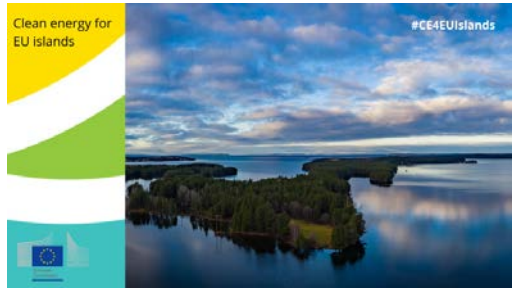
Instituto Tecnológico de Canarias (ITC)

Renewable Energies Department

The challenges and the future of non-interconnected islands: lessons learnt for other islands and the mainland



Gonzalo Piernavieja
R&D&I Director

itc INSTITUTO TECNOLÓGICO DE CANARIAS

Gobierno de Canarias

Energy singularities of EU Islands

EU Islands are confronted with a number of energy challenges due to their specific climatic and geographic characteristics.

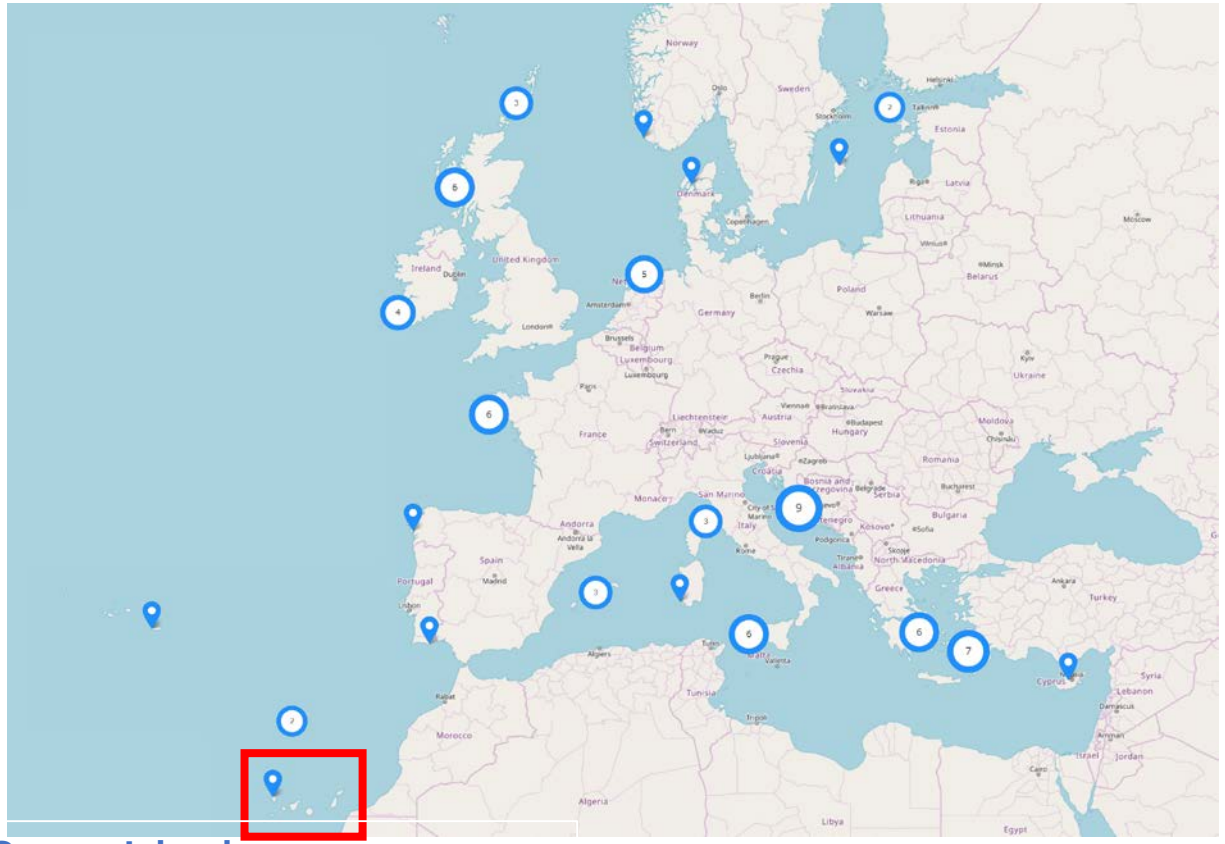
Most of the European Islands have a **high dependency on imported fossil fuels**.

Moreover, these energy systems have energy supply constraints due to the **lack of electricity (and also gas) interconnections which result in an increase in the difficulty to balance electricity supply and demand**.

These are the main reasons why the **energy cost in European Islands excesses the average of European countries due to the use of more expensive fuel and lower efficiencies of thermal power plants**.

The response to reduce climate change risks in energy sector needs to be focused **not only on generation systems, but also on overall electrical infrastructure**.

The electrical infrastructure needed to feed power generated in the island is located inland.



The Canary Islands

Islands require specific political actions that should be adapted to the special circumstances of these electrical systems.

Islands could serve as living labs in the framework of the energy transition of Europe, testing innovative solutions in local energy systems as a first step in the European decarbonisation strategy.

Energy singularities of EU Islands (II)

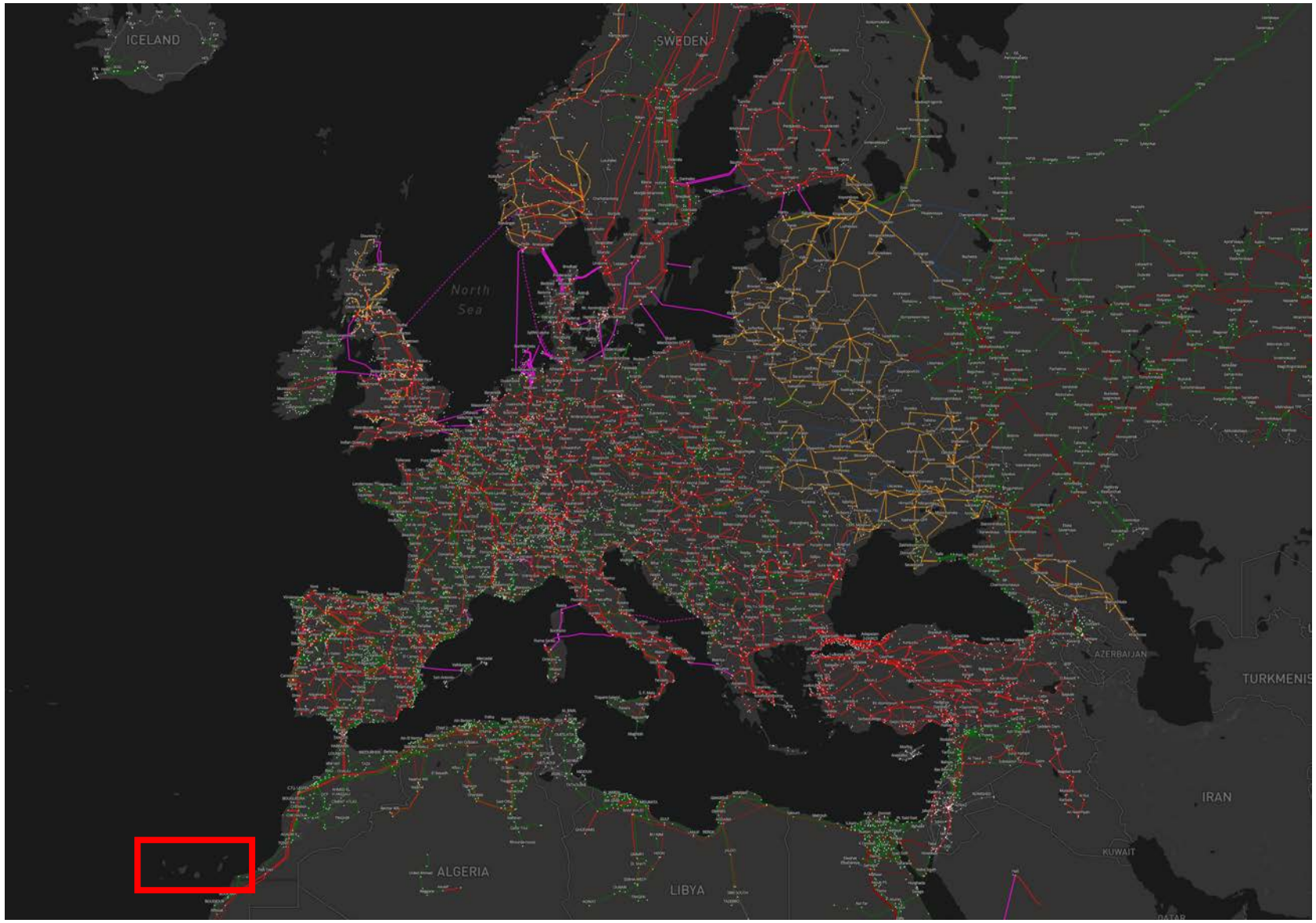
- Every electrical system **must guarantee a constant balance** between generation and consumption of electricity.

- This **balance is a challenge** of considerable importance, **especially in scenarios of high penetration of renewable energy** when these renewable resources are of a non-manageable nature.

- Each island region may have a **completely different energy situation**. In this sense, there are islands in which it may be more interesting to have traditional renewable sources (such as wind of solar power) and others in which these technologies would not be viable due to environmental, economic or social reasons.

- Islands and insular territories share the common characteristic of being regions with great problems of **limited space and generally highly protected due to their landscape and environmental quality**, what usually turns these regions into territories where the installation of new sources of renewable generation is not so easy

European grid map



Particular situation of the Canary Islands (I)

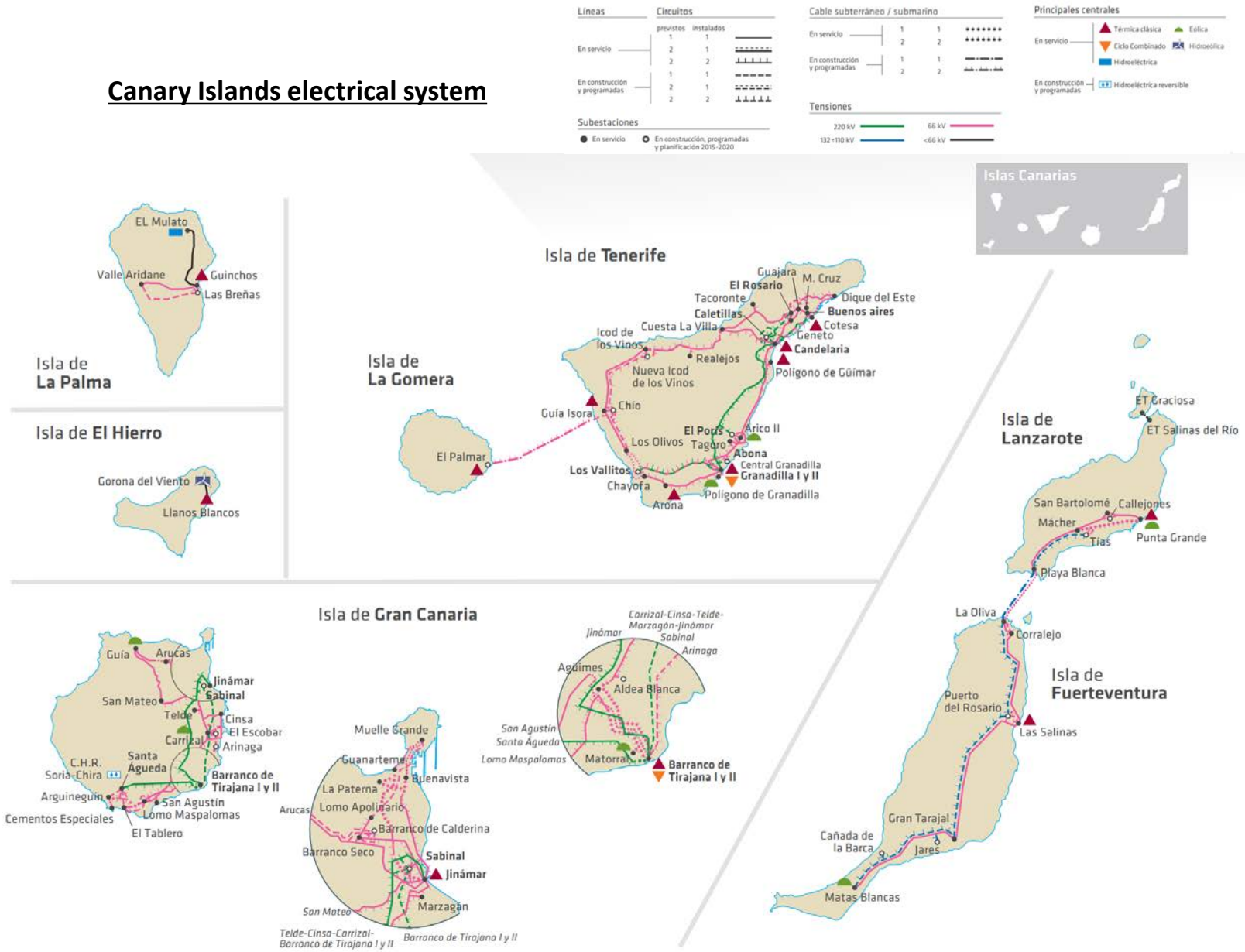
- Archipelago composed of 6 independent electrical systems.
  - There is not interconnection with the mainland.
  - **Current situation**: Only one interconnection between islands (Lanzarote – Fuerteventura 66 kV).
  - **Near future**: A new interconnection between Tenerife and La Gomera.

- **High potential of non-manageable renewable energy sources**. Specially: Wind & Solar power.

- There is also potential for geothermal energy in Tenerife, La Palma (both high-enthalpy) and Gran Canaria (medium-enthalpy).

- One **Pumped-hydro power station** in El Hierro and another under construction in Gran Canaria as a way to store non-manageable resources.

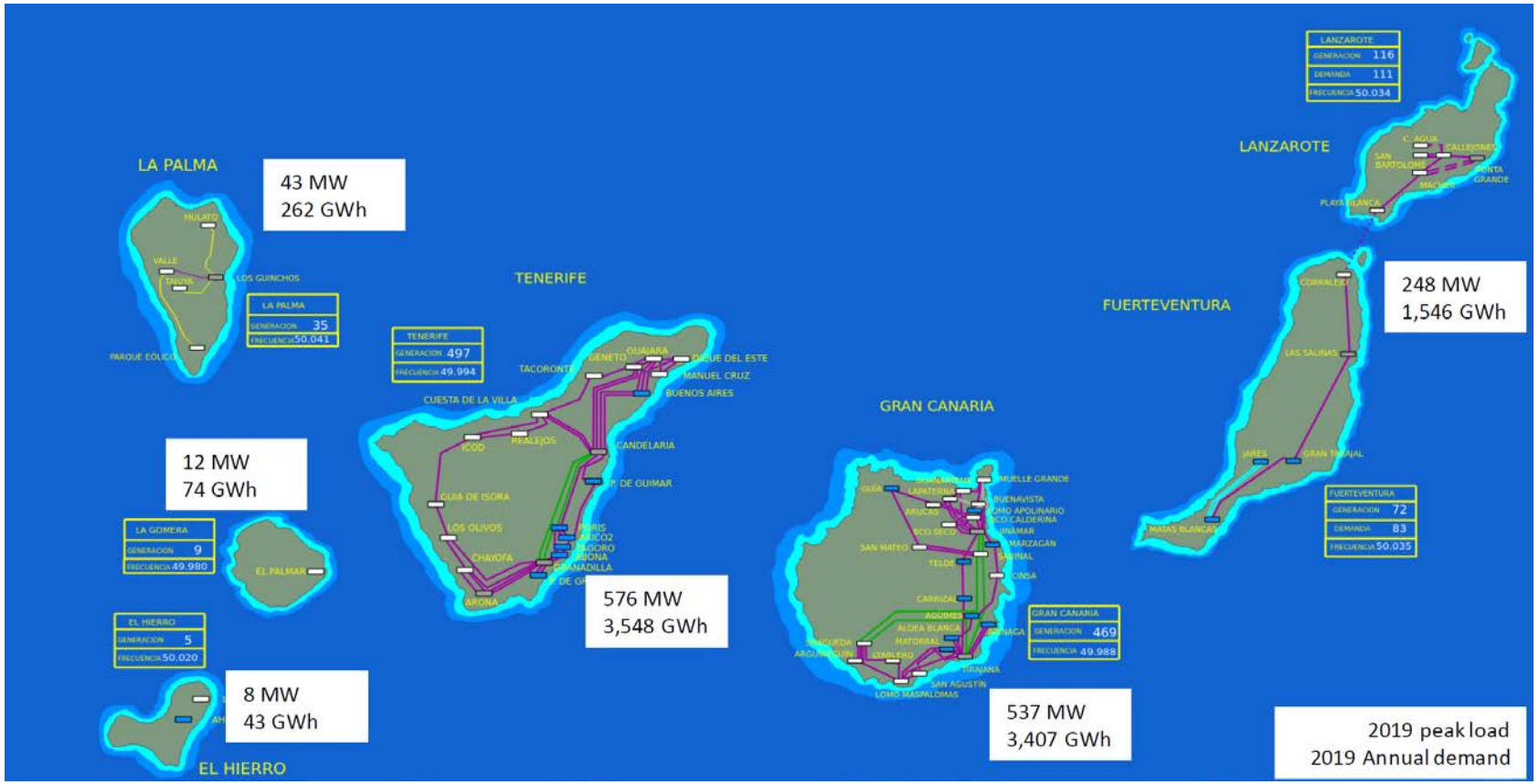
Canary Islands electrical system



Particular situation of the Canary Islands (II)

- Each electrical system have a different size (load demand peak power):
  - **Tenerife and Gran Canaria**: 530 – 580 MW
  - **Lanzarote and Fuerteventura**: 100 – 130 MW.
  - **La Palma**: 43 MW.
  - **La Gomera and El Hierro**: 8 – 12 MW.

- **Population:** 2.2 mill. inhabitants.
- **Importance of the touristic sector**: approx. 15 mill. tourists/year
- **Lack of water resources**. Importance of the water-energy nexus (desalination)
- **Significant weight of the transport sector**. Part of this sector will depend on the electrical sector.
- **Insular dimension**: strategic need to:
  - reduce (the still high) external dependence on fossil fuels and diversify the energy mix.
  - maximise the use of endogenous renewable energy resources.



Barriers in the integration of Renewable Energies

Non-manageable resources:

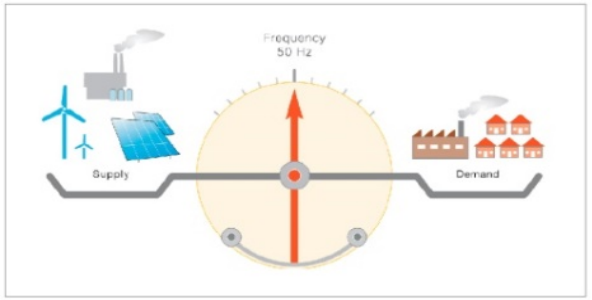
Mainly Wind and Solar power: The renewable production **depend directly on the variable renewable resource**.

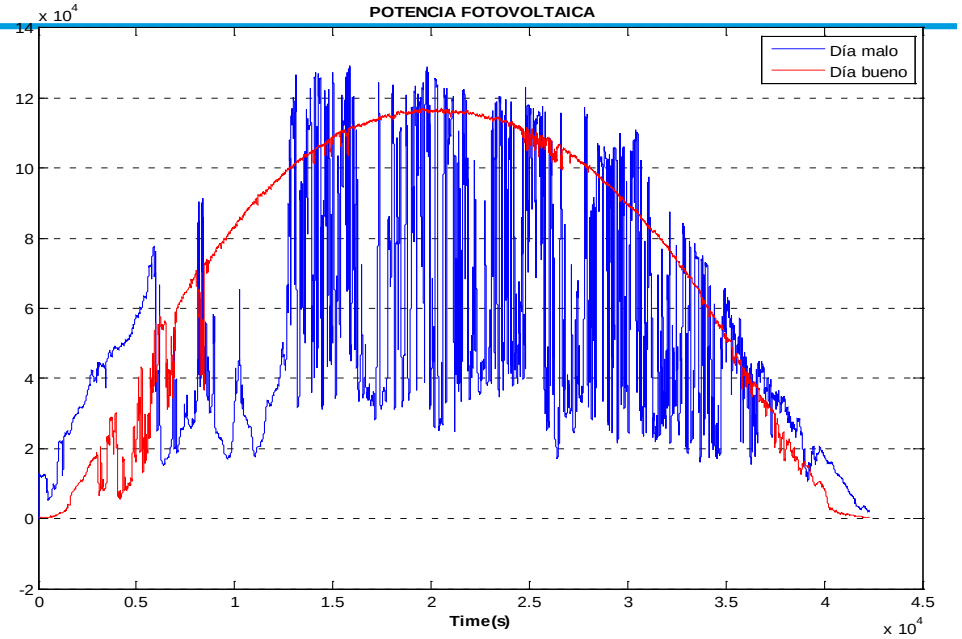
Challenge:

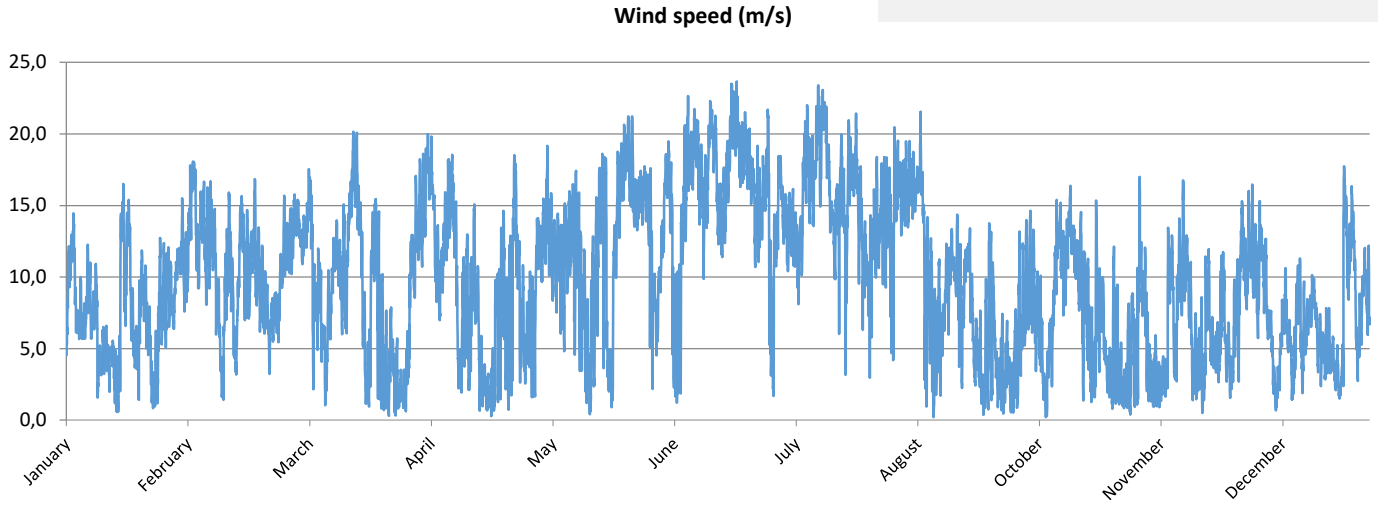
To manage the fluctuations of the renewable resource keeping the power stability of the electrical system.

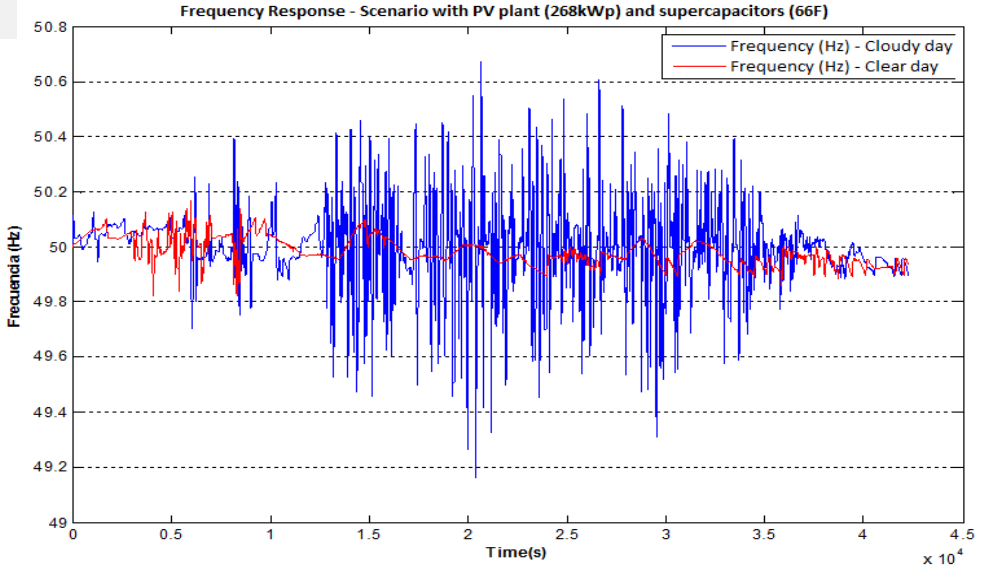
Solutions:

1. Forecasting tools.
2. Energy storage systems.
3. Advanced control units.









Strategies for maximizing RES penetration

Barriers in the integration of Renewable Energy

Electric system

Energy Planning

Economic/Administrative issues

Strategy for maximizing RES penetration

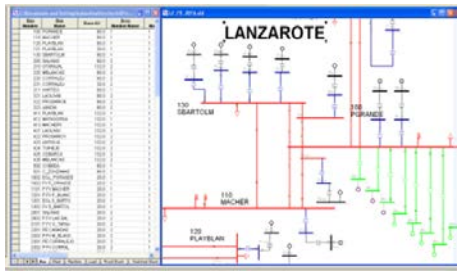
Grid stability analysis

Forecasting of non-manageable production

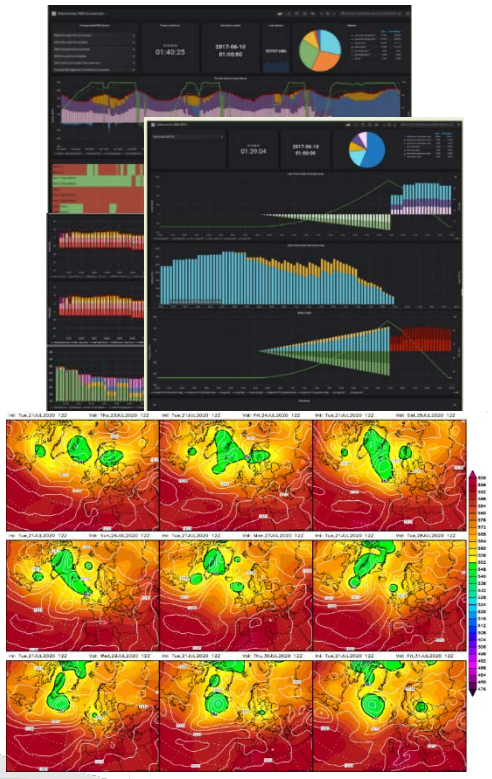
Demand Side Management

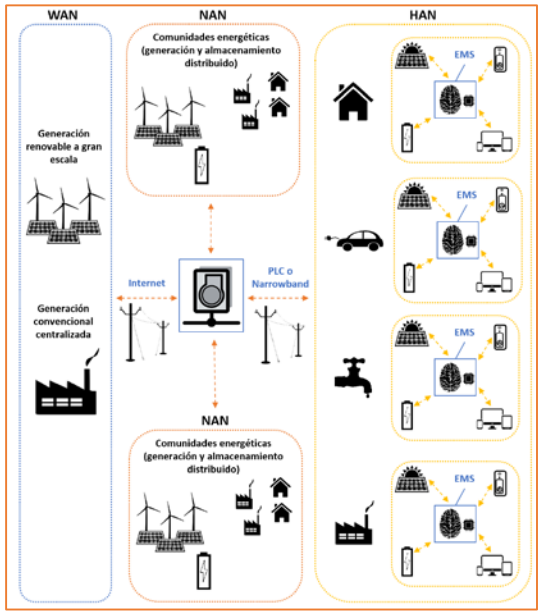
Energy Storage

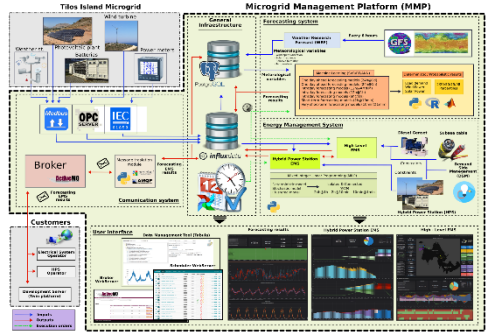
Distributed generation



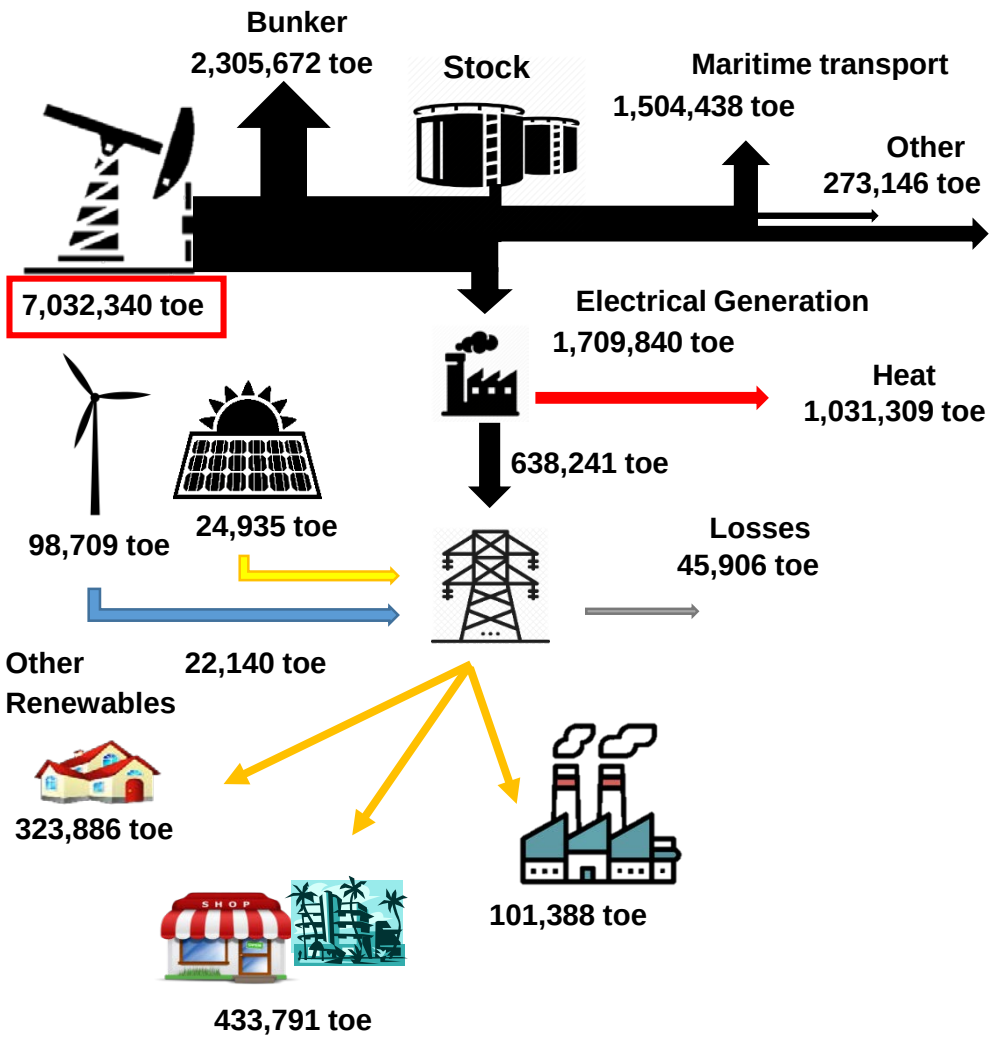
Security and reliability
Market – Risk planning
Scheduling
Planning







Energy Transition– Canary Islands



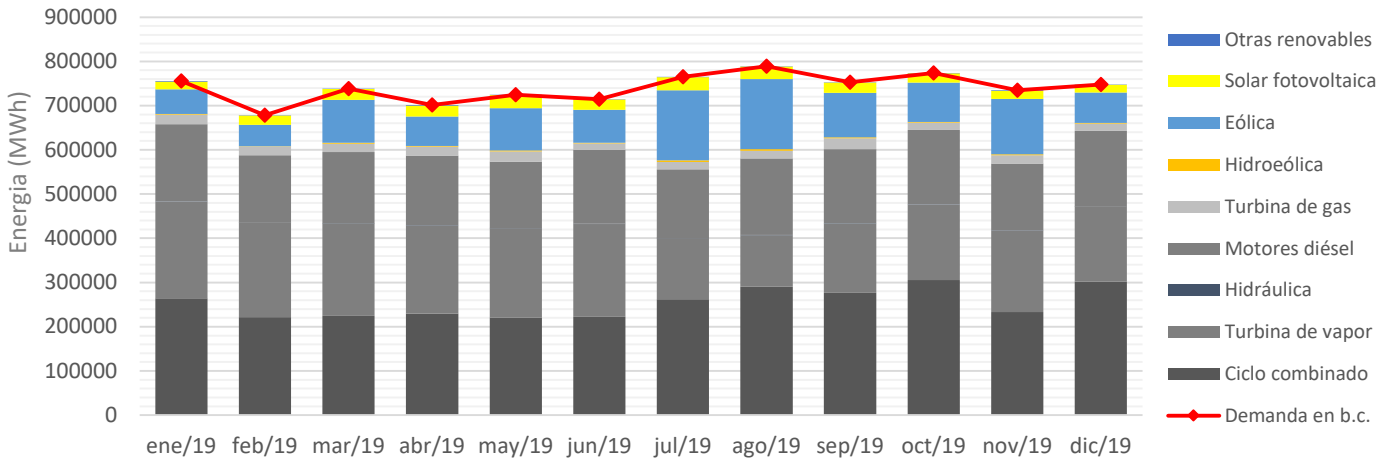
PNIEC 2030

- 23% GHG reduction compared to 1990.
- 42% of renewables on total energy consumption.
- 39,5% of improvement of energy efficiency.
- **74% of renewables in electricity generation**.

Canary Islands Objetives

- Decarbonisation of the Canarian economy by 2040.

Current state – Canary Islands



% current electricity generation in the Canary Islands

Renewable Energy

20%

Year 2020

Hydro: **0,04%**
Wind energy: 12,82%
PV: **3,14%**
Pumped Hydro + wind energy: **0,26%**
Other renewables: **0,11%**

MAC 2014-2020 Cooperación Territorial
Interreg

The Canary Islands Energy Transition Plan (PTECan)

Gobierno de Canarias
Consejería de Transición Ecológica, Lucha contra el Cambio Climático y Planificación Territorial
Dirección General de Energía

CANARIAS Por la transición energética | Plan de Transición Energética de Canarias

GOAL: Decarbonisation of the Archipelago by 2040 (incl. road + internal maritime and air transport)

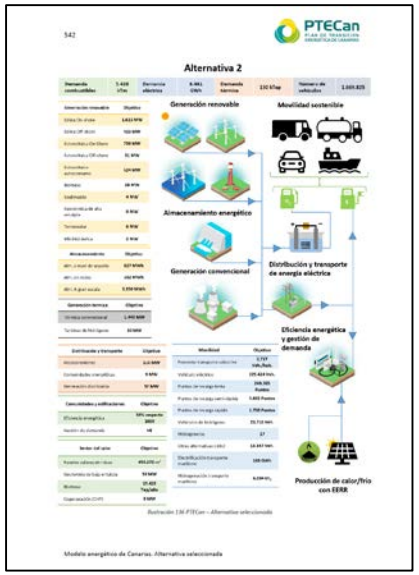
1040 *DECRETO 9/2021, de 18 de febrero, por el que se encomienda a la Consejería de Transición Ecológica, Lucha contra el Cambio Climático y Planificación Territorial la elaboración de un plan de transición energética para la Comunidad Autónoma de Canarias.*

PROYECTOS DE LEY

EN TRÁMITE
10L/PL-0018 De Cambio Climático y Transición Energética de Canarias. Página 1

8 Strategies that support the Plan:

- Self-Consumption
- Energy Storage
- Electric Vehicles
- Geothermal Energy
- Marine Renewable Energies
- Manageable Generation
- Green Hydrogen
- Demand Management and Smart Grids



Strategies available at: https://www3.gobiernodecanarias.org/ceic/energia/oecan/

Current status: Start of the Approval Process by the Regional Government (approval expected by 2022/2023)

General structure of PTECan

1 – PV self-consumption strategy | 2 – Energy storage strategy | 3 – Electric Vehicle strategy | 4 - Geothermal energy strategy | 5 – Marine Energy strategy | 6-Manageable Energy strategy | 7 – Green hydrogen strategy | 8 – Demand Side Management and Smart-Grid

OBJECTIVE
Decarbonisation of the Canarian energy system

CANARIAS
Por la transición energética
Plan de Transición Energética de Canarias

ENERGY DEMAND
Time evolution according to:
- ☒ Gross Domestic Product
- ☒ Population
- ☒ Price of fuels
- ☒ Right Emission Prices
- ☒ Climate Change IPCC

ECONOMIC DIMENSION
- Self-consumption
- Decarbonisation of the economy
- Blue economy: promotion of marine renewable energy
- Low carbon economy: promotion of RES and the electrification of heat demand and mobility
- Circular economy: energy recovery from waste

Alternative 0
Trend

Alternative 1
100% RES
0 % CO_2
2040
2030 2040

Alternative 2
100% RES
0 % CO_2
2040
2030 2040

DIAGNOSIS
- SWOT
- Specific objectives

ACTION PLAN
- Insularized
- Anualized

ECONOMIC ANALYSIS
- Financing
- Positive externalities

ENVIRONMENTAL DIMENSION:
- Conservation of landscape wealth
- Reduction of environmental pollution
- Mitigation of climate change
- Biodiversity Conservation

Strategic Environmental Assessment

DIMENSION SOCIAL
- Exploit new sources of green employment
- Fair Energy Transition
- Fight against energy poverty
- Promotion of energy communities
- Energy democratization

ANNUAL OBJECTIVES

INVESTMENT

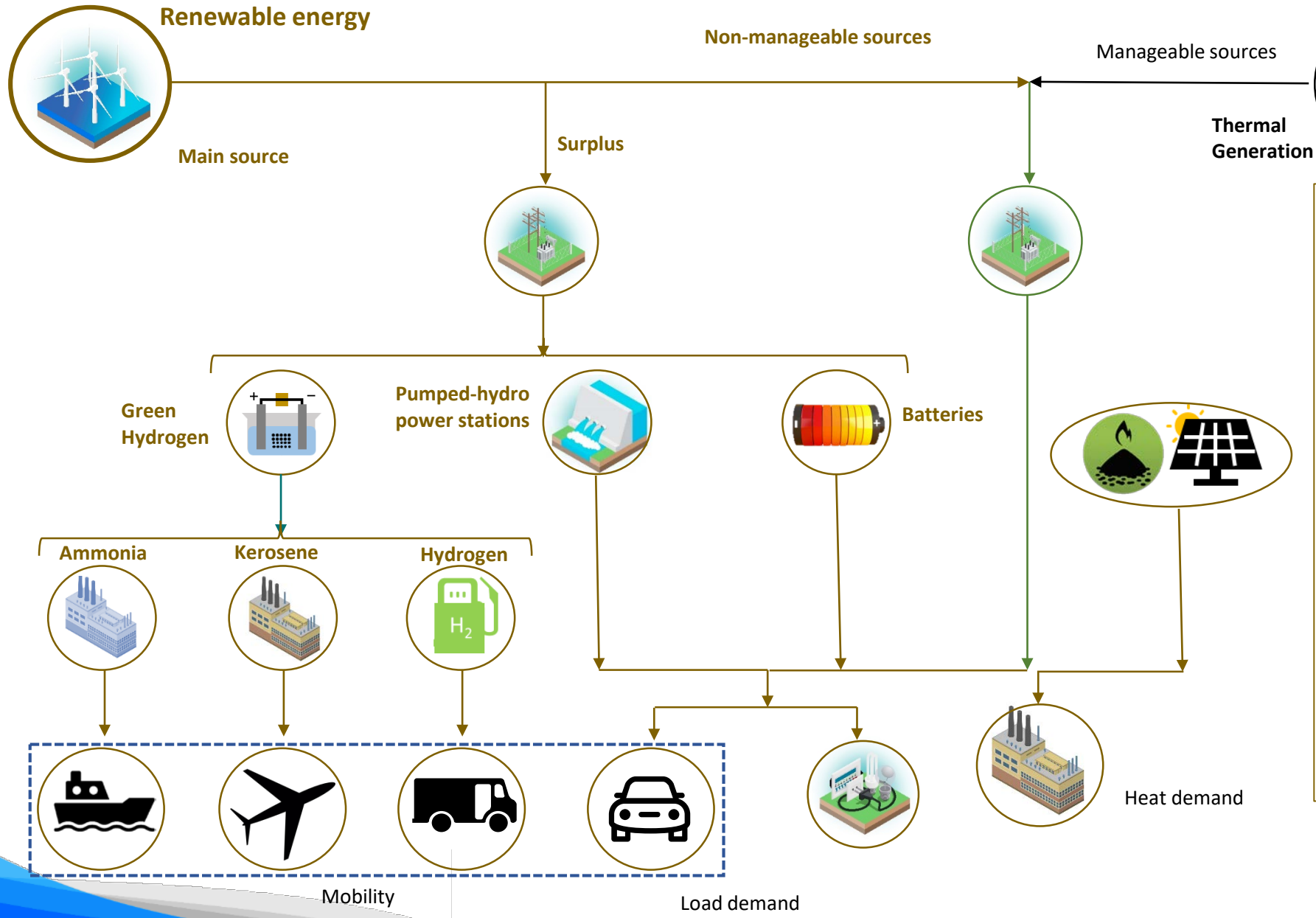
ZONIFICATION

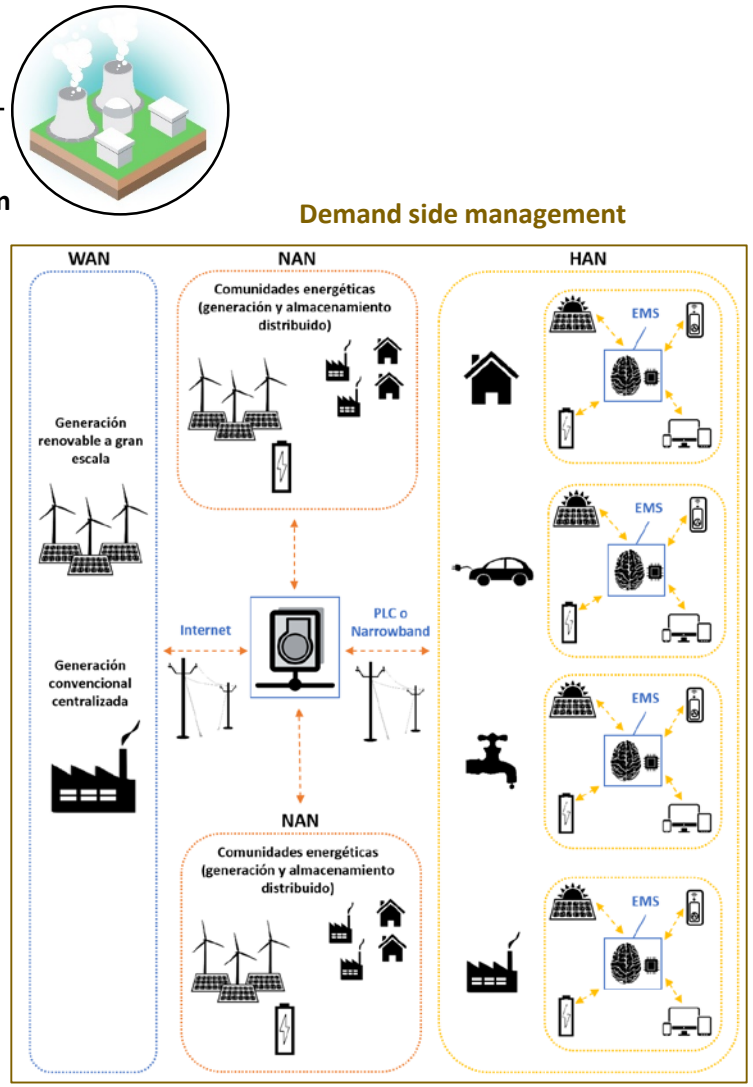
1040 *DECRETO 9/2021, de 18 de febrero, por el que se encomienda a la Consejería de Transición Ecológica, Lucha contra el Cambio Climático y Planificación Territorial la elaboración de un plan de transición energética para la Comunidad Autónoma de Canarias.*

PROYECTOS DE LEY

EN TRÁMITE
10L/PL-0018 De Cambio Climático y Transición Energética de Canarias. Página 1

Basic scheme of the proposed energy system



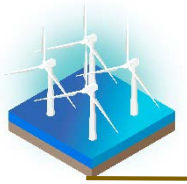


Current situation (2020)

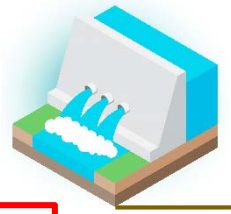
Fuel demand	3.531 kTm	Electrical power demand	8.355 GWh	Thermal energy demand	158 KTep	Number of vehicles	1.745.742

Renewable power generation

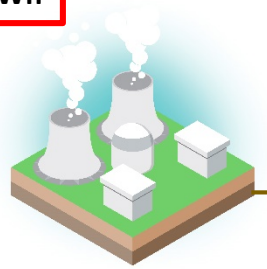
Total RES: 681,0 MW



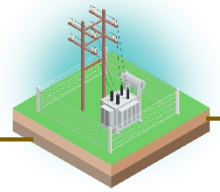
Energy storage



Storage: 155,5 MWh

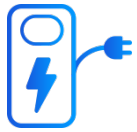


Conventional thermal generation



Distribution and transport of electrical energy

Sustainable mobility



Zero-emissions vehicles: 3.806 Vehicles

Heat/cold production with renewables

Energy efficiency and demand management

Renewable power generation	Current version
Onshore wind	463,4 MW
Offshore wind	5,2 MW
PV	182,3 MW
PV Off-shore	0,0 MW
PV self consumption	24,4 MW
Biomass	3,7 MW
Wave energy	0,0 MW
High entalphy geothermal	0,0 MW
Solar thermal	0,0 MW
Small scale hydro	2,0 MW

Storage	Current version
Consumer storage	- MWh
Grid storage	5,5 MWh
Large scale storage	150 MWh

Conventional thermal generation	Current version
Conventional Thermal	2.357 MW
Hydrrogen engines/turbines	0 MW

Mobility	Current version
Promoting public transport	0,81Veh./citizen.
Electric vehicle	3.806
Slow charging stations	156
Fast charging stations	75
Rapid charging stations	81
Hydrogen vehicles	7
Hidrogen stations	0
Other zero emissions alternatives	0
Maritime transport e-solutions	0 GWh
Maritime transport hydrogen	0 tH2

Heat sector	Current version
Solar thermal	125.019 m²
Low entalphy geothermal	32 MW
Biomass	toe/year
Cogeneration	89,98 MW

Communities and buildings	Current version
Energy efficiency	-
Demand management	No

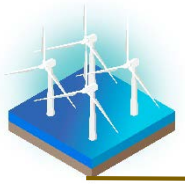
Objective 2030

Fuel demand	5.426 kTm	Electr. power demand	8.692 GWh	Thermal energy demand	130 kTep	Number of vehicles	1.669.825

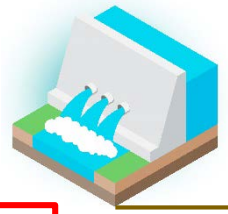
Renewable power generation

Renewable power generation	Objetivo
Oshore wind	1.606 MW
Offshore wind	430 MW
Fotovoltaica Antropiz.	759 MW
Floating PV	31 MW
PV self consumption	524 MW
Biomass	18 MW
Wave energy	4 MW
High enthalpy geothermal	30 MW
Solar thermal	6 MW
Small scale hydro	2 MW

Total RES: 3.410 MW



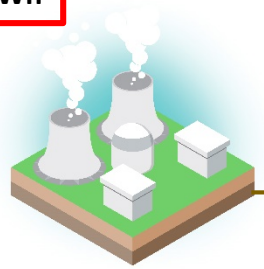
Energy Storage



Storage	Objetivo
Consumer storage	827 MWh
Grid storage	162 MWh
Large scale storage	3.350 MWh

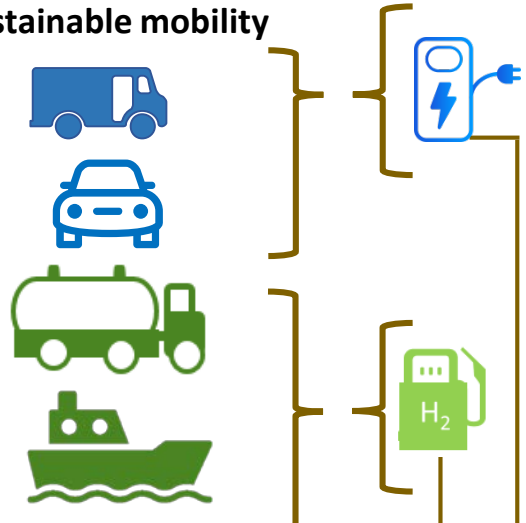
Storage: 4.339 MWh

Conventional power generation	Objetivo
Conventional thermal	1.440 MW
Hydrogen turbines/engines	45 MW

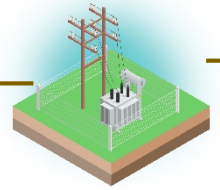


Conventional thermal generation

Sustainable mobility



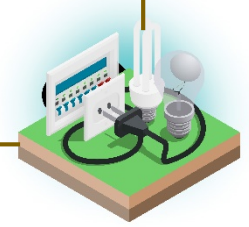
Hydrogen, Ammonia and Synthetic Fuels



Distribution and transport of electrical energy

Zero Emissions vehicles : 262.987 Vehicles

Heat/cold production with Renewables



Energy efficiency and demand management

Mobility	Objetive
Promoting public transport	0,717 Veh./citiz.
Electric vehicle	225.424 .
Slow charging stations	249.765
Fast charging stations	5.692
Rapid charging stations	1.700
Hydrogen vehicles	7.183
Hydrogen stations	17
Other zero emissions alternatives	13.847 veh.
Maritime electrical transport	168 GWh
Maritime hydrogen transport	6.834 tH_2

Heat sector	Objetive
Solar thermal	456.272 m^2
Low enthalpy geothermal energy	59 MW
Biomass	15.423 Toe/year
Cogeneration	8 MW

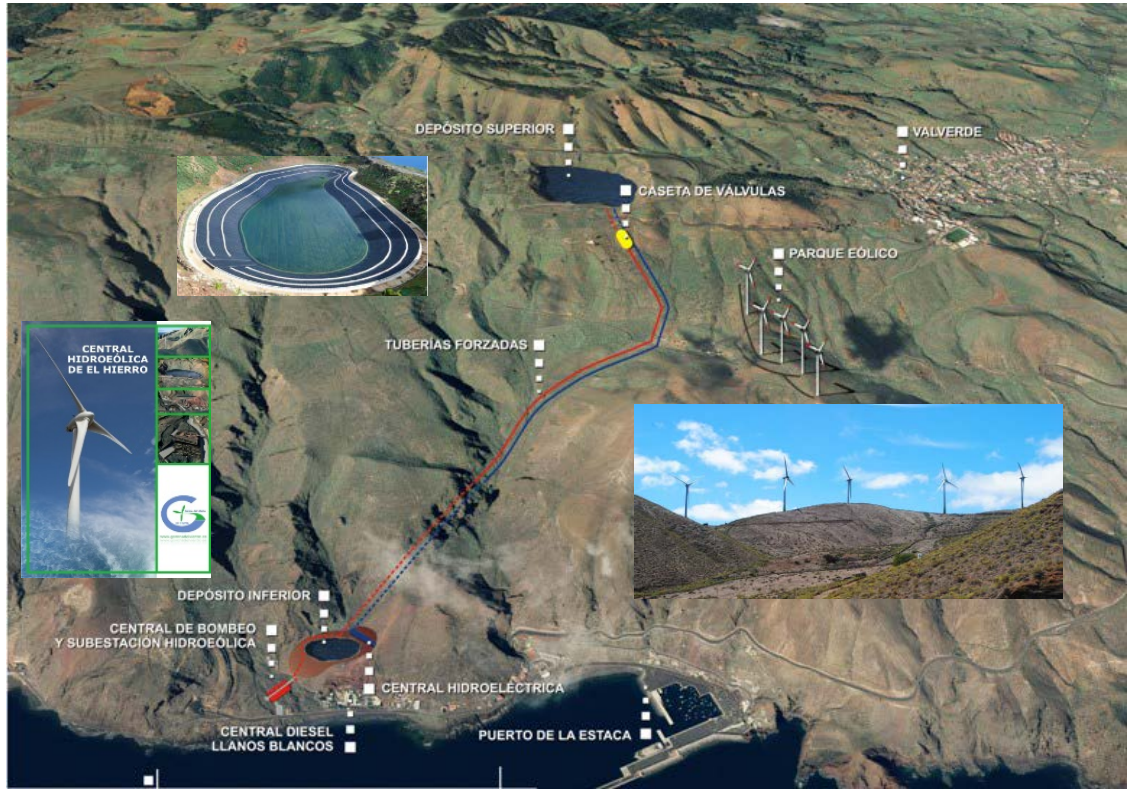
Communities and buildings	Objetivo
Energy efficiency	38% increase from year 2005
Demand management	VE

The Canary Islands: Natural Laboratory for sustainable energy technologies

Outstanding Projects

El Hierro Wind-Pumped Hydro Storage Power Station

- **60 % RES penetration**
- **1-2 months continuously 100%**

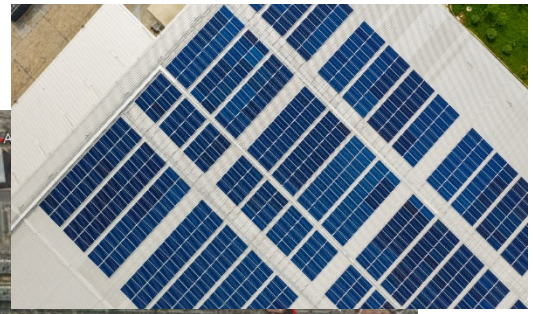


100% Sustainable La Gomera:

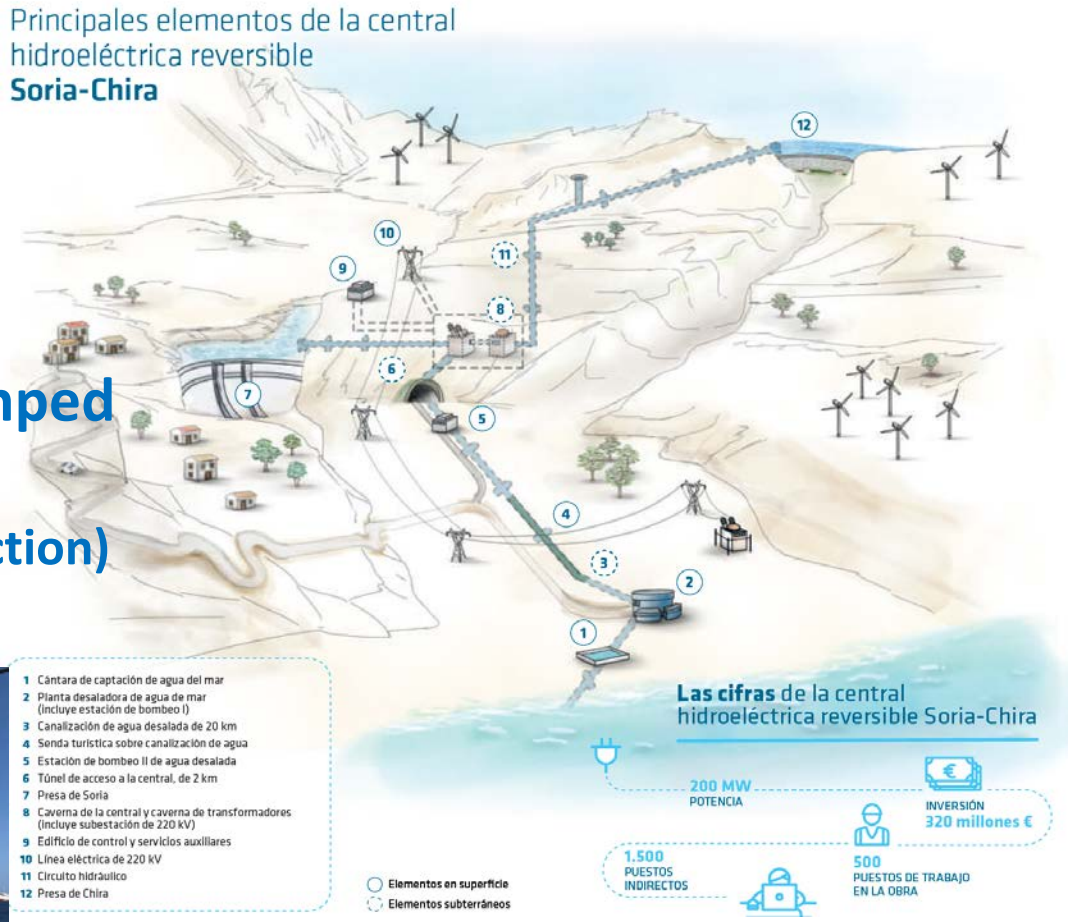
Distributed Renewable Energies (incl. microgrids and distributed energy storage)

The Canary Islands: Natural Laboratory for sustainable energy technologies

Energy Communities

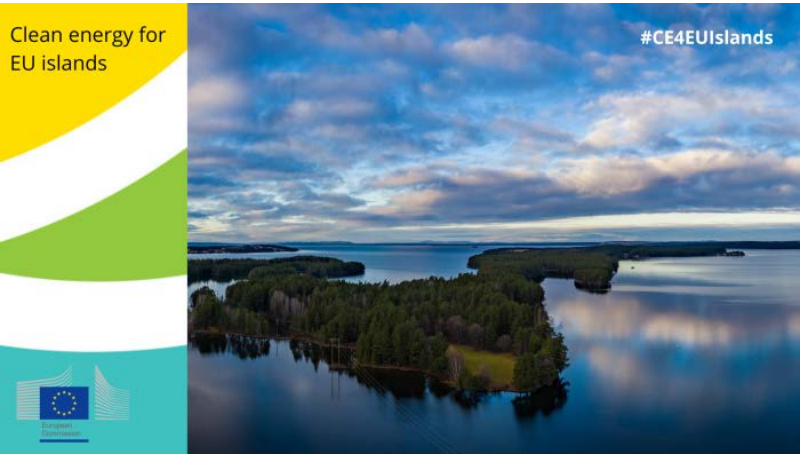


200 MW Pumped Storage (under construction)



Off-Shore Renewables

+ Several Green Hydrogen Initiatives



Thank you!!

Instituto Tecnológico de Canarias

Canary Islands Institute of Technology

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