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Managing political market *agencements*: solar photovoltaic policy in France

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Abstract:

The development of renewable energy is one manifestation of current transformations in the organisation of European energy production and markets. To illuminate the changes triggered by renewable energy policy, the evolution of solar photovoltaic policy in France is analysed with a focus on its central instrument, feed-in tariffs (FITs). FITs for photovoltaics raised difficulties in many countries, but their effects were particularly dramatic in France. Market sociology and science and technology studies are employed to describe FITs as *agencements* organising the markets and politics of electricity production. FITs are considered as inherently unpredictable insofar as they encourage innovation and the emergence of new actors. The ways in which three successive *agencements* of FITs for photovoltaics framed the politics and economy of photovoltaics in France, and how they addressed unanticipated effects, are discussed. This is suggestive of transformations and tensions in the construction of French energy policy.

Keywords: photovoltaics; solar energy; feed-in tariffs; France; energy policy; *agencements*

Introduction

The organisation of energy production and markets in Europe is undergoing transformations under the combined effects of deregulation and concerns about climate change. The recent development of renewable energy, largely driven by EU policy, is emblematic of these changes. It has heavily relied on market-based instruments intended to encourage innovation and redirect investment towards ‘green’ technologies. One type of instrument in particular – feed-in tariffs (FITs) – has proven very effective in driving an increase in the production of electricity from renewable energy sources (RES-E), notably wind and solar photovoltaics.

The success of FITs in accelerating the deployment of renewable energy has often come with unanticipated effects that have not always been easy to address. They have been especially challenging in the case of photovoltaics. The extremely rapid evolution in photovoltaic technology costs over the past decade exacerbated the transformative potential of policy support, leading to reforms and sometimes crises in many European countries. FITs for photovoltaics have been unstable in most countries implementing them, such as Germany, Spain and France (Jacobs, 2012). Here, I retrace the history of French photovoltaic policy as an example of the co-production of renewable energy markets and politics. My analysis looks into the complex interactions between technologies, politics and market dynamics as they play out in the design and evolution of one policy. Through this lens, I explore some of the implications of relying on market devices to coordinate political action: what does this case tell of the potential political re-orderings at play in renewable energy policy, and to what extent are these re-orderings at odds with traditional ways of making energy policy?

The effects of FITs for photovoltaics in France were as dramatic as they were unanticipated. Though France was never a leader in grid-connected photovoltaics, FITs drove an impressive increase in installed photovoltaic capacity: from 69 MW in 2008, it reached 5,412 MW in October 2014 (CGDD, 2014b); the target for 2020 was achieved five years ahead of schedule. However, the objectives of French photovoltaic policy were not always clear, and its effects have been difficult to manage, making its evolution chaotic. In 2009, France had the most attractive photovoltaic support scheme worldwide; in early 2011, it had suspended FITs for photovoltaics altogether. FITs brought about a crisis that was as brutal and unexpected as the market expansion they had triggered. They clashed with the established economic and political organisation of electricity production in France.

My discussion relies on a qualitative analysis of French legislation and regulatory texts on FITs and photovoltaics between 2000 and 2013, supplemented by around 40 semi-structured interviews conducted between 2011 and 2013 (Table 1). Drawing from market sociology and science and technology studies (STS), I describe FITs for photovoltaics as sociotechnical *agencements*. The notion of *agencement* implies a focus on the way things, discourses and people are put together to produce differences, and on the difficulties in keeping them together. It enables me to address the dynamic character of FITs and their irreducible unpredictability as devices designed to trigger transformations and innovations. It also translates into a view of

successive versions of FITs as constitutive of an organisation of electricity production, its politics and its market.

Table 1. Interviews

Interviews are cited using the category of interviewee and a letter, e.g. Government A.

Category	Number of interviews
Photovoltaic sector [PV]	6
Administration, policymakers and regulatory bodies [Government]	6
NGOs	5
Utilities and grid operators [Utility]	4
R&D	3
Farmers	7
Others (banks, international organisations, legal consultants, etc.)	6

As a result, the history of FITs is also that of tensions and frictions at play as the economy and politics of electricity production in France gradually move away from the centralised, technocratic model orchestrated by the national electricity corporation Electricité de France (EDF) that has prevailed since the mid-twentieth century. Photovoltaic policy challenges this model because of its object – a relatively decentralised renewable energy – and because of its vector – an instrument that opens up electricity production to diverse investors.

In the first section, I consider what insight is gained by describing FITs as *agencements*. In the following three sections, I retrace the evolution of French PV policy since 2000 with a focus on how this policy has framed, or failed to frame, the emerging economy and politics of photovoltaics. Each section corresponds to a different *agencement* of FITs. In the last section, I discuss what this account tells of energy policies and politics, especially in France.

Feed-in tariffs as political market *agencements*

FITs have played a crucial part in the recent development of photovoltaics in Europe. Their basic logic is to enhance the financial viability of renewable energy installations by guaranteeing access to the electricity grid and market, and ensuring a stable return on investment. The conditions of purchase of RES-E, their level of remuneration, and the time for which it is applicable are determined by policy-makers, though methods for doing so vary. In short, FITs are policy instruments that organise the transaction of RES-E with a dual objective: scaling-up RES-E production, and accelerating innovation in renewable energy technologies.¹

¹ This logic was largely shaped by Germany. Germany introduced FITs in 1991 to favour the integration of RES-E, and revised them in 2000 with the explicit objective to accelerate the development of RES-E. Their success in this respect drove their adoption in other countries. The 2000 German FIT system scheduled regular assessments and revisions, leading to iterative learning and

FITs create conditions for change in energy systems via the establishment of markets. This characteristic suggests an inevitable share of unpredictability regarding their effects, and their evolution to adjust to these effects. This unpredictability has been particularly dramatic with photovoltaics, whose support has triggered exceptionally rapid market growth and cost reductions (Jacobs, 2012, p. 198) that translated into policy instability. Hoppmann *et al.* (2014, p. 2) have shown that the evolution of German FITs for photovoltaics has been ‘strongly driven by – often unforeseen – developments in the technological sphere’ induced by previous policies, following an iterative pattern that they describe as ‘compulsive policy-making’. They see FITs as characterised by a need for repeated adjustment, and stress the importance of considering the interactions between policies and the dynamics of the socio-technical systems in which they intervene.

In a similar approach, I am interested in the management of the unpredictability of FITs in France. Though FITs were introduced in France following the German model (Debourdeau, 2011), their evolution was specific in at least two respects. First, it did not follow a process of iterative learning, but rather went through successive and rather abrupt redesigns. Second – and this might explain this specific reform pattern – contrary to Germany (Jacobsson and Lauber 2006, Hoppmann *et al.*, 2014), there was no political consensus in France regarding the objectives for photovoltaics; in fact, the issue had hardly been discussed on a political level *before* the introduction of FITs. The political debate over photovoltaics took shape *at the same time as* photovoltaic technologies and markets, as an effect of FITs, making the three hard to disentangle.

To address the unpredictability and multiplicity of the effects of FITs, I describe FITs as socio-technical *agencements* (Barry, 2001, Callon 2004, 2008, 2013, Laurent, 2015). The notion of *agencement* was developed in STS to account for the fact that any action depends on the coordination of heterogeneous entities (objects, humans, institutions, discourses, theories). An *agencement* is a combination of elements ‘endowed with the capacity of acting in different ways’ precisely because they are put together (Caliskan and Callon, 2010, p. 9). The notion sees the source of action in the relations between heterogeneous (material and discursive, human and non-human) elements, each taking full part in the action, but none able to act alone (Callon, 2008). Another key characteristic of *agencements* is their dynamic nature: their coordination requires careful adjustments and is never definite, meaning that their effects and evolutions are not fully predictable (Callon, 2013). The concept is thus useful to study how things are put and kept together to produce specific effects.

The notion has mainly been used to describe the organisation of market transactions: ‘market *agencements*’ organise ‘the joint and progressive emergence of goods, of their sellers and of their purchasers’ (Callon, 2013, p. 367). Describing market *agencements* means describing how

refinement. The objectives for FITs in Germany have been relatively consensual across political parties, and their design is informed by consultations with industry representatives, which does not prevent conflict.

the framings that enable economic activities are performed, and in that the notion is an extension of Callon's analysis of economic activities in terms of framings and overflows. This line of research focuses on the calculations at the heart of economic activities; it defines framing as an operation that makes calculation possible by tracing a 'boundary between relationships and events which are internalized and included in a decision or, by contrast, externalized and excluded from it' (Callon, 1998, p. 15). Excluded parameters may turn out to be relevant, leading to 'overflows' (what economics call externalities) that challenge the frame and lead to its redefinition. By definition, overflows cannot be addressed within the frame, so taking them into account implies modifying it. Overflows are particularly salient with FITs, which are designed to trigger changes, not all of which can be anticipated and controlled.

We can describe FIT schemes as market *agencements* insofar as they combine economic theories, paperwork, institutional arrangements and technical specifications (e.g. grid-connection) to organise state-backed transactions of PV-generated electricity. They define a form of contract, determine what kind of electricity it applies to, who can sell (PV-system owners) and purchase it (utilities), and at what price (Cointe, 2014). But FITs are not just market *agencements*: they are also political instruments, both in their objectives and in their making. Through the shaping of investment in photovoltaics, they contribute to shaping the energy R&D, production and distribution system in terms of electricity mix, electricity prices, planning of investments, regulation, and actors involved. Further, FITs schemes organise the procedures through which FIT structures and levels are negotiated, thereby determining which actors, institutions and issues are considered legitimate participants in the electricity system.

I consider FITs for photovoltaics as *agencements* organising the economy as well as politics. As such, their overflows can be economic externalities and/or political problems (Barry, 2001), matters that cannot be addressed within either the market or the political organisation set by FIT schemes. The description of the successive configurations of FITs as political market *agencements* in France and of how their overflows were channelled thus sheds light on the joint construction of photovoltaic markets and politics.

The interest of this case is not limited to the documentation of photovoltaic policy. First, it extends the notion of *agencement* beyond the description of the economic dimension of market transactions. The analysis of this inextricably economic and political instrument contributes to a growing field that builds on Callon's work to study the intertwining of market-making and policy-making (Callon, 2009, Geiger *et al.*, 2014) – a crucial issue at a time when markets play a central part in the organisation of collective life. Second, the construction and reformulations of French photovoltaic policy – and the difficulties it raised – are revealing of evolutions in the way energy policy is construed in France, especially since the liberalisation of energy markets. As such, it can shed light on the changes in French technopolitical regimes (Hecht, 1998) in the energy field.

2000-2005: the emergence of photovoltaic policy amidst conflicting technopolitics of energy

The gradual introduction of FITs in France

It is difficult to understand the emergence of renewable energy in France without considering the organisation of the French energy system. In her history of the early years of the French nuclear industry, Hecht shows how the elaboration of the nuclear programme was a matter of ‘technopolitics’, that is ‘the strategic practice of designing or using technology to constitute, embody or enact political goals’ (Hecht, 1998, p. 15). Similarly, Yon (2014) describes the ordering of the economy produced by the methods devised by EDF’s engineer-economists to calculate electricity tariffs. What was at stake in the arrangement of the electricity system in the second half of the twentieth century was the future of French electricity, but also the definition of the national interest, the ordering of the economy and industry, and the relationship between technology and politics. It resulted in a centralised system, largely controlled by officials from the *Grands Corps de l’Etat*², and centred around a notion of public service defined as the production and provision of cheap electricity (Hecht, 1998, Evrard, 2010), which has persisted to a large extent. The renewable energy sector initially emerged on the margins of, and often in opposition to this system (Evrard, 2010).

In the context of liberalisation of energy markets in the European Union, the resistance of French institutions to renewable energy gradually softened. Debates on the introduction of renewable energy were organised in the 1990s (Brosse, 1992, Souviron, 1994). They were marked by conflict between the ADEME,³ in favour of tariff-based incentives inspired by Germany and Denmark, and EDF, who defended tenders as more likely to trigger cost reductions (Evrard, 2010).

These evolutions found their legal expression in the 2000 law on ‘modernising the electricity public service’ transposing the 1996 EU directive on the integration of the electricity market. As renewable energy moved up the EU agenda, the law framed support to RES-E as a way to contribute to climate and energy objectives, drawing the contours of a political market *agencement* for the development of RES-E. It instituted purchase obligations, *multi-year energy investment plans* (PPI),⁴ the Contribution to the Electricity Public Service (CSPE) and the Commission for the Regulation of Energy (CRE).

Purchase obligations requiring that EDF purchase the electricity generated by renewable energy installations connected to the grid became the main instrument to achieve renewable energy

² The *Grands Corps de l’Etat* constitute the highest ranks of the French civil service. They are recruited from top-rank engineering and administration schools (e.g. Polytechnique, Ecole des Mines, ENA) and occupy senior offices in ministries and public institutions.

³ The ADEME (Agency for Environment and Energy Management) is a public institution under the control of the Ministry for Ecology. It was created in 1991 by the merger between several environmental bodies. Its history, composition and missions made it an advocate of renewable energy.

⁴ In French, ‘Programmation Pluriannuelle des investissements’.

objectives as set in the PPI elaborated by the Ministry in charge of energy (either the Ministry of Economy and Industry or the Ministry of Ecology, depending on governments). They are accompanied with FITs to be determined for each renewable energy source so as to reflect the avoided cost of electricity generation and social and environmental benefits (Jacobs, 2012, p. 72). In practice, this is usually negotiated with utilities, the ADEME, and industry representatives. Incurred costs for utilities are compensated through the CSPE, a levy on electricity consumption paid by final users: FITs impact electricity bills. The government can suspend purchase obligations if they are no longer in line with the PPI, and use tenders instead (Loi n° 2000-108, article 10). The CRE oversees the system.

Purchase obligations were a novelty in France: they implied that ‘energy policy [was] determined by public authorities, taken care of by a private firm, and funded by taxes’ (Utility A). The law effectively organises the delegation of renewable energy development to economic actors (renewable energy producers, electricity suppliers, grid operators, and electricity users), but their activities are steered by the government, which defines the objectives that calibrate FITs and can revise or reinterpret them.

The 2002 FIT agencement: an ineffectual compromise

Still in 2000, Green Member of Parliament Yves Cochet released a report on ‘the strategy and means to put in place means to accelerate the valorisation of renewable energy in our country’, as commissioned by the Prime Minister (Cochet, 2000). Illustrative of the current reflection on RES-E policy in France, it surveyed existing renewable energy support schemes and European regulation. Drawing on economic theory, European Commission expertise and lessons from the German experience, Cochet advocated guaranteed tariffs as the only instruments ‘able to speed up the development of renewable energy and to enable them to reach industrial maturity’ (Cochet, 2000, p. 21, author’s translation). He stressed the importance of adjusting tariffs to the evolution of costs, and of controlling market growth with transparent mechanisms for indexation and revision.

It took two years for the government, EDF, the ADEME, NGOs and representatives of the renewable energy sector to negotiate FITs for photovoltaics. The outcome adopted in 2002 reflected the tensions between the incumbent energy regime and the alternatives embodied by FITs and RES-E. On the one hand, the design of the FIT was in line with Cochet’s recommendations and with the German model in addressing the potential overflows of the instruments. Tariffs would decrease by 5% each year, and both the size of eligible installations and the amount of electricity purchased from one installation were capped (MEFI, 2002). In theory, this would provide visibility for both investors and policy-makers.

On the other hand, tariffs were calculated according to a different logic. The ADEME and the PV sector advocated the German method (Evrard, 2010, p. 314, NGO A), based on a commitment to take external costs into account (Jacobsson and Lauber, 2006, p. 267). EDF wanted to keep tariffs based on the avoided costs of conventional power generation (Jacobs, 2012, p. 182; NGO A), in line with its price-setting practices and, more broadly, its ordering of

the electricity system and economy. EDF prevailed, and the tariff was set at 15.25 eurocents/kWh, which was disconnected from actual technology costs and too low to attract investment (the German tariff was then at 51 eurocents/kWh). Paradoxically, the FIT *agencement* could manage unpredictability, but not trigger it. From 2002 to 2006, installed capacity increased from 1 MW to 22 MW (Jacobs, 2012, p. 182): despite an impressive growth-rate, photovoltaics remained marginal as an electricity source.

While institutionalising RES-E development as a political objective, the 2002 FIT *agencement* ensured the preservation of the prevailing economic and political ordering of French electricity. Even for Cochet, the objective of PV support at the time then was not to increase PV electricity production, but to provide a niche to encourage innovation and R&D (Cochet, 2000, p. 118). This *agencement* thus combined the novelty of a market-centred, entrepreneurial approach to energy policy influenced by EU and German policy and embodied by FITs, with a tariff calculated by civil servants in consultation with selected stakeholders among which EDF's voice dominated. As its effects were modest, the *agencement* did not generate new issues. It was reformed in 2006, so there is no telling how it would have managed overflows.

2006-2010: a versatile *agencement*

The 2006 FIT agencement: a one-size-fits-all symbolic measure

In 2006, conservative Prime Minister Villepin announced a doubling of FITs for photovoltaics to 30 eurocents/kWh in mainland France (MEFI, 2006a). While ambitions for photovoltaics remained modest⁵, this resulted in an economic and political re-*agencement* of PV support. Politically, in contrast with the two-year-long negotiations of the previous *agencement*, it was a rapid top-down decision. Interviews suggest that it was made directly by the Prime Minister as a symbolic gesture (NGO A). Because the process was not transparent, accounts are scarce. Nevertheless, it seems that stakeholders were not formally consulted; the ADEME and CRE intervened after the announcement, more or less successfully.

The new FIT marked a shift from avoided costs to investment costs as the reference. A 30 eurocents/kWh tariff was still low compared to installation costs, but the ADEME obtained the creation of a 25 eurocents/kWh premium for building-integrated PV (BIPV), i.e. for photovoltaics inserted in the very structure of buildings, and not just set on roofs. Access to the premium only required a signed statement that the installation met BIPV requirements (MEFI, 2006a): for many installations, the *de facto* tariff was 55 eurocents/kWh, which was close to investment costs. However, this change in tariff-setting was not an alignment with the German model or the existing expertise on FITs. The reform abandoned the caps on size of installation and the yearly decrease designed to take into account the dynamic effects of FITs. Instead of decreasing, the tariff was indexed to inflation rates. It could also be secured long before project

⁵ The 2006 PPI planned for 160 MW installed capacity by 2010 and 500 MW by 2015 (MEFI, 2006b).

realisation, encouraging speculation on decreasing costs. The CRE criticised the reform, warning about its potential costs, but was not heeded (CRE, 2006).⁶

The 2006 FIT *agencement* showed very limited consideration of the implications of supporting photovoltaics on the part of the government. It was a one-size-fits-all, static incentive focused on the transaction of PV-generated electricity regardless of how it was produced. It took no consideration of the dynamic effects it would have on markets, on technology costs, or on the industry. Its objectives were neither debated nor clearly stated, and, apart from the vague BIPV premium, did not frame technological choices. It did not organise relationships with industry representatives and stakeholders. Since it was polyvalent and generous, it enabled any investor to develop any photovoltaic project (Utility A), with no way to control their number or type.

This recklessness has two origins. First, the scheme was initially supposed to be revised after two years (Jacobs, 2012, p. 129). Second, it was intended as a marginal policy that would not have significant effects on French electricity: the PPI for 2006-2010 stated that photovoltaic policy was targeted at overseas territories and would not affect the centralised grid (MEFI, 2006b). Nonetheless, these limits were not translated in the FIT *agencement*, which included no clause for revision and no quantitative, qualitative or geographical constraints for access to FITs. The 2006 FIT was an *agencement* without a clear perimeter or objective, and without resources for representing and monitoring its effects: it made the emergence of photovoltaics possible, but did not organise it. Its fate entirely depended on what governments and investors chose to do with it.

Because it was not attached to specific objectives, the FIT could serve changing political goals. Between 2007 and 2009, renewable energy moved up the agenda. Energy became part of the portfolio of the Ministry of Ecology in 2007 – an important shift, as energy policy had always been steered by the Ministry of Industry (Evrard, 2010, p. 149).⁷ Ambitions for the development of renewable energy rose following the *Grenelle de l'Environnement*⁸ and the adoption by the EU of binding objectives for RES-E development in Member States. In 2008, a target of 5,400 MW of installed photovoltaic capacity by 2020 was adopted (MEEDDAT, 2008, 2009). FITs were now expected to act as instruments of change.

They soon exceeded expectations (Figure 1). The situation after 2008 was paradoxical: there was a strong political push in favour of photovoltaics, but a clear lack of resources to steer the policy. As module costs dropped, FITs made photovoltaics an exceptionally attractive State-backed investment that was virtually open to anyone. The lack of statistical apparatus and

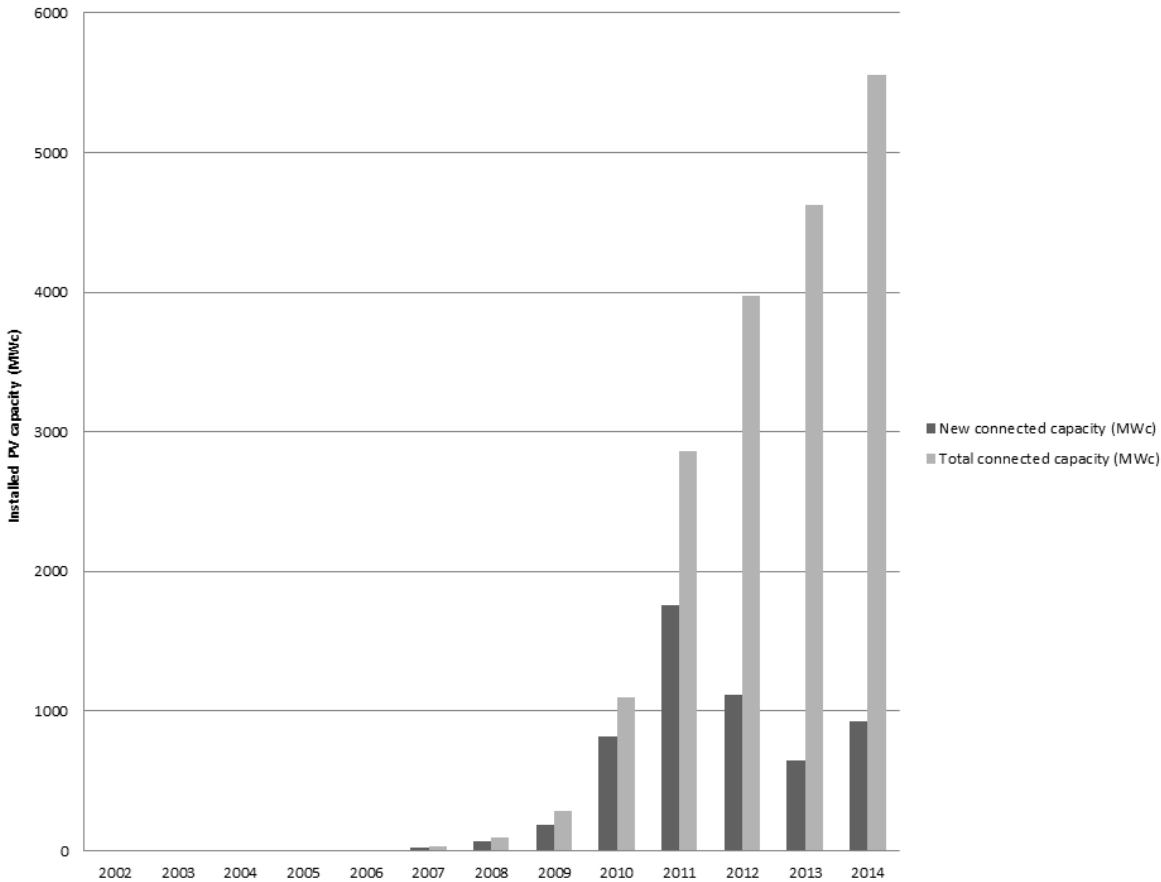
⁶ Instituted in the context of the liberalisation of energy markets, the CRE is in charge of ensuring fair competition in the energy sector, and tends to be wary of FITs.

⁷ Considering the organisation of French high-level administration in *Grands Corps d'Etat*, this was not just a symbolic change. Ministry of Industry officials mainly come from the *Corps des Mines*, in charge of nuclear and fossil industries, while those of the Ministry of Ecology are from the *Corps des Ponts, des Eaux et des Forêts*, in charge of infrastructural and environmental planning.

⁸ A consultation on environmental policy conducted in 2008, which resulted in legislation in 2009 and 2010.

human resources to keep track, of established representatives for the emerging sector, and of mechanisms to adjust FITs allowed for uncontrolled growth. By 2009, FITs for photovoltaics were higher in France than anywhere in the world. While they were displayed as proof of France’s commitment to renewable energy, they also made for easy profits.

Figure 1. Evolution of grid-connected photovoltaics capacity in France, 2002-2014. Given grid-connection delays, new installed capacity reflects projects that obtained purchase agreements two years earlier, hence the peak in 2012. Data: SOeS. <http://www.statistiques.developpement-durable.gouv.fr/energie-climat/s/energies-renouvelables.html> (retrieved 31/03/2015)



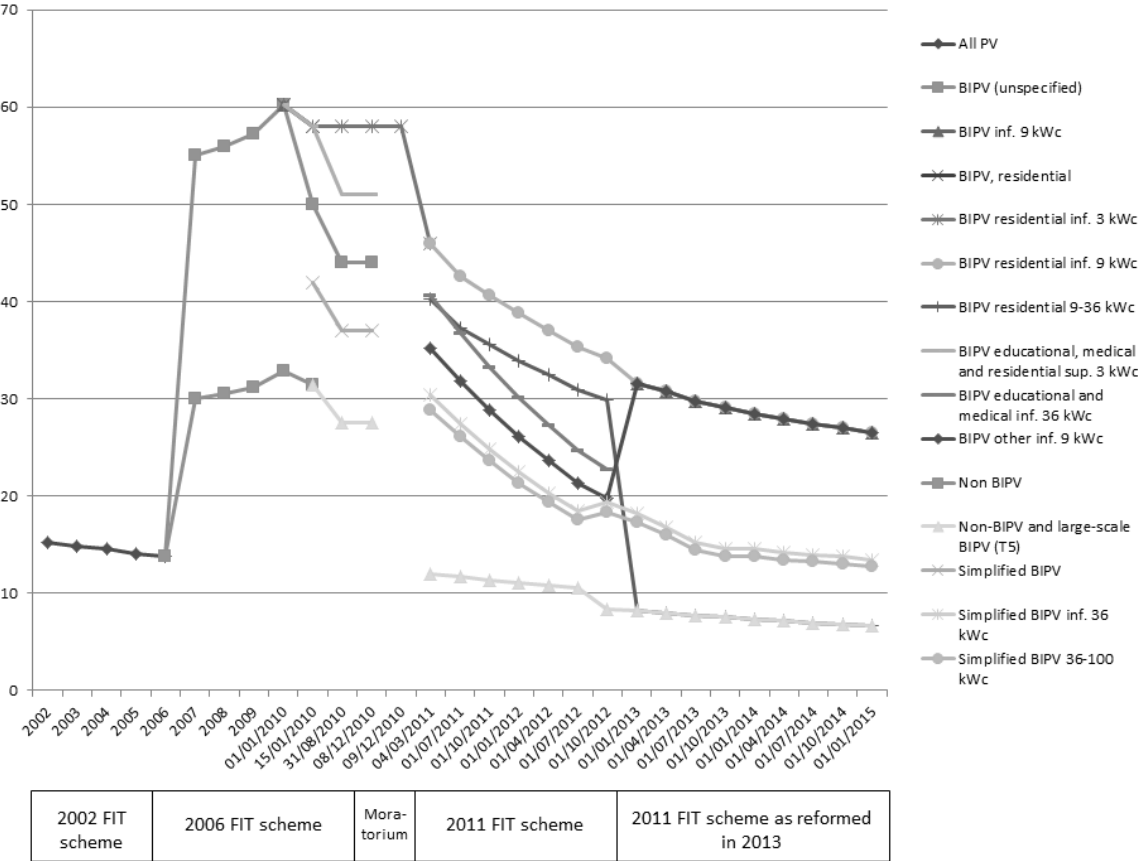
Ad hoc regulations and crisis

Concerns about policy costs, windfall profits and suspected speculation due to the gap between FITs and installation costs first arose in 2009 (Poignant, 2009, Government A, B, PV B). As the FIT *agencement* did not organise the evaluation and discussion of its framings and overflows, its unpredictability could only be addressed in an *ad hoc* manner. French photovoltaic policy after 2008 was characterised by instability, frequent reforms, and increasing complexity. Throughout 2010, policy-makers struggled to keep up with the speed of market development. FITs were reformed twice, in January and August 2010 (MEEDDM, 2010a,

2010c), and a dozen regulatory texts were released to enforce, adjust or amend photovoltaic policy on-the-go. Figure 2 shows the multiplication of FIT categories.

The first reform ended the one-size-fits-all tariff, and differentiated tariffs according to technical and geographical criteria (MEEDDM, 2010a). Tariffs were slashed, and delays in project realisation were reduced to limit windfall profits from the rapid decrease in installation costs. The second reform reduced tariffs again and reintroduced an annual decrease (MEEDDM, 2010c). Both were designed by a small team of civil servants in the Ministry of Ecology and Energy, with limited resources and a sense of urgency. Conducted in relative opacity, without formal consultations, they were thus prone to lobbying from stakeholders with leverage and access to policy-makers, such as agricultural unions or large utilities (Utility A, NGO B).

Figure 2. Evolution of FIT levels and categories for photovoltaics, 2002-2014.



The regulation of BIPV is emblematic of the makeshift manner in which overflows were dealt with in this *agencement*. Ministry officials identified BIPV as a source of problems, but also as a resource for re-orienting FITs. The unanticipated proliferation of photovoltaics was considered a political issue mainly because of the impact of FITs on the CSPE, and so on electricity bills. The bulk of this proliferation consisted in large BIPV projects that were hard to control and yielded incredibly high returns, often used to supplement farmers’ pensions or as financial vehicles, at the expense of electricity users (Debourdeau, 2011, Government A, B,

Other B). Redefining BIPV to restrict access to the highest FITs was one key objective of the administration. This was an attempt to make the material arrangement of photovoltaic installations a proxy for who and what a legitimate beneficiary of public support. This complex task, which involved considering the design of PV installations, the business models to be encouraged, the distributive impacts of FITs, and the very purpose of photovoltaic policy, was tentatively performed by the ministry in a top-down, technocratic way. A twelve-page ministerial circular listed technical requirements for BIPV (MEEDDM, 2010b), and an expert committee was created to assess eligible photovoltaic systems on a case-by-case basis. Both were *ad hoc* creations with no sound legal basis (Conseil d'Etat, 2012b).

None of this really worked. The *agencement* was a ministerial initiative whose legitimacy largely rested on its symbolic significance; while its impact had remained marginal, its generosity and flexibility could accommodate a diversity of interests without much need for political discussion. Now that it had disruptive effects, the legitimacy of top-down, *ad hoc* regulation crumbled. FITs were blamed for encouraging speculation, for subsidising Chinese industry, or for diverting money from more effective ways of reducing CO₂ emissions. They raised concern in Parliament and created tensions between the Ministry of Ecology and Energy, in charge of photovoltaic policy, and the Ministry of Economy and Industry. While the former remained a firm advocate of FITs, arguing that the exponential deployment of photovoltaics was precisely their aim (Assemblée Nationale, 2010), the latter was increasingly wary of their impact on electricity prices – a sensitive issue in France, where cheap electricity is considered a national asset. In November 2010, the government was reorganised: energy policy returned within the portfolio of the Ministry of Economy, Finance and Industry. Financial concerns took precedence over environmental ones, and, in December, a decree suspended access to FITs for photovoltaic projects, except for small-scale installations (MEEDDM, 2010d).

The tensions triggered by the rapid development of photovoltaics and its haphazard regulation culminated during the three-month consultation organised with stakeholders to renegotiate photovoltaic policy. The consultation staged the disorganization of photovoltaic politics by convoking concerned actors and interest in all their diversity; from an unusually untamed and conflictual assembly for French energy policy, no unified view emerged (Cointe, 2015).

2011 onwards: the institutionalisation of photovoltaic policy

The 2011 FIT agencement: an automatic containment device

Though the consultation was instrumental in mapping the consequences of photovoltaic policy, the government did not follow its recommendations (Cointe, 2015). In reaction to the crisis and to the disorganisation of the photovoltaic sector, the government re-arranged support so as to maximise control over photovoltaics and ensure they would not overflow their assigned space in French electricity.

This time, the perimeter and objectives of the new *agencement* were clearly defined. It had three aims: controlling the expansion of the photovoltaic market; containing political contestations

and negotiations; and promoting specific technologies that could benefit French industries. It was calibrated to support no more than 500 MW of new installed capacity each year, a cap deduced from the target of 5,400 MW by 2020 (Poniatowski, 201, NGO A, Government B, Utility B). Its legitimacy rested on calculation as the basis for resolving issues.

The *agencement* combined FITs and tenders. Small-scale BIPV installations were supported by a complex system of self-adjusting FITs detailed over six pages of text and three of tables and equations (MEDDTL, 2011). FITs were defined for several categories of photovoltaic installations with an automatic decrease clause, so that every trimester, their levels decreased in proportion with market evolution: the more projects submitted, the sharper the decrease. As one civil servant explained, the responsibility for dealing with the inherent unpredictability of FITs was entrusted to equations instead of consultations with the photovoltaic sector (Government A): the government deemed equations more trustworthy and fair than industry representatives. These equations, because they were not readily accessible to anyone who was not a trained engineer, effectively restricted access to FITs (Interviews NGO A, PV A; Poniatowski, 2010).

In a move to gain more control over the development and cost of large projects, the government organised two calls for tenders for ground-mounted, non BIPV and large-scale BIPV.⁹ One call targeted large-scale installations, with an objective to promote French industry, innovation and know-how (Government B). The other was a ‘simplified’ call for medium-sized photovoltaic installations that favoured lowest bidders – a compromise between the will to control the increase in installed capacity and the practical constraints of administering decentralised investments. Tenders also provided visibility of who developers were and what prices they claimed, information that even sector representatives did not have (PV A).

The 2011 *agencement* tightly framed photovoltaic development to make it as predictable as possible. As a consequence of the difficulty of the 2010-2011 consultation, the *agencement* disqualified sector representatives as reliable interlocutors, and delegated the responsibility for policy adjustment to equations devised by ministry officials. It also established a cap on the growth of photovoltaics and a hierarchy among types of installations, favouring small-scale BIPV and French innovation. This effectively reduced the spaces for market activity and for political expression.

Iterative adjustments

The clear frame and explicit objectives of the 2011 *agencement* put photovoltaic markets and politics back on track, in the sense that issues and overflows were henceforth addressed through institutional channels. This did not altogether suppress the need for direct political intervention. The new *agencement* was denounced by the photovoltaic sector as overly restrictive, and simultaneously criticised by public institutions for being costly and inefficient (Cour des Comptes, 2013, Dambrine *et al.*, 2012), but through institutional channels: lobbying from

⁹ In theory, they had access to a FIT, but it was deliberately set too low to guarantee profitability.

industry representatives who had organised after the consultation, meetings with officials, and public reports.

Despite its tight frame, the *agencement* managed to adapt to these various contestations, to the legacy of previous overflows and crises, to the still hard-to-track evolutions of photovoltaic markets, and even to the change in government following the 2012 national elections. These adaptations were incorporated in the *agencement* in 2012 and 2013 by amending two problematic features: the classification of photovoltaic installations, and the calibration of support to the needs of market actors.

In 2010, the classification of installations had become a crucial tool to manage the diversity of photovoltaics and to shape their role within the electricity system. The 2011 *agencement* was based on the *ad hoc* classification established in 2010, which was imperfect on both legal and practical grounds. In 2012, the *Conseil d'Etat* (France's highest administrative court) challenged this classification, declaring some of the distinctions introduced in January 2010 illegal (*Conseil d'Etat*, 2012a). Great uncertainty over tariffs ensued (PV A), until the *agencement* was revised to suppress problematic categories (MEDDE, 2013a). For very different reasons, the distinction between FIT-supported and tender-supported projects was also difficult to maintain. By late 2012, some developers dodged the tender procedure for ground-mounted projects and chose to rely on the very low FITs available for them, hedging their business plans on future cost decreases (Government D). This threatened the very logic of the *agencement*, since it undermined the categorization of PV installations on the basis of which support was determined. To prevent such overflows, the government drastically reduced the lowest FIT in 2013.

Another major issue was the viability of the market. The 2011 *agencement* was designed to contain the deployment of photovoltaics, not to sustain it. The 500 MW/year cap on new installations limited the market for photovoltaics on the basis of objectives that pre-dated its emergence, thereby locking it on a constant growth pathway. As initially intended, this materialised in drastic reductions in feed-in rates. Adding to the damage caused by the moratorium, this triggered a drop in activity, even for residential photovoltaics, which were still profitable (NGO A). This clearly appears in the decline in installed capacity in 2013 (Figure 1, CGDD, 2014a). The photovoltaic industry, now less suspected of greed, and advocates of renewable energy voiced their concern. The new government heeded them, and the *agencement* was re-adjusted in January 2013. Annual targets were doubled; the tariff grid was revised accordingly, and automatic decreases were limited to avoid smothering the market (MEDDE, 2013a, 2013b). Though it remains unclear to what extent the successive shocks of rapid expansion and brutal halt have been absorbed, 2015 showed a slight rebound in activity (CGDD, 2015).

The 2011 *agencement* is grounded in calculations by expert civil servants, and in that sense is in line with the traditional technocratic approach to energy policy in France. However, its evolution shows that it was eventually able to incorporate new actors (stakeholders in the deployment of photovoltaics) and new issues (related to categories of installations and to the

calibration of support) via direct governmental intervention. In a sense, it succeeded where the previous *agencement* had failed, namely in organising the politics of photovoltaics.

Future evolutions in photovoltaic policy will deserve attention. Following a National Debate on the Energy Transition, a law on Energy Transition for Green Growth was passed in 2015 (Loi n° 2015-992). It schedules the replacement of FIT by market premiums, in line with recent European Commission guidelines that promote a shift to tenders for larger RES-E installations, and systems based on premiums to market price (with exceptions for small installations) (European Commission, 2014). This upcoming *agencement* could be a novel combination in French energy policy: its legitimacy would be grounded in objectives defined collectively in a transparent process, and in the assessment of renewable energy policy instruments by the European Commission.

Discussion and conclusions

Here, I analysed how successive policies have organised the economy and politics of photovoltaics in France. My main focus was on the design and evolutions of FITs, seen not as mere policy instruments but as socio-technical *agencements* that shape the electricity production and distribution system, its markets, and its political organisation. In an approach similar to those of Hecht (1998) or Yon (2014), I described each FIT *agencement* as constitutive of a specific articulation of the French electricity system, its economy and its politics.

Given the marginal contribution of photovoltaics to French electricity production, I do not mean to say that FITs have thoroughly reconfigured energy production and politics. Nonetheless, they are emblematic of some recent evolutions, especially insofar as their logic is quite foreign to the prevailing French technopolitics of energy. FITs are inherently transformative devices; they are designed to trigger change by encouraging diverse and decentralised investments and entrepreneurial activity. Unanticipated effects are part of their normal functioning. The issue with FITs is not to plan the future energy system so much as to adjust to its policy-induced evolutions. Whereas in Germany, FITs have evolved along with the sociotechnical systems they transformed in an iterative manner, addressing unanticipated effects as they emerged (Hoppmann *et al.*, 2014), photovoltaic policy in France went through radical reforms, each organising the management of unpredictability in a different way.

In 2002, the first FIT *agencement* was shaped by tensions between the prevalent organisation of the energy system and alternative logics promoted by the EU (liberalisation) and by supporters of renewable energy. In its logic and basic design, the *agencement* was very close to the German FIT; it was designed to contain and absorb its own overflows in an iterative fashion. However, its final version remained embedded in EDF's practices of price calculation and in its ordering of the electricity system, of which it ensured the preservation: the level of FITs was based on avoided costs, not on investment costs, and photovoltaics were treated as niche products. In this *agencement*, unpredictability was never an issue, as it had little effect.

The reconfiguration of the *agencement* in 2006 was more ambiguous, insofar as the new *agencement* hardly assembled anything. The result of a rapid top-down decision, its purpose and perimeter were ill-defined. This translated in its rudimentary design. The 2006 *agencement* did not organise the evaluation and renegotiation of its framings and overflows: it was not associated with clear objectives, interests, stakeholders, or expertise, and made no provisions for re-adjustment. Given its flexibility, it could support changes in either markets or politics, but could not resist them in any way. This allowed it to live through evolutions in the organisation of renewable energy policy without being reconsidered, and to become a flagship for French environmental policy. By providing an extremely attractive incentive, it organised a protected market that was virtually open to anyone, without channels to consolidate information on its development or to negotiate its regulation. It was thus extremely unpredictable. This unpredictability was addressed by *ad hoc* renegotiations and attempts at re-framing, resulting in further political instability and eventually in the suspension of the *agencement* in late 2010. Interestingly, this *agencement* was only possible because photovoltaics were too marginal to be taken seriously in French energy politics and markets, but it made them a political and economic issue.

By contrast, the *agencement* devised in 2011 focused on the limitation and control of unpredictability. It was very tightly framed, and explicitly aimed to reduce and order both market expansion and political expression, as a result of concerns over policy costs and of suspicions that the photovoltaic sector had taken undue advantage of public aid. The responsibility for regulation was delegated to equations and to tendering procedures with well-defined criteria. In that sense, photovoltaic policy was channelled back into more traditional, institutionalised forms. Though the *agencement* had to be adjusted, it did not trigger crises or in-depth questioning, suggesting that it has been able to manage its own – limited – unpredictability. It can be read as an institutionalisation of photovoltaics in two senses. On the one hand, it clearly reduced the scope of market expansion and the potential for innovation, making photovoltaics more controllable and less subversive. On the other hand, it legitimated photovoltaics, and mechanisms such as FITs, as a minor, yet increasingly important part of the French energy system to which institutional, political, and economic resources are now devoted.

In this account, FIT *agencements* are not just market devices, but also organise the politics of the energy system, and in that sense their study contributes to reflections on the notion of *agencement* as a way to connect market sociology and studies of politics. Stating that FITs (or, indeed, any instrument of economic policy) are both political and market devices is nothing new, but approaching them as *agencements* that overflow sheds a new light on their hybrid character. It translates into an attention to how different configurations of FITs organise change in the technologies, politics and economy of energy, making it possible to see the (re)orderings of the energy system at play within the design and evolutions of a specific instrument.

French photovoltaic policy contrasts with past ways of shaping energy policy in France. FITs appear as emblematic of a shift from centralised, technocratic planning to a more diffuse organisation of energy politics largely coordinated by market devices that organise trade, competition, and innovation. Not everything about French photovoltaic policy breaks with

traditional French energy politics: the re-*agencement* of 2011 can be read as an attempt to turn FITs into another instrument for top-down, rational planning of energy production. However, the dramatic turnarounds and reconfigurations that occurred are suggestive of strong frictions between competing models for ordering the energy system. In France, such frictions stem partly from the EU-driven liberalisation of energy markets, and EU objectives and guidelines for renewable energy policy. FITs are a product of these two trends (Jacobs, 2012; Cointe, 2014), and it would be interesting to explore whether comparable frictions could account for difficulties with their introduction in other EU countries. Studies of renewable energy policies as *agencements* may then inform an analysis of the changing politics and economics of energy in Europe, and of the role of the EU therein.

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