



GOBIERNO
DE ESPAÑA

MINISTERIO
PARA LA TRANSICIÓN ECOLÓGICA
Y EL RETO DEMOGRÁFICO

TENERIFE BLACK-OUT

July, 15th 2020



Electricity Coordination Group
September, 22th 2020



Tenerife Characteristics

- **Isolated system** (planned interconnection with La Gomera island)
 - Central dispatching model.
 - Low network mesh and concentrated generation (orography conditions).
 - Reserve levels (according to Operation Procedures): 97,98 MW to rump-up & 189 MW to rump-down.
- **Installed capacity (1225 MW)**
 - Thermal capacity 918 MW: Granadilla (693 MW), Candelaria (139 MW), Arona (43MW), Guía de Isora (43MW).
 - Renewable capacity 307 MW: 196 MW (eolic) + 107 MW (photovoltaic)





Black-Out Incident (1/3)

➤ Before the incident

- Demand: 424 MW
- Generation mix: 15% RES (wind/solar)
85% Thermal (steam/diesel/combined-cycle).
- Granadilla Total Output: 339 MW (94% demand)
 - Granadilla CC-I: Gas 3 + Vapour 3: 53,2 MW + 31,0 MW (84,2 MW)
 - Granadilla CC-II: Gas 5 + Vapour 4: 52,5 MW + 26,0 MW (78,5 MW)

➤ Incident timeline

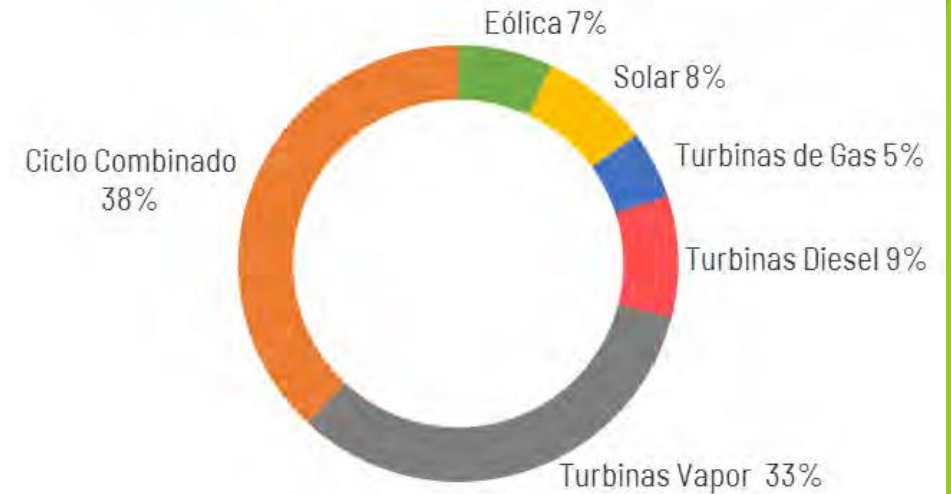
- 09:41 → Granadilla Gas 3 is accidentally manually triggered. Vapour 3 triggers. Frequency drops to 48,897 Hz.
- +5,2s → Granadilla Gas 5 rumps-up to its maximum output, and trips due to high temperature gradient of exhaust gases. Frequency drops to 48,066 Hz → automatic under-frequency control scheme activates.
- +2m5s → Granadilla Vapour 4 triggers.

The performance of the automatic under-frequency control scheme was not enough to compensate the progressive generation loss.

- 09:44 → Frequency drops, all generation groups trigger, the black-out occurs.

- Supply interruption: 424 MW
- Estimated Non Supplied Energy: 1.913 MWh
- Clients affected: over 515.000

Reparto de generación el 15/07/2020 a las 09:41 h



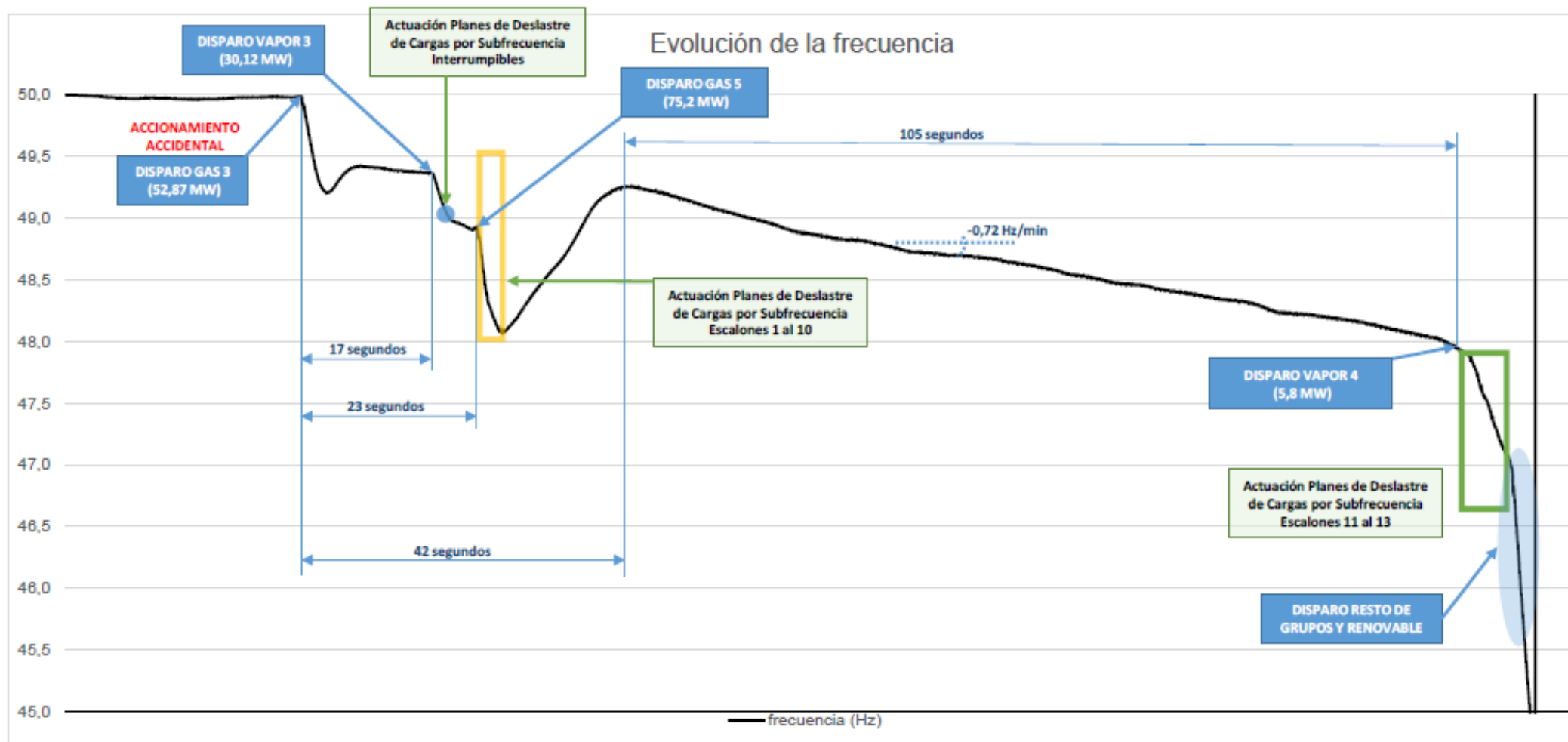
➤ Incident timeline

Generation and frequency variation during incident:



➤ Incident timeline

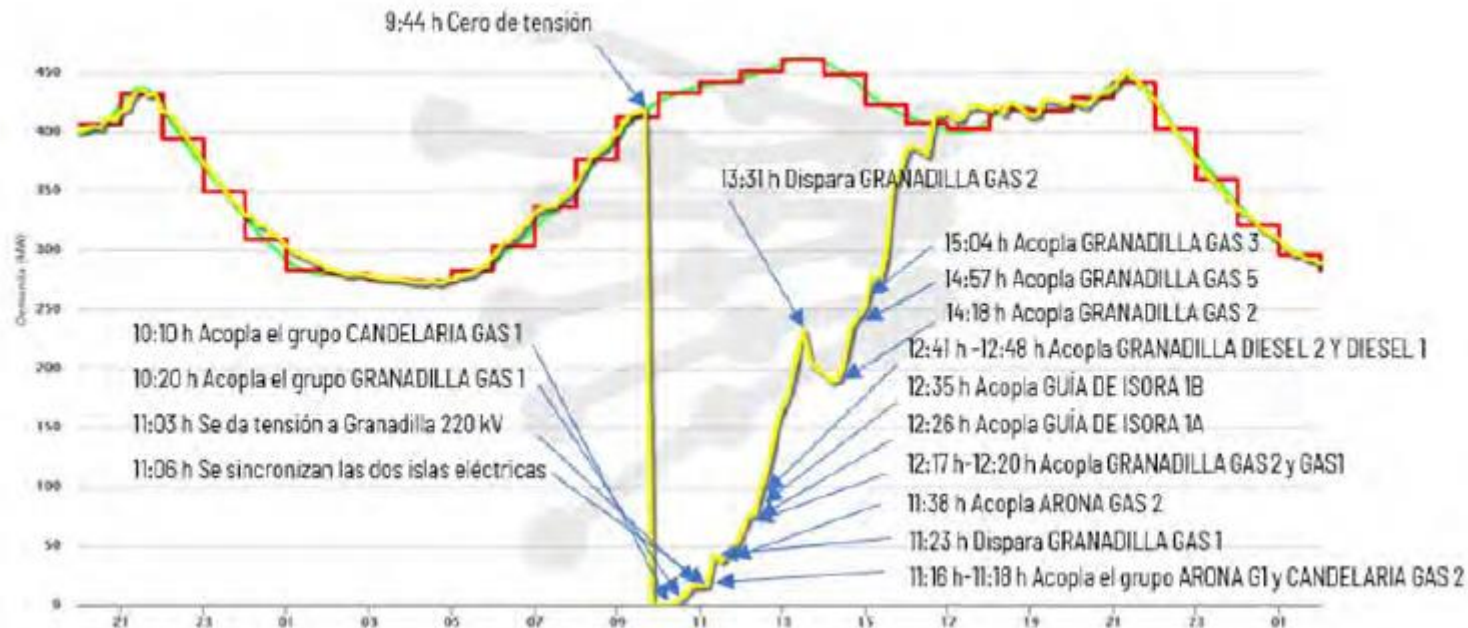
Frequency variation during incident:



➤ Tenerife system restoration plan

1. Connection of power sources with black start and island operation capabilities: Granadilla & Candelaria gas turbines.
2. Coupling of Granadilla & Candelaria gas turbines.
3. Bottom-up demand re-energisation in a controlled and safe way.
4. Supply re-energisation is completed at 16:44, once there is enough generation to supply all the demand.

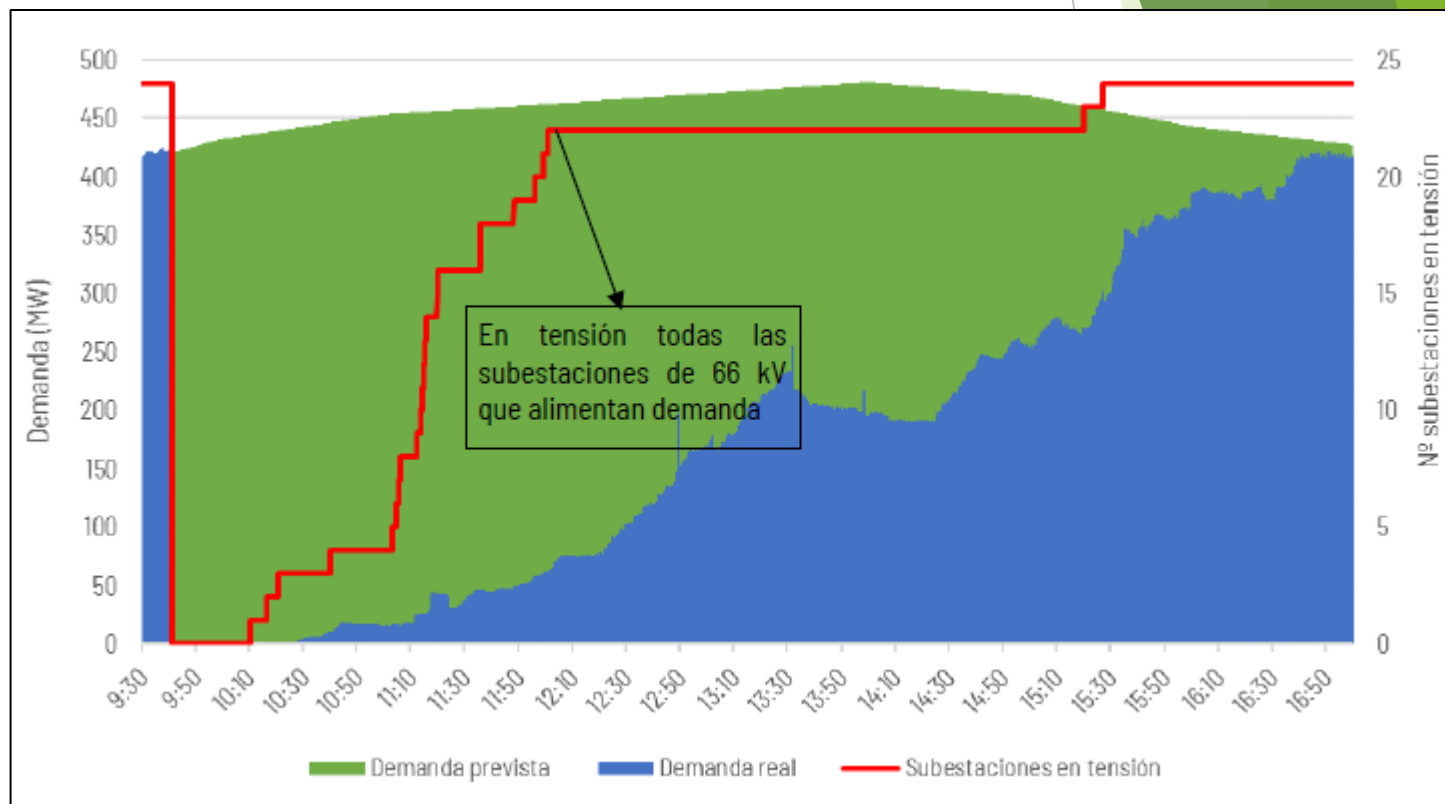
➤ Progressive generation coupling





➤ Progressive supply re-energisation

Time	% Supply re-energised
10:45	4% (20.688 clients)
11:30	10 % (51.521 clients)
12:30	20 % (103.042 clients)
13:20	40 % (206.085 clients)
14:40	50 % (257.605 clients)
15:15	60 % (309.127 clients)
15:40	80 % (412.169 clients)
16:45	100 % (515.211 clients)



Actual Supply vs Forecasted Supply



- On Wednesday, July 15th, 2020, Tenerife suffered an electrical blackout, starting at 09:41. All substations that feed the distribution network had tension at 12:00, and full supply re-energization occurred at 16:44.
- Investigation and determination of liabilities on-going by regional authorities.
- **Difficulties**
 - Tenerife is an isolated system, with low meshed grid.
 - Thermal generation is mainly concentrated in 2 sites.
- **Achievements**
 - Effectiveness of Restoration Plan
 - Proper functioning of the control and command centers of the TSO & DSO.

➤ Conclusions

- Interconnection is essential to ensure operational security and to facilitate system restoration.
- Grid development and reinforcement is key to achieve a more meshed and robust transmission system. Storage systems would strengthen the transmission system and the system operation, specially regarding RES implementation target (NECP 2030).
- Improve reliability of generation groups, trying to avoid undesired triggers and to speed up black start processes.
- TSO/DSOs should review, update & guarantee the proper implementation and function of the automatic under-frequency control scheme and other emergency plans.





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Thank you for your attention