A Realistic Diversification of Energy Sources and Technologies

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In view of uncertain and looming problems – prices, security of supplies, climate change –, the sector has quite frequently relied on the emergence of a exploratory or technological conquest, or on the discovery of a new source or technology, that will appear as the panacea that solves all our problems.

Regardless of the fact that technological innovation is one of the keys to long-term solutions, and that it requires our utmost efforts, there are sound arguments, as this paper will attempt to demonstrate, that prove that all future strategies – short, medium or long term – must be structured around a voluntary and realistic diversification of energy sources and technologies.

The diversification of sources as the goal

This was not always done in the past, and the present is little different. In general, investing cycles have focused on one or two energy sources or technologies. In the 1950s, coal represented over 50 per cent of the primary energy supply. Years later, in the late 1960s, that place was taken by oil products, which accounted for around 60 per cent of the supplies in the European Union and 70 per cent in Spain. Nevertheless, the oil crisis of the 1970s forced a reduction of oil consumption levels to 40 per cent of primary energy.

The same occurred with nuclear energy, which was introduced in the 1950s as the fundamental, and almost exclusive, future technology for the generation of electricity, and experienced a virtual standstill in investment in the 1980s, due to several causes.

At the turn of this century, after a long period without investments, perhaps due to the excess capacity brought about by oil shocks, the new investment cycle in the production of electricity focused, also almost exclu-

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sively, on natural gas combined cycles – as well as on renewable energies fitting a specific environmental policy. Nevertheless, a few years later, their competitiveness has been negatively affected by the high prices of natural gas, to the advantage of thermal coal plants – despite emission right costs. Even so, investments in these technologies have been at a standstill for many years.

All in all, over recent decades we have observed the splendour, decline and, on occasion, return of most energy sources: coal, oil, nuclear energy, coal again, natural gas and, perhaps, coal and nuclear energy again, alongside renewable energies.

What triggers these swings? Simply, the fact that there is no energy source or technology that can simultaneously and perfectly fulfil all the objectives of safety, economy and environmental protection established by energy and environmental policies. The use of each source produces contradictory effects as regards the achievement of these three objectives. Almost intuitively, we know some contribute more to the security of supply – domestic, fossil or nuclear sources – than others – imported hydrocarbons and certain renewable energies. Renewable energies and nuclear energy – although the latter involves a number of risks – contribute to the protection of the environment and, particularly, to the limitation of CO_2 emissions, while fossil energies produce adverse effects. Finally, from an economic perspective, in principle the most favoured sources are hydraulic energy, coal, nuclear energy and hydrocarbons – according to their historical average, despite price volatility. Conversely, other renewable energies require economic support on the basis of their environmental benefits.

In terms of priorities, the tendency has been to commit at each moment in time to one source alone, to the detriment of the others. Soon after, excessive use slows down the source's development through the intensification of its contradictory effects on overall energy objectives.

Fortunately – although by and large the result has never actually been sought after – this excessive and successive prominence of energy sources has, in the EU and in Spain, given rise to a combination of energy sources, a mix of primary energy and electricity, which is quite diversified. We have to learn the lesson and turn that felicitous, yet costly, historical result, into the goal for the future.

In other words, it is common knowledge today that all energy policies aim, above all, to achieve the best results in terms of security of supply, cost and environmental sustainability. Evidently, there are a series of cross-cutting actions that contribute to this end: efficiency and energy saving in the whole production, transport and energy consumption chain, the efficient operation of markets, and foreign policy for energy.

Ultimately, though, the mix of energy sources, each with its own contradictory effects on the objectives of energy policy, will determine levels of

security, cost and environmental sustainability. In other words, each mix will correspond to a different level of commitment to and balance between these goals. A genuine energy policy should express the mix that is being pursued, which, in turn, involves accepting commitments to different sources and goals, and, in the end, the management of inevitable contradictions.

In principle, making political decisions is no easy task. However, due to the reasons expounded below, the design of the mix should tend towards a balanced diversification of sources.

Comparing sources. Firstly, it is quite difficult to objectively assess and compare energy sources. In terms of the security of supply, in general, as mentioned above, domestic sources (renewable energies, nuclear energy, domestic fuels) offer more guarantees than imports, particularly more than those with cartelization risks, such as oil or natural gas. Yet, what should we make of the intermittence of certain, barely manageable renewable sources, or foreign dependence on uranium concentrates and their enrichment?

The mix of energy sources will determine levels of security, costs and sustainability

As regards costs, the volatility of oil and natural gas prices is common knowledge. However, when it comes to comparing them, with increasing frequency indicators point to the *internalisation of externalities*, taking into account other costs linked to production and consumption. In my opinion, that path is impracticable. How can we justify the support required by renewable energies by attempting to compare them to the investments and assistance that were required to develop conventional thermal energy, nuclear energy and the oil exploration and refining industry, or the costs linked to radioactive waste?

The same applies to the effects and risks linked to the environment, our habitat or our health. How can we compare the risks of nuclear energy to the deaths predicted statistically each year from coal mining, or the possible effects of global warming? How can we assess the negative visual impact of wind power or solar power, or the effects of hydroelectric energy? Comparisons in terms of the CO_2 produced by fuel combustion are not even entirely precise if the global balance is taken into consideration, including CO_2 linked to manufacturing, as in the case of biofuels or hydrogen. Furthermore, we should also consider the inefficiencies produced in the operation of electric systems, and the resulting increase of CO_2 production, given the need to instantly evacuate, for instance, the wind power produced in a unexpected yet natural way.

A context that is not easily predictable. In hindsight, looking back over the last 50 years, we come to the conclusion that most of the events

that have determined the evolution of the energy sector – political and military confrontations, oil price volatility, the Chernobyl accident, the perception of global warming – could not have been predicted or controlled by the people controlling energy policies.

When it comes to energy, Mrs. Thatcher's quote comes to mind: "Think the unthinkable, because the unthinkable happens." In other words, we know the challenges we face in the present, but are unaware of those that will appear in the future. Consequently, we come to the conclusion that we cannot merely consider what seems obvious at present, but must maintain all energy options sufficiently open, as certain major international energy institutions have been advocating for years.

Limitations regarding planning. The observations made above show that energy predictions in terms of demand, supply and prices, and therefore of desirable sources or technologies, have almost always been wrong, for one reason or another. The same applies to reliable forecasts for energy efficiency and saving, which are still beyond our control.

We are familiar with the inertia affecting energy systems, produced by long-term investments in developments in production and consumption, and the long maturation periods required by genuinely innovative technologies. A good part of the current disagreement regarding the future of certain sources or technologies is based on confusion, albeit more or less voluntary, over the number of years for which each one will have industrial availability. The paradigmatic example is that of nuclear fusion, which always has a life expectancy of around 50 years. Evidently, the field of technological innovation is so daunting that it is difficult to resist the temptation of establishing a fiction-technology of sorts.

Attempts to brusquely change energy systems are costly, as we can see if we look back on those, now forgotten, decades of the 1970s and 80s, when a peremptory reduction of the role of hydrocarbons was required. What makes a type of energy more expensive or insecure is not lack or scarcity, but the use of an incorrect mix, or an obsession with specific technologies, which can decisively affect a country's competitiveness. It is important to note that a suitable, well-studied mix is probably more influential in terms of the cost of energy than its market competence.

Furthermore, the decisions we make now will hardly have any significant effects before 2020, and a veritable structural modification of the energy mix can only be conceived by around 2050.

Energy policy, market and diversification

A key issue, which we generally tackle from a confused perspective, is the role played by markets and governments in establishing an appropriate di-

versification of sources and technologies in the long term. In the first place, can the market achieve that sought-after mix by itself? More importantly, if we accept the hypothesis that some government action is required to encourage certain sources or limit others, would it be feasible to channel this intervention exclusively through market mechanisms?

The answer is difficult and complex. Markets can help, certainly. In general, refining, electricity or natural gas companies do not only try to minimise their costs as regards supplies, but also to diversify them by seeking the continuity and security of their industries, while simultaneously integrating environmental goals using regulatory or economic mechanisms. They also mirror the uncertainties of the energy policy context, as has been the case of the standstill in coal-based generation in view of uncertain penalties attached to CO_2 production. Specifically, electricity companies have been very sensitive to the diversification of their technological base.

What makes a type of energy more expensive or insecure is the use of an incorrect mix

Unfortunately, however, this is not enough. Firstly, because it is impossible for the market alone to value specific, mostly intangible, concerns, like those mentioned before in this article. The only option is to turn to governmental decisions to influence the mix, but when it comes to introducing them, it is not always feasible to use only market mechanisms based on regulatory decisions and economic incentives.

It is important to acknowledge that in energy sectors, competition is necessarily very flawed. This is not only due to inherited oligopolist structures, but also to the existence of prior historical, economic and administrative barriers. How can we compete in equal conditions with the electricity sector when participants cannot genuinely have free access to all energy sources? At present, new possibilities for electricity generation are actually closed when it comes to hydraulic and nuclear energies, and even coal. They are only open to gas combined cycles and renewable energies.

Before market liberalisation, systems were planned, and when necessary – after the 1970s crises –, the EU made decisions regarding energy policy that had a powerful bearing on the mix, such as encouraging the use of coal and nuclear energy in the generation of electricity, and banning the use of hydrocarbons for these purposes.

Then, in 1985, a period began in which, sheltered by oversized energy systems and the abundance of cheap energy, there was no need to invest in or influence the mix. This unique situation led to a practice that championed the best energy policy to be the lack of a policy, declaring that the sole goal was for the market to be operative. There was but a single excep-

tion: climate policies. Indeed, once again, their development required governmental intervention, promoting – by using market mechanisms, of course – the development of renewable energies and CO_2 emission trading. Nevertheless, we must acknowledge that the operation of these market mechanisms currently requires major improvements in practice.

In all, governments are responsible for explicitly defining the goals of the mix, for which it is essential to formulate long-term energy policies that include suitable mechanisms – market mechanisms to the greatest possible extent – so as to achieve the goals set down. Unfortunately, neither the EU nor a good number of states have explicit energy policies.

Claude Mandil, former Executive Director of the International Energy Agency, expressed this clearly when he said that it is necessary to find stability "…in a balanced position that recognises the irreplaceable role of the market when it comes to developing competition, cutting costs and improving the services rendered, but which also admits that the market is flawed, and that the important options of where markets develop can only be determined by states, regardless of whether they refer to the level of security of supplies, the production structure (how much nuclear energy, how much from renewables?), or the electricity supply to underprivileged populations".

Current perspectives

As regards the EU, forecasts for the evolution of the structure of demand for primary energy in the EU-25 are reflected in the first table below.

Liquid fuels maintain a similar ratio. Natural gas doubles in proportion, as do renewable energies. Nuclear energy experiences a major cutback, and the share of coal is almost halved.

	1990	2010	2030
Liquid fuels	38.5%	38.4%	34.8%
Solid fuels	27.6%	18.3%	15.0%
Natural gas	16.6%	28.5%	32.0%
Nuclear	12.6%	13.7%	9.4%
Renewables	4.5%	7.4%	8.6%

Source: (European Energy and Transport-Trends to 2020-update 2005).

	2000	2015	2030
Liquid fuels	6.1%	3.2%	2.2%
Solid fuels	30.1%	21.9%	27.6%
Natural gas	17.4%	29.7%	24.0%
Nuclear	31.7%	24.8%	18.7%
Renewables	14.0%	20.3%	27.6%

Source: (European Energy and Transport-Trends to 2020-update 2005).

As regards the generation of electricity, the expected trend is expressed in the second table.

Nuclear energy appears to be the main source for the generation of electricity, while coal outdoes renewable energies and natural gas. Coal will presumably replace nuclear capacities, in part, while renewable energies will almost be doubled.

From the perspective of the goals of energy policy, the

primary energy mix becomes more insecure given the increase of dependence on hydrocarbons, to the detriment of coal and nuclear energies, which are safer sources. The same occurs to the electric mix given the increase in natural gas and the reduction of solid fuels. Nuclear and renewable energies compensate each other.

As regards CO_2, the sole improvement consists in a partial replacement of solid fuels with natural gas. In truth, a European mix strategy that is more efficient regarding security, cost and climate change will consist of a reduction of the importance of natural gas, with its growing problems regarding security, and the maintenance of or increase in the quota of nuclear energy, as well as, if possible, renewable energies. This would also allow for an increase in the share of solid fuels, even if there is no carbon capture and storage.

The situation is even more delicate in Spain. According to the proposal of the 2006-2016 plan for the electricity and gas sectors (January 2008), published by the Spanish Ministry for Industry, Tourism and Trade, the trends would be as follows as regards primary energy (first table in this page), and the generation of electricity (second table in this page):

	2006	2016
Liquid fuels	48%	42%
Solid fuels	13%	8%
Natural gas	21%	25%
Nuclear	11%	9%
Renewables	7%	16%

Fuente: Spanish Ministry for Industry, Tourism and Trade.

	2000	2006	2016
Liquid fuel	9.9%	7.0%	1.8%
Solid fuels	35.9%	23.0%	12.8%
Natural gas	9.7%	29.9%	35.2%
Nuclear	27.6%	19.8%	15.4%
Renewables	16.9%	20.1%	34.9%

Fuente: Spanish Ministry for Industry, Tourism and Trade.

The figures speak for themselves, especially considering that 2016 is rapidly approaching and that it is difficult to act on forecasts for that date. The following conclusions can be deduced:

– It is desirable to meet forecasts regarding renewable energies.

– It is essential to limit the growth of the share of natural gas.

– It is essential to return the nuclear energy quota to previous levels in the generation of electricity.

– It is essential to sustain the share of solid fuels, which are more abundant and cheaper, particularly in view of possible developments in capture and storage methods.