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A green *bubble*:
Spain and renewable energies, 1998-2014.

WORKING PAPER

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1. Introduction: the commitment to renewable energy.

On January 16, 2009, Barack Obama visited a company in Ohio that manufactured components for wind power generators. The 44th president of the United States said at the time that renewable energies "can create millions of additional jobs and entire new industries". [1] With this optimistic message, Obama justified a stimulus plan that aimed to double the production of renewable energies in three years, as well as to modernize the energy efficiency of 75% of federal buildings and protect 2 million families from inclement weather by renovating their homes. [2]

This stimulus plan was based on the examples followed by other countries "Think about what is happening in countries like Spain, or Germany and Japan, where they are making real investments in renewable energies", said Obama. But what was Spain really doing in the field of renewable energies and why was the world's largest economic power looking at our country? (Calzada et al., 2010).

The truth is that Spain began to make a strong commitment to encouraging the generation of clean energies at the end of the 20th century. A "white book" on new renewable energy sources, published by the European Commission in 1997,[3] established different national targets for the weight of renewables in relation to the gross final energy consumption of the Spanish economy, which was to reach 20% by 2020.

Table 1. Renewables share targets, percentage over gross final energy consumption.

	2010	2011-2012	2013-2014	2015-2016	2017-2018	2020
Target	12,1%	14,7%	15,9%	17%	18,5%	20,8%

Source: Castro-Rodríguez and Miles (2016) and Renewable Energy Plan 2005-2010 and 2011-2020.

The Spanish electricity system establishes a clear distinction between two areas of electricity generation: the ordinary regime and the special regime. The first is made up of all those plants whose installed capacity is equal to or greater than 50 megawatts. The second, on the other hand, covers those production units with an installed capacity of 50 megawatts that use cogeneration, renewable energies or biomass. In other words, the special regime is not synonymous with renewable energy, but most of these forms of production are included in it.

In order to promote the achievement of renewable energy production targets, between 1998 and 2013, Spain opted for the introduction of different premiums

[1] The news is available at the following link: https://grist.org/politics/he-knows-which-way-the-wind-blows/

[2] According to data from Our Word in Data, electricity generation from renewables in the United States increased from 416 terawatt-hours to 492 terawatt-hours between 2009 and 2012, an increase of 18.3%. Link to data: https://ourworldindata.org/grapher/electricity-renewables?tab=chart&country=~USA

[3] Available at the following link: https://europa.eu/documents/comm/white_papers/pdf/com97_599_en.pdf

and tariffs for special regime production. To this end, a mechanism known as *Feed-In-Tariffs* was applied. This is an intervention instrument that sets a reference price. In this way, renewable energy producers are guaranteed a fixed price for the electricity they generate and supply to the grid, agreed for a set period of time.

This price has tended to be higher than the market price, as the objective was to compensate for the higher costs associated with new renewable energy technologies, providing investors with a secure return. The difference between the market price and the price guaranteed by the tariffs would be covered by subsidies or additional charges that were paid by consumers on their electricity bill. The amounts of the premiums are shown in more detail in the next section.

This system ended in 2013, as will be explained in later sections of this document. Under the new model, incentive-based premiums have been replaced by a compensatory remuneration system in such a way that a "reasonable" return is guaranteed, understood as such the average yield of ten-year government bonds in the secondary market, a threshold to which is added an increment that depends on the degree of investment assumed. In addition, the dual system of ordinary and special regime has been ended, so that the current format is one of unified regulation.

As highlighted by Castro-Rodriguez and Miles (2016), renewable energy promotion policies can be considered relevant for moving towards a more sustainable future, but they have often tended to have significant shortcomings in both their design and implementation. In not a few cases, the incentives offered have not been linked to concrete metrics such as the degree of GHG emission reductions achieved by the country. This has led to a situation where the success of these policies has been measured solely in terms of the volume of investment attracted, without considering the impact of such investments in terms of their contribution to emissions mitigation.

In addition, the risk of these policies fostering speculative bubbles focused on capturing the rents offered in the renewable investment market has not been adequately assessed. If the high returns of certain projects are significantly amplified by generous public subsidies, this may make the investments disproportionately attractive compared to their true market returns. This could trigger an inefficient allocation of resources and eventually lead to the inevitable market corrections when adjusting incentive, feed-in tariff and subsidy policies.

As an example of this, Calzada et al. (2010) have estimated the cost to Spain of creating "green" employment in the field of renewable energies. The authors conclude that, for every job created in this sector, 2 of the resources needed by the private sector to create 2.2 jobs have been destroyed. [4] In other words, each job created through renewable energy incentives would have destroyed 2.2 jobs.

[4] The result is obtained by dividing the amount of subsidies in the renewable energy sector per worker (571,138 euros) by the average capital per worker (259,143 euros). The authors also obtain the same ratio by dividing the annual profitability per worker (55,946 euros) and the average productivity per worker (25,332 euros).

The second section of the document details the gestation of the renewable energy bubble. The third section refers to the *bursting of* this bubble and its legal consequences. The fourth section focuses on the economic costs of the *bubble*. The fifth section presents the conclusions of this research.

2. The gestation of the green bubble.

In Spain, feed-in tariffs offered as incentives for renewable energy production played a crucial role in creating a bubble in the sector. These premiums, which guaranteed high revenues for the electricity generated, encouraged a wave of investment in renewables, often without a proper assessment of risk and long-term sustainability.

The high profitability assured through these incentives attracted a disproportionate amount of capital to renewable projects, leading to an explosive

growth in installed capacity. However, this rapid expansion not only increased support costs significantly, but also distorted the energy market and put the financial stability of the entire Spanish electricity system at risk, thus contributing to the formation of a speculative bubble in the renewable energy sector, especially in the solar PV sector.

The starting point for this renewable energy bubble can be established as 1997, with the entry into force of Law 54/1997. In its original wording, Article 30.4 establishes that "the production of electric energy by means of non-hydraulic renewable energies, biomass, as well as hydroelectric power plants with a power equal to or less than 10 MW, will receive a premium to be set by the Government so that the price of the electricity sold by these facilities is within a percentage range between 80 and 90 percent of the average price of electricity". With the subsequent Royal Decree 2818/1998, this Law was developed, and at the same time it was agreed to renew the system for calculating the premiums every four years. However, this remuneration system was not at all as problematic as the following ones.

The decisive moment was the approval of Royal Decree 436/2004. With this new scheme, progressive regulated rates were established, according to the size of the plant. The remuneration of photovoltaic energy was undoubtedly the most favored. [5] In this case, these rates were 575% above the average reference rate (MRR) for the first 25 years of operation of plants up to 100 kW, in order to encourage and favor small developers. [6] Plants with a capacity of more than 100 kW were penalized in comparative terms, since their remuneration did not exceed 300% of the MRR.

However, as is often the case with such schemes, the incentives encouraged the astuteness of investors. Thus, in order to take advantage of the 575% surcharge on the TMR, multi-MW "solar farms" began to proliferate, driven by companies that operated such installations under the name of several clients, generally allocating to each one an amount less than the 100 kW limit. In this way, these companies could operate a large solar farm (e.g., 10 MW) connected by a series of transformers of up to 100 kW each. In short, subsidy schemes that offer grossly artificial gains end up fostering massive inefficiencies, while increasing the economic cost of deploying renewable technologies, in particular, and financing the energy costs necessary for life and production, in general.

Installed capacity between 2004 and 2007 rose from 21 MW to 618 MW - but the Spanish government wanted more, so on June 1, 2007, Royal Decree 661/2007 came into force. This new regulation was intended to offer continuity and stability to the PV sector, although its main difference lay in the attempt to control an

[5] Rates, premiums and incentives varied according to the type of technology.

[6] The average reference rate was established annually by the Government. In other words, a price arbitrarily set by the government. For example, for that same year 2004, the TMR was set at 7.2073 c€/kWh, while the energy pool price was 3.565 c€/kWh. This meant that a rate 575% above the TMR meant that plants up to 100 kW received subsidies 1,162% above the average pool price.

unintended consequence already caused by the previous regulation: namely, the exorbitant development of the aforementioned "solar farms" and the organizational shenanigans they had encouraged.

The photovoltaic remuneration framework was then decoupled from the remuneration for the average reference rate and, instead, a stable reference price was set, whose initial value in 2007 was published in the Royal Decree and whose future value would be updated annually according to the evolution of the Consumer Price Index (CPI).

In order to encourage greater professionalization in this sector, installations of more than 100 kW would no longer be intrinsically discouraged. Thus, farms willing to benefit from the regulated remuneration framework and with a capacity of up to 100 kW would receive 44 euro cents per kWh for the first 25 years. Plants between 100 kW and 10 MW would receive 41.75 cents per kilowatt hour sold. Both tariffs would be updated annually in line with the CPI.

Table 2. Scheme of premiums under the RD 661/2007 system.

Size	Duration and rate (euros kWh)
≤ 100 kW	Aid during the initial 25 years: 0.44 Aid after 25 years: 0.35
> 100 kW and ≤ 10 MW	Aid during the initial 25 years: 0.42 Aid after 25 years: 0.33
> 10 MW and ≤ 50 MW	Support during the initial 25 years: 0.23 Aid after 25 years: 0.18

Source: Mir-Artigues et al. (2015) and RD 661/2007.

In September 2007, the National Energy Commission (CNE) certified that, according to the information available up to August of that year, 85% of the target of 371 MW planned for the end of 2010 had been reached. In fact, the full target could have been reached in October 2007, i.e. more than three years in advance. In addition to allocating premiums above what was paid by the market, the quantities eligible for this subsidized price were not limited, so that deployment was massive.

Likewise, it was decided to remunerate renewable technology according to the hours of energy produced, without establishing any kind of limit, so that the greater the supply, the higher the price, contrary to all economic logic. The more energy produced by renewables, the higher the remuneration consumers had to pay in their electricity bills, through the premiums that were incorporated into their price.

The announcement of achieving 85% of the 2010 target in mid-2007 triggered the need to draft a new Royal Decree that would regulate tariffs and establish operating conditions for a prescribed period of one year. The twelve-month transitional period was chosen to allow facilities under construction sufficient time to complete construction and start operating (on average, in 10 months), thus taking advantage of the tariffs and regulations of RD 661/2007.

The draft Royal Decree, dated September 27, 2007, revised the target capacity to be installed by 2010, increasing it to 1200 MW. All installations that started up during the transitional period, once the new 1200 MW limit had been exceeded, would receive unsubsidized remuneration until the new Royal Decree came into force and, with it, the new tariffs. Subsequently, the CNE asked to modify the draft and finally succeeded in requiring that all facilities registered before September 30, 2008 would be covered by the new remuneration framework (Decree 661/2007), regardless of whether or not the 1200 MW target was reached.

A period of uncertainty then arose in anticipation of the new regulations that would come into force one year after the transitional period (September 2008). This shows that investors assumed that the new model was likely to be less favorable. This motivated investors to install as much power as possible before September 29, 2008, fearing that the subsequent regulation would be much more unfavorable to their interests.

This is the origin of the boom in the installation of new solar PV plants which, according to official records published by the CN, meant that, by December 2008, the scheme had managed to install more than 2934 MW of solar PV capacity. According to the CNE's own estimates, up to 4156 MW could realistically have been achieved, which would mean that 83.3% of the total capacity was installed in 2008 alone.

The new remuneration framework extended the generosity of the regulated tariffs to larger installations. Those above 100 kW and also those under 10 MW would enjoy in 2009 a regulated price of 44.5751 c€/kWh, and 47.0181 c€/kWh for those plants up to 100 kW. In addition, the one-year grace period allowed investors to install as much power as possible before its conclusion, so that there was a mass development of PV plants in the 100 kW to 10 MW range.

The effort to promote stability and professionalism in the photovoltaic industry, and the effort to ensure the broad participation of specialized players capable of managing high-capacity plants, did not achieve the expected results. On the other hand, sectors as diverse as construction, real estate and vehicle manufacturing made ambitious investments in the energy industry, which a priori was alien to them. Energy also became a financial product. The initial projects enjoyed yields of around 20%, so that these projects were sold and resold in packages with very attractive returns.

As recognized by Miguel Sebastián, Minister of Industry between 2008 and 2011, "the result of this pyramid was twofold: firstly, the bottom of the chain no longer received as much profitability and were more sensitive to any cut in remuneration, especially if they had gone into debt; and secondly, photovoltaic interests were atomized, lacked coordinated representation and were extraordinarily combative because they had been "promised" a profitability based on a number of remunerated hours that was neither regulated nor sustainable". (Sebastián, 2021, p. 168)

In 2007, generous feed-in tariffs allowed a 100 kW photovoltaic plant, with a leverage equivalent to 70% of its cost, to offer internal returns of up to 17%, significantly above the 5% per annum paid by the Spanish thirty-year bond. For example, an initial investment of 100,000 euros could be converted into 5,065,782 euros over 25 years, reinvested at the same 17% rate. However, despite such economic incentives, solar energy did not even account for 1% of Spain's total electricity production in 2008. (Calzada et al., 2010).

In view of this development, and as mentioned above, the Ministry of Industry belatedly sent a proposal for a Royal Decree on photovoltaic remuneration for the mandatory report by the CNE. This body, in its Report 30/2008 of July 29th , positively assessed the Ministry's intention to reduce the remuneration for this form of renewable energy, but recommended improvements in certain technical aspects of its application.

The CNE, aligning itself with the opinions of institutions such as the European Union, highlighted the effectiveness of the feed-in tariff system compared to other less successful models, such as the UK's green certificates, but warned that over-incentivization could have negative consequences, discouraging innovation and increasing the costs of the PV sector in particular and energy in general. The proposed Royal Decree followed the feed-in tariff model but with a strategy of progressive tariff reduction, inspired by the "German method", reflecting real costs and encouraging price reduction in emerging technologies.

The previous excessive financial support, which was based on the framework offered by RD 661/2007, resulted in a disproportionate burden for companies and families on their energy bills, while at the same time it led to an uncontrolled growth of photovoltaic installations, far exceeding expectations with an increase of 350% in 2007 and another 180% in 2008. The cost overruns were enormous. As an example, and to clearly visualize the disproportionate growth of solar, which was the most subsidized technology, it suffices to point out that in 2008, 2,716 MW of photovoltaic power were installed, which was equivalent to the sum of the nuclear power plants of Garoña, Vandellós and Cofrentes, which then contributed 2,645 MW. (Sevillano, 2023).

The new remuneration framework of RD 1578/2008 implemented a more flexible and coherent system, differentiating two types of facilities with different tariffs, depending on their location and power. The new system seeks to balance the incentive for technological development without falling into excessive remuneration that could stagnate innovation, adjusting the tariffs when 50% of the planned power quota is not reached in consecutive calls. In other words, a first cut in premiums was formally approved, although the problem continued to grow until it led to the major adjustment that took place five years later.

Despite the entry into force of the new remuneration model, which is slightly more consistent and in line with accumulated investment, the *Feed-in-Tariff* incentive

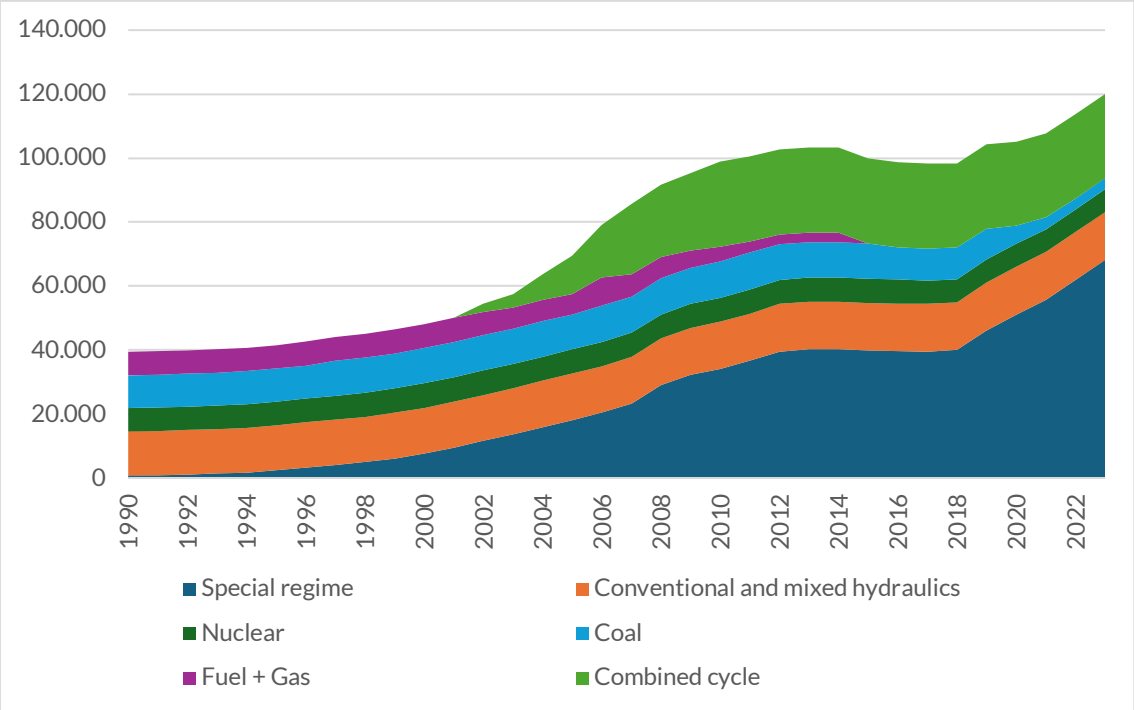
system continued to operate until 2013, leading to a steady increase in the premiums paid to special regime technologies.

For example, in 2009, the cost of premiums increased considerably, as production hours also increased, despite the fact that there was no significant increase in installed capacity. The 2007 regulation condemned us to pay a very high electricity bill for a very long period of time. Thanks to this, the profitability of photovoltaic plants remained at around 7%. It is from 2013 when the bubble burst completely and a series of legal consequences took place that are still being paid for today.

QUANTIFYING THE SIZE OF THE RENEWABLE BUBBLE.

Figures 1 and 2 below show the evolution of installed electrical power in Spain in megawatts, differentiated by type of technology. The total amount of installed electrical power in Spain has increased threefold over the last thirty years, from 40,000 to 120,000 MW between 1990 and 2023. As can be seen, conventional hydro and nuclear have remained constant since 1990, while coal has lost, especially in recent years. The increase in installed capacity is due, on the one hand, to the strong increase in combined cycle plants and, above all, to the growth of special regime plants, i.e. those subsidized by renewable premiums.

Figure 1. Installed electrical power in Spain, in MW .[7]



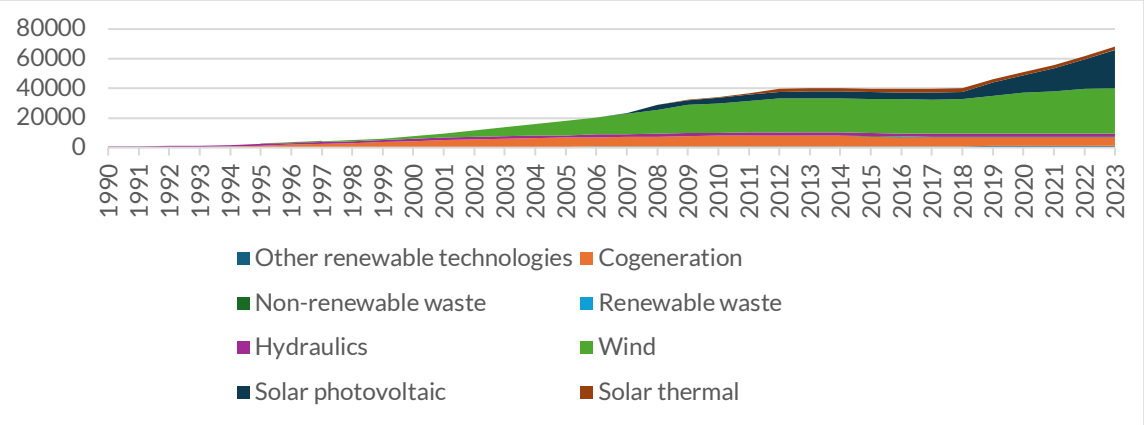
Source: own elaboration based on Red Eléctrica.

[7] The historical series since 2015 for hydro technology does not distinguish between conventional and special regime. Therefore, in order to maintain the historical series, the total installed capacity of hydro since 2015 has been divided according to the weight that each of the categories (conventional and special) maintained for 2014.

The evolution of installed capacity in special regime plants has been spectacular during this period. As can be seen, installed capacity was around 5,000 MW in 1998. In 2013, when the bubble finally burst, this figure reached 40,000 MW. Also noteworthy is the stability observed between 2013 and 2018, in which no changes can be seen. Since 2018, solar photovoltaic technology has been growing intensely again, which explains much of the growth observed over the last five years, although the explanation for this phenomenon goes beyond the scope of this paper.

Differentiating by type of technology, wind power is the one that develops more strongly at first, with a stable growth from 1998, when it had an installed capacity of 643 MW, until 2013, when it reached 23,000 MW. Solar photovoltaic, on the other hand, did not take off until the Royal Decree of 2007, but between 2007 and 2008, its installed capacity increased more than fivefold. The successive reforms approved limited its growth, although the costs, as will be detailed in the fourth section, are still being paid today.

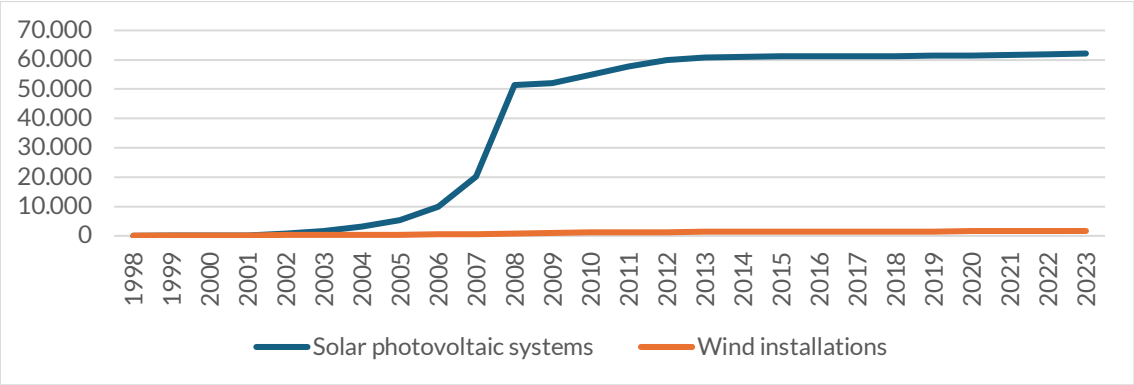
Figure 2. Installed power of the special regime (primed) by technology, in MW.



Source: own elaboration based on Red Eléctrica.

The spectacular increase in solar photovoltaic can be seen in Figure 3, in contrast to the other type of energy that has received more aid, namely wind power. The number of renewable installations grew moderately during the first years of the feed-in tariff system. However, from 2007 onwards, the figure doubled from just under 10,000 to over 20,000. In 2008, during the transition period, this figure more than doubled to 51,310 installations. Since then, the rate of growth has stagnated, reaching a figure of approximately 60,000 installations, which is almost the same number as today. Without premiums, deployment ceased to grow, revealing the artificiality of the rise seen up to that point.

Figure 3. Number of solar photovoltaic and wind power installations.



Source: own elaboration based on CNMC.

And why did the number of photovoltaic installations skyrocket so much? Although premiums were granted to special regime plants, the amounts of these subsidies depended on numerous factors, including the type of technology. In this case, photovoltaic plants benefited the most from this system, as shown in the following table. Thus, while renewable energies as a whole received an average remuneration of 103.4 euros/MWh, solar PV received 386.46 euros/MWh. The reason is that its premium was equivalent to 795% of the average market price.

Table 3. Average remuneration of renewable energy, 2000-2013, €/MHh.

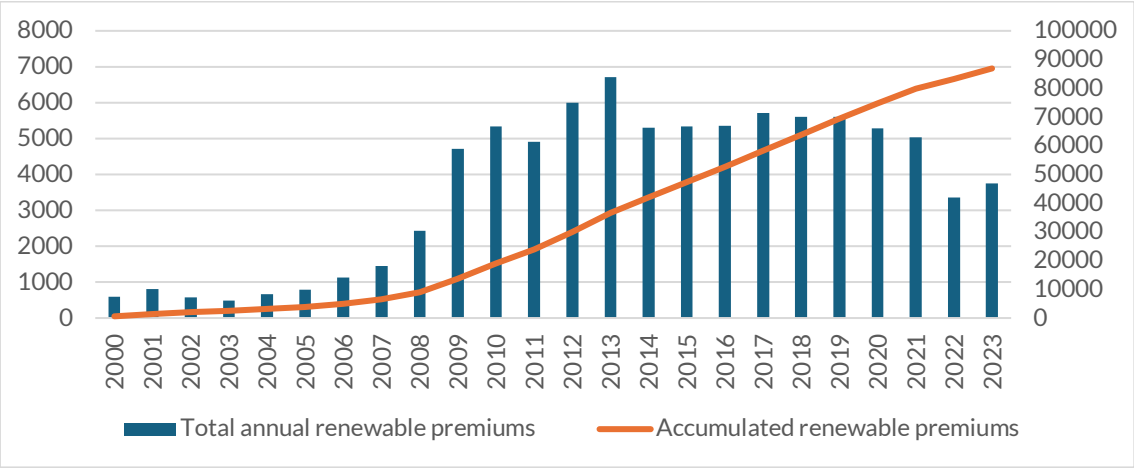
Technology	Average premium	Average market price	Average compensation	Premium over market price
Solar photovoltaic	343.27	43.19	386.46	795%
Solar thermal	259.68	43.19	302.87	601%
Wind	41.45	43.19	84.64	96%
Hydraulics	44.71	43.19	87.9	104%
Biomass	54.11	43.19	97.3	125%
Total	60.21	43.19	103.4	139%

Source: Castro-Rodríguez and Miles (2016) from CNMC.

The annual cost of subsidies remained at moderate levels until 2007, generating a cost increase equivalent to about 1 billion euros per year; however, from the time of the approval of Royal Decree 661/2007, the cost of premiums skyrocketed to more than 6 billion euros in 2013.

In cumulative terms, in the period between 2000 and 2013, renewable energy premiums have cost Spanish citizens some 36,595 million euros. These disbursements have not stopped growing due to the guaranteed retributions for 25 years, so that the accumulated amounts reach 86,915 million euros until December 2023. In other words, there are still two decades left in which consumers will have to pay around 6,000 million euros every year for a political decision taken in 2007. The total cost, therefore, could be around 300 billion euros.

Figure 4. Evolution of annual renewable energy premiums and cumulative, in millions of euros.



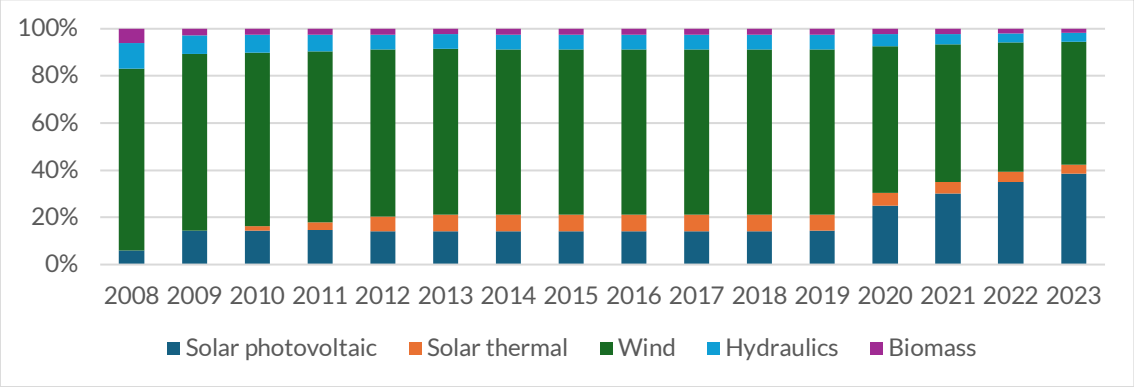
Source: own elaboration based on Castro-Rodríguez and Miles (2016) and CNMC.

Most surprising of all is what happened with photovoltaic solar energy. As already mentioned, its premium was significantly higher than that offered for the rest of the subsidized technologies. At the time of the bubble, this type of bet accounted for around 15% of the total amount of energy subsidized at that time, as shown in the figure below.

However, since solar was remunerated so favorably, its installations accumulated half of the premiums granted annually during the entire period analyzed. In other words, photovoltaic plants receive double the amount of the premiums received by wind power, despite the fact that their production is only one-fifth of the latter.

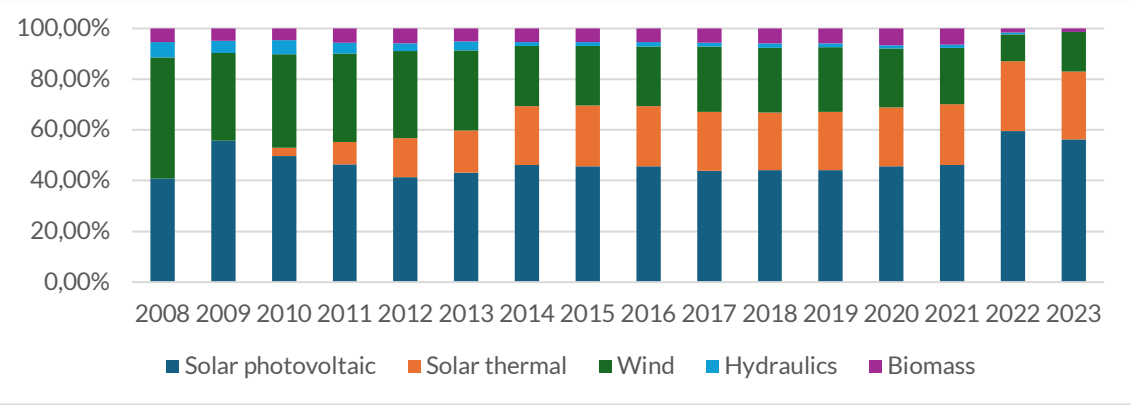
In addition, it is worth noting that, for example, in 2023 solar PV received a premium of €2,105 million for an amount of energy coming in of 35,673 GWh. In other words, the average premium was around 5.9 cents per kWh, or €59 per MWh. However, not all of the energy sold is premium-priced. In this case, the premium energy accounts for 7,406 GWh, so those who received a subsidy did so at a rate of 28.4 euro cents per kWh or 284 euros per MWh. The premiums are higher than what is reflected in the statistics, because not all energy is subsidized.

Figure 5. Percentage of energy primed by technology.



Source: CNMC.

Figure 6. Weight of each technology over total premiums granted to renewables.



Source: CNMC.

Table 4 summarizes the main data on the subsidies received by photovoltaic solar energy, including the total amount of premiums paid, the average premium received and the weight of this technology with respect to the rest of the technologies in the sector, from 2004 (the first year for which it was possible to obtain the data) to 2023. As can be seen, the weight of photovoltaics in the total amount of premiums received is oversized with respect to the percentage it contributes to energy generation.

Table 4. Summary table of the main indicators of solar PV feed-in tariffs.

Year	Total premiums (in thousands of euros)	Average premium (euros/ MWh)	% of premiums received with respect to total renewables	% with respect to the renewable generation mix	% of total generation mix
2004	6.146	341,44	0,93	0,08	0,01
2005	13.995	341,34	1,75	0,15	0,01
2006	39.887	372,78	3,53	0,35	0,04
2007	194.162	392,25	13,44	1,36	0,16
2008	990.830	388,71	40,88	6,09	0,96
2009	2.634.236	424,60	55,90	14,42	2,45
2010	2.656.291	414,72	49,62	14,32	2,46
2011	2.287.260	390,92	46,49	14,59	2,74
2012	2.470.212	388,70	41,38	14,12	3,08
2013	2.889.113	350,24	43,07	14,17	3,18
2014	2.444.690	299,74	46,06	14,18	3,08
2015	2.439.354	297,99	45,68	14,19	3,08
2016	2.440.773	308,06	45,63	14,18	3,05
2017	2.502.728	300,09	43,86	14,18	3,20
2018	2.469.189	320,30	44,06	14,18	2,98
2019	2.464.845	302,18	44,03	14,31	3,55

2020	2.405.742	315,42	45,59	25,06	6,09
2021	2.327.856	307,51	46,22	30,08	8,07
2022	1.997.579	239,29	59,62	35,15	10,10
2023	2.105.386	284,28	56,15	38,43	13,99

Source: own elaboration based on Mir-Artigues et al. (2015) and CNMC.

3. From financial unsustainability to legal uncertainty.

As mentioned above, Royal Decree 661/2007 was the trigger that inflated the green bubble and boosted investment in renewable energies, especially solar photovoltaic plants. Although new regulatory measures were introduced in the following years, they did not manage to stop the increase in the installed capacity of these plants, but only partially slowed it down.

In 2010, with Royal Decree 14/2010, the premiums were modified downwards. In 2012, with a new government at the helm, a moratorium was introduced on the aid offered to new renewable energy installations. Likewise, premiums and any other incentive were abolished, while calls for the installation of new plants were cancelled. This measure was announced as temporary, but was to be applied indefinitely.

Already in 2013, with Royal Decree 9/2013, the previous feed-in tariff system was put to an end at the cost of modifying the rules in force until then. In essence, the *Feed-in Tarffs* were replaced by a remuneration system based on a reasonable yield, a threshold equivalent to that of ten-year government bonds, plus a spread of 300 basis points (Castro-Rodriguez and Miles, 2016). This Royal Decree also incorporated a mandate for the Spanish government to approve a new legal and economic regime for existing electricity production facilities from renewable energy sources, in addition to the remaining technologies included in the special regime. [8]

For this reason, the Royal Decree 413/2014 was implemented, which basically involves the development of Law 24/2013. This new regulatory framework allows facilities the revenues derived from the sale of energy at market price, but also an additional compensation. This compensation includes a payment for installed capacity that covers investment costs not recoverable through the sale of energy. This was called investment remuneration. An operating payment was also included

[8] Royal Decree 9/2013 was of an urgent nature, since although gradual measures were being introduced to cut premiums and costs, weather conditions, demand and the situation of the public accounts made it necessary to take such drastic measures.

to compensate for the difference between operating costs and market revenues, a concept described as operating remuneration.

To determine these compensations, standard revenues from the sale of energy, average operating costs and the usual value of the initial investment for any efficiently managed facility were taken into account. Specific remuneration parameters approved by the Ministry of Industry, Energy and Tourism were established and adjusted to each type of facility, differentiating by factors such as technology or age.

The 2013 and 2014 measures led to an avalanche of legal appeals and litigation against the State. Major multinationals and international investment vehicles with renewable energy interests brought their claims before the World Bank's International Court of Arbitration (ICSID), invoking the Energy Charter Treaty and alleging that they had suffered retroactive cuts in regulated revenues. The original six claims were joined by more than 50 such lawsuits, with claims in excess of 10 billion euros. All the claims focus on the infringement of the principles of legal certainty and legitimate expectations.

The retroactivity of the adjustment measures was the main reason for the beginning of the litigation of the sector against the Kingdom of Spain. All the measures applied were aimed at reducing premiums and, therefore, the remuneration initially agreed with investors and producers was altered and the rules of the game changed in the middle of the game. Many companies in the sector went into insolvency proceedings and were financially strangled.

The legal uncertainty caused by these constant changes in legislation resulted in the paralysis of billion-dollar investments that were being developed in Spain, negatively affecting the economic stability of the sector and the economy in general.

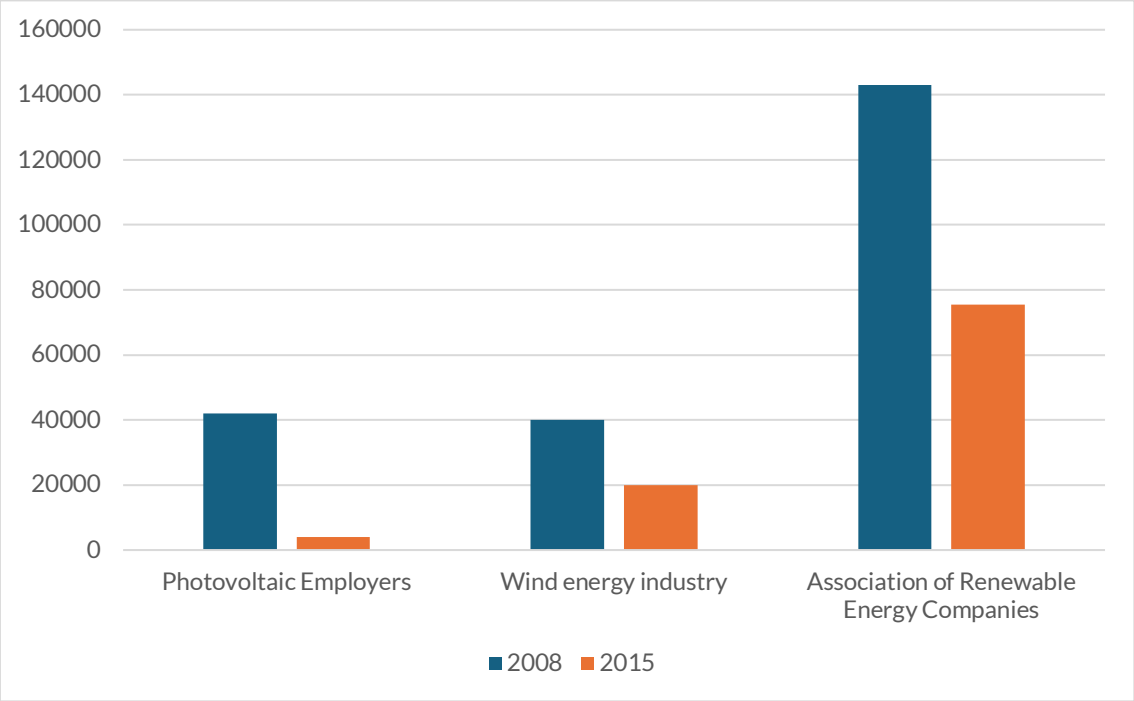
In particular, the PV industry experienced a drastic reduction in employment, from a peak of 42,000 workers to just 4,000 wage earners in 2015, according to data from the PV employers' association. This is a 90% reduction in the overall employment figures for the subsector.

For its part, the wind energy employers' association pointed out that the wind energy sector also suffered a significant reduction, retaining only half of the 40,000 active workers that the industry had in 2008. Therefore, the drop was close to 50% in this branch of activity.

By the end of 2015, the total number of employees in renewable energy had fallen to 75,475 from 142,940 in 2008, according to the Renewable Energy Companies Association, representing a drop of close to 50%.

This situation not only represented an immediate loss in terms of jobs and companies, but also the dismantling of a sector in which Spain had been a world leader. The country's long-term position was no longer recovered and the huge expenditures undertaken were not enough to sustain a boom clearly derived from extraordinarily generous aid which, to top it all, was withdrawn retroactively, creating a new problem.(Agustina, 2017)

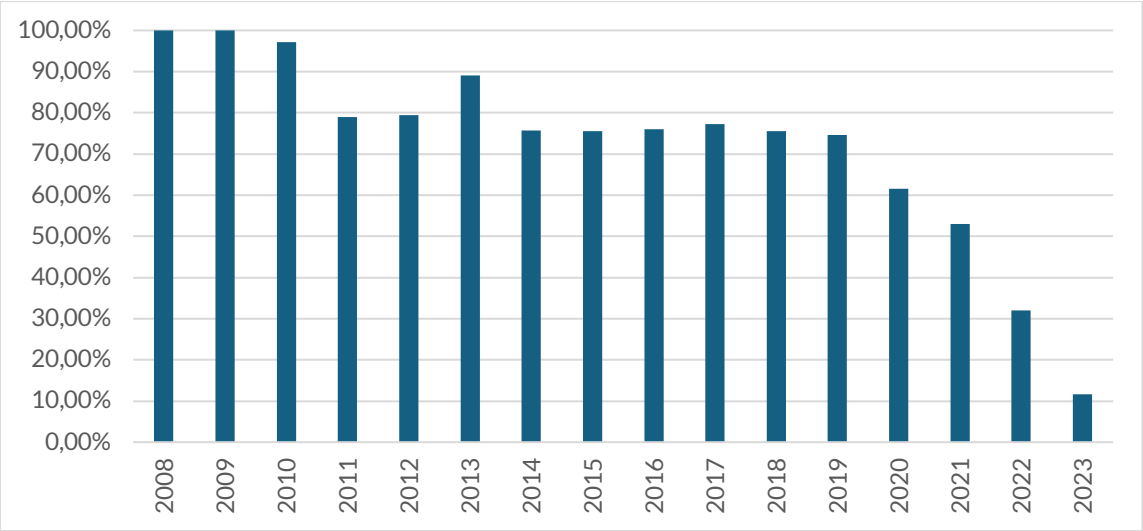
Figure 7. Evolution of employment in the renewable energy sector after the bubble burst.



Source: Own elaboration based on different industry sources.

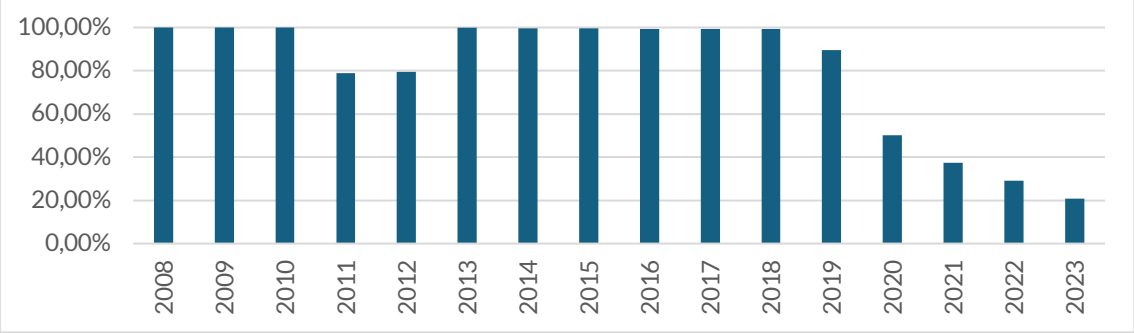
As can be seen in Figures 7 and 8, since 2010 and, especially since 2013, the percentage of prime power over energy sold by renewables has begun to fall. This drop is explained by the decrease in hydro and wind, since solar photovoltaic maintains a 100% share of primed energy.

Figure 8. Evolution of renewable energy premium, percentage of energy sold.



Source: own elaboration based on CNMC.

Figure 9. Evolution of solar PV prime power, percentage over energy sold.



Source: own elaboration based on CNMC.

The explanation for this circumstance lies in the fact that, at the time the subsidies were granted, solar was an immature technology that could only be developed thanks to the very high volume of subsidies it received. For this reason, between 2013 and 2018, installed capacity remained stable at around 4,700 MW. All this capacity was subsidized under the regime approved in 2007, albeit with cuts in the total amounts paid of 15% (400 million euros in absolute terms).

The measures adopted to prick the bubble had some success in terms of slowing down the escalation of costs that the State was assuming and that were being passed on to consumers, but at the cost of sinking Spain's image before international investors due to the flagrant legal uncertainty that the retroactive cut in premiums entailed, an open violation of the initial conditions offered to investors. The remuneration framework developed in Royal Decree 413/2014 came into force in June 2014, but it was applied since July 2013 and, during these eleven months, for example, renewable and cogeneration companies had to return 1,236 million euros. [9]

[9]See news at the following link:
https://www.expansion.com/2014/10/02/empresas/energia/1412244129.html

This case is an example of improper retroactivity, since the new regulation not only altered future expectations, but also affected the conditions under which investors had made their financial commitments and long-term projects, which in the case of multinational companies exceeded 70 billion euros.

By implementing legislative changes that affect previous situations without altering fully consolidated legal effects, a situation of insecurity is created that can have a negative impact on investor confidence and the long-term stability of the sector. This malpractice influences past economic decisions with present rules, compromising the perception of a stable regulatory environment, which is key to the sustained development of energy, an area that always requires heavy investment.

For this reason, and as indicated above, over the last few years the affected parties have filed numerous arbitration claims in different tribunals, but mainly in the ICSID of the World Bank. As of November 2024, the affected companies had a total of 34 awards rendered, of which 26 were in favor of the investors, to whom Spain owes some 1,562 million in compensation. In addition, due to the non-payment of such awards, Spain faces a series of additional obligations, with an additional cost of around 330 million euros, which is explained by the late interest on the payment of such compensations, the sentences in costs it has suffered and the fees of consultants and lawyers recruited by the Executive to continue litigating instead of complying with the awards. [10]

The truth is that Spain has refused to enforce such condemnatory awards, since it understands that they should be judged by the European Union Court. Due to Spain's continuous failure to pay, the aggrieved companies have filed lawsuits against the Spanish State in the courts of several countries, seeking the seizure of Spanish assets and property abroad. Several seizures of property, bank accounts and financial rights have already been approved in the United Kingdom and Belgium. In addition, the U.S. District Court and the Australian Supreme Court have opened the door to similar actions by recognizing Spain as a debtor country for this concept.

In addition, a technical *default* process is underway that has already caused economic damage in excess of 4.66 billion, due to the increase in financing costs and the associated reduction in economic activity. Since the situation remained in place through 2024, it is estimated that the accumulated losses to the public coffers and the national economy are going to exceed 12 billion. [11]

[10] Information presented at the III International Conference on Renewable Energy, Legal Security and Foreign Investment, held on May 30, 2024 in Madrid.
[11] For more information on the technical *default* process, see: https://spanishrenewabledebt.com/en/bond-default.

The affected companies demand that Spain honor its obligations under international law and resolve this series of non-payments that have placed the country in an extremely complicated situation, placing us above countries such as Russia or Venezuela in the index that evaluates the number of international awards pending compliance. This document, prepared by Professor Nikos Lavranos, highlights the precarious situation in which our country has been placed at the international level, since the non-payment of arbitration is unworthy of solid democracies and legal systems characterized by the rule of law. [12]

Table 5. Countries with the largest unpaid awards and amounts owed.

Country	Number of unpaid awards	Total amount of unpaid awards in billions of dollars
Spain	15	1,3
Venezuela	15	7,1
Russia	9	60,1

Source: Nikos Lavranos.

It should also be noted that Spain is the country that has suffered the highest number of complaints of this type, with 51 proceedings, well ahead of Italy or Romania, which have dealt with 14 and 8 disputes and have resolved such debts in a simple manner. This is not the case in Spain, which has refused to pay compensation, which is why the British and Australian courts have authorized the confiscation of State assets abroad, such as the London headquarters of the Cervantes Institute, the building of the Vicente Cañadas International School, four bank accounts and the right to collect compensation for the Prestige disaster, valued at more than 400 million euros.

The truth is that this situation of legal uncertainty is taking its toll on the deployment of renewables. According to the International Energy Agency's (IEA) *Renewables 2023* report, Spain has experienced a notable setback in its expectations for clean energy development for the period 2023-2027. [13] The IEA has attributed this setback to under-subscription in government auctions to allocate renewable generation capacity, highlighting the failure of the November 2022 auction, in which just over 1% of the capacity offered was awarded. [14]

[12] The table of contents is available at the following link: https://www.internationallawcompliance.com/wp-content/uploads/2023/10/FULL-Report-2023-DEF-25-OCT-.pdf

[13] Report available at the following link: https://iea.blob.core.windows.net/assets/96d66a8b-d502-476b-ba94-54ffda84cf72/Renewables_2023.pdf

[14] In Spain, the process of awarding capacity to install renewable energy began with Royal Decree 947/2015, aimed at establishing a specific remuneration regime for new electricity facilities from renewable sources, especially biomass and wind. Since the first auction in 2016, these have been held intermittently. The auctions allow winning companies to implement renewable energy projects, being awarded to those submitting the most competitive bids according to several criteria, including price, technology, and geographic location, among others. The conditions and the result of the last auction held in Spain are set out in the following document: https://www.boe.es/boe/dias/2022/12/05/pdfs/BOE-A-2022-20540.pdf

The results of these auctions suggest that the economic conditions offered were not attractive compared to financing options for non-subsidized projects. This situation reflects a mismatch between the maximum prices set by the government and the more competitive wholesale market prices, which are considerably higher. Although prices in the wholesale market have fallen since the peaks of the energy crisis, they continue to be higher than those established in the auctions, indicating that government valuation is unattractive to investors. To all this must be added the legal uncertainty described in the preceding paragraphs.

In addition to economic difficulties, the IEA report highlights additional problems affecting Spain, such as excessive bureaucracy or difficulties in obtaining necessary permits, which have slowed down the deployment of renewable projects. These challenges have led the government to stop calling new auctions for more than a year, although recently some modifications have been proposed to improve the situation, including additional requirements such as environmental impact and job creation in future awards.

Meanwhile, other countries have shown more significant progress in the adoption of renewables, with more favorable policies and conditions that have facilitated faster and more efficient deployment. In contrast, Spain has lagged behind, as reflected in the fourth section of the report, highlighting the need to review and adapt its regulatory and economic approach to foster more robust growth in this vital sector for the energy transition.

4. The economic cost of the green *bubble*.

In the previous pages we have explained the development and subsequent bursting of the renewable energy bubble, paying special attention to what happened between 2007 and 2013 and focusing on photovoltaic solar energy. Now that the volume of the premiums received and their disastrous review process have been dealt with, it is time to explain the costs generated by this great bubble for Spanish production agents.

Tariff deficit

The tariff deficit is, together with the renewables bubble, one of the main problems of the electricity system during the period analyzed. Sebastián (2021) explains in a rigorous and simple way that the tariff deficit is the difference between the revenues and the expenses of the system. Revenues are the tariff paid by consumers, while expenses include generation, transmission, distribution, premiums, compensation for non-mainland electricity generation and other regulated costs. The difference between revenues and costs generates a tariff deficit, which is recognized to the owners of the costs, i.e. the electricity companies, and is paid in the future. It is the consumers, i.e. households and companies, who pay the debt generated by the system.

It all starts with the electricity system regime that has been in place since 1997. In order to contain inflation problems, regulated tariffs are set and paid by consumers. Costs, on the other hand, are those established and recognized by regulatory standards. In other words, both the price paid by consumers and the amounts received by producers are regulated. Thus, we cannot speak of an economic deficit, but of a deficit of a regulatory nature:

> *"The tariffs paid by consumers would not adequately compensate the costs incurred by companies for the supply of electricity. The question is whether or not the costs recognized by regulatory standards reflect the actual costs of supply. Because, if the former exceed the latter, or if the actual costs are inefficient, then we would be faced with a deficit whose origin would have to be sought not so much in the lack of sufficient remuneration, but, on the contrary, in the regulatory rules that determine excessive or inefficient remuneration. In this second case, the deficit would be, at least in part, a regulatory deficit".* (Fabra and Fabra, 2012)

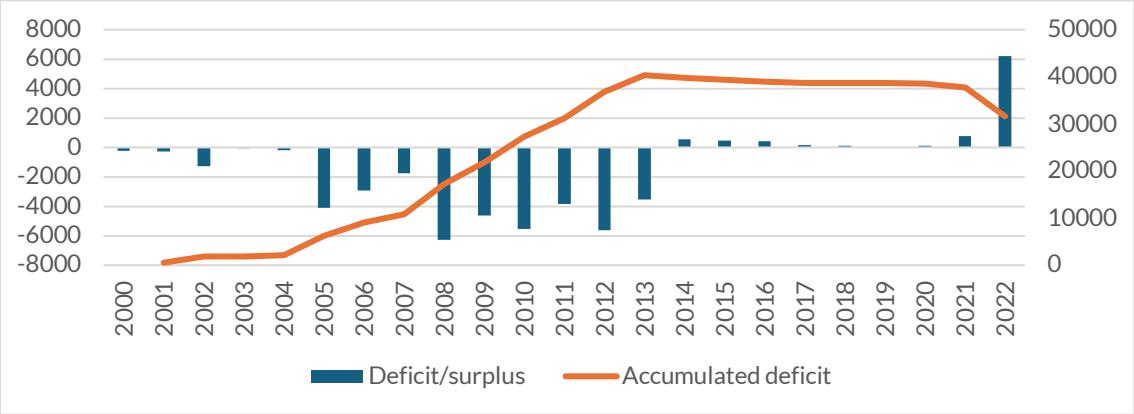
The determination of costs is given by the access tolls, which include the remuneration of regulated activities (transmission and distribution), as well as other external costs, including premiums for the special regime or the moratorium

on nuclear power. The government was responsible for calculating these costs in advance and adjusting the access tolls to cover them completely.

However, in practice, the tolls set were usually lower than necessary. This was because a full adjustment would result in a significant increase in the final price of electricity to be paid by consumers, which was considered politically undesirable. Thus, for essentially electoral or image reasons, the true cost of electricity to the end consumer was kept hidden. This meant that Spaniards were, in essence, subsidizing themselves without realizing it, accumulating the difference as part of the electricity tariff deficit, a debt that continued to grow and ended up affecting the financial stability of the entire national electricity system. We can give an example of this by looking at the last fiscal year for which a bulky annual deficit is observed, 2013.[15] During that year, the costs included in access tariffs were approximately 22 billion euros, while revenues from access tariffs amounted to 18.5 billion. Therefore, access tolls were lower than the estimated costs and the regulatory deficit increased in that year by approximately €3.5 billion.

The following figure shows the complete historical series of the tariff deficit and accumulated debt. It can be seen that the problem began to worsen in 2004. Up to that time, the accumulated debt did not reach 2 billion. From then on, the mismatch between regulated revenues and costs rose considerably, reaching 6,287 million in 2008. Between 2009 and 2013 the balance remains more or less stable between 3,500 and 5,500 million. Since 2014, with Law 24/2013, the deficit becomes a surplus. The system's debt, which reached over 40 billion euros, is now at 31.5 billion.

Figure 10. Annual and cumulative electricity system deficits/surpluses and cumulative d, in millions of euros.

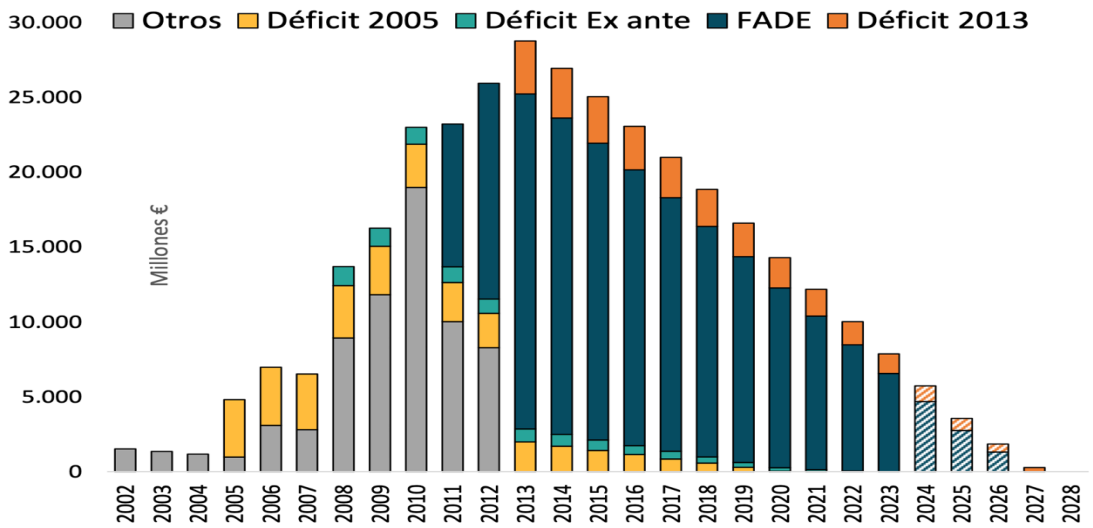


Source: own elaboration based on CNMC.

[15] Law 24/2013, which replaced Law 54/1997, establishes in Article 19 that any imbalance in the costs of the electricity system that is not covered by an increase in tolls and other charges, and that is within the allowed limits, must be financed by the participants of the settlement system. The contribution of each participant will be proportional to the economic compensation they receive for the activities they perform within the system. This means that if the income generated by tolls and charges is not sufficient to cover all costs, the different agents of the system, such as electricity producers and distributors, must contribute to the financing of the deficit according to what they earn for their work in the system.

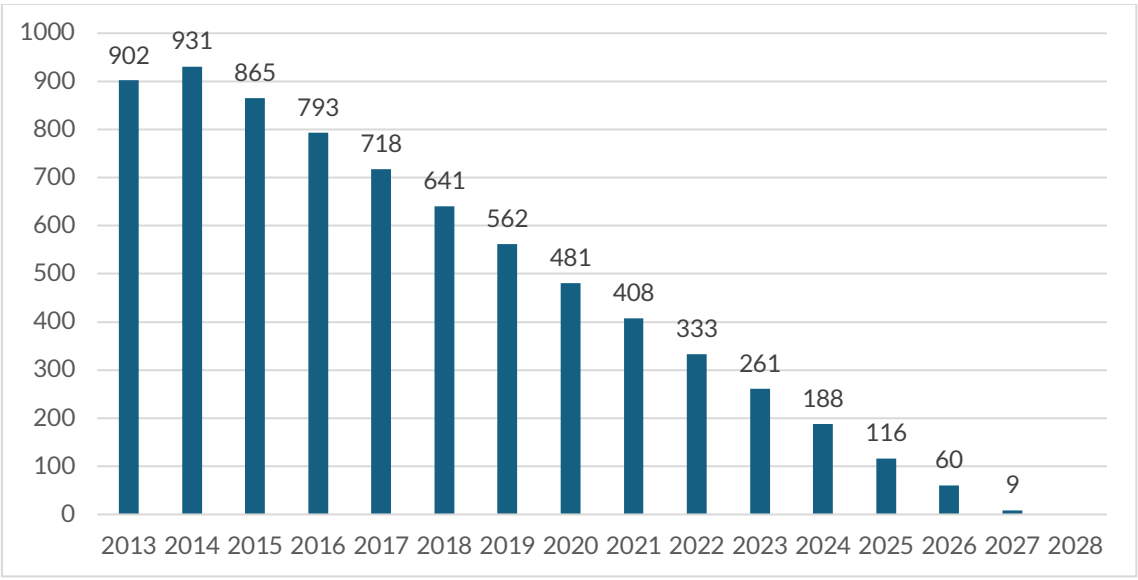
The system's outstanding debt did not stop growing until 2013 as well, exceeding €25 billion by far. Since then, the annuities paid within the bill have allowed the debt to be amortized in such a way that it has begun to fall significantly since then. The forecasts made by the CNMC indicate that, by 2028, this debt will have disappeared completely. At present, the debt per consumer amounts to 188 euros. At the worst point in the series, reached in 2014, each consumer was facing a debt of 931 euros.

Figure 11. Historical evolution (up to 2023) and future forecast (from 2024) of the electricity system debt (millions of euros).



Source: CNMC.

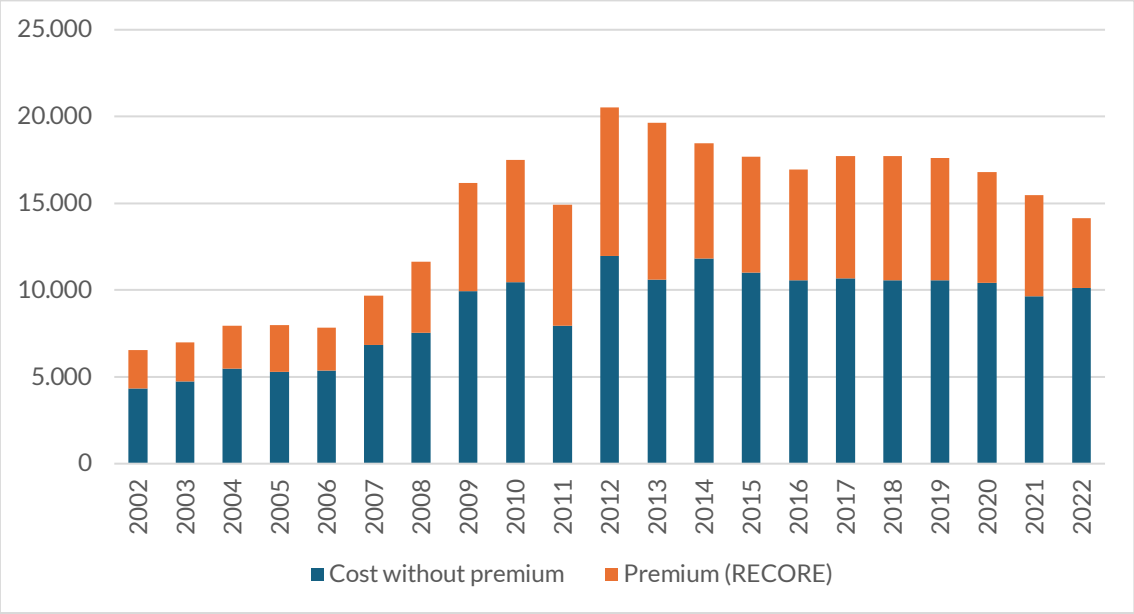
Figure 12. Debt per consumer generated by the tariff deficit.



Source: CNMC.

It can be seen that, until 2007, the weight of premiums in access tolls and, therefore, the contribution to the regulated costs of the system was limited, standing at around 30% of total regulated costs. However, from then on, and until 2013, this percentage increased dramatically, reaching close to 50% of total regulated costs. During the bubble, premiums for special regime energies reached figures similar to the rest of the system's regulated costs (Sevillano, 2023).

Figure 13. Cost of access tolls broken down by premiums for renewables and the rest, in millions of euros.



Source: Prepared by the authors based on Sevillano (2023) and CNMC.

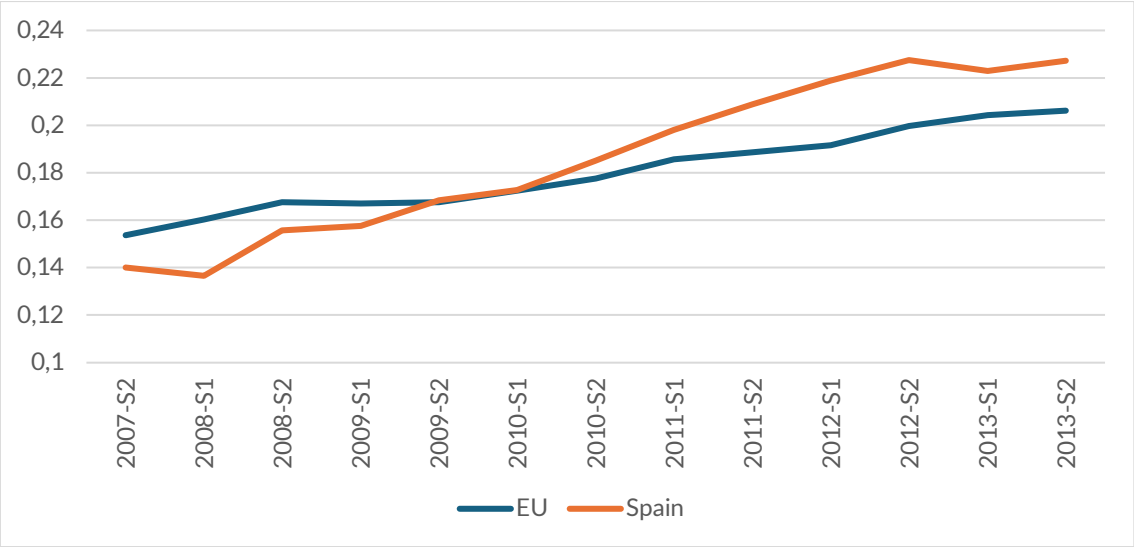
Cost escalation

Although the tariff deficit was used to camouflage the increase in regulated costs, tariffs were increased to try to reduce this gap. Thus, it is necessary to observe the evolution of prices to see if, indeed, the policy of subsidizing renewables has had an impact on citizens' pockets, not only in the future through the tariff deficit, but also in the present.

Eurostat provides half-yearly data on electricity prices for domestic consumers. In the second half of 2007, the first half-year with available data, the price per kWh in Spain was 0.14 euros, while the EU average was 0.1537 euros. In other words, electricity for European consumers was 9.78% more expensive than for Spanish consumers. In the second half of 2013, it was Spanish consumers who paid 9.28% more (0.2273 euros vs. 0.2062 euros). Until the second half of 2022, this gap continued to widen.

While the growth rate of electricity prices paid by households was 34.16% for the EU average, in Spain this increase reached 62.36%. In other words, prices increased 28.20 percentage points more in Spain than in the European Union.

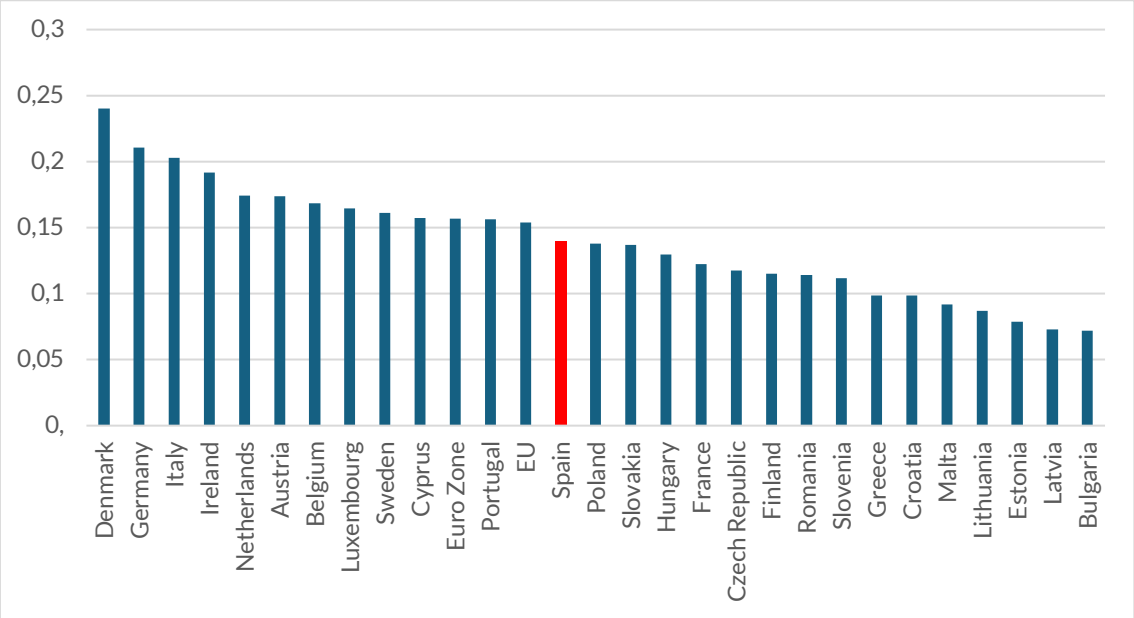
Figure 14. Evolution of electricity prices for households, in euros/kWh.



Source: Prepared by the authors based on Eurostat.

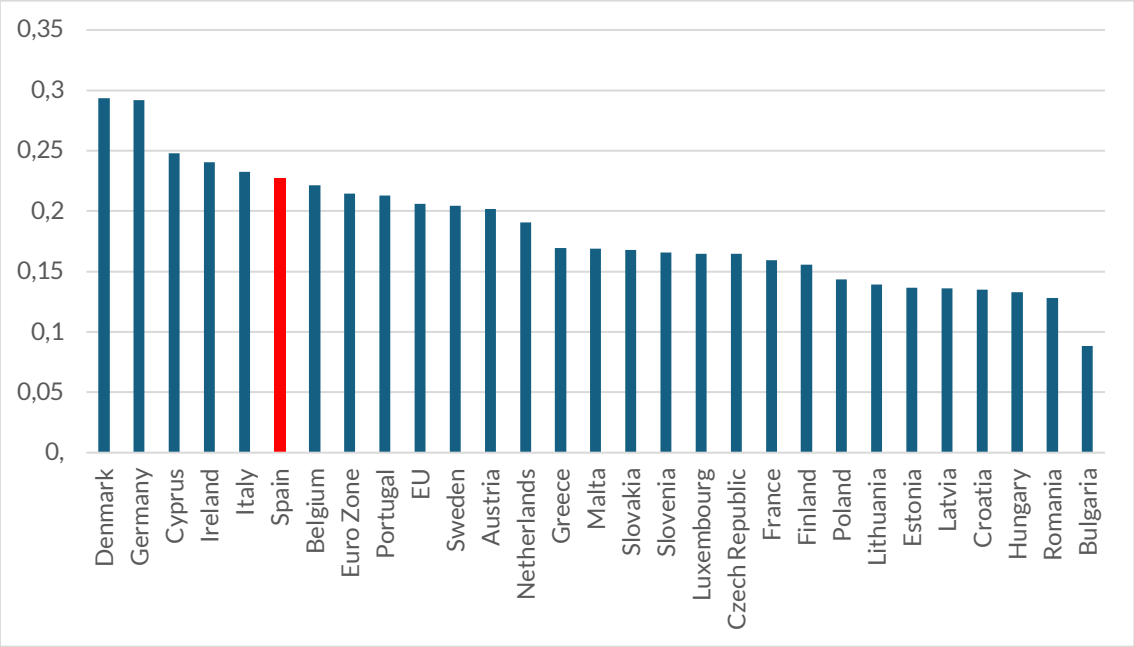
While at the time when the key regulation that later generated the solar PV bubble was passed, Spain was in an intermediate position in terms of household electricity prices among EU countries, the situation when the bubble burst was much worse, as Spain moved to the top of the table.

Figure 15. Electricity prices in European Union countries in the second half of 2007, in euros/kWh.



Source: Prepared by the authors based on Eurostat.

Figure 16. Electricity prices in European Union countries in the second half of 2013, in €/kWh.



Source: Prepared by the authors based on Eurostat.

As explained above, most of the money paid by households and businesses on their electricity bills is not determined by market conditions, but by political decisions, which in fact account for three out of every four euros of the cost paid by the private sector when financing its energy supply. [16]

These decisions include subsidies, compensation and taxes, so we are talking about costs that are not directly related to energy production. Excluding taxes, and according to Eurostat data, the increase in the cost of electricity that Spain has experienced is largely due to the additional tariffs approved to incentivize the use of renewable energies, as well as the costs associated with CO2 emission rights.

Since 2007, regulated costs have more than doubled from just over EUR 8 billion to nearly EUR 17 billion. This significant increase is mainly due to renewable energy tariffs, which have considerably increased their proportion of total costs.

[16] The bill can be divided into four parts: energy costs, transmission and distribution tolls, charges (including renewable remuneration) and taxes. Energy alone (the "free" price) accounts for about 25% of the bill. Charges, for example, represent about one third of the bill.

As indicated above, renewable premiums accounted for about 28% of the electricity bill. [17] In contrast, prices in the wholesale market have had ups and downs, but have generally remained stable. [18]

Industry competitiveness

During the renewable energy bubble in Spain, prices rose significantly, which had an adverse impact on the country's industry and economy. High energy costs, exacerbated by policies that supported renewable energy production through subsidies and feed-in tariffs, placed Spanish companies in a comparatively unfavorable position relative to their international competitors. This situation generated considerable pressure on industries that were heavily dependent on energy consumption, forcing them to reconsider their cost structures and investment strategies.

An emblematic case of the consequences of these high prices is that of FerroAtlántica, a company that faced significant difficulties due to the increase in energy costs. FerroAtlántica, known for its production of ferroalloys and silicon metal, is an energy-intensive company, which makes its operations particularly vulnerable to fluctuations in energy prices. The company was forced to evaluate its operations in Spain and, in the face of rising prices, implemented drastic measures to reduce costs, including relocating part of the new production to countries with a more favorable energy environment, highlighting the direct impact of energy policy on strategic business decisions.

Acerinox, one of the world's largest stainless steel manufacturers, is another clear example of the impact of high energy costs. The company opted not to expand its operations in Spain and instead increased capacity at its plants in Kentucky (USA) and Columbia (South Africa), due to lower energy costs in both countries. This decision was essentially based on the need to avoid Spain's high energy costs, which were negatively influenced by green energy policies.

Gonzalo Urquijo, president of the Unión de Empresas Siderúrgicas, publicly expressed the sector's concern about the sustainability of the industry under the regime of ever-higher energy prices driven by investment in renewable energies. He criticized public policies that, in his view, penalized traditional industries through high costs that were not offset by parallel improvements in infrastructure or incentives. Urquijo argued that these policies not only affected competitiveness, but also put at risk the viability of industrial operations essential to the Spanish economy, evidencing a clear sectoral dissatisfaction with energy reforms.

In September 2007, a group of eighteen large energy-intensive Spanish companies in the metallurgy, cement, chemicals, ceramics and gas sectors formed an

[17] Renewable premiums accounted for about half of the cost of charges and tolls, which in turn accounted for slightly more than half of the final bill paid by consumers.
[18] Information available at the following link: https://www.libremercado.com/2019-05-21/manuel-llamas-por-que-se-ha-disparado-la-luz-en-espana-culpen-a-politicos-y-ecologistas-87920/

association called Fortia. This group, which represented 18% of industrial electricity consumption in Spain and 7% of total demand in the Iberian Peninsula, was created with the aim of negotiating and purchasing energy centrally and seeking special treatment from the administration to exempt itself from the costs generated by current energy policies. This measure was seen as crucial to maintain its competitiveness vis-à-vis companies in countries with lower electricity costs.

The Spanish experience during the renewables bubble illustrates the complex economic and competitive challenges countries face when adopting energy policies that ignore market dynamics. As companies such as FerroAtlántica and Acerinox experienced significant increases in energy costs, driven by subsidies and regulated tariffs to support renewables, they were forced to make drastic strategic decisions, including relocating their operations to regions with more favorable energy costs.

This situation not only highlights the direct impact of green energy policies on industrial competitiveness, but also underlines the importance of a balanced approach that harmonizes environmental objectives with economic viability and industrial stability. The creation of the Fortia association by energy-intensive companies highlights an organized response by the industrial sector, which sought to deal with the situation by negotiating more favorable prices and mitigating as much as possible the adverse effects of these anti-growth policies.

This case underscores the need for energy policies to carefully consider the economic impact on economic activity and especially on industry, ensuring that sustainability efforts do not compromise the country's productive base and capacity.

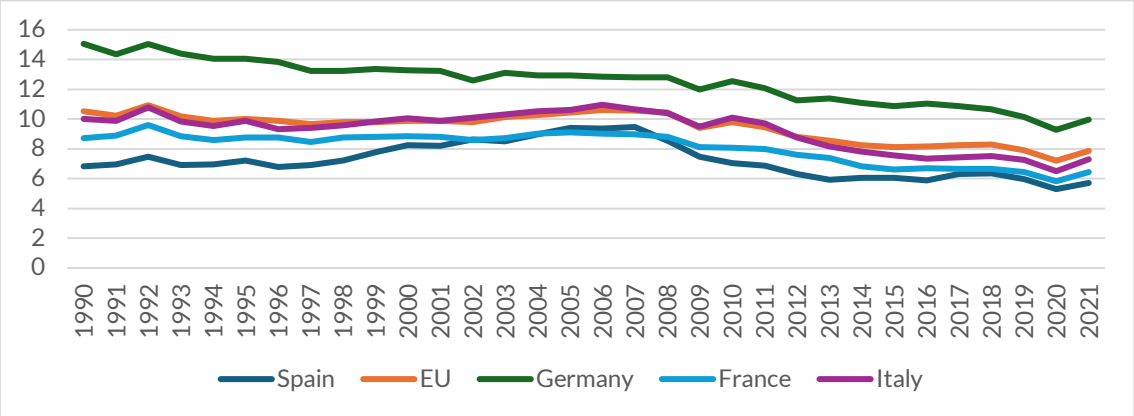
Loss of leadership and efficiency

The remarkable increase in installed capacity of the main renewable technologies during the bubble era came to an abrupt halt between 2013 and 2018. During this five-year period, the installed capacity of solar PV and wind, for example, barely budged from 4,600 MW and 23,000 MW, respectively. This is evidence of the boom and bust dynamics of renewable energy industries, or any others that rely exclusively on subsidies, mandates and similar regimes.

As a result, Spain ceased to occupy the top positions in the renewable energy sector. According to the *Green Innovation Index*, in its international edition, Spain had disappeared from the world ranking of renewable patents, being surpassed by countries such as China, France, South Korea and Taiwan. Moreover, established powers such as the United States, Japan, Germany or the United Kingdom have systematically surpassed Spain in this field from 2012 onwards.In addition, despite the great commitment to renewables at this time, CO2 emissions, adjusted for trade, have not performed much better in Spain than in other countries in our environment. It is true that there has been a slight decrease since 2008, but as in other countries in our environment, the explanation is due to the deterioration of the economic situation. Although it is true that there was an increase in the

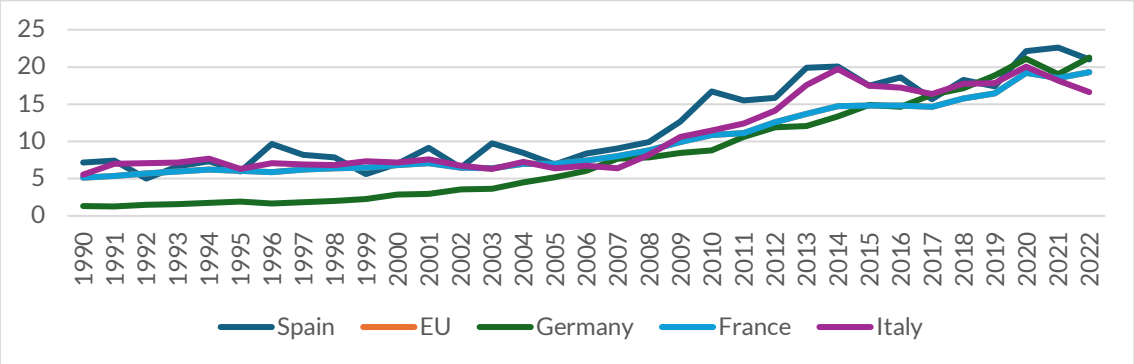
consumption of primary energy from renewable sources during the 2007-2013 period, and despite the fact that the increase was higher than in other countries in our environment, this differential was gradually lost in favor of other countries that also made a commitment to renewables. Moreover, while other countries have managed to maintain a more or less stable rate of growth in green energy, in Spain there has been a sharp decline in the post-bubble period. This is especially true for the technology that benefited most from the feed-in tariffs, such as solar.

Figure 17. Per capita consumption of CO2 emissions, in tons.



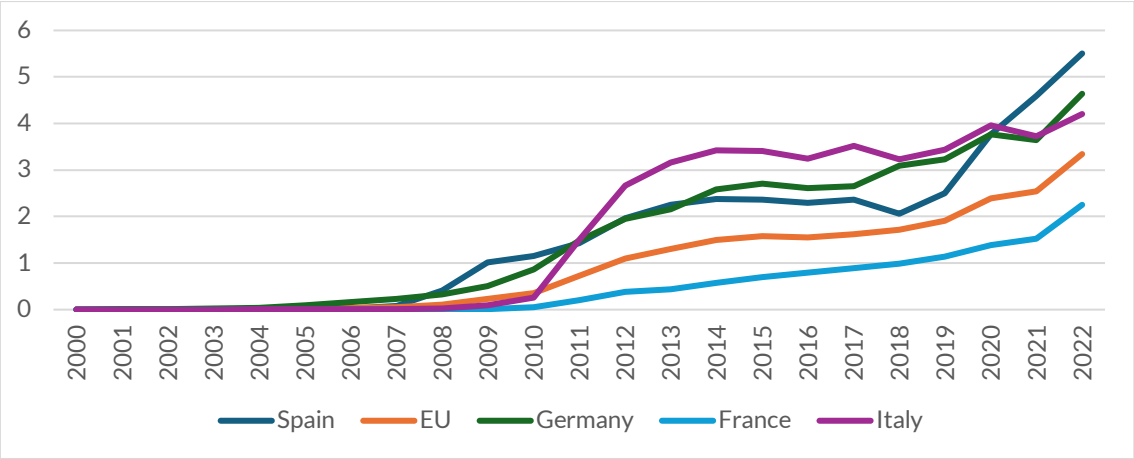
Source: Our World in Data.

Figure 18. Primary energy consumption from renewable sources (%).



Source: Our World in Data.

Figure 19. Percentage of primary energy consumption coming from solar energy.



Source: Our World in Data.

One possible explanation for these paradoxical results is that, as Díaz et al. (2021) point out, the key to reducing emissions is the adoption of energy-efficient technologies, or, in other words, to opt for pro-market solutions. As explained above, Spain has followed an energy model that goes precisely against the logic and dynamics of the market, applying heavy subsidies to technologies that were not at all efficient at the time they began to be subsidized. In fact, the authors find that emissions in Spain have a cyclical component, so that the commitment to renewables did not translate into gains in energy efficiency and the environmental performance indicators have not moved downwards due to renewables as much as to fluctuations in production and efficiency gains by producers.

5. Conclusions.

From the analysis of government intervention in economic activity and, specifically, in the renewable energy sector in Spain, it is essential not to underestimate the failures that can accompany these policies. Alleged market failures often justify the need for government intervention to correct inefficiencies such as externalities or information problems. However, it is crucial to recognize that government intervention is not error-free and that these can sometimes exacerbate the problems they seek to solve.

The public intervention errors committed during this stage have been the following: [19]

1. The first major mistake in Spain's energy policy was the allocation of overly generous subsidies for renewables, based on optimistic and unrealistic estimates of the evolution of production costs. Royal Decree 661/2007, for example, established tariffs for solar energy at disproportionately high prices compared to the market, keeping these tariffs regulated for extended periods of up to 25 years. This type of policy generated an unsustainable financial burden and discouraged the search for real efficiencies in the sector, distancing its dynamics from market operations.
2. The second major mistake was the lack of foresight about the resources needed to sustain these policies in the long term. Spanish legislation not only set too high a limit on installed renewable energy capacity, but also failed to enforce these limits effectively when necessary. This resulted in an oversizing of capacity that exceeded what was sustainable given the available resources.
3. The third major mistake was the creation of an environment of legal uncertainty derived from the abrupt cuts in regulated tariffs, which definitively paralyzed new investments and generated regulatory uncertainty that deeply damaged the investment climate in the sector, discouraging the private sector's commitment to the development of renewable energies and scaring off foreign investors.

In short, Spain's experience with the promotion of renewable energies between 1998 and 2014 is an emblematic example of the challenges and opportunities in the transition to a sustainable economy. During the period analyzed, the implementation of policies aimed at subsidizing a large increase in capacity that did not respond to the productive demand of the private sector fostered a disorderly growth that led to a speculative bubble, with significant socioeconomic impacts. The subsequent bursting of the bubble went hand in hand with a deterioration of legal uncertainty and negatively affected industrial competitiveness and the stability of the energy sector itself.

Lessons learned underscore the need to balance environmental objectives with economic sustainability and regulatory predictability in future renewable energy policies. Key lessons and insights from the renewables bubble are detailed below:

[19] In a similar vein, Santaló (2011) also points out these same errors.

1. Growth and boom in renewable energies: during the period 1998-2014, Spain experienced a remarkable growth in the installation of renewable energies, especially in the solar photovoltaic sector. Driven by subsidy policies and guaranteed tariffs, known as *Feed-In-Tariffs*, the country managed to multiply its installed capacity in clean energies. In 15 years, the country's installed capacity in renewable energies increased from 5,000 MW to 40,000 MW. This growth was particularly marked between 2007 and 2008, when photovoltaic installations increased fivefold due to generous financial incentives. 86,915 million, but there are still two decades of payments to be made, so the final figure may be in the region of 300 billion euros.
2. Formation of the speculative bubble: However, the rapid and poorly regulated growth of the sector generated a speculative bubble. The high premiums offered ensured high returns, attracting a disproportionate amount of investment, often without a proper assessment of risk and long-term sustainability. So much so that, for example, solar photovoltaic has been receiving twice the subsidies received by wind power, when its production is one fifth of the latter. This not only significantly increased support costs, but also distorted the energy market and put the financial stability of the Spanish electricity system at risk.
3. Economic and social impact: The boom in renewable energies was accompanied by significant economic and social costs. Clean energy premiums and subsidies drastically increased the cost of electricity for consumers and contributed to the tariff deficit, an accumulated debt that was passed on to future consumers. In total, as much as 40 billion euros of debt was accumulated in the system. In addition, the bubble and its subsequent bursting negatively affected the competitiveness of Spanish energy-intensive industries, many of which opted to relocate their operations to countries with lower energy costs. This impact was also reflected in job losses in the renewable energy sector and a decline in Spain's leadership in technological innovation in this field. Estimates suggest that the sector lost half of the employment it generated in five years, going from 143,000 jobs in 2008 to just over 75,000 in 2015.
4. Bursting of the bubble and legal consequences: in 2013, the feed-in tariff system was replaced by a new remuneration model based on reasonable profitability, which put an end to the dual system of ordinary and special regime. These changes, although necessary to curb the bubble, generated a wave of international litigation against the Spanish State by affected investors. The lawsuits alleged a violation of the principles of legal certainty and legitimate expectations, arguing that the abrupt cuts in guaranteed tariffs compromised investments made under the previous regulatory framework. This climate of legal uncertainty damaged Spain's image with international investors and slowed down the future development of renewable projects. Spain has been sued before various international courts, which have recognized close to 1,800 million euros in the various awards that the State has lost to foreign investors. Spain is on a par with

Russia and Venezuela in terms of disputes and unpaid awards in international courts.

Looking to the future

The lessons from what has happened are clear. The Spanish experience with the green energy bubble underlines the importance of abandoning interventionism and the pretension of designing or planning energy markets with our backs to the needs of the private sector. The implementation of financial incentives was done without adequate risk and sustainability assessment, which led to undesired consequences.

It is crucial that energy policies consider environmental benefits but also economic viability and market economy conditions. Looking ahead, Spain will need to strike a balance between encouraging investment in the sector and maintaining a predictable and sustainable regulatory environment that avoids repeating past mistakes.

Above all, this reflection should lead us to highlight the importance of the market as a fundamental mechanism for the development of innovations in the energy sector. Unlike public intervention, the market promotes efficiency, competitiveness and technological adaptation, which are essential factors for sustainable and lasting progress in the process of adopting and deploying renewable energies.

To address climate issues, we need to accelerate innovation, which requires encouraging the free development of competitive markets. Open economies are not only richer, they also have cleaner production models. By opening markets to competition, governments can encourage innovation and reduce the cost of new investment, which in turn drives economic growth, job creation and, environmentally, decarbonization.

In the West, energy use is increasingly decoupled from GDP and per capita CO2 emissions have been significantly reduced. Policymakers need to accompany these developments with tax breaks to facilitate market-driven decarbonization.

At the international level, a general agreement is essential to eliminate inefficient subsidies and to withdraw interventionist climate policies, promoting instead a free trade framework with competitive markets where subsidies are superseded and, above all, clear rules, duly assigned property rights and a context of low taxes and simple regulations.

Nations adopting such policies can access foreign investment flows through reciprocal tax incentives, such as tax-free debt for gross fixed capital formation across borders. Likewise, the bid for lower taxes can be articulated by rewarding emissions reductions with lower taxes, further incentivizing innovation, efficiency and sustainability of production.

These proposals seek to overcome current climate policies, which are often counterproductive and restrict freedom of enterprise. Instead of subsidies, regulations, taxes or policy decisions that pick "winning" industries and make others "losers," they advocate a free-market approach that incentivizes emissions reductions in a more efficient and equitable manner. This approach not only addresses climate policy in a smarter way, but also enables the development of an economic model focused on growth, innovation and wealth generation in a context of freedom. Future research at the Juan de Mariana Institute will explore this proposal further.

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