

Case Study

From coal desert to wind farm powerhouse

Lessons learnt from Teruel
region in Aragón, Spain

Initiative for coal regions in transition

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From coal desert to wind farm powerhouse: lessons learnt from Teruel region in Aragón, Spain

Spain has emerged as a frontrunner in the global wind energy sector, boasting the fourth-largest installed capacity worldwide. The arrival of renewable energy as the main energy source of the future is particularly evident in the region of Aragón and its former coal region of Teruel, which is on the way to transform itself into a renewables powerhouse. However, the rapid construction of giant wind turbines has sparked controversy, raising concerns about the quick changes of landscapes, how much local communities benefit, and long-term effects for the region. While the energy transition in the region is ongoing, the case of Aragón provides insights into success factors and barriers that provide lessons for other coal regions in transition.

DESCRIPTION

Location: Teruel region in Aragón, Spain

Type of action: Wind farm development projects

Actors: Federal government, regional government, local government, wind industry, citizen organisations

Financing conditions: EU funds, national funds, but mostly private investments



KEY POINTS

APPROACH

- Understanding **good wind conditions and available space as assets**, and thereby viewing wind energy development as bringing economic activity, profits for municipalities and jobs to rural regions, including to the former coal region of Teruel in Aragón, Spain

CHALLENGES

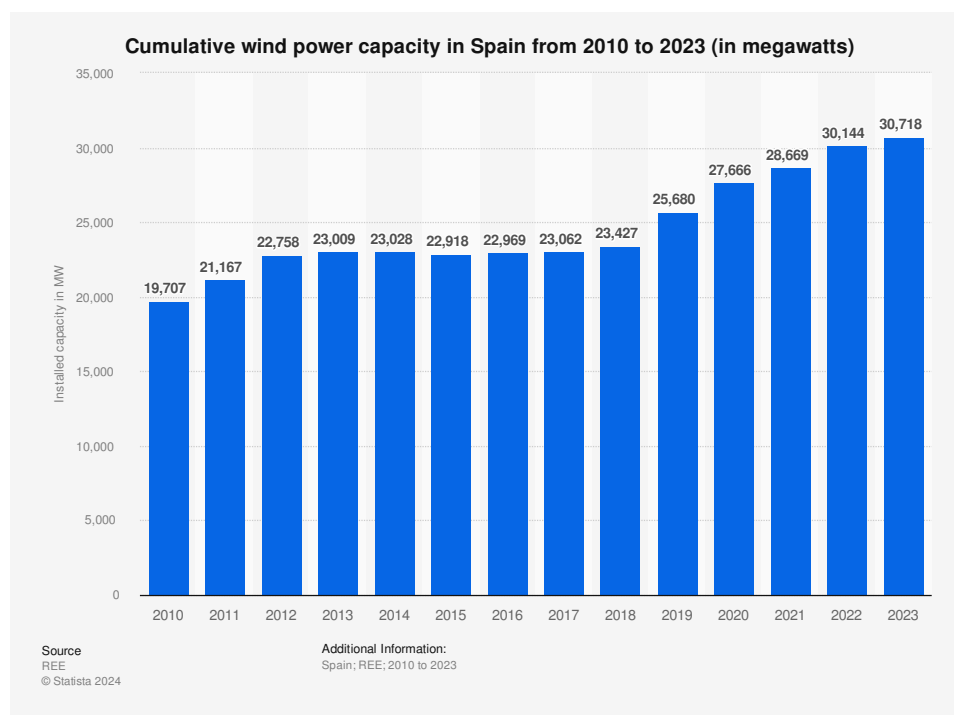
- It remains challenging to navigate the best ways to approach **public resistance against wind farms**, and especially in an emotional debate about landscapes and distributive justice of energy production, **and ensuring that municipalities and regions benefit enough** from the new renewables boom
- While setting new framework conditions led to an overall increase in wind energy development in Spain, the experiences in Teruel show that **problems can lie in the details**, e.g. on auction framework conditions, approval procedures, and environmental effects
- Coordination between political levels** and administration is not yet sufficient enough to leave no one behind

ENABLING CONDITIONS

- Enough **land** and favourable **wind conditions**
- Ambitious **climate targets** and a **national policy framework (CfD auction mechanism)** that make renewable energy development a business case
- Functioning and fast administrative processes**, including enough capacity at national, regional, and local levels, even though this is becoming more challenging
- Local communities included in territorial planning processes** and benefit at least partially from the revenues of wind farms.

ACHIEVEMENTS

- Installation of **4,200 MW of wind energy capacity in Aragón**, so far achieving a CO₂ emission reduction of 4.5 million t, and an estimated creation of 5,500 jobs, fully substituting former coal jobs
- Since the first wind farms were developed, **wind turbine manufacturing** has also been established in the region, thereby bringing in additional construction and maintenance jobs



Source: [Statista](#) based on Red Eléctrica Spain.

Introduction

While most new wind farms in Aragón are located near the City of Zaragoza, the province's main urban centre, the former coal mining region of Teruel has also developed quite some wind power projects. In 2022, the region had 175 wind farm parks representing 5,000 megawatts (MW) of installed capacity. The only Spanish region with more installed wind power than Aragón is Castilla y León (6,400 MW), which is twice as big by area. The success of Aragón's wind energy sector can be attributed to a combination of factors, including favourable natural conditions, supportive government policies, as well as lots of available land.

As an early leader in this technology, Spain's installed wind energy capacity grew steadily from the early 2000s until 2012 (see figure above), guided and incentivised by national feed-in tariff legislation initially introduced in 1997. In 2007, a revision of the law resulted in an additional wind boom; however, the changes also had flaws that led to a tariff deficit in the energy market system. Among other effects, it became unclear who would pay for rising subsidies, which eventually led to an end of the feed-in tariff system. After years of stagnation, the trend of increasing wind energy production continued in 2019, when legislative changes in Spain's National Energy and Climate Plan (NECP) for 2021-2030 introduced auctions as the main policy tool for scaling-up renewable energy development. This new legislation restarted another stark increase in renewable energy development that has continued until today.

Enabling conditions

Compared to many other countries in Europe, Spain has set relatively ambitious goals to decarbonise its economy and transition towards a sustainable future. Wind energy, with its vast potential in the country and proven track record, is a cornerstone of this strategy. By 2030, 74% of electricity generation should come from renewables and 100% by 2050. In order to reach that target, Spain aims to reach 62 GW of installed wind energy capacity by 2030 (up from 28 GW in 2022).

To reach these goals, Spain has set new framework conditions for the energy market to make a business case for investments into wind energy and other renewables, while simultaneously ensuring energy security and price certainty, and learning from mistakes made during previous phases of renewable energy policy.

The main policy tool to promote renewable energy source (RES) development is an auction scheme called "Régimen Económico de Energías Renovables" (REER)¹, also known as a Contracts for Difference (CfD)² feed-in premium. This CfD-model is furthermore discussed within the EU electricity market reform as the main tool for RES development.

1. For a detailed case study about the CfD and auction policy mechanism in Spain and other countries, see <http://aures2project.eu/case-studies/>
2. Contracts for Difference describe a financial incentive that enables stable consumer prices for a longer period and are at the same time a derisking mechanism (for example) for power producers that have to face high upfront costs when building up new energy capacity. The details of the Spanish application of the CfDs and the auctioning model can be [read here](#).

While the awarded power capacities in the first years after introducing the auctions were too low to be in line with Spain's overall energy goals (the 2023 tender only offered 1.5GW), stakeholders in the energy and climate sectors have nonetheless praised the mechanism as a functional way of organising renewable energy development. Overall, the new legislation is considered the main enabling condition for the recent wind energy boom in the country, as well as in Aragón and Teruel in particular. There are, however, also critical voices coming from local parties and citizen groups, who criticise the system for mainly benefiting large companies, while increasing barriers for smaller companies and energy communities to participate in tendering processes.

Former coal regions in Spain also benefit from additional tender processes set up by the national Ministry for the Ecological Transition and Demographic Challenge under just transition legislation put into place in 2020. The first tender under this process was for the development of renewable energy, with specific requirements for bidders regarding the involvement of former power plant workers, female employment creation, training provision, and other measures that support just transition (see box).

While auctions for wind development are set-up and processed mainly at the federal level, the sub-national level (autonomous communities) authorises smaller energy projects up to 50MW installed capacity³, and holds the mandate for broader territorial planning.

The continuous development of wind energy (and solar PV) has been identified as an asset of the region and a chance to provide jobs and income for its inhabitants. Since the first wind farms were developed, wind turbine production has also come to the region, bringing in construction and maintenance jobs. Hence, besides natural enabling conditions, the possibility of producing wind turbine on site represents another enabling condition for Aragón, stressing further the importance of producers and skilled workers for a successful energy transition.

Key challenges

While the wind energy boom in recent years has been considered a positive development by many in Teruel and in Spain, with more and more wind farms appearing across the country, there has also been an increase in protests against further wind energy development projects.

While in more densely populated areas like Germany, the main resistance against wind energy is caused by direct neighbours who fear direct effects such as shade or noise, in Aragón the impetus appears to be slightly different. As Aragón and especially the former coal region of Teruel,

³ This administrative procedure has also led to some controversies in the last years, as developers split up bigger wind farms into smaller neighboring parks to avoid falling under national regulations, as sub-national legislation, including in Aragón, have been reported to be less strict e.g., on environmental protection.

Ensuring projects are in line with just transition goals by defining additional selection criteria for renewable energy projects: a case from the Municipality of Andorra, Aragón

In June 2020, the Spanish government, through the Just Transition Institute ([Instituto para la transición justa, ITJ](#)), announced a tender specifically targeting the area near a closed coal-fired thermal power plant in Teruel for the installation of renewable energy. The tender incorporated several additional environmental and social criteria that should soften the negative side-effects of the closure of the power plant.

Objectives:

- Providing alternative job opportunities for former power plant workers
- Increasing female employment creation
- Creating employment in the industrial sector
- Providing vocational training for unemployed people
- Promoting self-consumption of electricity
- Promoting participation of local investors

The first tender in Teruel was the Andorra node, bidding for 1,200 MW. In November 2022, the 1,200 MW released were awarded to one power company selected from 12 applicants. The project foresees the investment of more than 1.5 billion EUR to install 1,800 MW of renewable energy in the area. To meet these objectives, seven wind farms will be created, and another seven solar power plants. Additionally, to deal with potential surplus energy from wind, an electrolyser will be installed to produce green hydrogen. A synchronous compensator will also be set-up to deliver higher quality and more stable renewable energy, thus contributing to the proper functioning of the electricity grid.

[Read more](#)

are among the least populated areas in Europe, distances between settlements can be large enough to negate those direct fears. Instead, resistance from local communities against wind farm development is mainly caused by a fear that the overall landscapes of the region are changing (which is widely framed as “destruction” of landscapes), leading to negative impacts on tourism, and further depopulation. The latter has been an ongoing problem in the region for decades, which may explain why wind farm development has become quite an emotionally charged debate in Spain⁴.

⁴ In fact, the public debate about pros and cons of renewables has been much more intense in Spain than in any other country in Europe so far.



Protests against the “Cluster Maestrazgo” wind energy project have been held all over the Teruel region, opposing the project due to environmental concerns and changes to landscapes.

Source: Teruel Existe

While Aragón is becoming one of the powerhouses of Spain, other autonomous regions have realised substantially fewer renewable energy projects (partly, but not only, due to less favourable conditions), contributing less to the energy transition. Even though the regional government of Aragón believes in the positive outcome of this wind energy boost for the region, in fact main beneficiaries of the wind energy boom are the energy companies that have invested in the region, therefore some political groups are raising questions about the [distributional justice of wind parks across the country](#). Some groups have also criticised the administrations of [not paying enough attention to environmental side effects](#) of wind farm development on wildlife and biodiversity, filing complaints regarding project approval processes. The Maestrazgo project, pictured below, is one such case. Regardless of whether these arguments are considered valid or not, and which narrative one may follow, the debate has surely influenced the political landscape of the region and may appear in other regions as they too develop renewable energy projects on a large scale.

One way to address resistance from local communities has been to increase efforts to show the positive community benefits of wind farms (see achievements section, below). Another recent approach has been to tender more community energy projects, to ensure that the wind energy developments are not only perceived as forced upon from top-down national decision making and big companies. Nonetheless, wind energy projects will likely continue to be a controversial topic. The debate about wind energy also used as a hallmark for a much bigger debate about how much a region can and should change, how tradition can be translated into modern society, and who benefits and loses within a sustainable transition.

While public resistance is a main challenge in the region, there are also more technical challenges. The latest renewable auction by the federal ministry only awarded 46MW of 1.5GW that was tendered out – which has been largely criticised as not enough to reach climate goals – due to insufficient consideration of higher production costs, which led most developers to bid above the threshold price of 47€/MWh⁵. This exemplifies one of the problems of the CfD-mechanism, requiring governments to set a functioning price cap that is not too high to enable low energy prices, but not too low to hinder the final realisation of the project. On top of that, time pressure is a challenging factor, since there is little time left to fulfil climate targets, short timeframe for project developers to apply for the auctions, and for public authorities to process, check and evaluate the bids in each tender. In Aragón, the regional authorities aim to establish fast-track procedures for renewable energy and to lower administrative procedures, yet [still struggle with the pace and workload of the renewables boom](#).

On the governance side, there is a strong need for vertical coordination among political and administrative levels to ensure coherence of policies. While the ability to set-up regional policies can be an enabling factor for renewable energy development in the region, some local communities and civil society groups have criticised the lack of coordination between the levels of government, saying this makes wind energy projects less well embedded into local territorial planning.

⁵ In 2021, the prices in the bids were much lower, even going down to 20€/MWh. More info on the auction process can be found here: http://aures2project.eu/wp-content/uploads/2021/10/AURES_II_case_study_Spain.pdf

Achievements

The former coal region of Teruel is without a doubt in an excellent position to become an energy transition success story in the coming years. With favourable natural conditions for generating power from wind turbines on a gigawatt-scale, the region is already a frontrunner in installed capacity of wind energy and will continue to develop more wind parks in the future, contributing to a transition away from fossil fuels and to reaching Spain's climate targets. As of 2022, [50% of the region's energy production](#) was generated by wind energy.

In the latest round of auctions, the municipalities in the region made an additional effort to ensure that local communities profit from the wind energy boom, in part to respond to rising opposition against new wind energy projects. For example, the *Clúster Maestrazgo* project, approved by the national public authority in 2022 and expected to start operating in 2025, entails 125 wind turbines with a total capacity of 762 MW in a rural part of Teruel. The project is expected to generate 1,200 jobs in construction and 200 during operation. City councils were eager to ensure that the wind farms not only create jobs, but also directly benefit residents, especially given the size of the project and the impact on the landscape. After negotiations with city councils, the company building and operating the wind farm offered all registered residents in the 40 neighbouring villages a free electricity scheme in form of a daily electricity bonus up to 15 kWh per household for the next 30 years⁶.

The municipalities will furthermore profit from tax revenues. For example, the Municipality of [Cantavieja will receive 350,000 EUR in taxes each year](#) thanks to the project, plus 72,000 EUR⁷ a year of returns from land lease to the power company. For a municipality of 700 residents with a public budget of around 1 million EUR in 2022, this is a lot of money. With these new financial possibilities, the municipality aims to invest in public goods such as the local school, propose incentives to attract doctors to the municipality and hopes to attract small businesses. While some still consider them to be uncomfortable buyouts, the wind farms are providing local communities with the financial boost to realise investments into quality of life that otherwise would not be possible.

Further reading

- 🔗 [All legislation documents of Aragón regarding wind energy](#)
- 🔗 [Case study about the Auctions system for renewable support in Spain](#)

KEY LEARNINGS

- As a frontrunner in renewable energy development in Europe, the Teruel region in Spain exemplifies that coal regions can successfully shut down coal industries and fully shift to renewable production.
- Especially in rural regions that lack alternatives for business development, wind energy projects can be a strong driver for job creation and can provide high revenues for municipalities.
- The more renewables that will be installed, the more important it will be to include citizens in the transition process, ensuring fair and transparent project development processes to avoid strengthening opposition.
- Even with the best communication and citizen inclusion methods, it may be unavoidable that some parts of society will fundamentally oppose any RES developments. Regions will need to figure out how to deal with rising opposition to energy transition implementation and continuously aim to ensure a just transition that is fair for all.

⁶ However, not all municipalities were accepting the offer, expressing a lack of trust in the deal

⁷ Both to private and public landowners, the company pays 9,000 EUR every year per windmill

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The Initiative for coal regions in transition is led by the European Commission.

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