Weather is significant predictor of wind turbine power output

Wind speed, temperature and pressure can predict the power output of wind turbines. Being able to forecast wind power generation using climate data will help in better planning and management of energy resources. It will further advance our understanding of ‘site selection’ for setting up new wind farms.

Methodology

In absence of timestamps for the power readings, we attempted to align all time series through periodicity. Wind patterns are remarkably less consistent than temperature patterns and consequently, turbine output, which is the weakest. It is extremely difficult to accurately determine the periodicity of the readings. Our best estimate is that approximately 250-300 readings represent a day’s worth of GE data.

Analysis

Search for maximum max cross-correlation and PCC to determine the optimal start timestamp for GE turbine reading

Comparing performance across methods and datasets

<table>
<thead>
<tr>
<th>Data - Model</th>
<th>RMSE (% of capacity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE Data - LSTM</td>
<td>37.11%</td>
</tr>
<tr>
<td>GE Data – Vector Autoregression</td>
<td>19.2%</td>
</tr>
<tr>
<td>Sotavento Data - LSTM</td>
<td>0.132%</td>
</tr>
</tbody>
</table>

Results

- Best alignment of time stamps for power output with wind data occurs at 0310 hrs April 24th, 2018, indicating readings at 5 minutes interval
- For standardizing and comparing the performance, all predictions were made on % utilization of installed capacity.
- The Sotavento data provides best error and directionality of prediction due to the vast amount of available data and aligned timestamps

Conclusions

Wind turbine power prediction in presence of time stamps of power output can be modelled using LSTMs. Usage of model may also be extended to discover new sites using transfer learning which can help in further raising the capacity factors for new and upcoming wind projects.

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References