Solar forecasting to increase income

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Forecasting: why?

Production = Consumption

Cost of Uncertainty: 2 to 50 € / MWh

Grid operator (TSO, DSO)
Plant manager
Traders
Technologies

- **Different aggregation level**
  - Site, Region, Country

- **Time horizon**
  - From a minute to a few days

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**steadyEye**

**steadySat**

**steadyMet**

<table>
<thead>
<tr>
<th>Minutes</th>
<th>Hours</th>
<th>Days</th>
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</thead>
</table>
Grid operation

Asset management

Energy trading
Energy trading
Forecast needs:
- Portfolio level
- Country / TSO level
- Day-ahead and intraday
PV production in Germany
⇒ Electricity price

https://www.energy-charts.de
Typical forecast errors

MAE = 5.9 %

MAE = 2.8 %
How to reduce risk?

- Uncertainty forecast
- Large portfolio
Probabilistic forecasting

Ensemble members (x20)

Ensemble average

Ensemble stdev

Area of low predictability

Area of high predictability
Spatiale distribution of the portfolio
Impact on error mitigation

Plant A

Plant B

Plant C

Portfolio
Impact of spatial distribution: Cumulative distribution of MAE

**Plant A**

85% of the time, Abs Err <10 % Pc

MAE = 3.5 %

Portfolio

95% of the time, Abs Err <10 % Pc

MAE = 2.2 %
Asset management
French tender for non interconnected area (ZNI)
- Tender 2011-2012 ⇒ 60 MW
- Tender 2015-2016 ⇒ 51,8 MW
- Tender 2016-2017 ⇒ 63,3 MW
Grid injection requirement ZNI1

- Controled ramp rate
- Flat profile
- Begining & end announced 1h before

40% plant peak power
Grid injection requirement ZNI2 et ZNI3

- Controled ramp rate (except during peak hour)
- No requirement on profile
- Injection during peak hour (P > 120% Pn)
- Announcement in D-1 (16h), and 3 re-announcements in D (4h, 10h, 14h)

120% plant nominal power
Example: 4.4 MW PV plant
Example ZNI1

Forecast D-1

Forecast D, ~10h
Forecast update allows to modify the announcement to grid-operator ⇒ reduce curtailment.
With persistence

PV 7385 MWh (100.0%)

Prélèvement 645 MWh (8.7%)

Pointe 2571 MWh (34.8%)

Non pointe 4402 MWh (59.6%)

Total 6973 MWh (94.4%)

With forecasts

PV 7385 MWh (100.0%)

Prélèvement 611 MWh (8.3%)

Pointe 2546 MWh (34.5%)

Non pointe 4803 MWh (65.0%)

Total 7349 MWh (99.5%)
### Yearly results (simulation ZNI2)

<table>
<thead>
<tr>
<th>Forecast model</th>
<th>With persistence</th>
<th>With forecasts</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMSE grid-operator announcement (5% deviation authorized, more = penalties)</td>
<td>9.8%</td>
<td>7.6%</td>
</tr>
<tr>
<td>Penalties amount (% of incomes)</td>
<td>3.2%</td>
<td>1.6%</td>
</tr>
<tr>
<td>PV curtailment (% of PV output)</td>
<td>7.2%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Injected energy</td>
<td>1308 kWh/kWc</td>
<td>1393 kWh/kWc</td>
</tr>
</tbody>
</table>

**Projected incomes**

- €                        
- €                        
+ 6.0%                    

**Distribution of daily income gap between forecast models**

![Bar chart showing distribution of daily income gap between forecast models](image)
Thank-you for your attention !!

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