Minnesota Energy Consortium
Spring Meeting – April 6, 2021
Zoom 1:00 – 4:00 PM

Attending: 39

Rose Patzer welcomed the group attending. This meeting's format is different than our usual bi-annual meetings. Ten of our Xcel Energy Higher Education Block Grant projects will be presented. The presentations will be recorded (videos) by the PI's and posted to our website www.energycareersminnesota.com when they become available.

- Jianwu Zeng, Minnesota State University Mankato. ***"An Intelligent Wind/Solar Microgrid with Wide Bandgap Multiport Converter."*** This was a 3-year project. The two objectives were to design an intelligent microgrid system to efficiently integrate renewable energy to the grid as well as to design a multiport power converter for various forms of renewable energy and battery storage. The focus areas included new topology, new device, power management, and power decoupling control. Outcomes included the modeling, design and build of a four-port converter. A microgrid test bed was constructed using four converters and a multi-layer power management system was developed for the microgrid.

- Scott Randall, Century College. ***"Strategies to Minimize Negative Impacts of Soiling PF Panel Efficiency."*** Study to determine feasibility and frequency of cleaning solar panels? Effects of soiling on solar production. Built system to collect data for every solar panel on a daily basis. Create research projects for students to conduct research with 3-4 faculty and dozens of students. Research focused on methods to mitigate soiling on panels to increase production. Compare different tilts on panels. Separated two different analyses – warm weather conditions (deposits of dirt, dust, pollen, etc.), winter conditions (snow). These affect solar production. We were able to monitor kilowatt hours for each panel involved. Collected water after washing and saved the content to be analyzed. No significant difference between the two – cleaning panels had no effect on energy production. There was enough rain in MN during the warm weather months to clean the panels. In the winter – the panels were cleaned after each snowfall with a brush. Ice melts off quickly as panels warm. When snow accumulation exceeded 1", production ceased. 45 deg. = 1.25% difference between clean and unclean. 15.3% on 22.5-degree panel. Sun angle and shorter daylight affects winter energy accumulation. Conclusion: benefits of cleaning in warm weather season is negligible. Benefits of cleaning in winter are noticeable, but not worth the investment of time or money.

- Scott Randall, Century College. Continued work on energy trailers comprised of a small wind system (tower), 4 solar panels, and storage system (4-100 amp hour batteries). Provides a couple hours of stored power. Installed 4000 inverter. Intended to use the trailer for community events, training. One of the trailers is going to Mankato and Century will keep the other one. (Riverland CC actually started this project and Century completed them). These are available for others to use to advocate wind and solar energy. Contact Carol Hegna.

- Scott Randall, Century College. ***"Structures, Portability and Drone Applications."*** Ground-mount racking system built from local materials and pre-engineered. Would hold a single row of panels or a larger array. The drawings are complete and give examples for 60 and 72 cell panels. Allows people to build based on local components. Listed all the parts/components. Wasn't able to get it engineered – didn't want to do this when used in many locations. This will help consumers who don't have funds to hire an engineer. To

get a building permit must have documentation of structural engineering related to project. Liability is an issue. Standardized load tables would be helpful.

- Vince Winstead, Minnesota State University/Mankato. "***Universal and Scalable Smart Grid Power Converter."*** MSUM-1 Scope: Concept is to develop a box for a converter device that allows multiple devices to be connected. Most are specific to a task. Proposal to develop more flexibility as to the type of syncs – power to a charge, to a grid, etc. Handle power conversion of different types and bi-directional. Timeline: Jan. 2017 – April 2019 and was extended a couple times due to need for more time and then due to Covid. Project terminated in Nov. 2020. Outcomes: Flexible installation, fewer parts (uncomplicated), Smart Grid capable. Goals: flexible and scalable power conversion system, verify and validate. Also want to market this. System composed of multiple devices, connected in a communication network – seen as a single converter. Developed a second generation device prototype. Many students involved and active in research. Hope to continue some further developments on their own – integration of sub-systems.

- Jacob Swanson, Minnesota State University/Mankato. "***Microwave Plasma Gasification System: Alternative Biofuel Research."*** Existing gasification systems have low energy conversion of about 5%. Dry wood chips and certain nutshells work well, wood pellets, grasses not compatible with feedstock. Goals: to evaluate technical feasibility of an IC engine running on syngas generated by a microwave plasma system. Objectives: Take existing process and modify it – replace the thermal gasifier with microwave plasma system. Turn material into syn gas and determine which microwave geometry and engine configuration result in the highest overall conversion of biomass energy into electricity. 40 students worked on this project.

- Vince Winstead, Minnesota State University/Mankato. ***"Axial Flux Generator Improvement."*** MSUM-3. Design and axial flux generator to be used for small renewable energy generations. Large entities are usually stabilized. When smaller scale, typically don't have ability to be stabilized. Replicate functionality of inertial characteristic of large scale wind turbine. Mimicking of large inertia with supplemental power source. Test and validate prototype design. Axial flux designs were chosen because of their simplicity. Goal was to build a device and implement the control mechanism and synchronize that it could work as one system. Project started in 2017 and was extended to 2020. Used extensive 3-D printing. Results: Multi-model simulations, electrical simulations, and controller development.

- Patrick Tebbe, Minnesota State University/Mankato. ***"Improving Vertical Axis Wind Turbine Performance with Placement Strategies."*** VAWTS vs. HAWTS. Vertical turbine – goal to analyze small scale turbines and improve understanding of the flow fields around VAWTs and the impact on performance. The second goal was to develop a simplified potential flow software code and use the results to analyze flow field around buildings. Accomplishments and Results and Conclusions: Data was gathered on VAWT performance and regional wind resources. A 2D flow code was developed and tested. Performance improvement with increased turbulence could be studied in the future.

- Matthew Julius, St. Cloud State University. ***"Microbial Power and Bioproduct Production from Using Food Waste."*** Looking at hi-profitable bio-masses utilizing liquid waste from anaerobic digestion system to produce commercially viable biomass. Mitigate food waste from the college campus and put power back on the grid and use co-products to create biomass through an anaerobic digestion system. Digestate slurries from anaerobic digesters using multiple waste sources were evaluated for commercial microbial

growth. Sustained biomass growth was achieved with digestate and novel applications for this material were explored. An anaerobic digestion system is in place, not yet operational on campus. Plan to harvest invasive lake species to generate bio gas.

- Ryan Fink (Matthew Julius), St. Cloud State University. ***"Microbiome to Maximize Biogas Production."*** The issue of counting bacteria accurately which lead toward the objective of this project: Identify the composition and stability of microbial communities in anaerobic digestion systems. A manuscript was developed detailing the microbial community composition systems for inferences on a 'universal' inoculum that could be designed for optimal, maximum, or recovery of biogas production processes in failed anaerobic digestion or fermentation systems. This information will assist in fine tuning a digester's microbiome to maximize biogas production.

- Vince Winstead, Minnesota State Mankato. "***Integrated Renewable Generator Development."*** (This recording was not shared due to lack of time. It will be accessible on the Energy Center's new website once that is launched). There were two objectives for this project including the development of an inexpensive and rapidly deployed solar panel racking system allowing a consumer to deploy a small-scaled solar array without special skills and to integrate flexible solar cells into an existing wind turbine structure. The researchers were able to demonstrate that thin film solar cells could be integrated with wind turbines, but the final integration was not completed. Several racking systems were explored and built, but due to wear from weather elements, it was determined that the currently available commercial solar racking systems are the best choice for solar installations.