Paris Session 2022

Long-term Operational Reserves Evaluation of Multi-Area Systems – Portuguese Case Study

SC C1 / PS3 / Q 3.1.5

The more probabilistic the planning environment becomes the more peak-load planning is being exchanged for load profile studies. What can be the advantages of studying load profiles and energy usage rather than focussing on peak demand capacity values only?

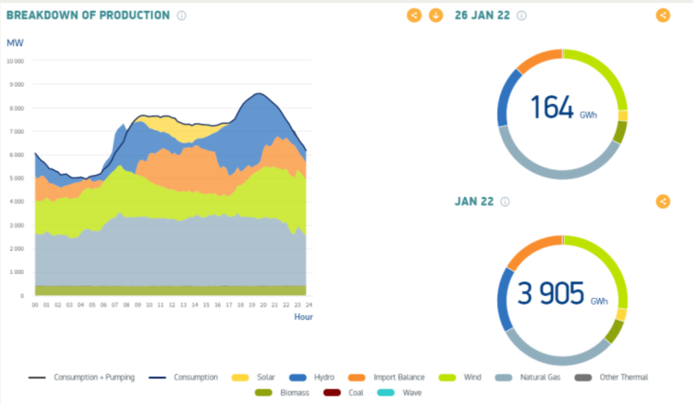
Nuno Martins - Portugal

Probabilistic Planning Environment
Integration of renewables – Main challenges

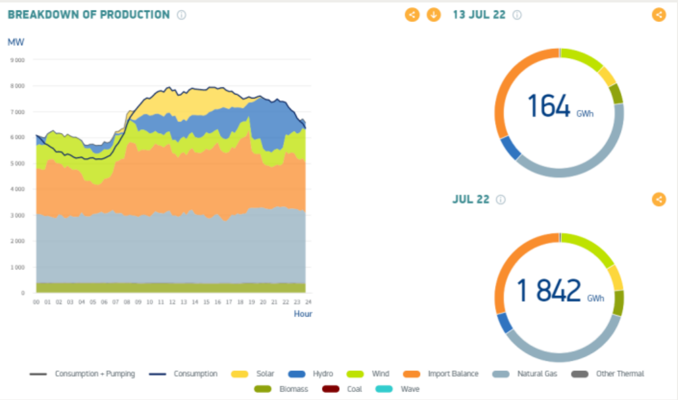
Main challenges of Renewable Energy Variability

- **Planning time-frame**
  - **Difficulties to meet electricity demand in peak load periods due to shortage of generation capacity related to the lack of primary energy resources (RES)**
  - **Uncertainty in peak load estimation, either at the system level or at the bulk consumption level, due to more flexible behavior of consumers especially those that can store energy or postpone equipment activation (e.g. electric vehicles, thermal loads, air conditioning, etc.) and due to the more frequent occurrence of extreme weather events (heat waves, cold spells, etc.)**
  - **Uncertainty in the annual energy consumption due to the massive integration distributed generation and the proliferation of energy communities**

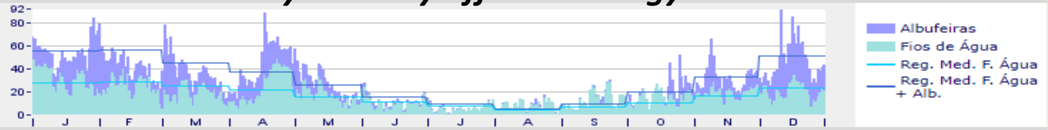
26/01/2022 (Current Annual Peak)



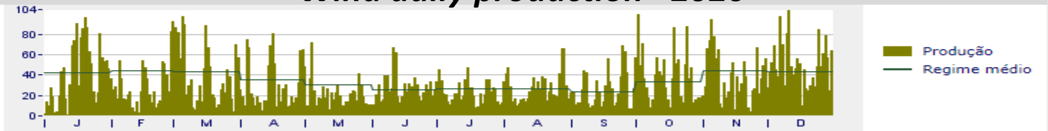
Heat wave 13/07/2022



Hydro daily affluent energy - 2020



Wind daily production - 2020



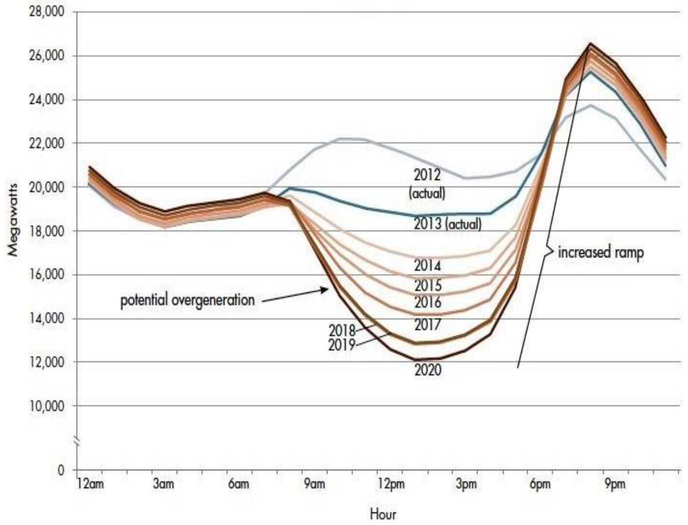
Solar daily production - 2020

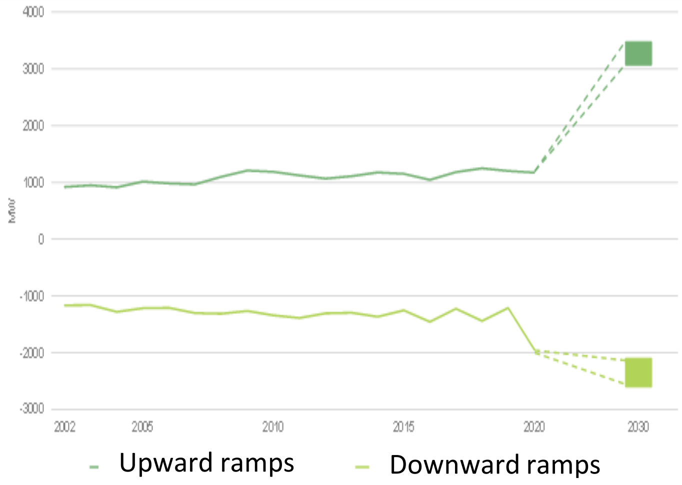
Source: REN

Probabilistic Planning Environment
Integration of renewables – Main challenges

Main challenges of Renewable Energy Variability	***Duck Curve example***	***Portuguese Maximum hourly range of wind production***

- **Operational time-frame**
  - **Defining adequate levels for the FRR and RR due to sudden loss of large generation values (abrupt changes in the resource)**
  - **Contradicting behavior of generation and demand, like solar PV generation decrease with simultaneous demand increase at the end of the day, which lead to greater operational reserve needs**





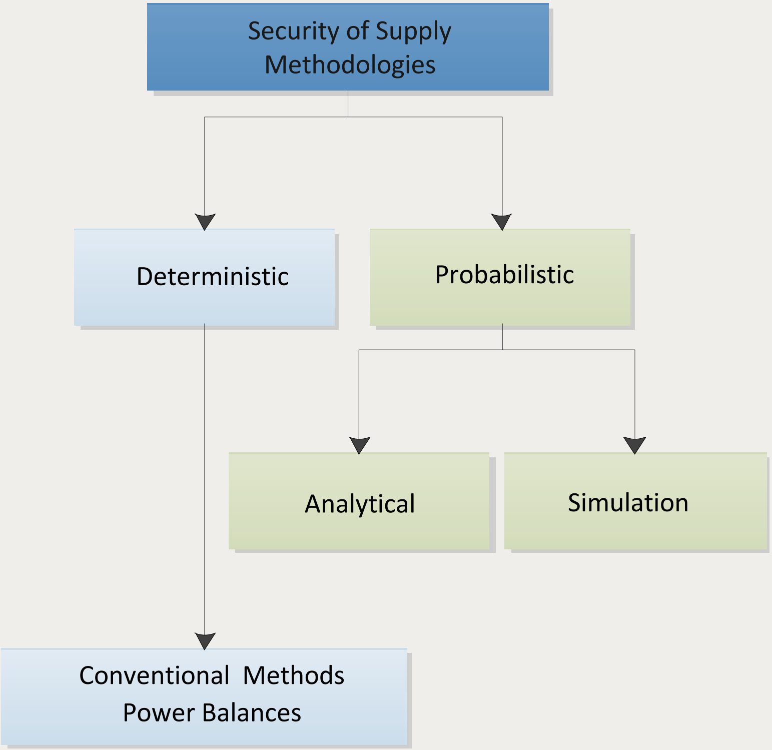
Source: REN

New planning tools and methodologies to evaluate Security of Supply in different time-frames are required to cope with the emerging power system paradigms

Group Discussion Meeting

Probabilistic Planning Environment
Integration of renewables – Main challenges

How to evaluate security of supply (planning methodologies)



	SoS Evaluation	
	Deterministic	**Probabilistic**
System stochastic and random nature	✗	✓
Loss of load risk evaluation (generation units outage, probability density functions)	✗	✓
Chronological simulation (correlation between random variables, maintenance plans, conventional loads, electric vehicles behavior)	✗	✓
Components availability (wind, water, solar)	✗	✓
Demand forecast uncertainties (long-term and short-term)	✗	✓
Results quality and robustness (generation structure, energy balances by technology, loss of load indicators, probability of meeting the annual peak load)	✗	✓

Classical probabilistic models have limitations

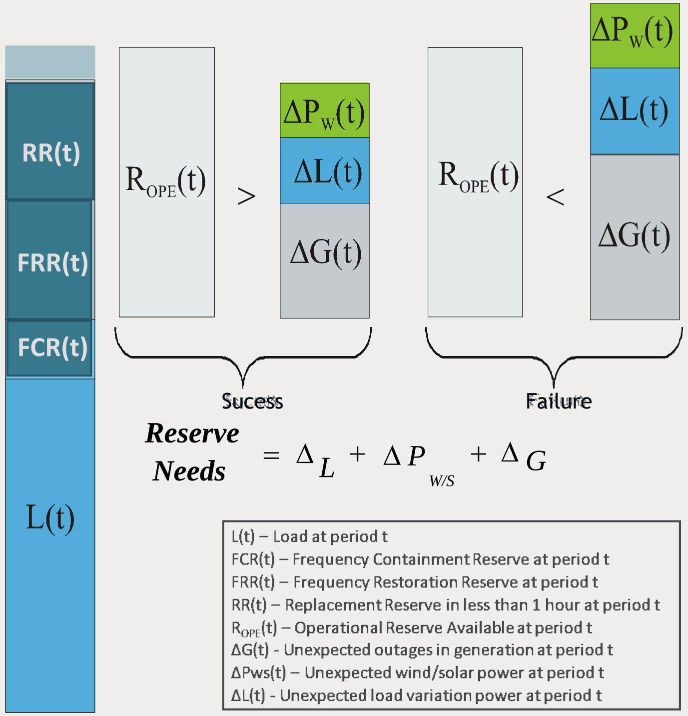
Only with new approaches can the static & operational reserve needs be accurately assessed

Probabilistic Planning Environment
Long term generation adequacy – PS-MORA Model

Planning secure and flexible generation systems

PS-MORA® - The main added value

Besides traditional approach (evaluate if the installed capacity is enough to supply the hourly demand), PS-MORA complement this analysis by assessing if the available Operational Reserve is enough to compensate the forecasts (RES, Demand, etc)



- **It is able to asses** if the installed capacity is enough to meet the load at period and the FCR and FRR at period (t), as well as **if the remaining capacity that can be up to an 1 h period (RR) is able to meet the needs of operational reserve between (t) and (t+1)**
- Perform adequacy and operational reserve assessments for interconnected electric systems **quantifying the impact of different levels interconnection capacities**
- Simulations can **aggregate electric systems or detail the network for the assessments**
- Besides the traditional randomness of natural resourced (hydro, wind and solar) and forced outages, it **incorporates forecast errors for operational analysis**

Risks related to insufficient Operational Reserve

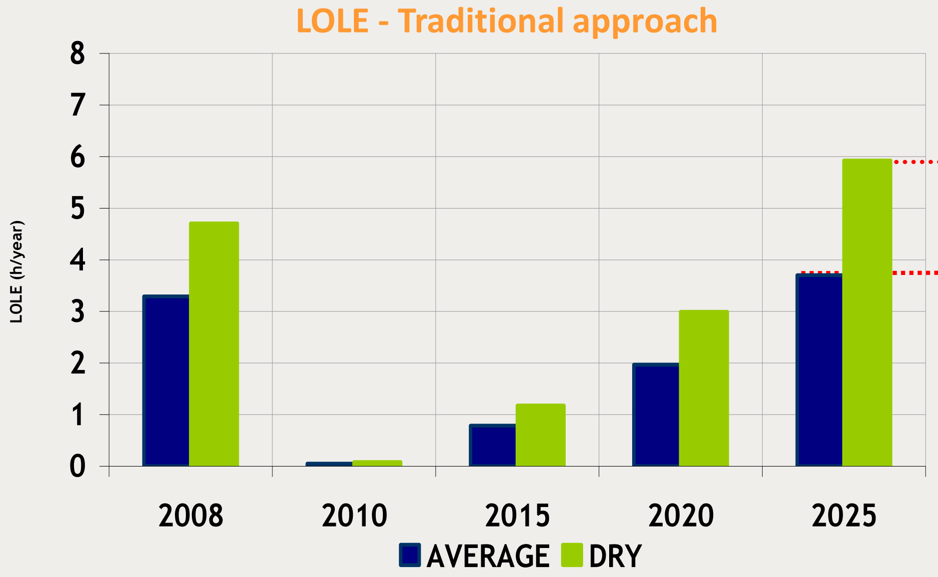
$$R_{OPE} < \Delta L + \Delta P_{W/S} + \Delta G$$

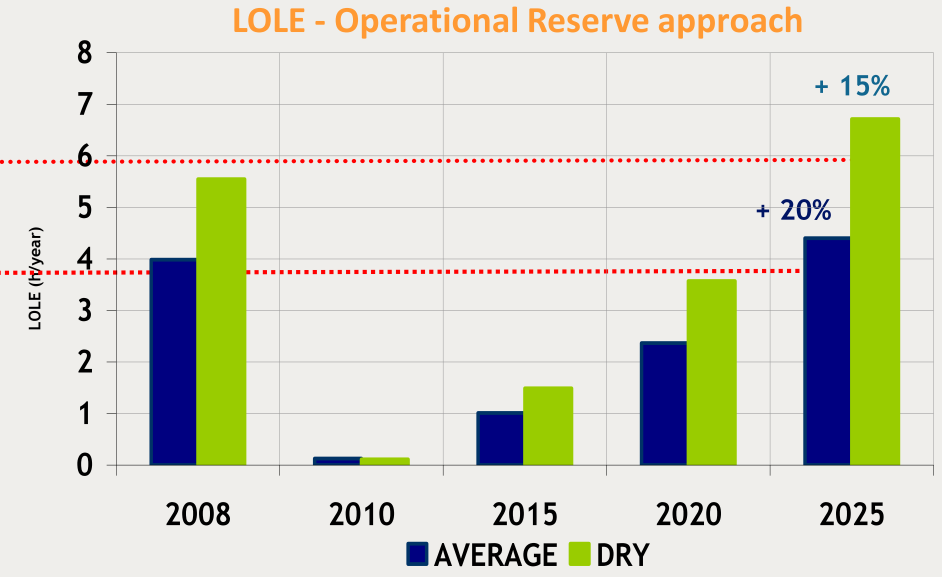
Insufficient operational reserve → when the deviations in load, wind/solar capacity and generation units forced failures are not guaranteed by the available reserve (FCR, FRR and RR)

Probabilistic Planning Environment
Long term generation adequacy – PS-MORA Model

Impacts on long term security of supply

Allows relevant improvements in the adequacy assessment of electric system with high penetration of renewable resources





Operational LOLE, **includes** ***Traditional LOLE*** **(insufficient available capacity to cover load and FCR) and** ***Insufficient Operational Reserve*** **(insufficient FRR and RR to meet the respective needs)**

FCR – Frequency Containment Reserve
FRR – Frequency Restoration Reserve
RR – Replacement Reserve