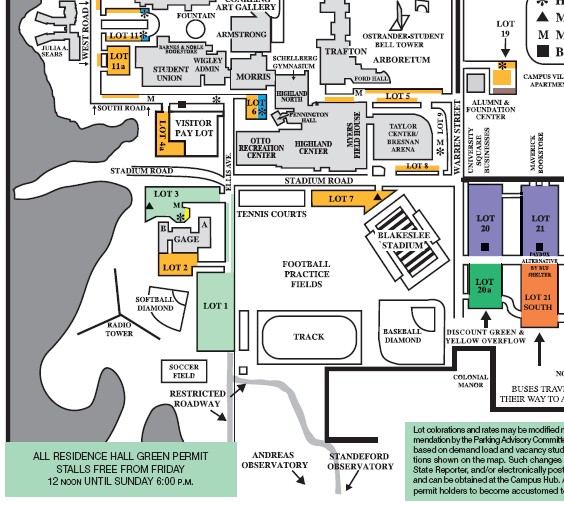
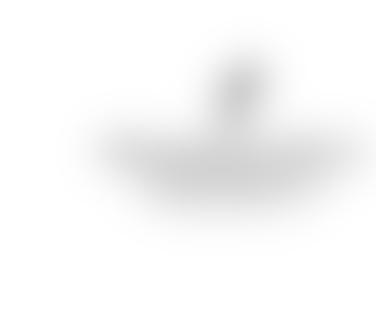
Urban Green Energy - SAWT 3kW

Abundant Renewable Energy – ARE 110

- Abundant Renewable Energy becomes XZERES Wind



Specifications



• SAWT 3kW – 3.3kW



rated

• ARE 110 – 2.5kW rated

• Skystream 3.7 – 1.9kW

rated (later 2.4kW)

• Helixwind S322 – 2.5kW



• Battery charging

– 48VDC pack

– Internal or

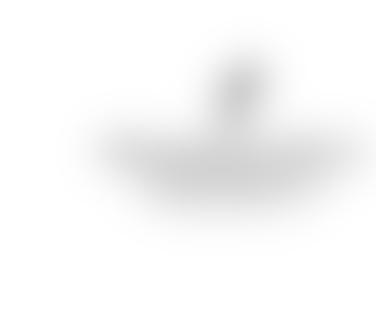
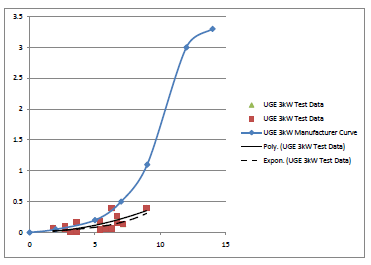
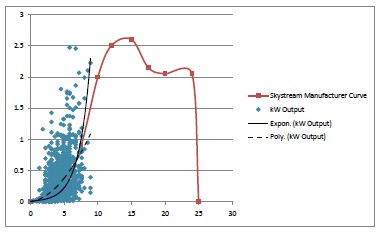
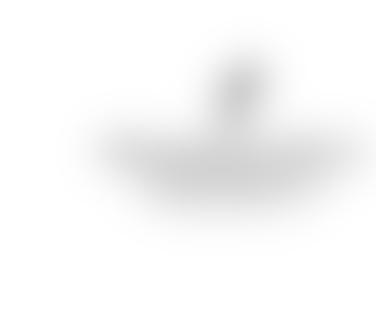
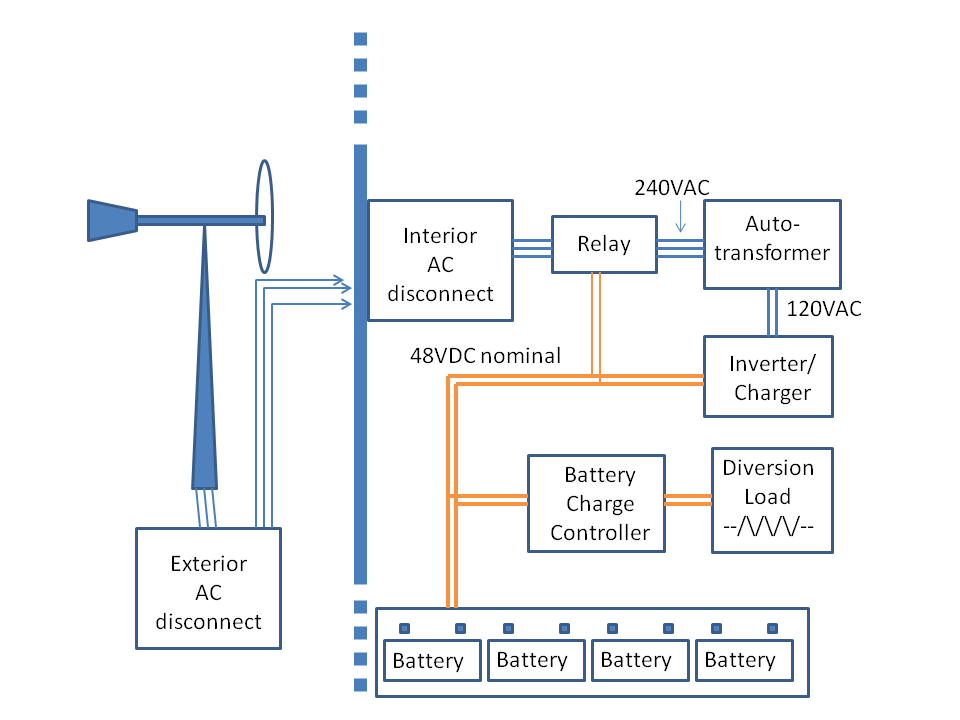
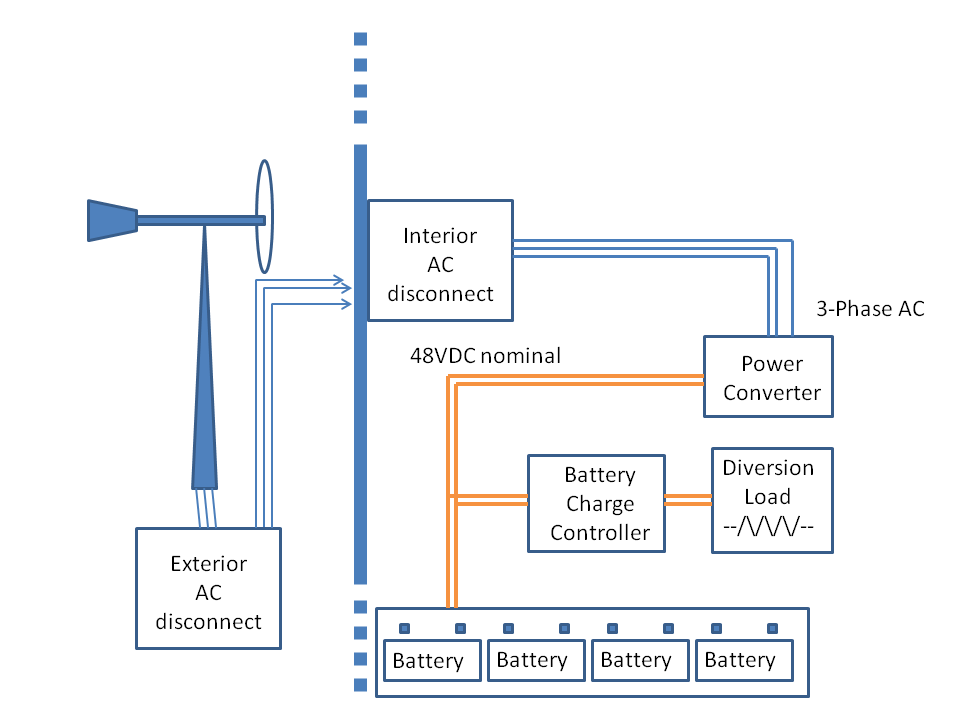
external rectifier

– Charge controller

– Grid isolated

– Diversion load

Configuration



*Southwest Windpower Skystream 3.7*

**18%** average MN

household demand

*UGE SAWT 3kW*

**3.3%** average MN

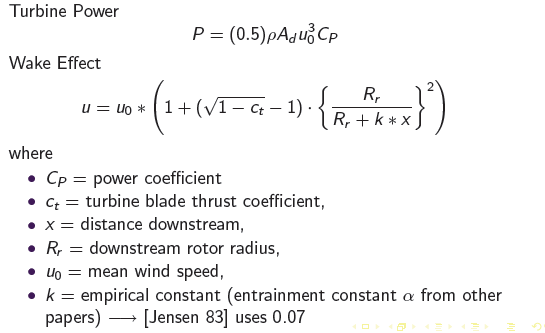
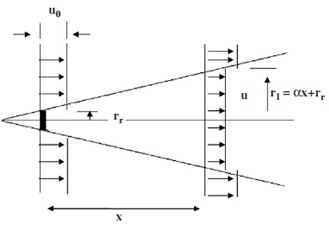
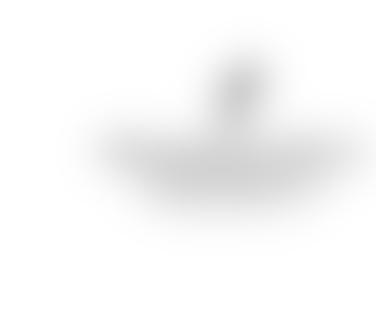
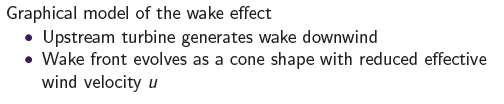
household demand

Results

Power law



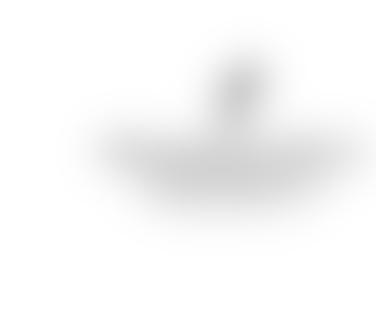
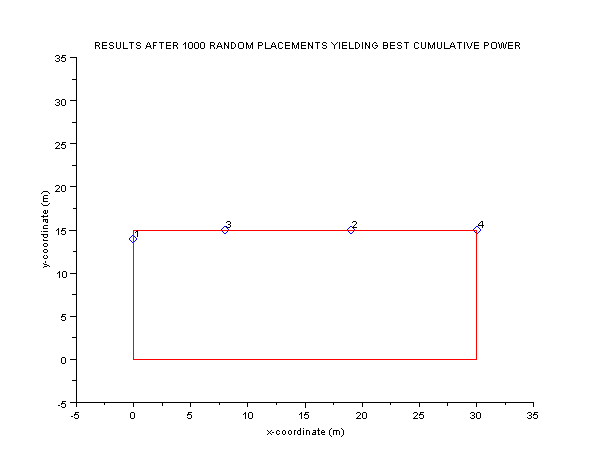
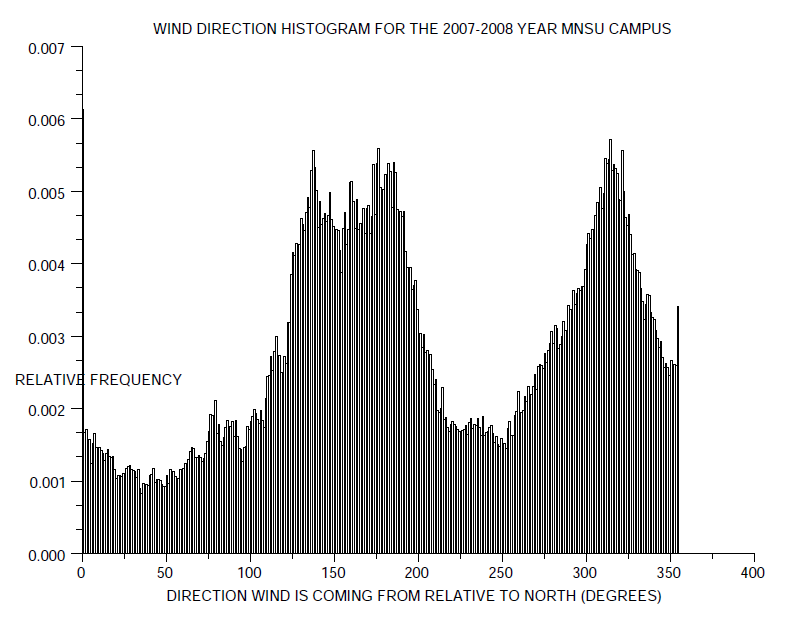
Modeling



• Modeling efforts based on manufacturer power curve,

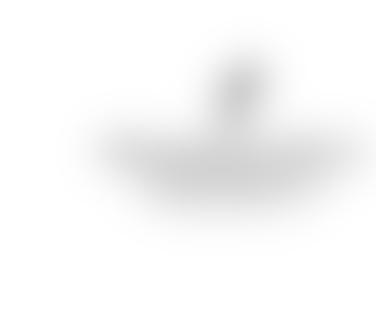
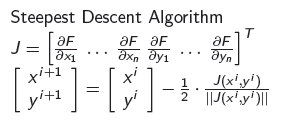
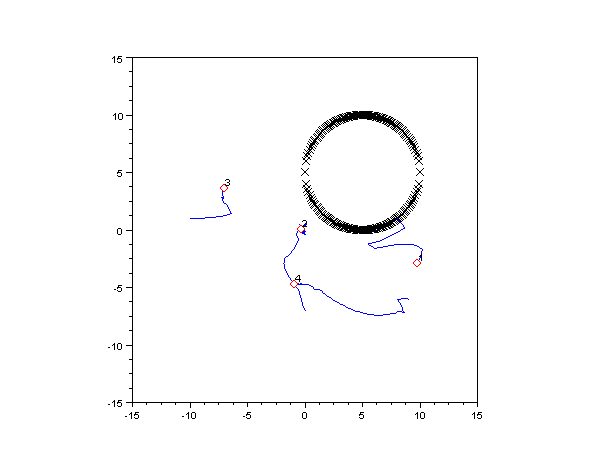
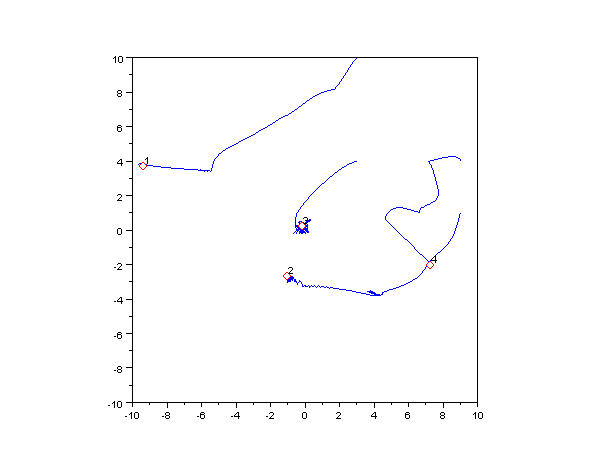
tower height, wind direction/speed and wake effect

Simulations



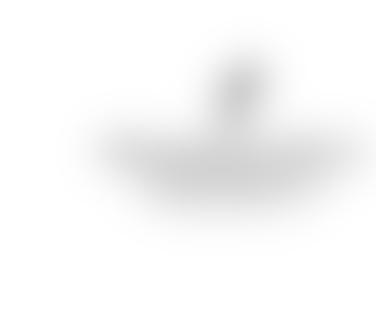
• Results of wind sensor data and Monte Carlo based turbine placement

Simulations



• Steepest descent algorithm driven by multi-criteria cost function

Next Steps



• Applied projects

– Helixwind S322 power converter

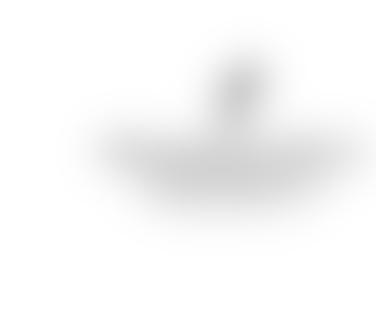
– Advanced power data acquisition (smart grid

capable)

• Simulation studies

– Convergence proofs

– Terrain/obstacle incorporation



Questions?