Dealing with Uncertainty in Microgrids Under Day-Ahead Forecasts: An optimal corrective approach

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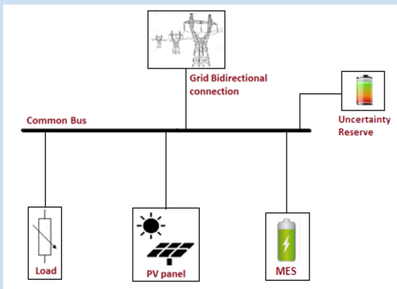
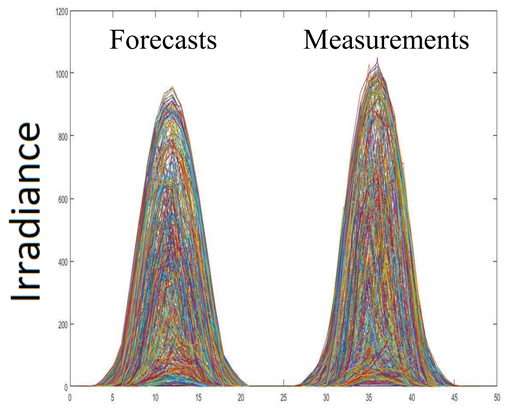
UNCERTAINTY AND MICROGRIDS

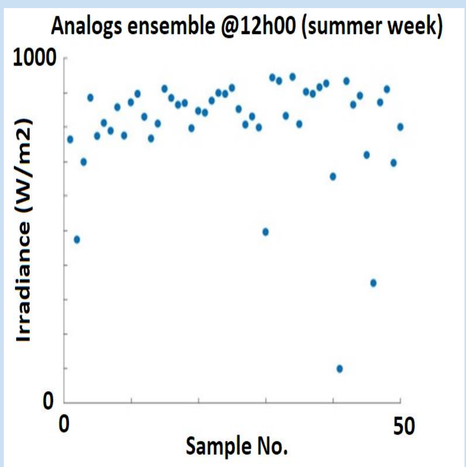
Renewable energy production is intrinsically uncertain, which entails difficulties for the optimal planning and scheduling of resources in renewable microgrids. An approach to deal with this issue is proposed here, that serves as a complement of traditional EMS with the aim of improving the performance and reliability of the system.

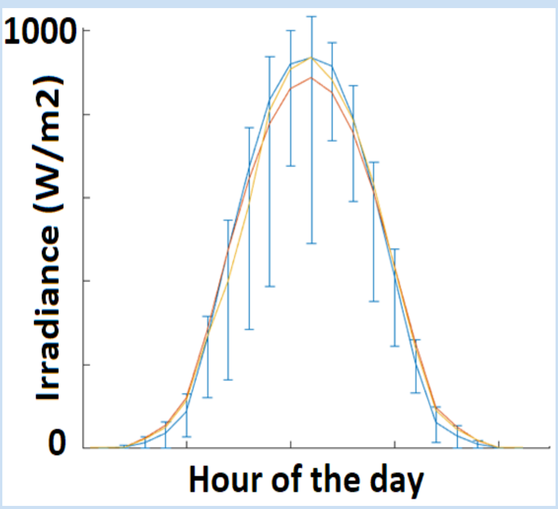


An extra storage element with a 'flat' cost-of-use is the key to achieve this goal. Super capacitors is an alternative.

ADDRESSING UNCERTAINTY







Similarity indicator

$$\|F_t, A_{t'}\| = \sum_{i=1}^{Nv} \frac{w_i}{\sigma_{fi}} \sqrt{\sum_{j=-T}^{T} (F_{i,t+j} - A_{i,t'+j})^2}$$

Hourly ensemble of similar hours

$$AN_t = \sum_{i=1}^{N_a} \gamma_i OA_{i,t_i}$$

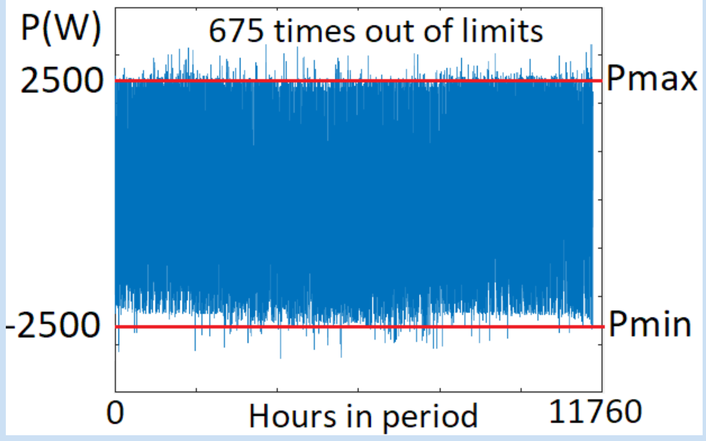
Observations are weighted based on their similarity score

$$\gamma_i = \frac{\frac{1}{\|(F_t, A_{i,t_i})\|}}{\sum_{j=1}^{N_a} \frac{1}{\|(F_t, A_{j,t_j})\|}}$$

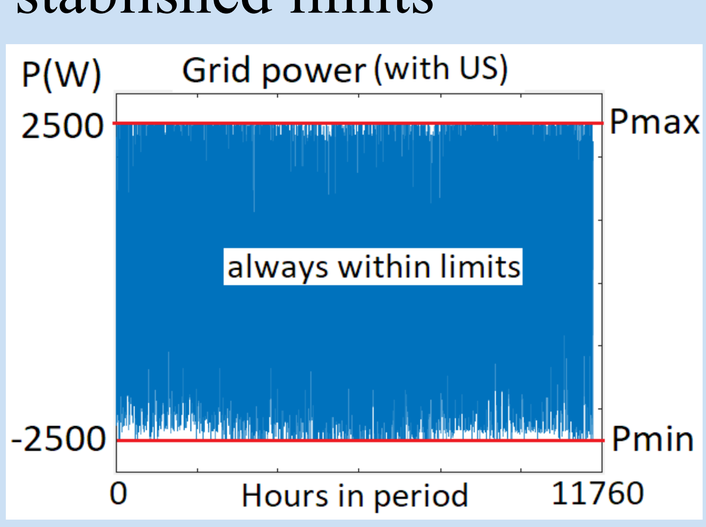
Weighted Average Forecast

Uncertainty is computed out of the standard deviation of the analogs ensemble for every hour of the day

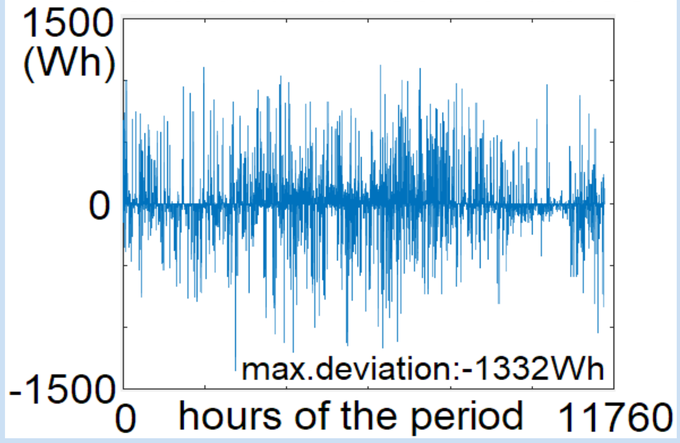
PRELIMINARY RESULTS



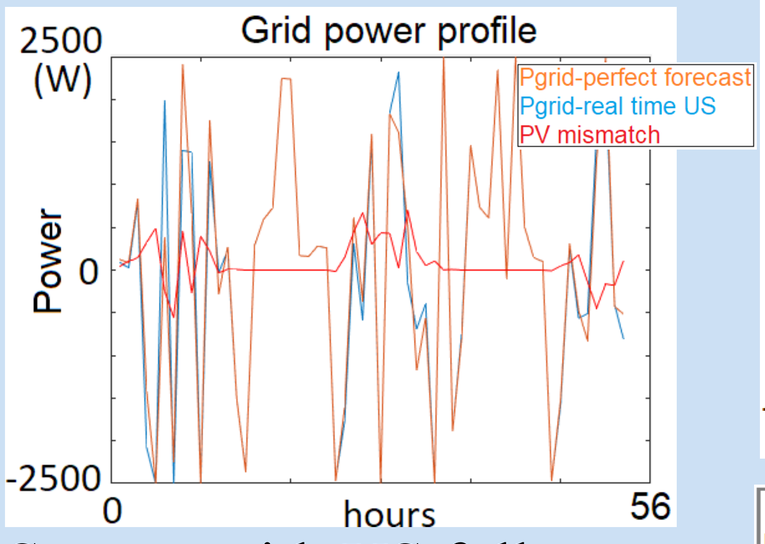
Mismatches between forecasts and real conditions make the grid power surpassing the stablished limits



The uncertainty storage implementation eliminates the problem



The state of charge of The US showed stability During the entire period (490 days-hourly)



System with US follows very closely the ideal grid profile and recovers from PV mismatches

THE OPTIMIZATION PROBLEM

$$Min\ f(P_{grid}) = \sum_{h=1}^{H} \Delta t \cdot Power_{grid}^{h} \cdot Price^{h}$$

$$E_{storage} + E_{grid} + E_{PV} + E_{load} + \Delta SoC_{SR} = 0$$

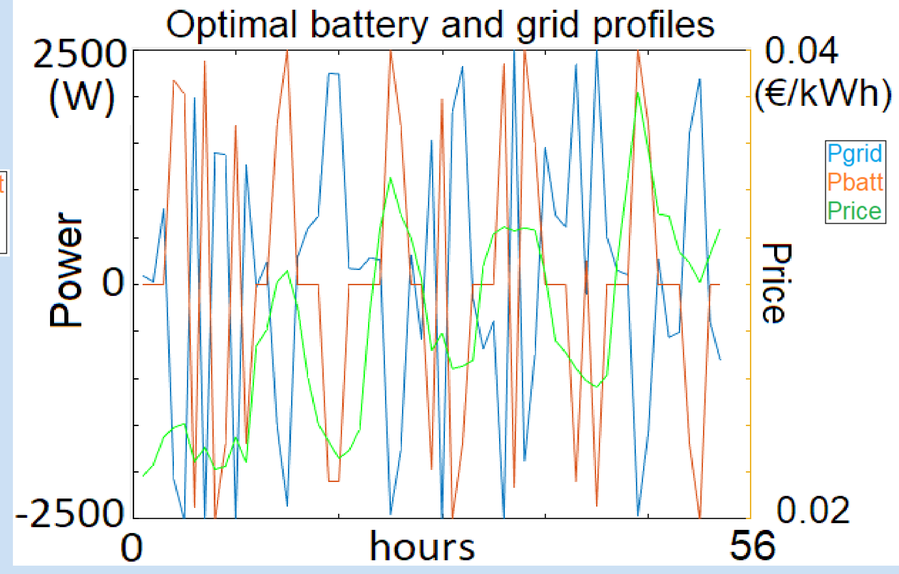
$$SoC_{storage}^{ini} = SoC_{storage}^{end}$$

$$SoC_{storage}^{t} - \Delta t \cdot Power_{storage} \leq SoC_{storage}^{max}$$

$$SoC_{storage}^{t} - \Delta t \cdot Power_{storage} \geq SoC_{storage}^{min}$$

$$P_{storage}^{min} \leq P_{storage} \leq P_{storage}^{max}$$

$$P_{grid}^{min} \leq P_{grid} \leq P_{grid}^{max}$$



Total cost over study period

Perfect-forecast system: 64.02€
Uncertainty-Storage system: 64.13€(+0.18%)

Coming Tests
- Different time steps for optimization
- US sizing from uncertainty estimations
- Real-time US size allocation

REMERCIEMENTS

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