Engineering Wind Parks

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Outline

- Introduction and definitions
- Taxonomy of engineering problems
- Wind farm design
- Wind farm operations
- Role of data
- Emerging tools

Why Optimize Performance?

1% (4MW) power loss at a 400 MW wind park translates into $1M revenue loss

Gerrad Hassan Corporation 2007

Note
1MW of energy powers 225-300 households

Definition

Capacity factor

Capacity factor =
Ratio of the actual amount (MW) of power produced over a year the power that would have been produced if turbine operated at maximum output 100% during the same time

Conventional power plant: 40% to 80% capacity factor
Wind turbine: 25% to 42%, though turbines typically operate 65% to 98% of the time

Note
- ✓ A 60-80% capacity factor possible with a large rotor and a small generator
- ✓ Turbine are designed to maximize return on investments from electricity production

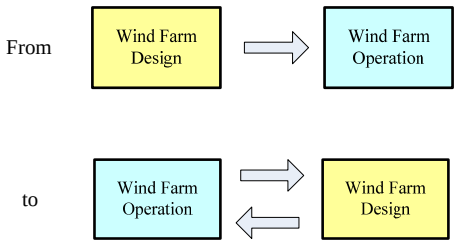
Availability Factor

Availability factor

Availability factor (availability): The percentage of time that a turbine (park) is ready to generate energy (i.e., not out of service for maintenance or repairs)

- ✓ Availability reflects the reliability of a wind turbine (or a wind park)
- ✓ Modern wind turbines have an availability of more than 98% - better than most of classical power plants

Park Design and Operations



Engineering Research and Practice Problems

- ✓ Design
  - Wind farm site selection
  - Turbine selection
  - Wind farm layout optimization
- ✓ Operations
  - Power output management
  - Power output prediction
  - Condition monitoring and maintenance
  - Fault detection and avoidance
  - Performance optimization

We Want to Be Here

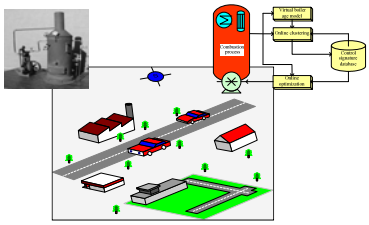
Living Industrial Laboratory

Data

Virtual Laboratory

What is Common?

Industrial Plant



Wind Farm

Process A

Automation

Process B

Technical Challenge (1)

Input

- Wind parameters (internal, external)
- Air parameters
- …

Given: Turbine parameters

Model

- Turbine
- Farm

Output

- Power at different time scales (Accurate prediction)

Technical Challenge (2)

Input

- Wind parameters
- Weather parameters
- SCADA parameters

Model

Objective:
- Max power

Output

- Biases of turbine control parameters

Technical Challenge (3)

Input

- SCADA data
- Wind data
- Weather data

Model

- Failure prevention

or

- Minimum maintenance cost

or

- Max availability

Output

- Maintenance schedule

Technical Challenge (4)