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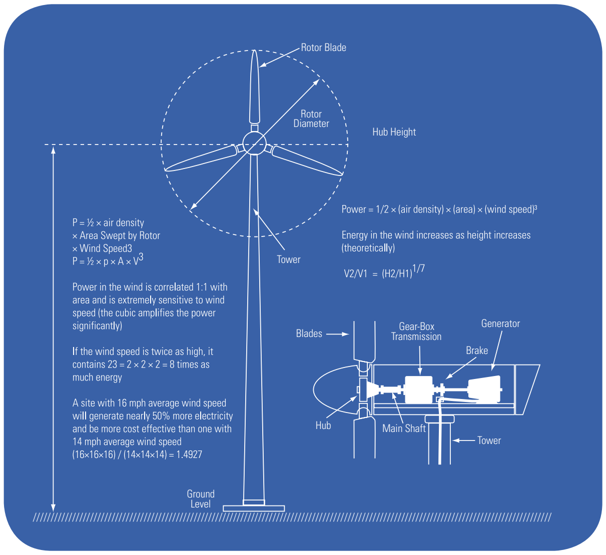
Analysis of Wind Turbine Controls to Increase Efficiency

Project Description:

Control systems for wind turbines become more important as turbine size increases. Developing more sophisticated controls is essential for optimizing turbine efficiency and performance, as well as extending equipment life. Global Energy Concepts, LLC developed a tool that translates the effects of a turbine's rotating blades into a linear model. This tool helps researchers and designers in the development of new wind turbine controls.



Benefits:

- Stimulate research and development: A linear model assists in designing controls that will increase efficiency and reduce equipment stress of wind turbines.
- Increase market penetration: Controlling turbine performance more accurately reduces production costs.
- Decrease maintenance costs: Reduced wind turbine stress prolongs equipment life and lowers maintenance.

Methodology:

GEC used the ADAMS model, a general stimulation software from MSC Software, for the basis of their work. ADAMS is a flexible tool for analyzing the structural dynamics of wind turbines. However, researchers and designers have had difficulty using the model to develop control systems, since it does not readily support algorithm designs of the controls. GEC had to create custom subroutines that included rotational and aerodynamic effects in order for the ADAMS model to be applicable to wind turbines.

Grantee: Global Energy Concepts, LLC, Seattle, Wash.
Web site: globalenergyconcepts.com
Additional Team Members: MSC Software, Santa Ana, Calif.
Project Dates: 2002-2003
RDF Funding Cycle: 1
Project Funding: $73,239
Project ID: CW-02
RDF Mission: To increase renewable energy market penetration, assist renewable energy projects and companies, and support emerging renewable energy technology through research and development.
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The project was divided into two phases:

1. GEC developed a simple model of a wind turbine that assumed both blades and tower are rigid bodies. Methods for incorporating the effects of rotation and aerodynamics were developed and validated.

2. These methods were applied to complex wind turbine models that included flexible blades and non-rigid towers. These models considered the blades and the tower as separate parts of the system, each with its own mass and inertia.

Objective:

- Develop a fitting model: The methods and software used to design wind turbine controls is based on physics and mathematical structures. Create a realistic model that integrates with these systems requires a high level of complexity.

- Establish a linear model: Traditional models that incorporate the structure and aerodynamics of a wind turbine are non-linear whereas the design of control systems require a linear model.

- Performance Optimization: Using a control system that reduces stress on the turbines components is an important element in improving overall performance. As turbine size increases, system stress assumes a greater role in performance, maintenance and equipment.

Outcome and Lessons Learned:

The results were used to create a model by comparing the simple model from phase one with the full non-linear ADAMS simulation. Comparisons were made between blade pitch response, turbine rotor speed, wind speed, generator torque, and tower motion to changes in blade position. There was a close relationship between the two models, meaning a less complex phase one model can serve as well as the full nonlinear ADAMS model for the development of wind turbine control systems.

Executive Summary:

A tool that creates linear ADAMS models for wind turbines, specifically incorporating rotational and aerodynamic inherent to large wind turbines was developed. This addition to the ADAMS toolbox can help in the development of better control designs for wind turbines with visible real-world effects.

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09-07-205 07/2009