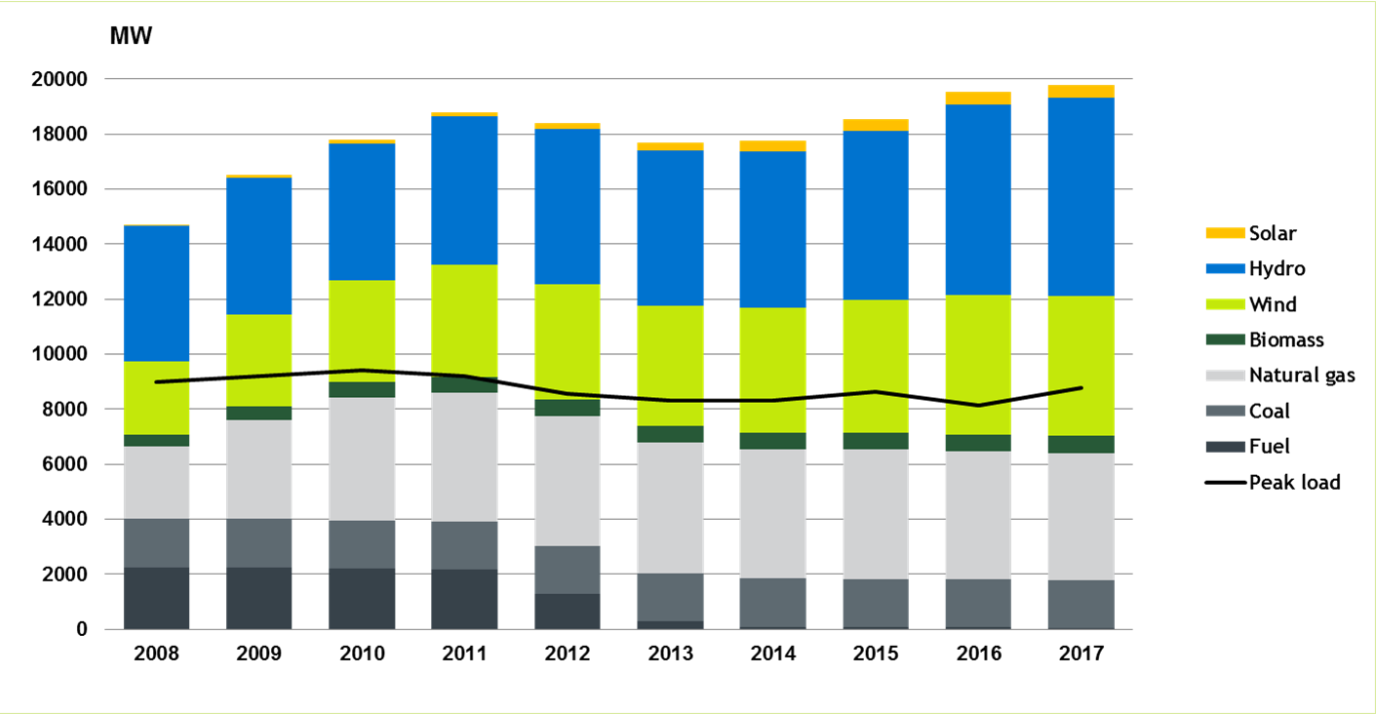
Wind and Solar Forecasting in Portugal
Status and Prospects

Rui Pestana - 20th June 2018

Topics

- Installed capacity in Portugal
- Energy supply in 2017
- Wind extremes in 2016 and 2017
- Wind power forecast tender
- Wind & Solar with SCADA
- Solar PV forecast
- Conclusions

Installed capacity in 2017



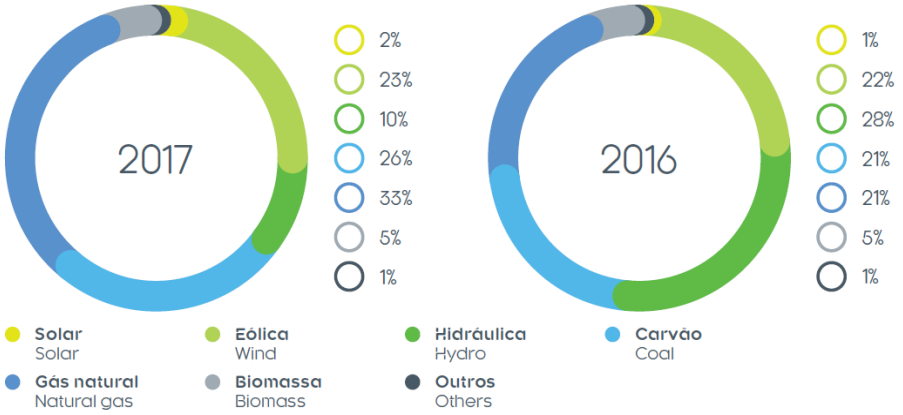
	MW
TOTAL	19 800
RENEWABLE GENERATION	13 397
Hydro	7 193
Wind	5 090
Biomass	624
Solar	490
NON-RENEWABLE GENERATION	6 403
Coal	1 756
Natural Gas	4 607
Others	40
PEAK LOAD	8 771
Hydro pumps	2 698

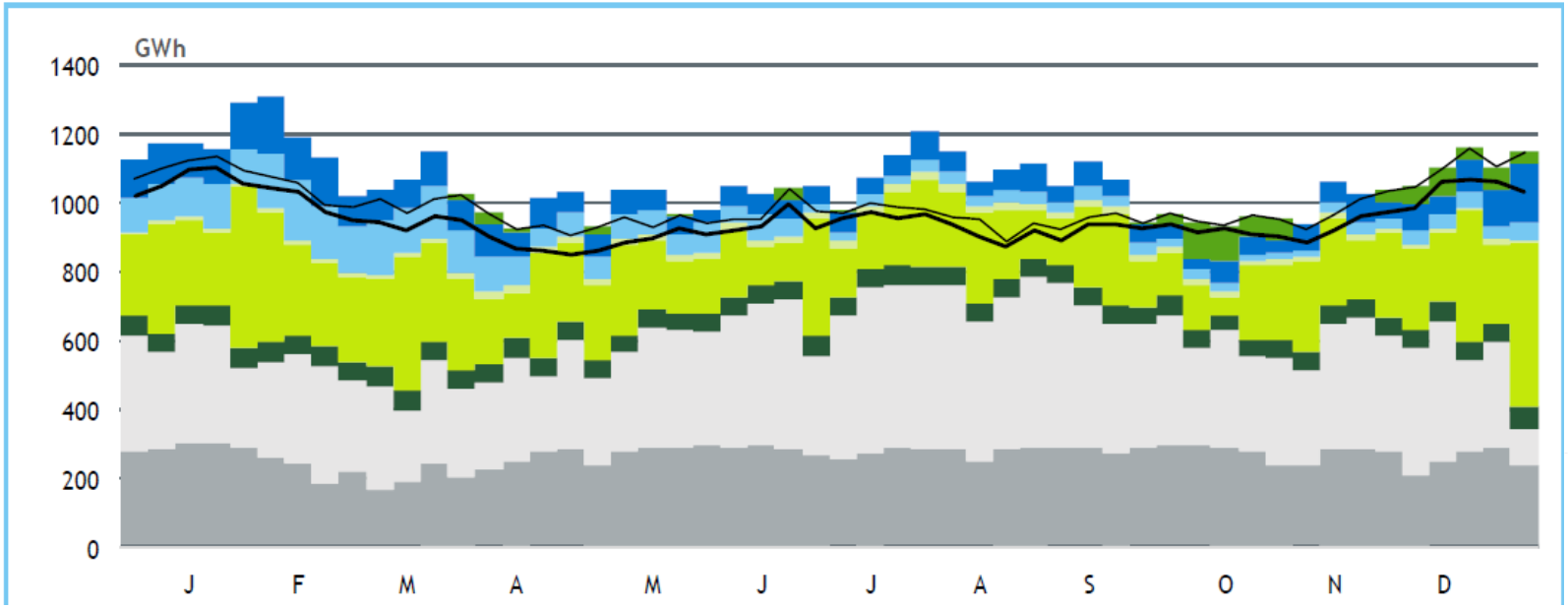
Peak load is less than half of total install capacity

Very good mix of flexible generation (Hydro & NG)

Energy supply in 2017

- Solar 2%
- Wind 23%
- Hydro 10% (dry year)
- Biomass 5%





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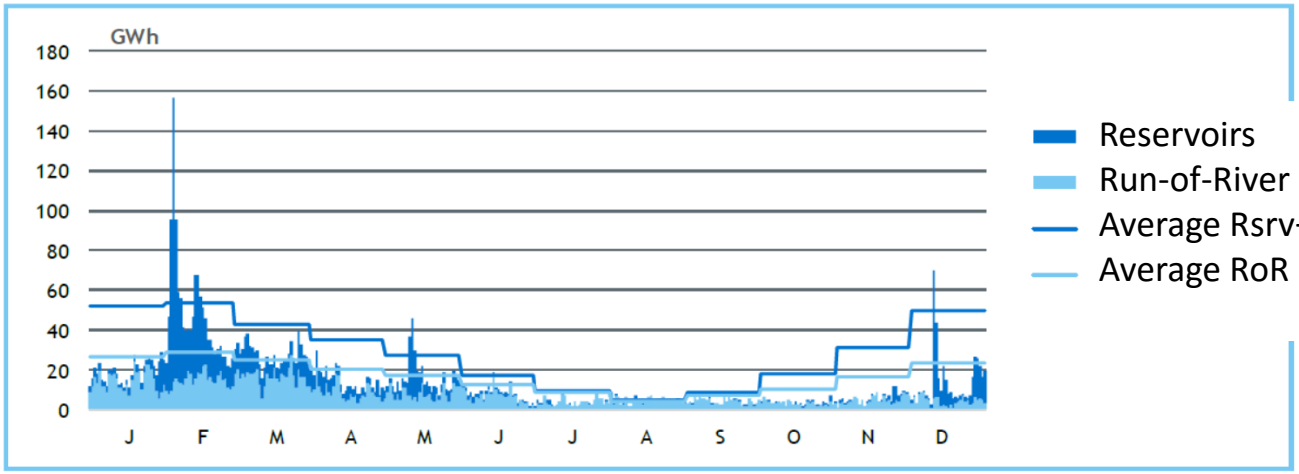
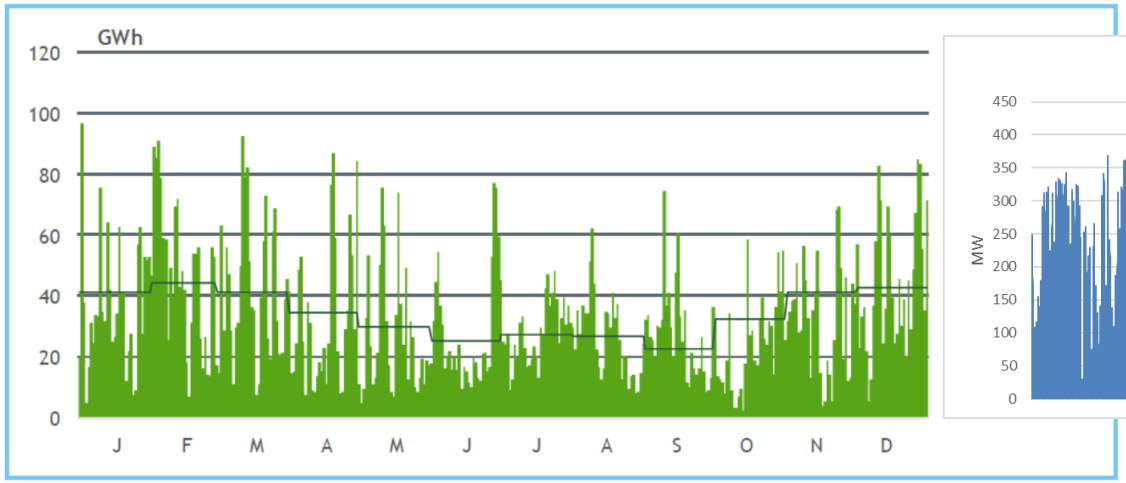
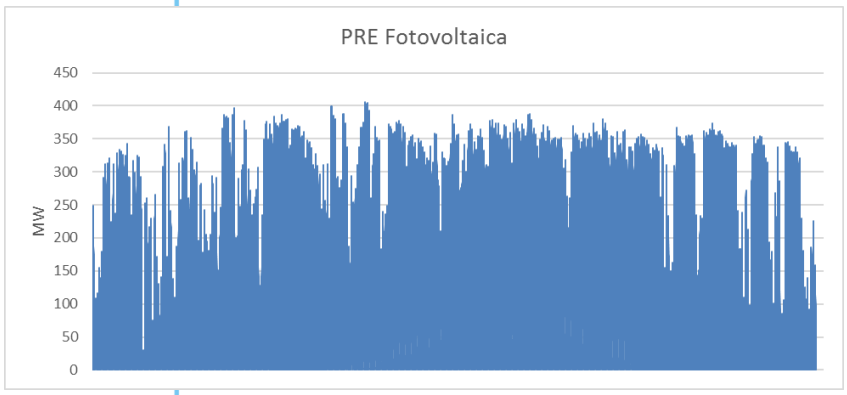
Hydro – season behavior



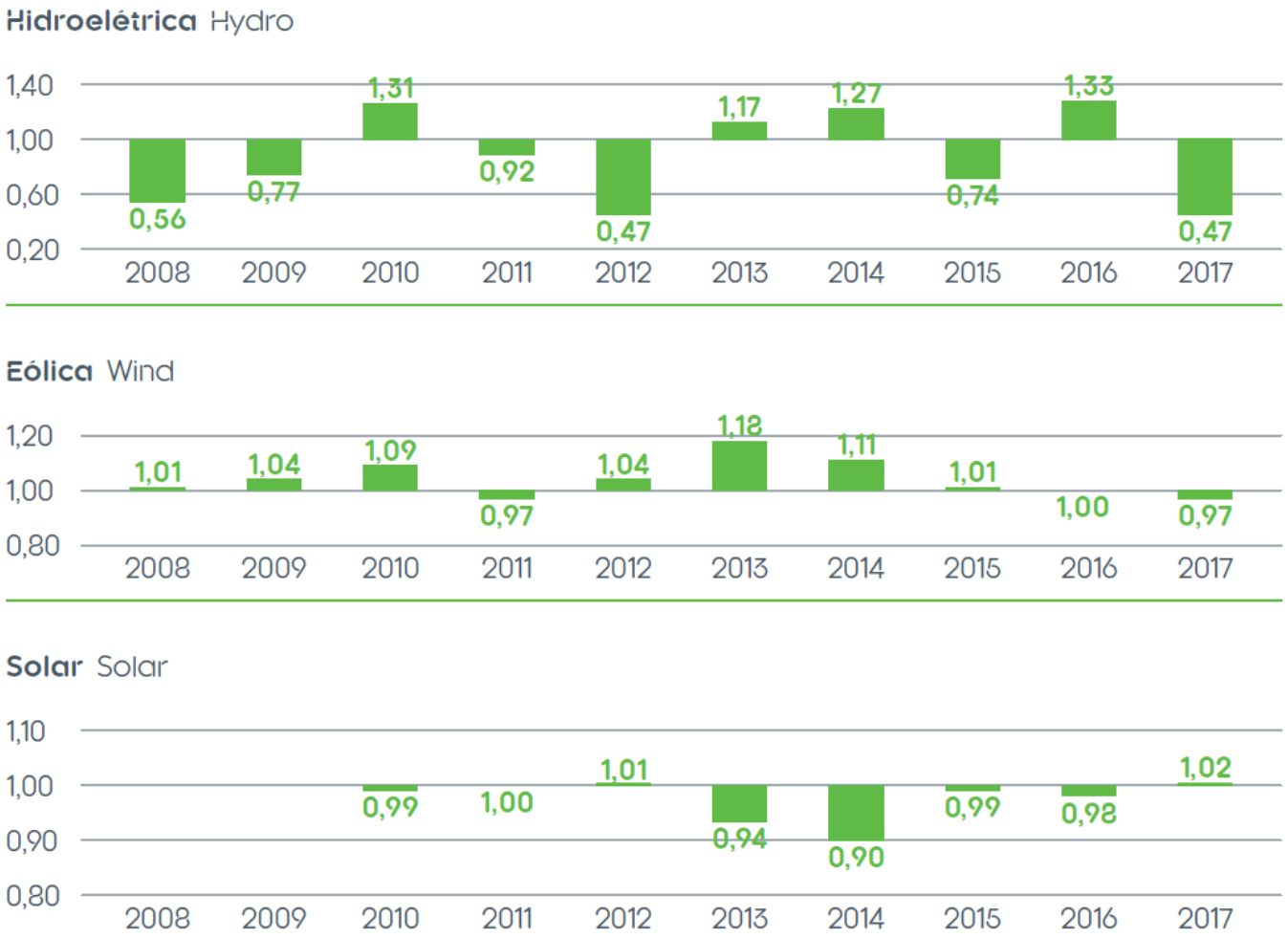
Wind



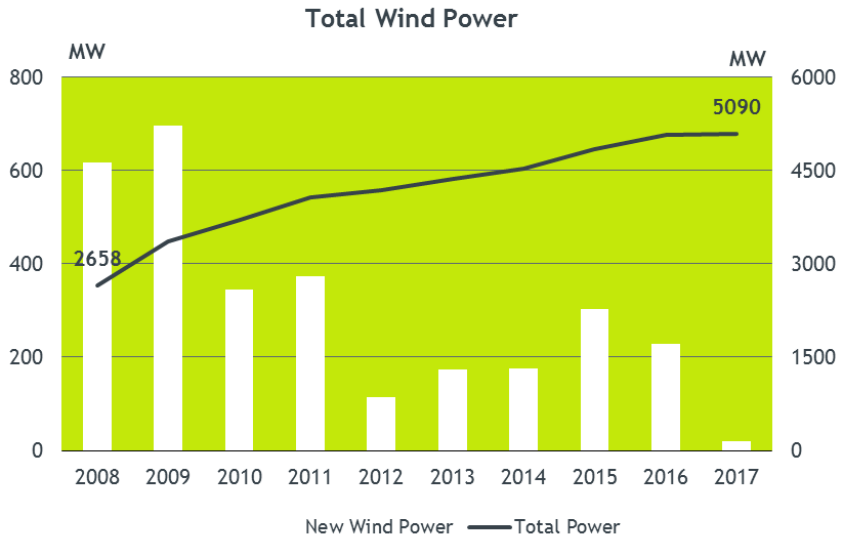
Solar

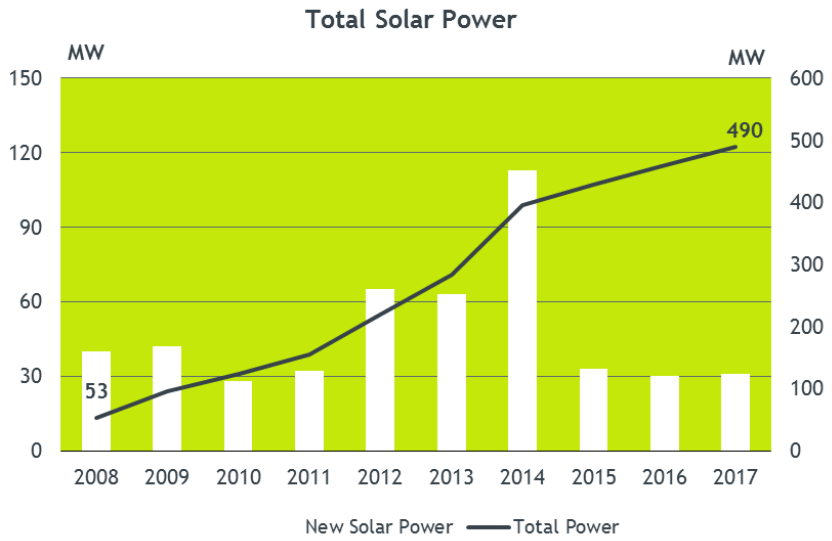


Renewable Capability factor (yearly)

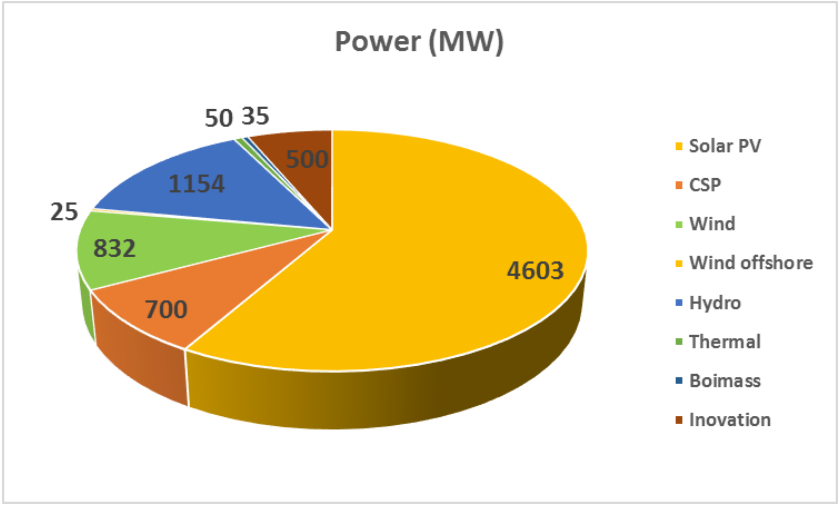


Wind and Solar power install capacity



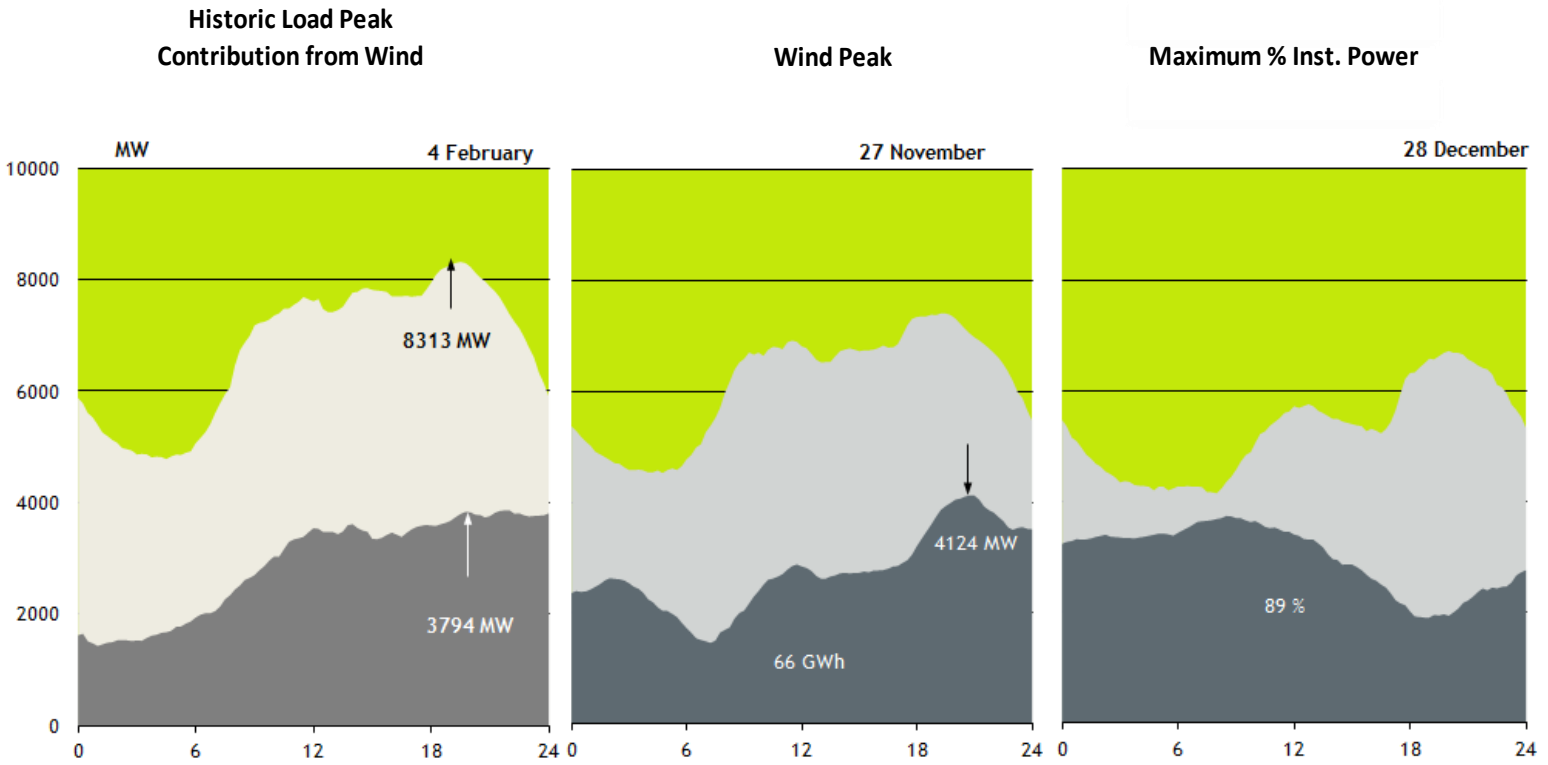


New requests from Producers (Dec-17)



Extremes in 2014

- 89% of the load was delivered by wind (instantaneous)



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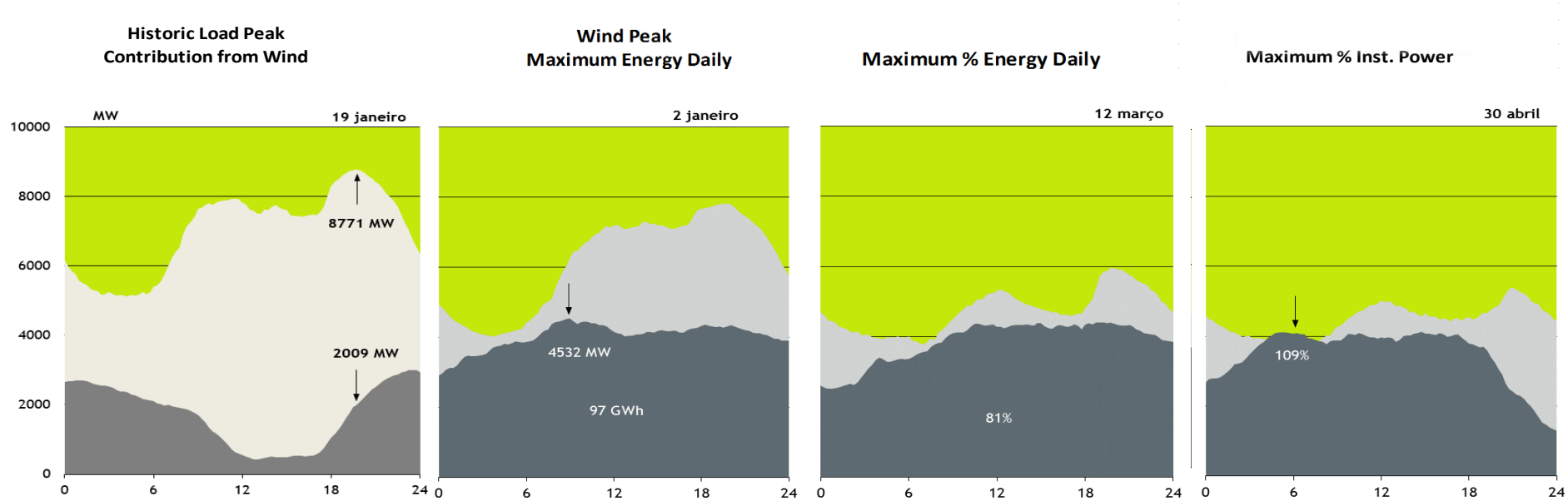
Extremes in 2017

- 109% of the load was delivered by wind (instantaneous)



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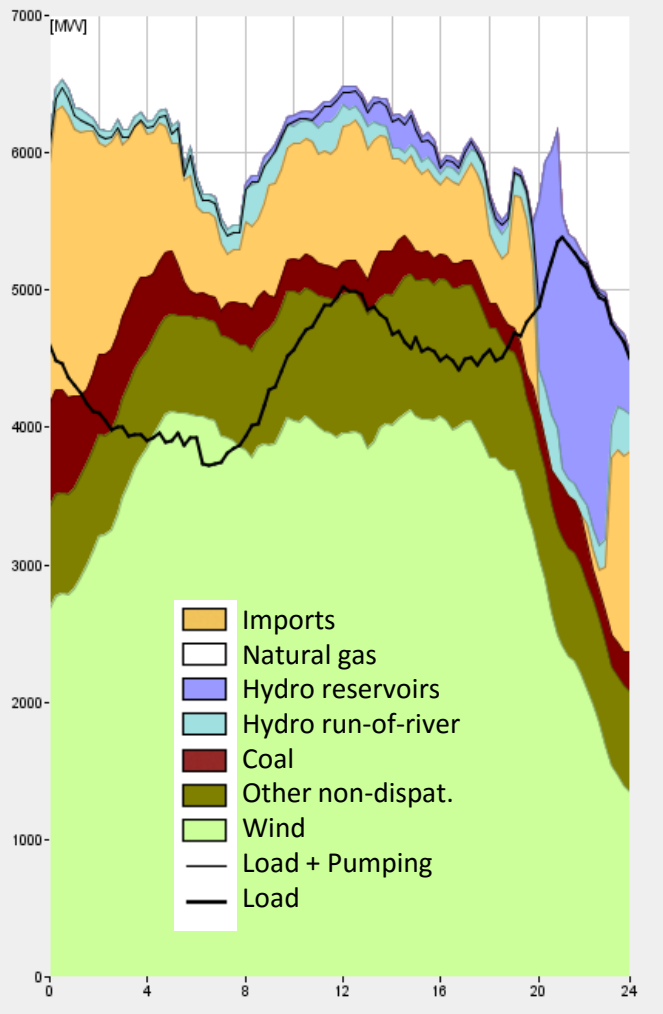
Extremes in 2017 (30th April)

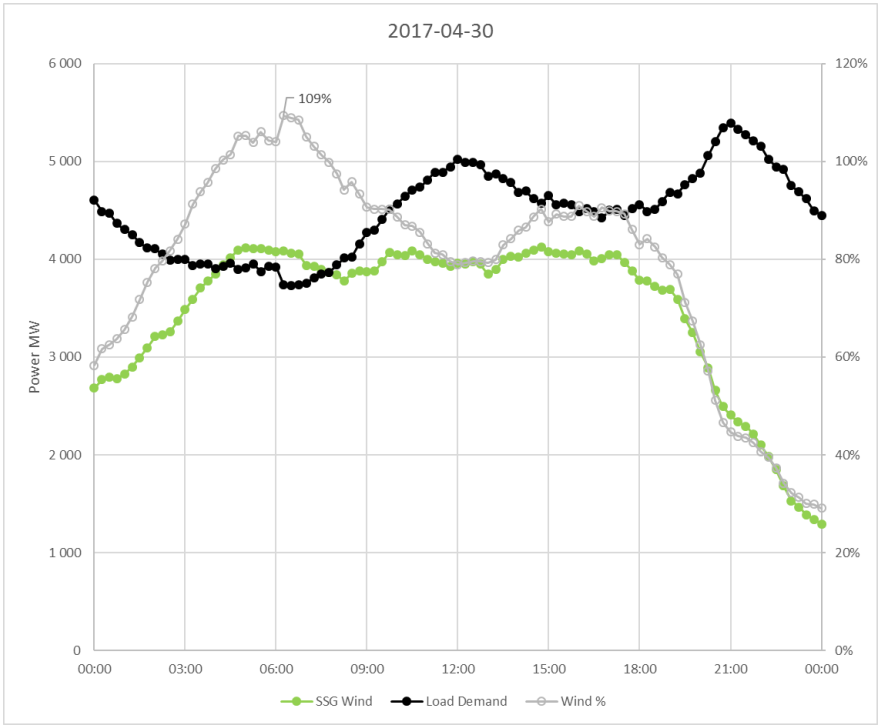


109 % = Wind / Load

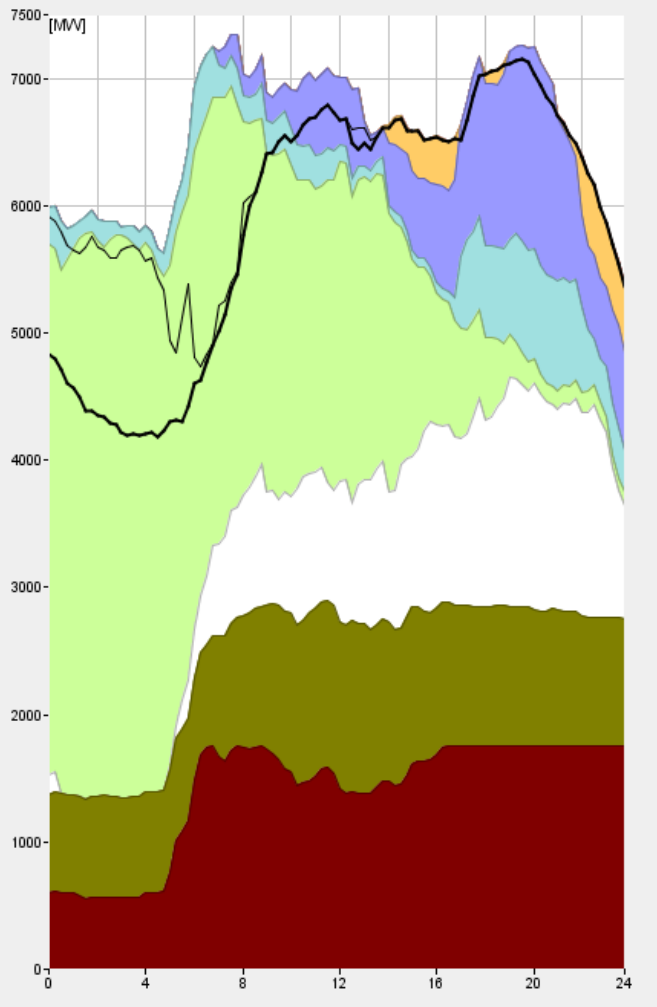
72 % = Wind / (Load + Pumping + Exports + Losses)

72 % = Wind / (Generation + Imports)

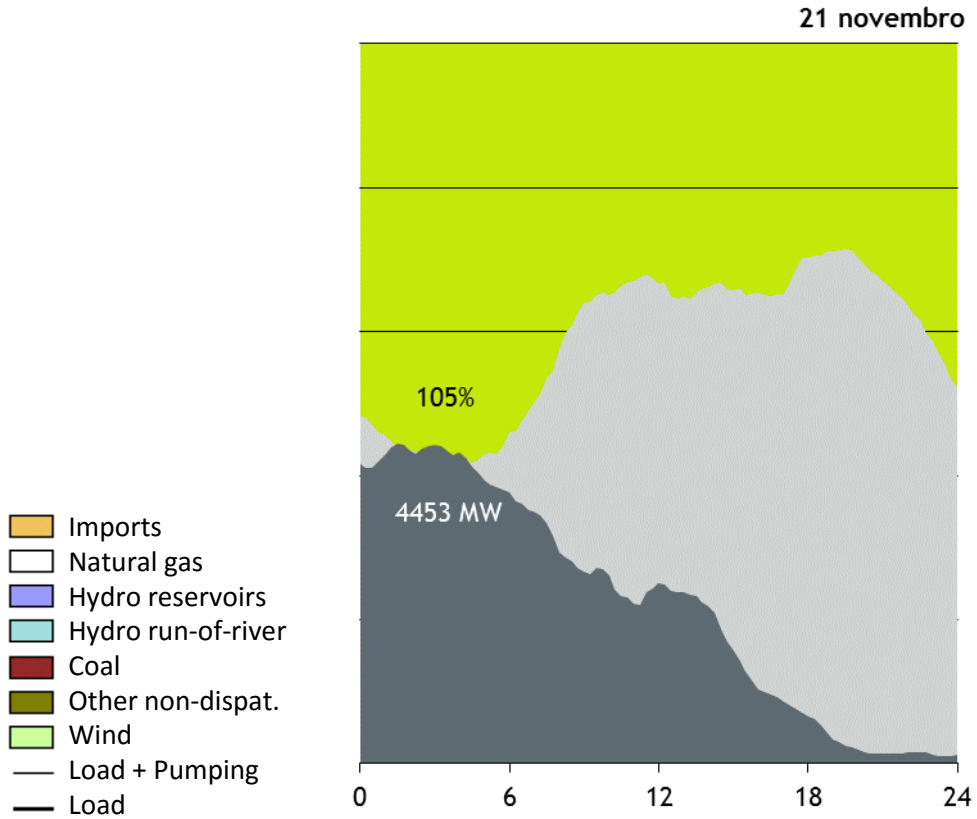
80 % = Wind / Generation



Extremes in 2016 (21st November)

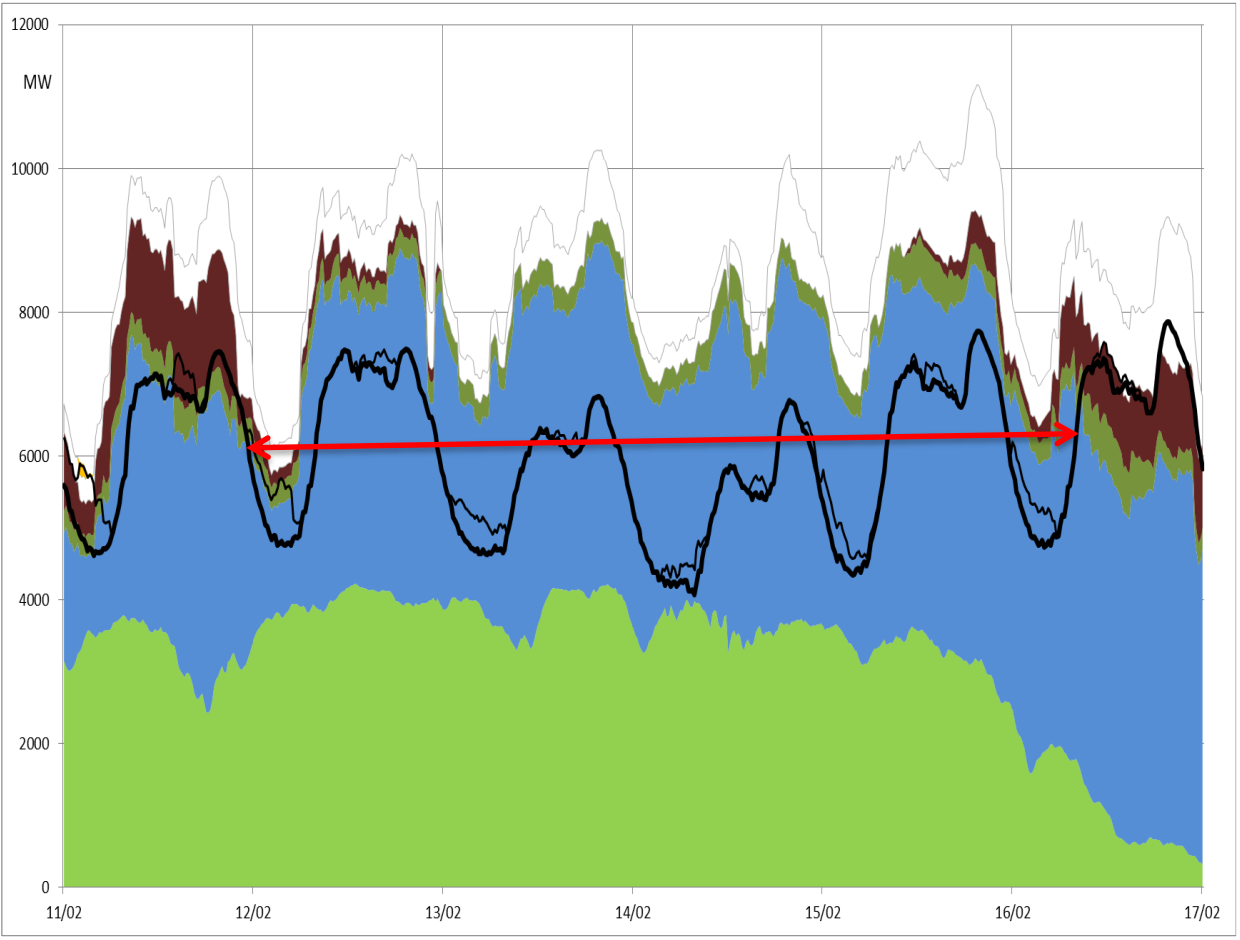


From Maximum to minimum (99 MW) in 22 hours



Wind and Solar Forecasting in Portugal – Status and Prospects

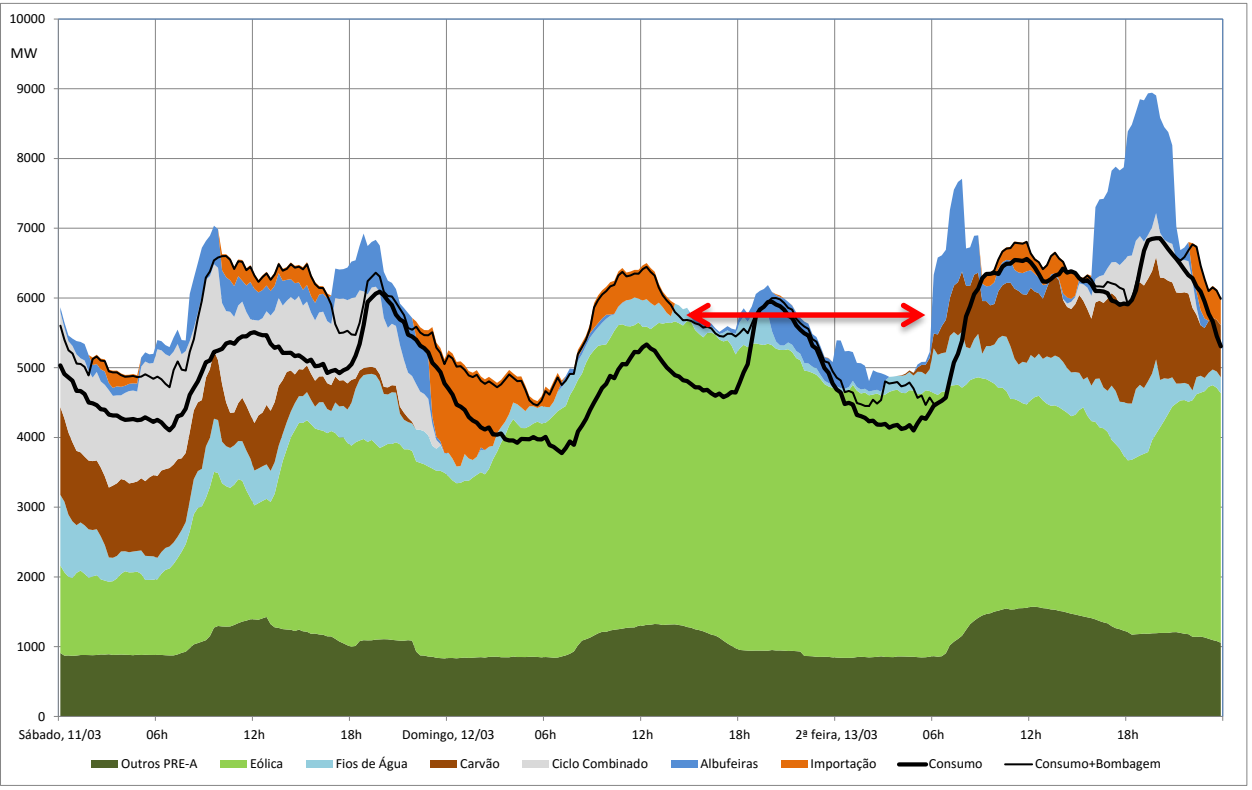
In Feb-2016, RES has supplied all national consumption for 4 consecutive days (Wind and hydro were the main RES generation sources)

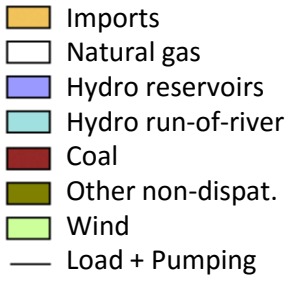


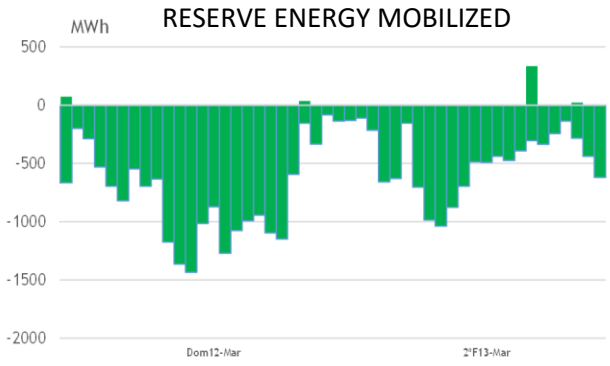
Minimum demand load	4.078 MW
Maximum demand load	7.737 MW
Average wind share	60%
Average hydro reservoir share	36%
Average hydro run-of-river	33%
Other RES share	5%

In Feb-2017, Wind was curtail for the 1st time (and only time)

Total order of curtailment of 1388 MWh (/11974 GWh) = 0,0116%

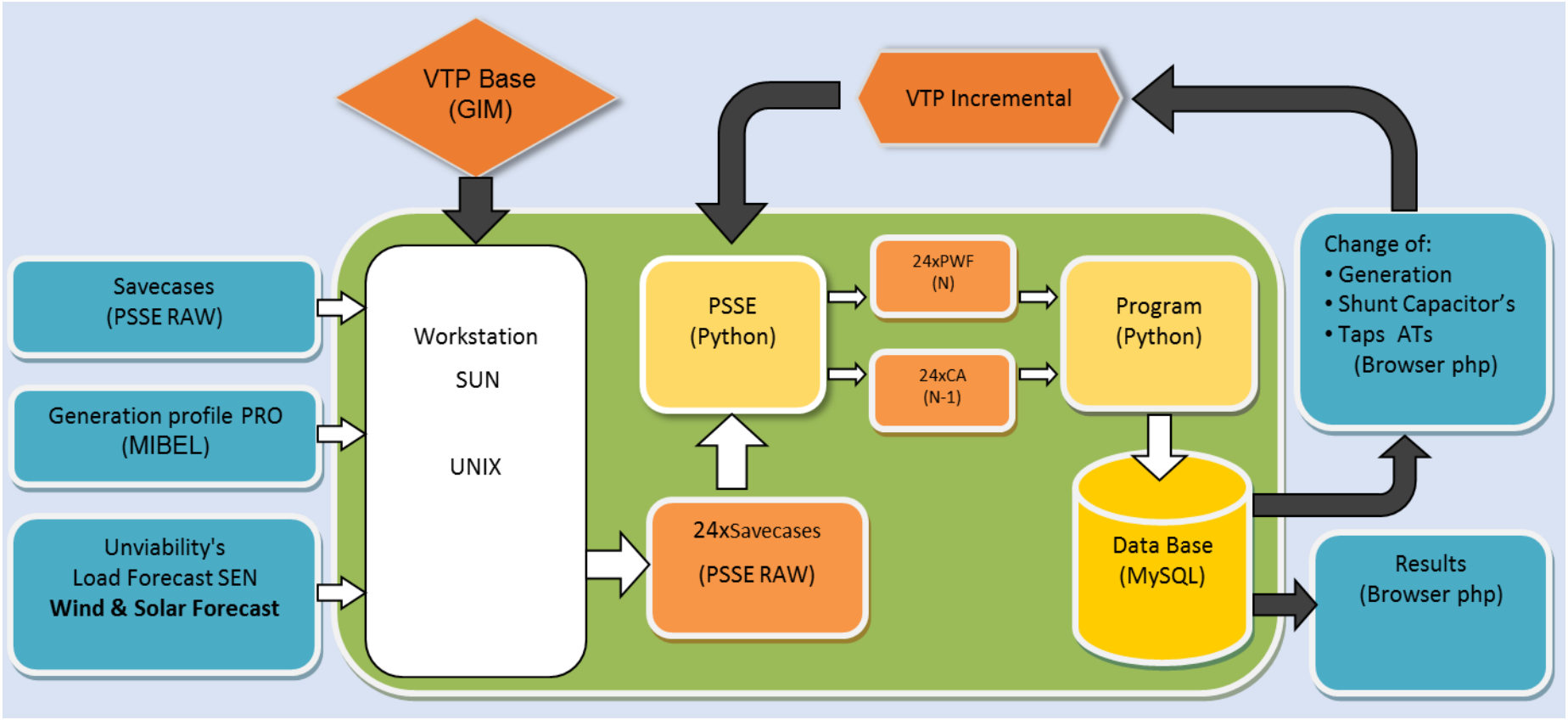






Security Analysis process

- REN developed internally a tool for the validation of the day ahead market, that takes in consideration the last wind and solar forecast:



Annual wind power forecast tender by REN (PT TSO)

- Invited 10 provider, 8 have accepted.
- 2 months real trial period.
- 120 wind farms, totalizing 4300 MW.
- Ranking multi-criteria formula:

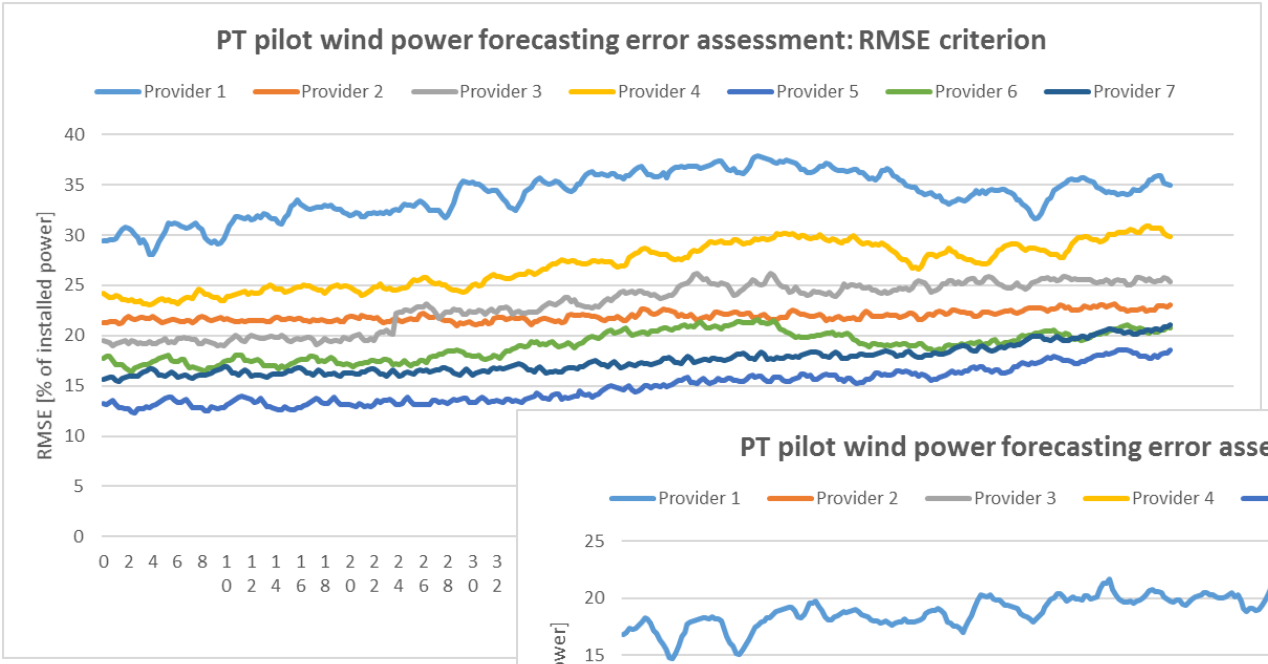
$$Rank = V_{Time\_Horizon} + V_{Reliability} + 4xV_{Performance} + 2xV_{Cost}$$

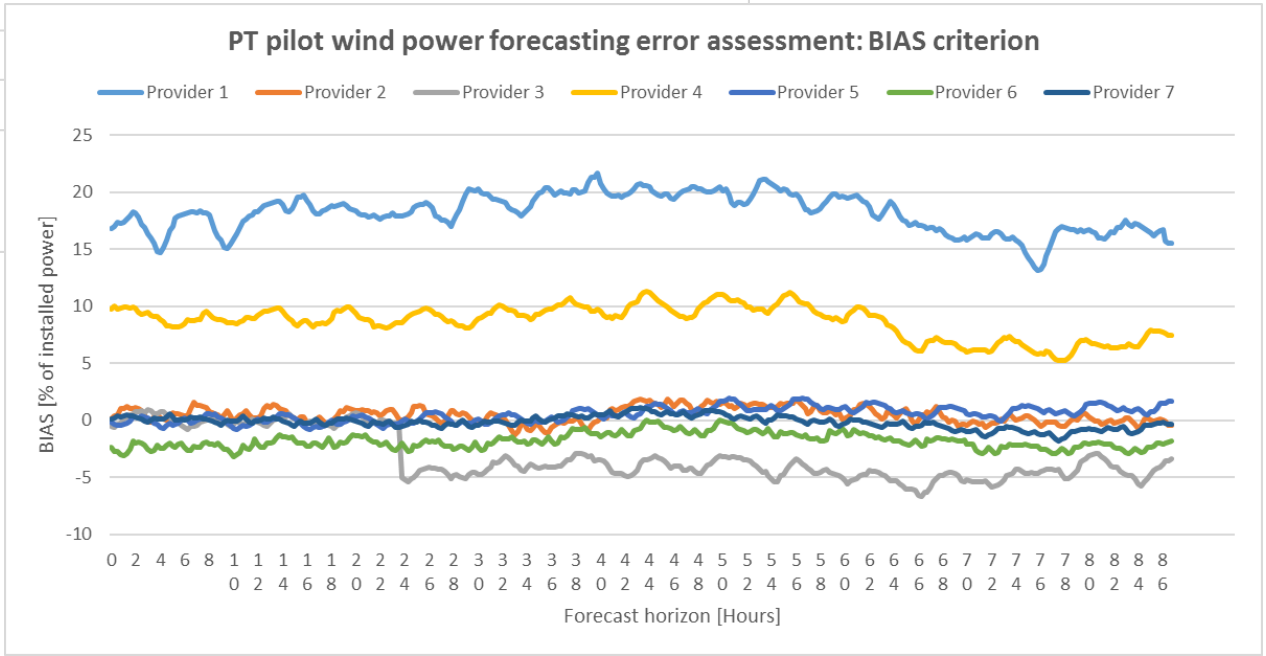
- Performance formula:

$$V_{Performance} = 25\%\ Perf\ (D) + 50\%\ Perf\ (D\text{-}1) + 25\%\ Perf\ (D\text{-}5)$$

- Best 2 have a two year contract, next 2 have one year contract.

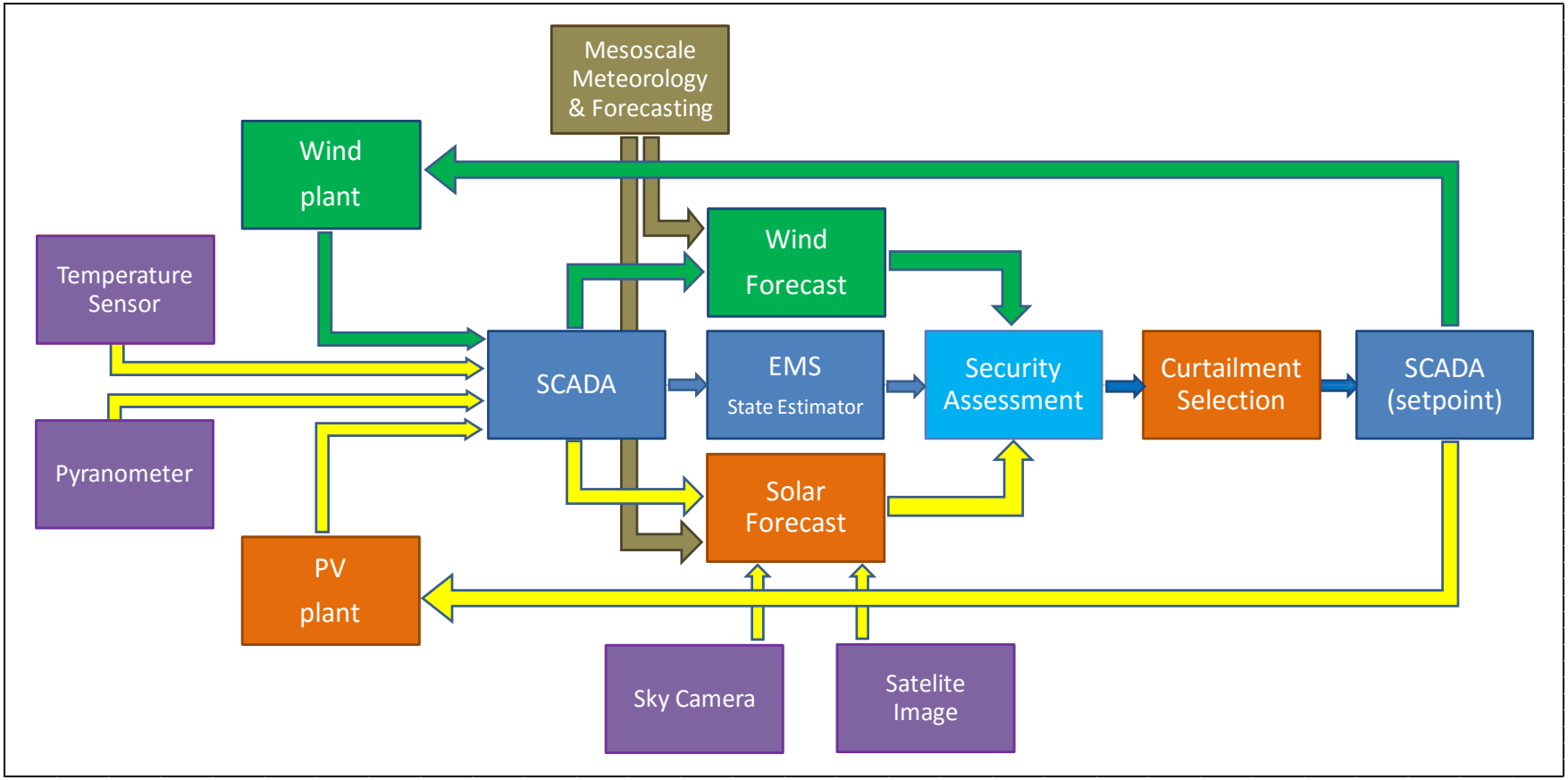
Wind power forecast assessment (#7 providers, 3 days)





Wind & Solar forecast with SCADA

- REN has meteorological sensor's at the substation that can improve the very short term forecast:

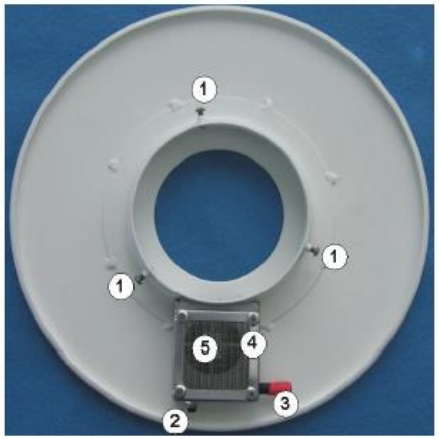


Sky Camera's in Portugal

1. SRF-02 since May 2015 (Lisbon)

- Without solar shield
- With solar shield and ventilation

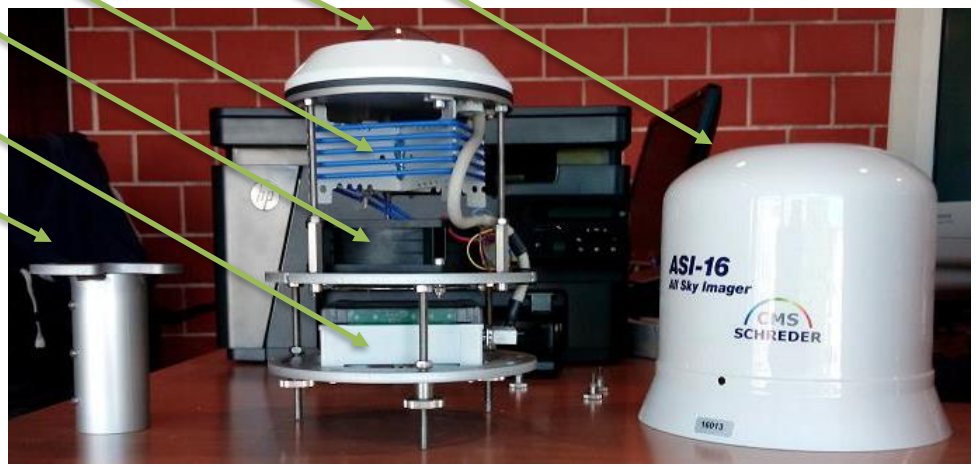
  (Mid October 2015)



Sky Camera's in Portugal

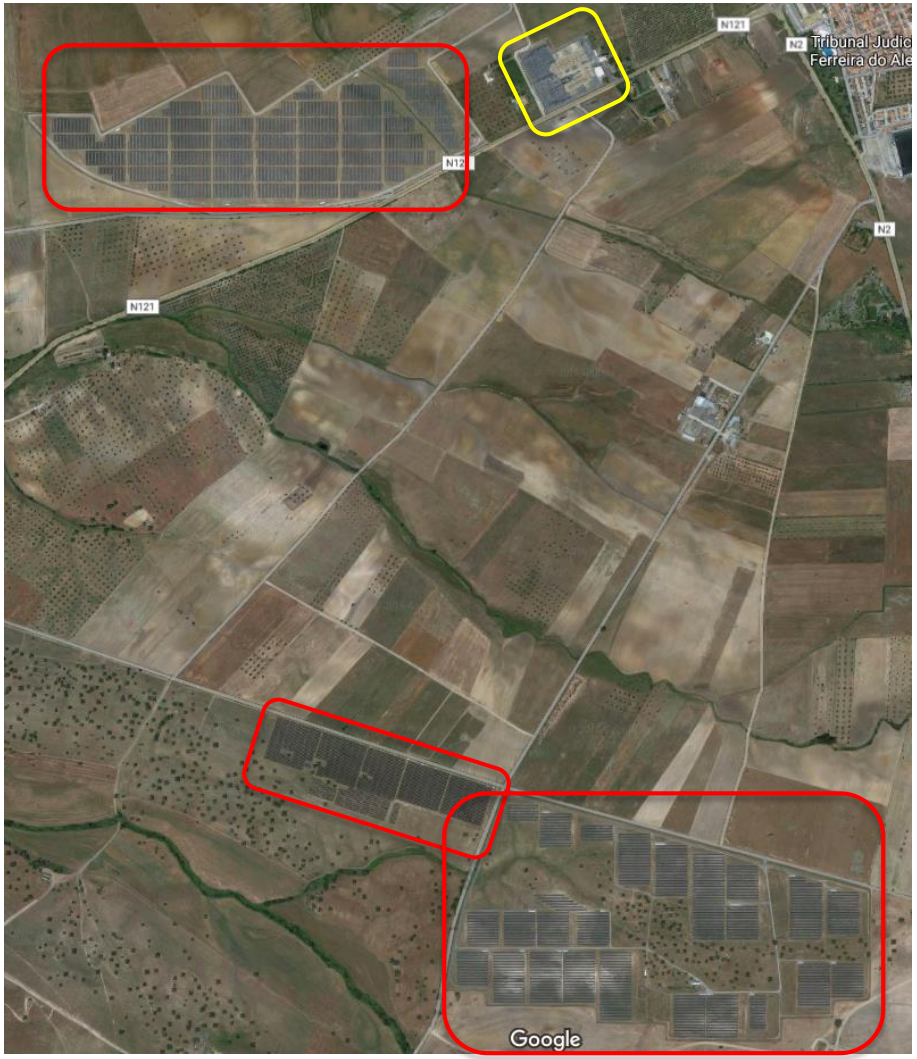
2. ASI-16 since Oct 2016 (Alentejo)

- Solar shield
- Camera
- Heating
- Ventilation
- CPU
- Support



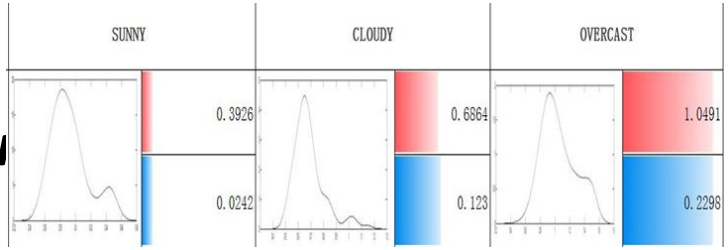
Sky Camera's in Portugal

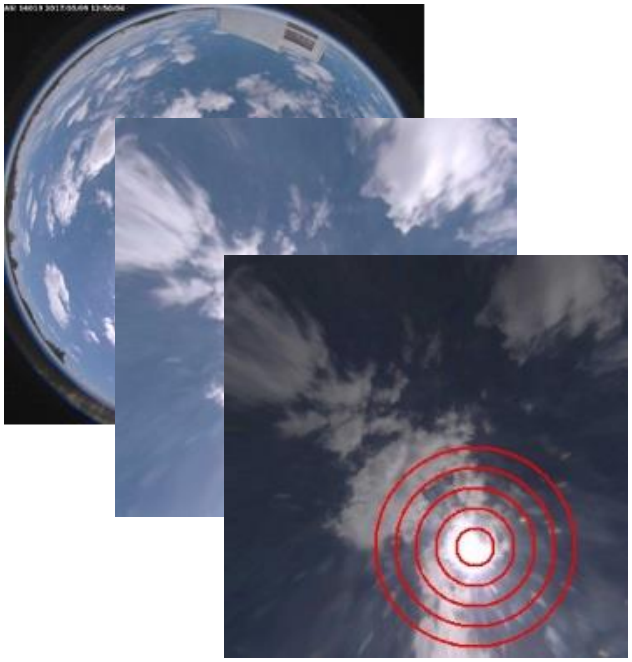
- ***Ferreira do Alentejo***

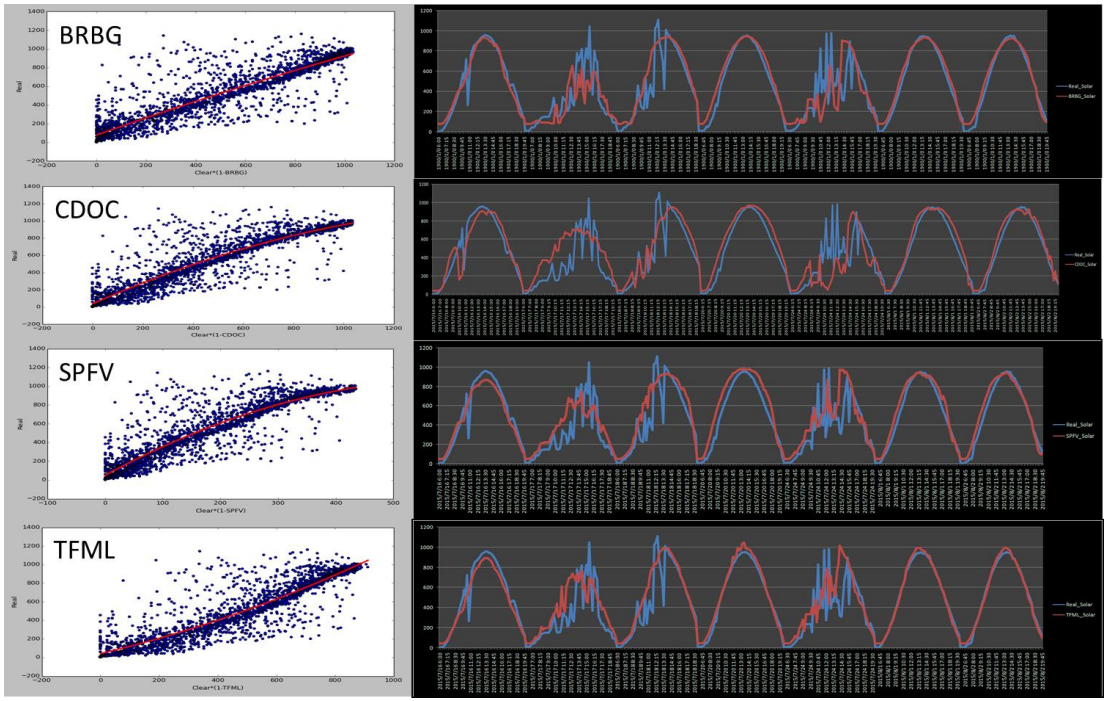


Cloud Index – developed by R&D NESTER

- ***SPFV – Solar Pixel Solar Vector***
- ***TFML – Texture Feature over Mean Lu***

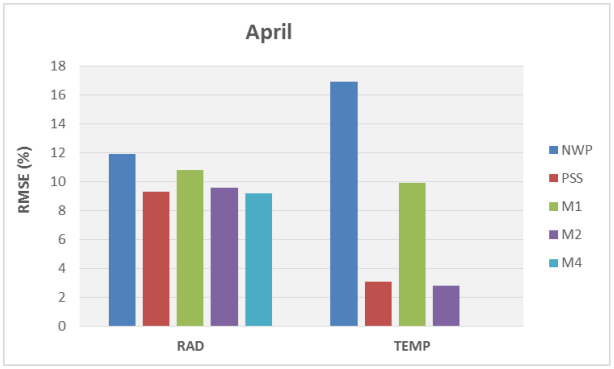


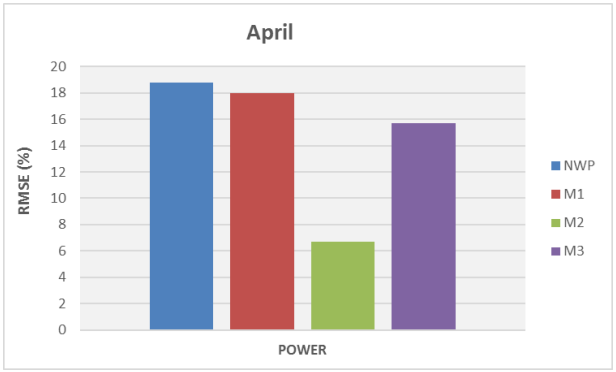


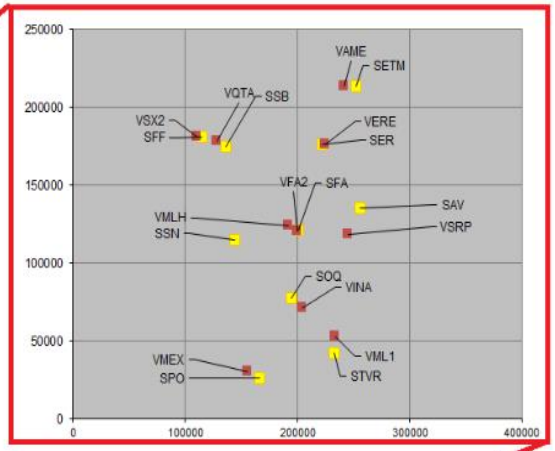


Spatial and Time analysis

- ***Solar Radiation***
- ***Ambient Temperature***
- ***Active Power***



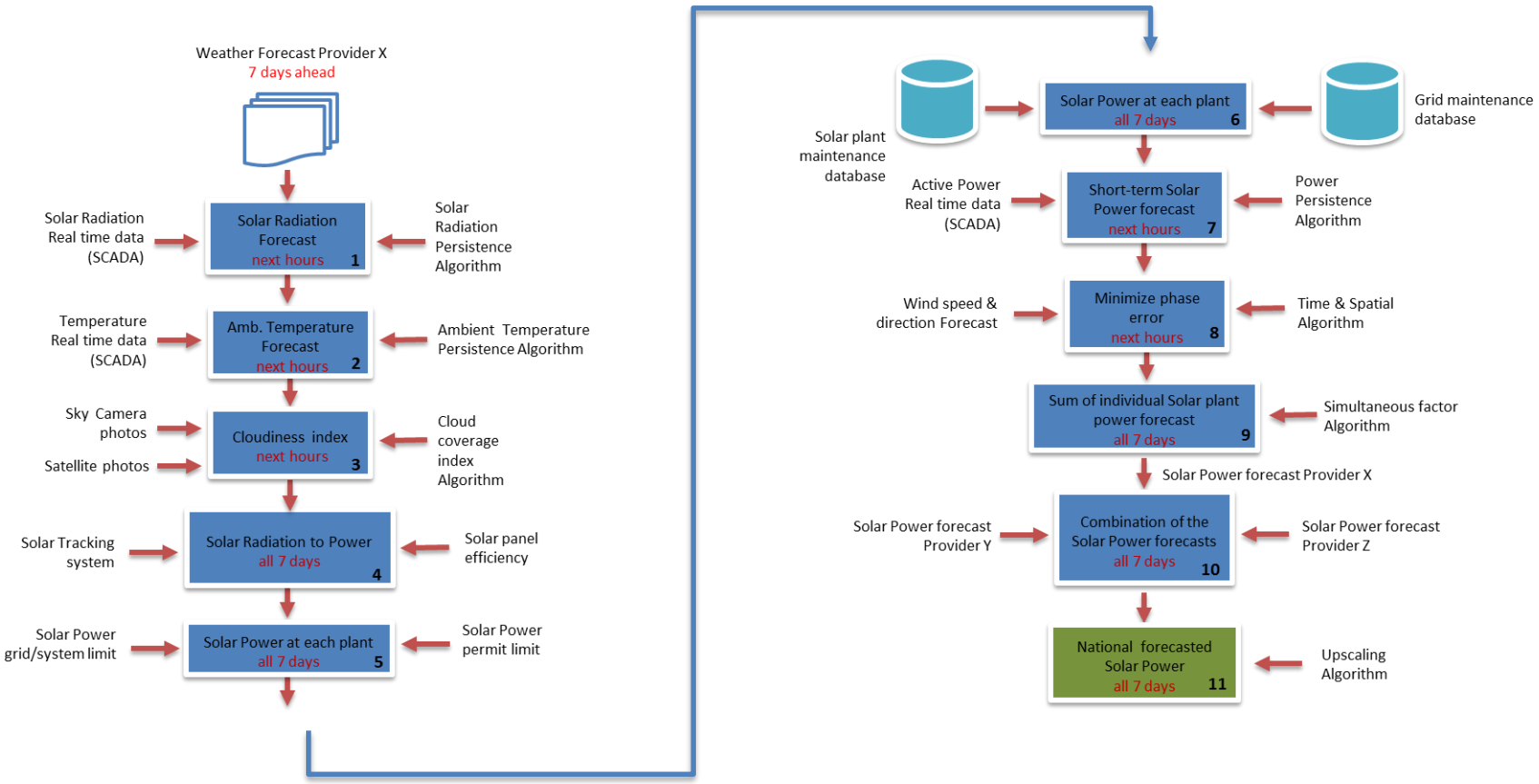




TSO Substation

PV Plant

Solar Forecast Flowchart



Conclusions

- Spatial & Time algorithms can reduce the short-term forecast error, taking advantage of multiple site's with real-time data.
- Every new big PV plant is required to install a sky camera and send the photos automatically to the System Operator.
- The SO is requiring Power Forecast and not wind or solar radiation.
- Portugal is on the top list of wind integration, with almost no curtailment.
- Solar is the next big challenging.

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Thanks

Obrigado

Any Questions?

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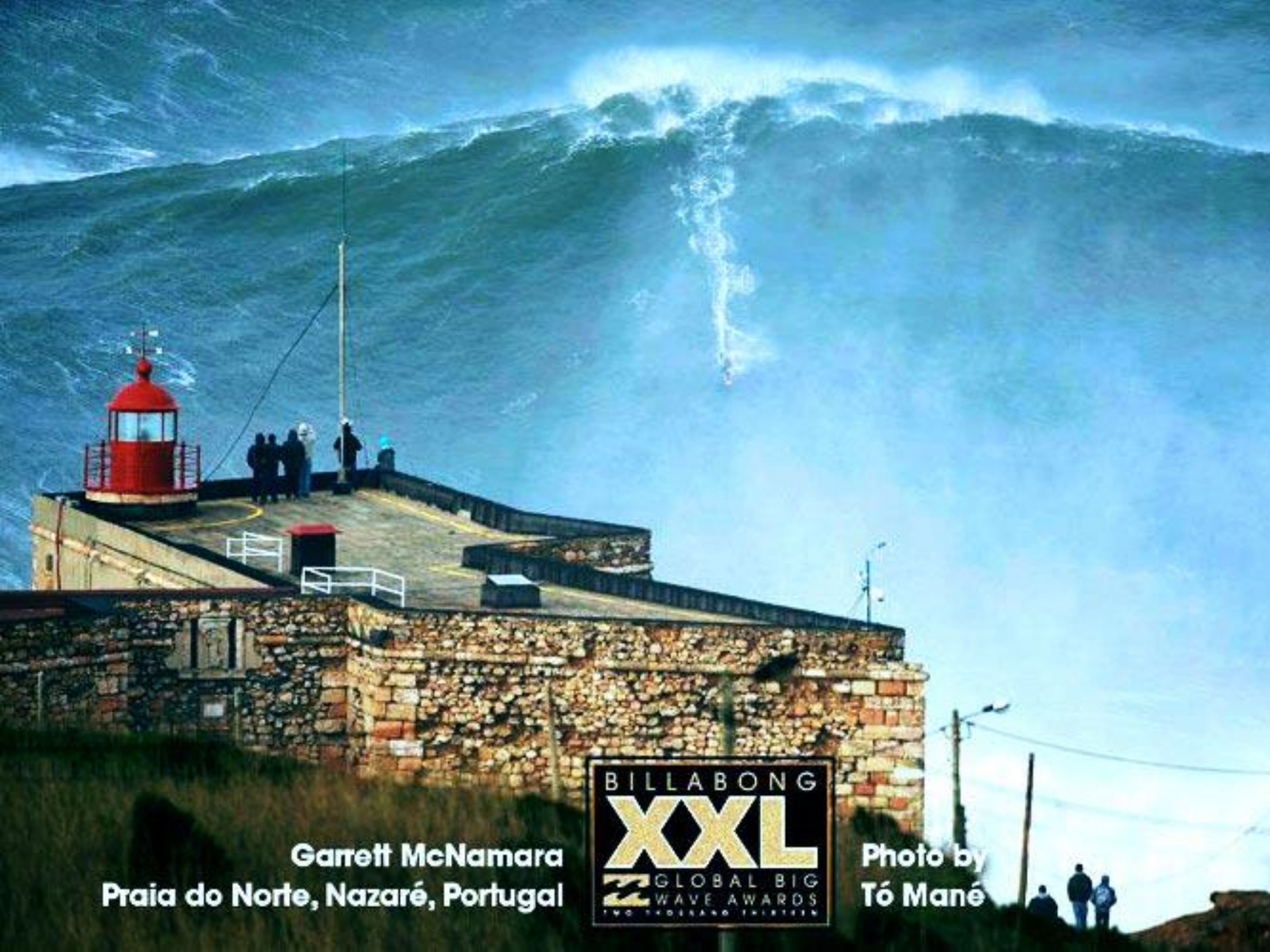
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GLOBAL BIG WAVE AWARDS
Garrett McNamara
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