Simulation of power systems: proposal of an enhanced validation procedure

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Abstract
Planning of power systems is assisted by simulation computer models, generally calibrated using one year of historical data to ensure reliability. This procedure makes the model sensitive to that year’s particular conditions, possibly jeopardizing the adequacy of simulations of scenarios under different weather conditions. This work proposes a new multiyear calibration method using linear regressions to obtain the relevant calibration parameters. To validate the method, simulations in EnergyPLAN of two heterogeneous historical years in Portugal are used to compare the standard and the multiyear approaches. The results show that the multiyear calibration allows significant improvement in the model accuracy for a wider range of weather conditions, enhancing the confidence on the simulation of future scenarios.

Case study
Portuguese electric power system

- Period 2011-2015

Methods

<table>
<thead>
<tr>
<th>Standard calibration</th>
<th>Multiyear calibration (MY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>How to perform a standard calibration of one past year?</td>
<td>Linear regressions for each CP</td>
</tr>
<tr>
<td>Input Historical data required</td>
<td>Predict CPs given the climate indicators of the reproduced year</td>
</tr>
<tr>
<td>Calibration Parameters</td>
<td></td>
</tr>
<tr>
<td>Final Calibration Parameters (CPs)</td>
<td></td>
</tr>
<tr>
<td>Usually kept constant for simulation of other scenarios</td>
<td></td>
</tr>
<tr>
<td>when the outputs and historical data match</td>
<td></td>
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</tbody>
</table>

5 standard calibrations are performed – one for each year of the period 2011-2015

Validation

WET year (year 2000; precip. of 1092 mm)

DRY year (year 2005; precip. of 524 mm)

5x Standard calibrations

Multiyear calibration

CPs - linear regression (using indicators from the year)

Results

Calibration parameters

Condensing powerplant (PP) efficiency

Annual water supply

Run-of-river coefficient

5 standard calibrations — 5 sets of CPs (2011 to 2015)

Multiyear calibration

42%

2100

42%

2400

2700

100

500

900

1300

Pp efficiency [%]

Wind index [MM/MW]

Water supply [MM/MW]

Run-of-river coefficient

Deviation of the output results from the historical data for both calibration methods: (1) the use of the standard calibrations on each validation year are represented by the box plots and the dots/diamonds (2000 and 2005, respectively); while (2) the multiyear calibration applied to each validation year are shown on the columns.

Conclusions

Proper model calibration

Standard calibration

Multiyear calibration

Future work

- Higher number of observations

- Test the methods in other contexts (e.g. climate, electricity mix) and in other simulation tools

If the conditions between calibration & simulation year are:

- similar
- reasonable results

- different
- high discrepancies

More accurate results

Higher trustability

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