

# Evaluation of Photovoltaic Short-term Forecast Benefits for Isolated System Operation

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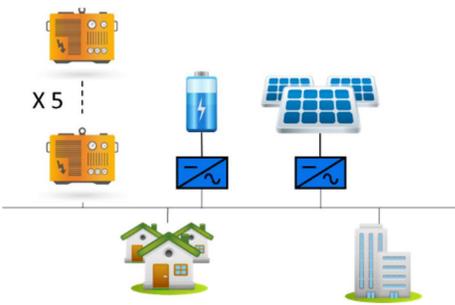


## ABSTRACT

This paper deals with the energy management control using an advanced short-term PV forecast solution for a PV-ESS-diesel hybrid off-grid microgrid. Analysis by simulation addressing a technical comparison between such solution and other forecast options, such as persistence or perfect forecast, is performed, in order to evaluate potential gains both in storage sizing and fuel consumption. Further than a case study, the work offers a generic simulation framework allowing other microgrid simulations, both grid-tied and off-grid, as the plant model and the control system are structured under a general approach, facilitating the system modeling and simulation.

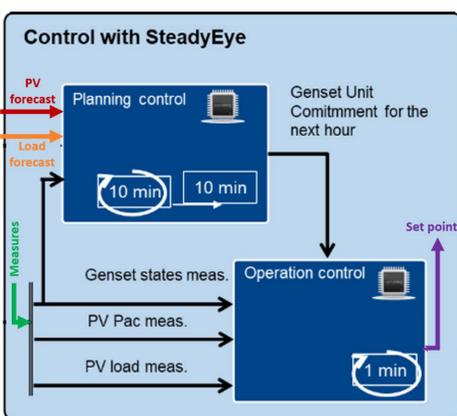
## 1. CASE STUDY

Hybrid energy system that supplies power to an off-grid mining site located in the Australian desert.



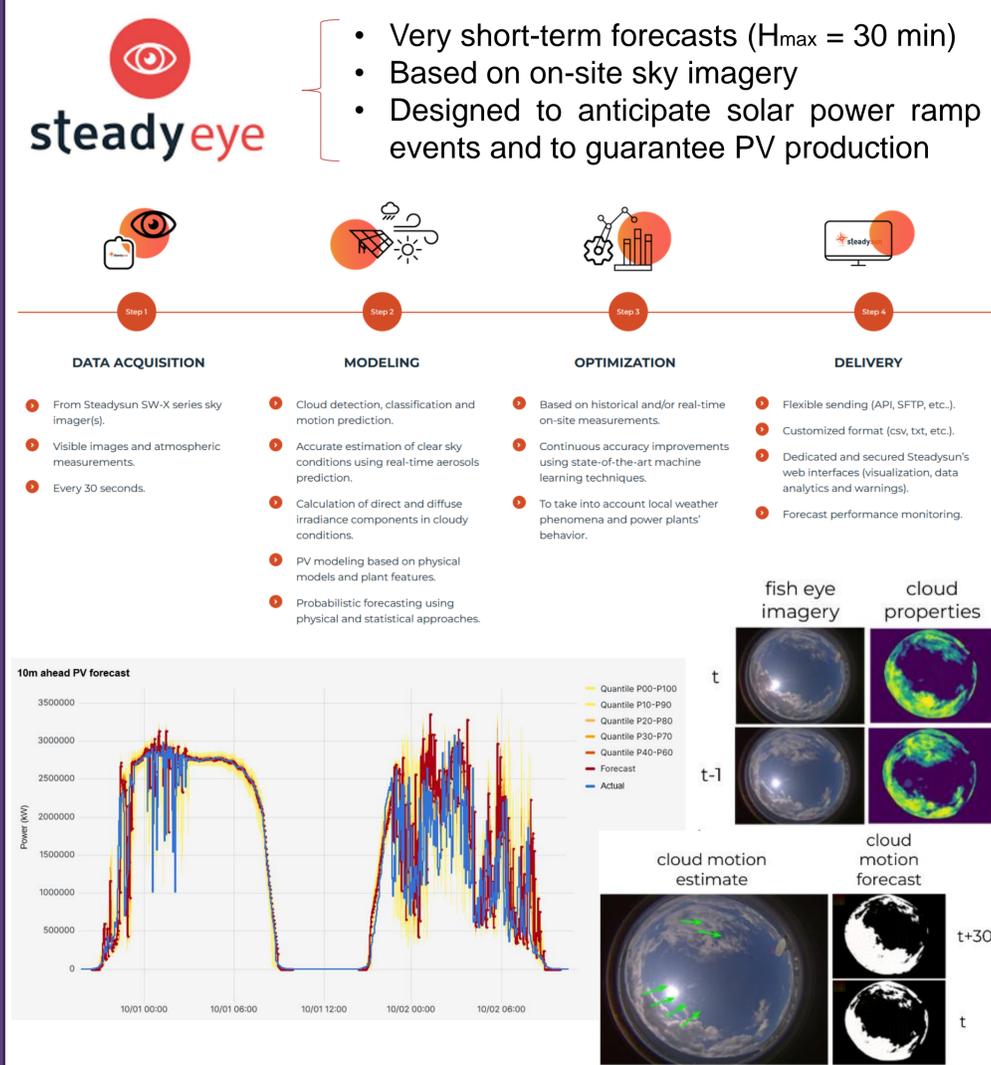
Two-level control system:

1. Planning control for genset action anticipation.
2. Operational control to compute set points of PV curtailment, storage action (charge or discharge) and genset power sharing



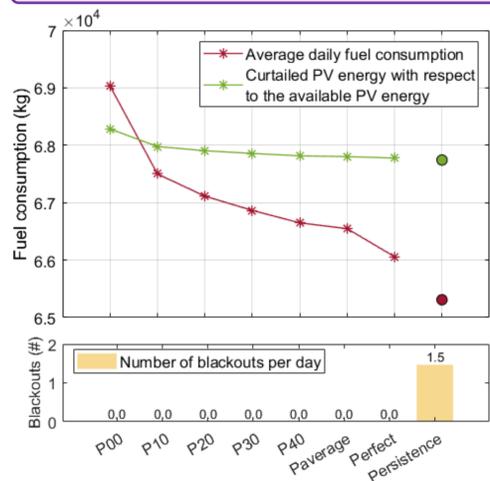
Objectives: prioritize the use of PV energy either to provide to the load consumption or to charge ESS in case of overproduction, avoid genset underload operation, use ESS to discharge in case of overconsumption to complete PV and genset production.

## 2. SHORT-TERM SOLAR FORECASTS



## 3. SIMULATION ANALYSIS AND MAIN RESULTS

### Selection of the PV forecast options



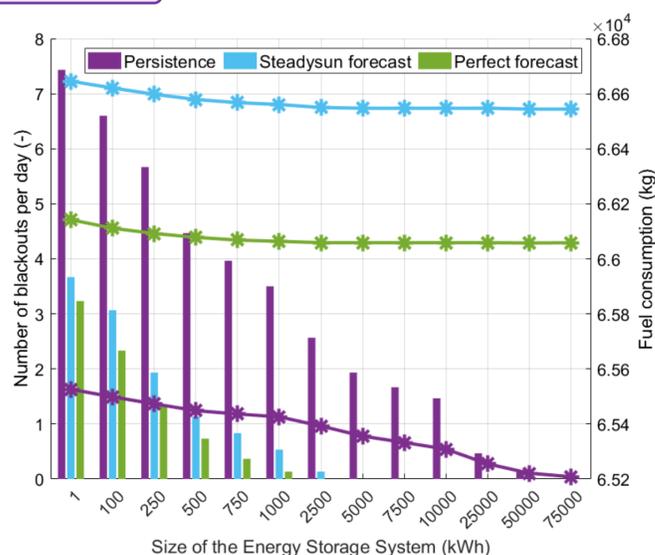
- Perfect forecast represents: ideal case.
- Persistence: forecast equal to the actual power of the previous day (considered the simplest way of generating a forecast).
- Percentiles P00-P100: confidence intervals of the forecasts, where PXX indicates that the actual measurement will only be smaller than this limit XX% of the time.
- Paverage: deterministic forecast.

The more conservative the forecast is, the highest consumption of fuel is obtained

### Impact on the size of the ESS

- Significant difference in the frequency of blackouts ( $\approx 100\%$  in the best case)  $\rightarrow$  persistence is strongly discouraged.
- Small difference in the consumption of fuel ( $\approx 3\%$  in the worst case)

The use of SteadyEye forecasts can reduce by 15 the size of the ESS



## 4. CONCLUSIONS

The impact of the use of solar forecasts in the control of an isolated hybrid PV-ESS-diesel system is studied through simulations. For this purpose, a simple but efficient control strategy based on short-term PV forecasts is developed. The different scenarios that are proposed in order to analyze the sensitivity of the system to different parameters. The benefits of the use of an accurate solar forecast in terms of genset fuel consumption and ESS sizing is finally demonstrated.

Future steps of investigation:

- Analysis of further energy systems (different climate, bigger ratio of PV/diesel peak power, shorter persistence horizon, etc.).
- Economic impact of the use of short-term forecasts versus overall cost of the system will be studied in future research.

## References

1. T. P. Do, F. Bourry, and X. Le Pivert, « Assessment of storage and photovoltaic short-term forecast contribution to off-grid microgrid operation », in 2017 IEEE PES Innovative Smart Grid Technologies Conference Europe (ISGT-Europe), sept. 2017, p. 1-5. doi: 10.1109/ISGTEurope.2017.8260234.
2. P. Besson, T. P. Do, G. A. Koucoi and F. Bourry, « Integration of Short-term PV Forecasts in Control Strategies of PV-Diesel Systems », in Proceedings of the 8th solar integration workshop, 2018.

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