Application of solar radiation forecast for the management of a mixed PV-biomass power plant: a preliminary evaluation.

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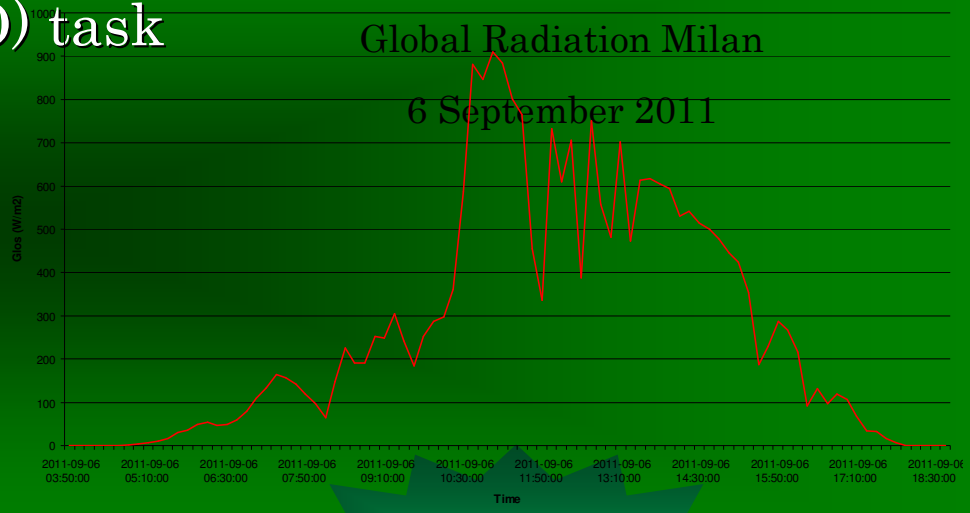
Introduction

20-20-20 targets by EU → Boost to Renewable Energy Sources (RES) → Criticalities on the Italian trasmission grid

Transmission System Operator (TSO) task

Observed Demand

Forecasted Demand



uncertainty

RES high variability

unbalance between power demand and power bid

Introduction

unbalance between power demand and power bid

RES → Priority dispatch (rule constraint)

RES → Cannot be modulated (technical constraint)

TSO

Power drastic reduction

Power plant shedding

Early production forecast → saving of energy reserve

Governmental Rule
"system with predictable input energy profile"

System with predictable input energy profile

Ministerial Decree Aug-2010 (art.2, par.1, lett.q):

- PV plant (200KW- 10 MW) + power plant (less or equal the PV power (P))
- 10% daily error on hourly power forecast (8.00 a.m – 8 p.m) supplied by the RE producer the day before for 300 days a year.

$$err_{day} = \frac{\sum_h |P_h^{obs} - P_h^{for}|}{\sum_h P_h^{for}}$$

$$N = \sum_{day} (err_{day} < 10\%) \geq 300$$

First CASE: radiation forecast + PV

Extra Bonus = 53 €/MWh (20% of the feed in tariff on PV plant)

Second CASE: radiation forecast + PV + Biomass Plant

EDISON

RSE Ricerca Sistema Energetico

PV plant characteristics:

- STC (standard test conditions) efficiency modules = 17%
- BOS (balance of system) efficiency = 75%
- Area = 8 m^2/kWp
- Power = 200 kWp


Edison PV plant - Milan

Production [kWh] =
irradiance [kW/m^2] *h* 17% * 75% * total area [m^2]

RSE global radiation forecast applied to a PV plant

Global Model ECMWF → LAM Model: LAMI (ARPA EMR) 7 Km → pres, temp, rhu, liquid/ice water content, cloud cover +72 h (1h step)

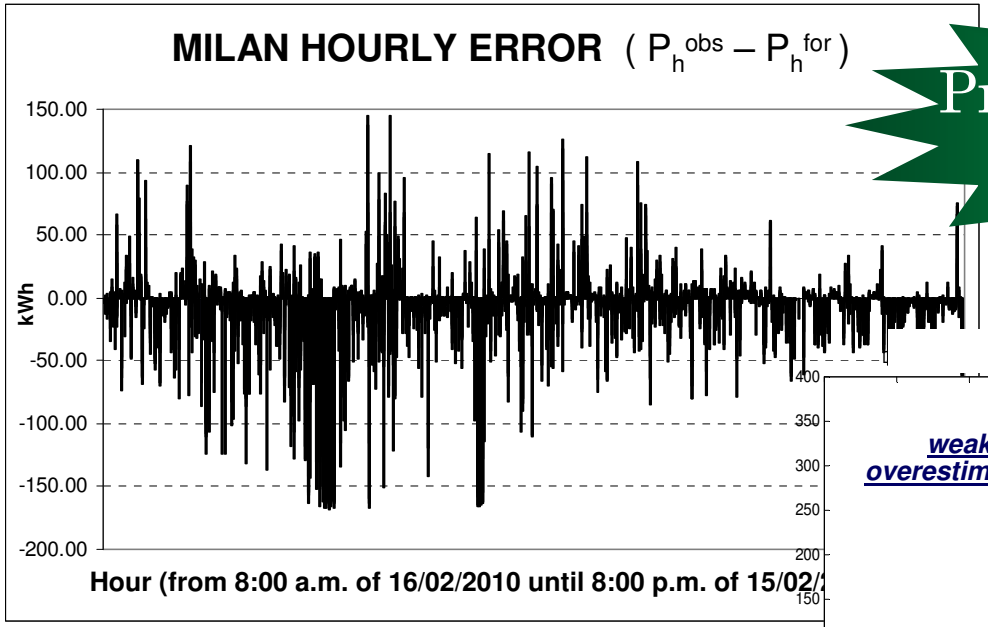
RTM: Radiative Transfer Model (Geleyn-Hollingsworth) → Global horizontal irradiance +24 h (1h)

Verification period:

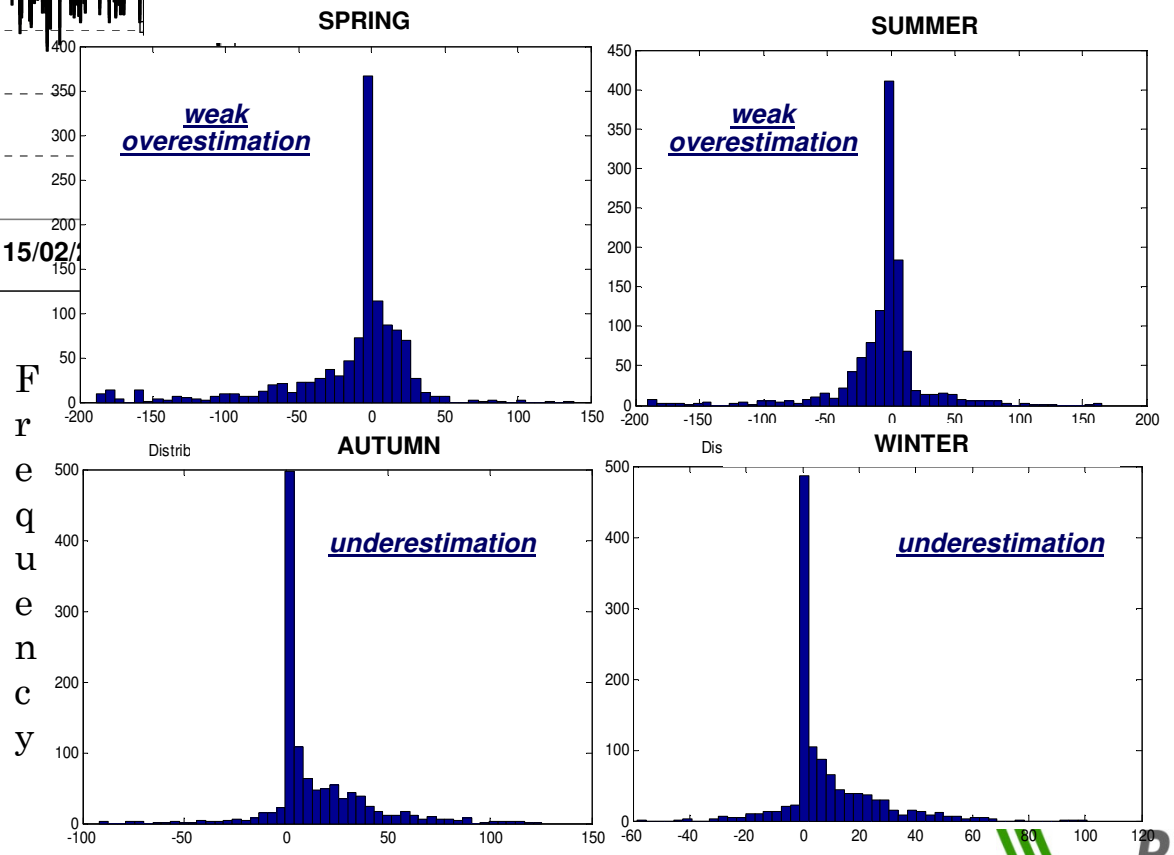
February 2010 – February 2011

EDISON

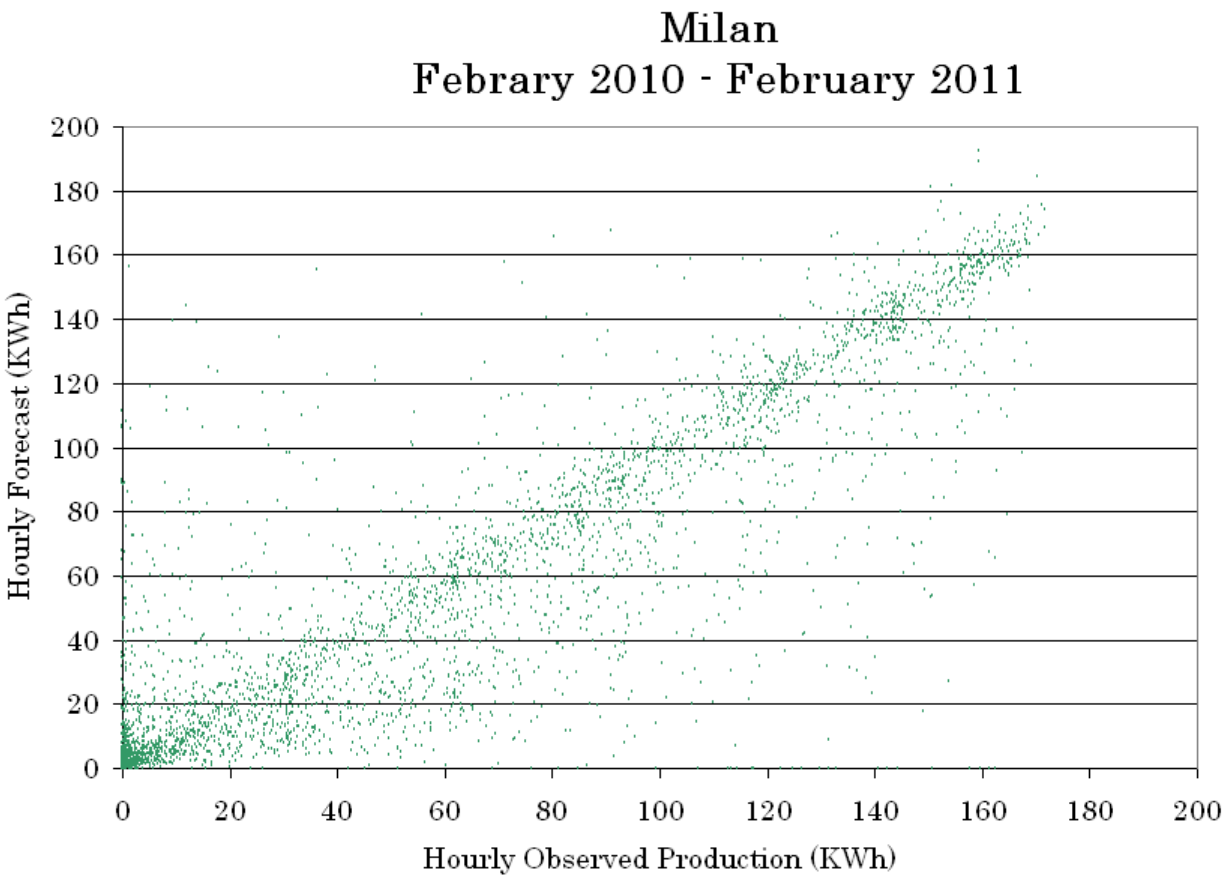
RSE global radiation forecast applied to a PV plant



Production forecast overestimation



RSE global radiation forecast applied to a PV plant



	KWh
RMSE	24.21
MAE	12.79
BIAS	4.69

$Err_d < 10\%$	RSE forecast	Rule constraint
N days	83	300

EDISON

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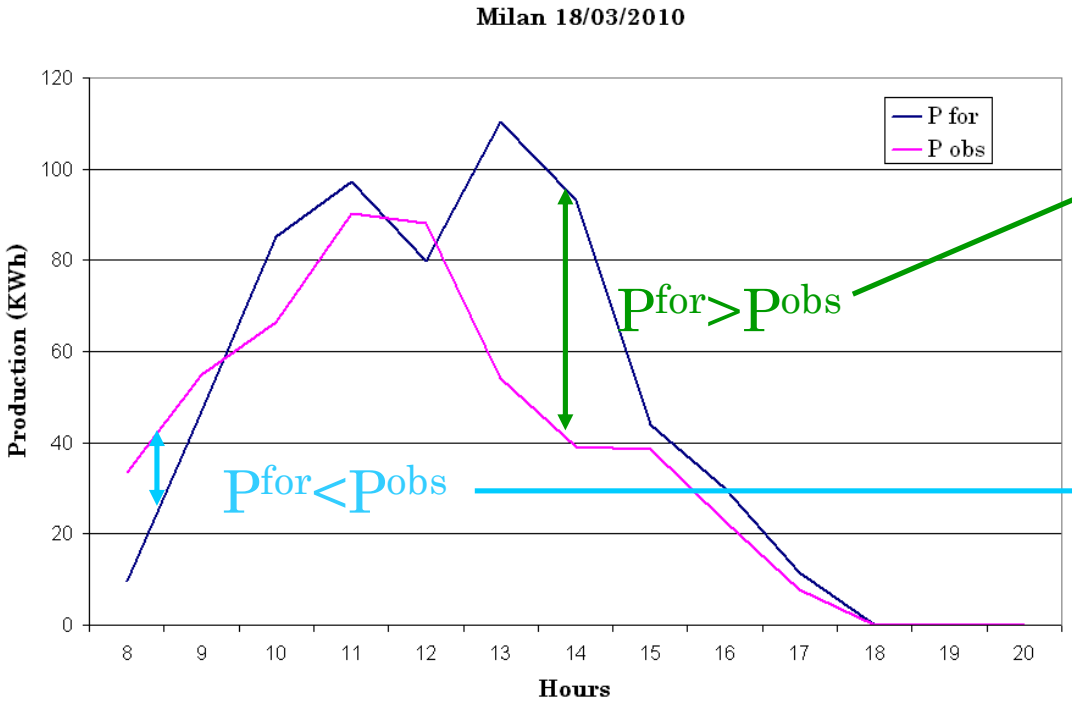
Mixed solar - biomass power system

Main features of biomass power plant:

- Wood chips power plant
- Electrical efficiency = 24%
- Power plant = 200 kWp
- Feed in tariff = 280 €/MWh with P<1MW



Biomass plant production ↑

Biomass plant production ↓

Economic assessment

- CASE A. REVENUE: PV (no extra bonus) + full power BIOMASS => two separeted power plants (1 year)
- CASE B. REVENUE: PV (with extra bonus) + modulated BIOMASS => integrated system (1 year)
- DIFFERENTIAL REVENUE: economical loss of biomass modulated plant

Economic evaluation	k€
A: PV+Biomass Revenue at full power	491
B: PV+Revenue of modulated biomass	441
C: Avoided biomass source costs	11
(B+C)-A : Revenue Variation	-39

-6% with respect to the biomass revenue at full power considering the PV extra bonus

Conclusion

- The radiation forecast alone is not enough to get the PV extra bonus
- The integrated PV-Biomass system causes an economic loss
- The loss depends on different factors (type of biomass source, source cost…)
- Appropriate incentive
- Forecast improvement by statistical postprocessing
- Smart grids
- Virtual power plants

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Thank you