Proposal Participation in Portland State University (PSU) MME CAPSTONE Curriculum

Urban Wind Turbine Demonstration Project

PSU Facilities Department

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Summary Information

Title: Small, urban, rooftop wind turbine system with vibrational and noise mitigating apparatus

Subtitle: Polymer (or other material) mounting system for a small, urban, rooftop wind turbine

Category: Renewable energy industry

Intellectual Property: Oregon Wind

Year: 2009-2010

Sponsor Name: Kimberly (Kim) King, Oregon University System (OUS) & Oregon Wind

Sponsoring Advisors & Mentors: Kimberly (Kim) King, Denis Letourneau, Mike Aubry, Laurence Steigjer

Sponsor URL: http://www.kimgerly.com/resumes/kresume.html, http://www.ous.edu/, http://www.oregonwind.com/, http://www.silvercrestec.com/

Sponsor Information: Kimberly King is a Project Engineer and Post-taught MSc Graduate Renewable Energy Engineering (REE) Student at the Centre for Renewable Energy Systems Technology (CREST), which is affiliated with Loughborough University, UK. Her MSc thesis research focus is small wind applications in the built/urban environment. Her long-term interests are in hybrid renewable energy systems. She is also matriculating at PSU in the MME Department. She additionally conducts engineering research and analysis as a Renewable Energy Project Engineer for SilverCrest Energy and Automation.

The OUS's role is to offer support and invest in higher education by helping Oregon university campuses' efforts to achieve educational missions. The OUS has earmarked $50,000 in funding for an urban, rooftop small wind turbine demonstration project. The OUS Vice Chancellor has a mandate to implement, where OUS meets a target to produce 100% of all the campuses' energy via renewable energy resources as part of the OUS Climate Action Plan.

Denis Letourneau played a key role in the development of the ocean energy device, AquaBuOY, where he held the position of VP of Engineering at Finavera Renewables' Portland, OR, USA Headquarters. He is one of the designers of the Architectural Wind AVX1000 Wind Turbine, and currently manages the Advanced Technologies Group at AeroVironment, which also has a focus in building electric vehicle (EV) chargers.

"Oregon Wind is a small wind turbine developer based in Portland, OR. Oregon Wind is currently in the process of bringing its first product, the Revolution™, to market…Oregon Wind's commitment to sustainable, local manufacturing promises to make the Revolution™ "Urban Wind Turbine" the most sustainable turbine on the market." Mike Aubry, Project Manager and Technical Lead, Mechanical Engineer. Mike obtained his BSME from the University of Portland.

Laurence Steijger is an Electrical Engineer and Renewable Energy Engineer with extensive experience in instrumentation and controls design and engineering. Located in the Midlands of the UK, he currently holds the position of Lead Engineer at the consultancy Silvercrest Energy and Automation, which specializes in energy conservation, maximizing of resource efficiencies, system automation and integration. He also performs consultancy work at CREST.

Project History

Results from the Warwick Wind Trials (WWT) in the UK, which concluded in early 2009, yielded discouraging results. A deterrent to the fledging small wind industry includes a recent revelation about mechanical noise issues during the WWT in the UK. This was in part due to the fact that high-performing wind turbines (WTs) had to remain switched off for the majority of the trial following complaints about mechanical noise from the building residents. Noise levels were an unexpected issue at three of the trial sites. These sites were multiple occupancy, high-rise buildings. Two of these wind turbines are now permanently turned off due to a local environmental health officer stating that the wind turbines are now considered a statutory noise nuisance.

The small wind industry has been decreasing every year since 2002 in the USA. Opportunities can, however, exist for some small, urban wind turbine installations (WT) in a cityscape, provided the wind resource is adequate and the mounting location(s) of the WTs are properly sited in the prevailing wind direction.

These new revelations about noise issues could further compromise the small wind industry. This noise nuisance, however, could be lessened, and perhaps be mitigated if care and foresight is adequately investigated early on in the design process on pre-existing and new structures. A more prudent manner to investigate opportunities to reduce noise might warrant investigating the air borne problems (rotational speed, blade tip speed), since the tip of the blades and relative speed in the air is where most of the noise is created. These noise problems may not be necessarily corrected by damping the WT with a mounting mechanism, but a mounting apparatus might help reduce the transmitted vibrations created by the wind turbine.

Scope of Work

The scope of this project is to design, build and install a rooftop, stand-alone mounting system comprised of a polymer (or other appropriate material) and concrete foundation. In tandem, this project requires designing and installing (an) urban wind turbine(s). The mounting system for the urban, rooftop, small wind turbine (WT) will act as a load distribution mount, and a mechanical acoustic noise, dampening medium. The final design must employ a flexible, durable, modular mechanism that allows swapping-out of dampening blocks. It must also be comprised of dampening blocks formed out of a polymer (or other appropriate material) that may be affected to wear from changes in the seasonal weather patterns. The design must also include instrumentation that will measure loads and noise imparted to the dampening blocks. Additionally, a performance monitoring system on the building integrated WT installation will measure and monitor the energy from sensors placed on the WTs. The final design must also include a web site interface that displays real-time data.

NB: It is assumed this installation will be a rooftop installation.

The scope of this project has three phases.

Phase 1 – Design Process [Fall Quarter 2009]

Design methodologies will be discussed as a framework for solving broadly defined technology problems. Interdisciplinary organizational principles will be presented as tools in the design process and as a foundation for subsequent project course, these include:

- Becoming familiar with the Oregon Wind Revolution™ Wind Turbine.
- Researching polymers and other materials that might act as suitable noise dampening agents for a mounted, small, rooftop wind turbine.
- Investigating the building structural load limitations/challenges as per the Oregon Wind Revolution™ Wind Turbine.
- Investigating structural mounting requirements/limitations based on roof composition and mounting hardware for the Oregon Wind Revolution™ Wind Turbine.
- Investigating instrumentation that can be utilized to measure loads contributing to noise issues.

Phase 2 – Conceptual Design Project [Winter Quarter 2010]

With a broadly defined design project, students work in groups of three to five under supervision of a faculty advisor and an industrial advisor. The interdisciplinary student team comprised of mechanical engineers, electrical engineers and computer engineers/scientists develops conceptual design solutions for their project, evaluating the conceptual designs and choosing one to pursue in detail. The design process encompasses engineering analysis and broader factors, such as group organization, interdisciplinary interaction and communication. Specifically, these tasks include the following:

- Designing the polymer dampening agent(s) to facilitate mitigating prospective mechanical noise issue for the Oregon Wind Revolution™ Wind Turbine.
- Designing a mechanism and a flexible, durable, modular polymer (or other appropriate material) dampening 'blocks' that can be swapped-out based on wear due to changes in seasonal weather patterns.
- Design the concrete mounting foundation.
- Design the electrical instrumentation and select sensors that will measure loads contributing to noise issues.
- Design or select data acquisition, monitoring and reporting hardware and software to monitor loads which may contribute to noise issues e.g. but not all, due to time constraints, aerodynamic, gravitational, inertial, operating loads (generator, brakes, yaw), extreme loads (wind gusts), tower shadow.

- Select sensors for the wind turbine that will measure average wind speed, wind direction and temperature. This system is comprised of five major constituents:
  - Controls hardware
  - Weather Station hardware – HOBOWare, vertical anemometers or equivalent
  - A Data Acquisition System (DAS) e.g. Campbell Scientific Units, HOBOWare or equivalent
  - A dedicated personal computer
  - Monitoring Software – wind turbine manufacturer software, Fat Spaniel, Lucid Design Group or equivalent
- Build back-bone web interface.
    - Project URL: [We could ask the PSU CAT to provide us with a location where we could park a WordPress web site, install a PHP/MySQL back end for managing data logged and to monitor the project timeline/progression, and eventually the web interface for the reporting system]

Phase 3 – Detailed Design Project [Spring Quarter 2010]

The detailed design for the conceptual design chosen in the Conceptual Design Phase is completed. Students are expected to verify that the final design meets the objectives specified at the beginning of the Conceptual Design Phase. Ideally the design is fabricated and tested. The particulars include:

- Installing the concrete foundation and mounting apparatus.
- Installing the wind turbine(s).
- Installing sensors, data acquisition, monitoring and reporting systems on the mounting apparatus and the wind turbine(s).
- Testing and tuning the systems.
- Commence data acquisition, monitoring and reporting via the web interface.

Other Information

Disciplines

- Mechanical Engineering
- Materials Engineering/Science
- Computer Science/Engineering
- Systems Engineering
- Civil Engineering

Skills

- Fluid Mechanics
- Mechanics of Materials
- Mechanical Design
- Civil Engineering
- Instrumentation design, integration with data loggers
- SolidWorks/3D CAD
- Computer Programming
- Basic web skills i.e. HTML, graphics manipulation, video streaming. A student with skills in coding PHP/MySQL would be ideal.

Additional Resources

- Access to a team of seasoned engineering mentors from the small wind industry and international consortiums (tentative on the latter) specializing in renewable energy systems research.

Contact Information

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