

## GTZ-TERNA Expert Workshop 2009: Grid and System Integration of Wind Energy

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### Draft Program

| GTZ-TERNA Expert Workshop 2009: Grid and System Integration of Wind Energy |                          |   |  |  |   |            |
|--|--------------------------|---|--|--|---|------------|
| Programme Overview   |                          |   |  |  |   |            |
| Time   | Monday 09.11.2009        | Tuesday, 10.11.2009   | Wednesday, 11.11.2009  | Thursday, 12.11.2009   | Friday 13.11.2009   |            |
| 9:00   | TERNA<br>Expert Dialogue | Welcome GTZ/DigSILENT   | Grid Connection of Wind Farms (DigSILENT)  | Parallel Session 1:<br>Impact of Wind Generation on Power System Stability (DigSILENT) | Parallel Session 2:<br>Modeling Power Prices - What is the influence of wind power feed-in? (Energy Brainpool, to be confirmed) | Field Trip |
| 9:30   |                          | Short presentation of the Delegations (Delegations of Mexico, Chile, Egypt, Marokko, Senegal, South Africa, Pakistan and Vietnam) |  |  |   |            |
| 10:00  |                          | Coffee-Break  | Coffee-Break   | Coffee-Break   |   |            |
| 10:30  |                          | Introduction: The Use of Wind Energy - State of the Art and Outlook   | Connection Conditions for Wind Generation (Grid Code Aspects) (DigSILENT)                | Parallel Session 1:<br>Island Systems with High Wind Penetration (DigSILENT)           | Parallel Session 2:<br>Software Tools for Wind Power Prediction (ISET, confirmed)   |            |
| 11:00  |                          | Wind Turbine Generators (WTGs) - Physical Principles and Generator Concepts (DigSILENT)   |  |  |   |            |
| 11:30  |                          | Lunch Break   | Lunch Break  | Lunch Break  |   |            |
| 12:00  |                          | Time for sight-seeing and shopping / Wind Energy and Development Dialogue (optional)  | Wind Power Prediction for Power System Operation (ISET, confirmed)                       | Parallel Session 1:<br>Open Session  | Parallel Session 2:<br>Grid Code Compliance Studies for a 100MW Wind Farm (DigSILENT)   |            |
| 12:30  |                          |   |  |  |   |            |
| 13:00  |                          |   | Impact of Large Scale Wind Generation on Power System Planning and Operation (DigSILENT) | Case Studies: Grid Integration Studies and Experience (DigSILENT)                      |   |            |
| 13:30  |                          |   |  |  |   |            |
| 14:00  |                          | Get Together  |  | Joint Dinner "Fernsehturm Berlin"  |   |            |
| 14:30  |                          |   |  |  |   |            |
| 15:00  |                          |   |  |  |   |            |
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| 19:00  |                          |   |  |  |   |            |
| 19:30  |                          |   |  |  |   |            |
| 20:00  |                          |   |  |  |   |            |

| <b>Tuesday, 10.11.2009</b> |   |
|----------------------------|---|
| 09:00 h                    | <p><b>Welcome</b></p> <p>Welcome GTZ – <i>R. Posorski/GTZ</i><br/> Welcome DIgSILENT – <i>M. Pöller/DIgSILENT</i><br/> Presentation of the workshop topics – <i>M. Pöller/DIgSILENT</i></p>   |
| 09:30 h                    | <p><b>Short Presentation of the Delegations</b></p> <p>Around five minutes per delegation + discussions</p> <ul style="list-style-type: none"> <li>• Mexico</li> <li>• Chile</li> <li>• Egypt</li> <li>• Marokko</li> <li>• Senegal</li> <li>• South Africa</li> <li>• Pakistan</li> <li>• Vietnam</li> </ul>   |
| 10:30                      | <p><b>Coffee Break</b></p>  |
| 11:00h                     | <p><b>Introduction:</b><br/> <b>The Use of Wind Energy – State of the Art and Outlook</b><br/> <i>M. Pöller/DIgSILENT</i></p> <p>Wind energy use world-wide – numbers and facts<br/> Support schemes in the EU, concepts and experience<br/> Grid integration challenges in Europe and world-wide</p>   |
| 11:30 h                    | <p><b>Wind Turbine Generators (WTGs) – Physical Principles and Generator Concepts</b><br/> <i>O. Amaya/DIgSILENT</i></p> <p>Wind energy conversion<br/> Turbine technologies<br/> Wind turbine operation<br/> Generator concepts:</p> <ul style="list-style-type: none"> <li>• Fix speed induction generator</li> <li>• Induction generator with variable rotor resistance</li> <li>• Doubly-fed induction generator</li> <li>• Generator with fully rated converter</li> <li>• Synchronous generator with hydrodynamic controlled gearbox</li> </ul> <p>Comparison of generator concepts with regard to LVRT and reactive power capability</p> |
| 13:00 h                    | <p><b>Lunch Break</b></p>   |
| 14:00 h                    | <p><b>Time for sight-seeing and shopping</b> / Wind Energy and Development Dialogue (optional)</p>  |

| <b>Wednesday, 11.11.2009 – morning sessions</b> |   |
|---|---|
| 09:00 h   | <p><b>Grid Connection of Wind Farms:</b><br/><i>M. Pöller/DIGSILENT</i></p> <p>Topologies for wind-farm collector grids (radial/ring)<br/>Impact on thermal component ratings<br/>Impact on power flows and n-1 security<br/>Voltage variations/Reactive Power Control<br/>Impact on short circuit currents<br/>Power quality aspects (Flicker/Harmonics)<br/>Fault ride-through aspects</p>  |
| 10.30 h   | <b>Coffee Break</b>   |
| 11:00 h   | <p><b>Connection Conditions for Wind Generation (Grid Code Aspects)</b><br/><i>M. Pöller/DIGSILENT</i></p> <p>General aspects of connection conditions for wind generation</p> <ul style="list-style-type: none"> <li>• Connection Point – general definitions</li> <li>• Active power generation and frequency control</li> <li>• Reactive power and voltage control</li> <li>• Behavior in case of grid disturbance</li> <li>• Black start and plant reconnection</li> <li>• Secondary equipment</li> <li>• Power Quality Aspects</li> </ul> <p>Validation of performance criteria<br/>International practice:</p> <ul style="list-style-type: none"> <li>• SDLV/Germany</li> <li>• The Grid Code/National Grid</li> <li>• Requerimentos para Interconexion de Aerogeneradores al Sistema Electrico Mexicano</li> </ul> |
| 12:30   | <b>Lunch Break</b>  |

| <b>Wednesday, 11.11.2009 – afternoon sessions</b> |  |
|---|--|
| 13:30 h   | <p><b>Wind Power Prediction for Power System Operation</b><br/> <i>Presenter: A. Wessel/ISET</i></p> <p>Characterizing the problem of wind power integration<br/> Wind power fluctuation and save grid management<br/> Principles of wind power prediction methods<br/> Day-ahead- and shortest-term forecasts<br/> Importance of numerical weather predictions<br/> Spatial forecast error smoothing of wind power predictions<br/> Optimized dispatch using wind power prediction for grid nodes<br/> Use of wind power predictions in Germany<br/> Outlook at future usage (direct trading of wind power)<br/> Illustration and evaluation of forecast quality<br/> Confidence intervals of wind power forecasts<br/> Research activities</p> |
| 15:00 h   | <b>Coffee Break</b>  |
| 15:30 h   | <p><b>Impact of Large Scale Wind Generation on Power System Planning and Operation</b><br/> <i>M. Pöller/DIGSILENT</i></p> <p>Availability – Impact on capacity planning<br/> Variability – Impact on generator dispatch and reserve allocation<br/> Impact on required transmission capacity<br/> Impact on frequency control<br/> Impact on reactive power and voltage control<br/> Reactive power compensation (SVCs, switched and fixed capacitors)</p>  |
| 17:00 h   | <p><b>Summary and Discussion</b><br/> <i>Chair: M. Pöller/DIGSILENT</i></p>  |
| 17:30 h   | <b>End of second day</b>   |

| <b>Thursday, 12.11.2009 – morning sessions</b> |   |  |
|--|---|--|
|  | <b><i>Parallel Session 1</i></b>  | <b><i>Parallel Session 2</i></b>   |
| 09:00 h  | <p><b>Impact of Wind Generation on Power System Stability</b><br/><i>M. Pöller/DIGSILENT</i></p> <p>Power system stability – definitions and concepts<br/>Wind generation impact on transient stability aspects<br/>Wind generation impact on inter-area oscillations<br/>Wind generation impact on voltage stability constraints<br/>Wind generation impact on frequency stability</p> | <p><b>Modeling Power Prices – What is the Influence of Wind Power Feed-In</b><br/><i>S. Sacharowitz/Energy Brainpool (to be confirmed)</i></p> <p>Influence of wind generation on electricity prices<br/>Modeling approaches for price developments</p>  |
| 10:30 h  | <b>Coffee Break</b>   |  |
| 11:00 h  | <p><b>Island Systems with High Wind Penetration</b><br/><i>Presenter: O. Amaya/DIGSILENT</i></p> <p>Operation of wind-diesel systems<br/>Reserve allocation<br/>Voltage control<br/>Frequency stability<br/>Grid faults</p>   | <p><b>Software Tools for Wind Power Prediction</b><br/><i>Presenter: W. Slaby/ISET</i></p> <p>Wind power prediction methods<br/>Requirements of wind power prediction methods<br/>Software architecture for Wind Power Prediction Tools<br/>Software and system reliability of Wind Power Prediction Tools<br/>Technical integration<br/>Example: Wind Power Management System (WPMS)<br/>Further developments</p> |
| 12:30 h  | <b>Lunch Break</b>  |  |

| <b>Thursday, 12.11.2009 – afternoon sessions</b> |  |   |
|--|--|---|
|  | <b><i>Parallel Session 1</i></b>   | <b><i>Parallel Session 2</i></b>  |
| 13:30 h  | <p><b>Workshop 1: Open Session</b><br/> <i>Chair: M. Pöller/DIGSILENT</i></p> <p>Topics of special interest, as identified during the workshop<br/>           Questions and Answers</p>  | <p><b>Workshop 2: Grid Code Compliance Studies of a 100MW Wind Farm</b><br/> <i>Presenter: O. Amaya/DIGSILENT</i></p> <p>Basic design considerations for a 100MW wind farm<br/>           Reactive power capability at the grid connection point<br/>           Harmonic compliance studies<br/>           Flicker studies<br/>           FRT studies</p> |
| 15:00 h  | <b>Coffee Break</b>  |   |
| 15:30 h  | <p><b>Case Studies: Grid Integration Studies and Experience</b></p> <p><i>M. Pöller/DIGSILENT:</i><br/>           "dena-study": Integration of Onshore and Offshore wind energy into the German transmission grid until the year 2020</p> <p><i>O. Amaya/DIGSILENT:</i><br/>           Feasibility Study for the integration of up to 2800MW of wind generation in the Western Cape/South Africa</p> <p><i>M. Pöller/DIGSILENT:</i><br/>           Assessment of potential security risks due to high levels of wind generation in South Australia</p> |   |
| 17:00 h  | <p><b>Summary and Discussions</b><br/> <i>Chair: M. Pöller/DIGSILENT</i></p>   |   |
| 17:30 h  | <b>End of Grid and System Integration Workshop</b>   |   |
| 18:30 h  | <b>Joint Dinner at "Fernsehturm Berlin"</b>  |   |