EDF FORECASTING TOOLS

Stéphanie DUBOST
EDF R&D – Applied Meteorology Team

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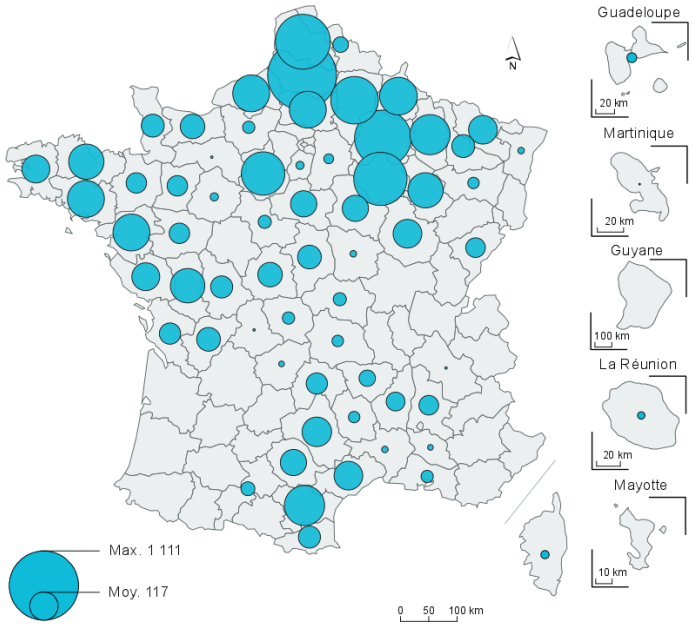
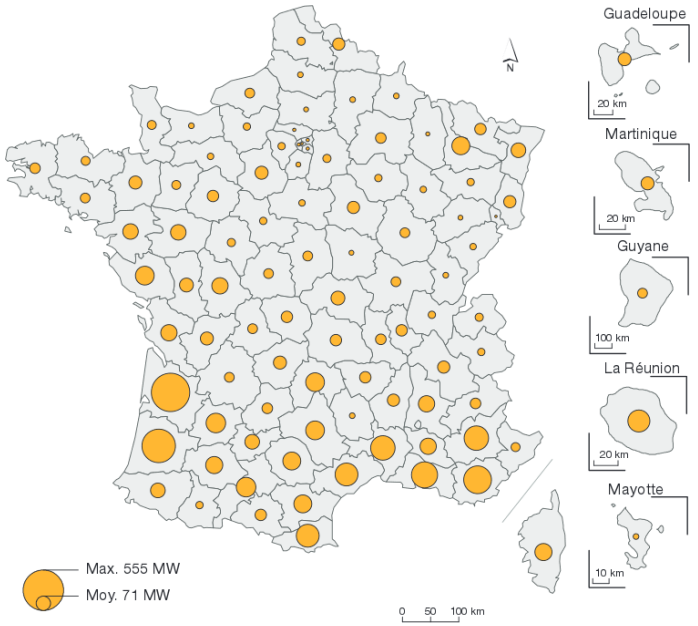
SUMMARY

- Wind and solar power installed capacities in France
- Context and wind and solar power forecasts needs of EDF business units
  - French DSO
  - EDF optimizer for continental France
  - EDF SEI (Non Interconnected areas)
- EDF R&D ‘s Forecasting tools with confidence intervals
- Conclusions about the use of uncertainties

WIND AND SOLAR INSTALLED CAPACITIES IN FRANCE

- **End of 2016, the total installed capacity was:**
  - **Wind power: 11.7 GW** (> 1500 farms)
  - **Solar power: 7.1 GW** (> 380,000 installations including rooftop and farms)





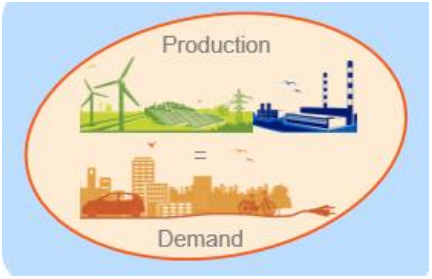
FRENCH DSO: CONTEXT AND NEEDS

- **Almost 90% (in capacity) of the installations in continental France are connected to the distribution grid** (at the end of 2016**)**
  - Wind power: 10 381 MW
  - Solar power: 5 763 MW
  - The technical characteristics of the installations are partially known (wind turbines, solar panels)
  - For wind power: 10' measurements at every farm (not in real time)
  - For solar power: 10' measurements for <50 % (in capacity) (not in real time)

- **Needs at**
  - National scale to minimize losses on the grid (1 to 3 days ahead)
  - Local scales to
    - Optimize grid operation in anticipation (short –medium term Operational Planning) resolving the physical constraints (real time up to several days/months)
    - Optimize the "major" maintenance works schedule (one –three years in advance) for primary substations

EDF IN CONTINENTAL FRANCE : SEVERAL BALANCING AREAS

- **EDF – Generation & supply**
  - **Must balance** (production + purchases) and (demand + sales) for **its balancing perimeter**
  - National scale
  - Forecasting several days ahead
    - Wind/solar power productions have priority dispatch and influence the remaining dispatch
    - **Anticipate the need to stop a nuclear plants due to minimum stable generation constraints**
  - *Forecast tools use only public data at regional/national scales*



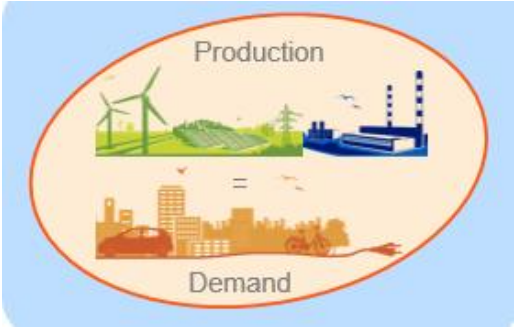
- **EDF – Purchase Obligations** (producers with purchase obligation contracts)
  - Must balance the forecast and the sells on the electricity market
  - National scale
  - Day-ahead forecasts before 10 am to give trading orders + Intra-day for adjustments
  - *Access to production data but not in real-time*

Electricity market
EPEXSPOT

- **EDF – Aggregator (still to be consolidated)**
  - National scale but only a few farms (not covered by feed in tariff) to start with
  - Must balance the production and the consumption on its perimeter
  - Day-ahead forecasts before 10 am to give trading orders + Intra-day for adjustments
  - *Access to production data but not in real-time*

EDF-SEI: CONTEXT AND NEEDS

- **SEI (Insular electric systems) is a vertically integrated utility operating in the insular territories**
  - Corsica
  - Réunion, Guadeloupe, Martinique, Guyane



- **Key Missions**
  - Managing the grid (transmission and distribution)
  - Ensuring supply and demand balance
  - Integrating renewables while ensuring the safe operation of the electrical system

- **Needs for forecasting tools to**
  - Minimize production cost at the global scale (forecasts from real time to day ahead)
  - Adapt the reserve requirements to the expected variability (dynamic reserve requirements defined as a function of system conditions including expected RES variability)

- A real time global production is available

EDF R&D RENEWABLE FORECASTING TOOLS

Medium-long range

Ensemble forecasts

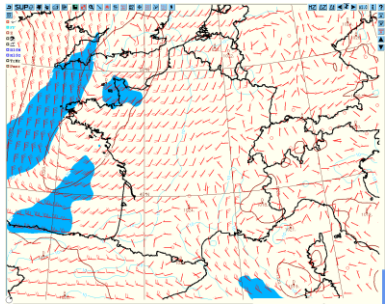
Climatology

Short range: D+1 to D+4

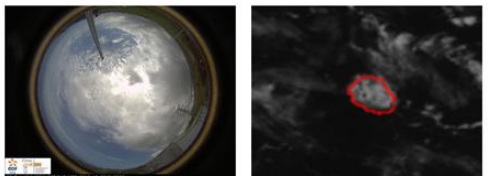
Very short range: H+1 to H+6

Weather forecasts

- Météo-France, ECMWF)
- deterministic, ensemble forecasts



- Real-time estimates or measurements
- Cloud motion (PV): cameras or satellite

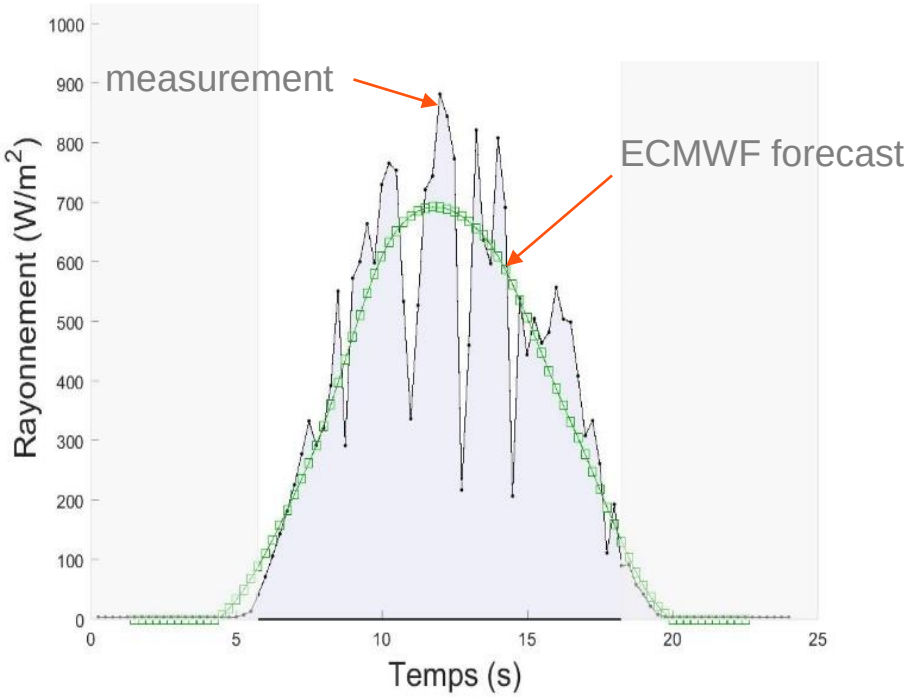


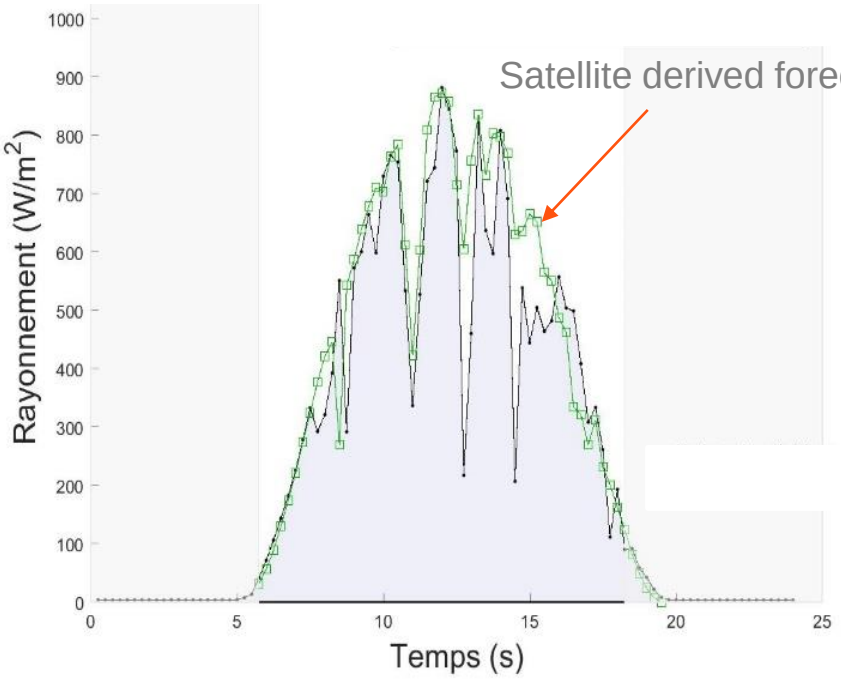
Fusion of all the forecasts

FORECASTS AND LOCAL SCALES

- **Difficulty of the local scale**
  - Need to have 10 to 30 mns resolution forecasts
  - The high variability of the production and the forecast's resolution don't match
  - **The evaluation criteria to be considered are far from obvious:**

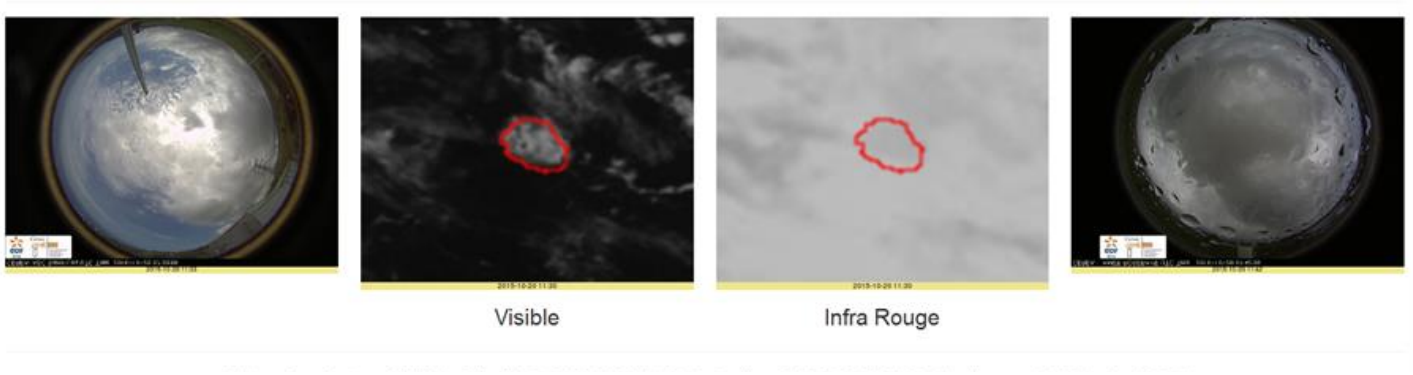
Same day, quite different forecast's resolutions, quite same RMSE…

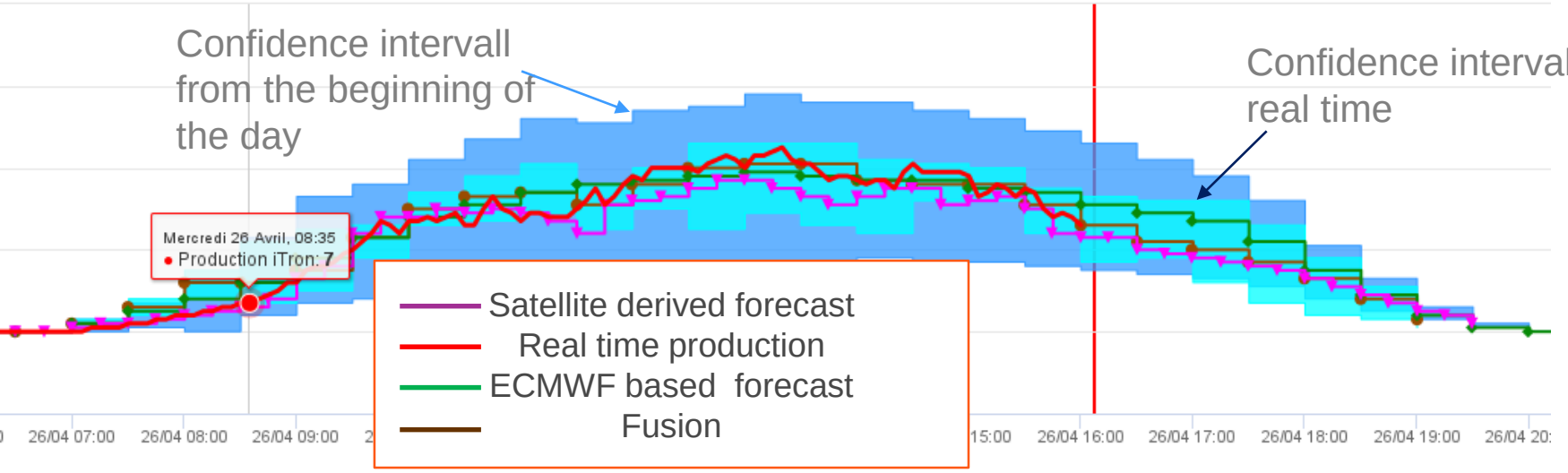




Need to provide confidence intervals that will inform about the expected variability

DEVELOPMENT OF CONFIDENCE INTERVALS





EDF R&D may provide confidence intervals with the solar power forecasts, at local/global scales

…THAT ARE NOT YET USED

Drivers for developing probabilistic approaches at local/regional

- The variability of the generation at local level
- The resolution of the weather forecasts
- The need to know about the expected variability of the production at relatively high temporal and spatial resolutions

EDF R&D currently able to provide confidence intervals at local and global scales however

- **The forecasts and their uncertainties are input data for dedicated applications**
  - That provides information on the risk of observing a constraint on the grid, given uncertainties on intermittent productions and demand
  - That enables EDF SEI to adapt the reserve capacity according to the expected variability of the production (dynamic reserves)
- **Those applications still need to be developed in most cases**
- **This analysis is shared with the clients mostly for local needs**

THANK YOU

QUESTIONS?

Contact: stephanie.dubost@edf.fr