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Una empresa de Redeia

The Spanish experience

2nd Asia-Pacific Regulatory Forum

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June 2023

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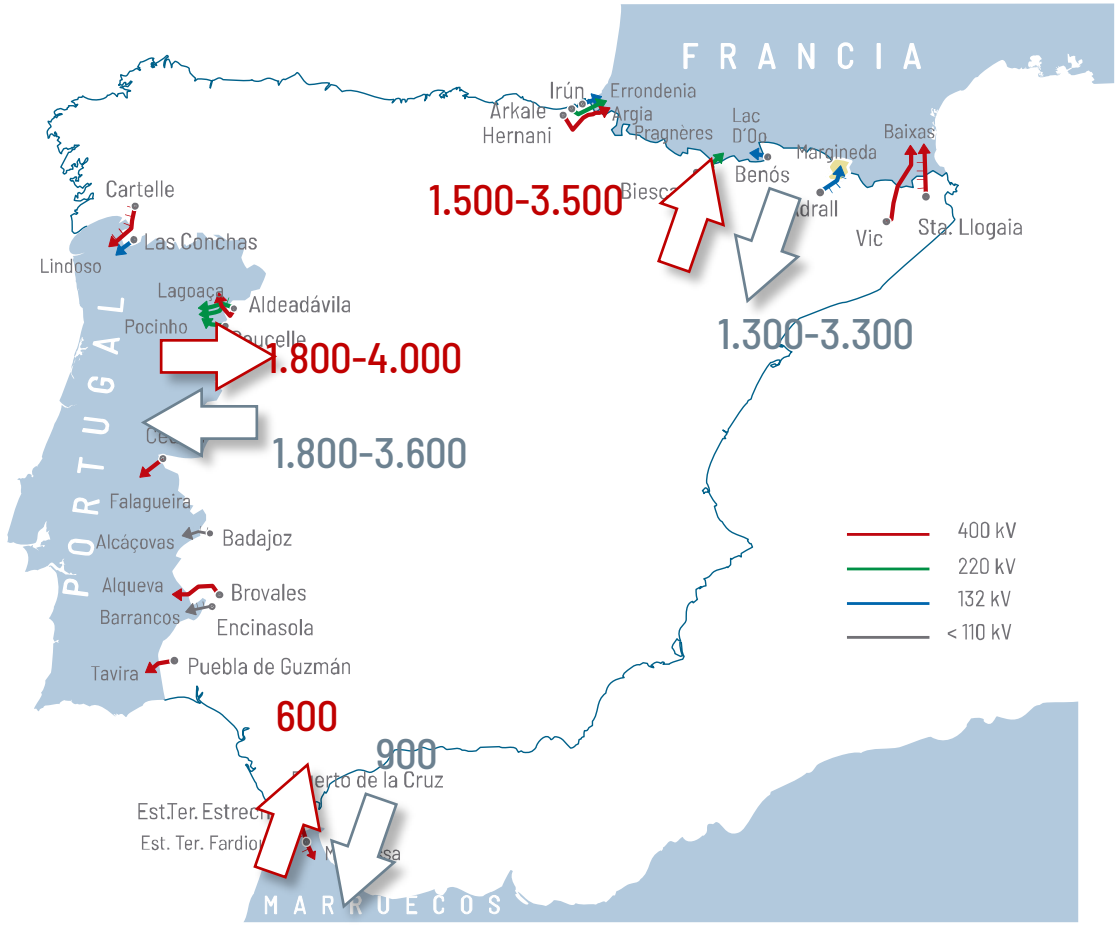
1. The Spanish power system

The Spanish power system

International interconnections. Typical Transfer capacities (MW)



- Spain is part of the european interconnected system. We are interconnected with France, Portugal and Morocco
- Red Eléctrica is the Spanish Tranmission System Operator
- Red Eléctrica owns all the tranmission system in Spain (normally 400 kV and 220 kV grid)
- Red Eléctrica guarantees system supply

Installed power (MW) – Spanish power system

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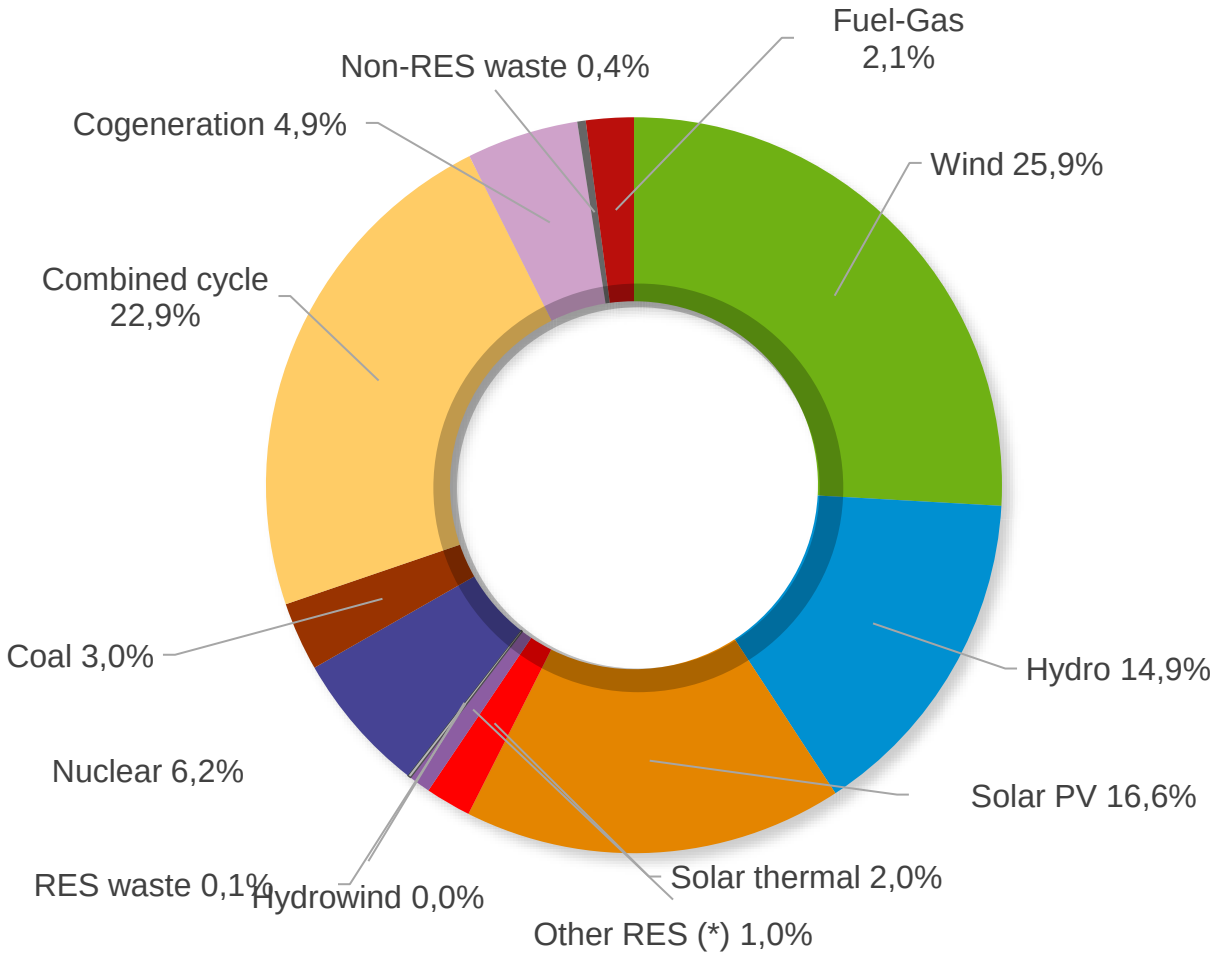
December 2022



Technology	MW	%
Wind	29.729	25,9%
Hydro	17.094	14,9%
Solar PV	19.113	16,6%
Solar termal	2.304	2,0%
Otrher RES (*)	1.093	1,0%
RES waste	170	0,1%
Hydrowind	11	0,0%
TOTAL RES	**69.514**	**60,5**
Nuclear	7.117	6,2%
Coal	3.464	3,0%
Combined cycle	26.250	22,9%
Cogeneration	5.638	4,9%
Non-RES waste	426	0,4%
Fuel-Gas	2.408	2,1%
NON RES	**45.303**	**39,5**
TOTAL	**114.817**	**100%**

Storage systems	MW	%
Pure pumping	3.331	100

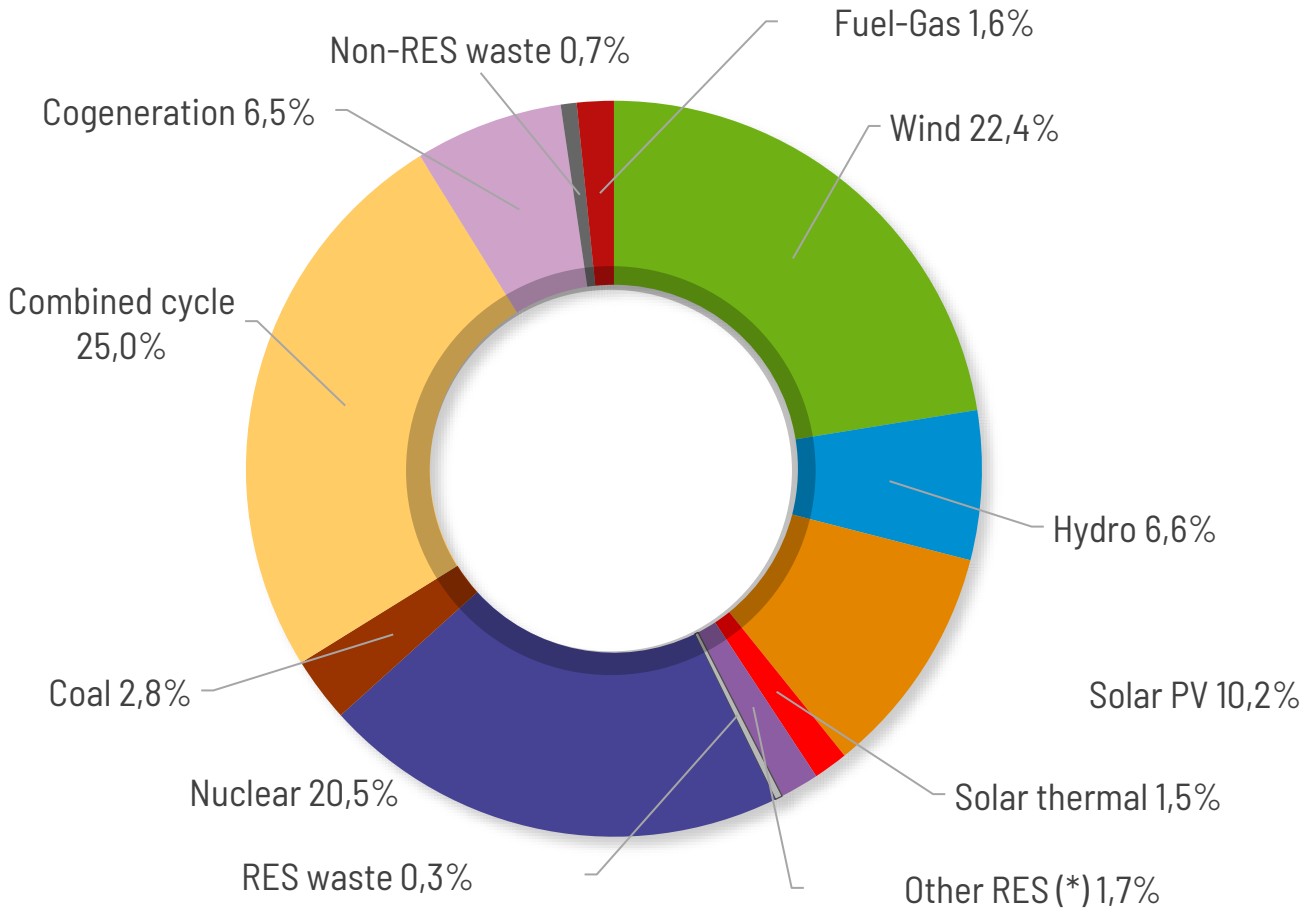
Spanish power system installed capacity (MW): 118.148 MW

∑ Non CO2 energy≈ 66,7 %

(*) Includes biomass, biogas, hydro marine and geothermal

Producción (GWh) - Sistema eléctrico NACIONAL

December 2022 (prov.)



Tecnología	GWh	%
Wind	61.176	22,4%
Hydro	17.863	6,6%
Solar PV	27.864	10,2%
Solar thermal	4.123	1,5%
Other RES (*)	4.656	1,7%
RES waste	878	0,3%
Hydrowind	23	0,0%
RES	**116.583**	**42,8**
Nuclear	55.984	20,5%
Coal	7.765	2,8%
Combined cycle	68.138	25,0%
Cogeneration	17.758	6,5%
Non-RES waste	1.900	0,7%
Fuel-Gas	4.413	1,6%
NON RES	**155.958**	**57,2**
TOTAL	**272.541**	**100%**

Almacenamiento	GWh
Turbinación Bombeo	3.776
Consumo Bombeo	-6.092

∑ Renewable Energy ≈ 42,8 %

∑ Non CO2 Energy ≈ 63,3 %

(*) Includes biomass, biogas, hydro marine and geothermal

Installed generation in Spain

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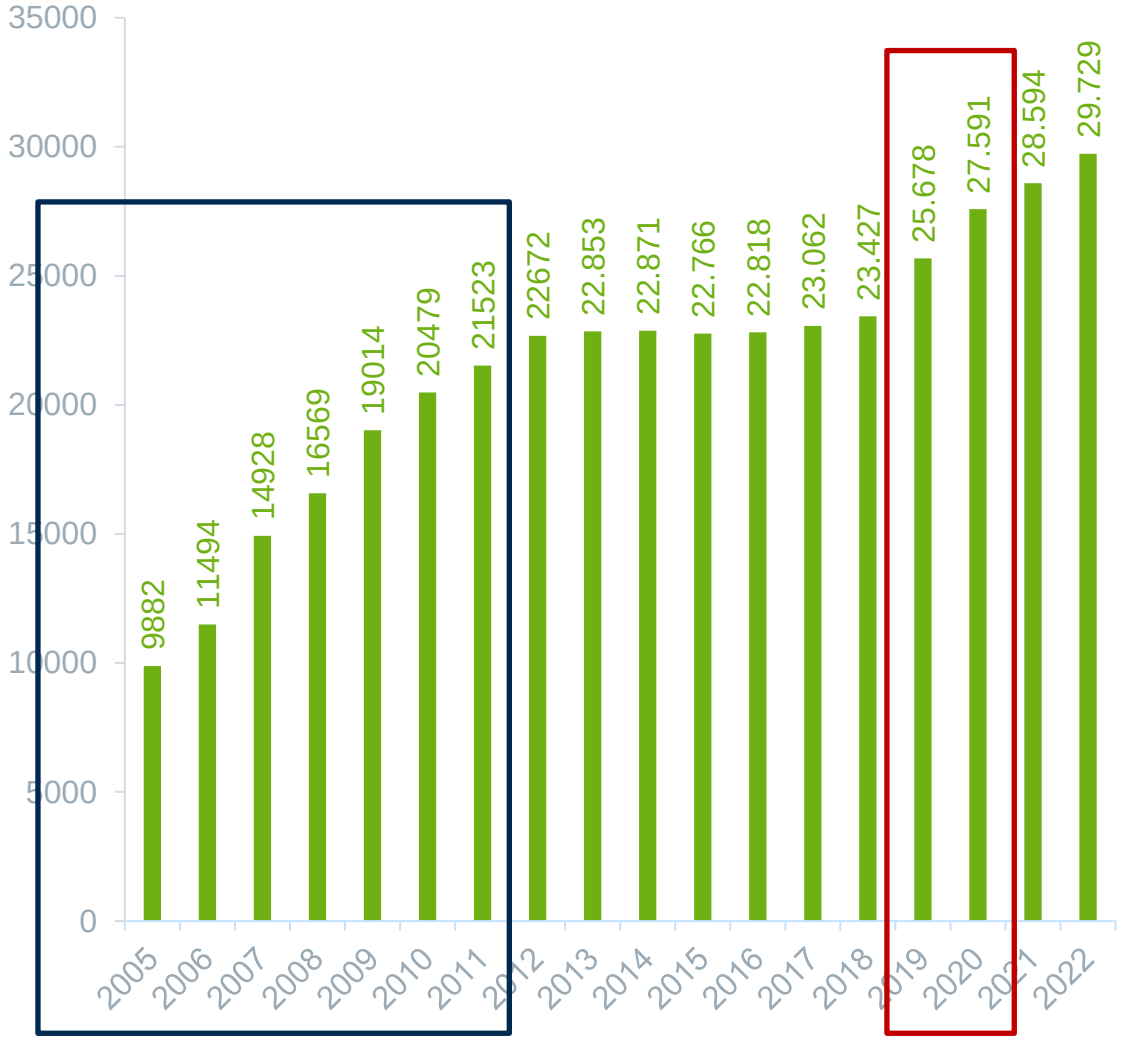
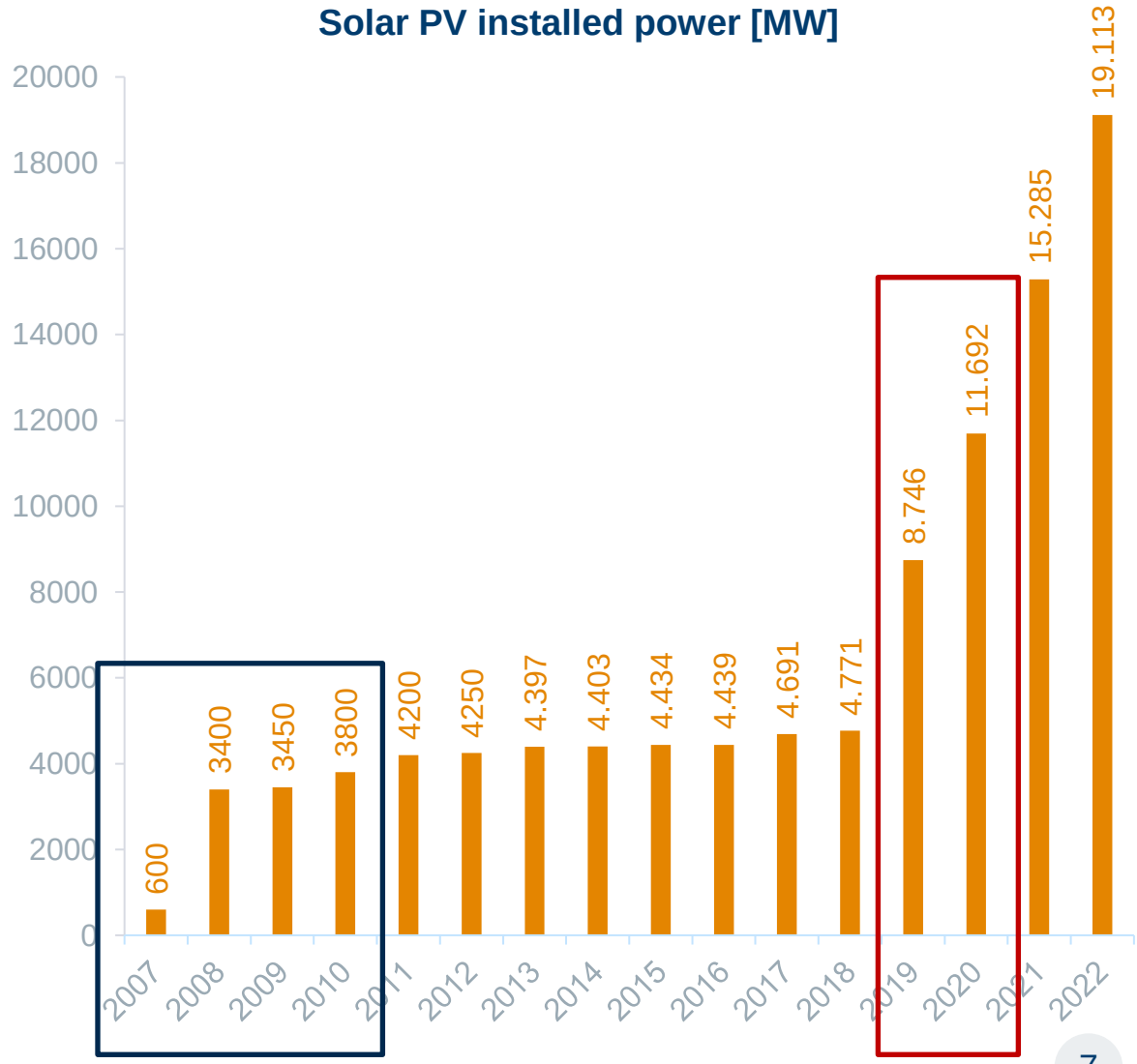
Wind installed power [MW]



Solar PV installed power [MW]



Daily demand coverage (15/05/2023)

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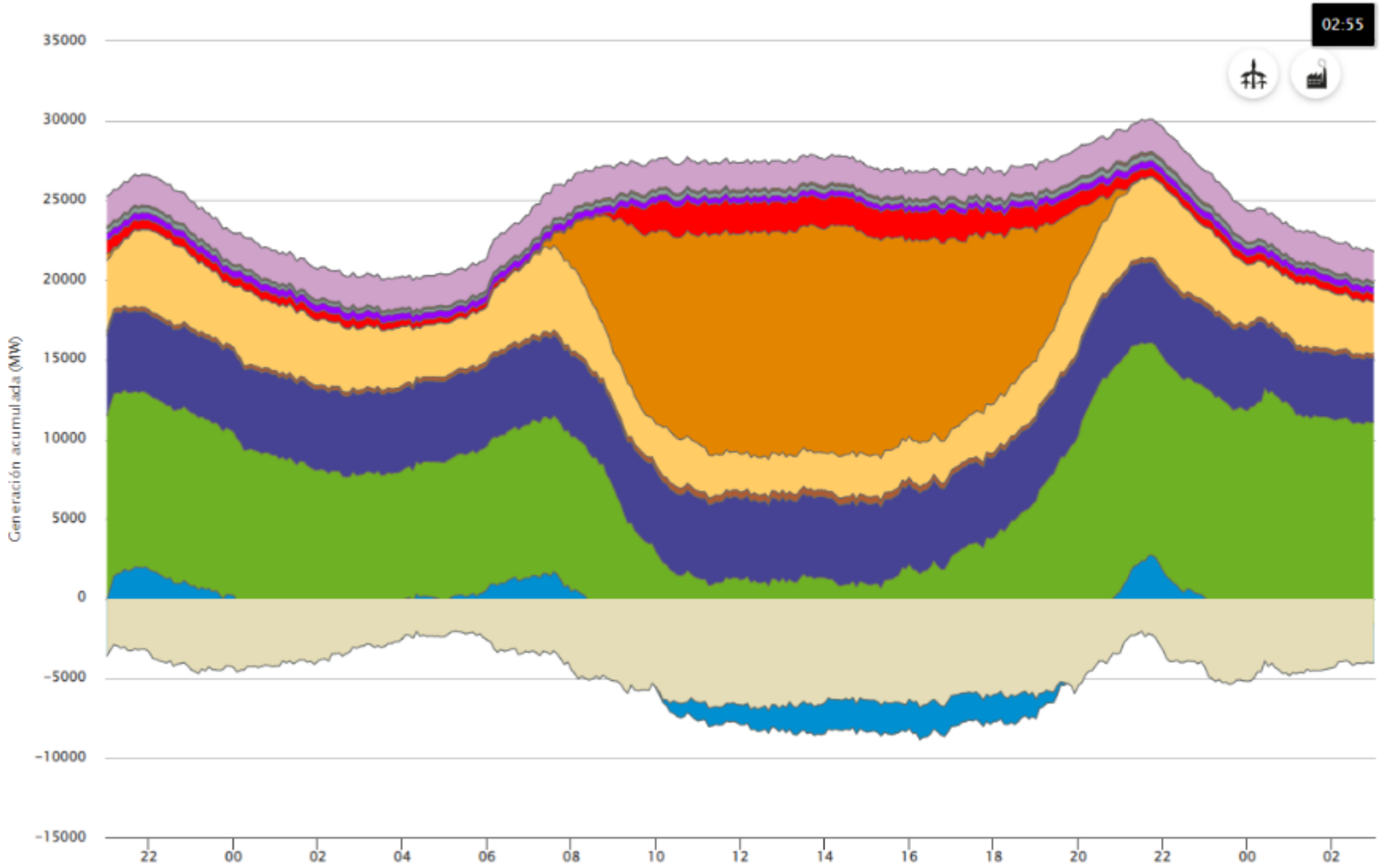
Estructura de generación acumulado progresivo (MW) a las 02:55 - 16/05/2023

Cogeneración y residuos	1922	7,42(%)
Turbina de vapor	91	0,35(%)
Turbina de gas	29	0,11(%)
Motores diésel	211	0,81(%)
Térmica renovable	434	1,68(%)
Solar térmica	508	1,96(%)
Solar fotovoltaica	16	0,06(%)
Ciclo combinado	3306	12,76(%)
Carbón	263	1,02(%)
Nuclear	4051	15,64(%)
Eólica	12644	48,82(%)
Hidráulica	2424	9,36(%)
Intercambios int	-4039	0(%)



SOURCE:
https://demanda.ree.es/visiona/peninsula/nacional/acumulada/2023-05-15

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2. Challenges

Challeges in renewable energy integration

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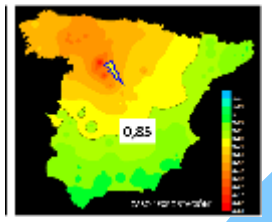


Real time studies

Observably and controllability

Network congestions

Distributed generation

Primary resource variability

Forecast

Demand Coverage

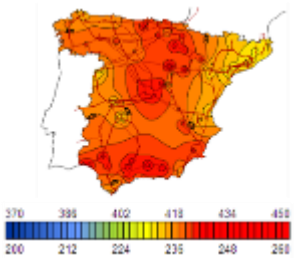
Curtailments

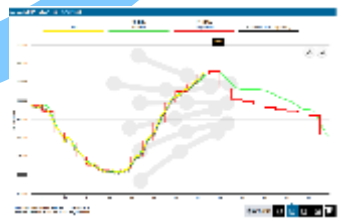
Flexibility

Voltage control

Transient Stability

Real Time Setpoints





Red Eléctrica Power system real time control centres

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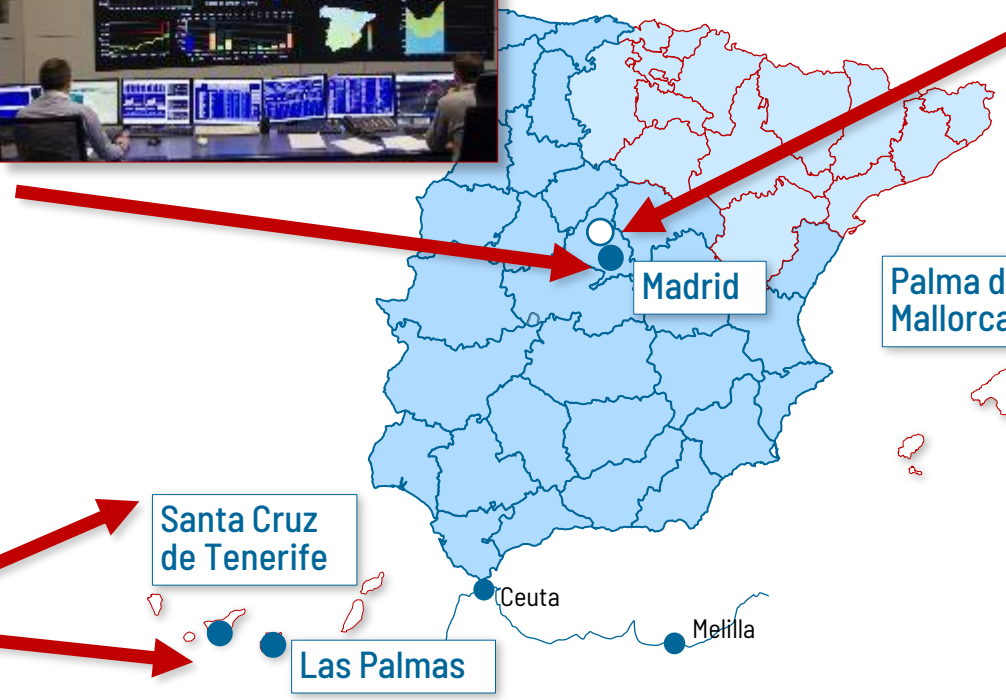
24 hours per day, 365 days per year

CECOEL

CECRE

CECORE



CECOIC

CECOIB

CECRE: Renewable Energy Control Centre

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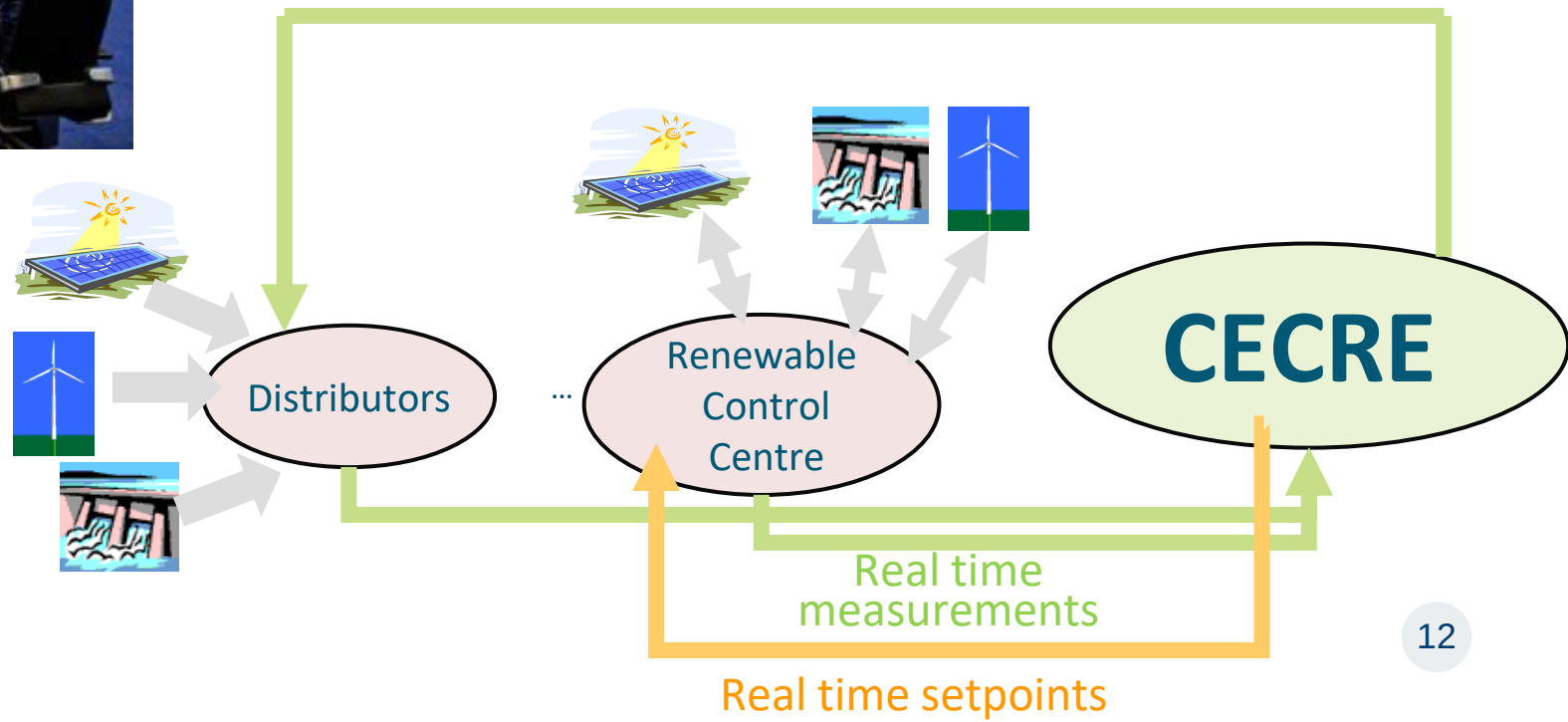
Pioneer and reference center worldwide in the integration of renewable energies, cogeneration and waste. (Commissioned in 2006)

Objective: to achieve a high level of integration of renewables without compromising the security of the system.

Main Function: articulate the integration of the production of renewable electrical energy based on the needs of the electrical system.

% Observability (>1 MW)	
Wind	99%
Solar PV	90%
Solar CSP	100%

% Controlability (>5 MW)	
Wind	99%
Solar PV	74%
Solar CSP	100%



Innovative solutions – congestion management

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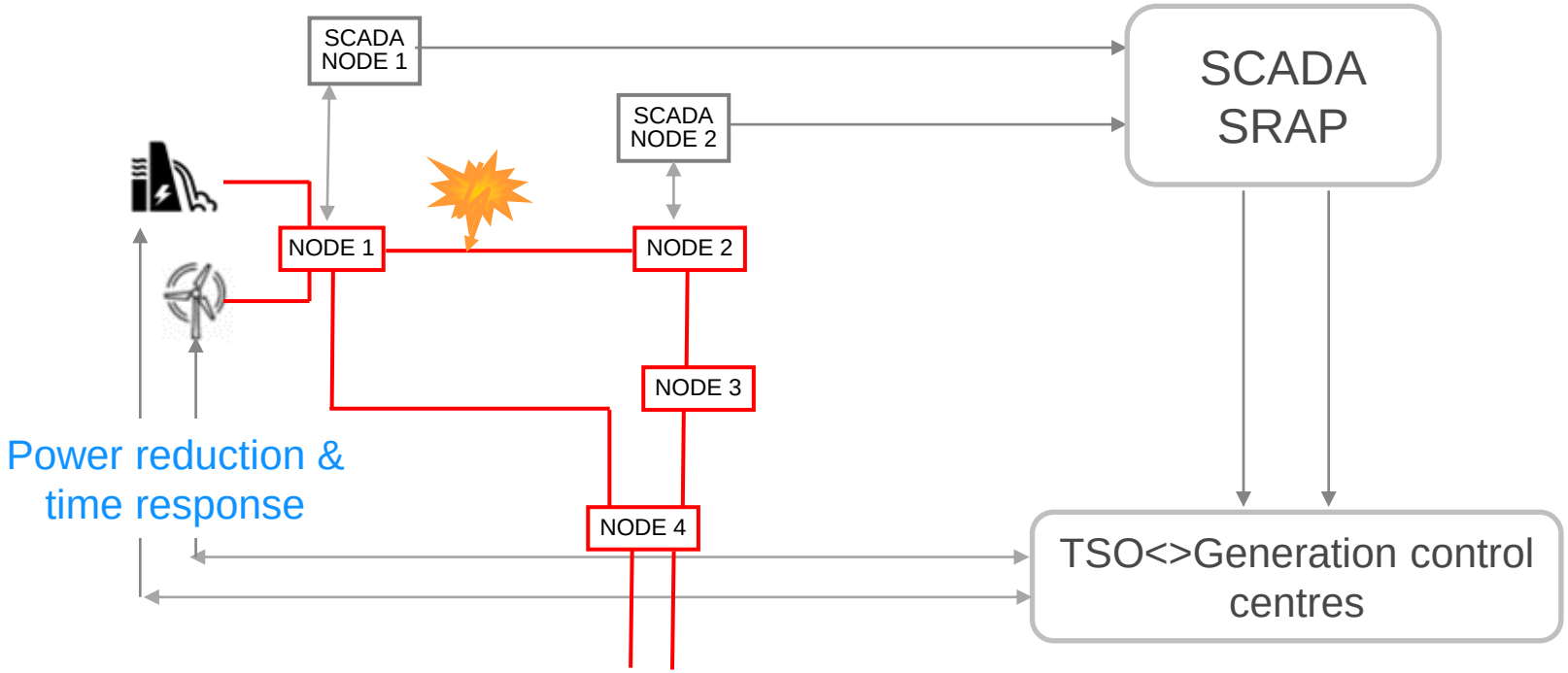
Automatic Power Reduction System (SRAP) is one of the latest control measurements implemented within the Spanish Power System (Commissioned in 2022)

New tool, integrated within the Scada System of the Red Eléctrica Control Center, that **automatically sends set points to qualified units (power plants) upon the detection of predefined events in the transmission grid**.

- ✓ Power is courtailed only if the incident takes place
- ✓ Power plants avoid preventive redispatching
- ✓ The system is more flexible than the current tele-tripping systems
- ✓ It allows for maximising the integration of renewable generation and the use of the grid



SRAP within regulation : Red Eléctrica operational procedure 3.11 (technical requirements and conditions to subscribe)

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3. The future

Power system decarbonization objectives

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43 %
Renewables over production

68 %
Renewables over production

74 %
Renewables over production

100 %
Decarbonized power system

2022 — 2026 — 2030 — 2050

Transmission network planning:
https://www.planificacionelectrica.es/

PnIEC
Energía y Clima

PNIEC:
https://www.miteco.gob.es/images/es/pnieccompleto_tcm30-508410.pdf

Renewable	Non-Renewable
30 GW	3.5 GW
19 GW	7 GW
17 GW	25 GW
2.3 GW	5.6 GW

Storage: 3.3 GW — 0 GW

Renewable	Non-Renewable
41 GW	0 GW
25 GW	7 GW
17 GW	25 GW
2.3 GW	4.6 GW

Storage: 4 GW — 0.5 GW

3 GW (9 h)

Renewable	Non-Renewable
49 GW	0 GW
38 GW	3 GW
17 GW	25 GW
2.3 GW	3.7 GW

Storage: 7 GW — 2.5 GW

5 GW (9 h)

- Wind
- Solar PV
- Hydro
- Solar thermal
- Pumping
- Coal
- Nuclear
- Combined cycle
- Cogeneration
- Bateries

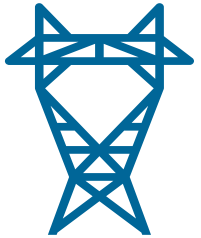
Next steps

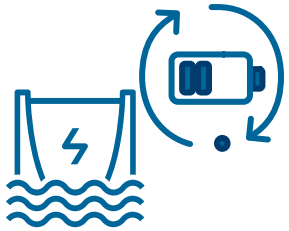
Tranmission network reinforcements and investment

There is a need for grid reinforcement in order to continue integrating and maximizing renewable energy production within the Spanish power system (solving congestions, enabling new connection points for generation and ensuring supply to consumers)

International interconnection reinforcement (French boarder)

Developing international electrical corridors enable maximizing renewable integration and contributes to maximize system security. There is a need for developing more interconections between Spain and the rest of Europe (France).



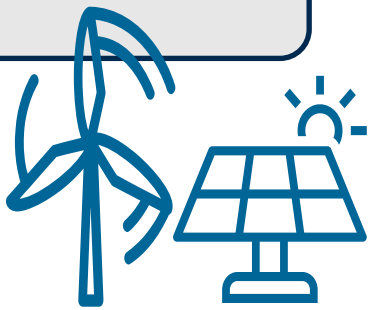


Energy storage deployment

Within the Spanish system there is an immediate need for more energy storage. Energy from sunny hours shall be stored and be produced after sunset in order to maximize renewable energy integration.

Further renewable energy development

There is still a great amount of new Renewable Energy to be installed in Spain. New plants and more energy shall be integrated within the Spanish system. Technical performance controls shall be implememted and activated within the plants in order to ensure stability.



PNIEC: https://www.miteco.gob.es/images/es/pnieccompleto_tcm30-508410.pdf

Regulatory lessons: access and connection rules

Generation access and connection rules: access to the grid shall be a right, and the procedure shall be developed in a transparent and non-discriminatory way.

2013 Spanish main Electrical sector Law (LSE 14/2013) . Access and connection articles were not completely developed

2018 RDL 15/2018 approved, with special measures to increase and implulse renewable energy connections.

2020 Approved law to order the Access and connection permissions, as too much permissions were expeded (RDL 23/2020)

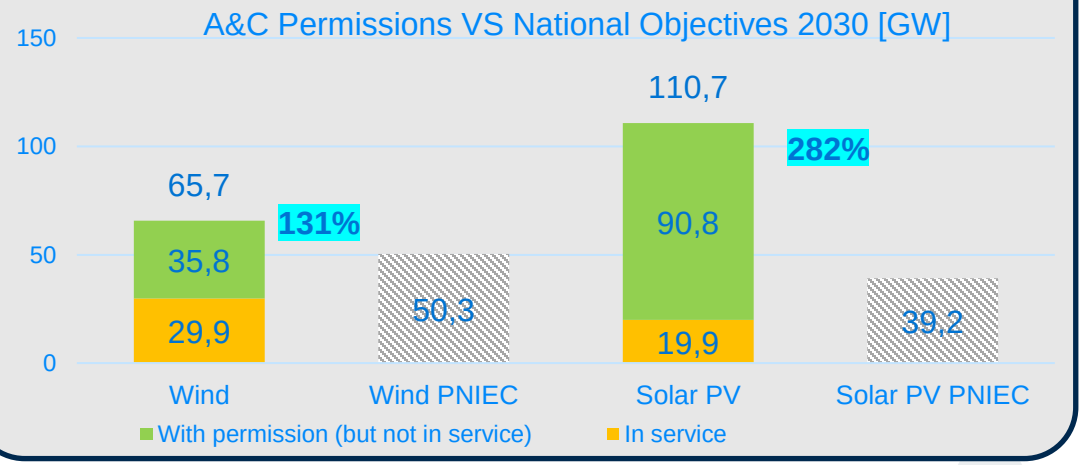
2021 Finally, Access and connection rules were completely defined within the law (RD 1183/2020)

2022 During 2022 and 2023, most of the Access capacity in the Spanish tranmission network is reserved to future ACCESS AUCTIONS. Special criteria will be taken into account:

2023

- Social and environmental benefits of the Project
- Technology criteria
- Innovation criterio
- Criteria related to the date of commissioning

During those years (2018-2020), applications for Access and connection permissions of new Renewable generation increased exponentially. The Ministry had put some order within the projects, in order to ensure that they were being developed and were not only “paper”.
Now, **all generation projects with Access and connection permission in Spain shall pass 5 administrative milestones within a determined deadline**, in order to keep their permission (RDL 23/2020). Also, they have to be commissioned before 5 years since the date of the permission. If not, their permission expires.



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El valor de lo esencial

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