



# The Electric Power System

**- Spain -**



# Basic facts

- ❑ Area: 505 957 km<sup>2</sup>
- ❑ Population: 46 439 864 (2015)
- ❑ Number of TSOs: 1
- ❑ Number of DSOs: 336  
(source: MINETUR)
- ❑ 28 Mio. consumers  
(source: CNMC)
- ❑ Peak load: approx. 41 GW (2015) ; 46 GW (2007)  
(source: REE)
- ❑ Average interruption of electricity: 5,3 min (2014)  
(source: REE)

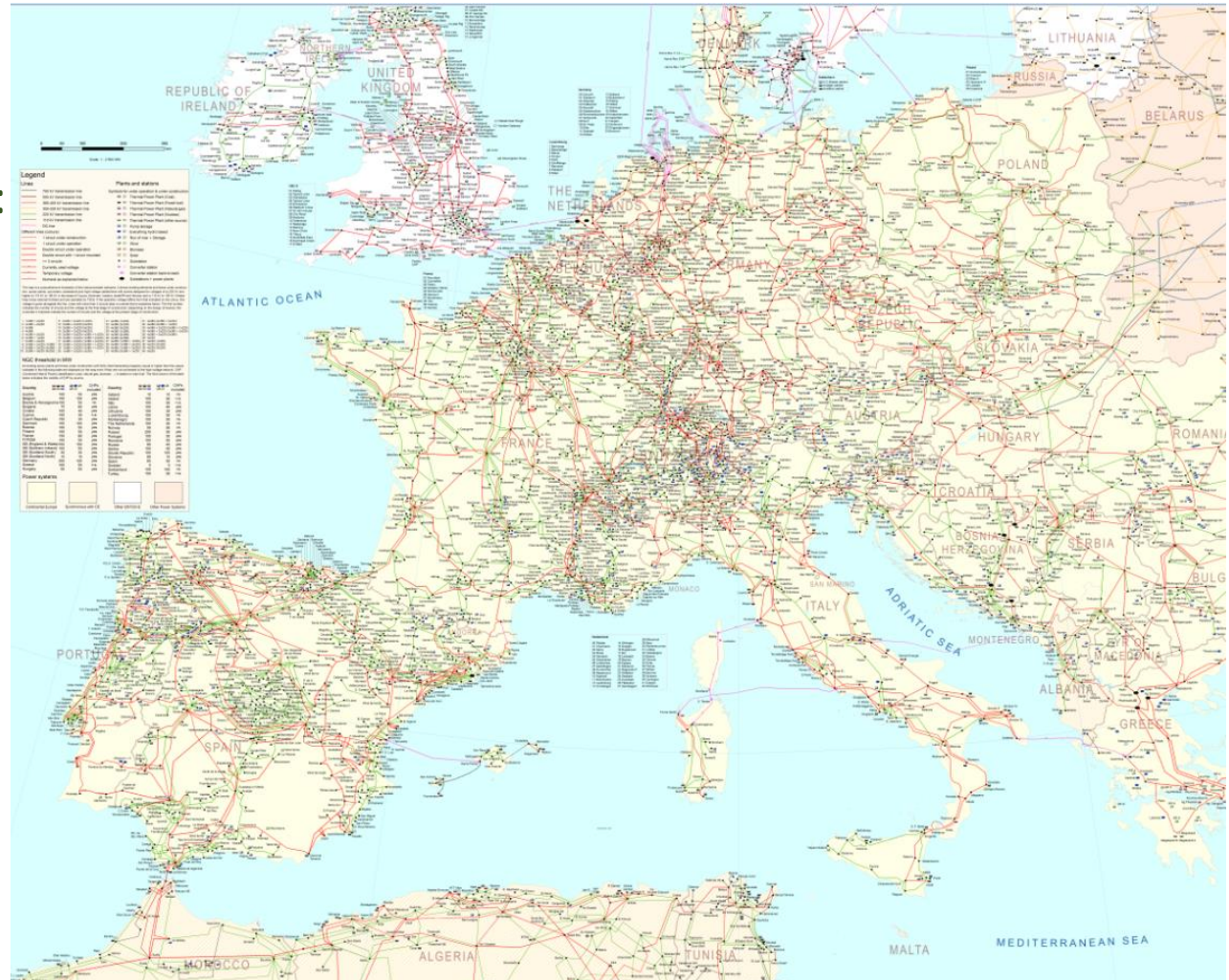




# Spain in the European meshed grid

□ Interconnectors with:

- France
- Portugal
- Morocco
- Andorra

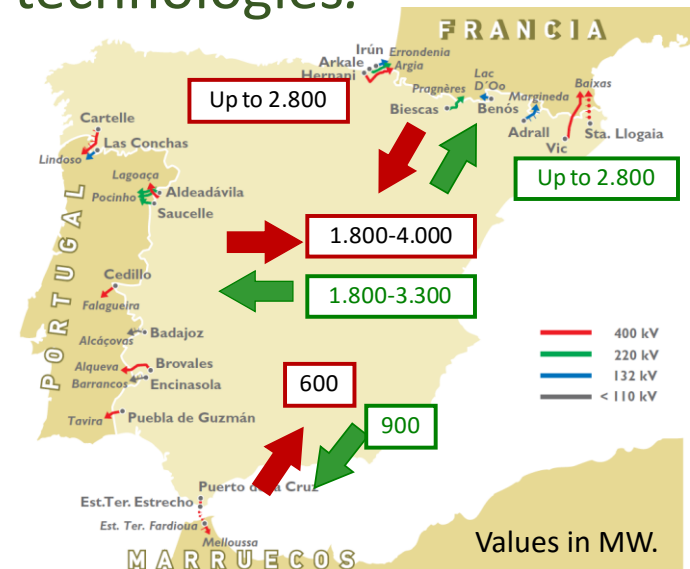


Source : ENTSO-E



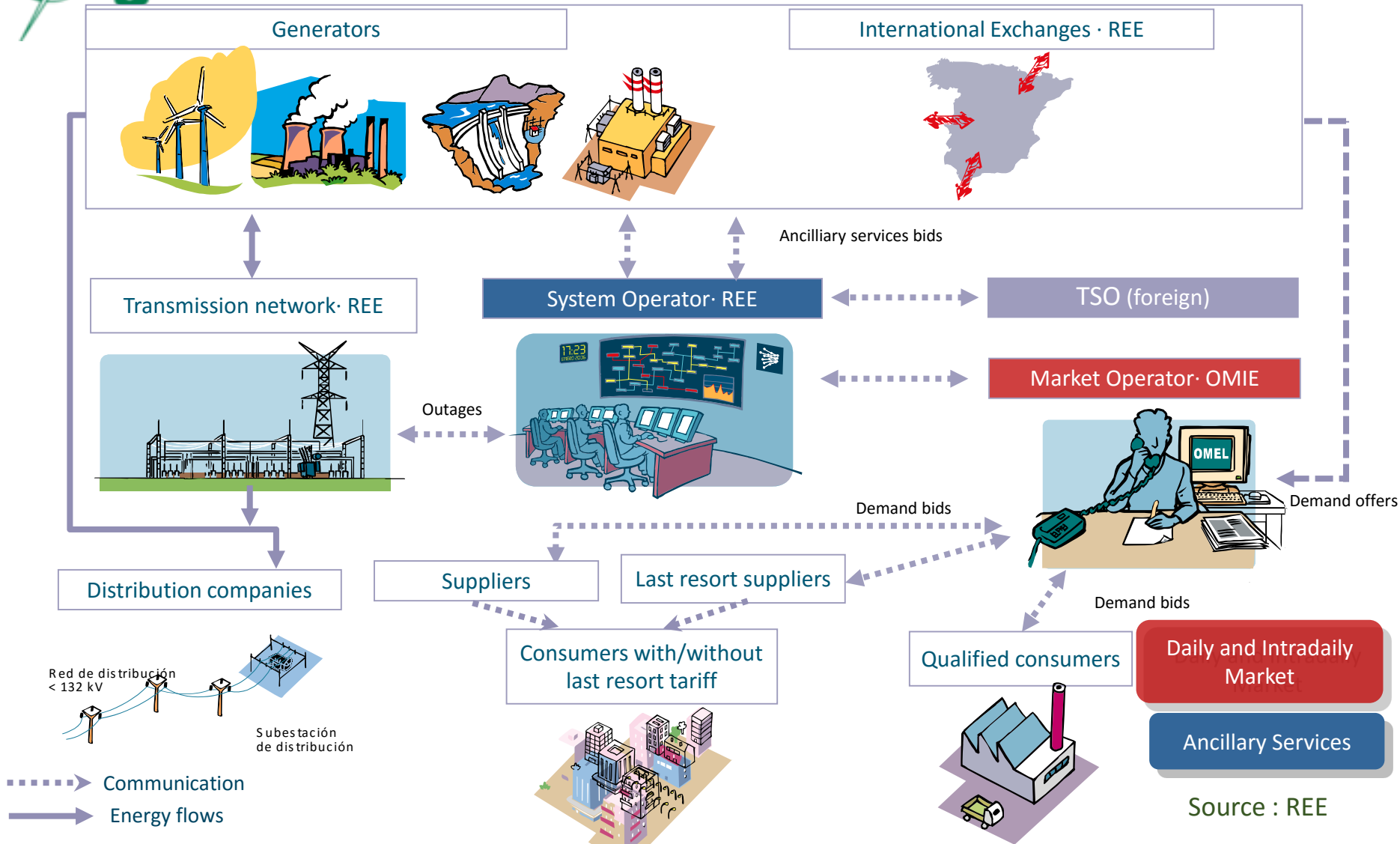
# Grid facts and characteristics

- ❑ Mainly 400 and 220 kV assets.
- ❑ Highly meshed transmission grid. High Psc.
- ❑ Limited exchange capability with other systems.
- ❑ Diversification of power generation technologies.
- ❑ Important contribution of renewable technologies.





# Structure of electrical power system





# Structure of electrical power supply. Interface T-D [MVA transformation]

TSO

Bulk-Industry &  
Singular Consumers  
(High-Speed Train)

400 kV

TSO-Grid

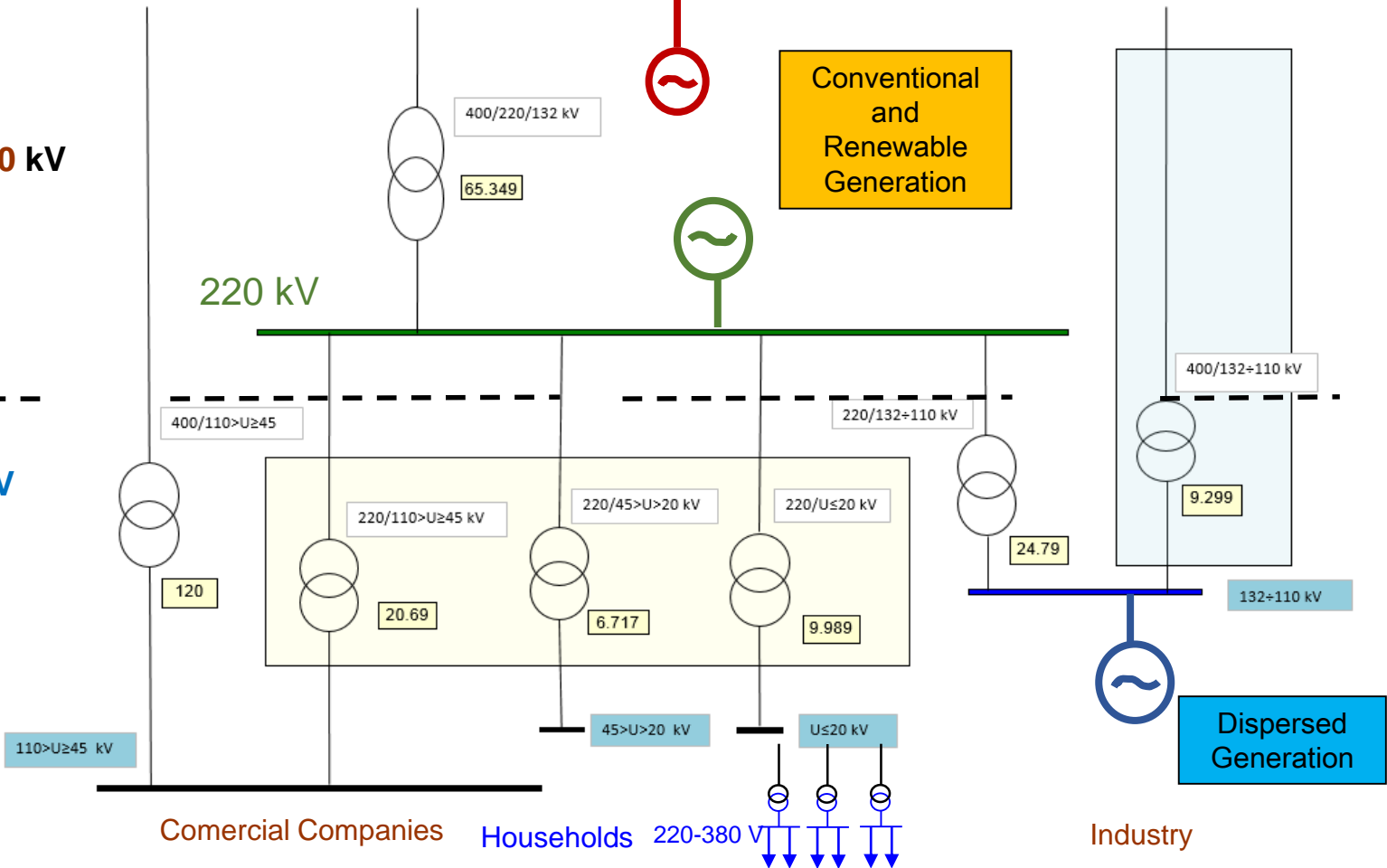
220 - 400 kV

220 kV

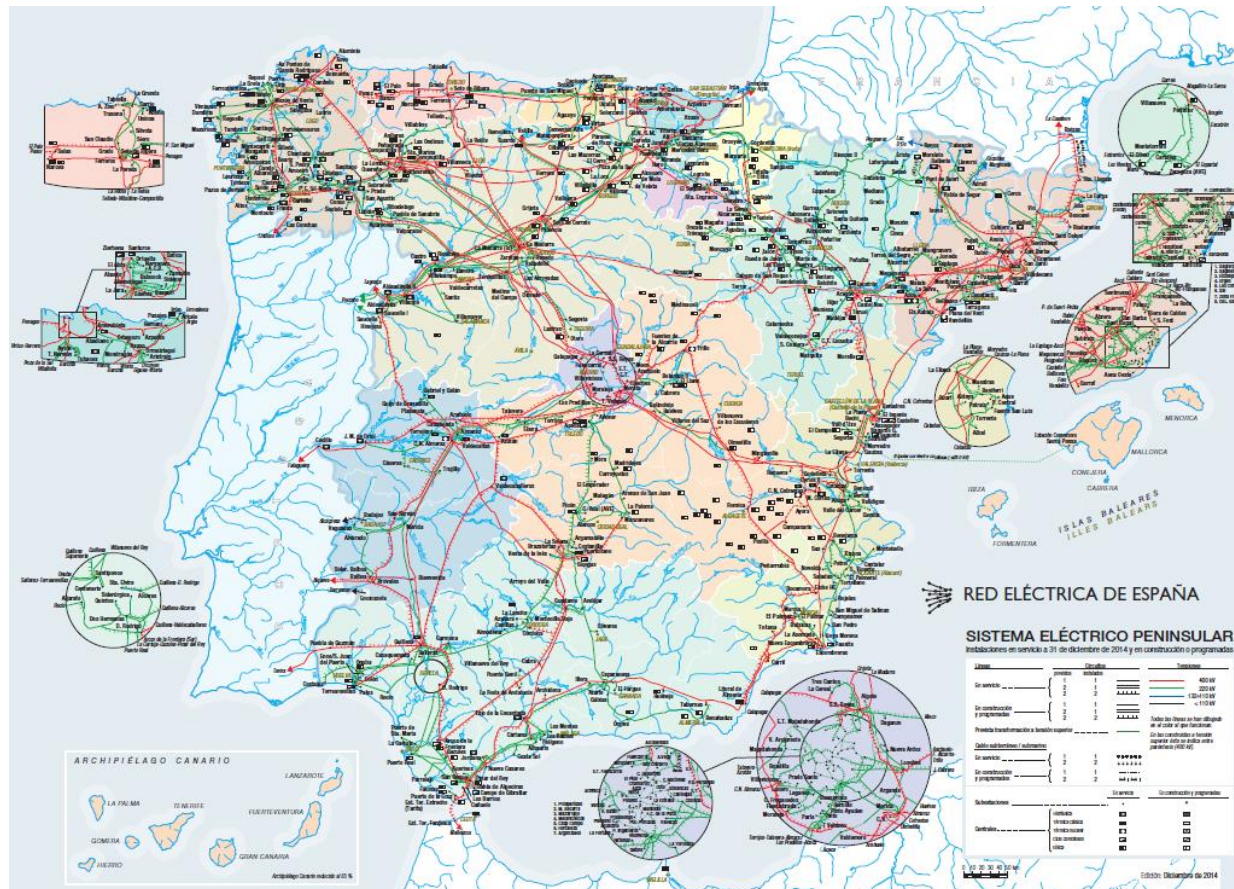
DSO-Grid

$\leq 132$  kV

20/10 kV



# Map of the high voltage grid



Source : REE





# Information on TSO

- Name: REE
- Network length (km) : 39 905
- Served area (km<sup>2</sup>) : 505 957
- Annual energy consumption (TWh) : 243,5

(source: REE)

- Website: <http://www.ree.es>



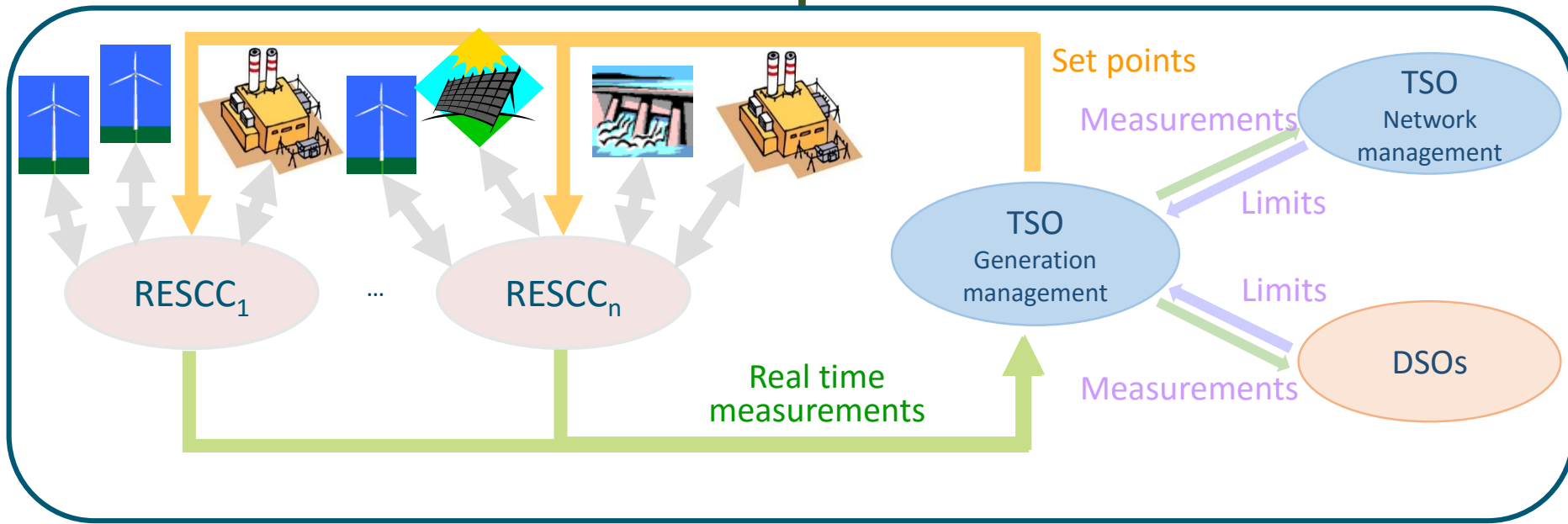
# Information on TSO

		1985	2010	2011	2012	2013	2014
km of 400 kV circuit	Red Eléctrica	9,860	18,792	19,671	20,109	20,639	21,094
	Other companies	899	0	0	0	0	0
	<b>Total</b>	<b>10,759</b>	<b>18,792</b>	<b>19,671</b>	<b>20,109</b>	<b>20,639</b>	<b>21,094</b>
km of $\leq$ 220 kV circuit	Red Eléctrica	4,069	17,291	17,891	18,260	18,558	18,702
	Other companies	10,258	109	109	109	109	109
	<b>Total</b>	<b>14,327</b>	<b>17,401</b>	<b>18,001</b>	<b>18,370</b>	<b>18,667</b>	<b>18,811</b>
Total km of the transmission grid	Red Eléctrica	13,929	36,084	37,563	38,369	39,197	39,795
	Other companies	11,157	109	109	109	109	109
	<b>Total</b>	<b>25,086</b>	<b>36,193</b>	<b>37,672</b>	<b>38,478</b>	<b>39,306</b>	<b>39,905</b>
Busbars	Red Eléctrica	373	3,762	3,961	4,150	4,295	4,360
	Other companies	1,099	113	113	113	113	113
	<b>Total</b>	<b>1,472</b>	<b>3,875</b>	<b>4,074</b>	<b>4,263</b>	<b>4,408</b>	<b>4,473</b>
Transformer capacity (MVA)	Red Eléctrica	2,311	66,596	68,996	74,596	76,871	79,871
	Other companies	26,616	0	0	0	0	0
	<b>Total</b>	<b>28,927</b>	<b>66,596</b>	<b>68,996</b>	<b>74,596</b>	<b>76,871</b>	<b>79,871</b>

Source : REE

# Cooperation of TSO and DSOs

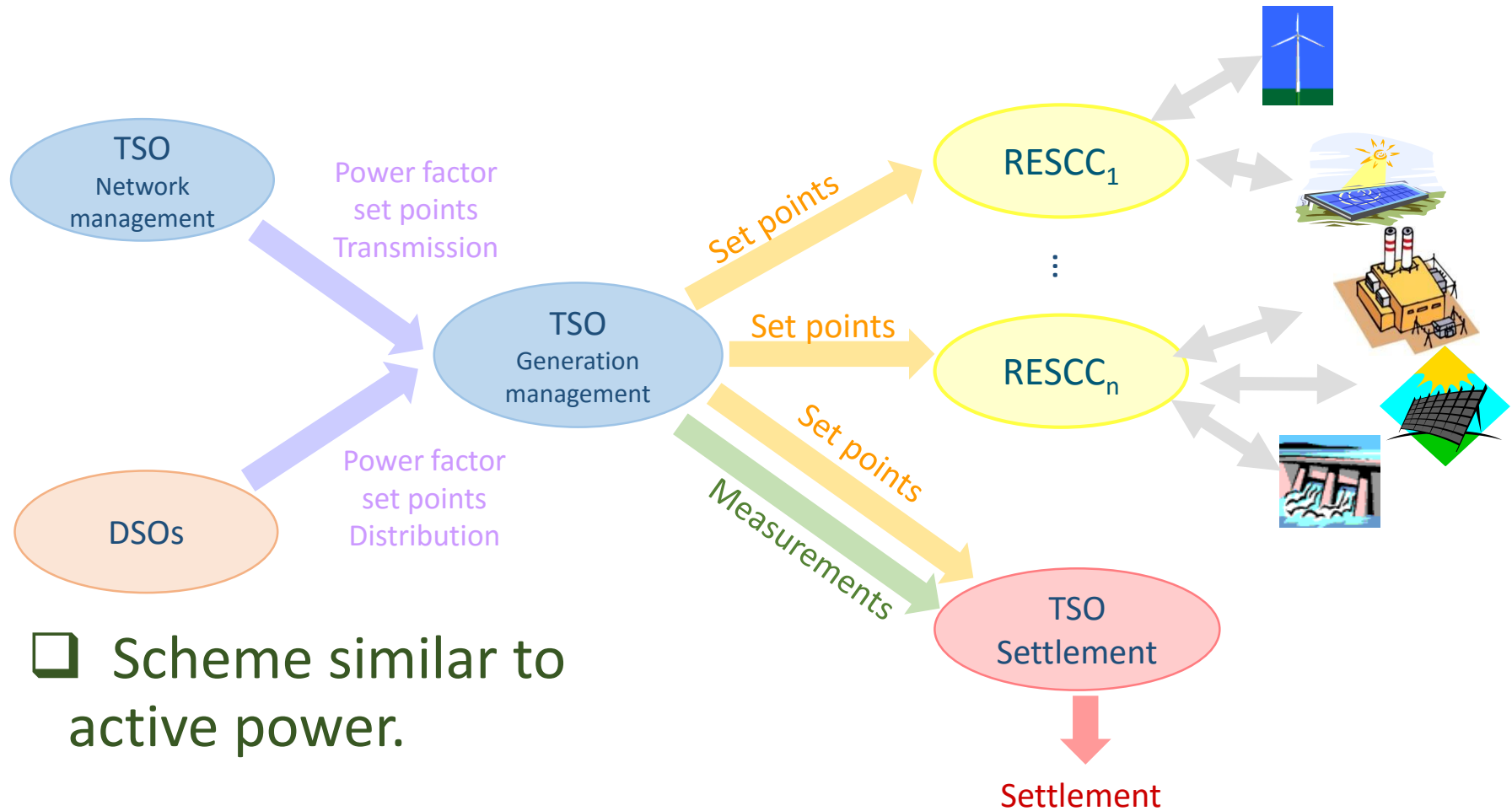
## Active power



- ❑ TSOs and DSOs calculate limits that apply to generators that contribute to a constraint.
- ❑ With this limits and the units involved, the TSO calculates the individual set-points according to regulation.



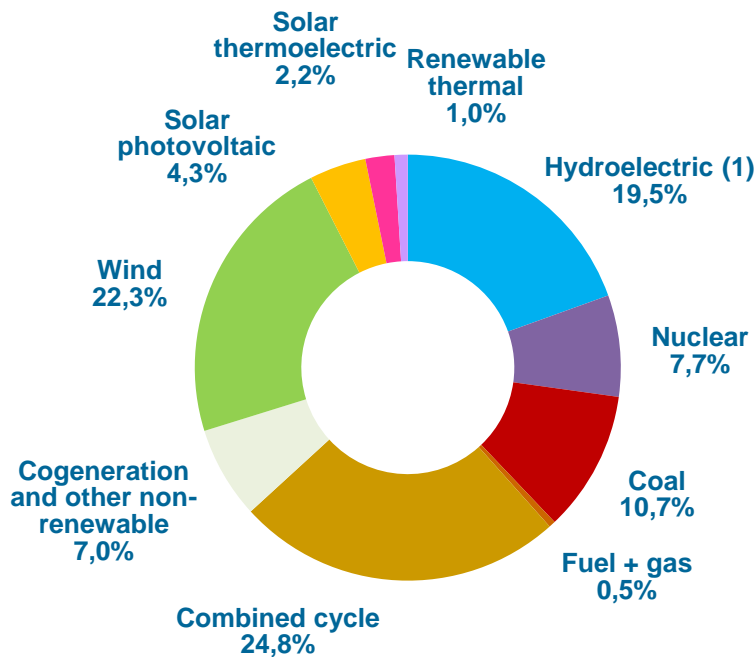
# Cooperation of TSO and DSOs Power factor regulation



❑ Scheme similar to active power.



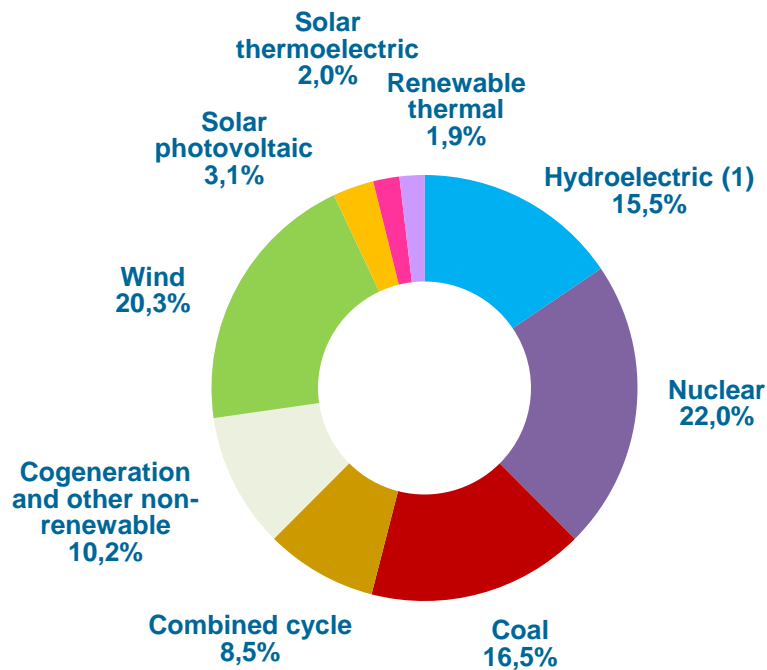
# Installed capacity with reference to primary resources (2014)



Technology	MW	%
Hydroelectric (1)	19,897	19.5
Nuclear	7,866	7.7
Coal	10,972	10.7
Fuel + gas	520	0.5
Combined cycle	25,348	24.8
Wind	22,845	22.3
Solar photovoltaic	4,428	4.3
Solar thermoelectric	2,300	2.2
Renewable thermal	1,012	1.0
Cogeneration and other non-renewable	7,075	7.0
<b>Total</b>	<b>102,262</b>	

Source : REE

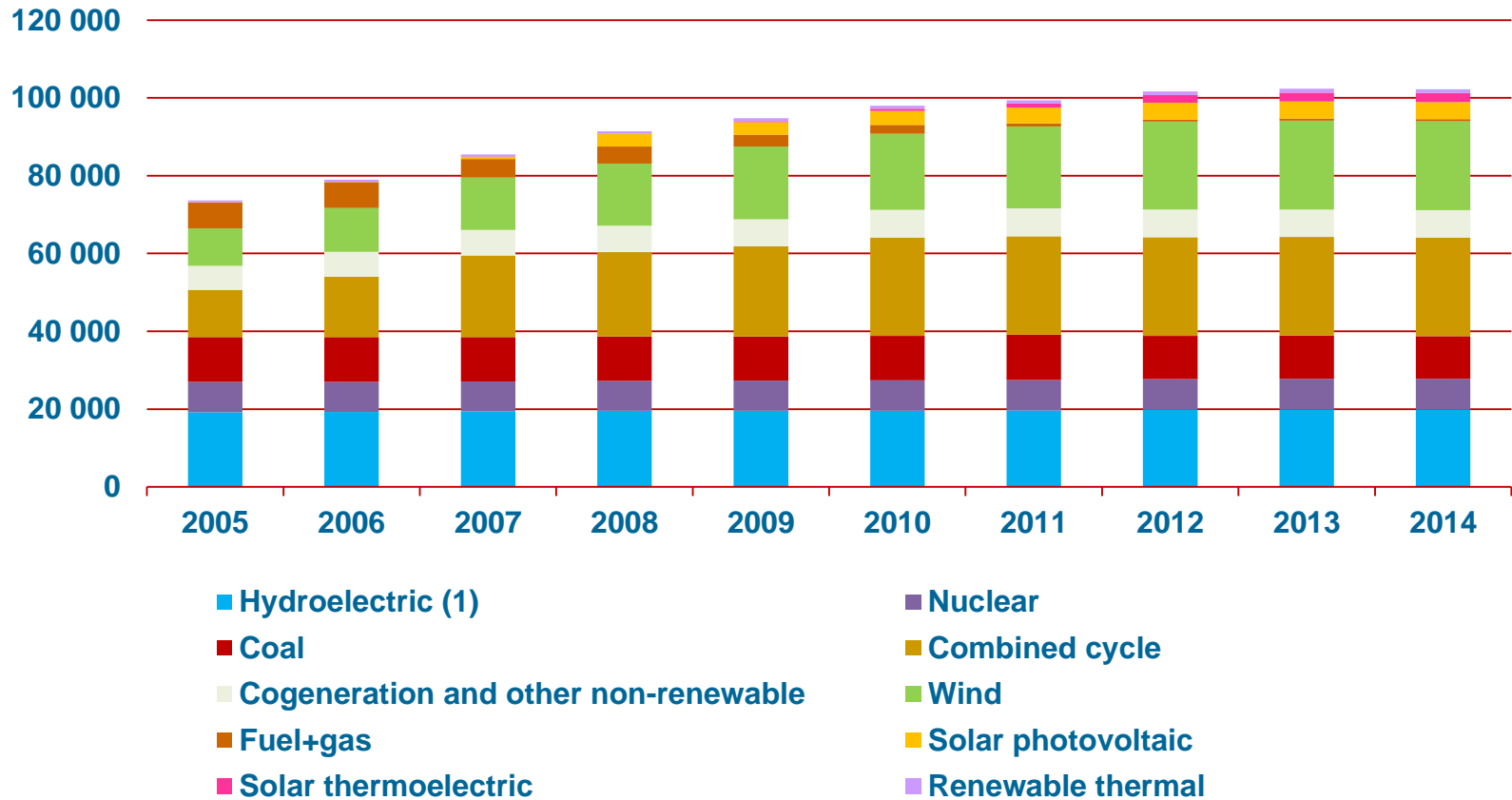
# Energy production with reference to primary resources (2014)



Technology	GWh	%
Hydroelectric (1)	38,790	15.5
Nuclear	54,925	22.0
Coal	41,139	16.5
Combined cycle	21,328	8.5
Cogeneration and other non-renewable	25,596	10.2
Wind	50,630	20.3
Solar photovoltaic	7,794	3.1
Solar thermoelectric	4,959	2.0
Renewable thermal	4,718	1.9
<b>Total</b>	<b>249,880</b>	

Source : REE

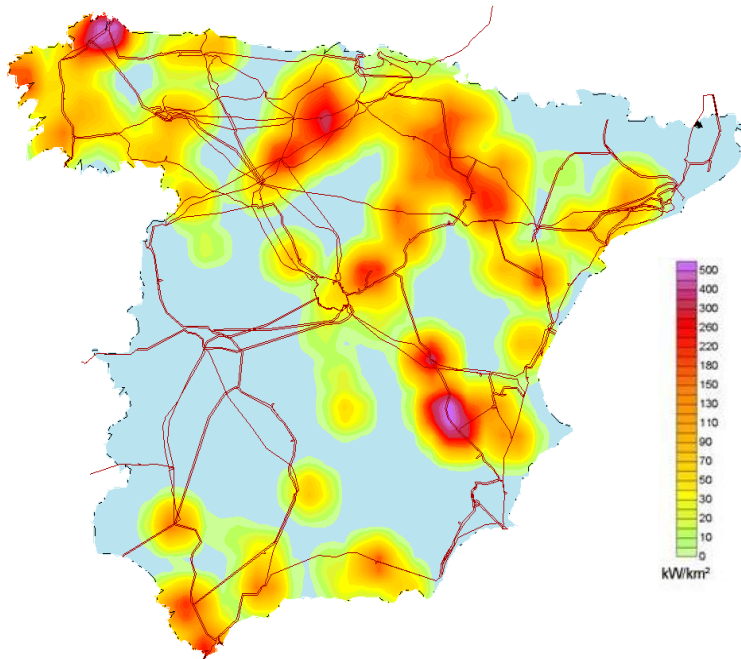
# Development of generation capacity since 2005



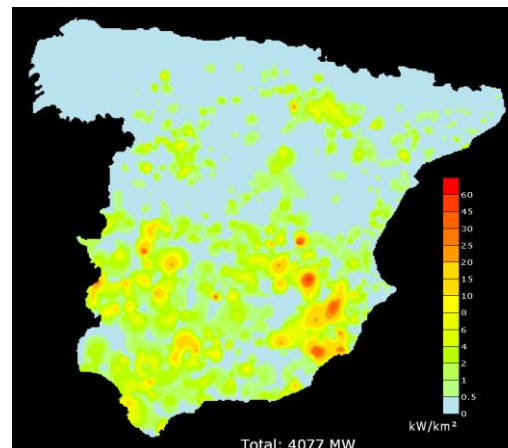
Source : REE

# Location of renewable energy sources

Wind



Photovoltaic

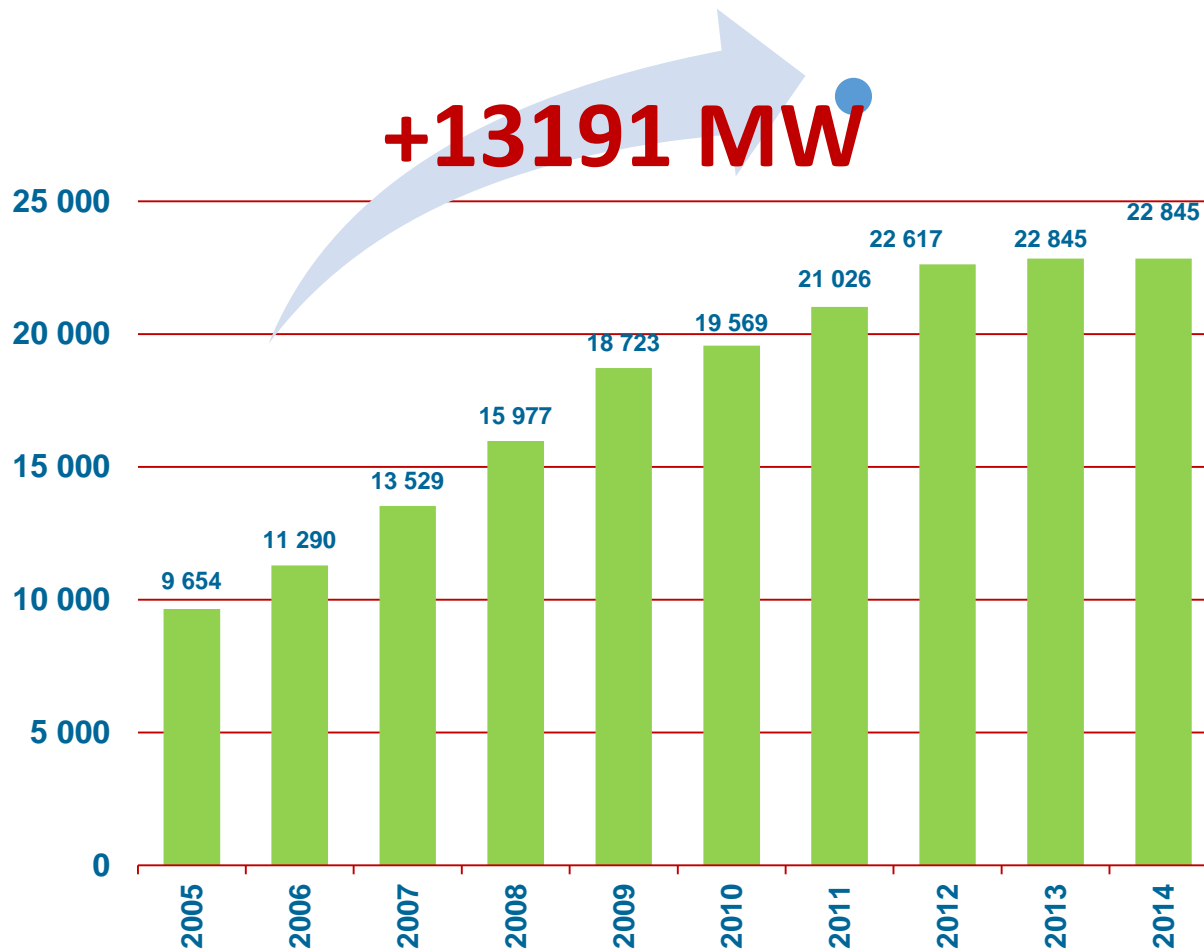


Thermoelectric



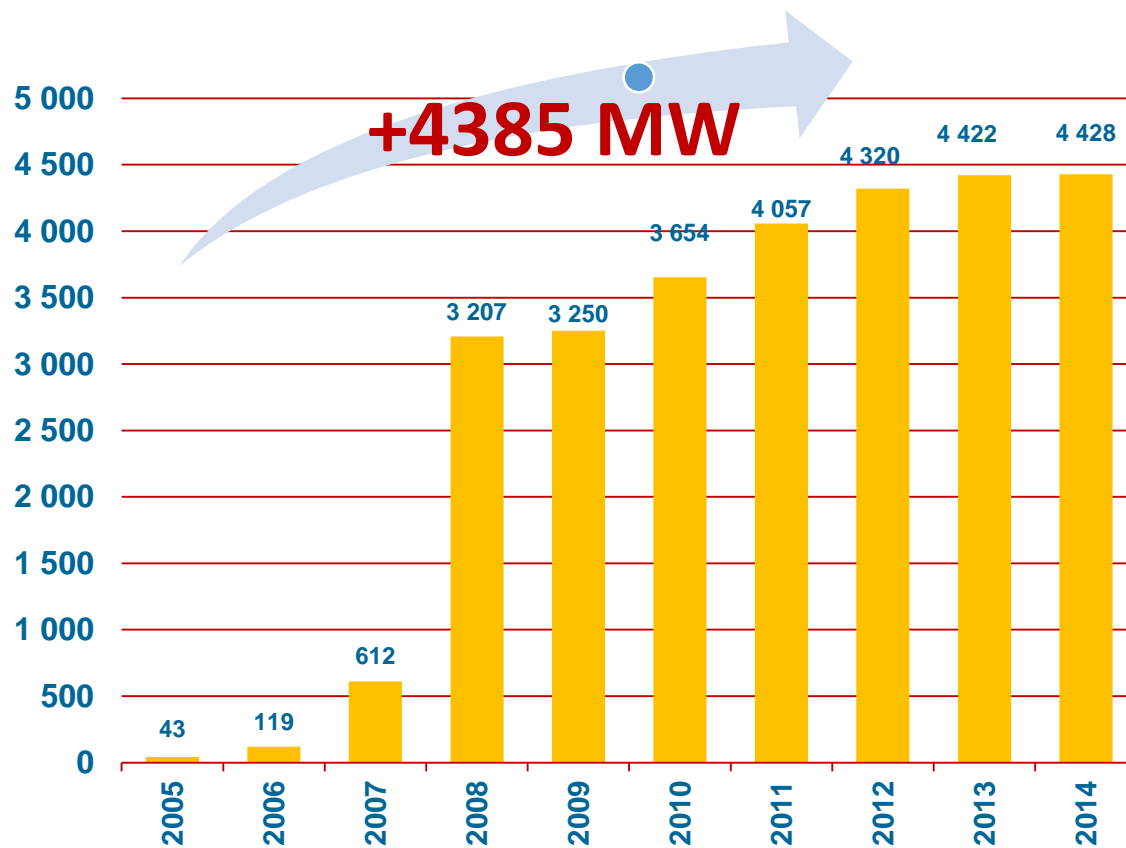


# Development of wind power

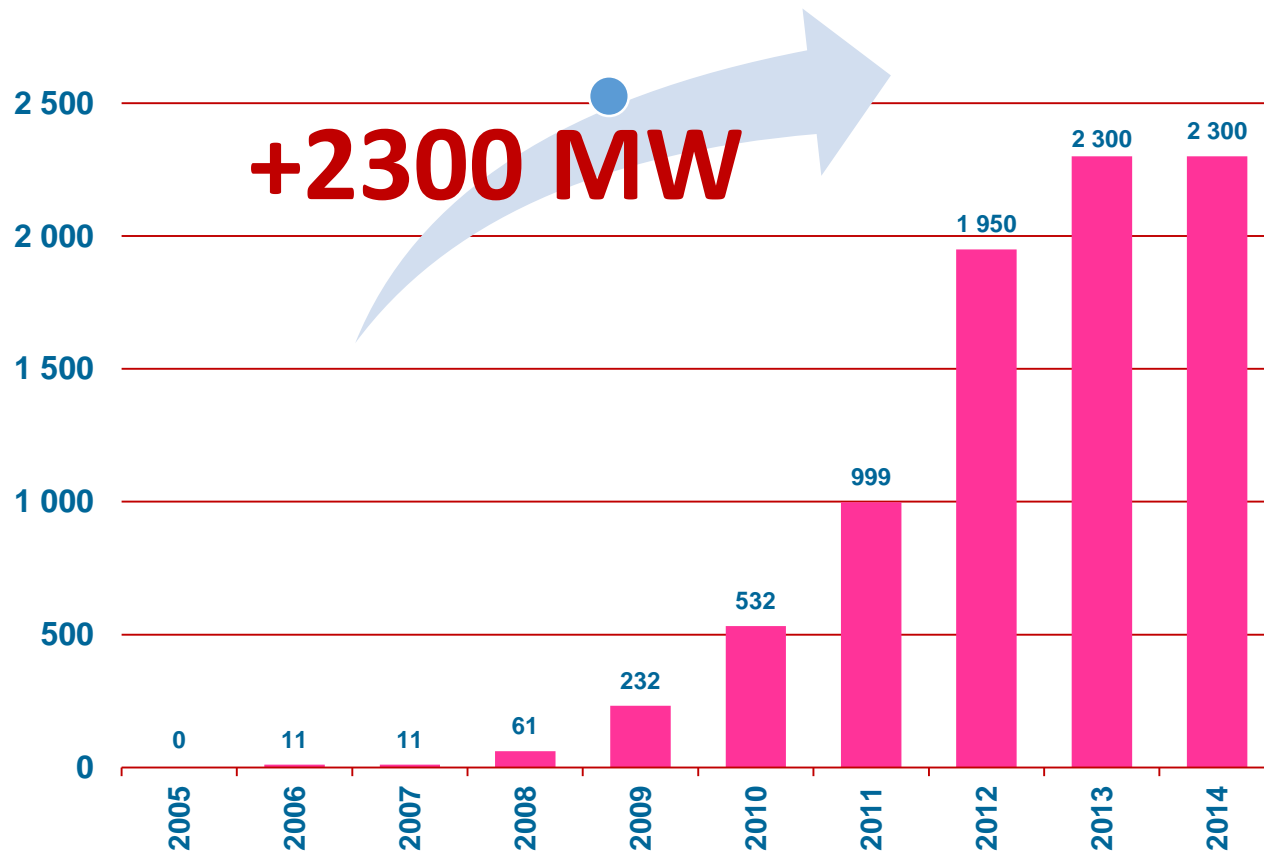




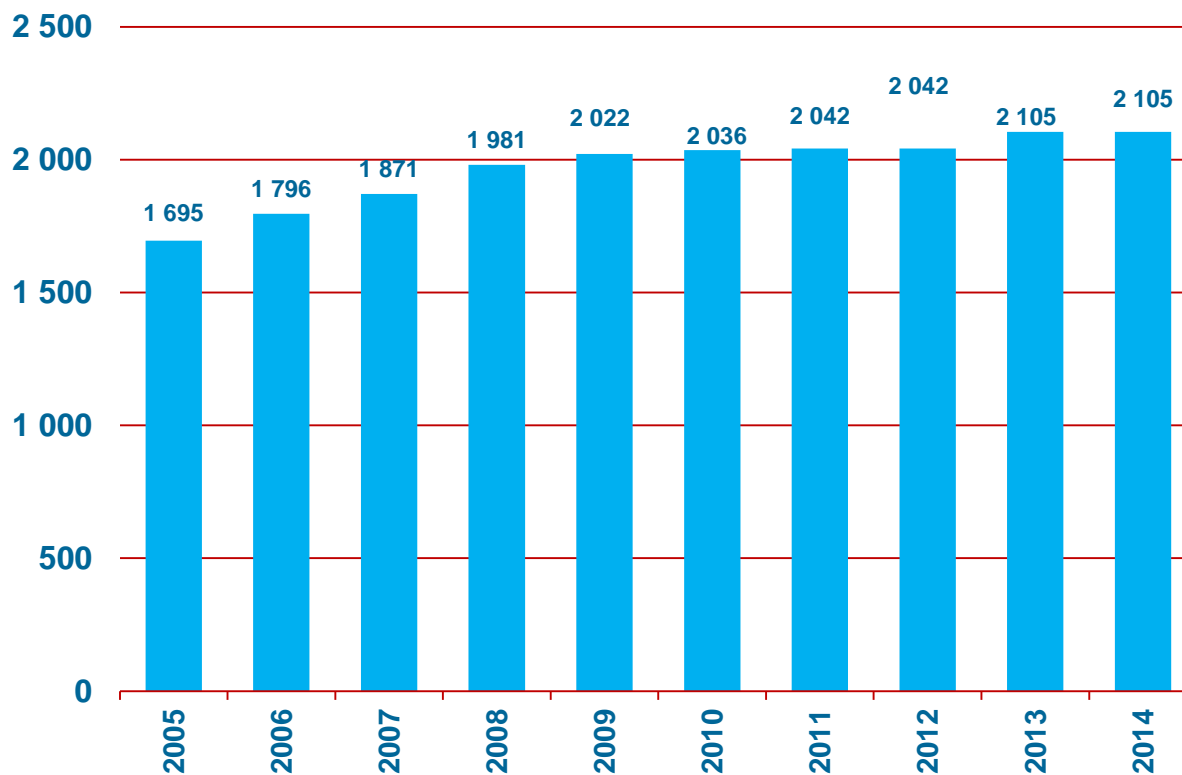
# Development of photovoltaic power



# Development of thermoelectric power

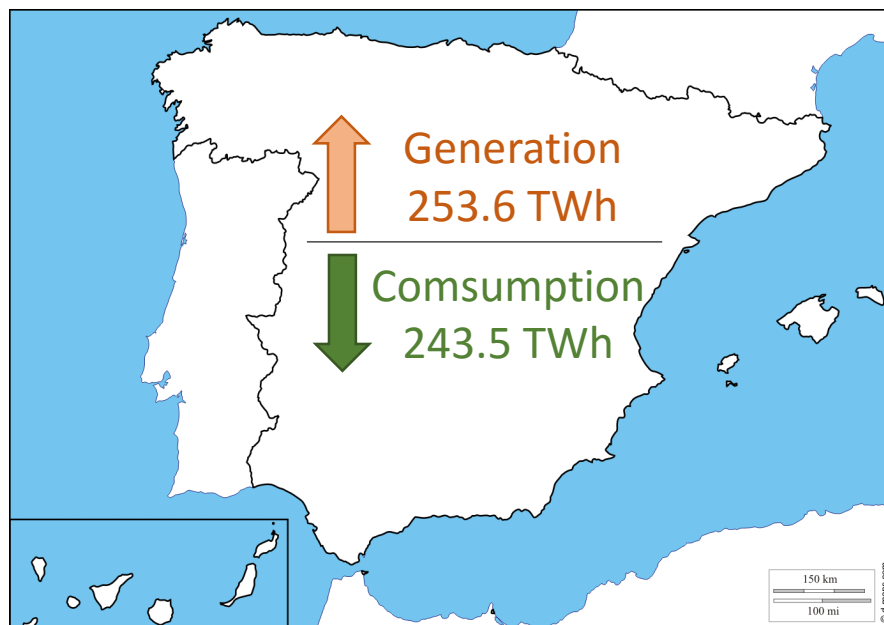


# Development of mini-hydro power



# Power balance in 2014

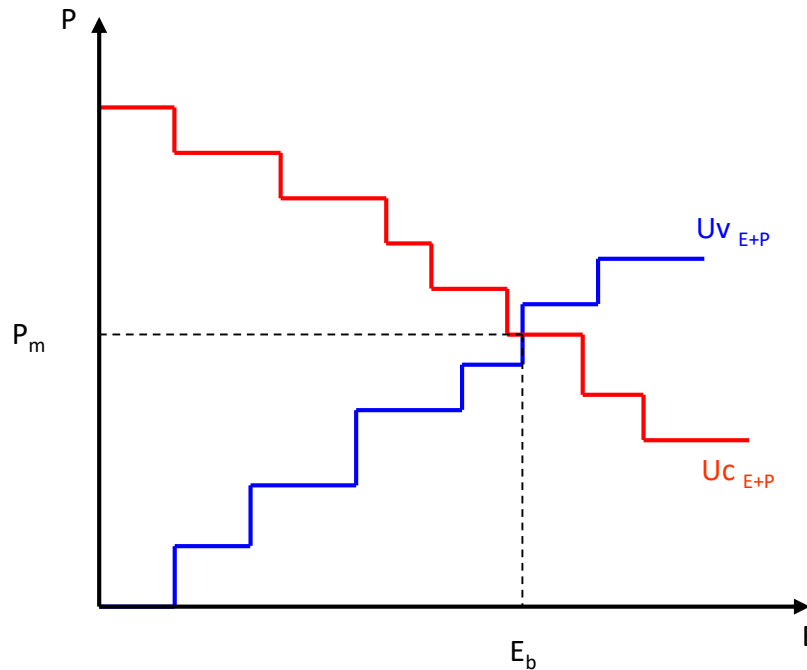
- ❑ Generation (TWh): 253.6
- ❑ Consumption (TWh): 243.5
- ❑ International Imports (TWh): 3.6
- ❑ International Exports (TWh): 7.0



# Market coupling

## □ Day-ahead market: MIBEL

No congestion Spain-Portugal



# Market splitting

## □ Day-ahead market: MIBEL

*Market Splitting: Congestion (i.e. Spain→Portugal)*

