Agenda

- Motivation
- Implementation status
- Results and value
- EMPS model development
- Implementation challenges
Motivation

- More renewable intermittent production Nordic and Continent
- Currently about 34 GW solar installed in Germany, 32 GW wind power
- More transmission capacity to Continental system
Implementation status

DONE:
- 3 hourly resolution (56 load segments) in long term price forecast 2012
- Continental and Nordic (EMPS) model integrated with consistent weather scenarios

IN PROGRESS:
- Weekly 5 year forecasts with high data frequency (3h or h) to be implemented this year
- Larger implementation job in operative forecasts
  - Includes seasonal model
  - More surrounding tools and systems, more time critical processes
Weather scenarios in EMPS (Nordic model) and NEMO (Continental model)

Continental prices for each weather year (3 hourly resolution)

**EMPS**
Price for weather year $x$ is a function of:
- Inflow ($x$)
- Temperature ($x$)
- Wind ($x$)
- Snow ($x$)
- Continental prices ($x$)

**NEMO**
Price for weather year $x$ is a function of:
- Wind ($x$)
- Temperature ($x$)
- Sun ($x$)
- Exchange with the Nordic region ($x$)

Exchange between the Nordic and the continental market for each weather year (3 hourly resolution)

Iteration process
Results example: Interconnectors

- Both examples from the same week and scenario
- Able to show an irregular price pattern and corresponding flow
- Very different results – aggregation to 4 load segments causes problems
Value of 3 – hourly data

- Detailed weather scenarios
  - Describes short term variations on production and prices caused by weather
  - Correlations between weather variables (temperature, solar, wind, snow and inflow)
  - Consistent scenarios – correlations in time and space described

- Better price forecasts
  - Describe short term variation
  - Explains historical short term variations reasonably well

- Calculate value of flexibility
  - Investments
  - Water values
Challenges

- Model development
  - Basic functionality all ready developed
  - Stressing parts of the original logic – need for further development

- Calculation
  - Problem size increases with more data – time is a limited factor
  - Both model improvements and better hardware needed

- Detailed input
  - Matching of time series data
  - Even if model is ready, detail and quality of input is an issue

- IT systems development
  - Surrounding models and tools are not necessarily ready for handling 3-hourly data
  - A lot of data to handle (56*260*80 = 1,164,800 data for each variable)
Model development

- Extension to hourly data (From max 12 to 168 load segments)
- Samtap calculation time improvements
- Wind and exogenous prices with hourly data
- Daily consumption temperature correction
- Maskenett.DATA as time series
- Parallel seasonal model
- Daily inflow in seasonal model
- Calendar model (Remove 52 week year and EFI – week)
- Time series API
- ReOpt (samtap extension/alternative)
## Calculation times (5y parallel Nordic model)

<table>
<thead>
<tr>
<th>Model</th>
<th>4 load segments</th>
<th>3 hourly data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategy</strong></td>
<td>15 min</td>
<td><strong>90 min</strong></td>
</tr>
<tr>
<td><strong>Detailed dispatch</strong></td>
<td>7 min</td>
<td>25 min</td>
</tr>
<tr>
<td><strong>Seasonal model</strong></td>
<td>5 min</td>
<td><strong>10 hours</strong></td>
</tr>
</tbody>
</table>

- Strategy scales only to 14 cores (number of aggregated areas)
- Seasonal model is built to scale for hundreds (thousands?) of cores
- Reporting (kurvetegn etc.) also consumes a considerable amount of time
- Working on parallel seasonal model
- Will acquire new hardware
Detailed input

- Daily temperature correction helps explain actual consumption better
- Still no exact match
- What details are most important, and where to improve model and input?
- The level of precision required is demanding
IT - tools need adaption

- Surrounding tools and systems not ready for higher frequency data
- The increased amount of data calls for more sophisticated data handling
Concept for input and results

- Store all time series in a database
- Calendar time series (not EFI week)
- Work with APIs - abstract away from inefficient file formats and result applications
- Build new tools for handling input / results
THANK YOU