

RED
ELÉCTRICA
DE ESPAÑA

Grupo Red Eléctrica

**An analysis of large RES penetration
impact on traditional system
operation at the Canary Islands
isolated power systems**

Future trends and contingency measures

4th International Hybrid Power Systems Workshop
22-23 May 2019. Crete, Greece

Índice

1. REE at a glance
2. The energy transition in the Canary Islands
3. Main challenges of large RES penetration in isolated power systems
4. Facing the challenges: the approach
5. Massive RES energy integration: energy storage
6. Conclusions



REE at a glance

RED ELÉCTRICA DE ESPAÑA

The Spanish TSO



- 4 control centres
- 43.801 km of transmission grid
- 4.360 busbars
- 85.144 MVA transformer capacity



The energy transition in the Canary Islands

The energy transition in the Canary Islands

The Canary Islands

- 6 isolated electrical systems on 7 islands
- Generation mainly based on fossil fuels
- Low meshed weak infrastructure
- High wind and solar potential



El Hierro

Tenerife

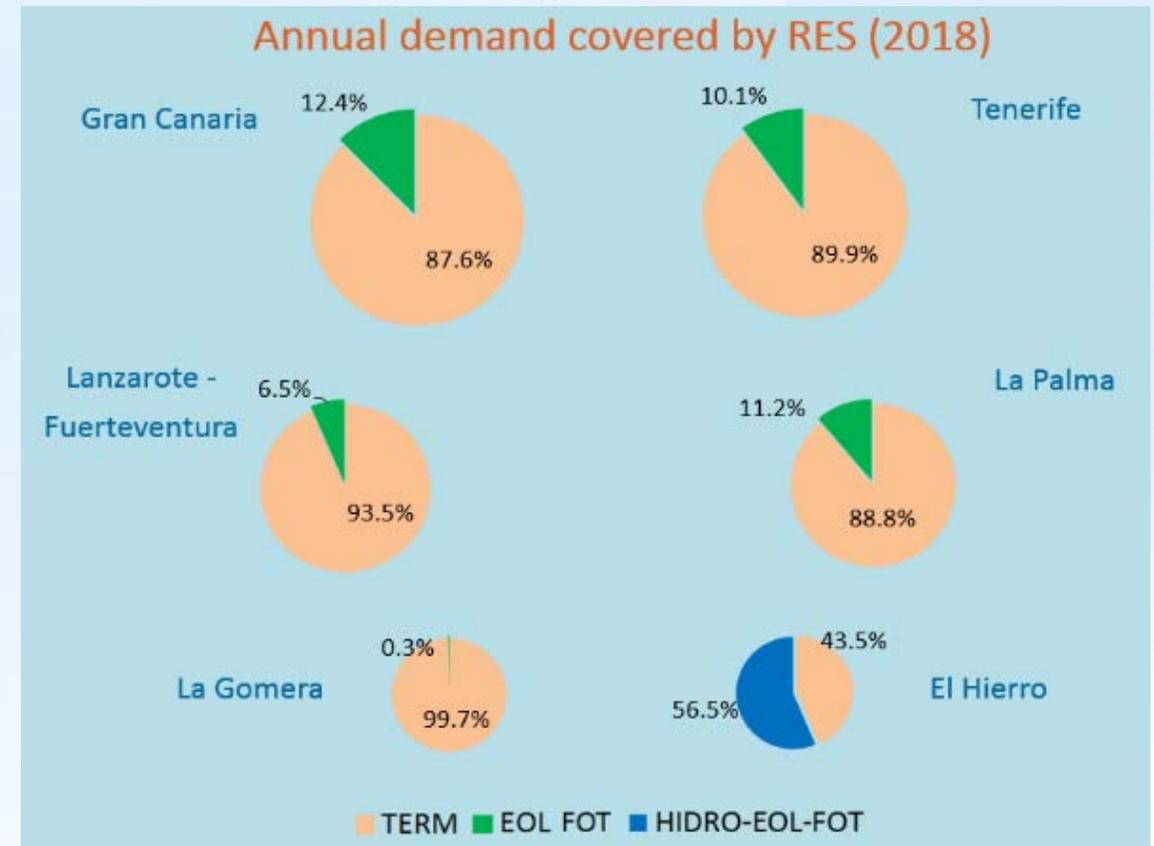
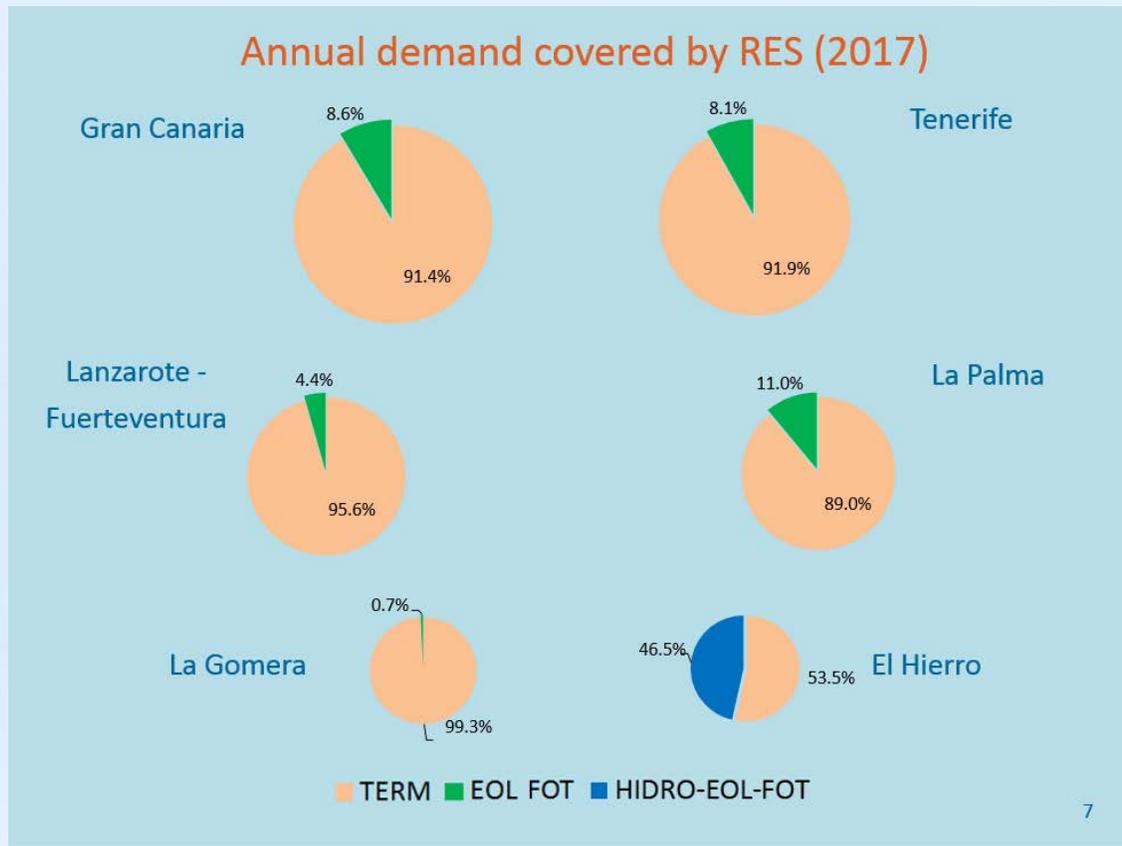
Spanish mainland

ENTSO-E



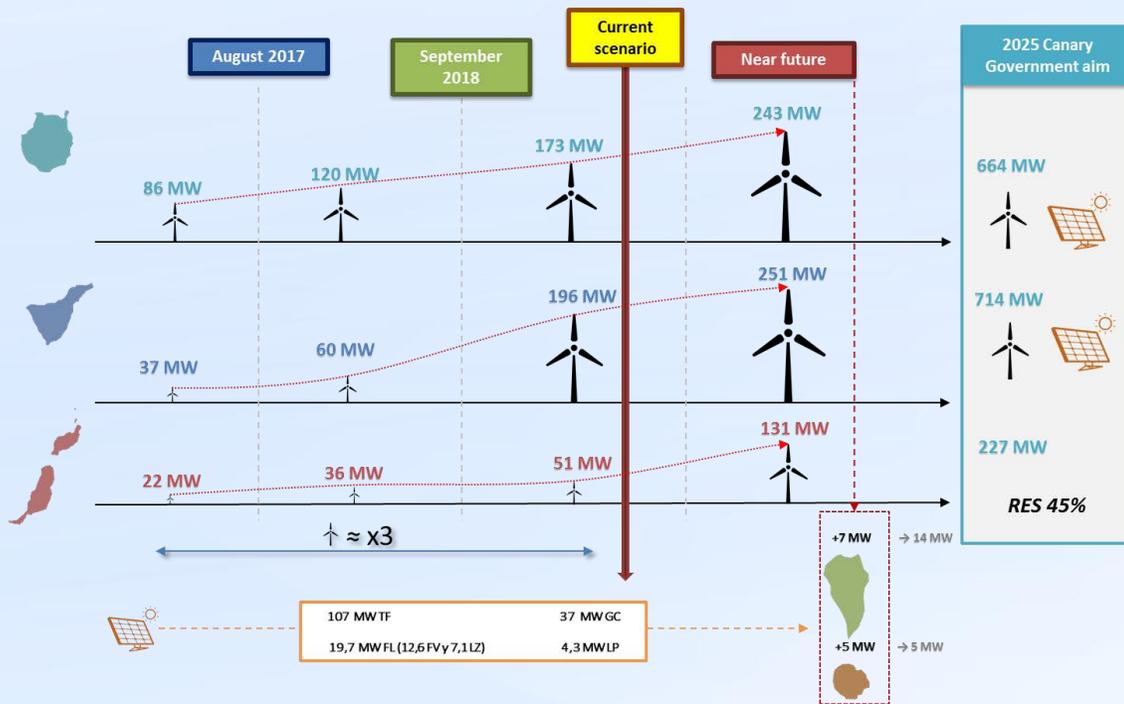
The energy transition in the Canary Islands

Renewable Energy integration evolution

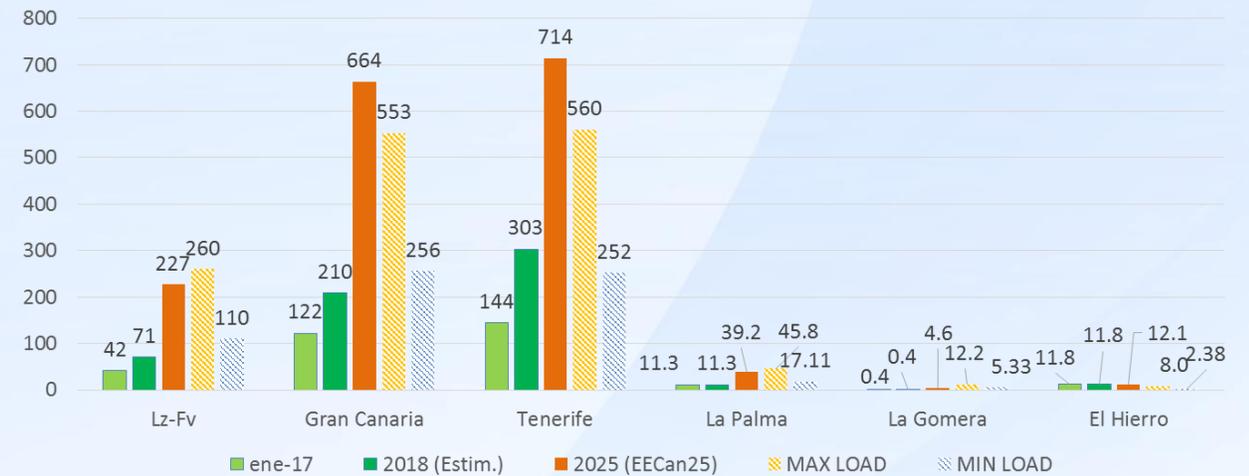


The energy transition in the Canary Islands

Renewable installed capacity: current vs future



Current and future RES installed capacity vs load (MW)





Main challenges of large RES penetration in isolated power systems



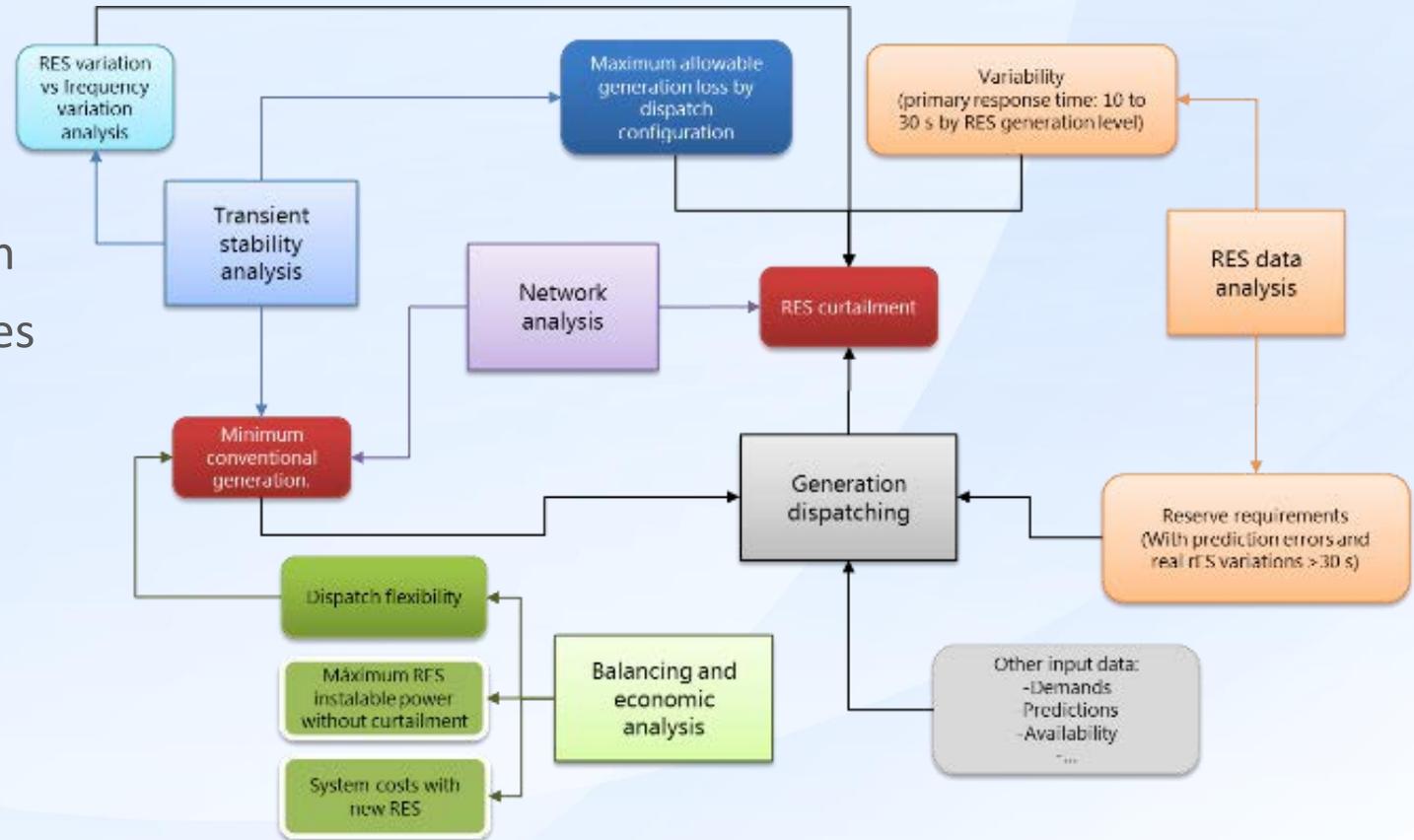
Facing the challenges: the approach

The approach

Study methodology scheme

Considering:

- RES variability
- Frequency degradation
- Minimum synchronous generation
- Thermal units flexibility capabilities
- Reserve requirements
- RES generation forecasts
- Overall system economics
- Network topology



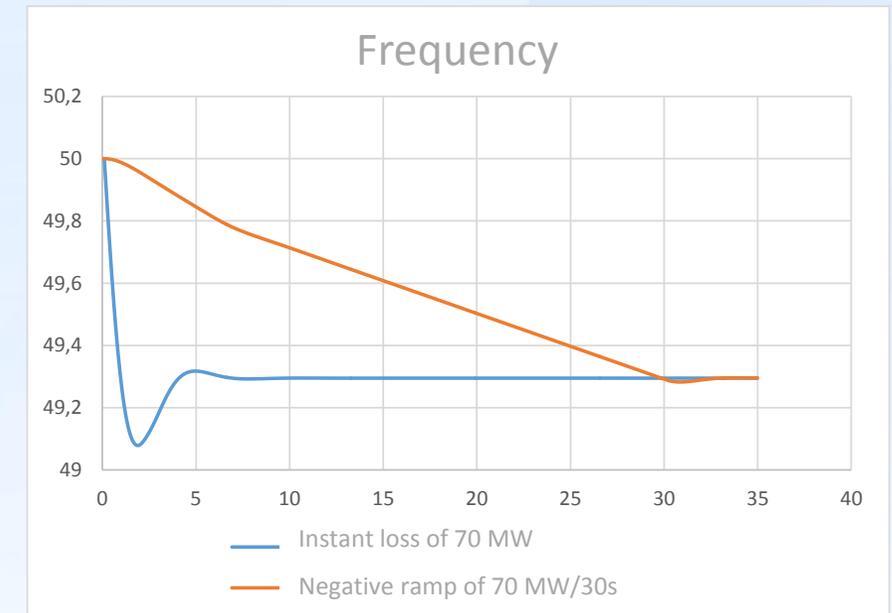
Transient stability analysis and frequency

Considering:

- A wide range of future RES penetration scenarios have been created
- Different demand power levels have been analyzed
- Minimum reserve requirements defined in network codes have been considered
- A critical loss of generation is considered as the most severe incident, both for Gran Canaria and Tenerife.
- Positive and negative ramps, in 30s timeframe have also been considered.
- Validation criteria:
 - $F_{min} > 49 \text{ Hz}$
 - $df/dt > -2 \text{ Hz/s}$

Results:

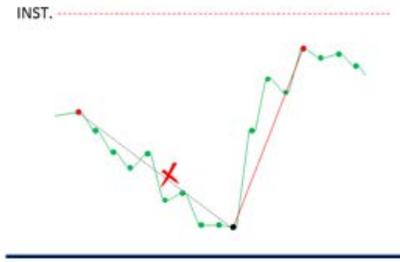
- A “must run” set of synchronous units is identified.
- Several thermal units configurations are possible, allowing to deal with maintenances or availabilities.



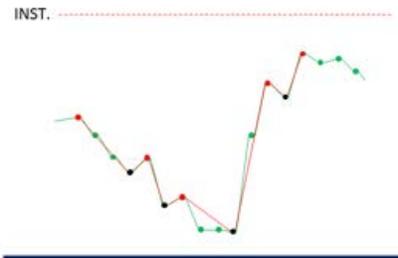
RES generation variability

Total uncertainty

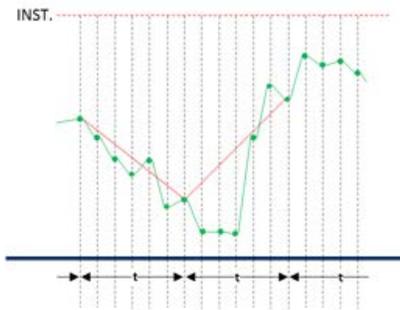
Maximum variations



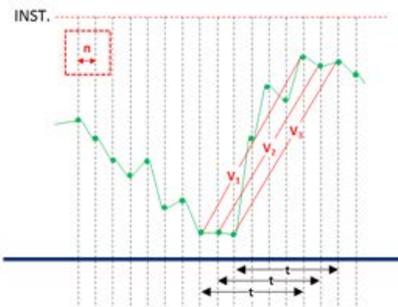
Real variations



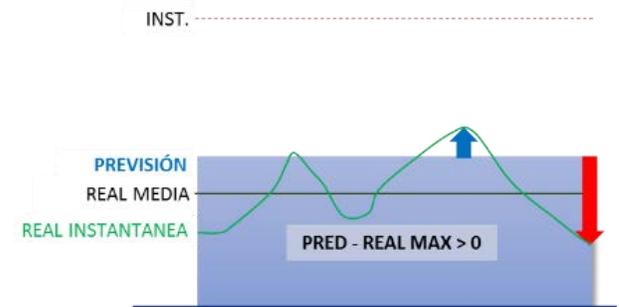
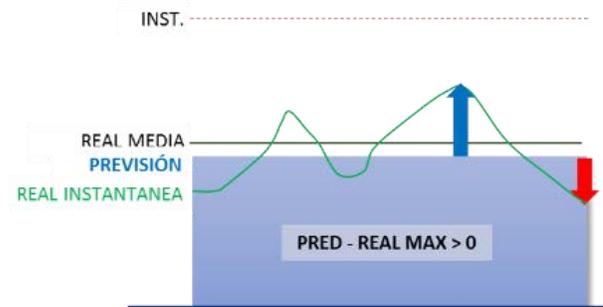
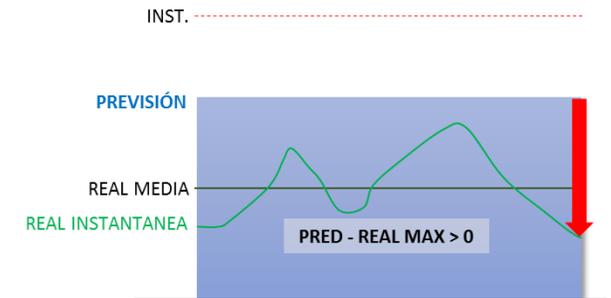
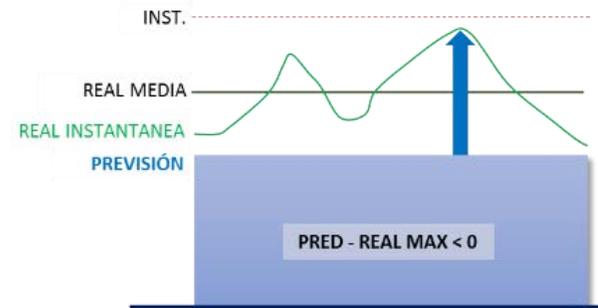
Moving window no overlapping variations



Moving window overlapping variations



Partial uncertainty (with RES forecasts)



RES generation variability (II)

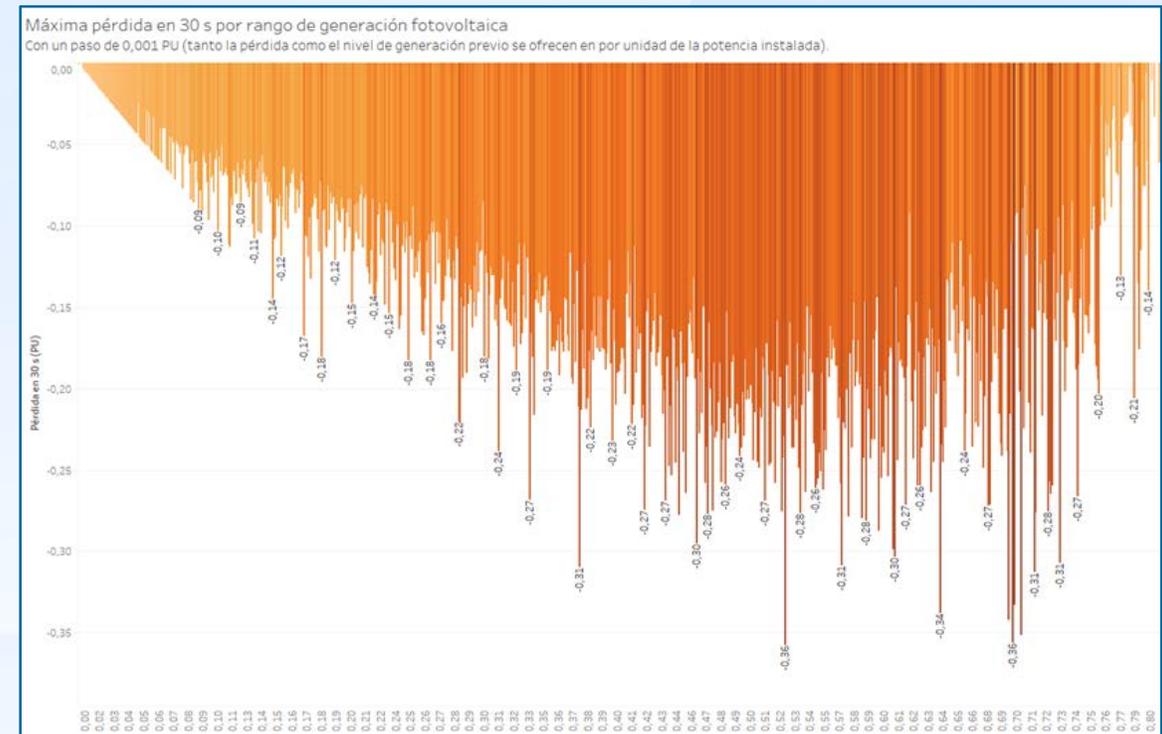
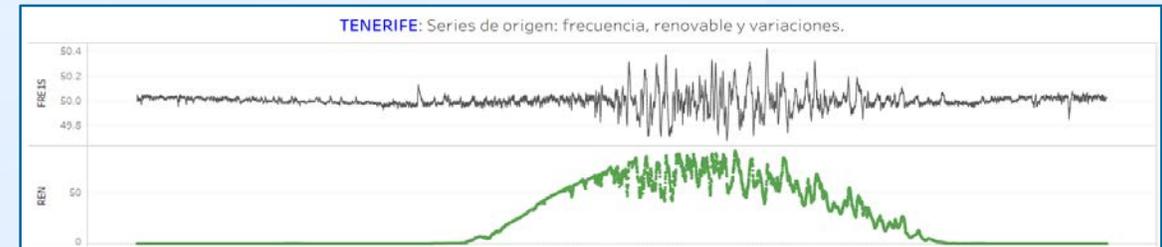
As a result we defined:

Reserve requirements:

- **Primary reserve** requirements from the analysis with total uncertainty.
- **Secondary reserve** requirements from the analysis with partial uncertainty.
- **Tertiary reserve** requirements from a combined analysis:
 - For the first hours there is a chance to be right
 - From there on there is not (low frequency model refresh).

Curtailement requirements:

- From the analysis with total uncertainty.
- High amount of RES variations (upwards or downwards) with a potential relevant effect on the system → curtailments to limit the risks.



Network limitation studies

The current situation:

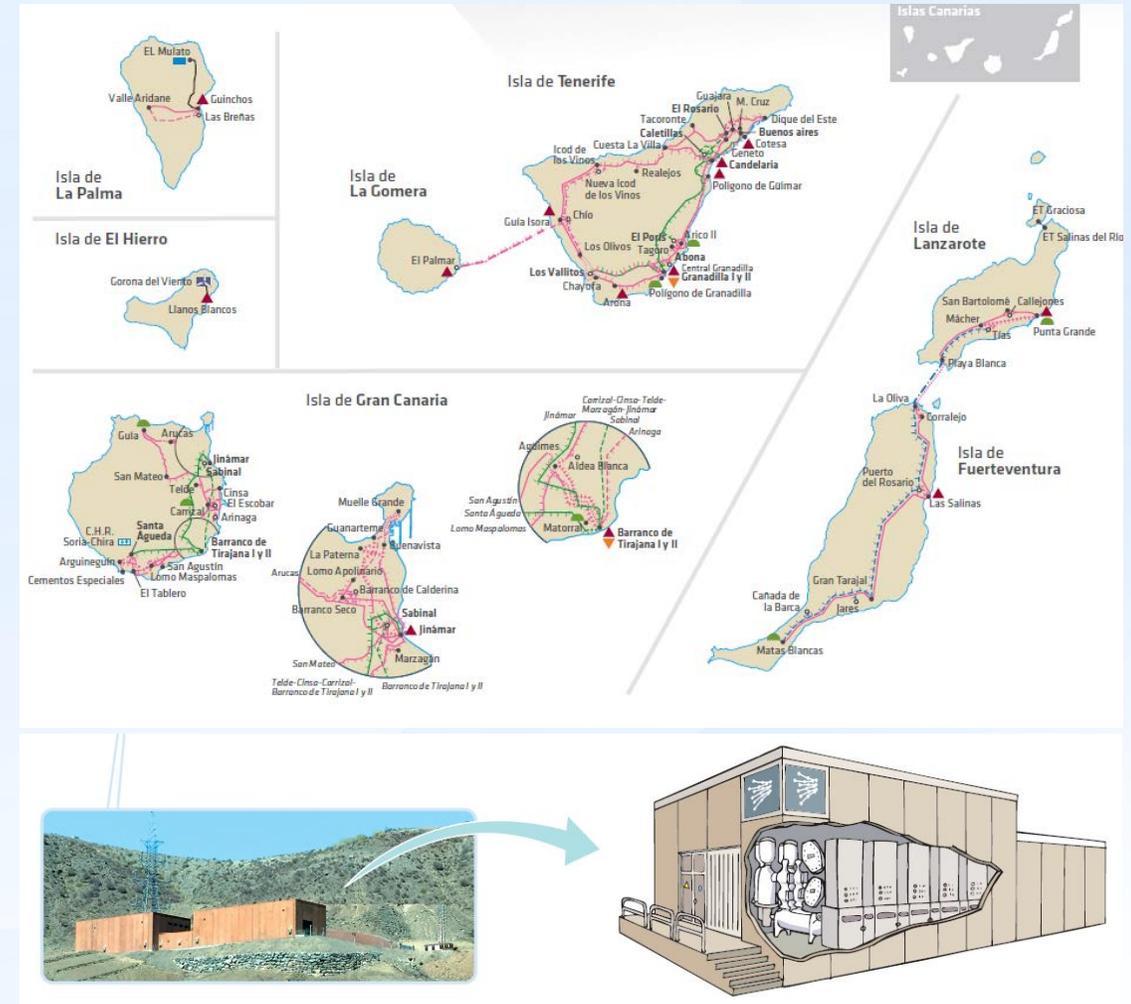
- Large network infrastructure developments planned ahead for the short-term high RES scenario
- Almost all planned developments, mainly new substations in the areas of RES development, have been built
- The recent announcement of new RES tenders have triggered the need to properly analyze new potential future scenarios

Analysis performed:

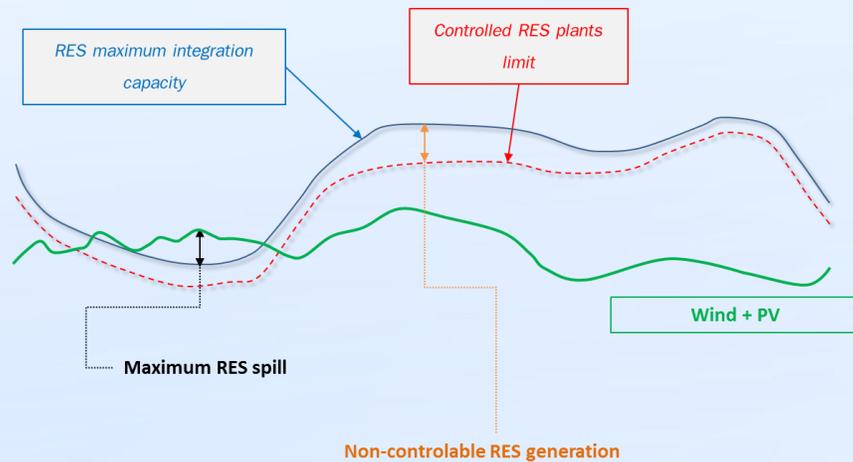
- N-1 situations in all relevant network areas.
- Potential congestions in specific areas were an overcapacity is expected

Results:

- No scenarios have been found as problematic
- Specific solutions have been designed for the future, among them:
 - Topology maneuvers to change power flows
 - Extra thermal generation in specific power plants
 - RES curtailments



Restrictions due to balancing



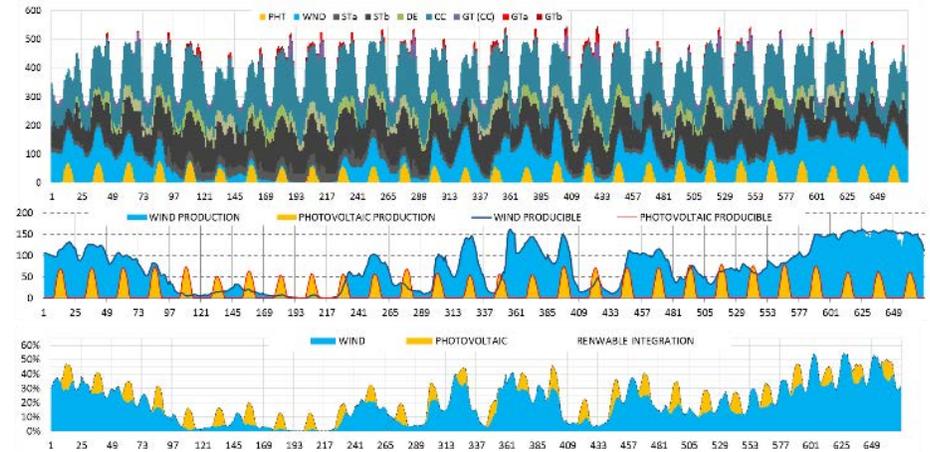
The analysis:

- Thermal units restrictions considered: Start-up time, shutdown time before start-up, running time before shutdown and shutdown time
- Monthly scenarios
- Simulation of day-ahead scenarios vs actual situation with real RES generation data

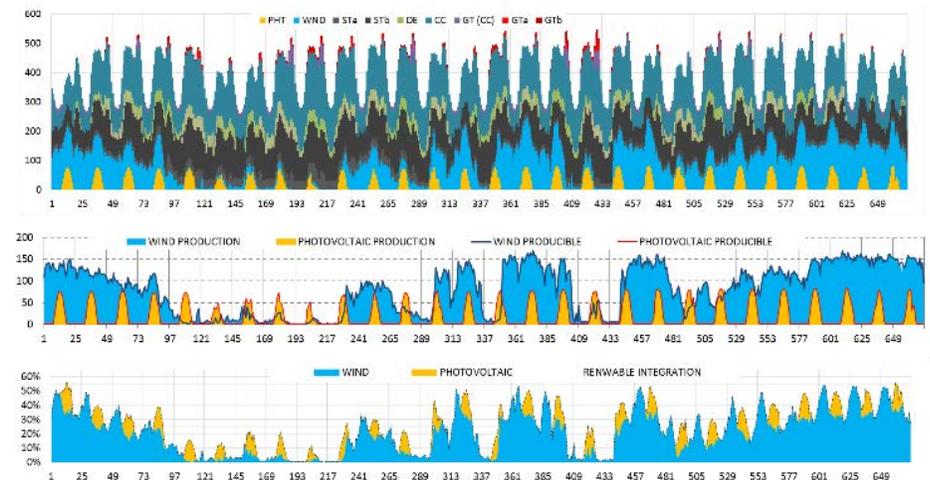
Results:

- No feasible solution in real time
- Must-run and reserve criteria redefined
- Changes of the combined cycles modes are sometimes needed

Day ahead simulations



Real RES production series





Massive RES energy integration: energy storage

Massive renewable Energy integration: Large scale energy storage

STORAGE: CENTRAL HIDROEÓLICA DE EL HIERRO (CHE)

Present

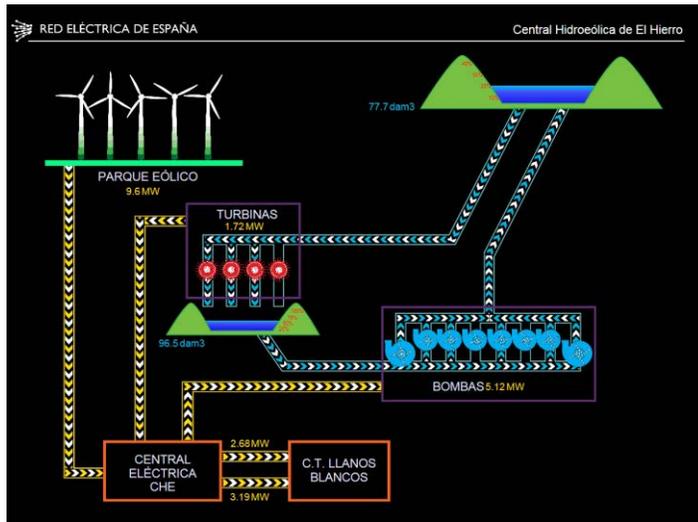


Future

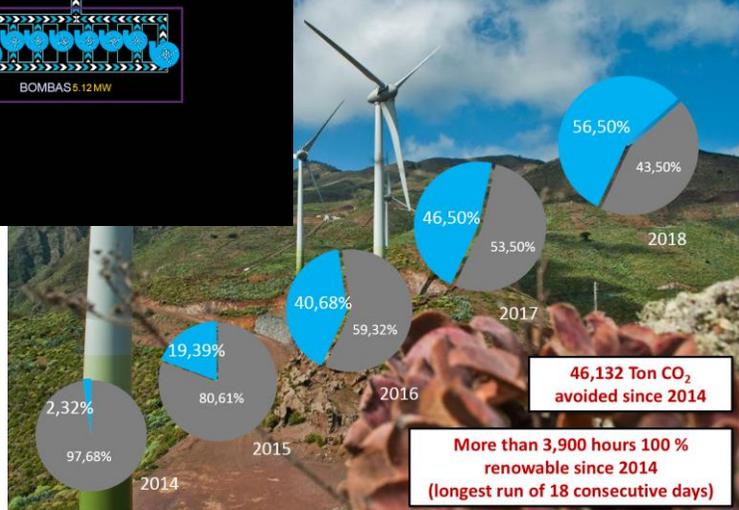


STORAGE: SORIA-CHIRA REVERSIBLE PUMPED STORAGE

200 MW / 3.200 MWh



RES integration in El Hierro Island



11.32 MW / 200 MWh





Conclusions

Conclusions

- **Large RES development** is already ongoing in the isolated power systems of the Canary Islands.
- **Big challenges** arise from the perspective of **system stability** and maximization of **RES integration**.
- RED ELÉCTRICA, as the TSO, has built a methodology used to perform an **extensive analysis** of the implications for the mid-term scenario, covering:
 - System stability
 - Uncertainty and variability of RES generation
 - Network congestion
 - Synchronous generation requirements due to balancing
- **Solutions have been found** in order to securely integrate RES generation in the **current scenario**, mainly related with must-run, reserves and curtailment criteria, as well as topology maneuvers.
- RES developments are expected to continue in the coming years, forcing to reevaluate the systems' behavior on a continuous basis.
- **Flexibility solutions will be needed** in the mid-term, mainly **energy storage**, as without it large RES energy integration into the islands' mix won't be possible.



RED
ELÉCTRICA
DE ESPAÑA

Committed to intelligent energy

Thanks for your attention

www.ree.es