

## Spain electric grid

From generation to final consumption, the electricity system encompasses all the phases that electricity goes through. It is a complex process that involves multiple stakeholders, a system that continues to generate doubts even though it is such a prevalent part of our lives. Everyone has heard the famous phrase, "If they have explained the Spanish electricity system to you and you understand it, they have explained it badly". Let's get started!

The Spanish electricity system took a regulatory turn in 1997 with the Electricity Sector Law 54/1997, amended by Law 24/2013, which restructured and separated all the activities involved in this process. Energy generation, transmission, distribution and commercialisation became separate and independent activities.

As the name suggests, the first step is to produce the electrical energy that reaches the end consumer. The places where energy is generated are called power plants, with varying degrees of efficiency depending on their type. When it comes to renewable energy, these power plants include wind farms, photovoltaic plants, hydroelectric power plants, solar thermal power plants, biomass plants and biogas plants.

In Spain, electricity generation is regulated by the State, but it is liberalised, which means that any person or company can generate electricity, feed it into the grid and sell it.

Spain has also been a benchmark in integrating renewables into the electricity system. Specifically, in 2021, electricity generation in Spain emitted 35.96 million tonnes of CO<sub>2</sub>, compared to 36.13 million tonnes in 2020. This figure is expected to continue to improve in the coming years, considering the objectives adopted in the PNIEC, where it is forecasted that 74% of electricity generation will be produced from renewable sources by 2030.

The electricity travels from the power plants, through the transmission network (large high-voltage towers), to the electricity distributors' substations. This directly conditions the rest of the phases of the electricity system since electricity needs to be transported to the distributors as soon as it is generated.

In addition, the challenges of large-scale electricity storage mean that production is subject to demand, so all unconsumed energy must be exported. An algorithm based on this demand accurately estimates the generation needs for the future.

Before feeding the energy into the transmission grid, the voltage is raised from the generation voltage--which generally ranges between 6-18 kV--to the transmission grid voltage, which can be 110, 132, 150, 220 or 400 kV. This step is performed in large transformer substations downstream from the power plants for reasons of efficiency; the higher the voltage at which the electricity is transported, the lower its intensity, and therefore the losses in the form of heat in the conductor cable, something known as the "Joule effect".

Red Eléctrica de España (REE) is the sole manager of the transmission grid. Its responsibilities include the operation and maintenance of the transmission grid, its extension and the real-time management of electricity demand, with ongoing communication with generators so that they can start up or stop according to demand. REE also provides information on interconnections, the unavailability of generators and forecasts of the energy that will be generated.

In this third phase of the electricity system, the transmission grid usually takes electricity to areas close to population centres, where an electricity substation reduces its voltage to levels that normally range from 1 to 66 kV (occasionally, there are also sections of the distribution grid at voltages of 110, 132 or 150 kV). The distribution grids are then connected from these substations to homes, businesses, and industries that require electricity.

In this phase, energy is sold to end customers. The distributors buy energy on the power exchange or reach bilateral agreements with generators to buy and subsequently sell energy to customers at an agreed price. Commercialisation is liberalised, and anyone can create a commercialisation company. There are two types of distributors:

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