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)
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
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**
Restoration Plan (2/2)

- Progressive supply re-energisation

<table>
<thead>
<tr>
<th>Time</th>
<th>% Supply re-energised</th>
<th>Number of Clients</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:45</td>
<td>4%</td>
<td>(20.688)</td>
</tr>
<tr>
<td>11:30</td>
<td>10%</td>
<td>(51.521)</td>
</tr>
<tr>
<td>12:30</td>
<td>20%</td>
<td>(103.042)</td>
</tr>
<tr>
<td>13:20</td>
<td>40%</td>
<td>(206.085)</td>
</tr>
<tr>
<td>14:40</td>
<td>50%</td>
<td>(257.605)</td>
</tr>
<tr>
<td>15:15</td>
<td>60%</td>
<td>(309.127)</td>
</tr>
<tr>
<td>15:40</td>
<td>80%</td>
<td>(412.169)</td>
</tr>
<tr>
<td>16:45</td>
<td>100%</td>
<td>(515.211)</td>
</tr>
</tbody>
</table>
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.
Thank you for your attention