Predicting hosting capacity of photovoltaic power production in low-voltage grids using regressive techniques

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2017-10-24
Outline

• Introduction
• Motivation
• Data & Method
• Results
• Conclusion
Introduction

- Photovoltaic (PV) power generation and residential electricity consumption rarely coincide.

- The amount of PV power that can be installed in a low-voltage (LV) grid without affecting power quality is called hosting capacity (HC).

- The HC is usually estimated by time consuming power flow simulations.
Motivation

• Solving power flow equations is time consuming

• Many specifications of the LV grid are known, including load data

• Our method might facilitate further PV power penetration with relative ease
Data & Method

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- Multiple linear regression (MLR)
- Gradient boosting (GB)
- Gaussian Processes (GPs)
Performance metrics

- MAE
- RMSE
- PICP = \( \frac{1}{N} \sum_{i=1}^{N} \epsilon_{n} \), where \( \epsilon_{tn} = \begin{cases} 1 & \text{if } y_{i} \in [L_{i}, U_{i}] \\ 0 & \text{if } y_{i} \notin [L_{i}, U_{i}] \end{cases} \)
- PINAW = \( \frac{1}{NR} \sum_{i=1}^{N} (U_{i} - L_{i}) \)
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Results MLR

RMSE = 15.7 kW
MAE = 12.2 kW
Results GB

RMSE = 16.6 kW
MAE = 14.0 kW
Results GPs

RMSE = 17.4 kW
MAE = 14.0 kW

(a) Simulated HC (kW) vs. Predicted HC (kW)

(b) HC (kW) for Grid T341 to T976

- Simulation
- Prediction
## Results

<table>
<thead>
<tr>
<th></th>
<th>MAE (kW)</th>
<th>RMSE (kW)</th>
<th>PICP (-)</th>
<th>PINAW (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLR</td>
<td>12.2</td>
<td>15.7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>GB</td>
<td>14.0</td>
<td>16.6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>GPs</td>
<td>14.0</td>
<td>17.4</td>
<td>0.750</td>
<td>0.565</td>
</tr>
</tbody>
</table>
Conclusion

• Regression offers a quick insight into the HC of an LV grid

• MLR showed best results but generalizes less well to different datasets

• Accuracy should be improved \( \rightarrow \) more data is required and additional variables should be included
Thank you