Gas & Wind Integration and Energy Management
Outline

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Combined wind power and combustion based power systems for offshore oil & gas installations
Options to structure of the integration of offshore wind farm and oil & gas installations

Physical integration – (1) Stand-alone system and (2) Grid-connected system
Options to structure of the integration of offshore wind farm and oil & gas installations

Stand-alone system:
1. Control strategy for autonomous supply
2. Stochastic and controllable system integrated
3. Increased need for storage buffer
4. Installed capacity and wind forecast should be planned according to power/energy demand
5. Active power control of thermal power system for “matching” with both stochastic supply and demand
6. A stand-alone thermal power system with “auxiliary” wind power supply

Grid-connected system:
1. Integration with onshore grid (power quality requirements)
2. Onshore grid can act as energy buffer
3. Energy surplus and shortage can be handled through export and import
4. Changes in production and consumption of energy offshore can be handled
Control system for autonomous hybrid power systems involving wind power system

<table>
<thead>
<tr>
<th>Operation Strategy</th>
<th>How it is implemented</th>
<th>Objective(s)</th>
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<tbody>
<tr>
<td>Spinning reserve</td>
<td>determining the minimum diesel capacity based on renewable energy and load forecasts</td>
<td>avoid system collapse in case of a sudden loss of renewable power generation or increase of demand</td>
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<tr>
<td>Load management</td>
<td>by switching on/off different optional and deferrable loads (e.g., water pumps, desalination units, etc.)</td>
<td>power balance of the system and minimum loading for diesels</td>
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<td>Minimum run time</td>
<td>pre-set a minimum duration for each diesel operation</td>
<td>reduce diesel on/off cycles</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>measuring a power surplus over the demand before switching off diesels</td>
<td>reduce diesel on/off cycles</td>
</tr>
<tr>
<td>Storage management (short-term storage)</td>
<td>flywheel, hydraulic/pneumatic reservoir, battery bank</td>
<td>compensate rapid power fluctuations</td>
</tr>
<tr>
<td>Storage management (long-term storage)</td>
<td>battery bank, pumped water</td>
<td>reduce diesel on/off cycles and safe fuel</td>
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Some common operation strategies that can be used by a supervisory controller to improve hybrid power system operation.
Control system for autonomous hybrid power systems involving wind power system

- Type of renewable energy sources
- Depth of renewable energy penetration into the total energy production
- Type of components in the renewable energy production
- Information about forecasting of renewable energy source and feed forward control
- Type of structure
- Requirement on power quality
- Availability of energy storage, type and size of energy storage
- The control problem

Schematic diagram showing electric production using wind turbines and fuel cells
Options to energy optimization strategy

Typical Energy Optimization Model

- Backup
- Power quality
- Grid limitations

Wind park
Power system of modern offshore oil&gas installations

Statoil and Sintef—Concepts of Integrating Wind Power with Offshore Oil & Gas Platforms

Ref. The Potential of Integrating Wind Power with Offshore Oil and Gas Platforms
Wei He, Gunnar Jacobsen, Tiit Anderson, Freydar Olsen, Tor D. Hanson, Magnus Korpås, Trond Toftevaag, Jarle Eek, Kjetil Uhlen and Emil Johansson
Wind input data for studies on integration of offshore wind farms into combustion based power supply systems of oil and gas installation

1. Optimal components, system configuration and optimal control
2. Procedure to generate synthetic wind data
3. Fluctuations in the lumped power output
4. Performance of off-shore wind parks
5. Characteristic of wind turbulence
6. Coupling of wind farms with oil and gas platforms
Options to match wind generation with thermal power stations in isolated grid
Options to match wind generation with thermal power stations in isolated grid

1. Optimal control for system dispatch
2. Addition of storage capacity
3. Effect of different operation strategies/storage capacity on potential fuel
4. Option for storage capacities
5. Flywheel storages, Battery storage, Hydrogen storage
Cost of integration

**Stand-alone system:**
- No grid connection means lower infrastructure cost
- Energy storage is costly
- Island mode needs more complex control system
- Wind forecasting may be critical
- Stronger need for back-up power supply for oil and gas installation

**Grid-connected system:**
- Onshore grid connection is costly, especially at large distance to shore
- Flexible situation
- The grid connection may be a bottleneck
Conclusion

• This report presented the proposed concept of combined wind power and combustion based power systems for offshore oil and gas installation.

• Stand-alone system and grid-connected system

• Control system for autonomous hybrid power system has several challenges

• Optimization problem to obtain high efficiency is substantial

• Various types of wind input data

• Different cost figures related to two possible alternatives
Financial plan
Thank you for your kind attention