energy storage

IEA Technology Collaboration Programme

COUNTRY REPORT
SPAIN

Delegate: Dr. Cristina Prieto

University of Seville

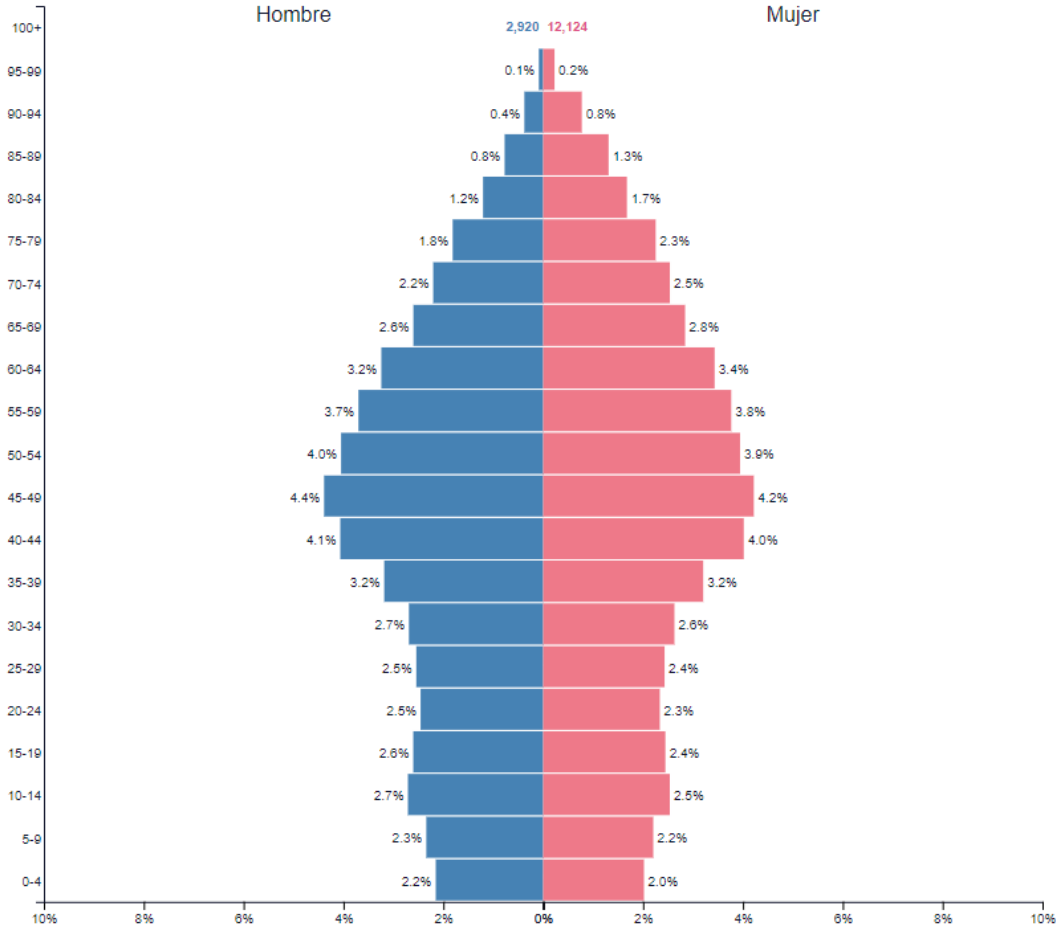
93nd Executive Committee Meeting (XC93)

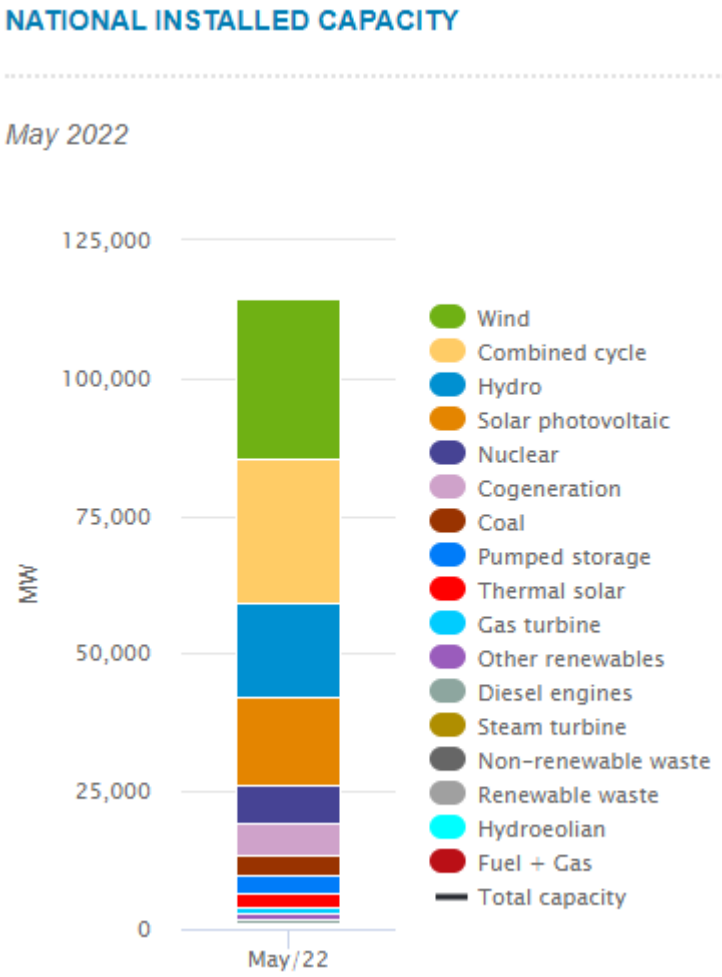
19th May 2022

Country Specific Information

2022

Población: 46,719,147





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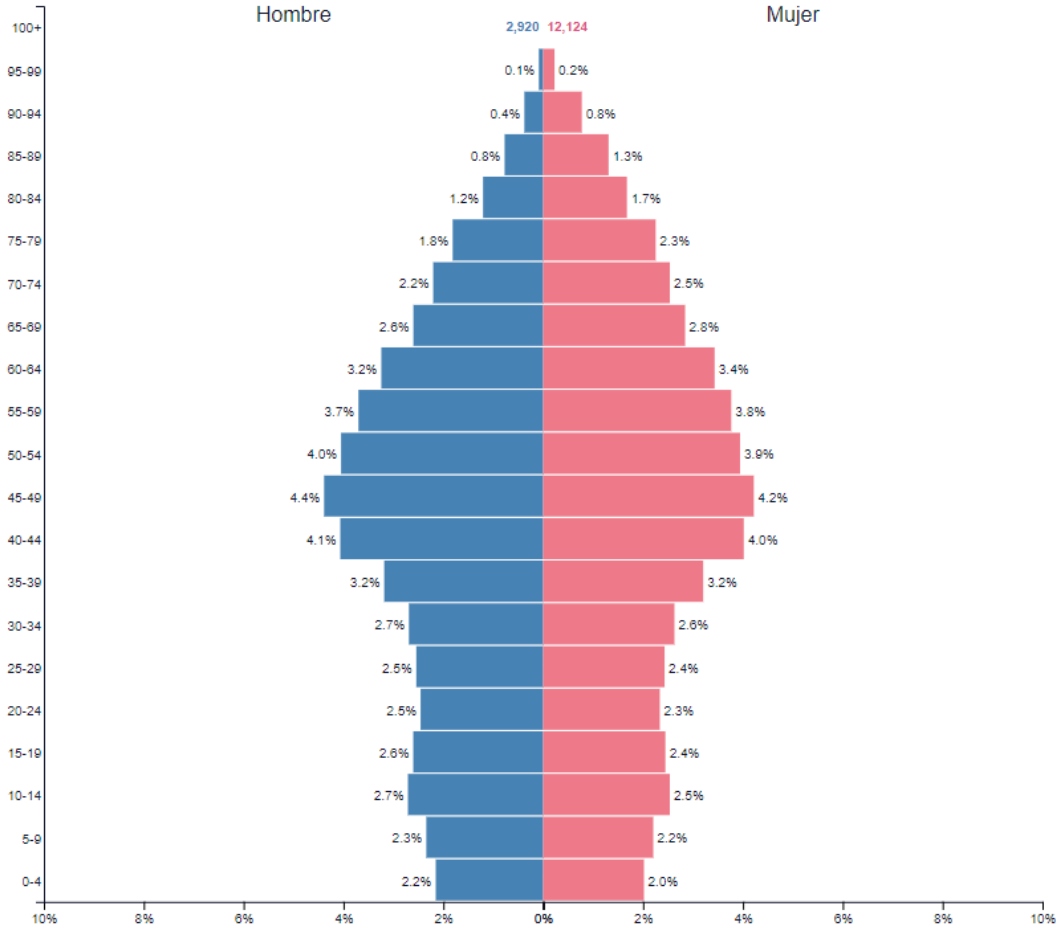
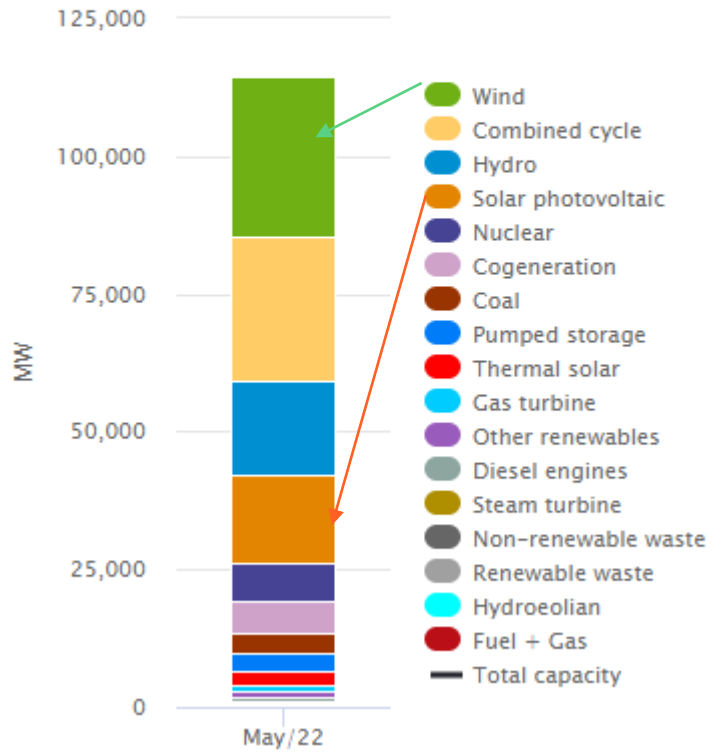


NATIONAL INSTALLED CAPACITY

May 2022



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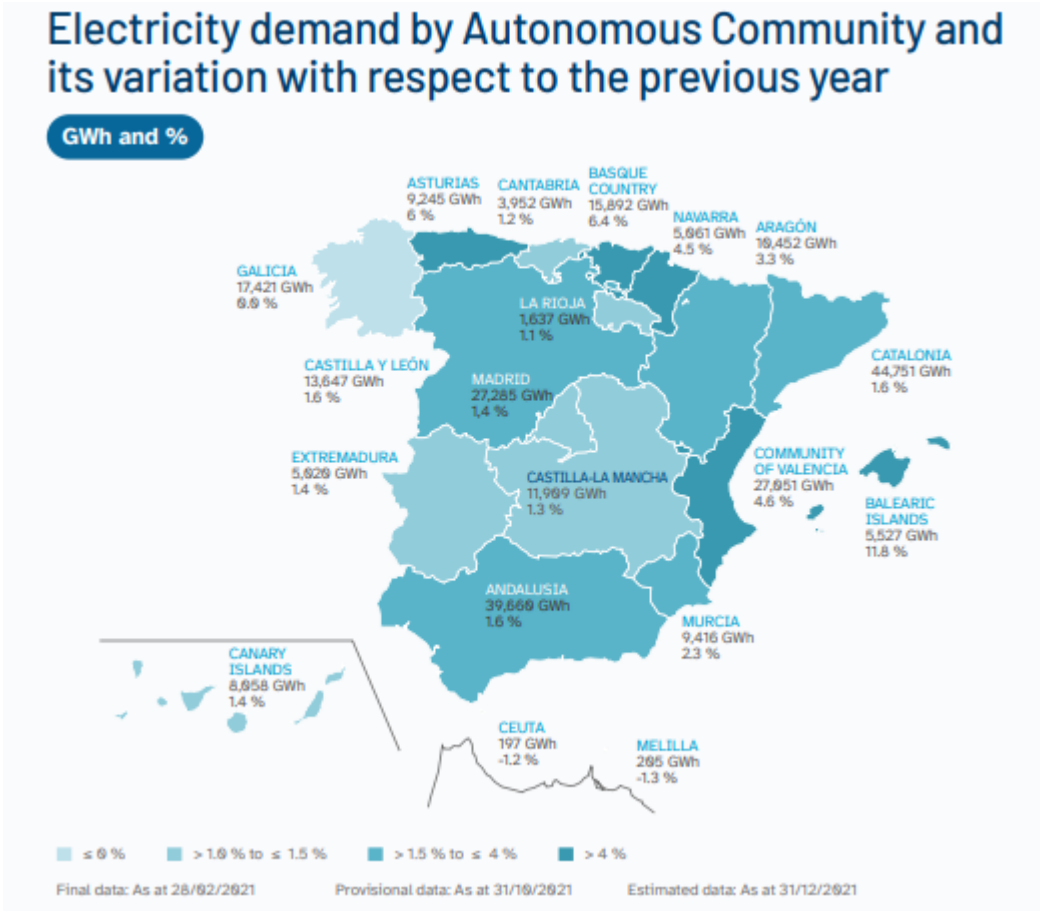

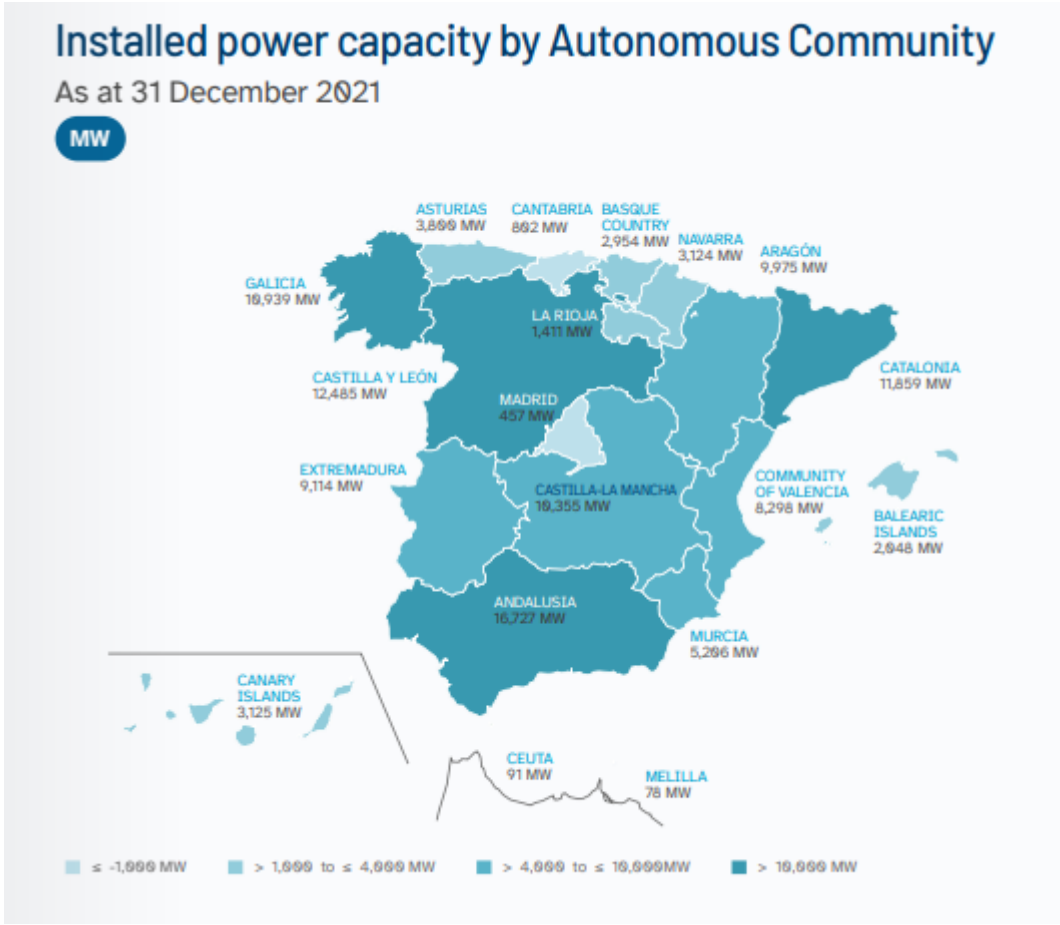

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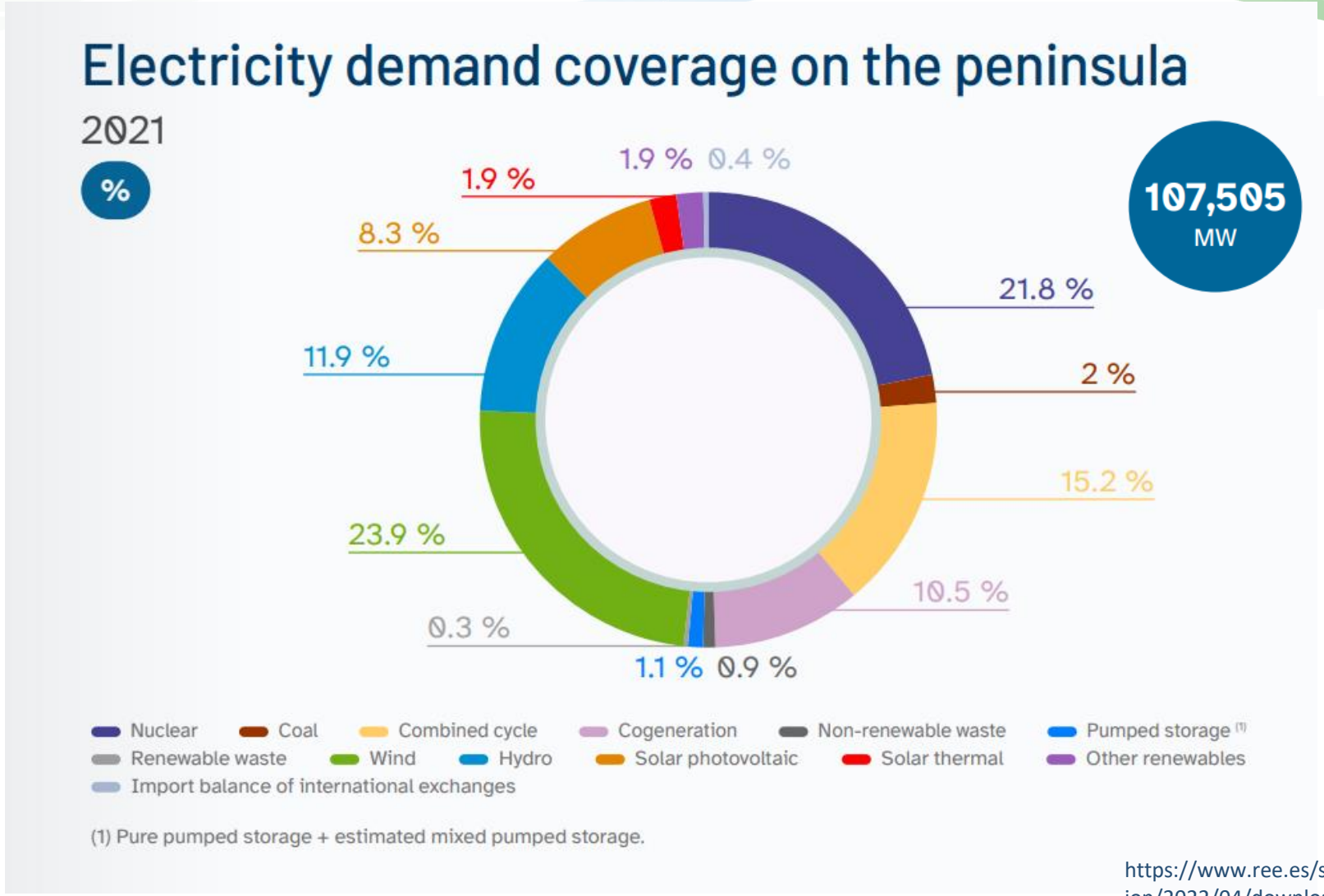
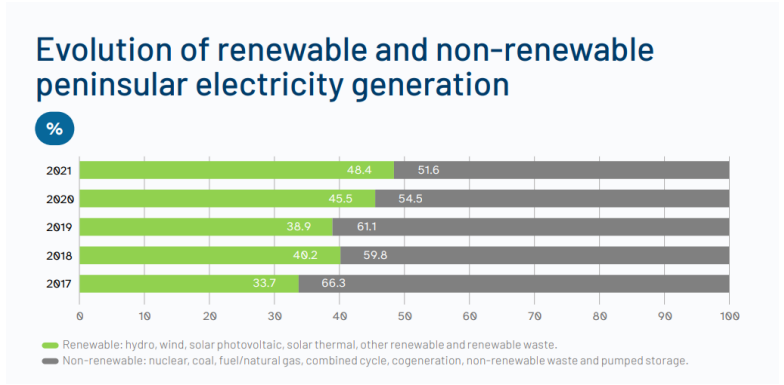


48.4 % share of renewables in the overall peninsular electricity generation mix



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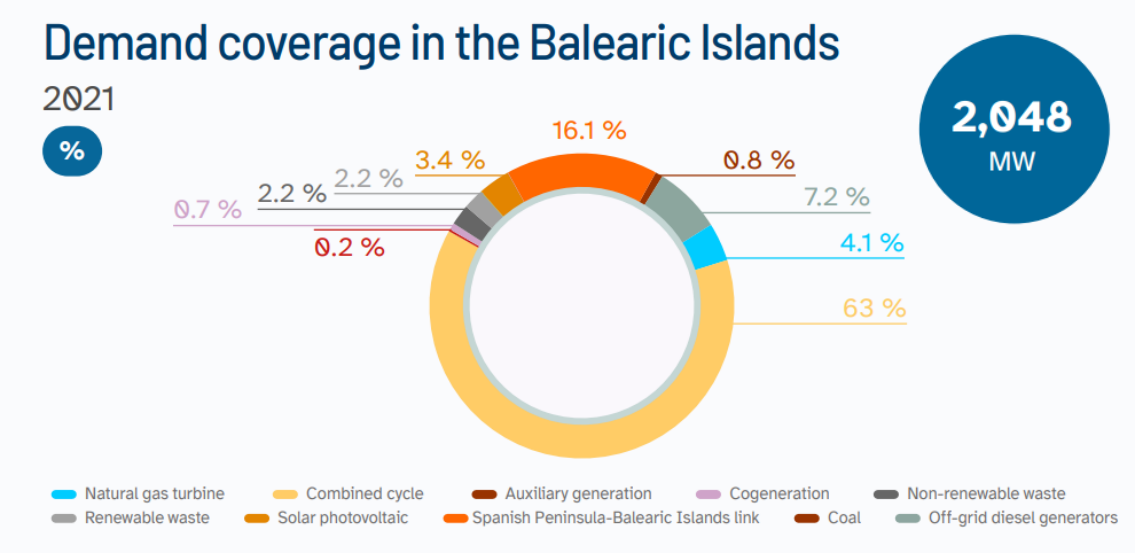

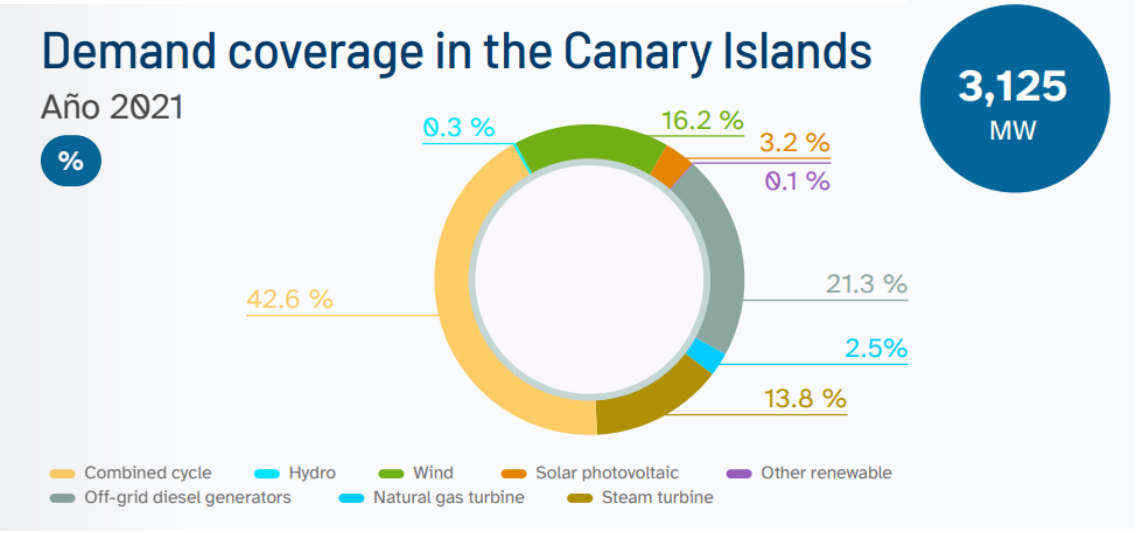

In terms of demand coverage in the electricity generation mix of the Balearic Islands, the share of coal-fired production continued to decrease, closing the year at only 0.8% (4.5% in 2020), and combined cycle continued to grow, reaching a share of 63% (48.8% in 2020).

Regarding the Canary Islands, renewable energy covered 19.9% of annual demand, the highest value ever registered to date, a significant value for an isolated electricity system, and that in March 2021 contributed to covering up to 30.5% of the generation mix.

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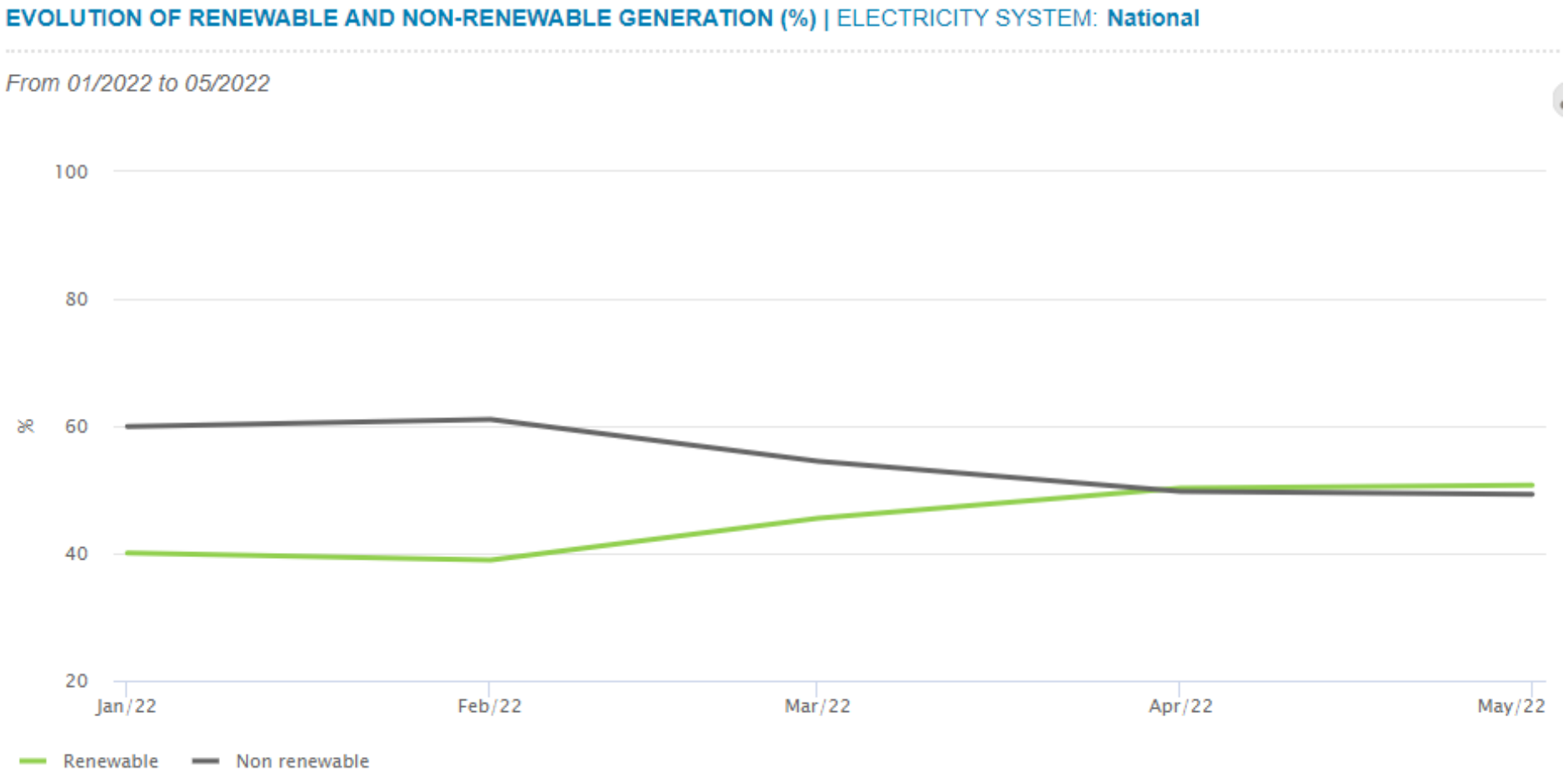
Country Specific Information



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RDD Information

National Integrated Plan for Energy and Climate (PNIEC)

- Ecological transition to net-zero
- 74% renewable capacity in electricity generation by 2030 (100% in 2050)
- 42% of renewable energy by final use **by 2030** (32% EU target)
- 6 GW storage capacity by 2050

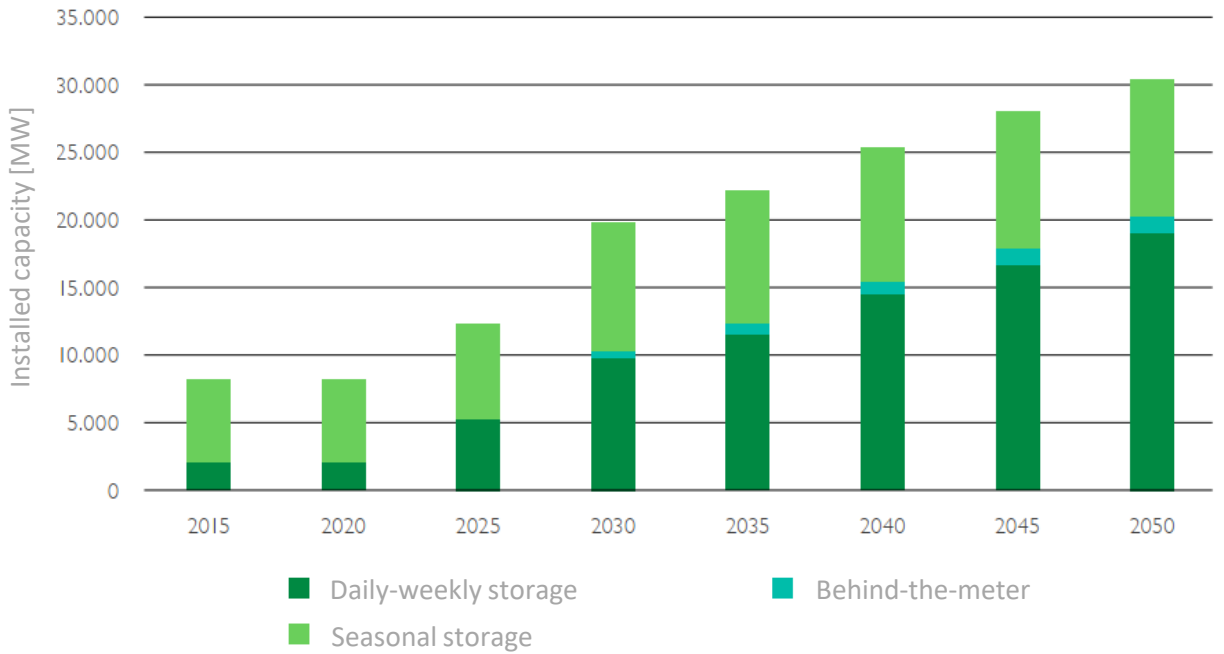
Renewable **final** energy evolution by sector (PNIEC)

Sector	2021	2030	Variation
Electric generation	10208 ktoe	21792 ktoe	113%
Heat pumps	629 ktoe	3523 ktoe	460%
Residential	2640 ktoe	2876 ktoe	9%
Industry	1596 ktoe	1779 ktoe	11%
Transport (biofuels)	2348 ktoe	2111 ktoe	-10%
Agricultural	119 ktoe	220 ktoe	85%
Other	241 ktoe	435 ktoe	80%

RDD Information

National Energy Storage Strategy based on PNIEC

- Allow 74% renewable capacity in electricity generation by 2030 and 100% in 2050
- Technologically neutral
  - Thermal storage promoted
    - Technological leadership in Spain (Molten salts)
  - Electro-chemical storage promoted
    - Already commercially present
    - Electric vehicle potential
  - Green hydrogen promoted
- Storage as multi-services provider
- 30 GW storage capacity by 2050



RDD Information

National programs

- Recovery, Transformation and Resilience Plan (PRTR)
  - Plan to regulate European funding for resilience after COVID
  - 140 000 M€
  - 40% dedicated to ecologic transition
  - Two funding schemes:
    - Regional specific funds for local needs
    - Strategic lines at country level (PERTE)
  - Several strategic lines: Renewal Energies, green Hydrogen and Storage (PERTE-ERHA)
    - 7 000 M€
    - First grant for R&D innovative Energy Storage (50 M€) closed the 10th May
    - Iberian Center for R&D in Energy Storage

RDD Information

National programs

- SolCan, EolCan2 and SolBal2
  - Construction and start-up of power generation installations based on PV and wind in Spanish islands
  - Storage as a bonus
  - 20 M€ / 54 M€ / 20 M€
- R&D instruments by the National Research Agency (AEI)

Parque de generación del Escenario Objetivo (MW)				
Año	**2015**	**2020***	**2025***	**2030***
Eólica (terrestre y marítima)	22.925	28.033	40.633	50.333
Solar fotovoltaica	4.854	9.071	21.713	39.181
Solar termoeléctrica	2.300	2.303	4.803	7.303
Hidráulica	14.104	14.109	14.359	14.609
Bombeo Mixto	2.687	2.687	2.687	2.687
Bombeo Puro	3.337	3.337	4.212	6.837
Biogás	223	211	241	241
Otras renovables	0	0	40	80
Biomasa	677	613	815	1.408
Carbón	11.311	7.897	2.165	0
Ciclo combinado	26.612	26.612	26.612	26.612
Cogeneración	6.143	5.239	4.373	3.670
Fuel y Fuel/Gas (Territorios No Peninsulares)	3.708	3.708	2.781	1.854
Residuos y otros	893	610	470	341
Nuclear	7.399	7.399	7.399	3.181
Almacenamiento	0	0	500	2.500
Total	**107.173**	**111.829**	**133.802**	**160.837**

*Los datos de 2020, 2025 y 2030 son estimaciones del Escenario Objetivo del PNIEC.

Fuente: Ministerio para la Transición Ecológica y el Reto Demográfico, 2019

RDD Information

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	Abr/22
Hidráulica	17.094
Turbinación bombeo	3.331
Nuclear	7.117
Carbón	3.764
Fuel + Gas	8
Motores diésel	769
Turbina de gas	1.149
Turbina de vapor	483
Ciclo combinado	26.250
Hidroeólica	11
Eólica	28.743
Solar fotovoltaica	15.812
Solar térmica	2.304
Otras renovables	1.093
Cogeneración	5.656
Residuos no renovables	441
Residuos renovables	170
Potencia total	**114.196**

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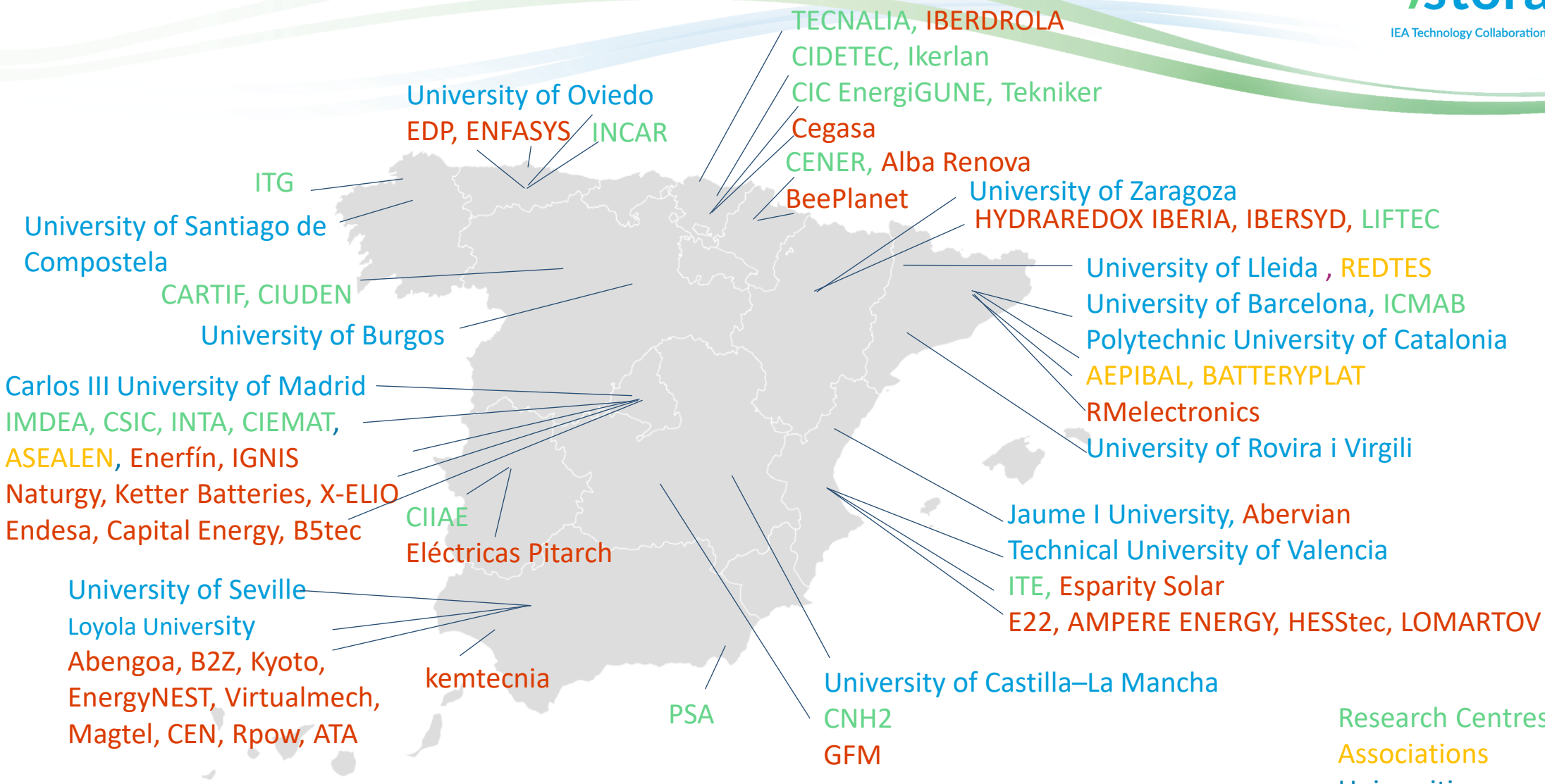
RDD Information

	Technology	Energy Capacity	Round-trip Efficiency	Maturity
Mechanic	Pump (PHS)	1-100 GWh	80%	★★★★
	Heat pump (PHES)	500 kWh - 1 GWh	70 - 75%	★☆☆☆
	Adiabatic compressed air (ACAES)	10 MWh - 10 GWh	> 70%	★★★★
	Compressed Air (CAES)	10 MWh - 10 GWh	45 - 60%	★★★☆
	Liquified Air (LAES)	10 MWh - 8 GWh	50 - 100%	★☆☆☆
	Flywheels	5 - 10 kWh	85%	★★☆☆
Electrochemical	Batteries (Li-ion)	< 10 MWh	86%	★★★☆
	Flow Batteries (V, Zn, Fe, Zn-Br)	< 100 MWh	70%	★★★☆
Electric	Superconducting magnetic (SMES)	1 - 10 kWh	> 90%	★★☆☆
	Supercapacitor	1 - 5 kWh	90%	★★☆☆
Chemical	Power to gas (H2)	up to 100 GWh	20 - 40%	★☆☆☆
	Power to X (P2X)	1 MWh - several GWh	50%	★☆☆☆
Thermal	Heat: sensible (molten salts)	100 MWh - 10 GWh	40 - 60%	★★★★
	Heat: sensible	10 - 50 kWht	50 - 90%	★★★★
	Heat: latent (PCM)	50 - 150 kWht	75 - 90%	★★★☆
	Heat: thermochemical (TCS)	12 - 250 kWht	75 -100%	★☆☆☆

Source: Estrategia de almacenamiento energético

Energy Storage Landscape



Research Centres	> 20
Associations	4
Universities	> 13
Industries	> 32

Policies & Market

Specific ES policies

- Law 24/2013 of the electricity sector (General Law that regulates the electricity sector)
- RD 110/2015 on waste electrical and electronic equipment
- RD 244/2019 Technical, administrative and economic regulation for self-consumption
  - Allows storage facilities for self-consumption
- **RD 23/2020 Defines the legal figure of owner of storage facilities**
- RD 960/2020 Regulation of the economic regime of Renewable Energies
- **RD 1183/2020 regulates access to storage facilities to the grid**
  - Storage facilities as productions plants
  - Allows hybridization of production plants with storage systems (both new and existing)
- RD 27/2021 on batteries and accumulators and the environmental management of their waste
- RD 6/2022 on the response of the consequences of the Ukrainian war
- CNMC Circular 3/2020 establishing the methodology for calculating electricity transmission and distribution tolls
- CNMC Circular 1/2021 Establishes methodology and conditions for access and connection to transportation and distribution networks, including storage facilities in its scope
- CNMC Resolution of December 11th, 2019, that approves conditions related to grid balance
- CNMC Resolution of December 10th, 2020, that allows the participation of storage in regulation markets
- Spanish Strategy for Science, Technology and Innovation 2021-2027 (EECTI 2021-2027)

Top 3 cases/projects

- **CSIC vanadium flow battery**
  - Working prototype
    - 10 kW
    - 20 kWh
  - Redox flow battery
  - Designed for stationary uses
  - Expected life >20 years

- **Thermal batteries with molten salt**
  - Two-molten salt tank in CSP plant for dispatchability
  - Two-molten salt tanks in pumped heat electricity storage
  - Two-molten salt tanks in LAES

- **Iberian Center for Research in Energy Storage (CIIAE)**
  - The full cycle of energy storage, from the raw materials to its scale-up and application
  - Research:

    - Energy storage in the electricity sector.

    - Hydrogen and power to X.

    - Thermal energy storage
  - Infrastructures:

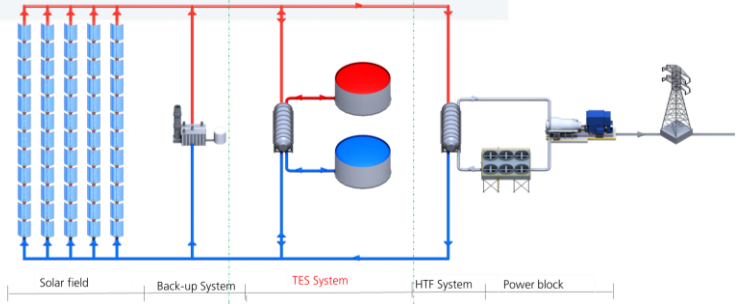
    -Pilot plant with scientific and technical infrastructure

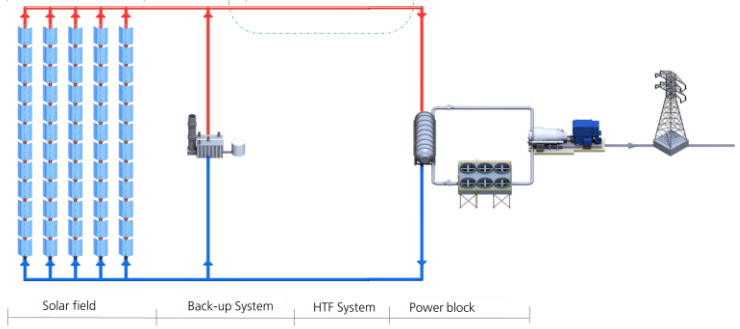
    -Technological incubator

Top 3 cases/Thermal batteries with molten salt

49 CSP plants: 2,300 MW
20 CSP with TES: 6,850 MWhe

New Storage capacity: 11,000 MWhe (+adding 8h TES in 28 CSP Plants)





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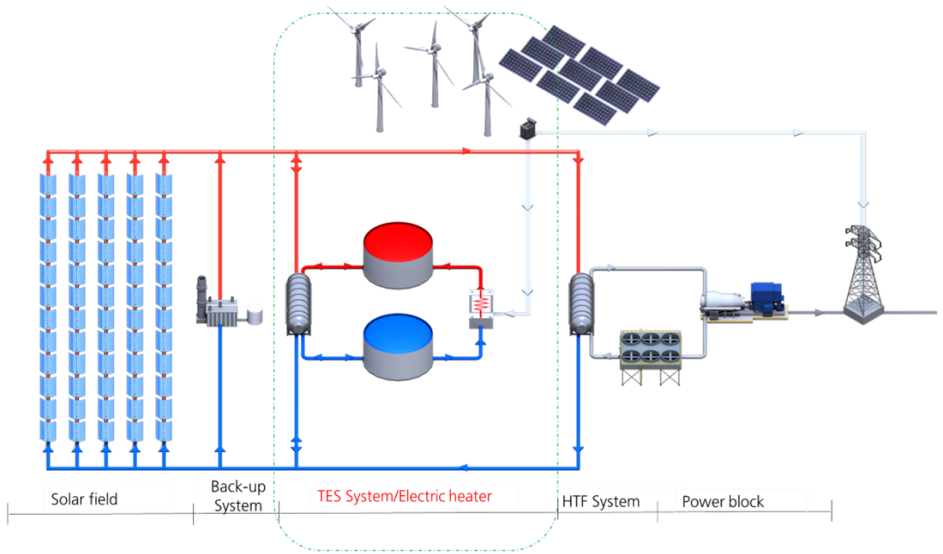

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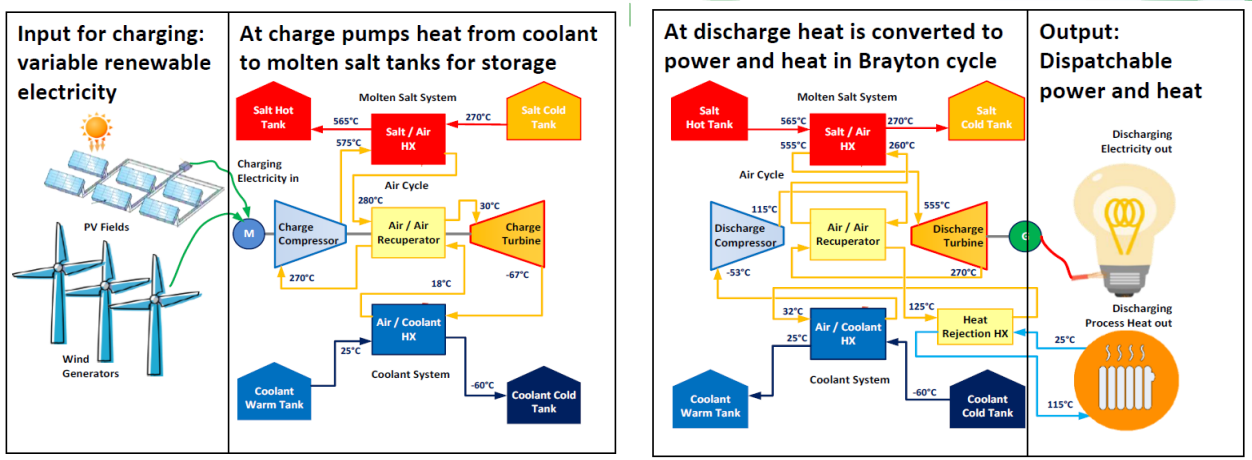

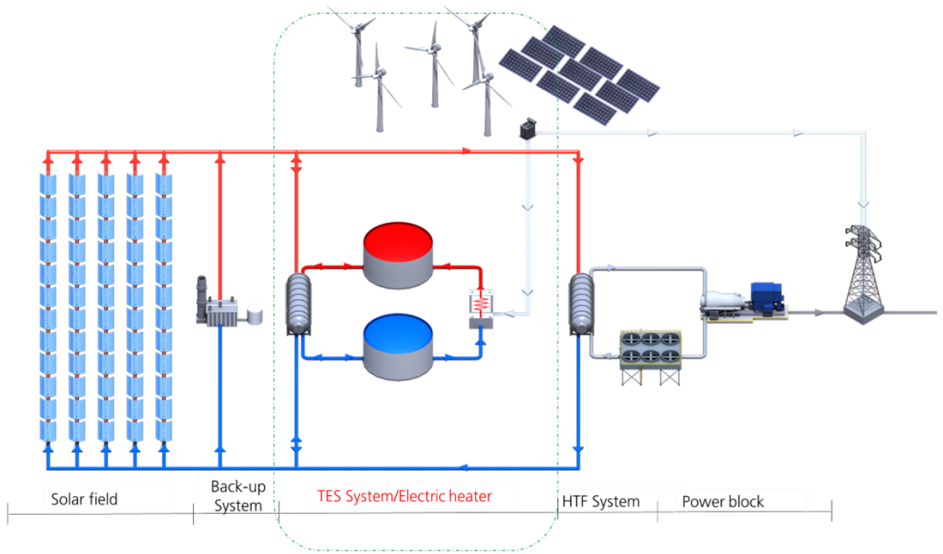

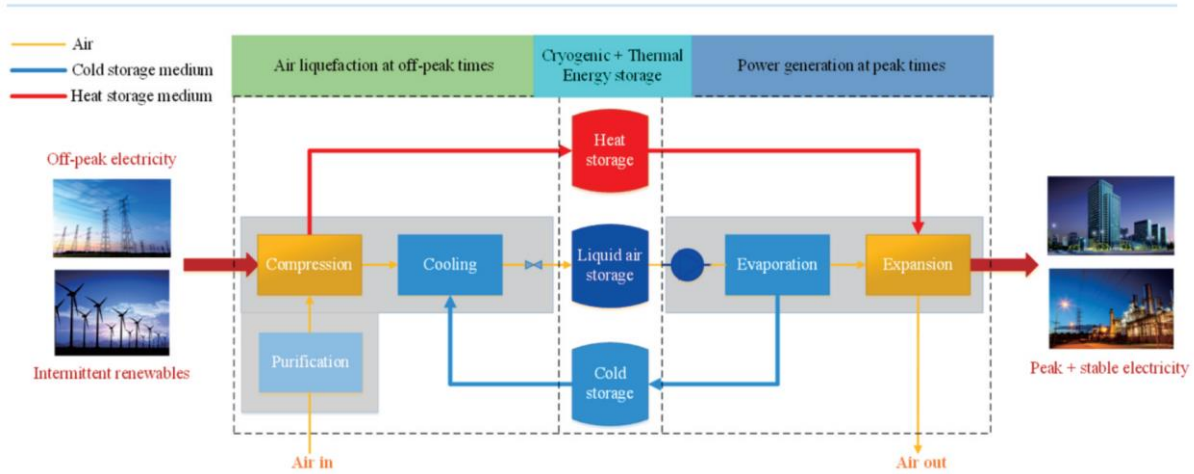

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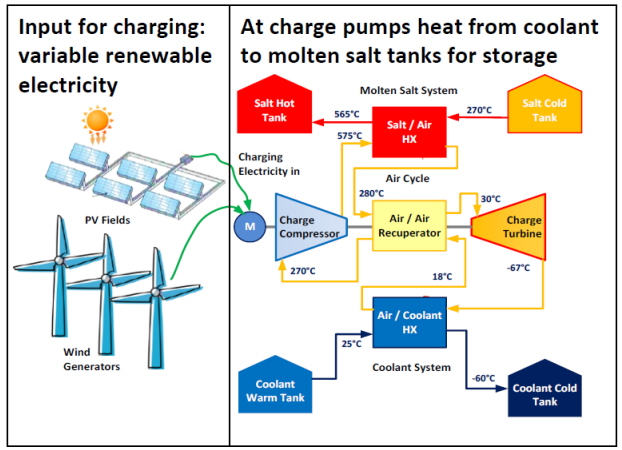
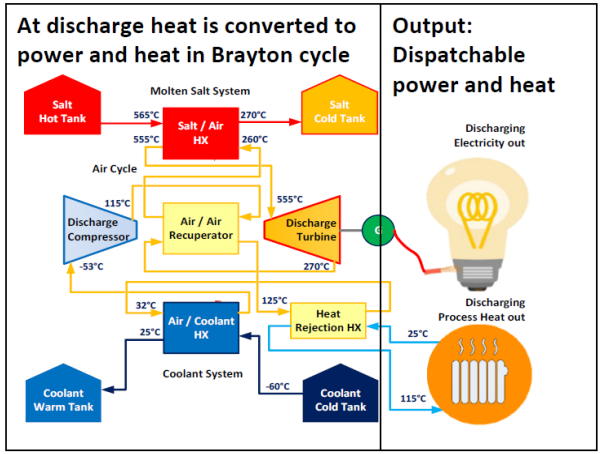
energy storage
IEA Technology Collaboration Programme
Sun2Store project | MALTA





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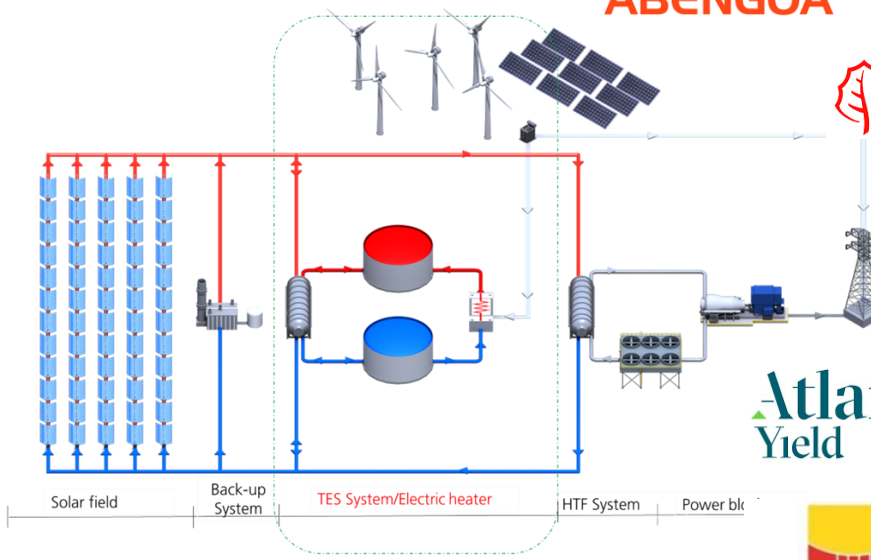

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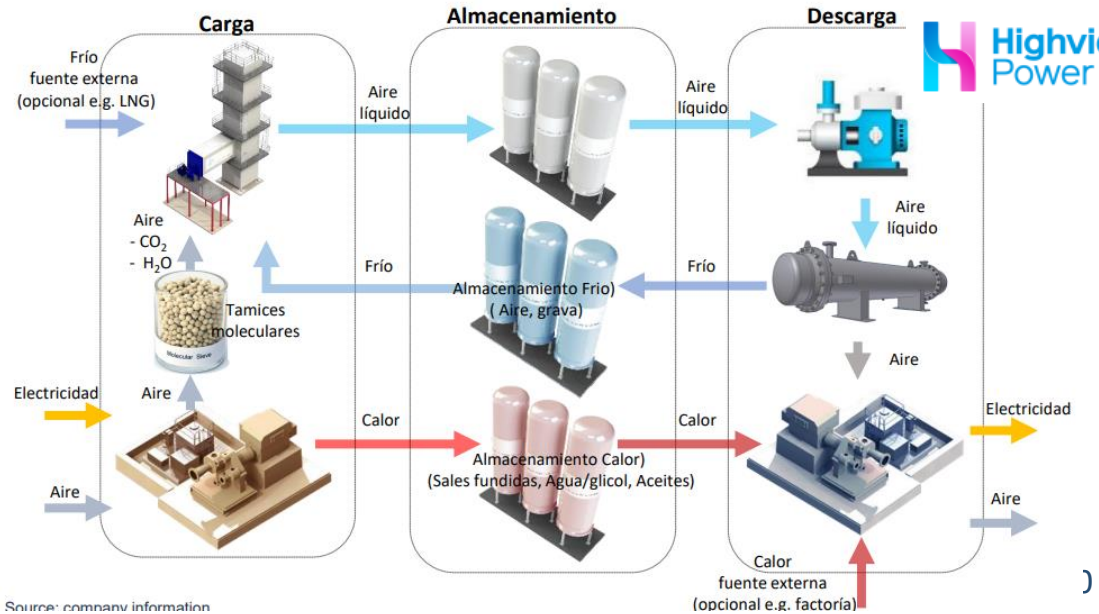
Atlantica Yield

Magtel

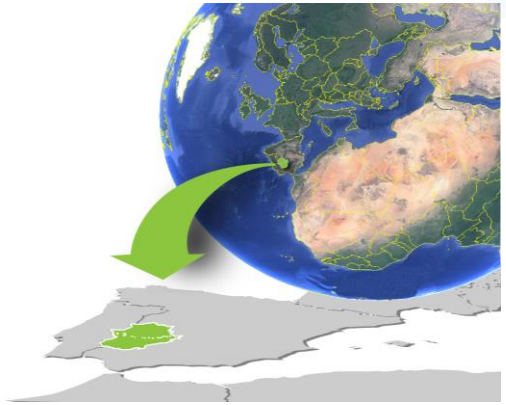
Marquesado Solar

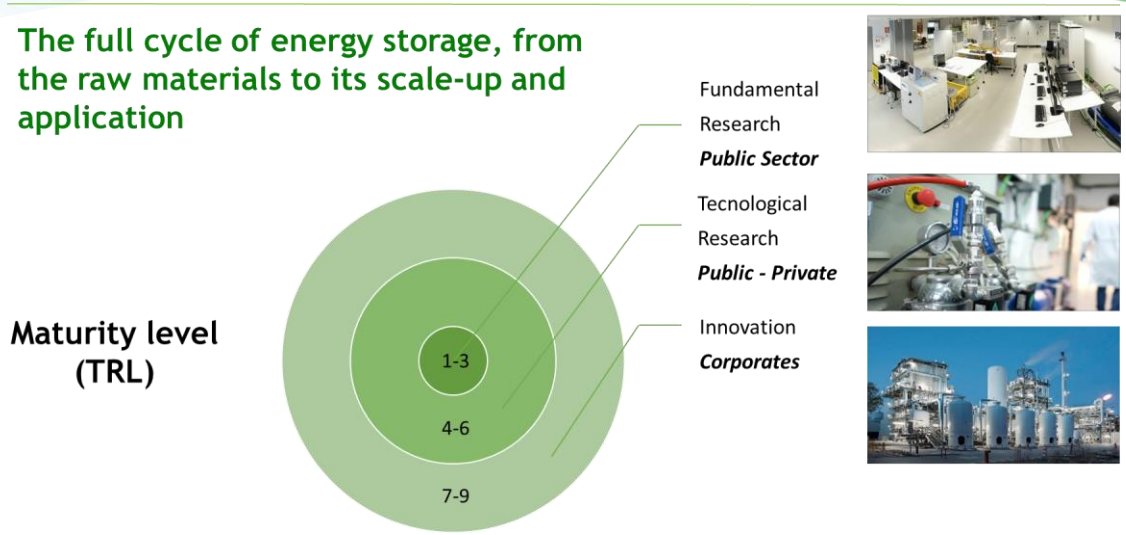


Highview Power

Source: company information

Top 3 cases/Iberian Energy Storage Research Centre(CIIAE)





CIIAE

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Plan de Recuperación, Transformación y Resiliencia
GOBIERNO DE ESPAÑA
ESPAÑA PUEDE
Expediente financiado por el Mecanismo de Recuperación y Resiliencia

- **Horizontal research lines:**

LH 1. Design, synthesis and characterization of advanced materials for energy storage at different levels.

LH 2. Multi-scale modeling: atomic and molecular, advanced control and monitoring, systems and scaling.

LH 3. Analysis of systems, life cycles and techno-economic and environmental impact.

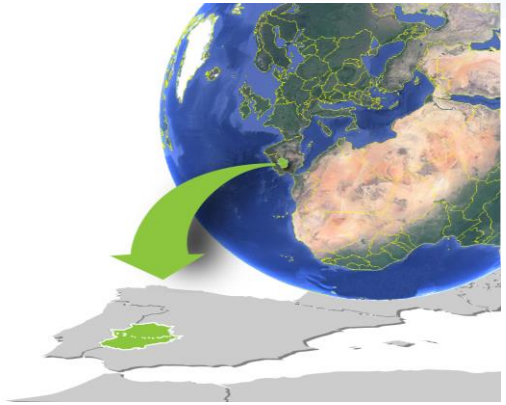
- **Verticals research lines:**

LV 1. Energy storage in the electricity sector.

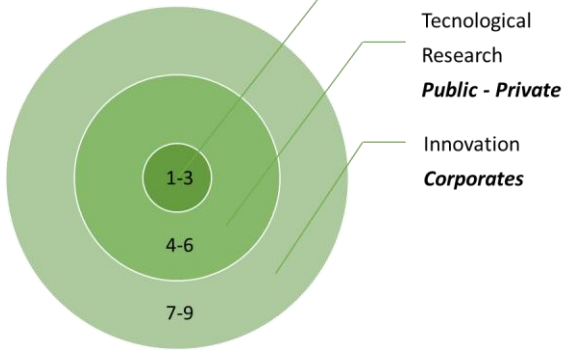
LV 2. Hydrogen and power to X.

LV 3. Thermal energy storage

Top 3 cases/Iberian Energy Storage Research Centre(CIIAE)



The full cycle of energy storage, from the raw materials to its scale-up and application



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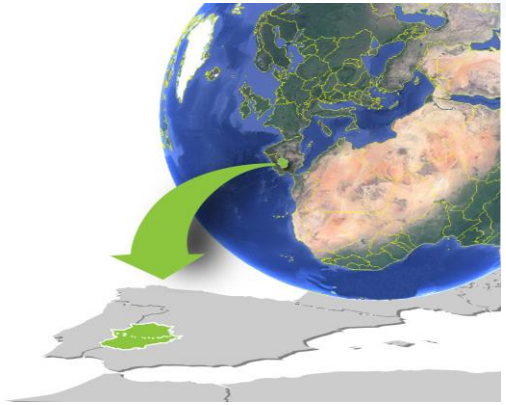
LV 3. Thermal energy storage

- **Advanced materials** to improve the performance of current batteries. New applications that provide functionality to network operators.
- **Battery degradation** to improve their cycles and life times for the development of reliable and profitable products, as well as their possible recycling.
- **Materials and nanotechnology applications** to increase the energy density, insulation, resistance to high temperatures and reduction of costs of the supercapacitors. Applications in the energy storage markets.
- **Components testing in Large Scale** (MW)

Top 3 cases/Iberian Energy Storage Research Centre(CIIAE)



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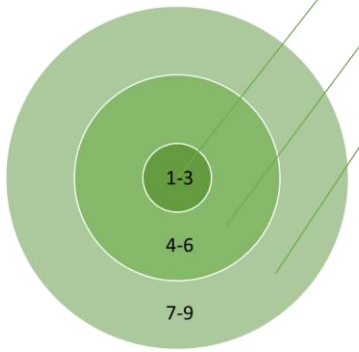

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LH 3. Analysis of systems, life cycles and techno-economic and environmental impact.

- **Verticals research lines:**

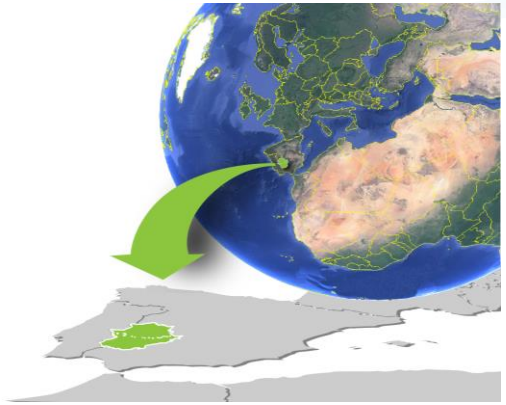
LV 1. Energy storage in the electricity sector.

LV 2. Hydrogen and power to X.

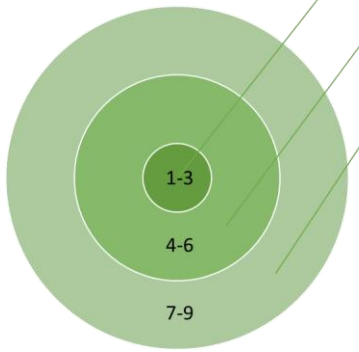
LV 3. Thermal energy storage

- Electrochemical materials and processes for production of **green hydrogen.**
- Materials and processes for **hydrogen storage and transportation.**
- Conversion to fuels and chemicals by **integrating CO2 with hydrogen.**
- **High pressure electrolysis**.
- **Components testing in Large Scale** (MW).

Top 3 cases/Iberian Energy Storage Research Centre(CIIAE)



The full cycle of energy storage, from the raw materials to its scale-up and application



CIIAE

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GOBIERNO DE ESPAÑA
ESPAÑA PUEDE
Expediente financiado por el Mecanismo de Recuperación y Resiliencia

- **Horizontal research lines:**

LH 1. Design, synthesis and characterization of advanced materials for energy storage at different levels.

LH 2. Multi-scale modeling: atomic and molecular, advanced control and monitoring, systems and scaling.

LH 3. Analysis of systems, life cycles and techno-economic and environmental impact.

- **Verticals research lines:**

LV 1. Energy storage in the electricity sector.

LV 2. Hydrogen and power to X.

LV 3. Thermal energy storage →

- **Phase change materials (PCM).** Design and modification of PCMs, improvement of thermophysical properties, including heat transfer, encapsulation and stabilization.
- **Materials and integration of thermal energy storage systems (TES)** and cold thermal energy storage (cold TES) in adsorption cooling systems.

Contacts

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Asociación española de almacenamiento de energía

https://www.asealen.es/

Asociación Empresarial de Pilas, Baterías y Almacenamiento Energético

https://aepibal.org/

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energy storage

IEA Technology Collaboration Programme

The Energy Storage TCP
Thanks for your attention

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