PV Integration and storage optimization for a solar farm on a mall rooftop in Reunion Island

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Reunion Island energy context
Reunion island’s profile

- 850,000 inhabitants

- 841 MW overall production capacity
  - Diesel: 291 MW
  - Coal/bagasse (cane residue): 210 MW
  - Hydro: 134 MW
  - **Solar: 187 MW**
  - Wind: 15 MW
  - Biogas: 3 MW
  - Grid storage: 1 MW
Important energy challenges

- Fossil fuel dependancy:

  Reunion Island: 86.1%  Mainland France: 47.5%
Ambitious energy targets and solar potential

- **European plan on climate change:**
  - 20-20-20 targets

- **French Overseas Departments and Territories targets:**
  - 100% autonomous energy for 2030
  - 50% renewable for 2020

- **High solar potential**

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Reunion electric grid issues

- No interconnection

- Operating reserve:
  - 211 MW Diesel Generator
  - 80 MW combustion turbine
  - ~50 MW Hydraulic Power
  - 1 MW Grid Storage

- Maximum renewable injection on the grid set to 30% by the local DSO.
French Energy Regulation Commission (CRE) initiatives for solar development
Solar Initiative for grid stability

- Tenders released by the French Energy Regulatory Commission (CRE), specific conditions for French insular areas
- Experimentation of rules regarding the feed-in profile tariff

**1st tender (2011)**

**2nd tender (2015)**

Profile to be announced the day before, adjustment in intraday (for the 2nd tender)
Feed in profile detail

- Elements needed from the producer:
  - $P_{\text{ref}}$: power reference for the stable phase
  - $T_{\text{er}}$: ending time of the load rising phase
  - $T_{\text{st}}$: starting time of the load decreasing

- Producer must respect:
  - $P_{\text{ref}} < 40\%$ of installed capacity
  - During rising and decreasing phase:
    - The power slope must remain between 0 and 0.6% of the total installed capacity
  - During Stable power phase:
    - The power injected must stay around $P_{\text{ref}}$ with a 2.5% tolerance
Expectation on the solar generation

Profiles expected:

Solar producers → Actor/manager of their Intra-day and Short-term stability

Solar radiation and profil production

Credits: Reuniwatt
Solar producer needs with this new regulation

- **Storage capacity:**
  - Due to peak shaving ($P_{ref}$)
  - High response time
  - Appropriate capacity sizing

- **Forecasts at diverse time horizons required:**
  - **Day-ahead** forecast for profile declaration commitment
  - **Intra-Day** forecast for storage optimisation
  - **Short-term** forecast for operational plant management

Credits: Albioma

Credits: Reuniwatt
“Le Portail” solar power plant
Le Portail, mall rooftop solar power plant

- Located in Saint-Leu, Reunion
- In operation since September 2014
- 946 kWp rooftop solar panels
- 1200 kWh lithium storage capacity

Credits: Albioma
Energy Management System (EMS) deployed

- Automatic forecast data acquisition from Reuniwatt
- Optimum Storage and injection recalibration every 15 minutes
- Automatically send next day power profile at 4PM every day
Focus on Reuniwatt solar forecast technologies
The Portail solar power plant forecast details

- Reuniwatt provide forecast on
  - **Global Horizontal Irradiance (GHI)** with its components:
    - *Direct Normal Irradiance*
    - *Diffuse Horizontal Irradiance*
  - **Temperature**
  - And their related **confidence interval**

- Each 15 minutes
- 32 hours ahead
- Granularity 15 minutes

Credits: Reuniwatt
Reuniwatt solar forecasting tool: Soleka

- A multiple technology approach to ensure the best performance forecast for every time horizons and spatial scale:

  - Cloud tracking using ground-based sky images
  - Cloud tracking using geostationnary satellite images (credits: Eumetsat)
  - Regional Numerical Weather Prediction Forecasts
  - Time series modeling (ARMA, SVM, ANN)

Credits: Reuniwatt
Results
Impact of the forecasts on the Portail PV storage system

- Project allow us to improve our forecast accuracy:

Measured performance of the production forecasts

- But also to improve solar production injection of the power plant:

  87 to 95% production injection
In Conclusion
Conclusion

- On this use-case application of solar forecast solutions deployed on PV + storage systems we have seen:
  - Forecast solutions are suitable solutions to reduce solar variability on the grid
  - The global system allows us to inject more photovoltaic electricity on the grid and maximise income of solar power plants
  - Those systems are particularly interesting for feed-in-profile systems as currently in experimentation on Reunion Island

- Possible research perspectives for the forecast solution
  - Adjust the current deployed system to integrate the 2015 tender regulation with:
    - intra-day adjustment
    - evening price calls on peak-hour demand mechanism
  - Estimate, with the deployment of similar systems, the possibility to increase the renewable energy injection limit, currently set to 30% of the total mix.
Thank you!

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