



WHY WE ARE SUSTAINABLE? (PHOTO CREDIT: JOSE LUIS RODRIGUEZ)

## SPAIN

Renewable sources-based power supply in Spain reached 44% of total power consumption in 2020. (Total power demand declined by 5.6%).

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**T**hroughout 2020, wind power was the second largest source of electricity generation in Spain, with a relative generation growth of up 5.8%.

According to the Spanish National Integrated Energy and Climate Plan 2021-2030 (NECP) the government is committed to reach about 50,258 GW of installed wind capacity which means about 28.86 billion EUR (35.29 billion USD) to meet European targets for 2030.

The Spanish wind sector installed 1,720 MW during 2020 [1], which is accounts for 10% of all new wind

TABLE 1. KEY NATIONAL STATISTICS 2020: SPAIN

Total (net) installed wind power capacity*	27,445 GW
Total offshore capacity	0,005 GW
New wind power capacity installed	1,720 GW
Decommissioned capacity (in 2020)	GW
Total electrical energy output from wind	53.64 TWh
Wind-generated electricity as percent of national electricity demand	22.68%
Average national capacity factor**	23.0%
Target (by 2030)	50,26 GW
National wind energy R&D budget	108 million EUR (132 million USD)

\*Installed wind power capacity: Use nameplate power ratings of the installed wind turbines.

Only include turbines in operation the whole year: **(MWh production/8,760 hrs) / MW installed capacity**

MWh total electrical production from wind turbines operating 1 January through 31 December divided by 8,760 hrs divided by the total installed wind capacity (in MW) at the beginning of the year.

capacity in Europe in 2020. Wind power has become Spain's the number one technology (24.67%) regarding installed power capacity on the Spanish peninsula. Spain was the number seven in Europe in new investments with investment decisions in new onshore wind farms totalling 1.5 billion EUR (1.83 billion USD).

In December 2020, the draft of the Spanish Marine Space Management Plan (POEM)—crucial for the future offshore wind deployment—was presented, and a new Royal Decree to regulate the access and connection of offshore wind to the electricity transmission and distribution networks also entered into force.

National investments for wind-related R&D totalled 108 million EUR (132 million USD) in 2020.

## Market development

### Targets and policy

By the end of 2019, the Spanish government announced its final draft of the National Integrated Energy and Climate Plan 2021-2030 (NECP) [3], raising the country's ambitions on greenhouse gas emission (GHG) reduction to 23% compared to 1990 level and 28% renewables share through electrification and transport. That plan established that the combination of all renewables will amount to 120 GW of total installed

capacity by the end of 2030. This capacity will translate into 74% renewables share in electricity generation and 42% share of renewables in the final energy consumption.

This goal should set Spain on track to achieve a 90% reduction in gross GHG emissions by 2050 compared to 1990. By then, Spain's power system is expected to operate on 100% renewable energy.

The NECP 2021-2030 proposed wind capacity growth is presented in the table below.

### Progress and operational details

Spain installed 1,720 MW of new wind power capacity in 2020. These installations included 1,051 in Aragon, 216 MW in Castille and Leon, 65 MW in Castille La Mancha, 24 MW in Galicia, 24 MW in Andalusia, 263 MW in Navarra, and 29 MW in the Canary Islands

Land-based wind power capacity increased by 1,720 MW to 27,445 MW in 2020, comprised of 1,267 Wind Farms which include 21,431 Wind turbines. Wind-based electricity generation was responsible for 53.64 TWh/yr, representing 22.4% of total electricity generation (which experimented a reduction of 5.6% due to pandemic). Wind-based electrical generation decreased 1% from 2019 due to a lower-than-average wind year,

Capacity MW/Year	2015	2020	2025	2030
Wind Energy (on & offshore)	22,925	27,968	40,258	50,258

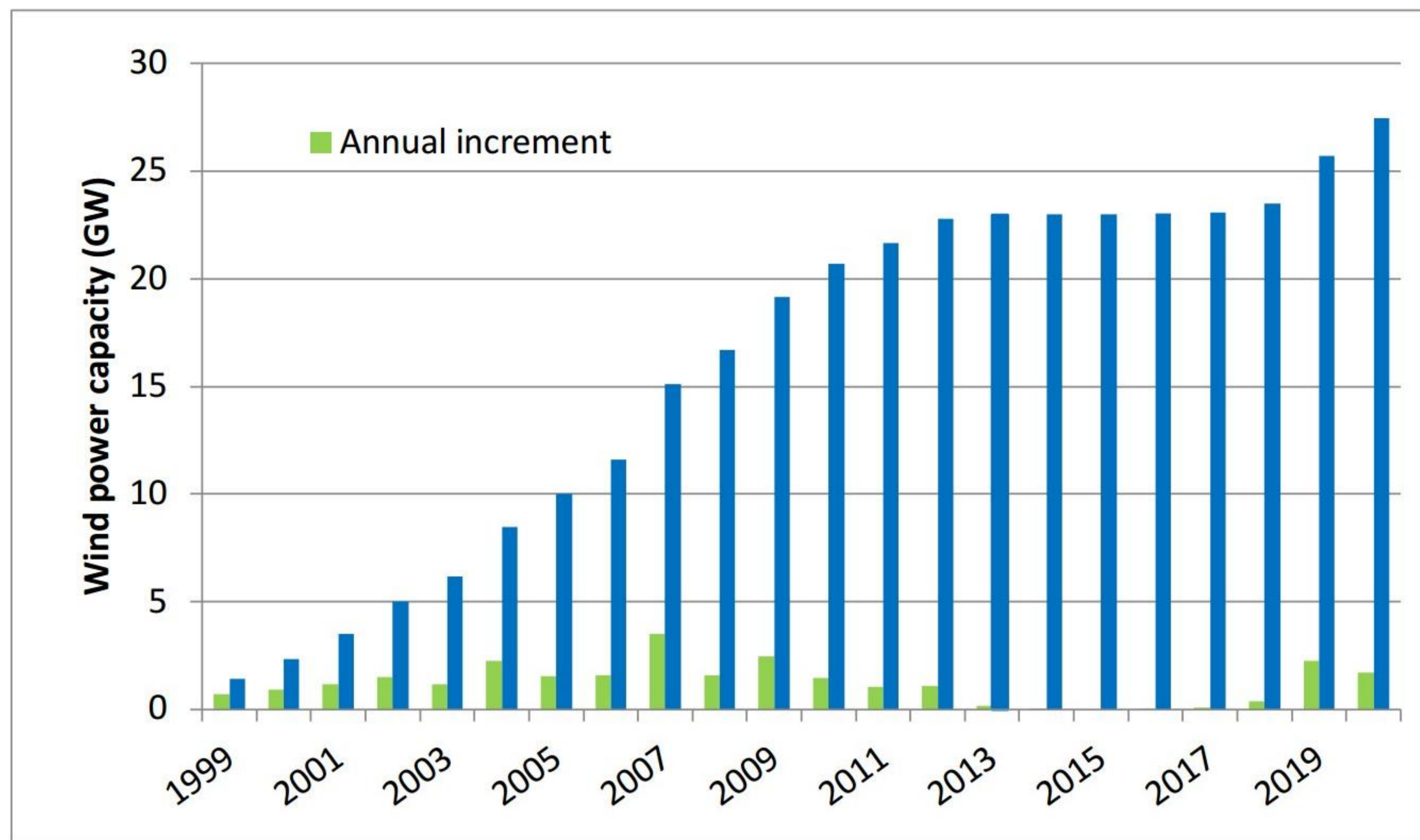


FIGURE 1: ANNUAL AND CUMULATIVE INSTALLED WIND POWER CAPACITY IN SPAIN (SOURCE: AEE)

but remained the second-largest source of electricity generation in Spain (Figure 2).

In Spain, the participation of wind power in balancing services started in 2016, and by the end of 2020, 16.7 GW of the total 27.4 GW wind power capacity installed in Spain had successfully passed the Operational Capability Tests (OCTs) [4]

**Matters affecting growth and work to remove barriers**

In the beginning of 2020, Spain had a backlog of more than 430 GW worth of requests for grid access. The Government considers that some of these projects are speculative ventures given their immaturity and

the fact that around 60% of grid access holders have not applied for a corresponding connection permit. These circumstances make it more expensive to realize sound projects that will significantly drive investments and create jobs. To help solid projects get ahead, in June 2020 the Government set up a Royal Decree Law 23/2020 which sets deadlines for each milestone in the permitting chain, which project developers have to meet to obtain the next permit. Failing that, any granted permits will expire automatically and deposited financial guarantees will be lost. In all, developers have five years to complete the whole process. Within three months following the RDL’s entry into force, permit holders can exit the chain and claim their deposits. In the meantime, the RDL imposes a moratorium on new requests for grid access until these permits are further regulated. New regulation on access requires developers to present projects in mature stages and previous studies.

Another law, the RD 1183/2020, was approved in December 2020 in order to face up to the new reality of the power sector with the regulation of the access and connection to the electricity transmission and distribution networks with the intention of adapting to EU requirements.

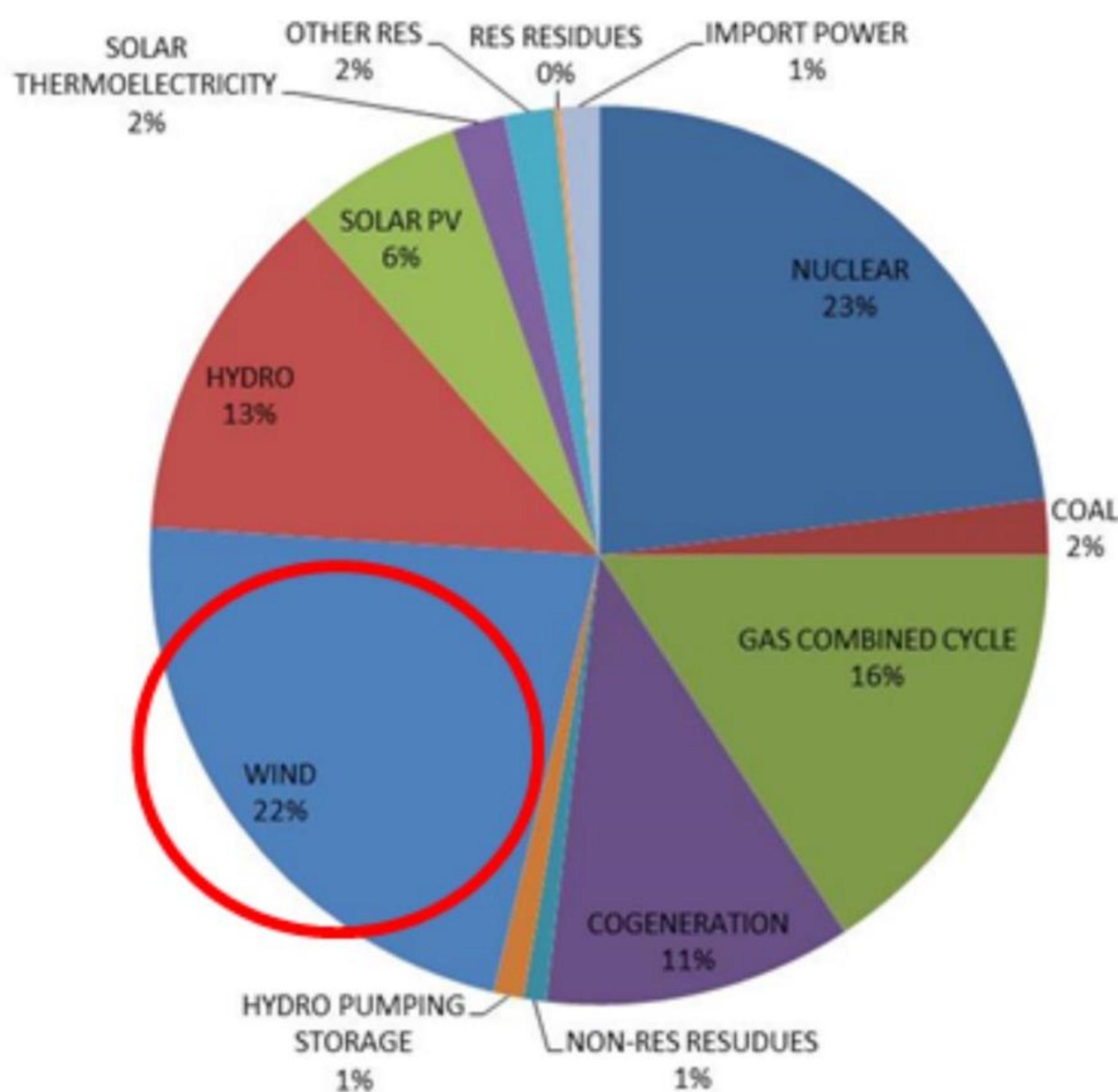


FIGURE 2. SOURCES OF THE 2020 POWER SUPPLY IN SPAIN (SOURCE: REE)

Wind Power is now the number one technology: 25.5% of the total installed power capacity of 105 GW in the Spanish continental power system.

Considering that these two laws that have already been approved, the lack of harmonization of the procedures for obtaining permits in the different Autonomous Communities, and the limitations of the administration to manage a large number of requests and claims over time, growing concern from developers is anticipated regarding project due dates.

## R,D&D activities

### National R,D&D priorities and budget

In September 2020, the Spanish Science, Technology and Innovation Strategy 2021-2027 [7] was approved with the main objective of doubling the amount of public and private investment in R&D+i to 2.12% of GDP by 2027.

The Spanish government considers wind energy a national priority. R&D activities primarily focus on land-based applications: increasing O&M cost competitiveness, extension-of-life strategies for wind farms, optimized manufacturing process, etc. Offshore wind R&D activities are increasing, especially for floating applications. National investments in wind energy R&D amounted to 108 million EUR (132 million USD) in 2019. This budget is slightly higher than in the previous years.

### National research initiatives and results

According to the EU Implementation Plan, the main targets of Spanish R&D are the reduction of the LCoE for onshore and offshore wind turbines by improvement of the performances of the entire value chain and the development of cost competitive integrated wind energy systems including substructures which can be used in deeper waters (>50m) at a maximum distance of 50 km from shore with a LCoE of less than 0.12 EUR/kWh (0.14 USD/kWh) by 2025. In this sense, several R&D projects have been funded in 2020 by the Spanish innovation agency CDTI in line with the main target, e.g. the TOTEM Project addressing technologically improved towers and the LEON Project focused on new electric technologies for onshore wind turbines, both of them coordinated by Siemens Gamesa. Also the project FUTUREGEAR in order to develop a technological demonstrator for the next future gear generator, coordinated by Siemens Energy Transmission. Regarding floating offshore wind, the LEAF Project, aimed at Spanish leadership within floating offshore wind development, has been funded by the new Misiones-CDTI instrument. This cooperative project includes the following partners: Esteyco, S.A; Nautilus Floating Solutions, Exponential Renewables, Saitec, and Enerocean. Two more R&D projects related to floating offshore wind have been funded: the FOW-TLP-C2S Project focused on developing an offshore floating wind innovative rigid pipe TLP mooring system. This is a joint partnership

between Bluenewables, S.L. and Tubacex Servicios de Gestion S.L.. The WIND-BOS Project focused on developing a Wind Farm BOS Plan individually developed by the company Bluenewables S.L., and the BERIDI Project for developing innovative engineering solutions for the offshore wind market. This project is developed by the company Beridi Maritime, S.L. Finally, few projects related to wind energy have been funded by the Spanish Research Agency (AEI) in 2020. Only one project titled GreenKite2, addressing the modelling and flight testing of airborne wind energy and traction systems lead by the UC3M.

“The draft of the Spanish Marine Space Management Plan has been launched for public consultation, demonstrating the availability of significant renewable energy potential in Spanish waters.

### Test facilities and demonstration projects

The first Spanish floating wind platform prototype developed by the company Saitec Offshore Technologies was installed at a testing site in Santander Bay (Spain), 800 metres off the Cantabrian coast. The 1:6 scale ‘BlueSATH’ offshore wind prototype has a prestressed-concrete floating base with two hulls and is affixed to the seabed with a single-point mooring. The base is designed to swing about the mooring like an FPSO in order to optimize power generation in changing wind conditions. Like other concrete-base floating offshore wind designs, the SATH (Swinging Around Twin Hull) concept is intended to maximize local content and local labour involvement during construction. This technology is an innovative, competitive, and cost-efficient solution for the offshore wind industry which has been validated in several water tank tests since 2014. The prototype commissioning was successfully completed in September 2020. Two months later, when the prototype had completed its planned test cycle for the year and was waiting for a tow back to shore for the winter season, the heavy Epsilon storm crashed into Spain’s northern coast when ten-metre-high waves broke and capsized the wind turbine prototype. After results from the BlueSATH test were analysed, the decision was that a larger 2 MW prototype—the DemoSATH—will be built by Ferrovia Construction for Saitec and utility customer RWE Renewables. The 90-foot by 210-foot structure will be assembled in the Port of Bilbao and will be towed out to a test site about two miles off the port at a water depth of 85 metres. It will be moored using anchors connected by a hybrid system of chains and fibre lines. The start of the operations is scheduled for early 2022.



FIGURE 3: BLUESATH FLOATING WIND PLATFORM. 1:6 SCALE PROTOTYPE

### Collaborative research

Spain serves as Operating Agent for IEA Wind TCP Task 31: Wakebench: Benchmarking Wind Farm Flow Models. Spain also participates in:

- o Task 11: Base Technology Information Exchange
- o Task 25: Power System with Large Amounts of Wind Power
- o Task 30: OC6 Offshore Code Comparison Collaboration, Continuation with Correlation
- o Task 34: Environmental Assessment and Monitoring
- o Task 37: Wind Energy Systems Engineering
- o Task 40: Downwind Wind Turbines
- o Task 41: Enabling Wind to Contribute to a Distributed Energy Future

### Impact of wind energy

The demand for electricity in Spain has suffered a decline, particularly due to the COVID-19 pandemic, which has slowed economic activity. Specifically in 2020, electricity demand stood at 249,819 GWh, 5.6% lower than the previous year. In terms of generation, renewable production reached an all-time high of

110,450 MWh, a 44% share of the electricity generation mix in 2020 (37.5% in 2019).

In this regard, it should be noted that wind power generation accounted for more than one fifth (21.9%) of the national generation mix. The average electricity price for January-June 2020 was 28.98 EUR/MWh (35.44 USD/MWh) reaching the floor of 10 EUR/MWh (12.23 USD/MWh) in April, 39% lower than the last year. This reduction was caused mainly by the COVID-19 effect, but also by the huge wind energy production. According to AEE report [2], the reduction of electricity wholesaler market price due to the wind energy production amounts 1.292 billion EUR (1.580 billion USD), around 5.26 EUR/kWh (6.43 USD/kWh)

### Environmental impact

According to AEE [2], during 2020, wind energy prevented the emission of 29 million tons of CO<sub>2</sub> (11.3% of the total CO<sub>2</sub> emissions).

### Economic benefits and industry development

The Spanish wind sector employs 30,000 people annually. More than 240 companies work in Spain in 16 of the 17 Autonomous Communities. Wind Energy directly and indirectly contributes 4.07 billion EUR (4.97 billion USD) to the GDP, which represents 0.35%. The sector accounts for 0.83% of total exports, around 2.062 billion EUR (2.449 billion USD), in 2020.[2]

There are currently installed 1,267 wind farms in 812 municipalities.

The main wind turbine suppliers were Siemens Gamesa ER, Vestas, GE RE, Nordex-Acciona WP and Enercon.

The average rated power of the 2020 installed wind turbines was 3.46 MW.

Spain ranked seven in Europe in new investments with investment decisions totalling 1.5 billion EUR in new onshore wind farms covering capacity of 1.72 GW.[5][6]

The total wind energy sector R&D investments accounted for the 4.19% of its total contribution to the Spanish GDP (108 million EUR /132 million USD) with around 1,203 related patents applied within the period 2004-2019.

A new cartographic tool for zoning the territory based on the foreseeable impacts that they may present for the implementation of renewable energy projects, specifically, wind and solar PV.

### Next term

The onshore wind energy domestic market in Spain is probably going to be one of the most exciting in Europe over the next decade. The commitment to the Integrated National Energy and Climate Plan 2021-2030 NECP 2021-2030 which targets 24.26 GW of new wind capacity in ten years, guarantees at least 3 GW/year. The new auctions currently under management confirm the future situation. Even the progressive reduction of the cost of energy produced with onshore wind farms is allowing the promotion of viable 100% merchant wind farms in windy areas in Spain. In addition, between 10 and 15 GW of wind capacity is expected to be repowered during the next decade.

Despite the lack of offshore wind targets in the NECP 2021-2030, some initiatives are emerging such as the company Greenalia, which has started in 2020 the procedures for the development of five 50 MW floating offshore wind farms in the Canary Islands.

Regarding R&D activities a new plan has been launched by the European Commission to tackle the effects of the COVID-19 crisis. This Recovery, Transformation and Resilience Plan is the key instrument for the Next Generation EU Funds, which will play a crucial role in

helping Spain emerge stronger from the crisis, and securing the green and digital transitions. This plan includes projects in prioritized R&D areas like wind energy. For this reason, the R&D activity in the next years seems really exciting.

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