CHALMERS Wind Power Research

Ola Carlson

20101104
Department of Energy and Environment
Division of Electric Power Engineering
Electric Power Engineering - research

Application areas:
1. wind power
2. transmission, distribution
3. electrical and hybrid vehicles

Core competences:
- Power system
- Power electronics
- Electrical Machines

✓ Experimental and theoretical basis.
Chalmers is a part of Power Cluster and WP3-skills leader

- Discuss the BSc/MSc profiles with companies within the wind energy branch in form of expert interviews.
- Developing of content for training modules for off shore
Wind Power at Chalmers

- 1975-1990  Generators, soft-starters, 1 generation of variable speed systems, test at Chalmers wind turbine, 40 kW’s pitch-controlled
- 1990-2005  Design of permanent magnet generator, power electronic converters, design and control
- 1995-201x  Wind turbine/farm modeling for power system, fault-response
- 2003-201x  Wind turbine supporting grid voltage, increased stability and frequency control
- 2000-201x  Design of collection grid in wind farms, AC or DC and HVDC-connections to the transmission grid
- 2010 – Wind Power Technology Centre
- 17 PhD – thesis
Large-scale renewable electricity production and its integration into the electricity network
Offshore Wind Power Electric system
new research project

High voltage generator

dc/dc converters

Multi terminal HVDC

3 PhD & 2 researchers

Components, system, modeling
Theory studies, simulations,
Measurements in laboratory
and in operation
DC grid with HVDC transmission

local wind turbine grid

offshore platform

transmission system

collecting point

wind farm grid interface

PCC

Nordic project: DTU, Vestas, VTT, Sintef, Chalmers, ABB
Wind Energy Research in Sweden

**Vindval**
- Acceptance and environment

**Vindforsk**
- Wind in forest and mountains
- Integration in the electric grid
- Future dc-grid, generator
- Operation and maintenance

**Wind Centre**
- Development, design, manufacture & maintenance of wind turbines

**El. system for wind power off shore**
- High voltage generators
- DC collection system
- HVDC transmission
The Swedish Wind Power Technology Centre

Approval by Swedish Energy Agency in November -09
Research starts in Nov -10
Goal - Wind Centre

Develop system knowledge for a complete wind turbine to be able to:

- Be an internationally recognized and competitive centre for wind turbine design development
- Contribute to Swedish entry into the global wind turbine industry
- Contribute to increasing the Swedish presence in component manufacturing for wind turbines by developing, designing and producing mechanical and electric drive train, yaw- and pitch-systems
Industry partners

SKF
ABB
GE Wind Energy (Sweden)
Göteborg Energi
Marström Composite
Trivventus Energiteknik
Diab
+ more welcome
Personell – Wind Centre

• At universities: 8 senior researcher
  10 PhD-student
  1 technician

• At industries in parallel research and development projects: 5 senior researcher
  5 industry PhD-student
  5 engineers/technician

• Sum: 20-30 persons at university and industry

• Tight cooperation between Industry and Chalmers
<table>
<thead>
<tr>
<th>Theme group 1</th>
<th>Theme group 2</th>
<th>Theme group 3</th>
<th>Theme group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power and Control Systems</td>
<td>Turbine and Wind Load</td>
<td>Mechanical Power Transmission and System Optimisation</td>
<td>Structure and Foundation</td>
</tr>
</tbody>
</table>

Design for good maintenance
Full Power Converter system operation with mechanical system

- Full control of P & Q
- All power through the converter
- Generator AG, SG, PM

Start up of a wind turbine

Chalmers 1984, industry 1990
Turbine and wind loads

- Large transient wind loads
- Amplitude and frequency of wind loads
- Propagation of dynamic loads to the gearbox and bearing
- Composites for the rotor blades
- Aero acoustic noise
Schematic sketch of the drive train
Structural Dynamics
-cross-section of research to be applied on wind power

Modelling and simulation of coupled mechanical systems,
Tests, including field tests, to develop and validate numerical models
Studies of linear and nonlinear systems with deterministic or stochastic properties
Identification of acting loads from response data
Optimization of systems with random properties or loading conditions
Maintenance

- Problem: high maintenance cost, impeding the growth of wind power
- Maintenance not optimized: large potential savings by reducing
  - cost for maintenance activities and component failure
  - cost due to production losses
  especially for large offshore wind parks

➢ Need for systematic methods for asset management (AM) of wind power plants
Coming/planned Project in Göteborg

Göteborg Energi install:

4 MW General Electric

8 MW HVDC-light converter

Chalmers cooperation:

• Validation of models for mechanical and electrical systems
• New control with LiDAR
• Grid code tests for the wind turbine
Vindenergisatsningar i Västsverige

Power Väst
Energimyndigheten
Utbildning vindkraft, industrikontakter,

InMotion VG-Region
• Industriutvecklingsforskning
• Informationsspridning högskola till/från industrin
  Allmänhet & samhälle

Chalmers: Energy Initiative
Högspänning
Elnät
Vindkraftsintegration

VindCentrum
• Utveckling, konstruktion & tillverkning av vindkraft

Forskning om havsbaserad vindkrafts teknik - elutrustning

Provplats Göteborg