Wind Turbines

Presented by the West Lafayette Wind Crew

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Problem Statement

With wind energy projected to contribute 20% of the world’s renewable energy market by 2030 we must use a more quiet, efficient, durable, cost effective, and environmentally friendly way to convert wind to electricity.

Projected growth in electricity consumption by 2030: 50%
Aerodynamics Lab Experiment

- Experiment was conducted to understand the relationship of angle of attack and speed to the lift generated for a wing section in a wind tunnel
- Carried out flow visualization experiments with dye over a wing section and other objects like sphere and cylinder
- Used a program designed by a PhD student Zachary Adams to find an optimum configuration for the orientation of blade in a vertical axis wind turbine

Model of wind tunnel

Program used to project efficiency of Vertical Axis Wind Turbines
Aerodynamics

Horizontal Axis Wind Turbine
- Drag depends on angle (pitch)
- Larger angles are rarely used
- Creates more pressure
- Causes ends to curl
- Leading edge creates most
- Airfoil shoulder

Vertical Axis Wind Turbine
- Pitch constantly changes, making it hard to model
- Efficiency can be boosted by placing the turbines close to each other because the displaced air of the blades increases drag for the blades of nearby turbines
- Uses drag from the wind to create energy
Applications and Output

**Horizontal:**
- Best in large, remote installations, for feeding into the grid
- Require a large, open area to operate at maximum efficiency
- Best operate in areas with constant wind direction
- Average turbine produces 2.5-3.5 megawatts

**Vertical:**
- Best in private installations for residential usage
- Need little area to run
- Can operate in irregular winds, but such changes cut down on efficiency
- Average turbine produces 500-1000 watts
Cost and Maintenance

Horizontal Axis Wind Turbines
- Operation and maintenance costs are 10 - 35% of the cost of the turbine
- Maintenance is costly and complicated

Vertical Axis Wind Turbines
- Cheaper to manufacture
- Secondary costs total 15-30%
- Low storm damage
- Cheaper maintenance
- $10,500 - $17,500
- 1,962 - 3,362 kW hr / yr
Environmental Effects

- Old blades are dumped in landfills
- Cement factories reuse the old blades
- Vertical and Horizontal blades give off zero emissions
- Made of Glass Reinforced Fiber Plastic or Carbon Fiber
- Noise of Vertical Turbines compared to Horizontal turbines
- Birds and Bats can get caught in Horizontal turbines much easier
- Windmills can harbor poisonous snakes
Policy Questions

- Wind power of Indiana compared to other countries
- Growth of wind power compared to other renewable energy sources
- Future of wind power
- "Not In My Backyard" Politics

Amount of wind power in 1997

Amount of wind power in 2013
Social Impact

Horizontal Turbine
- Block the view
- Also blocks radar and telecommunications (less of a concern in developing nations)
- High short term employment
- More energy for use

Vertical Turbines
- Does not block radar or telecommunications
- Does not block view
- Small market (small market = little employment)
- Energy for single homes and small villages (developing nations)
Thank You Duke Energy Academy at Purdue!
References


