Towards a New Energy Model
Challenges and solutions to enable large RES penetration in the Canary Islands’ isolated power systems

3rd International Hybrid Power Systems Workshop
Tenerife - May, 8-9 2018
AGENDA

REE at a Glance
The Canary Islands Electrical Systems
A Vision for Tomorrow
The TSO Challenges
What We Are Doing
REE at a Glance
The Spanish TSO

- 4 control centres
- 43.801 km of transmission grid
- 4,360 busbars
- 85,144 MVA transformer capacity
REE at a Glance

TSO in the Canary Islands
The Canary Islands Electrical Systems

TODAY

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

0.042 TWh  3.4 TWh (x80)  248 TWh (x6,000)  3.278 TWh (x78,000)

El Hierro  Tenerife  Spanish mainland  ENTSO-E
Annual demand covered by RES (2017)

Gran Canaria
- 91.4%
- 8.6%

Tenerife
- 91.9%
- 8.1%

Lanzarote - Fuerteventura
- 95.6%
- 4.4%

La Palma
- 89.0%
- 11.0%

La Gomera
- 99.3%
- 0.7%

El Hierro
- 53.5%
- 46.5%
A Vision for Tomorrow

A BIG move towards renewable energy

- Reducing oil dependency
- Reducing CO₂ emissions
- Exploiting local primary energy sources
- Minimizing system costs

Current and future RES installed capacity vs Peak demand (MW)
The TSO Challenge

Large amount of non-controlable generation in the energy mix

Solar

Wind
What we are doing

Facing the challenge...

NETWORK DEVELOPMENT

INTERCONNECTIONS

ENERGY STORAGE

R&D
NETWORK DEVELOPMENT
What are we doing

NETWORK DEVELOPMENT

<table>
<thead>
<tr>
<th>Infraestructuras planificadas 2015-2020</th>
<th>220 kV</th>
<th>132 kV</th>
<th>66 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subestaciones</td>
<td>220</td>
<td>220</td>
<td>220</td>
</tr>
<tr>
<td>Nuevas subestaciones</td>
<td>75</td>
<td>65</td>
<td>55</td>
</tr>
<tr>
<td>Ramas (km de circuito)</td>
<td>194</td>
<td>194</td>
<td>194</td>
</tr>
<tr>
<td>Líneas</td>
<td>90</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Compensación [Mvar]</td>
<td>220</td>
<td>132</td>
<td>66</td>
</tr>
<tr>
<td>Reactores</td>
<td>-</td>
<td>27</td>
<td>18</td>
</tr>
<tr>
<td>Condensadores</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Inversión estimada 2015-2020
€ 991 Millones de euros

Planificación 2015-2020

*Red de gestión: Activaciones en ejecución.
What are we doing

NETWORK DEVELOPMENT
INTERCONNECTIONS
What we are doing

INTERCONNECTORS

- **La Gomera – Tenerife**
  - (planned)
  - 42 km
  - 2x 66kV

- **Gran Canaria – Fuerteventura**
  - (in study)

- **Lanzarote – Fuerteventura**
  - (planned)
  - 14 km
  - 1x 132 kV

- **Gran Canaria – Fuerteventura**
  - (current 1x66 kV)**
What we are doing

STORAGE: SORIA-CHIRA REVERSIBLE PUMPED STORAGE

Demanda 2025 - 3.679 GWh

Potencia renovable instalada
588 MW
65 MW

Chira max
5,200 dam³

4,500 dam³
3,600 MWh
18 horas a plena carga

Soria max
32,500 dam³

200 MW turbinación
220 MW bombeo
What we are doing

STORAGE: SORIA-CHIRA REVERSIBLE PUMPED STORAGE

A Project redesigned by the TSO to serve as a tool for:

- System stability
- Security of supply
- RES Integration

Main design requisites

- Units with smooth start and stop maneuvers
- Maximum control over active power both generating/pumping
- Fast transition between operating modes
- Continuous operating range
- Reactive power regulation capabilities (MVar) for voltage control
- Black-start capabilities
- Other: frequency-power regulation, inertial response, transient overvoltage, etc.
What we are doing

STORAGE: CENTRAL HIDROEÓLICA DE EL HIERRO (CHE)

El Hierro island:

- Peak demand: 7 - 8 MW
- Lowest demand: 3.5 - 4 MW

CHE:

- Owned by Gorona del Viento:
  - Cabildo de El Hierro
  - ENDESA
  - Instituto Tecnológico de Canarias
- Dispatched by the TSO

Technical specs:

- Wind: 11.5 MW
- Pumps: 6.4 MW
- Turbines: 11.4 MW
- Upper reservoir: 380 dam3
- Lower reservoir: 149 dam3
- Roundtrip efficiency: 50%
What we are doing

STORAGE: CENTRAL HIDROEÓLICA DE EL HIERRO: 100% RENEWABLE

Longest run being 100% renewable: January 25th to February 12th, 2018 (18 consecutive days)
RES integration in El Hierro island

2216 hours 100% renewable
What we are doing

STORAGE: CENTRAL HIDROEÓLICA DE EL HIERRO

El Hierro system frequency

Before

After
ALISIOS/OSMOSE

Hybrid storage projects to provide system services

TENERIFE

LANZAROTE - FUERTEVENTURA

Multi-megawatt hybrid storage to provide system services in high RES penetration scenarios.

- Managing RES variability
- P-f Regulation
- Inertia emulation
- Voltage control
- Congestion relief

Hybrid storage to keep security of supply and operating efficiency in a low Meshed isolated power grid.

- STATCOM: 25 Mvar
- SUPERCAPACITOR: 10 MW – 55 MWs
- FLYWHEEL: 1.6 MW – 18 MWs
- BATTERY: 3 MW - 1 MWh
Summary

The Canary Islands face a **big challenge** in its way to a cleaner power system.

The **TSO role is key** to achieve the objectives.

We are facing the challenge from **different angles**.

We are achieving some **promising results**.

There is still **a lot of work** to do...
Thank You!

Pablo Santos – Isolated Systems Dept.
Red Eléctrica de España
pasantos@ree.es

Thank You!