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Opinion paper

A critical analysis of the Spanish electrical system: risks and opportunities by 2050

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Abstract: The Spanish electrical system is now in a position to take advantage of developments from the recent past. Many of its facilities, such as nuclear and coal power stations, have a useful life which will come to an end during the 2020–2030 decade [1] (from 2021 in the case of Vandellós 2, and up to 2028 in the case of Santa María de Garoña). The mankind is currently going through a global environmental crisis which includes greenhouse effect gas emissions as a major component [2]. These are closely linked to the energy system, particularly to electricity generation, and could be a determining factor in the future evolution of such a system. Clearly, such a crisis can potentially lead to serious difficulties in accessing energy for many people. The energy business sector has been undoing its ties to particular territories and has been expanding towards other countries to become more and more dependent on foreign capitals and decision-makers. Now that a stagnant period for electricity demand is being experienced, this does not favor new schemes. However, new proposals should be considered given that many infrastructures will soon be obsolete. In this paper some scenarios are proposed to contemplate the transition of the Spanish electrical system towards an energy model with the year 2050 in mind, where the goal is to lower greenhouse gas emissions [3]. One of the factors to be considered during this period should be the participation of renewable energies. Transport and mobility are also likely to undergo some changes, for similar reasons, and in this time frame they will increasingly be designed to use electricity.

Keywords: energy; electricity; renewable; environment

1. Introduction

During the industrial and economic development of Spain, the electrical system has been a major revitalizing element, in the same way as the railway system or public works. So important is this effect that it should be mentioned before any other considerations.

The current global crisis is focused on financial aspects and has so far had particular effect on the western world. Unemployment is one of the most important issues, and increased to 26% in Spain in 2013 [4], although it has descended to under 25% during 2014. In addition, nothing seems to indicate that the crisis will not have more widespread effects in future years. The so-called emerging countries could see a sudden slow-down in economic growth, and the poorer countries may see their already seemingly permanent problems exacerbated by increasing energy prices and a limited access to financial markets.

But when thinking about this crisis in a global way, it seems clear that there are some further issues to be considered. For example, an ecological crisis could be caused by mankind's insistence in not respecting the biophysical limits of biogeochemical cycles in the ecosystems, such as carbon and nitrogen cycles. Then there are also other matters related to large-scale social breakdown around the globe, which can trigger different consequences, such as new food access crises or limits to freedom.

Returning to the Spanish case, it should be pointed out that energy imports have risen to 75% of primary energy [5,6], consisting basically of oil and gas (where dependency exceeds the value of 99%), but also uranium and coal. The share corresponding to both hydrocarbons is equivalent to about 5% of the Spanish gross national product (GNP) and this is one issue that is hampering economic growth and job creation.

Some actions have been promoted by the Spanish administration in order to improve energy efficiency within the economic model. As a result, energy consumption has decreased from a figure close to 200 toe/M€ of GNP until 2004 (198.8 in 2004), down to values under 170 toe/M€ in 2012 (165.6 in 2012) [5].

The Spanish energy system involves emissions of about 284 Mt/year of CO_2 [5], which means a per capita value of 6.5 t/year. Other emissions are CH_4 (33 Mt), N_2H (24 Mt), HFCs (8 Mt), PFCs (0.3 Mt) and SF_6 (0.4 Mt). If coherence with plans to counteract the evolution of climate change is sought, these figures should be clearly reduced, at least by reducing CO_2 to half its value. The top emitters are the goods transport sector and personal mobility, followed by electricity generation. Both together account for 2/3 of the total amount.

When discussing climate change, it should be noted that Spanish population tends to regard renewables in a favorable way [7,8]. This will be considered by the authors as a starting point in order to assess how much this sector can be present in the energy system in general, and, of course, in the electrical system in particular. However, this commitment in favor of renewables can also be seen as a factor that can help to reduce energy dependency and create jobs in industry.

2. Electricity in the Spanish electrical system

The final energy consumption in Spain in 2012 was 89.311 Mtoe [5]. Its breakdown, shown in Table 1, can be of use when thinking about some points, such as the following:

1. The most important factor is fuel demand for transport and mobility. It is directly responsible for the major energy dependency on oil. Oil accounts for over half the contribution of primary energy.

A historical analysis reveals that approximately a 20% of consumption can be due to aviation. A little over the 40% is used for goods transport, basically by mean of trucks and vans, to which a small contribution from freight trains can be added. The remaining 40% can be accounted for by cars, buses and other motorized vehicles. It is feasible to think of policies and cultural changes that would lead Spain to different usage profiles, including increased austerity or more thoughtful use of private vehicles, but the way of life of Spanish cities and the great share that tourism has in the economy mean that it can be assumed that this sector will continue to be the biggest energy consumer in the future. In the considerations presented here, it will be stressed that oil dependency has its origin in transport and mobility, which is where technological solutions are needed that involve diversification of the energy sources used in the sector. Electricity should increase its participation significantly, through the promotion of vehicles using electricity or hydrogen and increased electrification of the rail system.

2. The share of electricity in final consumption is 23% at present, a figure similar to that for other developed countries. It could, however, be increased in the future if there is an increase in demand by electricity users or the possibility of involving electricity in the transport system. Half of Spain's electricity consumption is currently due to industry. The country has significant participation by several sectors such as the iron and steel industry, metallurgy, the chemical industry and others that are very intensive in electricity demand. The need for more job creation together with a wide territory can be factors that could hold or even make increase this presence of basic industry. Services for tourism and commerce involve a bit over 25% of net availability of electricity in the Spanish system. Here, an increase in demand is foreseeable. Another 25% of electricity demand is due to domestic household use. Spanish homes have an average daily demand of 10 kWh, which means a yearly value of almost 4,000 kWh, although there is a strong dispersion of consumption: there are single-family houses with high consumption values of more than 10,000 kWh per year, whilst in the rural communities or in less well-off districts values closer to 1,000 kWh per year can be found. The economic crisis has not favored an increase demand in broad sectors of society. Only regulations towards positive price discrimination to benefit the less fortunate sectors of the population could possibly have the effect of supporting or even promoting electricity consumption among these social groups.

Table 1. Final energy consumption in Spain in 2012.

Technology	Energy consumption in ktoe (%)
Coal	1,076 (1.2%)
Electricity	20,427 (22.9)
Gas	15,551 (17.4%)
Gas obtained from coal	238 (0.3%)
Oil	45,634 (51.1%)
Renewables	6,385 (7.1%)

Electricity demand is obviously met by a mix of different sources. In Table 2 the values of demand coverage for the year 2012 can be seen in the peninsular system [9]. The demand for energy was of 269,161 GWh in the peninsular system. The set of renewables came to a third of the total. In

Table 2, OR stands for ordinary regime and SR for special regime.

Table 2. Electricity generation in Spain in 2012.

Technology	Demand coverage in the electricity system in 2012 (GWh)
Hydro (ordinary regime)	19,455
Nuclear	61,470
Coal	57,662
Fuel/gas	7,541
Combined cycle	42,510
Hydro (special regime)	4,635
Wind	48,472
Solar photovoltaic	8,171
Solar thermoelectric	3,443
Renewable thermal	4,736
Non-renewable thermal	33,716

Coal was the most important electricity generation source until 2008. It accounted for 40% of the total. The building of combined cycle power stations and the increased share of renewables have reduced the presence of coal to values under 20%, although over the last two years there has been a certain return, either as a way to support the Spanish mining industry or to make the most of favorable prices of imported coal. However, as can be seen in Table 2, nuclear power plants generated more energy than coal power stations in 2012.

In the disputes between mining sector companies, trade unions, and the Spanish government, the government has agreed to certain proposals by the European Commission to end aid to coal generation by 2015. Social protests continue, although currently they are not strong. But there is also a proposal for constituting a public company in the province of Leon. This does not seem to be feasible as it would involve a new deficit concept for the State.

The possibility of an end to aid, the fact that coal power stations are already over 40 years old, and the difficulty in adapting them to environmental guidelines, such as emission limits, all indicate that these power stations will probably be out of service by 2020.

Installed power in combined cycles, some 25,000 MW, is oversized for the electricity mix nowadays. Perhaps there was no proper planning when many new utilities were proposed and appeared in the Spanish electricity system in recent years, but the fact is that they are being operated at 25% of their overall generation capacity [9]. The installation of new groups does not seem to fit easily in this scenario, although there are some new proposals that have not yet been rejected.

3. History and planning of the Spanish electricity system

The last fifty years have involved continuous changes in the technical, business and social aspects of the Spanish electricity system. Until the sixties of the 20th century, the generation system was made up of mainly hydro and coal stations. The State planned the system, which was run by

private companies at the generation and distribution levels, and there was a public company whose aim was to support the generation system, mainly with domestic coal.

During the sixties the private companies committed themselves to using fuel oil in generation, because the specific investment was lower than that for coal, and low oil prices were expected. To this effect power stations were built with a total nominal power of 11,000 MW. The oil crisis in 1973 made an agreement possible between the State and the companies which left such stations in a standby situation, and there was a subsequent return to coal. In addition, an extensive plan for nuclear power plants went into development.

In 1985 Red Eléctrica de España (REE), the Spanish Transmission System Operator (TSO) was created [10]. From the outset it was a public corporation, and its aim was to optimize the electricity mix according to cost optimization and supply security.

The Spanish electricity system worked hand-in-hand with the public administration up to 1997. It was the public administration which defined the planning of the system with agreement from electricity companies, and fixed the tariffs by taking into account the investment in the transmission and distribution systems. Paying back installation costs was included in the rates system. Then, in 1997, the new law governing the electricity system (Ley del sector eléctrico [11]) was published and changed not only the operational system but also the conceptual framework. Strategic planning disappeared, and the electricity and gas sectors were deregulated. Any investments made from that date on were not guaranteed in the rates. Those made before that date received the part that had not yet been recovered from a so-called "change to competition" fund (which included coal and nuclear plants).

The response to this change from the new privatized electricity sector was a disordered building of combined cycle power stations. At the end of 2012 there were 27,144 MW installed in such plant, in addition to 7,373 MW in co-generation stations, a large number of which operated with natural gas.

It should not be forgotten that a substantial part of Spanish natural gas imports come from countries in northern and western Africa, and also from the Middle East [12]. In Central and Northern Europe there is more dependency on Russia and in the South of Europe there is dependency on Arab countries. Where gas for the Spanish System comes from can be seen in Table 3 [5]. Under the denomination Gulf there are three countries: Abu Dhabi, Qatar and Oman.

Table 3. Spanish imports of natural gas (souce: ENAGAS).

Country	Imports in TWh
Algeria	41.2
Norway	5.2
Gulf	11.2
Trinidad and Tobago	6.9
Nigeria	15
Egypt	1.9
France	8.9
Peru	7.6
Yemen	0.4
Belgium	1.4

The Spanish electricity sector has also seen some changes in its business structure, from which some facts are worth pointing out in order to understand its evolution and to detect those aspects that can be labeled critical:

- In Catalonia, the company Fuerzas Eléctricas de Cataluña (FECSA) went bankrupt in 1985, due to investments made in the Ascó and Vandellós nuclear power stations, where the financial costs exceeded the standard values assigned in the regulatory framework. This coincided with an unclear situation in court concerning Banca Catalana, which involved politicians from the autonomous community. The problem was resolved with a fund and assets transfer between the former Empresa Nacional de Electricidad (ENDESA) and FECSA, of an amount that came to over €3,600M.
- The electricity companies ENDESA, Iberdrola and Unión Fenosa (UF) took part in investments in other countries during the nineties. These investments were focused very particularly on Latin America, and increased the debt of those companies.
- Some Spanish companies were sold to energy companies in other countries. For instance, ENDESA was sold to the Italian public company ENEL, after a process where territorial interests also played their part, beginning with an attempt to set up a Catalan electricity company with the company that had finally saved FECSA from going bankrupt. Also, at a previous stage, Hidroeléctrica del Cantábrico was sold to the Portuguese company EDP with some interference from the French EDF and the German E.On.
- That attempt to create a Catalan energy company finally came to an end with the acquisition of UF, a company based in Galicia and Madrid, by Gas Natural, a company whose HQ is in Barcelona. This process contributed to Gas Natural's debts.

All these facts have led to weaknesses in the make-up of the Spanish electricity sector and, at the same time, a reduced capacity to intervene by the Spanish State or the autonomous communities. One point of concern has to do with future strategic and public planning, which may be deemed necessary for the common good, and about which there will be further discussion in this paper.

4. Environmental issues

Spanish society initially accepted the environmental impact of electricity generation and, though there were some protests during the years of dictatorship, they were not numerous. Subsequent stages saw protests grow, though this depended on location and types of facility.

The hydraulic system was developed with three goals, i.e., to supply irrigation systems, to supply cities with drinkable water and for electricity generation. In those regions where the two first goals were not priorities, such as Galicia and Aragon, there had already been important confrontations during the time of the dictatorship. In both regions (now called autonomous communities) problems continue to appear due to new installations or the bad use of existing ones.

In the Tagus basin, the demand for electricity from Madrid involved a very high preasure in favor, first in the upper part of the basin, but also at the lower end near the border with Portugal. This situation has given rise to a great distortion in the ecosystem, that notably increased with the diversion from the river Tagus to the Segura.

As for coal thermal stations and the mining exploitations connected to them, there have been some contradictions. On the one hand, they have involved social and economic development in certain areas, but on the other they have brought with them a very significant environmental impact.

The emissions of sulfur oxides exceeded 2 Mt per year and those of nitrogen oxides, half a million. The following observations can be made for the different autonomous communities:

- Galicia. Exploitation of brown lignites in opencast mines. The restoration of the mine at As Pontes de García Rodríguez with water and the creation of an artificial lake has given rise to some criticism. The restoration of the mine of Meirama has not been finished. The emissions of sulfur oxides in both plants were very great and the high chimneys spared the plumes into the Cantabrian area.
- Asturias. This is an autonomous community where mining has always been a very important social component, and there are still issues linked to the mining reconversion that have not yet been resolved. The power stations have produced medium and high levels of nitrogen oxides emissions.
- Castile and Leon. Anthracites and soft coals were extracted in this community. The former caused very high levels of nitrogen oxides emission at the power stations of Compostilla and La Robla, for example. Nowadays there is some extraction activity in the mountains of Laciana with a heavy environmental impact and a growing public opposition movement.
- Aragon. The building of the Andorra plant caused some public opposition, more when the proposal was to allocate it in the proximities of the river Ebro, with the intention of taking water from that river. The sulfur oxide emissions have been significant and the restoration has been very inconsistent.
- Castile-La Mancha. Puertollano underwent the transformation from underground mining to opencast works, and its level of restoration is good. The building of a regasification plant with combined cycle has become a landmark in the history of the clean use of coal.
- Andalusia. The mining basin of Peñarroya has not seen much controversy, and the same can be said of the plant at Puente Nuevo. Both coal plants operate with imported coal. Los Barrios and Carboneras experienced public opposition during the building periods.

Spain's nuclear plants have always lived alongside heavy public opposition. Even from the outset, the plan to construct 37 groups at the end of the 1970s was unnecessary in the Spanish power system. However, they were seen as a great economic opportunity for private companies, which, in 1975, forced the Industry Ministry to keep the public company out of their development.

Demonstrations against building such plants in Euskadi were very large and added to that autonomous community's already complex political situation. But the protests also appeared in Galicia and Castile and Leon, where projects were at advanced stages. Finally, only seven were built.

Uranium mining had already created health and environmental problems in the exploitations at Andújar, and the media had discovered the appearance of diseases, including cancer, possibly being linked to the activity. The mine of Ciudad Rodrigo was closed because of economic interests and the mineral was obtained from Niger.

5. A vision for the future

For the purpose of designing future scenarios in the Spanish electricity system there are some factors that suggest uncertainty, which can be summarized as follows:

- Low presence and capacity of the Spanish State in the tasks that mark guidelines and designs for such future development.
- Trend for the electricity companies to have a greater presence of foreign investors, who will

predictably look for high profits over short time periods.

- Low level of interconnection of the Spanish electricity network with the main European Union (EU) system through France. A higher level of transmission interconnection would be desirable.
- Situation of economic crisis which involves uncertainty with respect to the conventional vision of economic evolution and energy demand.

However, there are institutional and academic stances suggesting or even demanding a set of significant changes in the energy system, to reduce green house effect gas emissions and also to limit dependency on fossil fuels, which is highly desirable in a country with a dependency of more than 75%. It should not be forgotten that gas and oil imports amount to 5% of Spain's GNP, and forecasts for these fuels are not very promising.

The basic guidelines for this change in technological model for the energy system are mainly the following, not forgetting action at a political and cultural level to help people use energy in a smarter and more efficient way:

- Progressive change in the energy contribution to the transport and mobility system, with oil derivatives being substituted by other energy sources, such as natural gas, bio-fuels, hydrogen or electricity. In Spain's case, however, the issues raised by increases in natural gas use are generally the same as those for oil. Likewise, fuels sourced from agriculture can give rise to environmental problems in countries where the raw materials are cultivated, although an increased presence in Spain is foreseeable. This is why the main proposal is to move towards the use of electric vehicles and, eventually, ones using hydrogen.
- Such an amount of electricity consumption should be provided with low greenhouse effect gas emission options. In general, the commitments in this sense point towards two very different options: nuclear energy and renewables. In the particular case of Spain, a commitment to nuclear energy is not easy because public opposition will be very great and discrepancies would appear caused by the existence of different autonomous communities. Surely the proposal would be to install new plants in the poorest communities, which should accept this less desirable option only with the future possibility of selling energy to the richer ones. The renewables option appears somewhat simpler, and it is the one proposed in this paper, although there are technical difficulties for large scale implementation.

All this strategic change is proposed as a goal for the energy system with 2050 in mind as a date for being consolidated, although there will have to be some transition scenarios between the present situation and the future scenario. This does not seem a very easy task given the ultraliberal trend of the markets nowadays, where the role of States has been progressively decreasing, alongside public participation in the debate.

6. Transition scenarios

The uncertainty about what can happen over the next few decades is, obviously, a determining factor for drawing up evolutionary schemes. There is no evidence that the economic crisis will disappear until 2030 at the earliest, with all the nuanced effects that it will have on analysis.

Unemployment and precarious employment will be critical topics. Nowadays it is difficult to think of any economic schemes for Spain by which some half a million jobs a year can be created. This implies that the country will not be able to have a jobless figure below 2 million during many years.

There are some other uncertainties in Spain, including the political ones, and all this is within the framework of European policies. The role of the state and its capacity to influence are not clear. However, a set of transition scenarios is here presented, with 2030 in mind as a date when some policies should be decided upon in order to advance towards 2050. These scenarios are given in Table 4.

In group A of scenarios (Sc. A.1–3) the assumption has been made that there is no significant increase in electricity demand during this decade and next one. The crisis is ongoing and there can be a certain shift in the transport and mobility system towards the direct use of electricity but this does not mean in practice important changes in the final electricity demand, which reaches a value of 300,000 GWh. Some institutions in Spain foresee that the number of jobs destroyed during the crisis will not be recovered at least during the next two decades. So the hypothesis is acceptable. On the other hand, at the end of 2012 electricity consumption was lower than 270,000 GWh [9], a figure that allows us to predict a final total figure of 300,000 if there is some economic growth after the first two decades.

Table 4. Energy scenarios by 2050 (values of energy in GWh).

Technology	Sc. A.1	Sc. A.2	Sc. A.3	Sc. B.1	Sc. B.2	Sc. B.3
Nuclear	20,000	40,000		40,000	60,000	
Coal		10,000	10,000		15,000	20,000
Combined cycles/Gas	125,000	70,000	45,000	160,000	80,000	75,000
Cogeneration	30,000	40,000	50,000	40,000	50,000	60,000
Hydro	15,000	15,000	15,000	15,000	15,000	15,000
Wind	80,000	80,000	120,000	100,000	120,000	140,000
Solar and other renewables.	30,000	45,000	60,000	45,000	60,000	90,000

In group B of scenarios (Sc. B.1–3) the assumption has been made that there is a significant shift from consumption of oil derivatives to electricity. Under this assumption and in parallel with a certain recovery in the economic situation, a value is concluded for the generation that is 1/3 greater than the generation today and in scenarios A, i.e., 400,000 GWh. Note that this would not necessarily imply growth in total energy consumption as the assumption is being made that some of the energy currently produced using different sources will be obtained from the electrical system, regardless of the fact that there may be growth in demand for current uses of electricity.

In both cases several possibilities are contemplated for the behavior of the State and Society, and also for the kind of support received by nuclear energy or renewable developments. And this is what differentiates sub-going from 1 to 3, alongside the attempt to reduce CO_2 emissions in electricity generation. Also the assumption is made that no new nuclear plants will be built, but the life of the existing ones could be extended, in options 1 and 2, so as not to allow new coal stations (1), or only to allow a limited number (2).

Scenario B.3 involves no nuclear energy in the system and an important share of renewables, in

particular wind energy, which would meet 35% of demand. This scenario would force the system to have some 52,000 MW installed in wind parks. The question here is: is it possible to obtain this amount of energy from wind parks? According to two reports published by Greenpeace, it is [13,14]. In fact, the proposal of that organization is to meet all energy demand in Spain in 2050 with renewables, not just electricity demand. The figures given by Greenpeace from the extensive work reported in those references speak of 91,500 MW in inland wind parks and 16,500 MW in off-shore wind parks. So the figure of 52,000 MW is still below figures given by them. One interesting discussion would be about the control requirements of the electrical system if the share of renewables were to increase in the mix. But that is not a discussion for this paper, although an interesting fact that can be reported here is that the electricity system in Spain has operated with wind farms covering 64% of electricity demand without any technical problems, which was the case, for example, in September 2012.

7. The opportunity of renewables

In Spain there has been a development process for renewables with the following aspects being considered:

- Rapid increase connected to an interest for what is novel, linked to a cultural idiosyncrasy also in the industry tradition.
- Lack of planning in development. There is progress, but without an adequate assessment of impositions due to the energy framework.
- Use of a bonus system in a similar way to those used in other sectors.
- Industrial development that can be broken from the falling rate of new installations. It is already visible.

The scheme called B.3 in Table 4 is an opportunity for renewables, especially wind and solar energies. It should be a very well planned option and with important industrial development in parallel, which could be linked to an interesting contribution to job creation. Currently in Spain there are some 500,000 jobs in what is considered to be the “green sector”, of these almost 100,000 correspond to renewables, which could face a risk of major job losses.

Several studies show that wind energy has made a significant contribution to this employment make-up, about 30,000 jobs [15], many in industry and design. The photovoltaics sector has rapidly lost its manufacturing industries, with Isofotón the only surviving company. Thermal solar, however, is experiencing dynamic business, which has created about 20,000 jobs.

A criticism that can be made about the development of renewables is the fact that promoter companies have profits as their bottom line, seeing the sector only as an investment, and not worrying about complex management aspects or promotion of associated industrial activity. This is a deeply-rooted business culture in Spain, and is not just present in some parts of the electricity sector, although it would appear to particularly prevalent there.

8. Conclusions

In this paper an explanation has been given of the Spanish energy system. The perfect key expression for this system could be energy dependency, which has been seen to rise up to 75%. In the case of oil and gas, two important fossil fuels, this dependency rises to values nearing 100%, i.e.,

Spain's capacity to producing them is inexistent, which can also be said of uranium.

What has been explained in this paper should have implications for energy policy in Spain. There is an economic crisis in the EU that is mainly affecting countries in the south, and that crisis also affects the electrical system. In Spain there has been a significant flow of assets out of the country and a major part of the total is now in foreign hands.

Three-way discrepancies can be detected, i.e., among Government, Companies and Society. This became highly visible in the decree used to set the price rise in 2014, which affected mainly the small consumers.

The public feels trapped in a kind of cobweb and perceives that the Government is weak and, in some ways, is also trapped in the web, or even collaborates with the business sector to create the web. The fact that distinguished political leaders take jobs in the energy companies when they end their careers in politics undoubtedly contribute to this impression.

In this context, renewables are in the middle of such controversies. The power companies accuse them of being the cause of the accounting deficit that exists in the system. But the companies present profits with margins similar to those existing in the same sector in other European countries.

Electricity generation in nuclear power stations, which make up a fifth of total demand, has very high profits, more than half the invoicing in part due to the fact that most of these facilities were paid for by the creation of a public fund for the transition to the liberalization in the sector, which the consumers are now paying.

Given this mess, the only solution that can be guessed at is that the Government goes back to really representing the State and adopts a new attitude in the face of all the players existing throughout the energy system, particularly in the case of renewables. The Government should analyze what objectives are to be fulfilled by the energy system, and they inevitably include:

- Reducing CO_2 and other greenhouse gas emissions assumed by the UE;
- Reducing energy dependency, which, it must not be forgotten, has risen to 75%;
- And converting the investments already made and those that will be made in the future into really profitable ones.

In addition, a dialogue is vital between the Government and the social partners in the medium term, i.e., around the year 2030, and obviously in the long term, i.e., around the year 2050.

The public's knowledge of the energy system is very limited. It is necessary to develop educational efforts, which is not easy given the interests of different economic lobbies that are capable of guiding the debate.

The scenarios are varied but there does not seem to be a single one of them without renewables given the situation of energy dependency.

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