Solar energy assessment and forecasting in insular regions: the Tahiti case study

Guillaume Tremoy[1], Damien Raynaud[1], Pierre Besson[1], Wajih Mahmoud[1], Elena Escudero Ramos[1], Théo Masson[1], Jérôme Lehaire[1]
guillaume.tremoy@steady-sun.com
[1]**Steadysun**, Savoie Technolac, Le-Bourget-du-Lac, France

Context

2 thermal plants (8 diesel generators)

148 MW

18 hydropower plants

48 MW

>3200 rooftop PV installations

45 MWp

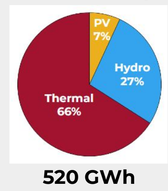
4 PV+ESS plants (2024)

30 MWp

Virtual Synchronous Generator

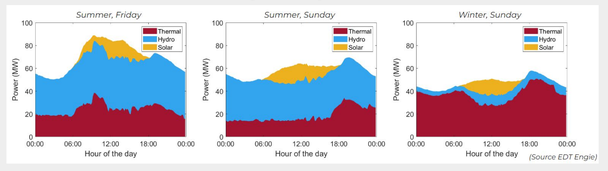
15 MW / 5 MWh

Production mix (2021)



520 GWh

Daily load profiles



Demand/supply balancing, scheduling

- **Peak load** ~80-90 MW (~50-60 MW)
- Rooftop PV > PV+ESS > Hydro > Thermal
- **Grid code** for PV+storage integration

- Solar PV **oversizing & curtailment**
- **Storage** systems development
- **Grid code** modifications and EMS

Grid stability

- Ensured by thermal generators only
- **Spinning reserves regulation**: > 85% PV production / highest genset power

- More **flexible** thermal generators
- **Storage** systems (virtual synchronous generator)

Energy transition plan

- 37% RE in 2020
- **75% RE by 2030** (2015 policy)
- **55% RE by 2030** (current pathway)

- Energy **sufficiency**: -5% consumption
- +5 MW **hydropower** (+175 GWh)
- +70 MWp **solar PV** (+110 GWh)

100% electric mobility

- **Doubling** of power & consumption
- Would require heavy investment in infrastructure

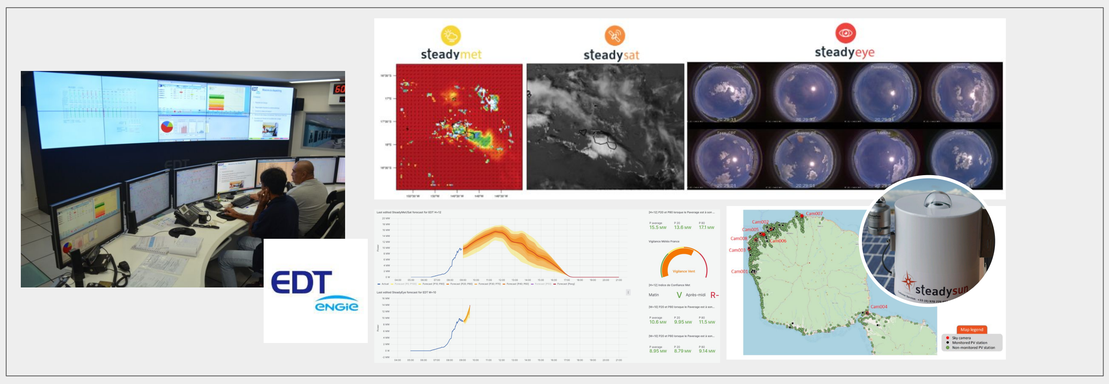
- +400 GWh (+100 MW thermal / +350 MWp solar PV)

Grid management

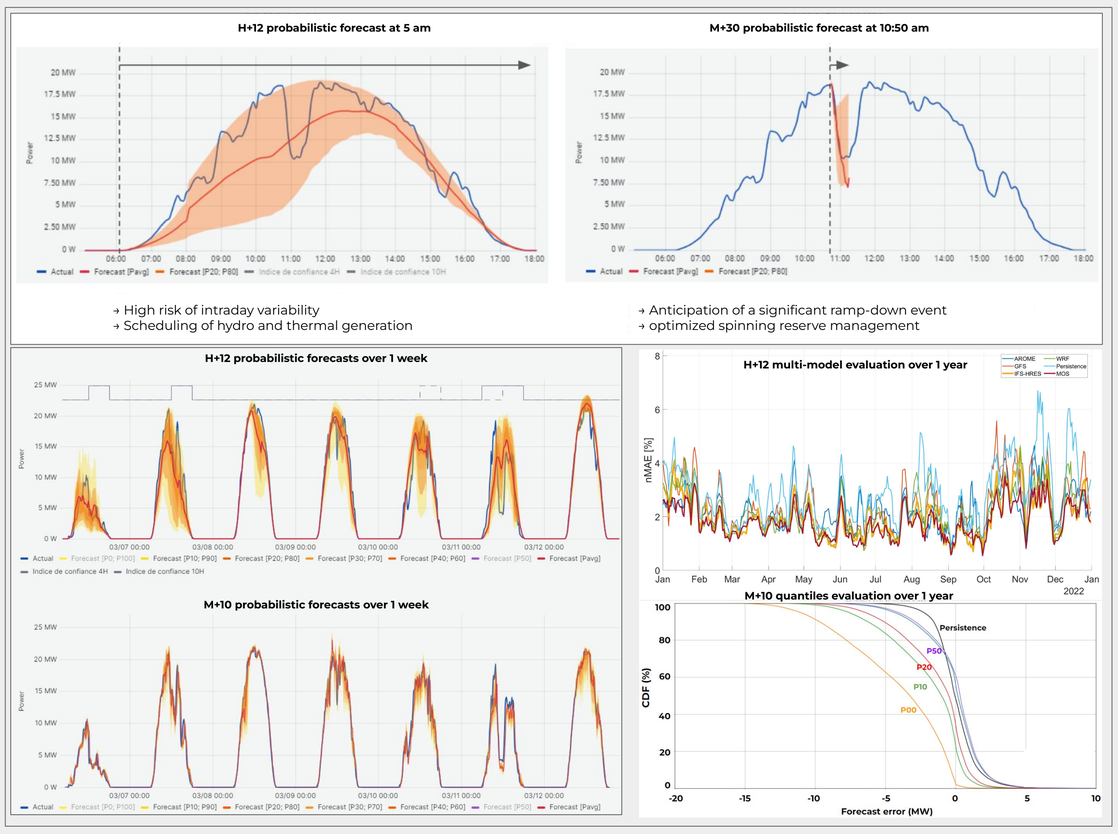
How to maximize the use of RE while ensuring power network stability?

Demand/supply balancing and scheduling (hydropower, gensets)
➔ **12 hours ahead** total PV production probabilistic forecasts, every 1 hour

Spinning reserves management (fuel saving, maintenance costs)
➔ **10-30 minutes ahead** total PV production probabilistic forecasts, every 1 min



Solution: Cloud-Edge Physics-AI forecasting system and services



Results: H+12 and M+30 forecasts examples and performances

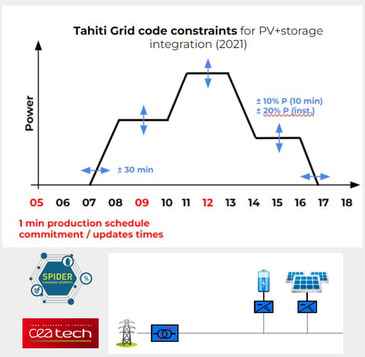
Hybrid plant development & operation

How to enhance projects profitability at the different stages?

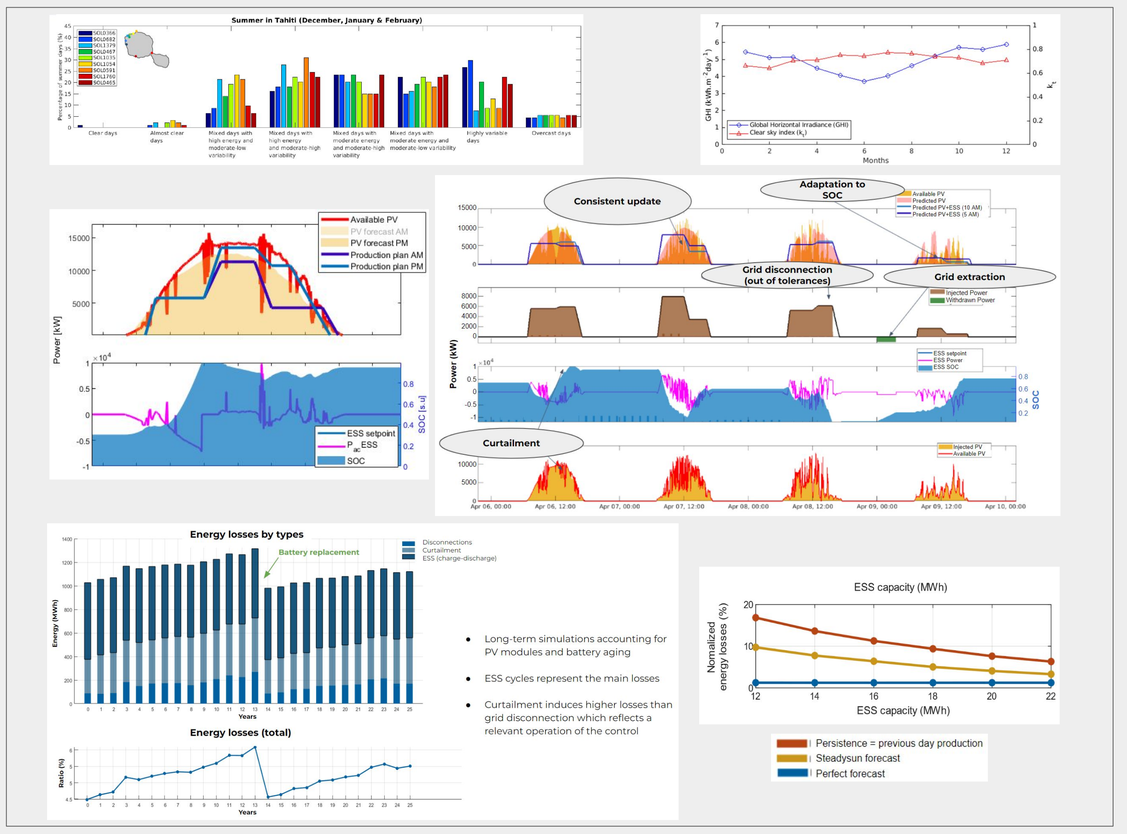
Project development (CAPEX optimization)
➔ **Solar resource and PV+ESS energy yield assessment**

Plant operation (OPEX reduction)
➔ **12 hours ahead** PV+ESS production forecasts, every 15 minutes

- **Use of historical and live data**
  - Network of 10 pyranometers
  - 40 supervised PV plants → estimated irradiance (inversion modeling)
  - Satellite derived irradiance data
  - Irradiance and PV forecast data
- **Simulation platform (SPIDER)**
  - Modeling of PV+ESS
  - Optimal planning and control strategies
  - Simulations using historical data (measurements, estimates, forecasts)
  - Techno-economic indicators



Solution: solar energy assessment and forecasting services



Results: solar resource and PV-ESS yield assessment; ESS optimal sizing

Conclusions

- Forecasting is an **essential solution** to foster the integration of solar energy:
  - Ensures balance on the network by anticipating short term variability
  - Reduces the spinning reserve and its dependence on fossil fuel
  - Increases the technical and financial **attractiveness** of PV (lower LCOE)
- Whatever the stage of maturity of the project, forecast data brings added value:
  - CAPEX **optimization** (optimal ESS sizing)
  - OPEX **reduction** (lower the amount of penalties and curtailment risk)
  - **Increased** ROI

Perspectives

- Additional weather/cloud observation and PV monitoring systems
- Data assimilation into HR NWP models
- More AI (e.g. ML based cloud nowcasting using satellite imagery)

More info:
- https://www.steady-sun.com/webinar-insular-system-evaluate-and-anticipate-solar-energy-variability/
- https://wandb.ai/capecape/ddpm_clouds/reports/Diffusion-on-the-Clouds-Landing-Page--VmlldzozNzQ1OTkz

7th International Conference Energy & Meteorology, Padova 27-29 June, 2023