energy storage

IEA Technology Collaboration Programme

COUNTRY REPORT
SPAIN

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Universidad de Sevilla

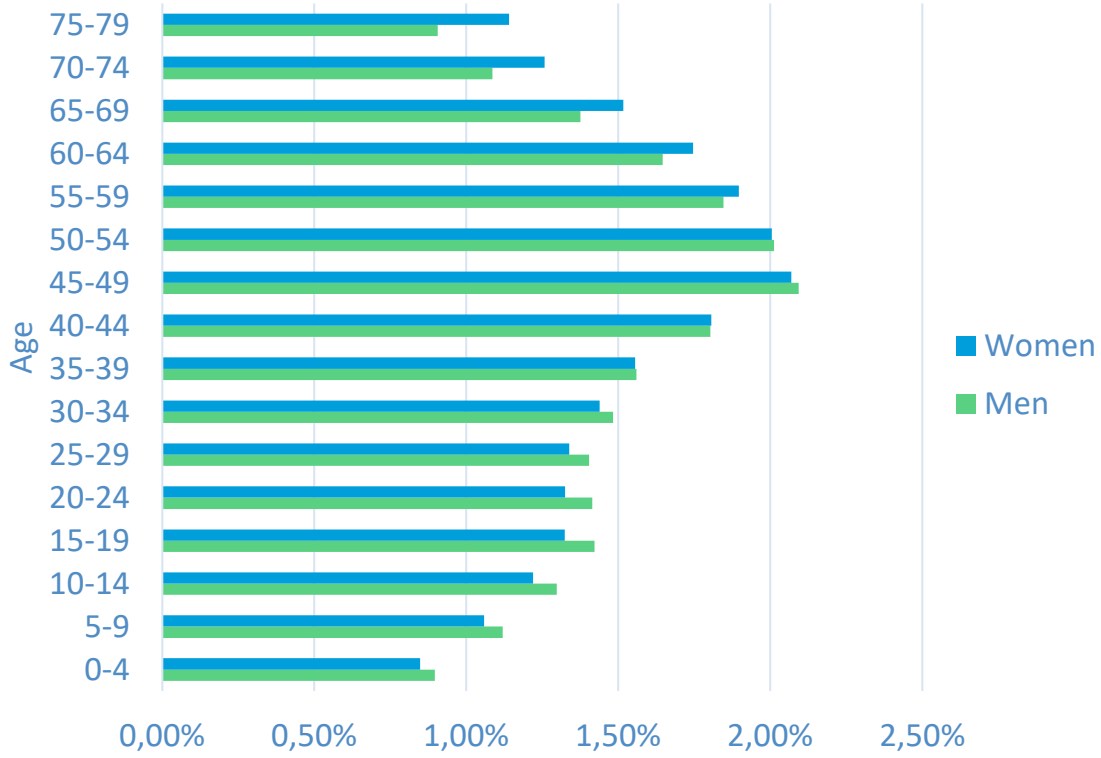
99th Executive Committee Meeting (XC99)

May 20th and 21st 2025

Country Specific Information

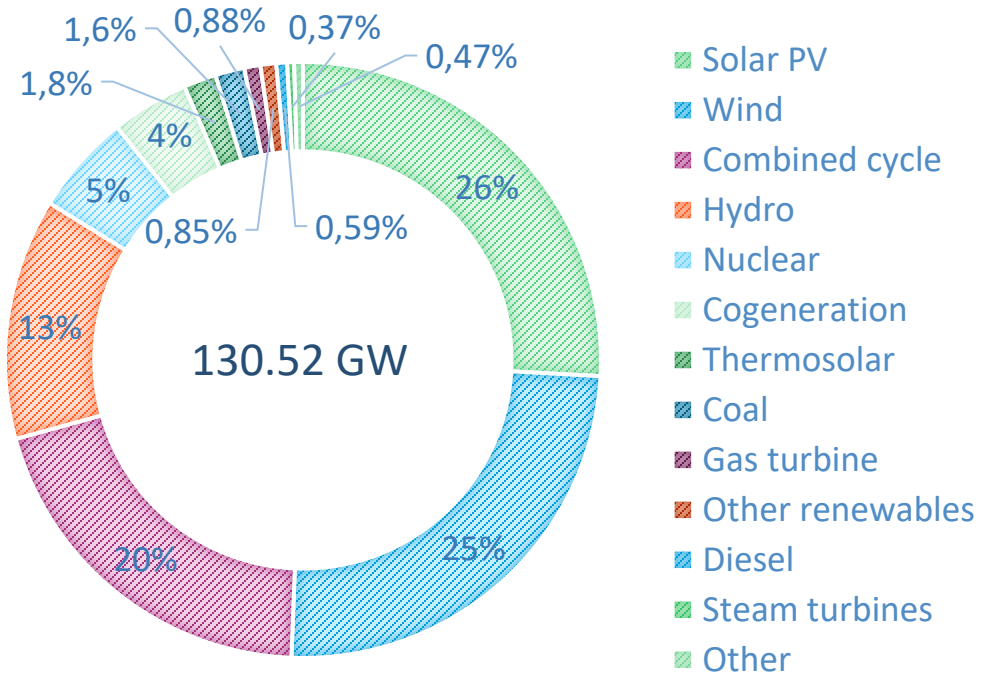
Population

- 49.078 Million (Jan 2025)



Source of data: https://www.ine.es

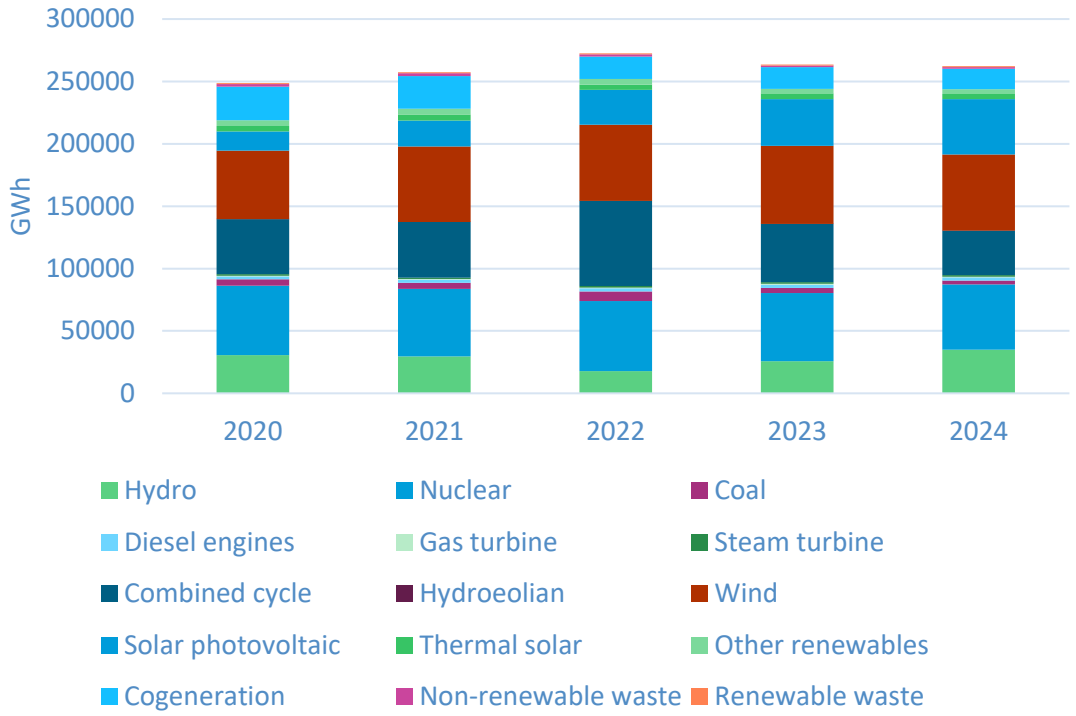
National electrical generation

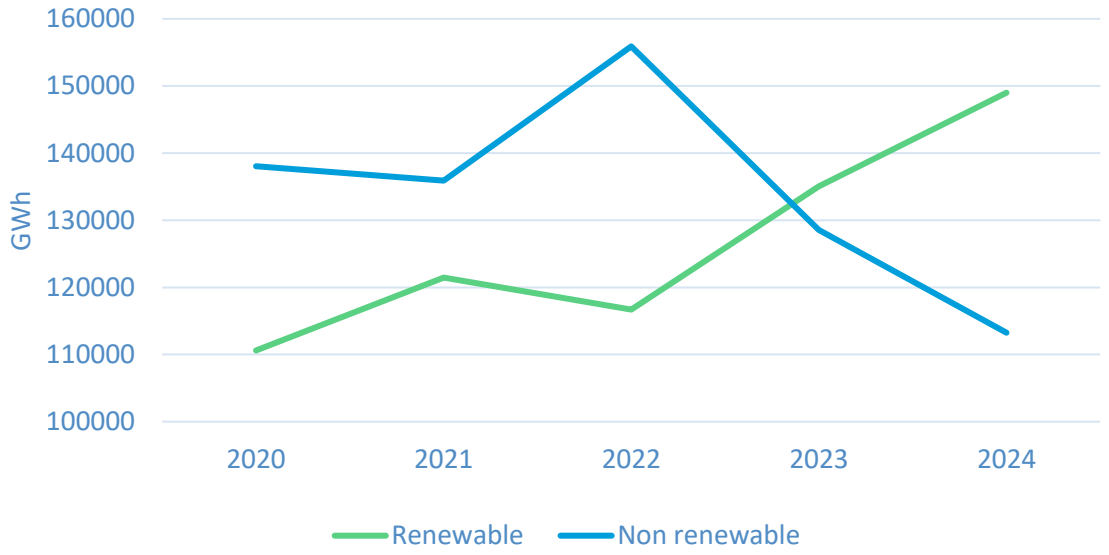


Source of data: https://www.ree.es

Country Specific Information

Evolution of energy generation



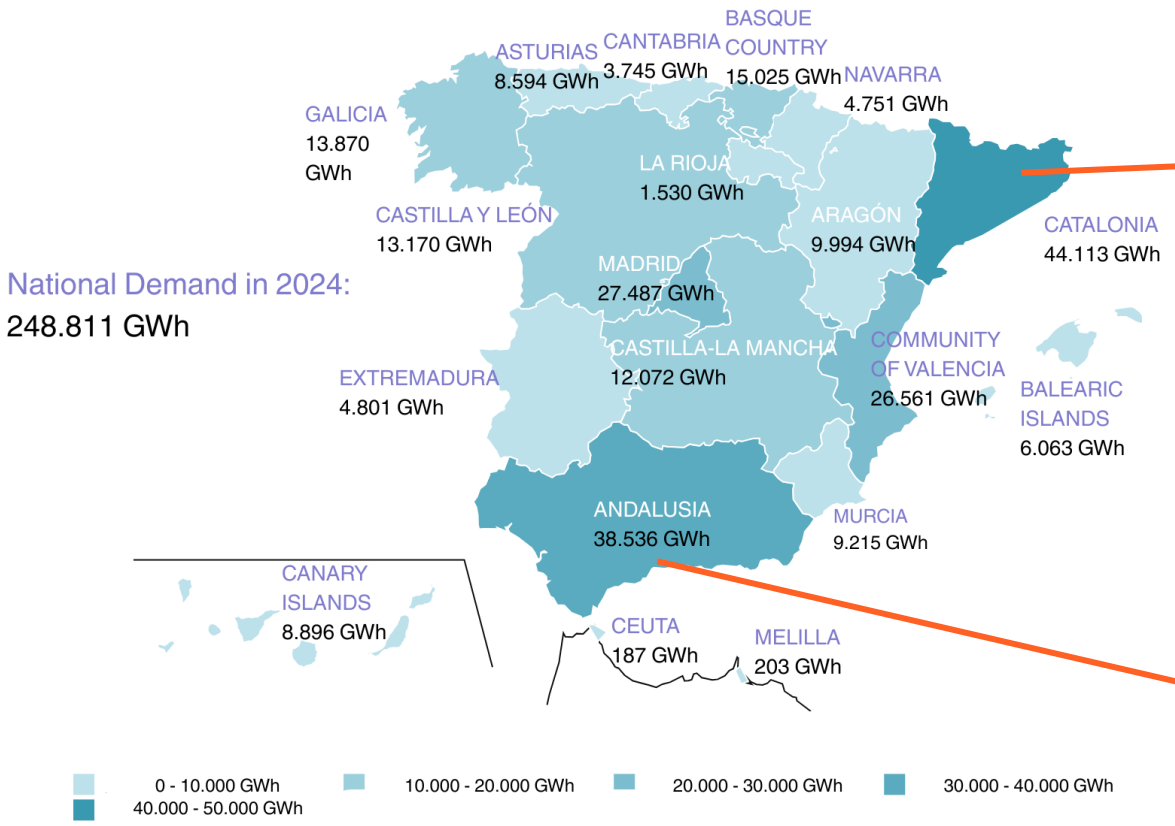


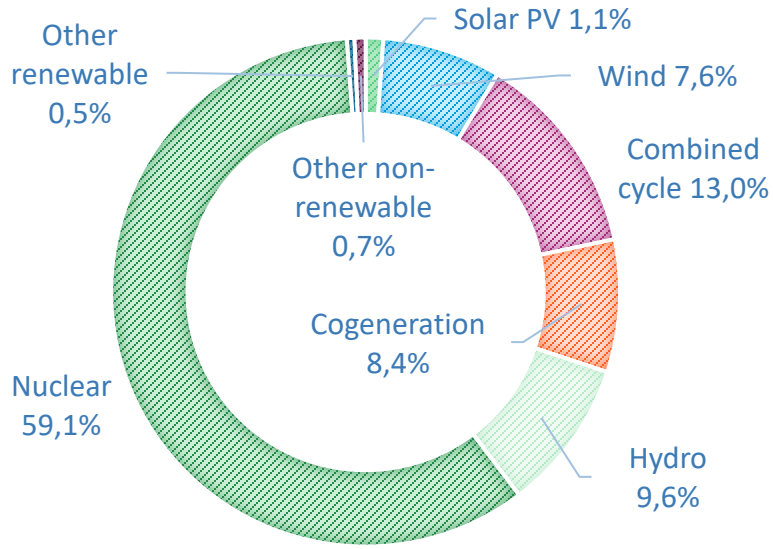
Source of data: https://www.ree.es

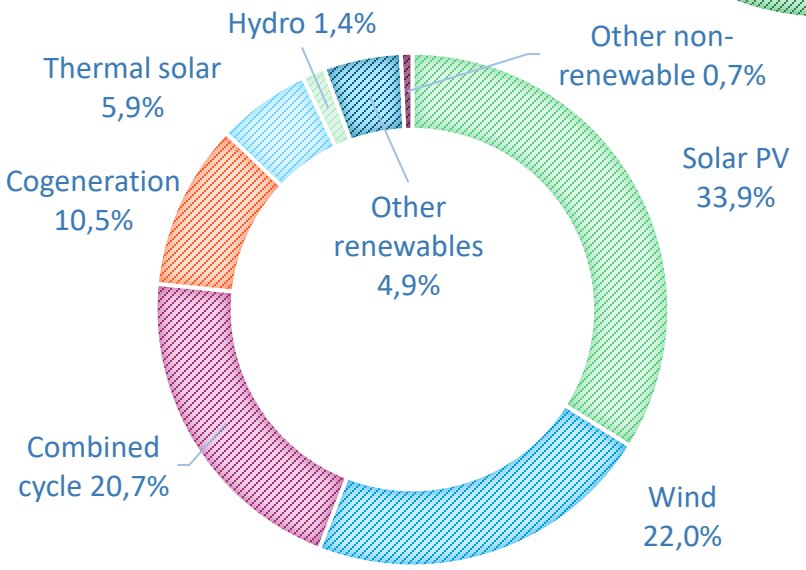
Country Specific Information

Demand by Autonomous communities

National Demand in 2024:
248.811 GWh



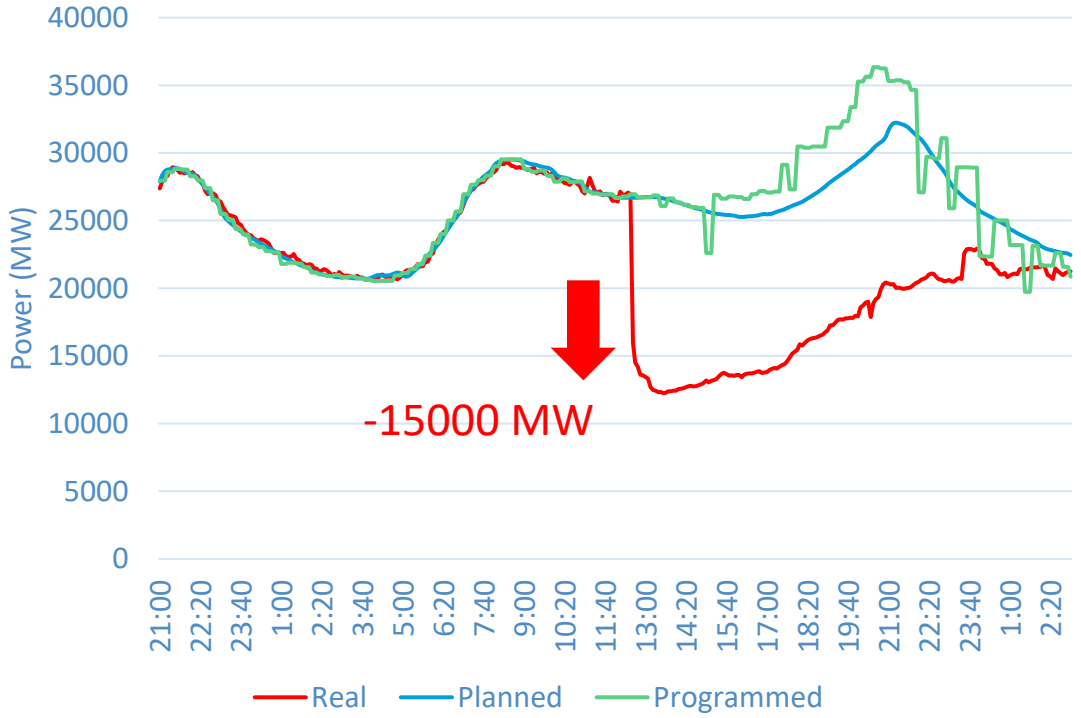




Source of data:
https://www.ree.es

Country Specific Information

- **National shutdown!**
  - March 28th, 2025. 12:30
  - Impact: Portugal, France



Source of data: https://www.ree.es

- **How could energy storage prevent this event?**

A more robust deployment of energy storage, such as batteries, thermal storage, or pumped hydro, may have:

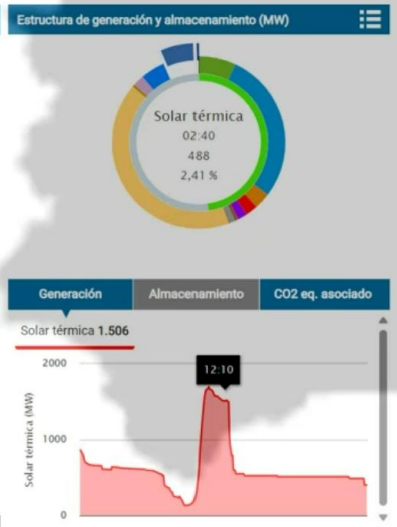
- Provide flexibility services during peak solar hours or excess wind generation
- In case of unbalanced, energy storage can help stabilize the grid
  - A proper mix for fast and slow response is required
  - Stand-by thermal energy storage may be designed for frequency services

Country Specific Information

BLACK OUT 28/04/2025 IN SPAIN.

Blackout occurred in Spain due to **grid instability**. While the official causes have not been confirmed, several hypotheses and expert opinions point to a combination of critical failures:

- A **transmission line between Spain and France** failed. According to the **N-1 safety criterion**, a line should have absorbed the load. However, this **second line also failed simultaneously**, resulting in a rare double contingency.
- The sudden loss of export capacity caused an **excess of generation**, leading to a **rise in voltage and frequency**. With a **low number of synchronous generators** online at that moment, the system frequency exceeded **50.2 Hz**.
- It remains uncertain whether a higher share of synchronous generation could have prevented the blackout under such extreme conditions.
- As frequency and voltage deviated from safe limits, **protective relays** in various facilities were tripped, disconnecting them from the grid. This **cascade of disconnections** further destabilized the system, accelerating the blackout



This type of risk is well-documented and known. Unfortunately, despite awareness, the scenario materialized.

There is ongoing debate about the root cause—whether it lies with excess of renewables, less nuclear energy, or other factors. The truth is, the issue is not easily attributed to a single source.

Important to highlight that thermosolar plants remained connected to the grid during the blackout, providing stability and contributing over 560 MW.

Country Specific Information

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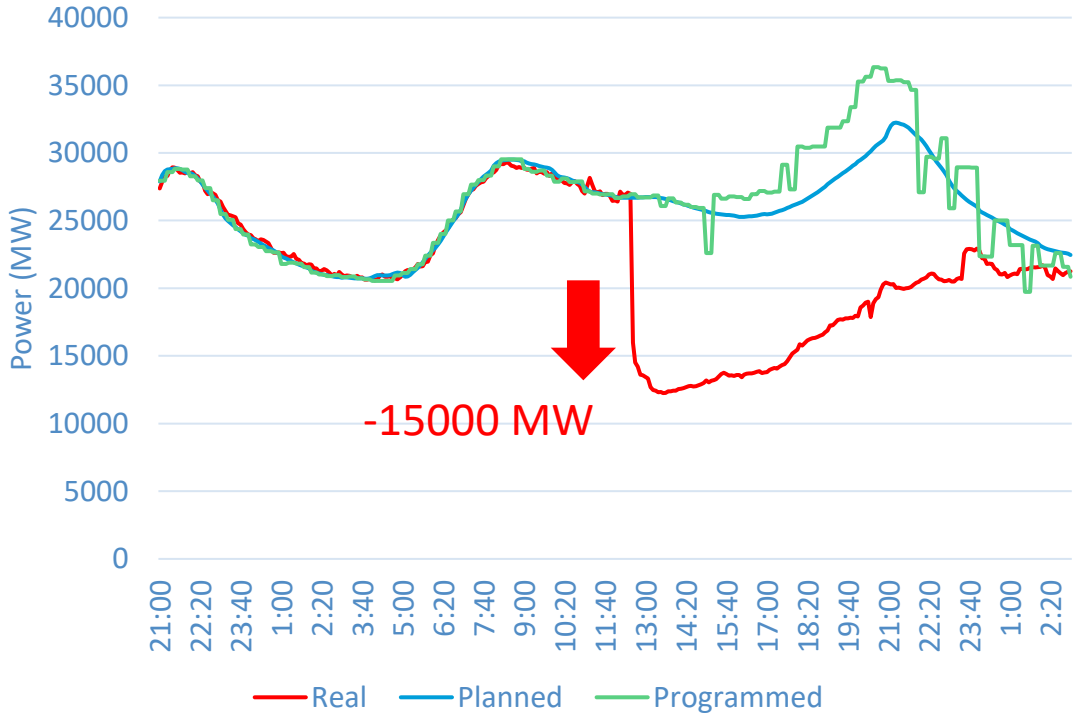

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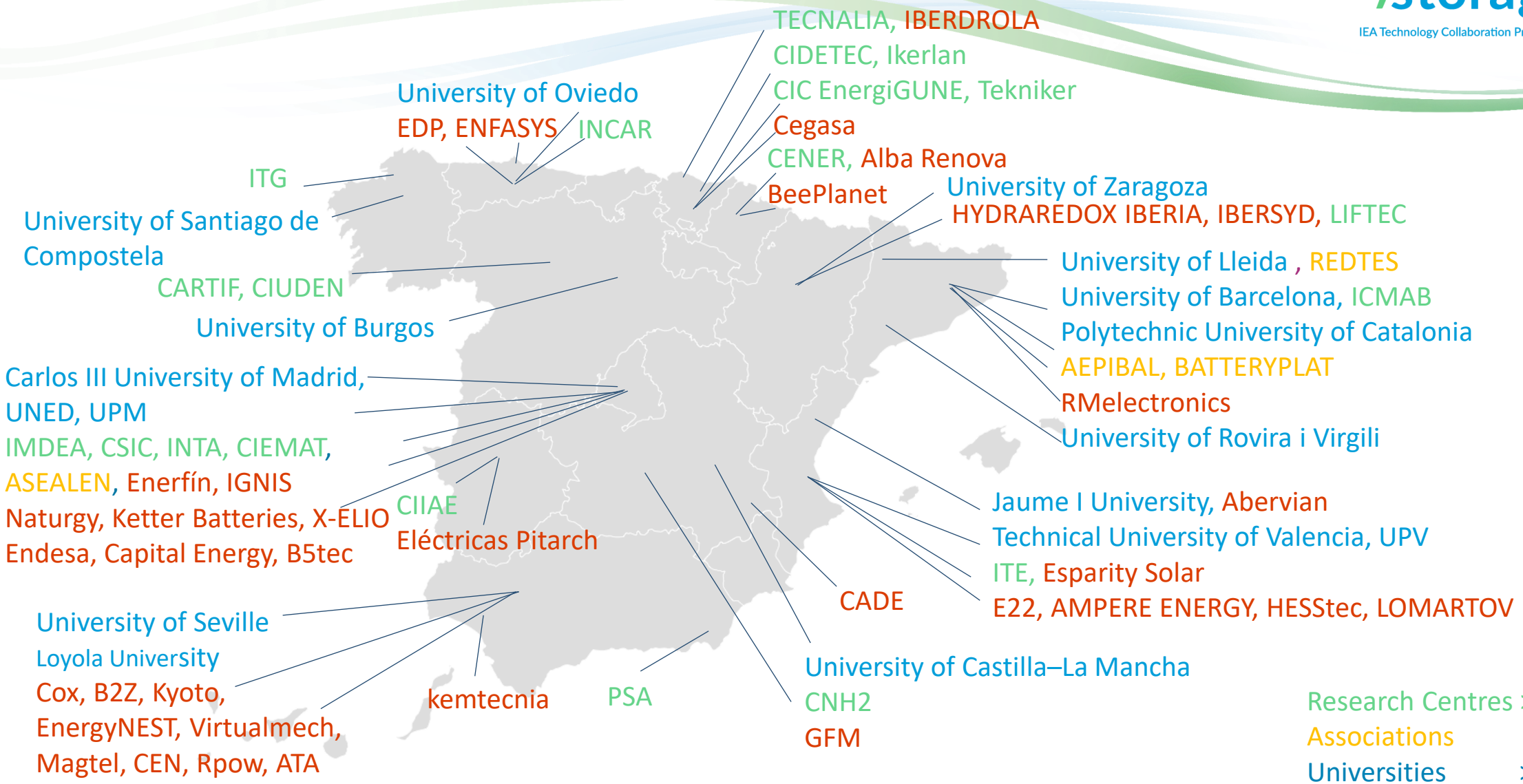
Energy Storage Landscape



Research Centres	> 20
Associations	4
Universities	> 15
Industries	> 35

Policies & Market

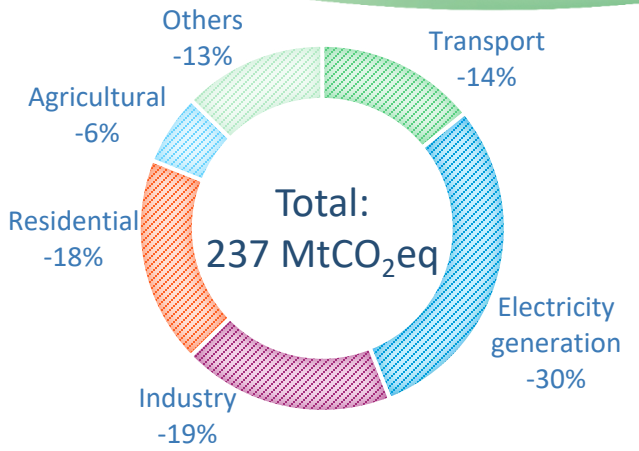
- **EU Legislation**
  - Regulation 2022/869: guidelines for trans-European energy infrastructure
  - Directive 2023/2413: the promotion of energy from renewable sources
  - Directive 2024/1711 and Regulation 2024/1747: improving the Union's electricity market design
- **Royal Decrees and state regulations**
  - Law 24/2013 of the electricity sector (General Law that regulates the electricity sector)
  - RD-Law 23/2020 establishes an updated regulatory framework to facilitate the integration of energy storage and hybridisation technologies with renewable generation facilities
  - RD-Law 8/2023 introduces a financial guarantee scheme for energy storage facilities
- **National Integrated Plan for Energy and Climate (PNIEC)**
  - National strategic orientation tool that integrates energy and climate policy with a time horizon of 2030, in accordance with national and European regulations
- **National Energy Storage Strategy**
  - Spain's strategy targets 20 GW of storage by 2030 and 30 GW by 2050, outlining key actions, challenges, and opportunities to support a decarbonised energy system

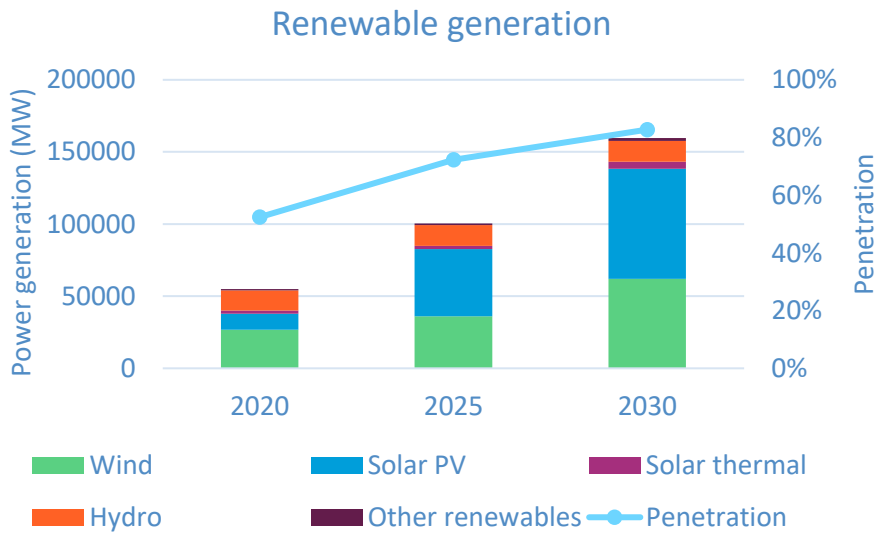
RDD Information

National Integrated Plan for Energy and Climate (PNIEC)

- Transition to net-zero CO_2 emissions by 2050
- Electricity generation with 81% of renewable penetration by 2030
- 43% improvement in energy end-use energy efficiency
- 48% of renewable energy by final use by 2030
- 22.5 GW storage capacity by 2030 (including solar thermal storage)

Greenhouse gas reduction compared to 2005



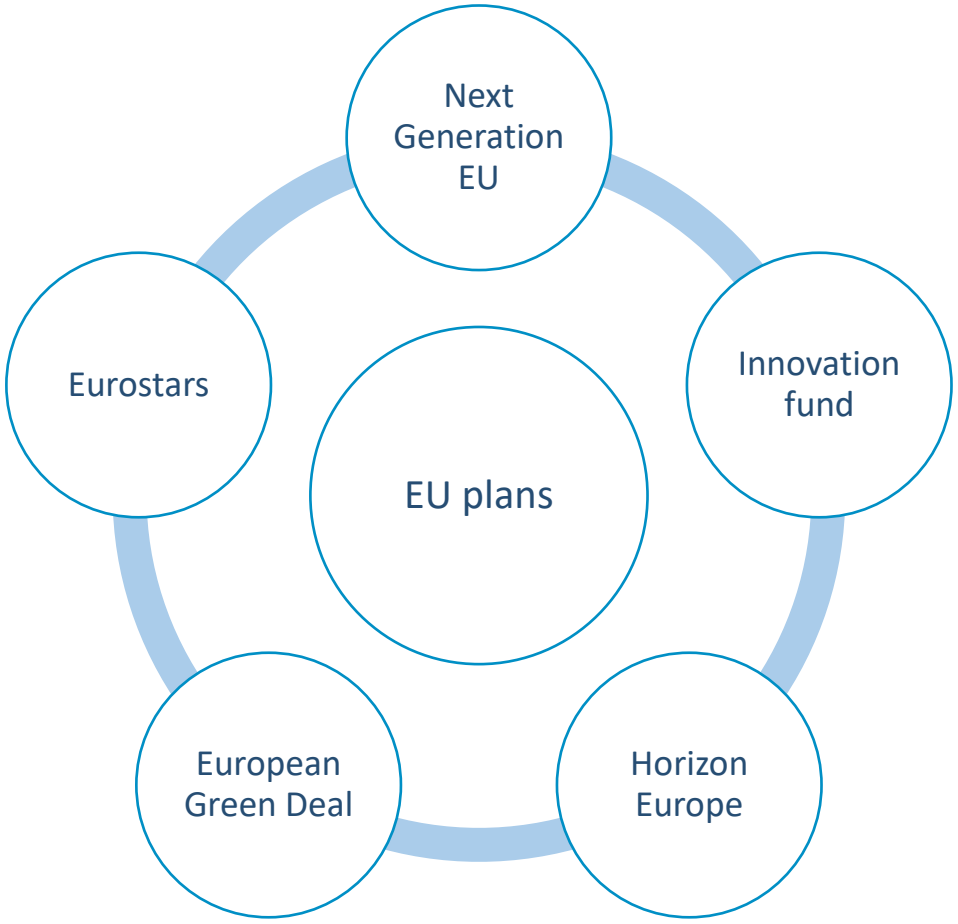


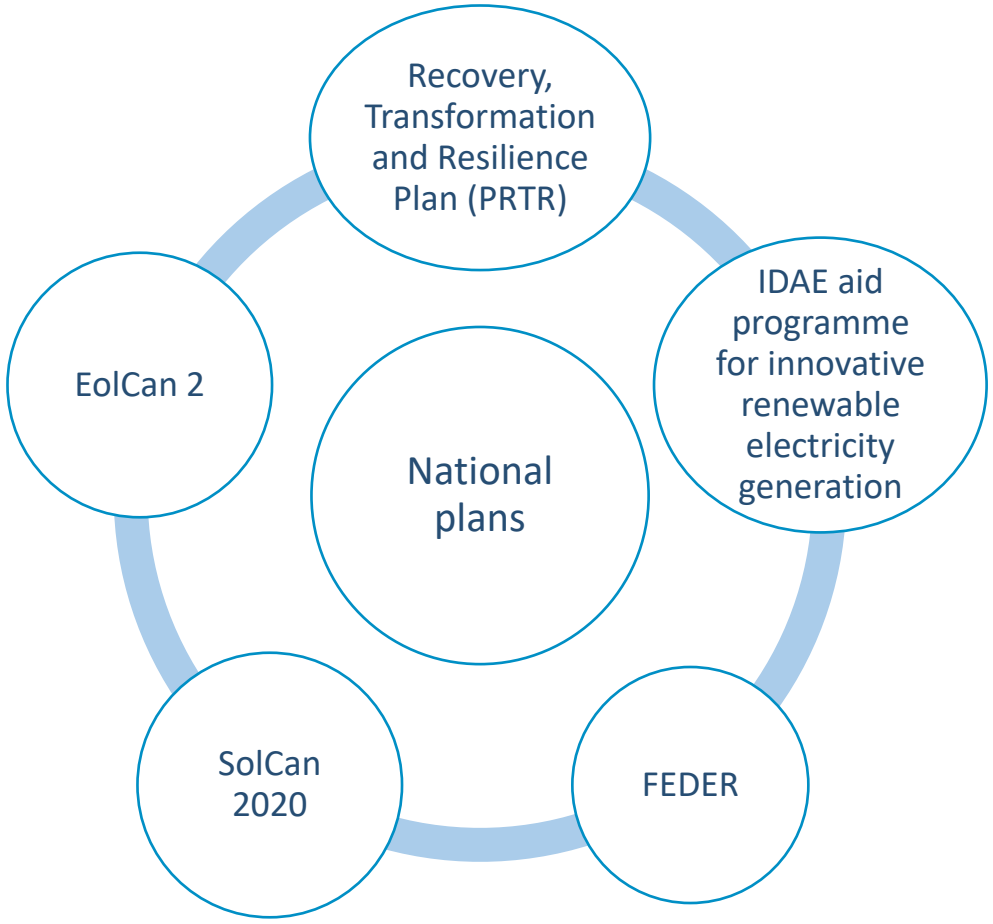
RDD Information

- **National Energy Storage Strategy**
  - **Target:** Storage capacity in Spain is set to grow to 22.5 GW by 2030 and 30 GW by 2050, covering daily, weekly, and seasonal storage.
  - **Diverse Storage Solutions:** A wide range of storage technologies—electrical and thermal—will play complementary roles in decarbonising power generation and end-use sectors such as mobility, buildings, and industry.
  - **Market Integration & New Actors:** Enabling storage participation in current and future market mechanisms is vital to unlocking its full value and establishing it as a new market player.
  - **Industrial & Economic Opportunity:** Storage development offers major opportunities along the value chain—boosting job creation, strengthening domestic industry, and reducing reliance on critical raw materials.
  - **Innovation & Leadership:** Strengthening R&D and innovation will accelerate technology deployment and maintain Spain's leadership in key renewable technologies.

RDD Information

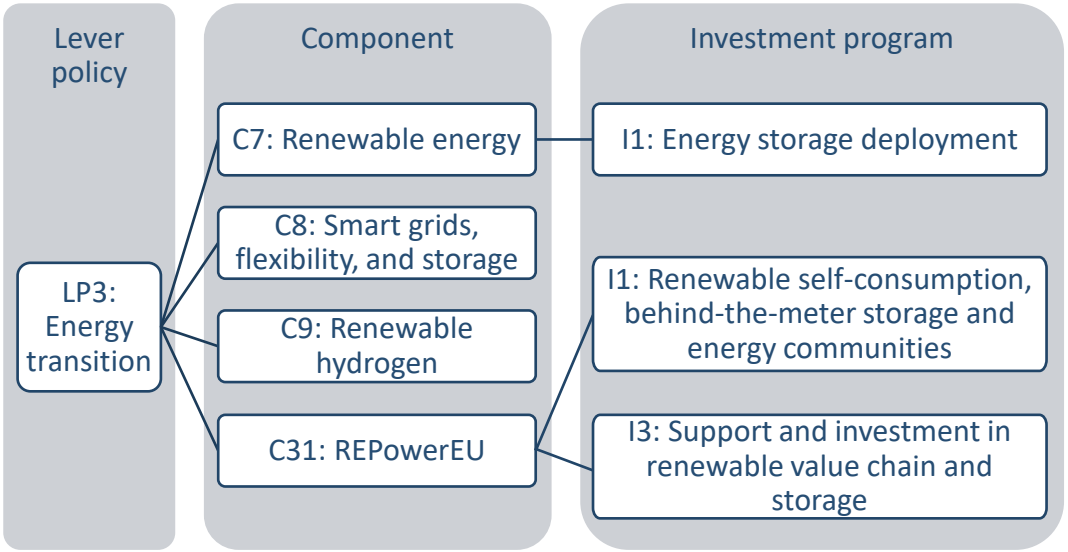
- **Funding**

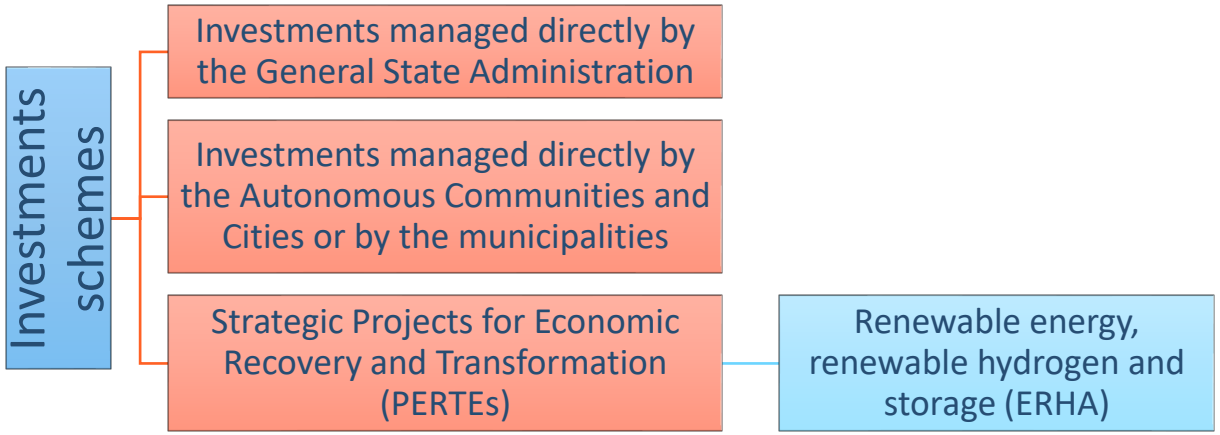




RDD Information

- **Recovery, Transformation and Resilience Plan (PRTR)**
  - Plan to regulate European funding for resilience after COVID
  - 160000 M€ projected investment up to 2026, 40% dedicated to ecologic transition
  - Four transversal axis projected in 10 lever policies and distributed in 31 components that make it possible to articulate the coherent program of investments and reforms of the Plan.





RDD Information

- **Call for Energy Storage Grants (FEDER 2021–2027)**
  - Promote the decarbonization of the Spanish electricity system through the large-scale deployment of energy storage technologies, facilitating greater integration of renewable energy.
    - **€700 million**, co-financed by the Multi-Regional Operational Programme (FEDER 2021–2027).
    - Community funds managed by IDEA.
  - Direct subsidies covering up to **85% of the total project investment**.
  - Participating projects framework:
    - **Stand-alone energy storage** projects connected to the transmission and distribution networks
    - **Hybrid energy storage projects** coupled **with existing** or **new renewable** energy generation facilities
    - Technologies include reversible pumping, **thermal storage**, among others
  - Expected impact:
    - Estimated support for 80 to 120 projects
    - Between **2.5 GW** and **3.5 GW** of new installed energy storage capacity

VICEPRESIDENCIA TERCERA DEL GOBIERNO

MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

IDAE Instituto para la Diversificación y Ahorro de la Energía

Fondos Europeos

Top 3 cases/projects

- **RedTES**
  - Spanish association focus on advancing TES through collaboration, knowledge sharing, and joint action, breaking down barriers to innovation and boosting international impact
  - +40 institutions (universities and research groups)

Red TES
Red española de almacenamiento de energia térmica

- **HYBRIDplus**
  - This project proposes the implementation of an Electrified Cascaded Thermal Energy Storage based on PCM (Phase Change Materials) for latent and sensible storage, as one of the ways to implement inertia.
    - This project has received funding from the European Union's HE R&I Programme

HYBRIDplus

- **Renewal Energies, green Hydrogen and Storage (PERTE-ERHA)**
  - Program that seeks to promote the energy transition in Spain, specifically in the renewable energy, renewable hydrogen, and storage sectors.
    - 6,5 M€ for 10 Thermal Energy Storage Projects
    - Storage capacity will increase by about 90 MW, reaching close to 600 MWh of energy capacity.

Plan de Recuperación, Transformación y Resiliencia
ALMACENAMIENTO

Top 3 cases/projects

- **RedTES Network Highlights**
  - **Connect & Collaborate:** Foster strong links and shared activities among Spanish research groups working on TES.
  - **Advance Knowledge**: Support R&D efforts that drive innovation and expand scientific understanding.
  - **Tackle Challenges Together**: Unite to overcome technological, economic, and social barriers, strengthening Spain's global research presence.
  - **Deliver Real-World Impact:** Generate research outcomes that offer practical solutions for industry and increase public awareness of TES benefits across various applications.

Visit us at https://redtes.udl.cat/
or scan the QR code

Top 3 cases/projects

This project has received funding from the European Union's Horizon Europe research and innovation programme *under grant agreement No 101084182*

- **HYBRIDplus: Electrified Thermal Energy Storage system based on PCM Cascade**
  - **PCM Cascade**: TES cascade configuration using 3 to 4 different PCM reproduces the effect of a thermocline. The heat is stored as latent and sensible heat.
  - **Hybridization**: Using an electrified TES, it is proposed to store excess electricity from variable renewable energy system.
    - HYBRIDplus project includes a real-world testing pilot plant at University of Seville. (Construction in progress).

Visit us at
www.hybridplus.eu
or scan the QR code

Top 3 cases/projects

This project has received funding from the European Union's Horizon Europe research and innovation programme *under grant agreement No 101084182*

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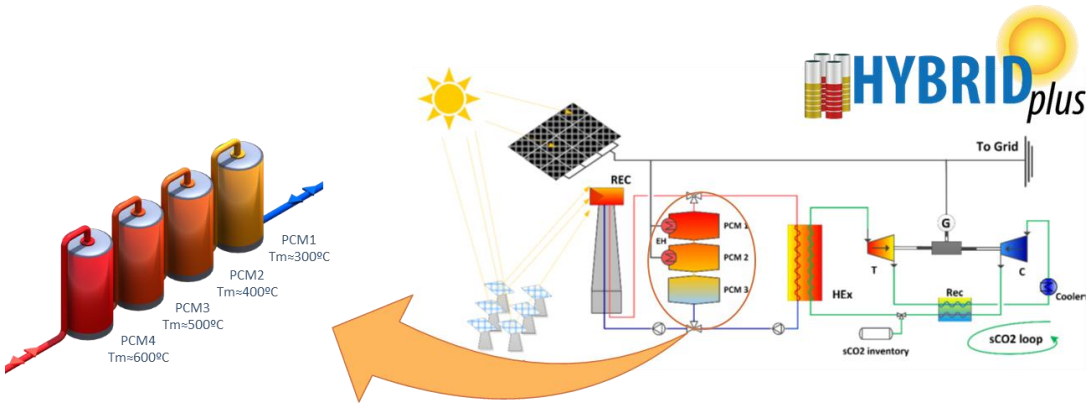
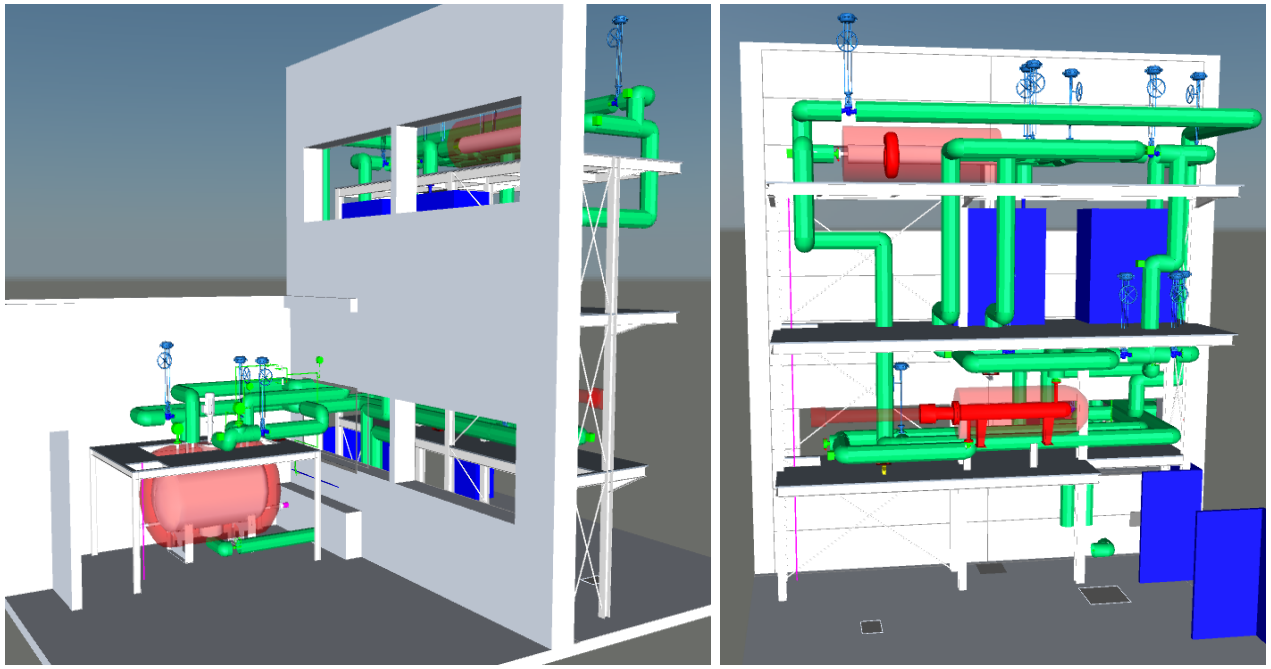


New Pilot Plant for Electrified Sensible and Latent Heat Energy Storage up to 600 °C



Top 3 cases/projects

- **PERTE-ERHA: Thermal Energy Storage System for Heating Network**
  - Generation of hot water for a sustainable Heating Network in each of these cities, which would represent, for the estimated storage capacity, a reduction of more than 10.5 ktoe per year.
  - 8 projects awarded.
  - Based on Biomass Resources.

+ 190 MW of installed storage capacity

+ 550 MWh of storage capacity

+ €3.7 million in aid granted

Place	Installed Storage Capacity (MW)	Storage Capacity (MWh)	Aid granted (Millon €)
Zamora	20,96	125,78	0,798
Lugo	20,52	131,54	0,568
Palencia	12,00	116,00	0,835
Mostoles (Madrid)	12,00	86,30	0,608
Guadalajara	10,00	53,00	0,515
Ávila	5,97	35,86	0,328
Olvega (Soria)	1,00	4,29	0,095

Top 3 cases/projects

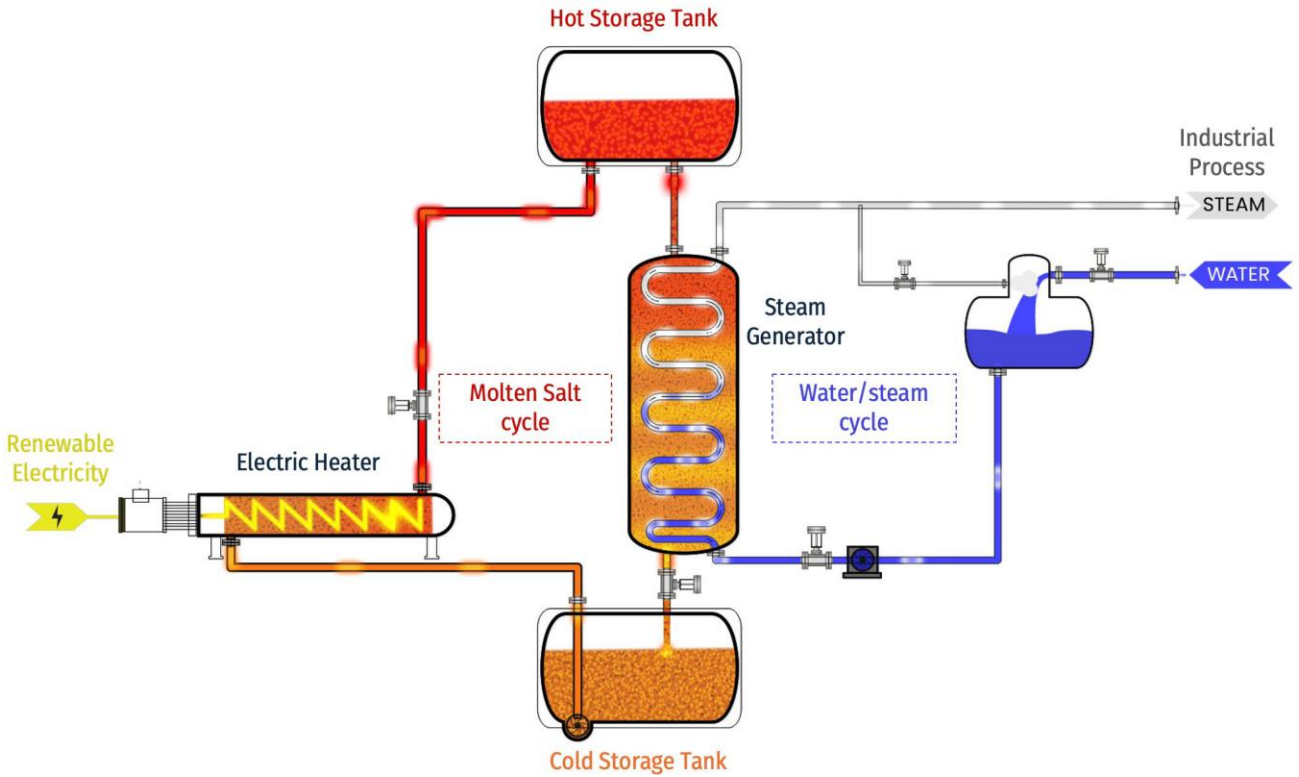
- **PERTE-ERHA: Thermal Energy Storage for Process Heat Decarbonization with Power-to-Heat system**
  - Based on ThermalBox® system, developed by Build to Zero, which will use 100% renewable electricity.
  - This system will produce process steam through thermal energy storage in molten salts, eliminating the use of fossil fuels and reducing CO_2 emissions by 1,277 tons per year

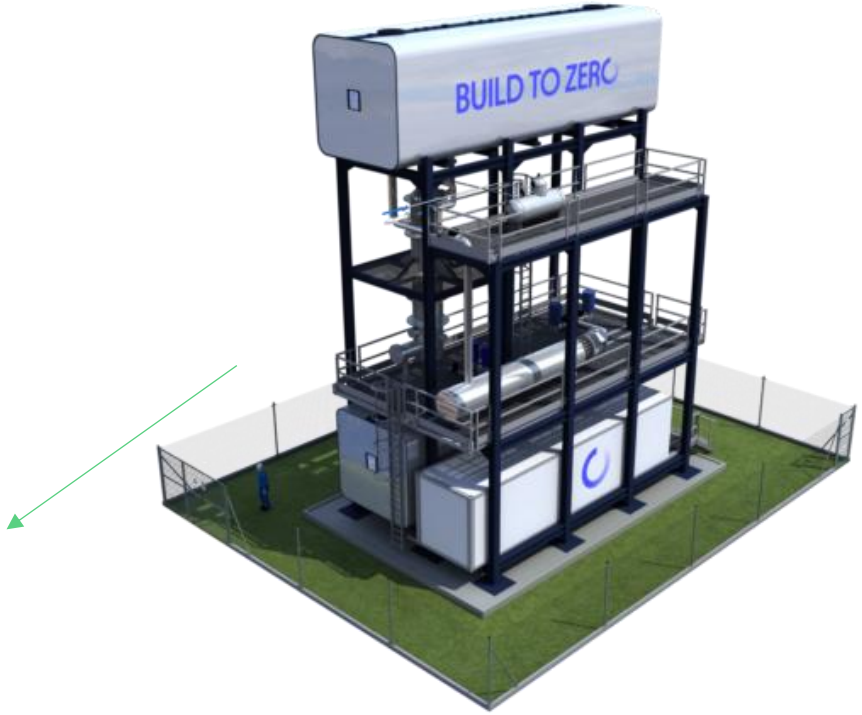
Acideka

- 4,39 MWp of PV supply
- 2,5 MW_{th} from ThermalBox®, based on a 400 °C storage in molten salts
- 14 MWh_{th} of energy storage capacity

Top 3 cases/projects

- **PERTE-ERHA: Thermal Energy Storage for Process Heat Decarbonization with Power-to-Heat system**





UNIVERSIDAD D SEVILLA

energy storage

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The Energy Storage TCP
Thanks for your attention

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