Do renewable sources of energy exist? Can the energy transition be steered?

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References are often made to the “sector of renewables” when talking about the energy transition. This article focuses on the difficulty of defining this sector, given its heterogeneity, and on its institutional construction around a metaorganization, a trade group of renewables, in interaction with public authorities: the Syndicat des Énergies Renouvelables. Wittgenstein’s concept of “language game” is used to analyze this construction. The crisis of photovoltaics in France is reviewed to shed light on the difficulty of steering the energy transition.

Do renewable forms of energy exist? The question might seem odd. Year after year, more and more wind turbines are being built on land and in the sea; solar panels are being installed on roofs, or solar farms at ground level; and biogas units are generating electricity. The meaning of our question lies elsewhere. We often talk about renewable sources of energy as if they form a distinct category, and often refer to the “renewable energy sector” — whence the question: do “renewables” form a category such that we can talk about a “sector”?[1]

To answer this cognitive question about the construction of a category (ROSCH 1978), we shall draw on Wittgenstein (WITTGENSTEIN 2004, RACINE & MÜLLER 2008). This question reaches beyond its purely intellectual dimension. Let us assume that contemporary societies are undergoing an energy transition for switching from fossil fuels (coal and petroleum) and the atom — the very grounds of the upsurge of industry during the 19th and 20th centuries — to cleaner, less dangerous forms of energy (RAINEAU 2011, SOLOMON & KRISHNA 2011). Is it possible to steer this transition (LEACH 1992) if we cannot talk about a renewable energy sector?

We shall start by showing that renewables are hard to define, that this category is not homogeneous, and that this makes it hard to talk about a sector. Notwithstanding this, the second point of our argument is that nation-states (in particular France), by their determination to steer the energy transition, have brought this sector into existence through an organizational and political construction process. However the concept of a sector still causes problems and leads us (the third and last point in our argumentation) to inquire into whether it is actually possible to steer the energy transition.

On the nonexistence of the renewable energy sector

A review of the concept of renewable energy soon shows that the various forms of renewable energy do not form a category and that talking about a renewable energy sector is problematic. Our research examined the definitions provided, this sector’s history and geopolitics, and the factors underlying its heterogeneity.

The difficulty of an intensional definition

The traditional way to define a category is to make an intensional definition. Article 3 of the International Renewable Energy Agency’s (IRENA) statutes offers a definition: “the term “renewable energy” means all forms of energy produced from renewable sources and [in a] sustainable manner”.[2] However what is “renewable” is, in fact, a more complicated question than imagined at first sight, as we shall see. As for sustainability, it is a question that arose during the 17th and 18th centuries out of fears that forests would

[1] This article, including quotations from French sources, has been translated from French by Noal Mellott (Omaha Beach, France). The translation into English has, with the editor’s approval, completed a few bibliographical references.

[2] Statutes of 26 January 2009 available at https://www.global-regulation.com/translation/colombia/6405289/through-which-the-%2526quot%253bstatute-of-the-international-renewable-energy-agency-%2528irena%2529%2526quot%253b-approved%252c-done-in-bonn%252c-germany%252c-on-janua.html.

Methodology

This analysis of renewable energy does not posit this sector as a given fact but instead as an institutional fact constructed through strategic interactions between agents (SEARLE 1995). The objective of this "comprehensive research" (DUMEZ 2016) is to bring to light the process whereby this sector has been constructed as an institutional reality. To do so, we have looked for what characterizes this sector despite its diversity and concluded that seeing it as a single category is problematic.

Turning to the institution that brought this sector into existence in France — the Syndicat des Énergies Renouvelables (SER) — we have analyzed documents and met persons who were at this trade group's origin and have presided over it. We also met public actors, in particular at the Ministry of the Environmental Transition and Solidarity. To understand the social construction of this sector, its weaknesses and resilience, we focused on a critical case: the "arrangements" for supporting photovoltaics during the crisis at the end of the 1990s. This diverse information has been completed with secondary "cold" data from an analysis of the literature and of interviews. Interviews, used as a material to be "*interpreted*" (PIORE 2006), enabled us to test the interpretations constructed during research. This article contains excerpts from several interviews, including various presidents of SER.

eventually be depleted (BERKOWITZ & DUMEZ 2014). More demanding, Hansen and Percebois (2012: 68) have defined renewable energy as being "taken from natural movements [flows] and not from stocks that do not reconstitute themselves. Forms of renewable energy can, therefore, be constantly extracted from the environment, but this does not mean in unlimited quantities within any given period or time."

Another element comes into play. Global warming and greenhouse gases have boosted the development of renewables that emit less CO_2 than fossil fuels. According to the Observatoire des Énergies Renouvelables (Observ'ER), "renewables produce little or no wastes or pollution from emissions, take part in the fight against greenhouse gases and CO_2 in the atmosphere, facilitate a reasoned management of local resources, create jobs".[3] This definition focuses on two different points. First of all, renewables have (or can have) a local dimension: they feed into grids that are more local than those hooked to fossil fuels or nuclear energy. The second point: renewables have low emissions of CO_2. Greenpeace has introduced yet another factor: the catastrophic potential (related, in part, to this local aspect) is incomparably weaker in the case of renewables than of fossil fuels or the atom.[4]

Meanwhile, researchers and academics often skirt around the difficulty of providing a definition. A good example thereof comes from Sine and Lee (2009:126) who — but briefly in a footnote — state that "renewable energy is typically defined as energy that is not subject to depletion".

But then, as we shall now see, it is no simpler to make an extensional definition of renewable energy.

The sensitive question of an extensional definition

IRENA's aforementioned definition goes on to list renewables as "including, among others: 1. bioenergy; 2. geothermal energy; 3. hydropower; 4. marine energy, including energy from tidal and wave and ocean thermal energy; 5. solar energy; and 6. wind power".[2] In the United States, the Waxman-Markey bill of law (2009), which would have become the American Clean Energy and Security Act but was never voted, "defines: (1) 'renewable electricity' as electricity generated from a renewable energy resource or other qualifying energy resources; (2) 'renewable energy resource' as wind, solar, and geothermal energy, renewable biomass, biogas and biofuels derived exclusively from renewable biomass, qualified hydropower, and marine and hydrokinetic renewable energy; and (3) 'other qualifying energy resource' as landfill gas, wastewater treatment gas, coal mine methane used to generate electricity at or near the mine mouth, and qualified waste-to-energy." An EU directive contains a very similar list: "'energy from renewable sources' means energy from renewable nonfossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases."[5]

These lists are compatible with some intensional definitions but not others. If renewables are supposed to be environmentally friendly, then hydroelectricity poses a problem. Building dams destroys or deeply alters local ecosystems. Some pundits have concluded that this form of energy must be barred from the list even though it relies on water, which seems to be renewable. The use of wood and everything related

[3] http://www.energies-renouvelables.org/energies_renouvelables.asp

[4] https://www.greenpeace.fr/energies-renouvelables-france/

[5] Article 2 of the Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources (Document 32009L002).

to it has also come under discussion. Forests can be reconstituted if they are sustainably worked (not to extract more wood for energy purposes than what is replanted — conservation of the stock by acting on the rates of movements in and out). Accordingly, wood can be classified among renewables. But when burnt, it emits CO_2. So, the debate still goes on about whether wood is a renewable. A similar problem arises with methanation, which has both pros and cons in relation to the environment.

The biggest controversy centers on nuclear energy. With reference to the criterion of being "renewable", uranium does not fit in among the sources of renewable energy. From an inventory management approach to the stock and movements however, we can consider that nuclear power does not jeopardize the stock of uranium on the planet. Though not renewable (except in the case of the now abandoned plans for the Superphoenix power station), this stock is not at risk of depletion. But the question of placing nuclear power among renewables remains open if renewables are defined as forms of energy that produce very low CO_2 emissions compared with fossil fuels. Furthermore, if renewables are to create local jobs, this is an additional argument for placing nuclear power on the list. But if we see renewables as alternatives that reduce the risk of major industrial catastrophes, then the atom should obviously be kept off the list.

As we see, the lists used for an extensional definition vary widely depending on whether or not to include hydroelectricity, wood, methanation and especially nuclear power. We lack any perfectly clear criteria for deciding whether to include or exclude these forms of energy among renewables.

A complicated history

The history of oil as a source of energy gives us a very clear glimpse of what we call a "sector" (URRY 2013). In the mid-19th century, petroleum was produced as a substitute for whale oil in lamps. With the invention of private motor vehicles, the search was on for an alternative to coal, which could be used by locomotives but not automobiles. World War I imposed oil as the fuel for vehicles on land (apart from trains), ships (diesel fuel) and the first "aeroplanes". This history is scientific, technical, industrial and, too, political (MITCHELL 2011, CALLON 2013). Likewise, the history of electricity from its scientific discovery at the threshold between the 18th and 19th centuries till its use in industry at the doorstep of the 20th century clearly corresponds to the history of an industrial sector (HUGHES 1983).

In contrast, the chronology is fuzzy when we try to write a history of renewable energy. The long and short terms are entangled without any clear view of a consistent "sector". Renewable sources of energy have existed since humanity. Depending on the sources, their use is dated back to Ancient Times or even prehistory. "The first form of energy that people used was their own physical force. Homo Erectus in China is said to have learned how to control fire approximately 500,000 years ago. Homo Erectus used the biomass (mostly wood) to cook and heat […] When people made objects, they started combining these primitive forms of energy and, above all, had recourse to the energy of water and wind. […] Windmills appeared in Rome and China in the third century BP. They then spread throughout Europe and became, according to Braudel, the essential implement of the domainial economy. At the end of the 18th century, more than 500,000 water-mills were in use in Europe […]. Geothermal energy was also used before our era by the Romans for their baths and sometimes for heating homes. In 5000 BP, wind power was helping Egyptians sail on the Nile. However it was much later, toward the 7th century, that the first windmills appeared in Persia for gristmilling and pumping water. Toward 1000 CE, they were being used for irrigation in the Netherlands. […] Renewable sources provided the forms of energy used by our very ancient ancestors" (MEUNIER 2011:17-18).

Later on, these forms of energy were used to generate electricity: 1827, the first hydraulic turbine, invented by Benoist de Fourneyron; 1887, the first wind turbine, designed by Charles Francis Brush in the United States; and 1883, the first photovoltaic cell, made by Charles Fritts. These inventions sprung up in such different contexts that we can hardly talk about a "sector", not even one "in construction". This driving force in each case seems to set it apart from the others. At the time, fossil fuels (coal and oil) were not expensive, and the techniques for using them found a place in very narrow market niches.

Only after the oil shocks during the 1970s did the phrase "renewable energy" crop up. It was, in a way, a rediscovery according H. Durand (1982) who opposed the idea of "new energies". In a political context of activism, social groups attracted by the defense of the environment were advocating forms of energy turned toward demand instead of supply (the latter represented by the nuclear lobby), and demanding that the supply side be decentralized to make room for local initiatives (ÉVRARD 2014).

The complication of geopolitics

Definitions of renewable energy also vary because of geography and politics, the two sometimes related (but with no simple determinism). Solar, wind and hydroelectric power are quite clearly linked to geography. A land with neither rivers nor a coastline, without wind but very exposed to the sun, will have a single renewable source of energy: solar power (but with as possibilities: photovoltaics and thermal uses). For countries in the far north, solar power will not be a serious option. On the contrary, France — with its rivers, coasts, windy regions, zones with a high rate of solar irradiance, areas with livestock and with forests, and its overseas departments and territories that benefit from the trade winds and sun — has a wide range of options. Climate zones and nation-states make for a complicated geopolitical map of renewable energy, even within the European Union.

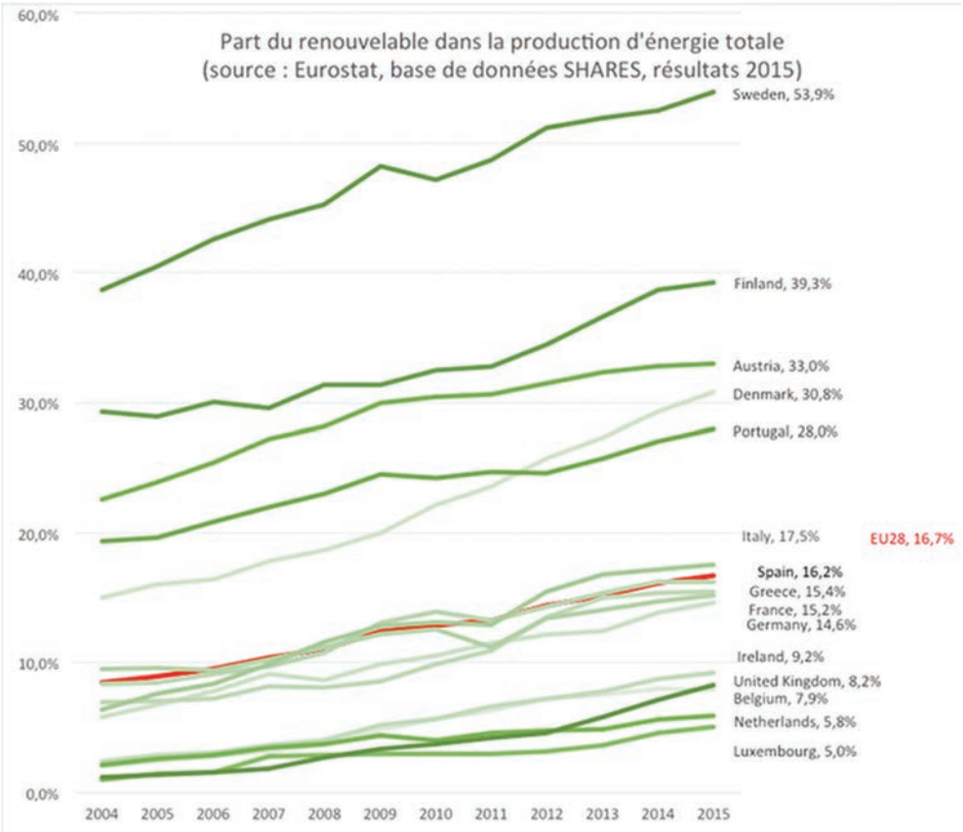

Figure 1: The share of renewables in total energy production
Source: Eurostat, SHARES database, results 2015.

As we see on Figure 1, geographical proximity (*e.g.*, Spain and Portugal) might correspond to substantially different rates of development for renewables, whereas distant geographical conditions (*e.g.*, Denmark and Portugal) might be linked to a development of renewables. This diversity of situations is, therefore, explained not by geography or technology but by differences in institutional trends and policies.

Factors favoring heterogeneity

If there is a renewable energy sector, it is highly heterogeneous. Solar power can be thermal or photovoltaic, each with its own technology and stakeholders. As much (perhaps a little less so) can be said about onshore and offshore wind power. Furthermore, the size of stakeholders varies widely, ranging from big global industries (EDF Renouvelable, Vestas) to small or medium-sized firms (engineering, consultancy and service firms, companies that install solar panels, etc.).

Furthermore, the problem of acceptance accentuates the heterogeneity of renewables. Acceptance has been a problem in particular for hydropower (in relation to biodiversity) and wind power (in relation to land- or seascapes). The first major study on acceptance focused on the market for wind power (CARLMAN 1982 & 1984). Among the factors that jeopardize the social acceptance of a project are: the lack of support by key stakeholders; the inability of political leaders to formulate coherent and therefore efficient policies; an underestimation of the sensitivity of public opinion to the impact on landscapes (WÜSTENHAGEN et al. 2007); and the absence of a shared vision of territorial (local) development (CANEL-DEPITRE 2017). This last point is to be related to the NIMBY effect (not in my backyard): the position adopted by persons who see something as positive for society but negative for themselves (BAUWENS 2015). In this respect, solar power is much better accepted than wind power. These differences in the level of acceptance add to the differences within the "category" of renewables.

Family resemblances

Wittgenstein has pointed out that, when dealing with a notion that encompasses a diverse empirical reality, we have, since Socrates, looked for the essence that the elements in a set have in common, a sort of hard core shared by all elements. When we see a pony, a draft horse, a pure breed and a zebra, we try to grasp the essence that makes these animals with different appearances, behaviors and living conditions a horse. But this essence often does not exist. Wittgenstein cited the example of games: there is no common core or essence shared by chess, crossword puzzles and dodgeball. Games do not share a common property, but they do have family resemblances that are not clearly defined (WITTGENSTEIN 1996:61, GINZBURG 2004). This holds, too, for renewables.

It is impossible to define renewable sources of energy by referring to a common feature, but families that share features can be detected: the family of renewables that does not use fossil fuels; the family that does not produce CO_2; the family that causes no major industrial risk; the forms of energy that do not reduce biodiversity; etc. Nevertheless, according to Wittgenstein, when we mention a concept, we usually, spontaneously think of a prototype. When thinking "bird", we see an animal that flies. When faced with an ostrich or a flying fish, the distinctness of the concept becomes problematic. In other words, the prototype that forces itself upon us when we mention a concept tends to skew our vision of things: "A main cause of philosophical diseases – a one-sided diet: one nourishes one's thinking with only one kind of example" (WITTGENSTEIN 2004:§593). For renewables, the prototypes are probably furnished by wind and solar power, but the category of renewable energy is much more open and heterogeneous than these two prototypes suggest.

To conclude from the foregoing, we have a hard time talking about a renewable energy "sector" given its wide heterogeneity and the fault lines running through it, in between the various forms of renewable energy. What exists are families of renewable energy, each of which shares overlapping likenesses. So, how can we talk about a "renewable energy sector"?

On the mobile existence of a renewable energy sector

After all, a sector has been constructed through a compromise between different language games, a compromise that might undergo a crisis, as happened in France in the case of photovoltaics.

The language games of renewable energy

In a study on the nature of the "defense market", Depeyre and Dumez (2008) have explained that such a market exists through "language games". This phrase, borrowed from Wittgenstein (2004), is built on three ideas:

- First of all, a language game is not simply a matter of language. It mixes discourses and actions, words and deeds, declarations and decisions. A language game consists of "*language and the actions into which it is woven*" (WITTGENSTEIN 2004:§7).
- Secondly, language games are always plural: "*And this multiplicity is not something fixed, given once for all; but new types of language, new language-games, as we may say, come into existence, and others become obsolete and get forgotten.*" (WITTGENSTEIN 2004:§23). As we shall see, a language game centered on financial investments arose with regard to renewable energy. By analyzing an empirical case (a market or sector), we can, therefore, shed light on the multiplicity of the language games being played and on their evolution.
- Thirdly, although language games normally enable players to talk together and interact in a fluent, coordinated way, they can, in critical situations, generate tensions. In situations with public interventions, as in energy policy — itself a policy subsystem in the sense of Baumgartner and Bryan (1991) — language games can shed light on the dynamics of the compromises and crises in this subsystem.

These three ideas seem to suffice for explaining the dynamic construction of renewables as a sector.

Our first task is to detect the language games. On 29 May 2000 at the second conference organized by the Syndicat des Énergies Renouvelables (SER), Prime Minister Lionel Jospin made a speech that launched a genuine energy policy: "*For the sake of economic efficiency, to reinforce our independence in energy matters, to contribute to protecting the environment and to fighting against greenhouse gases, and, too, to replace imported energy with local jobs, the government wants to make energy policy a national priority […] We must develop a full-fledged, renewable energy industry.*"[6] For SER, the Prime Minister's attendance at this conference marked a brilliant success.

Three language games can be detected in this excerpt: an energy policy on the scale of the country; the protection of the environment; and the defense of a "territorial" industrial policy involving the government and economic agents. Presumably, these three, though distinct, would converge in actual practice.

The first language game concerned French energy policy in general and electricity in particular. This policy was shaped by the decisions made in favor of nuclear power and drafted out of a concern for "energy independence". It resulted in the production of electricity at a low cost, provided a strong stimulus for the creation of local jobs (EDF's personnel at nuclear power stations and maintenance personnel), endowed the country with a recognized know-how and, in the context of global warming, emits very little CO_2. This policy was drawn up outside the market through a language game fostered by public authorities: by state officials and the public electricity utility (EDF) and with a key role assigned to an engineering corps (Corps des Mines) positioned at the junction of politics, science and industry. The major problem stemming from this choice has to do with the ageing of reactors and the related risks, as evidenced by catastrophes, those averted (such as Three Mile Island in 1979) and those, from which other countries have not been spared (Chernobyl in 1986 and Fukushima in 2011). AT issue for policy-making is the energy mix. The share of nuclear power should probably be decreased to make room for renewables, but how much room? Till the start of the century,

[6] Declaration on 29 May 2000 in Paris by Prime Minister Lionel Jospin on the government's policy for developing renewables, available via https://www.vie-publique.fr/discours/133216-declaration-de-m-lionel-jospin-premier-ministre-sur-la-politique-mene.

renewables had mainly been developed in France's overseas territories, where there was sunshine, heat and wind for solar and wind power, where it was impossible to imagine installing nuclear reactors and where other alternatives (gas, oil, coal) would be expensive and cause pollution.

The second language game was environmental advocacy. It rallied researchers, industrialists, NGO activists and consumers around the idea of developing alternatives to dangerous, polluting sources of energy (respectively, the atom and fossil fuels). In this language game, environmental issues are so important that they override economic considerations (earnings, profit-making). Accordingly, the government should subsidize these alternative forms of energy. The result would be an alternative energy model that, more economical and more "distributed", would break with a centralized, productivistic system (like nuclear energy) and move toward a "producer-consumer" approach. In 2000, Lionel Jospin asked Yves Cochet, a green MP, for a report on this idea of a producer-consumer (COCHET 2000).

The third language game was played around the development of industry and innovations. Public authorities wanted to boost sectors of the economy that created jobs and made innovations. What exemplified this game in Jospin's discourse is the idea of developing a "renewable energy industry" (the last word referring, in this context, to both a "sector" and an "industry") that would create local jobs while improving the balance of trade (as local jobs replaced energy imports).

The renewable energy sector constructed out of a compromise between language games

The renewable energy sector was constructed around a compromise between these three language games — a social construction (BERGER & LUCKMANN 1966, SEARLE 1995) around a set of arrangements borrowed from neighboring Germany (DEBOURDEAU 2011).

At the start of the 1990s, given the pressure exerted by the Green Party, Germany wanted to move faster to shut down its nuclear power stations, and it also had to find ways to stimulate the growth of the states that used to be part of East Germany. Though inspired by a tradition based on a liberalization of the economy, the policy conducted was not hostile to government support, if limited in time, for nascent industries. The law adopted represented a compromise between several language games. It came out of a joint and, in principle, bill of law introduced by a Green MP and a Liberal MP from Bavaria. The arrangements were thus set up that enabled all these language games to come into play together.

The traditional electricity companies were forced to buy electricity from renewable sources at a price guaranteed by the federal government. In addition however, two key arrangements were added to moderate this decision. First of all, the system was designed on a sliding scale. The law assumed that renewables would initially cost more to produce than traditional energy but that they should grow to become competitive and thus no longer need subsidies. The goal was to reach a level where production costs for traditional and renewable energy would be equal, what has been called "grid parity". The guaranteed prices were to last only during the period when renewables still had higher production costs. Secondly, these production costs have been monitored very closely, a report on them being released twice a year. The guaranteed price is adjusted to decreases in the production costs of renewables. This setup seems to be a success. Thanks to it, renewables have grown, and a new industrial sector has sprung up, in particular around photovoltaics. Other countries such as Austria and Spain decided to adopt this policy; and France too.

In France, guaranteed prices were introduced in 1999 with the obligation to purchase "green" electricity from privately installed photovoltaic panels. An act of February 2000 generalized this approach; and a decree then fixed the prices for various sorts of renewables. Discussions on these prices have been conducted by source of energy. They have been facilitated by the fact that a single person represents various companies and trade groups.

At the start of the 1990s, six small firms with their principal operations overseas founded a "meta-organization" (of which the members are themselves organizations: AHRNE & BRUNSSON 2008, BERKOWITZ & DUMEZ 2016). This Syndicat des Professionnels Français des Énergies Renouvelables (SIPROFER) became, in 1998, the Syndicat des Énergies Renouvelables (SER). The renewable energy sector would be shaped through negotiations between the government and SER, as if the creation of a renewable energy trade group had brought this sector into existence — as if this were more important than that this sector had created a trade group to represent it. In the words of one of SER's presidents; "This umbrella grouping of renewables had more goodwill while the renewables taken separately had less and might even be strongly rejected (wind power). I understood right away that renewables were the positive umbrella for this organization. I also thought that the fate of each of the branches would eventually separate but that there was a possibility for pooling resources and solidarity."

SER thus legitimated its existence and, consequently, the existence of a sector that it would represent during negotiations with the state. As for the government, it needed information and studies. The state could claim to steer the energy transition only if it had opposite it a creditable representative of a sector on whom it could (and had to) rely. According to a president of SER, "I would think, and still think, that lobbying by lobbying professionals must be grounded on solid, professional information. It's not public relations or brokerage. We went to meetings in the cabinets of ministries and public administrations with briefs that were in advance of the information they had. That was true even for talks with the

president's and prime minister's offices and with central administrations. It was fundamental." SER's deep work for gathering information was done prior to interactions with state authorities. As one of its presidents said, "Even the meetings of our board of administration were well prepared. They were not traditional board meetings. Briefs were thick. Real technical discussions took place." Among the examples cited of interactions with public authorities: "We drew on the German example, fixing the purchase price. I negotiated with those ideas in mind with the minister of Industry at the time. I had a single colleague, and he made a business plan to show the conditions for developing wind power. We had received a plan that was not at all suitable. By referring to the work we had done, I managed to convince the minister. That was possible only because we had a very accurate, well-argued brief of information (the costs of connections, etc.)."

Obviously SER has had to represent the sector in all its diversity. It is structured in committees, at the time: overseas departments and territories, hydroelectricity, marine energy, bioenergy, solar power and photovoltaics, thermal solar power, wind power, the energy produced from wastes, geothermal energy, renewables and the building trade, industry, household heating with wood. The category "renewable energy", which figures in the trade group's name, thus covers a range of diverse activities. Over time, the balance between these various activities has shifted. The companies that founded SER worked mostly in photovoltaics. Then, wind power stepped in. In the first decade of the 21st century, solar power experienced a surge that would be stymied in 2011, as we shall see. This sector is still very heterogeneous; and the balance in this umbrella organization shifts. These shifts can cause friction between language games. One president said, "As soon as it started working, there were centrifugal forces. Wind power, solar power from photovoltaic, solar power for water-heaters, everyone wanted their own shop."

A crisis

We have sen why language games are always multiple and why they often operate like a routine without problems. But they sometimes enter into a crisis…

During negotiations on guaranteed prices, the renewable energy sector existed despite tensions. Public authorities negotiated with it; and it, with them. In general SER's president chose to be accompanied by the president of the appropriate specialized committee to attend negotiations. This game involved engaging the sector's weight and legitimacy as a whole sector and taking account of the specificity of each source of renewable energy.

As announced by Jospin, the German setup for a guaranteed price with the obligation to purchase was adopted in France (DEBOURDEAU 2011). Unlike in Germany however, the two arrangements for moderating this decision were not adopted: the sliding scale and the biannual monitoring of production costs. As a consequence, the state had no view of what was happening in this sector, of how the players were behaving. Right away, the Regulatory Commission of Electricity (CRE) drew the attention of authorities to the risks stemming from the arrangements as adopted. It explained that the procedure for setting prices "did not allow for foreseeing or controlling the production capacities to ultimately be achieved, or, thereafter, the cost for the community and the market consequences".[7] In 2007 however, the Grenelle of the Environment, a meeting of officials and organizations for a wide-ranging discussion of environmental issues, confirmed that no thought was being given to a sliding scale.

Meanwhile, a major industrial trend had taken off, as countries in Asia, notedly China, began mass-producing solar panels. This had two effects. First of all, it seemed unrealistic to imagine developing a photovoltaic industry in France; and secondly, the cost of imported panels was dropping.

So, a fourth language game came into play, unexpectedly, centered on investments. Players, in particular EDF-Énergies Nouvelles, pointed to the scissors effect between the high guaranteed price and the decreasing cost of imported solar panels. For the installation of solar panels, private persons were being solicited, as well as big retail chains (the roofs of their stores offered large surfaces for such installations) and even, among others, the army (since it had land and buildings, no longer used barracks) and farmers (for their sheds). A SER president told us, "At the time of the bubble, there was a bunch of opportunists. An Alsatian farmer became famous for his plans. A lot of farm sheds in my region were covered with panels that were useless for running a farm."

The bubble soon swelled, what the CRE called an asset bubble. Articles were written about this (FINON 2009, FINON & PEREZ 2006), but the information took too long to reach public authorities. According to one of SER's presidents, "The price of solar panels made in China fell in a very short time. Everyone was caught off guard, including myself. The price had become too attractive. There was a major disequilibrium of information. That's a point I learned. The person who made the final decision was under pressure from the circumstances, and his administration did not necessarily have the information. Those closest [to sources of information] were firms, who could buy a Chinese panel at a third of the price of a German panel. Of course, they didn't say so. The trade organization received the information later, but it was not meant to go tell public authorities 'Bring the price down [for purchasing green electricity]'. When things go fast, windfalls occur."

[7] Opinion of the CRE (Commission de Régulation de l'Électricité) of 20 December 2001 on the executive order that set the conditions for purchasing the electricity generated by installations that used radiation from the sun, as cited in Article 2(3) of Decree n°2000-1196 of 6 December 2000 (*Journal Officiel de la République Française,* 62, 14 March 2002, p. 4683).

Once the government received the first information about this bubble, it declared in November 2008 that it was planning to reduce the purchase price of electricity from €0.55/k-Wh to €0.45. It repeated its intentions during 2009 but without taking any measures. These announcements had a deviant effect: economic agents, anticipating a lower price, filed even more demands for installing panels. The system was running so wild that an interministerial meeting on 2 December 2010 declared a moratorium. The decrees issued on 12 and 15 January 2011 provoked an uproar among farmers. According to trade groups, farmers who had counted on the income from solar panels would be filing for bankruptcy. A decree of 16 March 2010 contained measures for the agricultural sector.

This situation sparked a heated controversy that reveals the opposition between various language games. The government asked Jean-Michel Charpin (from the Inspection Générale des Finances) and Claude Trink (engineer from the Corps des Mines) for a report. This report, published in September 2010 (CHARPIN et al. 2010), concluded that, in a country where nuclear energy provides electricity at a low cost, the costs of guaranteeing a purchase price for renewables in general and for photovoltaics in particular were much too high and that, in the case of photovoltaics, the guaranteed purchase price had mainly boosted the industrialization of China while worsening the balance of trade. At the same time, EDF announced that it would hike (+4%) the price of electricity for consumers at the start of 2011 — an increase widely blamed on the policy in favor of photovoltaics. Yves Cochet criticized the Corps des Mines for being set on a centralized system of electricity and defending nuclear power. This mustering of miscellaneous forces from the industry and from associations active in defending the environment culminated in a demonstration on 8 March 2011 with the slogan “Don’t touch my solar panel”. At issue was a much more decentralized view of the production and consumption of electricity. The hesitant government was criticized for its inability to define a coherent policy since it wanted to keep nuclear power as the centerpiece in the whole system while also developing renewables.

From 2006 to 2010, solar panels were installed with a total production capacity of 1000 megawatts, an achievement that had seemed very unlikely at the start. Nonetheless, we cannot conclude that a solar/photovoltaic industry had developed, since this economic activity amounted to installing panels imported in huge quantities. The steerage of the energy transition was trapped between contradictory language games that could have, it had seemed, been made consistent but that ultimately played against each other. Some players had invited themselves into the game unwanted (financial speculators), others (innovative industries) remained on the outside even though their development had been proclaimed as an objective.

At last, the government changed procedures and opened projects to calls for tenders, a choice based on a completely different principle. The installation of a targeted capacity of electricity from renewables was set and made public (a given number of megawatts of wind or solar power); and bidders proposed a price in relation to the target. The lowest bid was chosen. The government was now planning the volume of projects in terms of capacity.

Conclusion: Can the energy transition be steered?

The energy transition calls for passing from fossil fuels and nuclear power to renewables. As this study has shown however, there is no actual renewable energy sector. Meanwhile, governments, especially in France, have tried to steer this transition. For this purpose, the French government tried to consolidate renewables into a sector. A representative of this sector (SER) emerged and was deemed legitimate. In other lands in Europe, the equivalent does not necessarily exist. Instead, there is a trade group of firms in wind power, another for photovoltaic, etc., this organization (or disorganization) reflecting the diversity of renewables. Despite this single representation in France of a sector, tensions and differences re-emerged and have sometimes created difficulties both in the regular relations between firms and public authorities and in transactional contacts, *i.e.*, the momentary interactions taking place around a problem (HILLMAN & HITT 1999), as happened during the solar panel bubble. Even in a stable sector, firms, supposed to “defend their interests”, do not always know exactly what their interests are and only discover what they are through interactions with state authorities (WOLL 2008, BASTIANUTTI 2009). In a field as diverse as renewables, this process has been even more complicated.

Another factor has also come into play in France. The state and firms are facing a transition with a clear starting point: a very centralized system (with nuclear power predominant) for generating and distributing electricity. However it is more complicated to set the end point, or define the process for reaching it since this transition must remain relatively open while converging, through the thick of quite different language games, toward a new equilibrium. Players reason within the existing framework (*i.e.*, a centralized system): the share of nuclear power and fossil fuels is to be lower, replaced with an increased share for renewables — but players do not know the amounts of these shares. Other stakeholders think that we are heading toward a radically different model, a decentralized one with the emergence of “producer-consumers”. According to this view, these new players will adapt their consumption the fluctuating production that characterizes renewable sources of energy (the variable intensity of the sun, wind, and currents in the sea or in rivers). Furthermore producer-consumers will be much more economical in energy matters and their decisions will push the economy to save energy. The state has hesitated between these two approaches. On the one hand, it seems, with the shift from a guaranteed purchase price to public bids, to be oriented toward a planned transition within a centralized system. It thus seeks to very gradually increase the share of renewables in the system as it is. On the other hand, by authorizing and even boosting the consumption of self-produced

electricity,[8] the state seems to support the shift toward another type of electricity system, toward a decentralized grid based on microgrids (LASSETER & PIAGI 2004).[9]

Typical of transitions is a clear enough vision of the equilibrium being left behind (the "dominant system") and an emphasis on the final, desired stated and its technological dimension — but with insufficient thought being given to the social processes and dynamics (VERBONG & GEELS 2010) reflected in the multiple language games (DEPEYRE & DUMEZ 2008), which should be identified. Steerage of a transition, if possible, must take account of these language games and tend toward compromises (always fragile and threatened) while realizing that periods of tension and divergence will inevitably occur.

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[8] Order n° 2016-1019 of 27 July 2016 on the "self-consumption" of electricity.

[9] In its "Microgrids" and "More Microgrids" projects, the European Commission's hall defined microgrids as "low-voltage distribution systems with distributed energy sources (such as microturbines, fuel cells, photovoltaic systems, etc.), storage devices (such as flywheels, supercapacitors and batteries) and controllable loads (loads that can be controlled while operating the grid in islands). Microgrids are connected to the grid but can also operate as islands in case of problems on the principal grid" (http://www.smartgrids-cre.fr/index.php?p=microgrids).

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