MINNESOTA STATE
Energy Center of Excellence

get into energy

Presentation to AURI Renewable Energy Roundtable

August 23, 2017

Who are we?

- Collaboration of 10 Minnesota State Colleges and Universities delivering Energy Education programs and research
- A first tier ranked program with the Center for Energy Workforce Development (CEWD) in Washington DC.
- Directly affiliated with the Minnesota Energy Consortium, an industry-driven group seeking to address the future workforce shortage across the energy industries.

Key Activity Areas

- Workforce Development: The right education and training to support the energy industry.
- Focus on Diversity of future workforce (local talent for local positions)
- Pipeline: Increased awareness of energy related career opportunities
- Research: Education and industry partnerships that advance research in energy related fields.
- Collaboration at national level with the Center for Energy Workforce Development.

Energy Trailer

- Complete 8 panel collector system with Inverter and 8 storage batteries
- Science kits on solar, wind and hydro energy, fuel cells
- Solar Pathfinders
- Literature
  - Representing colleges and industry partners

Minnesota State Energy Center of Excellence

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Minnesota State Project Team

Program Manager	• Bruce Peterson, MN State Energy Center
Project Manager	• Rose Patzer, MnWest CTC
Principal Investigators	• Dr. Matthew Julius, St. Cloud State University • Dr. Patrick Tebbe, MN State University, Mankato

System Office	• Mike McGee
General Counsel	• Sarah McGee
Facilities	• Greg Ewig

Xcel RDF Background

- Funded by Xcel Energy Ratepayers
- Established by 1994 Prairie Island legislation to support renewable electric energy development
- Entirely supported by Xcel Energy ratepayers
- Program activities and expenditures subject to approval by the MN Public Utilities Commission
- Program managed by Xcel Energy with input from the RDF Advisory Board
- www.xcelenergy.com/rdf
- Mn Statute 116C.779, subd. 1 (d)

Xcel RDF Block Grant

- Higher Education institution research projects (Block Grant)
  - 2012 Legislation (S.F. 2181)
    Higher education institutions located in Minnesota may apply for multiple research projects and be exempt from third-party review requirements if instead the institution provides for project evaluation and selection by a merit peer review grant system.
- Permits Xcel Energy to issue an RFP to higher education institutions located in Minnesota
- Multiple projects to stimulate research and development within Minnesota into renewable electric energy technologies

Xcel defined program activities

Eligible Program Activities	Ineligible Program Activities
Will conduct research on the following: ✓ **Renewable technologies** such as wind, hydro, electrical generation from biomass, electrical generation from biofuel, solar photovoltaics, and electrical generation from solar-electric. ✓ Alternative renewable energy technologies not identified above but that meet the **statutory definition** as a renewable energy technology or fuel type.	× Any research activity that has received, or is currently receiving, RDF funding awarded through **prior RDF funding cycles** will not be eligible for additional funding to support program activities. × Research that proposes to **displace electricity** use through energy conservation or demand-side management programs. × Solar thermal research, whose primary purpose is **producing heat**, for example solar thermal water heat.

Funding levels

- Minnesota State Institutions Block Grant totals $5.5 million.
  - This includes funds for grant management
- Maximum for an individual proposal is $750,000

Performance Review Criteria

- Increase the market penetration within the state of renewable electric energy resources at reasonable costs
- Promote the start-up, expansion or attraction of renewable electric energy projects and companies within the state
- Stimulate research and development within the state into renewable electric energy technologies
- Develop near-commercial and demonstration scale renewable electric projects or electric infrastructure delivery products if those projects enhance delivery of renewable electric energy.

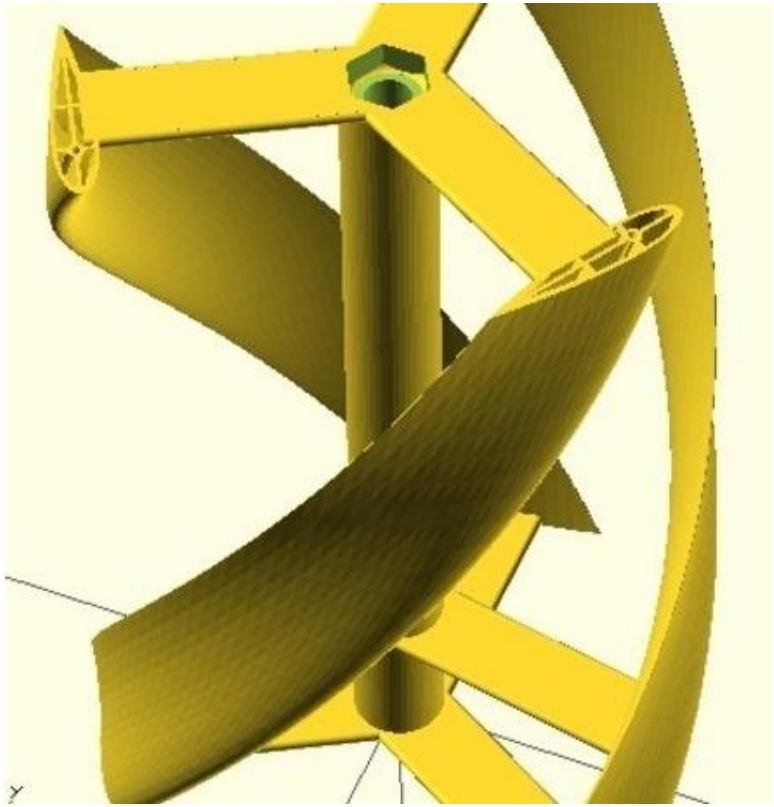
Improving Vertical Axis Wind Turbine (VAWT) Performance with Placement Strategies

Minnesota State University, Mankato

- Dr. Patrick A. Tebbe, P.E. (Mechanical Engineering)
- Dr. Namyong Lee (Mathematics)
- Dr. Nazli Yilmaz Wodzinski (Civil Engineering)

Executive Summary - Tebbe

Vertical axis wind turbines (VAWTs) offer advantages for small-scale electricity production particularly in regions not ideally suited to the more common horizontal axis wind turbines (HAWTs).

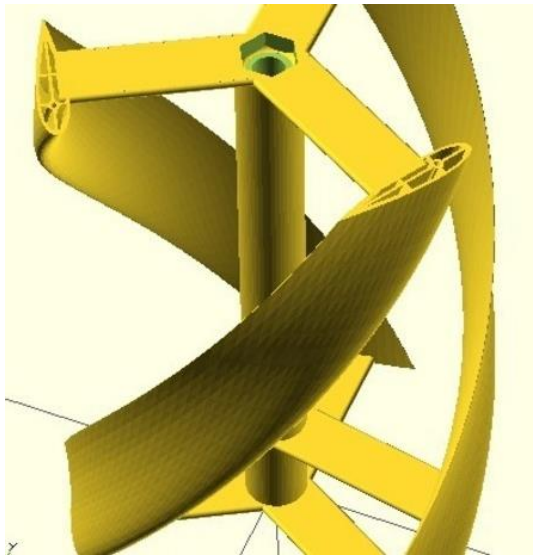


Executive Summary - Tebbe

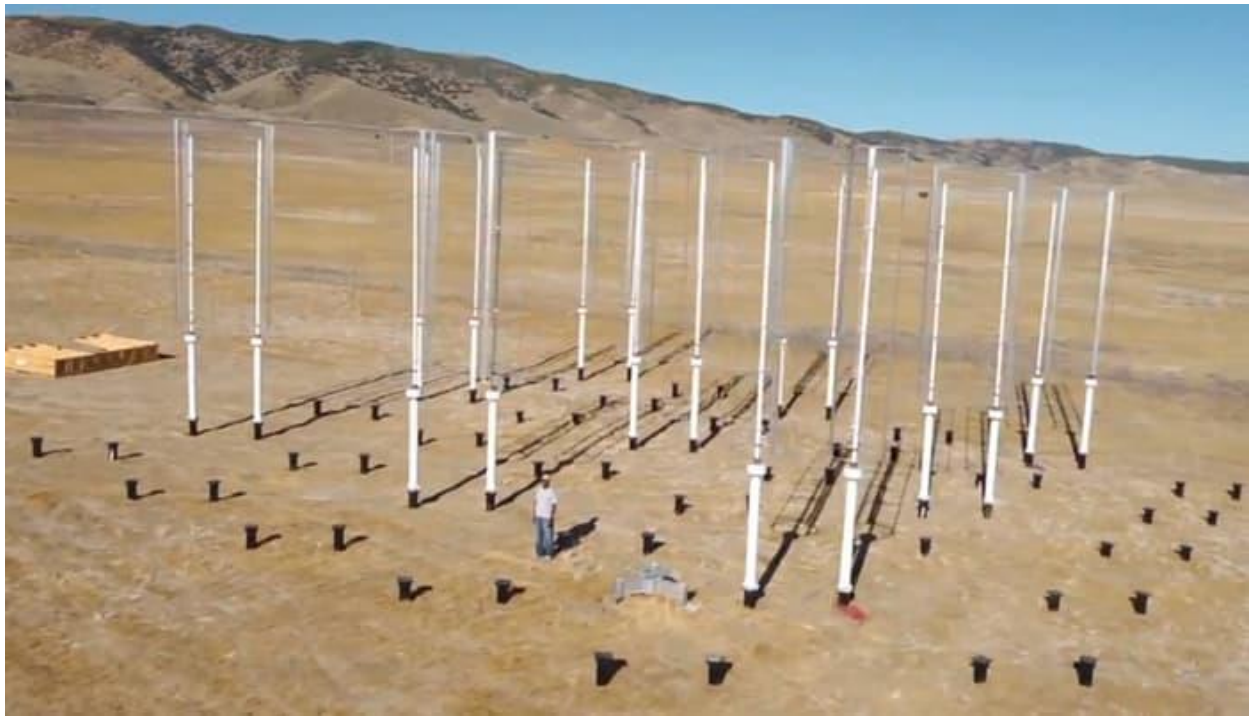
Goal 1: Create a simplified numerical placement tool for VAWTs.

Goal 2: Produce strategies for placement of VAWTs to improve performance and efficiency.

Goal 3: Determine areas of high potential for VAWTs in Minnesota.



Examples of VAWT Placements and Styles



•Renewable Development

• Fund (RDF) Grant Projects

Minnesota Renewable Energy Roundtable

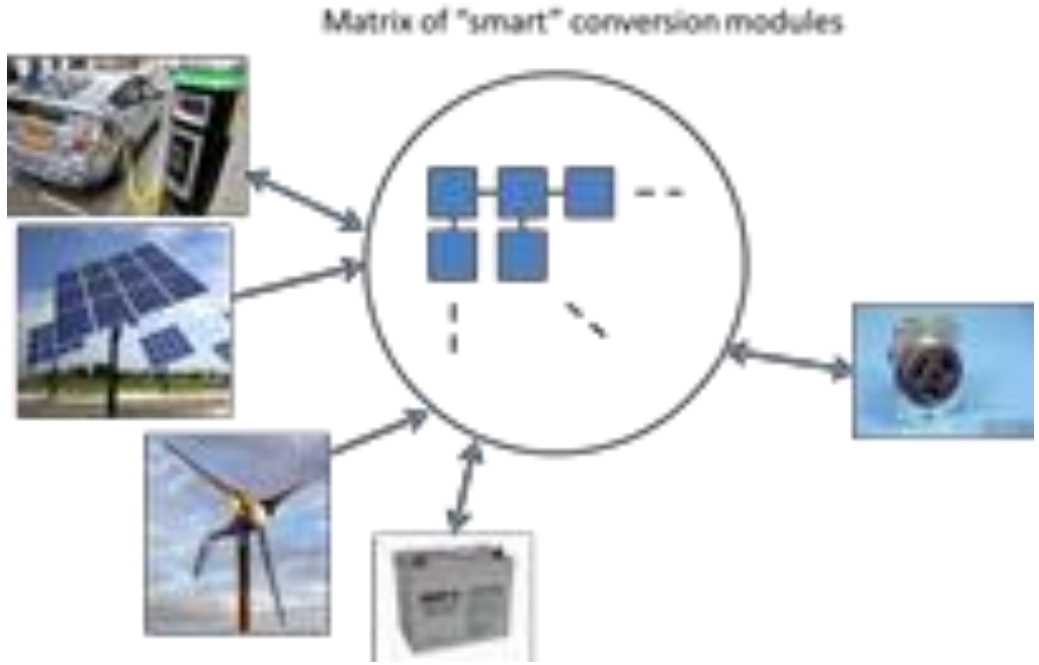
August 23rd, 2017

Presenter: Dr. Vincent Winstead

Minnesota State University, Mankato

Universal and Scalable Smart Grid Converter

- Awarded: ***January 2017***
- Project Timeline: ***January 9, 2017 – April 11, 2019***
- Outcomes
  - ***Flexible installation***
  - ***Fewer parts***
  - ***"Smart Grid" capable***



Universal and Scalable Smart Grid Converter

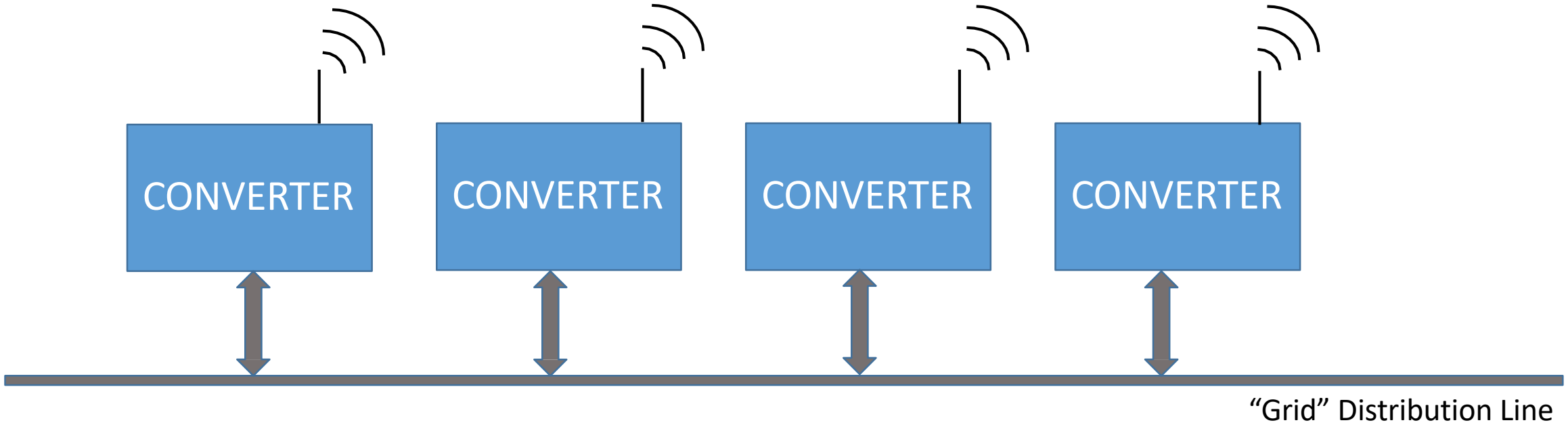
- Universal – concept intended to allow for either DC or AC sources at variable voltage and frequency

CONVERTER

~150VDC -> ~450VDC
Depending on manufacturer

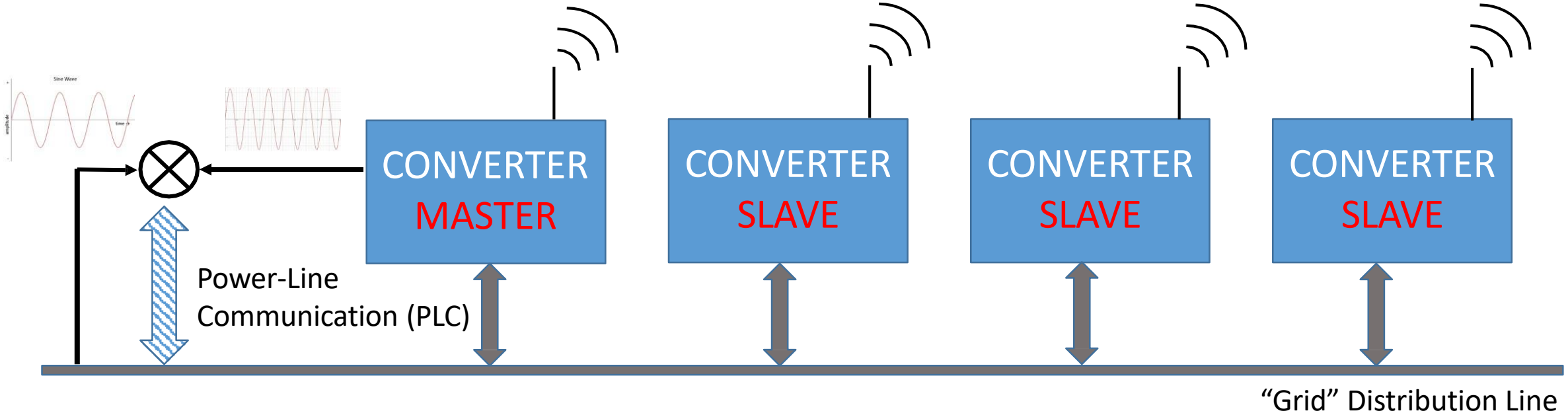
Universal and Scalable Smart Grid Converter

- Scalable – topology is based on connected network where one or more modules connected via wireless communication



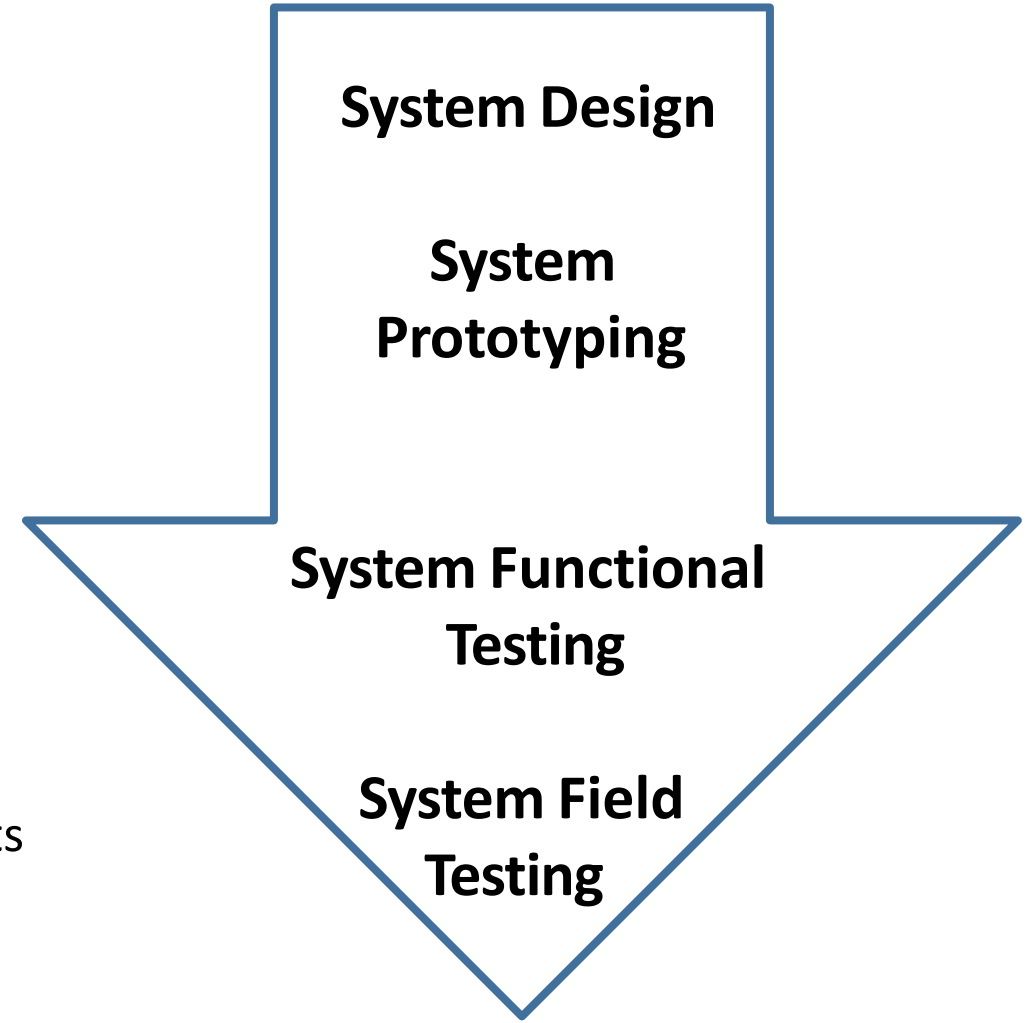
Universal and Scalable Smart Grid Converter

- Smart Grid – network topology also based on master/slave configuration where master device communicates status and power flow information from the network to/from the grid to the utility/co-op/other appropriate entity



Project Work Plan

- Two Principal Investigators (PIs)
  - Dr. Vince Winstead (MSU, Mankato)
    - Development of system specifications
    - Simulation of candidate topologies
    - Design and construction of prototype hardware and software
  - Mr. Steve Vietor (Riverland Community College, Albert Lea)- *SUB-CONTRACT*
    - Development of fixed wind and solar test assets
    - Development of two mobile electric vehicle assets

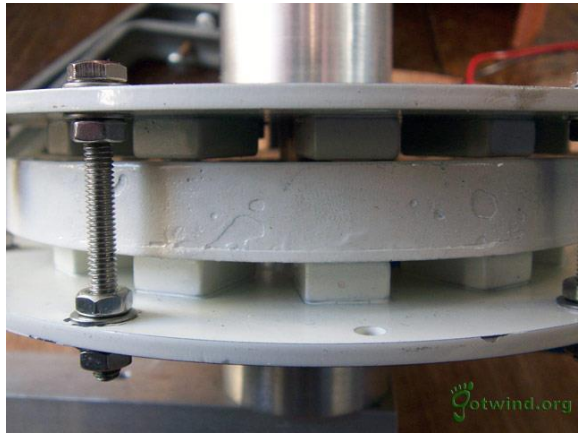


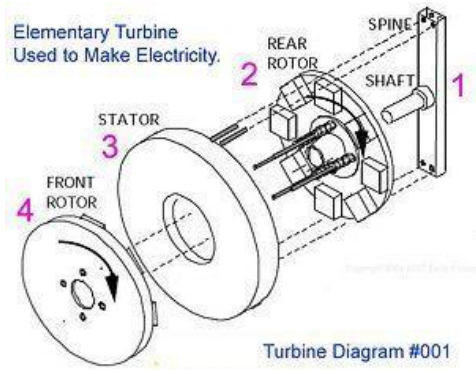
Project Progress

- Simulation and development work on-going at MSU, Mankato
- One (1) graduate assistant over the summer and three (3) graduate assistants starting this fall
- Anticipated first prototype including partial functionality by end of 2017
- Test asset development on-going
  - “Fixed” wind generation 50% complete
  - Mobile vehicle development partially complete
- Undergraduate assistants anticipated this fall at Riverland CC

Axial Flux Generator Improvements

- Awarded: ***September 2017***
- Project Timeline: ***September 1, 2017 – April 11, 2019***
- Outcomes
  - ***Integrated generator design***
  - ***Virtual Synchronous Generator (VSG) capable***
  - ***Improved "Grid" integration***





Axial Flux Generator Improvements

- Virtual Synchronous Generator (VSG)
  - Enhances ability of generator to interface with the “grid”
  - Enhanced “virtual” inertia
  - Integrated storage plus enhanced control

BIG inertia (i.e. tends to keep spinning as wind varies)

SMALL inertia (i.e. rotations fluctuate as wind varies)

Project Work Plan

- One Principal Investigator (PI)
  - Dr. Vince Winstead (MSU, Mankato)
    - Development of system specifications
    - Simulation and development of axial flux design with integrated storage and control
    - Construction and testing of prototypes
- Anticipated two (2) graduate assistants for duration of the project
- Anticipated multiple undergraduate assistants during the prototyping and testing stage

No waste:

Fine-tuning digesters’ microbiome to maximize biogas production.

Energy from waste

- Production of biogas from waste is a source of renewable and environmental friendly bioenergy.
- A diverse microbial community allows for the conversion of complex organic wastes into methane biogas.
- This community is sustained by a complex network of microorganisms cross-feeding and/or creating chemothermodynamic gradients.
- The consistency and stability of these digesting communities are critical for a stable energy supply.

As a result

we need to understand how mature microbial communities (microbiome) get established in the digester and their ability to react to disrupting external factors

Goal and objectives

Main goal of this project is to maximize biogas production by producing a mature microbial community stable in terms of output and easily manipulated through the modulation of the organic waste input.

Objectives

- Characterize initial microbial composition from the inoculate and the establishment of a mature microbial community.
- Characterize annual community patterning over a 1-year period.
- Experimental manipulation of input streams.

Expected outcomes

- Scientific/Operational Parameters
  - Composition of a stable microbial community producing efficiently biogas
  - Ideal composition of the input stream to maximize biogas
  - Best formulations of the input stream necessary to manipulate the digester's microbiome
  - Optimal initial inoculum for the digester
- Educational
  - Provide cross-disciplinary training to undergraduate and graduate students in microbiology, ecology, and environmental engineering.
- Economic and Environmental
  - Sale of renewable excess energy into the power grid
  - Nutrient recovery and management, thermal usage, bedding savings for farms, and carbon offsets
  - Digestate is a marketable and valuable soil amendment
- Intellectual Property
  - Metabolic model
  - Specific composition of the input streams
  - Digestate itself

Benefits to ratepayers

- Access to a clean and renewable form of energy
- Decreased cost for electricity
- Participation in an environmental friendly enterprise
- Awareness of helping the environment in terms of:
  - Smaller carbon footprint
  - Less use of land for waste disposal
  - Use of natural and environmental friendly digestate

Recycling of what would otherwise be waste would produce value added to the cost of energy

SCSU-1: Microbial Power and Bioproduct Production from Using Food Waste

- Dr. Matthew Julius, PhD
  - Professor of Biology
  - St Cloud State University

SCSU-1: Microbial Power and Bioproduct Production from Using Food Waste

- This work involves anaerobic digestion of food waste streams for energy production and the utilization of other digester outputs for production of high value algal biomass research. The scientific “heart” of this research will be focused on minimizing waste stream outputs from the anaerobic digester while simultaneously creating an additional revenue stream. Variations organic inputs should illicit changes in anaerobic digester outputs. Researchers working with these variations will track and evaluate digester products as part of a life cycle analysis, quantifying greenhouse gasses, nitrogen, and phosphorus. A model to optimize waste stream reduction and biomass profits will be developed using information from the life cycle analysis data.

SCSU-1: Microbial Power and Bioproduct Production from Using Food Waste

- **Task 1.0 Grow Target Taxa for use as an Inoculate**
- **Task 2.0 Build Four Replicate 10,000L Systems.**
- **Task 3.0 Preserve target algal cultures and sequence barcode genes (SSU, psbC, psaA)**

Century-1: Investigate Strategies to minimize Negative impacts of soiling on PV Panel efficiency

- Scott Randall, BSME
  - Solar and Renewable Energy Instructor
  - Century College

Century-1: Investigate Strategies to minimize Negative impacts of soiling on PV Panel efficiency

- Conduct a research study to investigate strategies to minimize the negative impacts of soiling on photovoltaic (PV) panel efficiency and reduce the cost-per-kilowatt hour of electricity produced within the context of Minnesota's mid-latitude, mid-continental climate

Century-1: Investigate Strategies to minimize Negative impacts of soiling on PV Panel efficiency

- Century will design and install a solar array
- Each panel in every row will either receive no treatment (soiling will be allowed to accumulate) or be exposed to selected study treatments
- Data regarding meteorological conditions will be collected continuously through a weather station located near the solar array.
- Data regarding the solar generation performance of each PV panel module will be collected on a continuous basis from an inverter and monitoring gateway located inside Century's Solar Lab. Data for each individual panel will include (a) power production, (b) energy production, (c) selected panels energy consumption related to solar panel heating to melt snow/ice, (d) voltage, and (e) current.

Questions?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